Keep Them in the Game: Screening for Cardiovascular Disease and Diabetes in Aging Athletes

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Purpose: This observational cross-sectional study of aging athletes aims to (1) compare the prevalence of cardiovascular disease (CVD) and diabetes in aging athletes to the general population, (2) describe anthropometric values of aging athletes, (3) investigate the influence of cardiovascular sport competition on these measures, and (4) address any predictive value of evaluated measures. **Methods:** Health and sport history, blood pressure, waist circumference (WC), waist-to-hip ratio, and body mass index (BMI) were collected on 2351 aging athletes. **Results:** Aging athletes showed a significantly lower prevalence of CVD and diabetes than the general population. Athletes demonstrated BMI in the overweight range, WC in a healthy range, and waist-to-hip ratio in a healthy range for women but just over risk thresholds for men. Average blood pressure was near stage 1 hypertension. Waist circumference and waist-to-hip ratio were superior predictors of disease in the population. Cardiovascular athletes showed a lower disease risk and overall superior anthropometric values than other aging athletes. **Conclusion:** Aging athletes demonstrate a relatively low prevalence of CVD and diabetes despite demonstrating some anthropometric measurements over risk thresholds. Measures of central adiposity seem best for predicting disease in this population. **(Cardiopulm Phys Ther J. 2020;00:1–8)** *Key Words: geriatrics, health behaviors, physical activity, senior athlete, masters athlete*

INTRODUCTION AND PURPOSE

As the population of older adults continues to grow, concern regarding conditions more common with aging grows with it. A recent report from the American Heart Association[1] notes that in adults older than 65 years more than 60% live with a cardiovascular-related diagnosis and in those older than 80 years this percentage increases to more than 80%. A recent National Health and Nutrition Examination Survey survey[2] found type 2 diabetes mellitus (DM) prevalence in the United States was estimated at more than 26% in those older than 65 years. The increasing prevalence of these conditions adds to the growing health care burden of our aging population.

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Clinical tools used by physical therapists in the preliminary screening for these conditions include blood pressure and anthropometric measures associated with obesity, such as waist circumference (WC), waist-to-hip ratio (WHR), and body mass index (BMI). Debates regarding which of these is best for the prediction of disease in aging adults are ongoing, although trends have emerged. Blood pressure screening is universally recommended for adults as a means for identification of hypertension and ultimately, prevention of cardiovascular events.[3] Waist circumference has been shown to be effective in older adults when determining the risk for DM[2,4] and cardiovascular disease (CVD).[5] In older adults determined through WC to have abdominal obesity, the prevalence of DM is more than 66%.[2] Waist-to-hip ratio seems useful in determining the mortality risk in older adults[6,7] much of which is believed to be related to CVD.[8] Body mass index is a commonly used tool and has been linked to both CVD and DM.[9] This measure, while popular, does seems to have more limitations when attempting to predict CVD[6,10] or DM[4] than measures of central adiposity and seems less predictive in aged populations.[4,6,11,12]

Physical activity is consistently promoted as an effective tool for improving these measures and reducing the risk of CVD[13] and DM.[14,15] Unfortunately, older adults generally demonstrate low levels of physical activity and purposeful exercise.[16] The US Department of Health and Human Services recommends 150 to 300 minutes of moderate-intensity aerobic exercise per week in addition to muscle-strengthening activities on 2 or more days.[17] Physical activity guidelines for older adults also include multicomponent physical activity defined as an activity that includes more than 1 type of physical activity, such as aerobic, muscle strengthening, and balance training. Examples include "some dancing or sports."[17] Despite these recommendations, most older adults demonstrate consistently sedentary behavior.[18]

A large and growing subset of active older adults participate in competitive sporting events.[19-21] These include masters athletes with minimum ages ranging from 18 to 35 years,[22,23] National Senior Games athletes aged 50 and older,[24] and many who engage in various independent and community sporting events. The physical activity levels and exercise habits of this population are more in-line with the recommendations of public health organizations and may make them a meaningful subset for exploring the potential benefits of maintaining higher levels of physical activity with aging.

Despite the growing popularity of sport competition with aging, research on the physical health of older athletes is sparse and awareness of health risks present in this population remains largely unknown. Health risks present in aging athletes are often overlooked because of the assumption that this population is innately low risk. Shapero et al[25] surveyed masters athletes in the northeastern United States and found more than 20% to be dissatisfied with their medical providers because they perceived a lack of attention to their concerns secondary to their status as athletes.[25] Shapero's findings also revealed athlete perceptions that their medical providers lacked an understanding of health concerns related to aging athletes.[25] Yet, the same survey found that over half of these athletes demonstrated at least one risk factor for CVD.[25] Studies of aging marathon runners found greater amounts of coronary artery plaques in this population leading to unexpected risks for cardiovascular events.[26,27] Careful cardiovascular evaluation of aging athletes has concluded that this population is not free from risk and, in fact, may be unaware of their own cardiovascular risk status.[28]

The aforementioned issues reflect the lack of comprehensive knowledge regarding this growing population. Studies of anthropometric variables in aging athletes to date have primarily described the population norms without addressing optimal variables for risk assessment or disease prediction.[29,30] Studies investigating cardiovascular health have been limited by the inclusion of younger athletes,[28-30] populations outside of the United States,[28-30] and primarily survey data.[25,29] Investigations of physical risk measurements have focused on cardiovascular measures not typical in physical therapy practice, including laboratory work, electrocardiograms, and detailed cardiology examinations.[28]

Physical therapists are well suited to screen for a CVD or DM risk in the general population of aging athletes using tools within their scope of practice, although ideal protocols for this type of screening have not been established.[31,32] Blood pressure, BMI, WC, and WHR are all tools accessible to the physical therapist that could be used in screening protocols for aging athletes if optimal variables to establish a risk were known.

Blood pressure, WC, and WHR have predictive ability for CVD in the general population of aging adults,[4,6,7] whereas WC and BMI demonstrate predictive ability in younger elite athletes.[33] These optimal measures have not been established for the aging athlete. Understanding the utility of these simple screening measures in the aging athlete population may allow physical therapists and other health care providers to better assess and educate this unique population.

The purpose of this investigation was to (1) describe the prevalence of CVD and DM in aging athletes 50 years and older and compare this with the US general population, (2) describe anthropometric and blood pressure values of aging athletes in the context of the current World Health Organization (WHO) thresholds, (3) investigate the influence of participation in cardiovascular sports on these measures, and (4) address the predictive value of evaluated measures.

METHODS

Participants

This observational, cross-sectional research protocol was approved by the authors' local institutional review board (IRB). Aging athletes (N = 2351) ranging from 50 to 100 years of age signed a written, IRB-approved, informed consent form and participated as part of a larger fitness screen offered during the National Senior Games summer competition between 2011 and 2017. To participate in the study, the athletes were required to be aged 50 or older and registered to compete in a National Senior Games event during the time of testing. Registration in National Senior Games competition requires qualification by place or qualifying time at the state level. Participants were recruited in the National Senior Games Athlete Village with posted advertisements and verbal announcements.

Health and Sport History

Each participant was asked by inperson interview to self-report their cardiovascular health status by indicating either yes or no to conditions grouped as CVD. This included: coronary heart disease, history of a myocardial infarct, heart failure, stroke, and diagnosed hypertension. Participants answering yes to any of the listed conditions were categorized for this study as having CVD. Diabetes mellitus diagnosis was also collected by interview. Athletes unsure of any medical diagnosis were categorized as not having the condition. Athletes reporting hypertension diagnoses controlled with medication were still classified as having the condition. Athletes reported their registered sport(s) from the 20 available National Senior Games events found in Table 1. Sports were designated by the authors as either "cardiovascular" or "noncardiovascular" based on the potential for cardiovascular demand in each. Athletes then estimated the number of minutes spent on cardiovascular exercise and strength training in a typical week. Clarification on the difference between cardiovascular and strength training was provided during the interview. Athletes participating after 2013 were asked the number of days each week spent exercising. Only purposeful exercise, not general activity, was counted.

TABLE 1

Cardiovascular Events and Noncardiovascular Events of the National Senior Games

Cardiovascular Events[a]	Noncardiovascular Events
Badminton	Archery
Basketball	Bowling
Cycling	Field events only
Pickleball	Golf (with cart)
Racewalking	Horseshoes
Racquetball	Shuffleboard
Road race (5K and 10K)	Softball
Swimming	
Table Tennis	
Tennis	
Track	
Triathlon	
Volleyball	

[a]Events were divided into groups based on anticipated cardiovascular system demand.

Anthropometric and Blood Pressure Measurement

Body Mass Index. Body mass index was calculated using a metric formula ([weight (kg)/height (cm)/height (cm)] × 10,000). Height was taken in centimeters using a Seca portable manual stadiometer with shoes off. Weight was measured in kilograms using an EatSmart Precision Plus instant read digital scale. Obesity was defined as a BMI of 30 or greater.

Waist Circumference. Waist circumference was measured in centimeters using the narrowest aspect of the waist with an inelastic tape in a horizontal plane. When the participant presented with an obese or ambiguous waistline the level of the umbilicus was used for measurement reference. Thresholds from the WHO for CVD and DM were used. Abdominal obesity was classified as WC >102 cm (40″) for men and >88 cm (35″) for women.[34,35]

Waist-to-Hip Ratio. Waist-to-hip ratio was determined by first measuring participant hip circumference in centimeters. Participants stood with feet together and the tape measure circling the hips at the point of greatest excursion of the hips, including the buttocks. Waist-to-hip ratio was then calculated using the WC already recorded (WC/hip circumference). Thresholds established for WHR by the WHO[35] for the risk of metabolic conditions and commonly applied in health care for identifying abdominal obesity are ≥0.90 for men and ≥0.85 for women.

Blood Pressure. Blood pressure was measured using an automated Omron HEM-711 DLX Automatic Blood Pressure Monitor on the supported left upper extremity in a seated position. The first reading of blood pressure was recorded for data analysis.

Participants completed all testing on a voluntary basis and were allowed to omit any questions or tests at their discretion. Tests with incomplete or missing data were omitted from statistical analysis. Participants who completed parts but not all of the available testing were only analyzed on completed components. All measurement tools were calibrated annually as per manufacturer's recommendations with the exception of the scale that was calibrated daily during data collection.

Statistical Analyses

Analyses were performed with SAS 9.4 and SPSS version 24.0. Binomial approximation to the normal was used to compare the aging athlete prevalence of CVD and DM with age and sex-matched prevalence data available from the American Heart Association[1] and the Centers for Disease Control and Prevention.[36] Two of the comparative groups from the general population were slightly younger than the senior athlete population and could not be modified. Thus, for comparison purposes the youngest age group for CVD comparisons included those aged 40 to 59 years from the general population while the aging athlete youngest comparative group was 50 to 59 years. Similarly, in the DM prevalence data the youngest general population for comparison included those aged 45 to 65 years while the aging athlete population included only those 50 to 65 years. All other age group comparisons were equal in range.

Descriptive statistics for both male and female athletes with regard to age, blood pressure, anthropometric measures, and exercise habits were performed.

Relative risk (RR) ratio and analysis of variance were used to compare disease prevalence and results of all measures on participants competing in cardiovascular events with those in noncardiovascular events.

variables.

RESULTS

Participants included 2351 aging athletes; 1394 women and 957 men with a combined average age of 68.08 (SD 9.26) years.

Comparisons of aging athlete CVD prevalence with that published for the general population by the American Heart Association[1] are presented in Figure 1. Within every age group and for both sexes, aging athlete CVD prevalence was substantially and significantly lower than that reported for the general population of older adults ($P < .0001$). Among male age groups, aging athletes demonstrated a 34% to 38% lower prevalence of CVD. Female aging athletes exhibited even larger differences with a 41% to 57% lower prevalence in CVD as compared to the general population. In comparisons of DM, an aging athlete CVD prevalence was 73% to 77% lower than the 2015 Centers for Disease Control and Prevention report for the general population with statistically significant differences within each age group ($P < .0001$) (Fig. 2).

Table 2 displays average age, blood pressure, WC, WHR, BMI, estimated minutes per day spent exercising, and the number of days each week athletes reported engaging in purposeful exercise. On average, aging athletes of both sexes reported spending more than 5 hours each week performing cardiovascular exercise, more than an hour each week on strength training, and overall, reported engagement in purposeful exercise more than 4 days each week. Average systolic blood pressure placed both male and female aging athlete averages in the category of stage 1 hypertension (130–139). Average BMI of both male and female aging athletes was in the overweight range (>25) with 14% of athletes falling into the obese (≥30) category. Waist circumference measures averaged below common risk thresholds of ≥102 or 88 cm, although 27% of athletes were classified as "at risk" on this measure. Average WHR for male aging athletes was 0.91. That is slightly more than the recommended 0.90 threshold, whereas female WHR averaged 0.82, well below the 0.85 threshold for a risk. Collectively, 40% of athletes were classified as "at risk" by WHR, although when divided by sex, 56% of male athletes and 29% of female athletes were classified as "at risk." See Figure 3 for classification percentages for each measure by sex.

Aging athletes participating in sports designated as cardiovascular had significantly lower numbers on all anthropometric measurements ($P < .0001$) but not on measures of blood pressure (Table 3). Relative risk calculations demonstrated a significantly lower risk for athletes in cardiovascular sports for both CVD {RR = 0.69 (95% CI [0.61–0.78])} and DM {RR = 0.35 (95% CI [0.24–0.51])}.

Table 4 displays ROC analysis and area under the curve (AUC) for each variable of interest by sex. Overall, all variables were significantly predictive for CVD except diastolic blood pressure (DBP) in men. For DM, all measures were significantly predictive except systolic blood pressure (SBP) in women and DBP in both sexes. Although most variables demonstrated statistical significance in their predictive ability, those that were most predictive for CVD included WC in men (AUC = 0.65, $P < .0001$) and SBP in women (AUC = 0.65, $P < .0001$). For DM, WHR was the greatest predictor in both men (AUC = 0.70, $P < .0001$) and women (AUC = 0.70, $P < .0001$).

DISCUSSION

Investigation into the prevalence of CVD and DM in aging athletes, as compared to the prevalence reported for

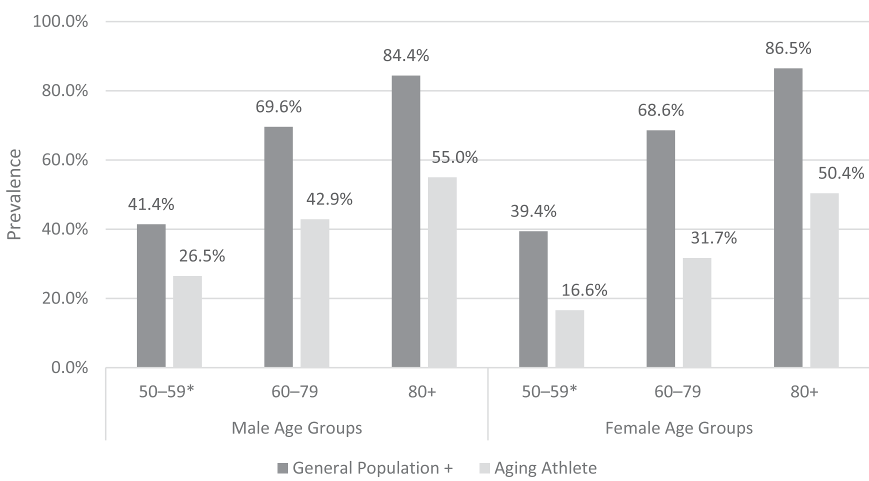

Fig. 1. Comparison of aging athlete cardiovascular disease prevalence with community prevalence using binomial approximation to the normal. A significantly lower prevalence for aging athletes were seen in both sexes and across all age groups compared with community prevalence, $P < .0001$. +Comparative data are from "Heart Disease and Stroke Statistics—2017 Update: A Report From the American Heart Association" Benjamin et al., 2017. *Community prevalence data include adults 40 to 59 years in the 50 to 59 years age category.

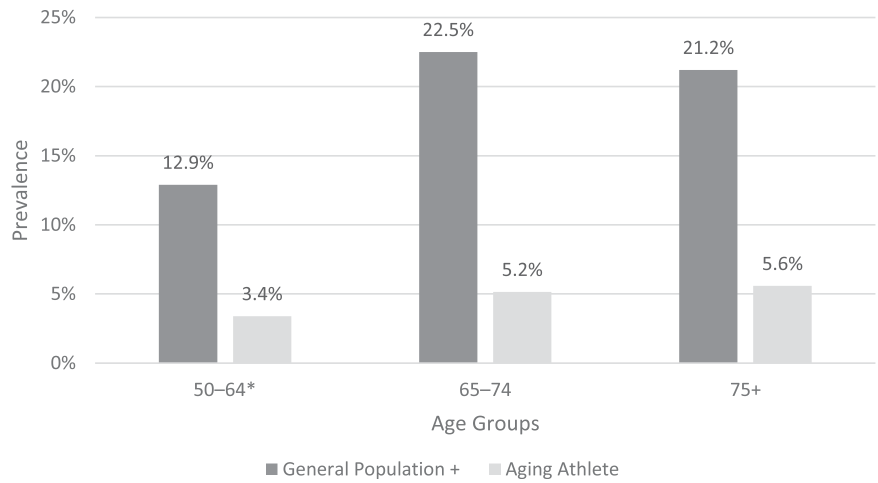

Fig. 2. Comparison of aging athlete prevalence of diabetes with community prevalence using binomial approximation to the normal. For each age group, aging athletes had a significantly lower prevalence of diabetes, $P < .0001$. +Community prevalence data from the Centers for Disease Control and Prevention (2015). *Community prevalence data include adults 45 to 64 years in the age category.

the general population, demonstrates substantially and significantly lower rates across each age and sex group. Cardiovascular disease and DM still demonstrate an increased prevalence with advancing age in these athletes that should be noted; however, neither reaches the prevalence found in the general population. Most impressively, in this population of older adults, the prevalence of DM, even in the oldest aging athletes, never reached 6%. These findings, in stark contrast to aging trends seen in the general population, speak to a large untapped opportunity for healthy aging in our society.

When considering those aging athletes who compete in cardiovascular sports, we found a 69.2% lower risk for CVD and a 34.7% lower risk for DM than those who

TABLE 2

Aging Athlete Blood Pressure, Anthropometrics, and Exercise Trend by Sex

Variable	N	Minimum	Maximum	Mean	SD
Male					
Age	957	51	100	69.80	9.32
SBP	934	83	203	137.82	18.39
DBP	934	44	123	78.81	10.34
BMI	946	16.78	47.06	26.64	3.70
WC, cm	946	63	133.5	94.52	10.94
WHR	945	0.71	1.10	0.91	0.07
Cardiovascular, mins	955	0	2500	340.81	275.68
Strength, mins	954	0	2520	69.62	129.96
Days per week	563	0	7	4.65	1.79
Female					
Age	1394	50	98	66.90	9.04
SBP	1373	78	217	131.36	19.12
DBP	1373	6	110	76.55	10.43
BMI	1369	15.41	51.20	25.53	4.34
WC, cm	1372	57	154	83.47	11.99
WHR	1372	0.62	1.08	0.81	.07
Cardiovascular, mins	1388	0	2100	330.41	249.42
Strength, mins	1388	0	3600	61.59	123.93
Days per week	864	0	7	4.65	1.72

BMI, body mass index; Cardiovascular, cardiovascular exercise minutes per week; Days per Week, days per week of purposeful exercise; DBP, diastolic blood pressure; SPB, systolic blood pressure; Strength, strength exercise minutes per week; WC, waist circumference; WHR, waist-to-hip ratio.

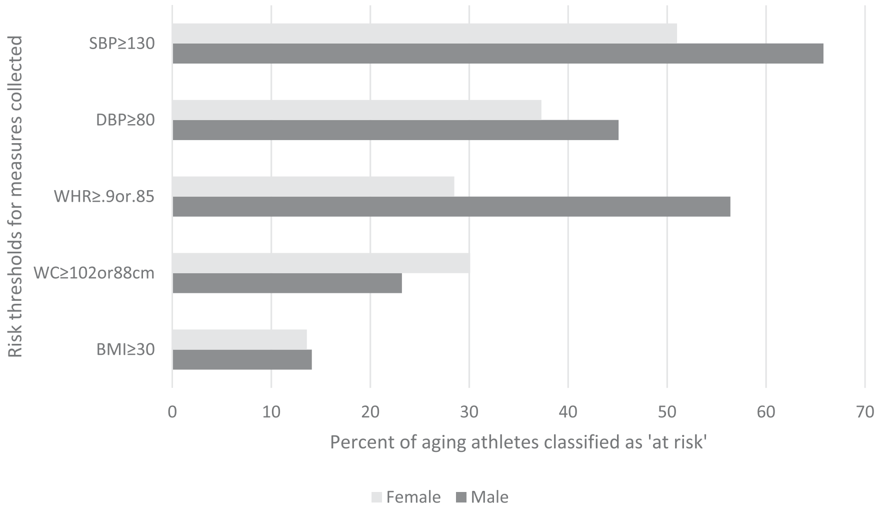

Fig. 3. Percent of aging athletes classified as obese or "at risk" by sex and standard thresholds. SBP ≥130, systolic blood pressure greater than or equal to 130 mm Hg; DBP ≥80, diastolic blood pressure greater than or equal to 80 mm Hg; WC ≥102 or 88 cm, waist circumference greater than or equal to 102 cm in males or 88 cm in females; WHR ≥0.9 or 0.85, waist-to-hip ratio greater than or equal to 0.90 in males or 0.85 in females; BMI ≥ 30, body mass index greater than or equal to 30.

participate in less demanding events, such as shuffleboard and horseshoes. In line with these findings we also found cardiovascular athletes to have significantly better anthropometric measures. These findings suggest, but cannot prove, an added benefit of activities that significantly stress the cardiovascular system. Because these athletes may have demonstrated a lower risk before engaging in cardiovascular sport competition, these findings are of association alone and cannot be considered causative.

The anthropometric and blood pressure findings for this cohort are most comparable with those of Climstein et al[29] who reported survey data for a younger group of masters athletes in Australia. Findings from Climstein's[29] study demonstrate a mean age approximately 13 to 15 years younger with slightly superior anthropometric and blood pressure findings in each category when compared with those reported in this investigation. These differences are likely attributable to age differences, although a difference in geographic location cannot be discounted. Climstein did not identify an optimal measurement variable, did not assess WHR, and did not investigate disease prevalence in his participants.

A study by Morrison et al[28] of nearly 800 masters athletes in Canada reported an overall prevalence of CVD at 11.4% and a prevalence of DM at 1%.[28] Similarly, Shapero's study of masters athletes in the Northeastern United States. reported a CVD prevalence of 9.1%.[25] These numbers, much lower than our findings, may partially represent the younger populations studied. Average participant ages for these respective prevalence studies

TABLE 3

Analysis of Variance Comparing Anthropometric Measures and Blood Pressure in Cardiovascular With Noncardiovascular Athletes

	Cardiovascular Athletes, Mean (SD)	Noncardiovascular Athletes, Mean (SD)	F	*P*
Male	N = 771	N = 174		
WC, cm	92.93 (10.30)	101.62 (10.9)	97.69	<.0001
WHR, cm	0.91 (.06)	0.94 (.06)	41.15	<.0001
BMI	26.08 (3.28)	29.16 (4.37)	109.58	<.0001
SBP	137.25 (18.77)	140.14 (16.44)	3.45	.06
DBP	78.56 (10.33)	79.54 (9.81)	1.26	.26
Female	N = 1179	N = 189		
WC, cm	82.44 (11.33)	89.86 (14.03)	65.04	<.0001
WHR, cm	0.81 (.07)	0.84 (.07)	37.86	<.0001
BMI	25.15 (4.06)	28.84 (5.24)	65.11	<.0001
SBP	130.93 (19.34)	133.78 (17.01)	3.62	.06
DBP	76.39 (10.56)	77.59 (9.61)	2.13	.14

BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure; WC, waist circumference; WHR, waist-to-hip ratio.
See Table 1 for cardiovascular and noncardiovascular events.

TABLE 4
Predictive Values of Variables Tested

	CVD			DM		
	AUC	*P*	95% CI	AUC	*P*	95% CI
Male						
SBP	0.59	<.0001	0.55–0.62	0.59	.04	0.51–0.67
DBP	0.51	.72	0.47–0.57	0.48	.68	0.39–0.57
BMI	0.63	<.0001	0.59–0.66	0.67	<.0001	0.59–0.75
WC, cm	0.65	<.0001	0.61–0.68	0.70	<.0001	0.62–0.77
WHR	0.63	<.0001	0.59–0.67	0.70	<.0001	0.63–0.76
Female						
SBP	0.65	<.0001	0.62–0.68	0.55	.23	0.47–0.63
DBP	0.59	<.0001	0.56–0.62	0.51	.42	0.42–0.61
BMI	0.58	<.0001	0.55–0.62	0.64	<.0001	0.56–0.73
WC, cm	0.60	<.0001	0.57–0.63	0.69	<.0001	0.61–0.77
WHR	0.60	<.0001	0.57–0.64	0.70	<.0001	0.63–0.78

AUC, area under the curve; BMI, body mass index; CI, confidence interval, CVD, cardiovascular disease; DBP, diastolic blood pressure; DM, diabetes mellitus; SBP, systolic blood pressure; WC, waist circumference; WHR, waist-to-hip ratio.

were 14[28] to 18[25] years younger than our studied cohort. This difference reflects the minimum qualifying age of 35 years for masters athletes as compared to the 50 years age minimum for National Senior Games athletes. Furthermore, our definition of CVD aligns with the American Heart Association[1] definition (coronary heart disease, myocardial infarction, heart failure, stroke, and hypertension) for ease of US prevalence comparisons. The Morrison study used cardiologist examination and diagnosis[28] alone, whereas Shapero[29] included only arrhythmia, atherosclerosis, valvular disease, pericarditis, and atrial septal defects. These discrepancies likely inflate our prevalence for purposes of comparison. Despite these differences, our comparisons with the US general population remain significant and may more accurately reflect a population aged 50 and older.

When seeking the best physical assessment measures for use in predicting CVD and DM in this population, our findings were clear that measures of central adiposity (WC and WHR) were superior to BMI. Waist-to-hip ratio emerged as the best predictor of DM in both men and women. Isolating a CVD risk was more ambiguous with SBP predicting CVD for female aging athletes but not for men. However, measures of central adiposity for both conditions seem more valid for men and women than BMI or blood pressure. These findings align with current recommendations for the general population of older adults as a recent report identified central adiposity as a measure superior to BMI for identifying the risk of mortality and heart disease in those aged 60 to 69 years.[6]

Limitations to this study include the observational nature of the design. Aging athletes voluntarily presented themselves to be tested that may have skewed the cross-section of participants to those who were most healthy. Furthermore, individuals with CVD and DM may be less likely to engage in sport competition and thus create potential underrepresentation in the population studied. However, the magnitude of difference seen with this population, the large population tested, and the high volume of purposeful exercise reported suggests that sport participation and even choice of sport may play a role in the health of these aging athletes. Health history data were self-reported and may have neglected athletes with a diagnosis of CVD or DM who were unaware or wished to keep this information private. Because the comparative population included some individuals who were younger than the aging athlete population, the differences between the 2 may actually be greater than that presented in this analysis. Methods chosen for measurement of central adiposity varied slightly from the WHO. However, investigation into measurement protocols for WC assures researchers that these differences in the protocol create no significant influence on results.[37]

Exercise is a known mechanism for preventing and even treating cardiovascular and metabolic conditions.[38,39] Observation of the extreme difference in disease prevalence between this active population and the general population should inspire both health care providers and aging adults to engage in a similarly active lifestyle.

CONCLUSION

Overall, these aging athletes who actively engage in sport competition demonstrate a significantly lower prevalence of CVD and DM. Yet, this population is not exempt from disease. Measures of central adiposity, particularly WHR, seem to be effective when screening for a risk in this population. When considering the exponential growth of the aging population and the costs incurred due to chronic disease states, physical therapists should consider application of central adiposity screening for aging athletes as a tool for early detection and disease prevention. These findings should encourage medical providers to motivate all patients toward better health through increased exercise and even engagement in competitive sport.

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