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The Impact of Previous Athletic Experience on Current Physical Fitness in Former Collegiate Athletes and Noncollegiate Athletes

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Background: Physical activity performed at moderate intensity is associated with reduced risk of mortality, cardiovascular disease, hypertension, and some types of cancers. However, vigorous physical activity during participation in college athletics may increase the risk of injury, which might limit future physical activity levels.

Purpose: To evaluate differences in current physical fitness levels between former Division I athletes and noncollegiate athletes.

Study Design: Cross-sectional study.

Level of Evidence: Level 3.

Methods: The sample was recruited from a large midwestern university alumni database and consisted of 2 cohorts: (1) former Division I athletes (n = 100; mean age, 53.1 ± 7.4 years) and (2) nonathletes who were active in college (n = 100; age, 51.4 ± 7.3 years). Individuals answered a demographics questionnaire and completed a physical fitness assessment consisting of 7 measures: percent body fat, 1-mile walk, sit-to-stand test, push-up, half sit-up test, sit and reach test, and back scratch test.

Results: Performance was significantly worse for former Division I athletes compared with nonathletes for percent body fat (mean difference, 7.58%; $F_{(1, 198)} = 59.91$; $P < 0.01$), mile time (mean difference, 2.42 minutes; $F_{(1, 198)} = 1.74$; $P = 0.03$), sit-to-stand test (mean difference, 4.3 repetitions; $F_{(1, 198)} = 6.59$; $P = 0.01$), and push-up test (mean difference, 8.9 repetitions; $F_{(1, 198)} = 7.35$; $P = 0.01$).

Conclusion: Former Division I athletes may be limited because of previous injury, inhibiting their ability to stay active later in life.

Clinical Relevance: It is imperative that clinicians, coaches, and strength and conditioning specialists understand the possible future repercussions from competing at the Division I level.

Keywords: physical activity; college athletes; limitations; NCAA; Division I

Physical activity performed at a moderate intensity is associated with reduced risk of mortality in the general population.[14-16] Specifically, moderately intense physical activity helps prevent cardiovascular disease, hypertension, and some types of cancers.[14-16] Participating in regular physical activity has been shown to reduce the risk of being overweight or obese.[14-16] Having excess body fat can cause various diseases, including hypertension, high blood cholesterol, type 2 diabetes mellitus, and coronary heart disease.[16,21]

Physical fitness is the ability of the body to function at optimal efficiency.[5,11] Components of physical fitness including cardiorespiratory fitness, muscular endurance, muscular strength, muscular endurance, flexibility, and body composition are important to overall health and performance of daily

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The authors report no potential conflicts of interest in the development and publication of this article.

DOI: 10.1177/1941738117705311

functional activities.[5,11] A complete picture of physical ability and health-related fitness is reflected in 5 domains: (1) cardiorespiratory function, (2) muscle strength, (3) muscular endurance, (4) flexibility, and (5) body composition.[5,11] A functional fitness test provides a more objective and comprehensive view of independent everyday activities than a self-report of activities of daily living. Traditionally, much of the emphasis in health care and health policy has been on measures of cardiorespiratory function because of the relationship between poor cardiorespiratory function and chronic disease. Over the past 2 decades, there has been a shift in emphasis among health care and public health professionals away from extending the life span to extending independent healthy years and improving functional capacity, thereby improving general health.[5,27,49]

Recently there have been several articles investigating the long-term health consequences of competing in collegiate athletics.[23,40,41,43,44] All these articles investigated self-reported health-related quality of life[23,40,41,44] or self-reported physical activity.[43] In general, former collegiate athletes had decreased health-related quality of life.[23,40,41,44] Specifically, measuring physical activity after retirement from collegiate athletics is a topic that has received limited attention. Injuries that occur during a collegiate athlete's competitive years may limit an athlete's ability to participate in physical activity as they age. Vigorous or intense physical activity during participation in college athletics may increase the risk of lower limb osteoarthritis, but the same activity done in moderation may delay the onset of disability and increase overall health.[4,22] Many of these studies have used self-reported measures to assess physical activity. However, an actual physical fitness assessment is essential in determining an individual's physical ability. Therefore, inclusion of retired student-athletes in studies that track physical fitness is needed and will generate a better understanding of how the retired student-athlete is "coping" with retirement and whether participation in athletics contributed to positive or negative outcomes later in life.[45] Retirement from an athletic career is a transitional process, and maintaining physical activity after retirement is difficult for many student-athletes.[46] Therefore, the purpose of this study was to evaluate differences in current physical fitness, using 7 standard fitness tests, in former Division I athletes and nonathletes.

METHODS

Before participating in the study, all candidates read and signed an informed consent form, and the study was approved by the Indiana University Institutional Review Board for the Protection of Human Subjects. Two hundred individuals volunteered: 100 former Division I collegiate athletes and 100 former college students who were recreationally active but played intramurals, club, or participated in other recreational activity on a regular basis (3-5 times per week) while in college. Both groups completed the same physical fitness assessment and questionnaires 1 time in a research laboratory.

Participants were recruited using convenience sampling from the university's alumni databases. Each database was queried for individuals between the ages of 40 and 65 years. The university's intercollegiate athletic alumni database was used for the Division I athlete group, and the general alumni database was used for individuals who participated in intramurals, club, or other recreational activities for the non–collegiate athlete group. Individuals meeting the above criteria were sent an email stating the purpose of the study and including contact information of the primary investigator for those interested in participating. All interested candidates completed a physical activity readiness questionnaire (PAR-Q)[7] to determine their readiness to participate in the physical fitness assessment associated with the study (Appendix 1, available in the online version of this article). It was particularly important to identify whether a physician had told them to not participate in specific physical activity or whether they currently had symptoms associated with cardiovascular disease. The PAR-Q screened each individual for predisposing risk factors indicating that he or she should not partake in physical activity without clearance from a medical professional. If a participant indicated a "yes" answer on any of the PAR-Q questions, he or she was excluded. The PAR-Q was developed to determine whether individuals between the ages of 15 and 69 years should engage in physical activity.[7] None of the individuals who volunteered to participate in the study were excluded based on their answers on the PAR-Q.

The sole inclusion criterion for the former Division I athlete group was the definition of a qualified candidate as a person who competed in a National Collegiate Athletics Association (NCAA) Division I–sanctioned sport. There were no exclusion criteria for the former Division I athletes group. Initially, 325 individuals met the inclusion criterion for the athlete group and were contacted. One hundred fifty responses were received indicating interest (response rate, 46.2%); however, due to scheduling conflicts, only 100 individuals were available to come to the laboratory and complete the study (n = 100; 60 men, 40 women; mean age, 53.1 ± 7.4 years). Based on the sex distribution of the former Division I athlete group, our goal was to obtain equivalent sex distribution in the nonathlete group. Inclusion criteria for the non–collegiate athlete group defined a qualified candidate as one who did not participate in an NCAA Division I–sanctioned sport but played intramurals, club, or participated in other recreational activity on a regular basis (3-5 times per week) while in college. Initially, 325 individuals met the nonathlete group criteria and were contacted. One hundred twenty responses were received indicating interest (response rate, 38.4%); based on schedules and wanting to have equal sex distribution compared with the athlete group, 100 individuals were able to come to the laboratory to complete the study (n = 100; 60 men, 40 women; mean age, 51.4 ± 7.3 years).

All participants came to the laboratory, and data were collected in 1 session. Individuals answered a demographics questionnaire including information about sex, age, weight, height, primary NCAA sport (if applicable), the number of years competing at the college level and professionally (if applicable), previous injury history (time loss injury in college, chronic injury in college, issues with overtraining in college, and whether they competed with an injury or illness in college), current medical status (diagnosed with osteoarthritis, current aerobic exercise, and current anaerobic exercise), and limitations (has injury sustained in college limited current ability to perform daily activities or physical activity/exercise). A time loss injury was defined as any injury causing at least 1 day of time loss.[17]

After the questionnaire, participants completed a physical fitness assessment that consisted of 7 functional measures: cardiorespiratory fitness, strength in arms and legs, endurance, flexibility, and body composition. Specifically, a 1-mile walk test (minutes) evaluated cardiorespiratory endurance,[31] a sit-to-stand test (number of sit-to-stands in 30 seconds) evaluated lower-body muscular strength/endurance,[19] a push-up test (number of push-ups) evaluated upper-body strength/endurance,[37] a half sit-up test (number of half sit-ups in 1 minute) evaluated core muscle endurance,[10] the sit and reach test (centimeters) evaluated lower-body flexibility,[1] the back scratch test (centimeters) evaluated upper-body flexibility,[35] and body composition was used to assess percent body fat.[9] The order of the physical fitness tests (other than body composition) were chosen at random for each participant (Appendix 2, available online).

Multivariate analysis of variance was used to analyze the difference between groups (former Division I athletes and nonathletes) on 9 dependent variables. The dependent variables included 1-mile walk, sit-to-stand, push-up, sit-up, back scratch, sit and reach, percent body fat, self-reported aerobic exercise, and self-reported anaerobic exercise. Follow-up univariate analyses were conducted on any significant findings. The alpha level was set at $P < 0.05$. Cohen d effect sizes were calculated between groups for all dependent variables. A small effect is considered 0.1, medium effect 0.3, and large effect 0.5.[8]

RESULTS

Tables 1 and 2 contain frequency results for the demographics questionnaire. Univariate analyses for the effect of group are significantly related to current percent body fat, mile time, sit-to-stand, push up, self-reported aerobic exercise, and self-reported anaerobic exercise. For self-reported aerobic exercise, former collegiate athletes reported 1.5 ± 2.2 aerobic hours per week while the non–collegiate athlete group reported aerobic exercise of 5.8 ± 2.7 aerobic hours per week ($F_{(1, 198)} = 52.43$; $P < 0.01$; $\eta_p^2 = 0.68$; $1 - \beta = 0.99$). Similar results were seen for anaerobic exercise, with former collegiate athletes reporting 0.5 ± 1.3 hours per week while noncollegiate athletes reported anaerobic exercise of 2.9 ± 1.5 hours per week ($F_{(1, 198)} = 46.19$; $P < 0.0$; $\eta_p^2 = 0.55$; $1 - \beta = 0.99$).

Former Division I athletes currently had a higher percent body fat than those who were nonathletes, with a mean difference of 7.58% ($F_{(1, 198)} = 59.91$; $P < 0.01$; $\eta_p^2 = 0.45$; $1 - \beta = 0.99$). In addition, 63% of the former athletes were determined to be above average for percent body fat (identified in either the excess fat [n = 47] or risky category [n = 16]). For the nonathlete group, 46% were determined to be above average for percent body fat (identified in either the excess fat [n = 32] or risky category [n = 14]).

Table 1. Demographic frequency statistics by group

	Athlete (n = 100)	Nonathlete (n = 100)
Years competing at Division I level (n)		
5	15	—
4	58	—
3	20	—
2	7	—
1	0	—
Years competing professionally		
5	8	—
4	7	—
3	5	—
2	7	—
1	3	—
0	70	—
Time loss injury during college		
Yes	78	20
No	12	80
Chronic injury during college		
Yes	60	18
No	40	82
Currently limited during activities of daily living		
Yes	21	0
No	79	100
Currently limited during sport/recreational activity		
Yes	57	6
No	43	94
Diagnosed with osteoarthritis by a physician		
Yes	43	10
No	57	90

Former Division I athletes had a slower mile time than nonathletes, with a mean difference of 2.42 minutes ($F_{(1, 198)} = 1.74$; $P = 0.03$; $\eta_p^2 = 0.13$; $1 - \beta = 0.61$). Former Division I

Table 2. Frequency of sport participation for each group

	n
Former Division I athlete group (n = 100)	
Football	30
M Diving	1
W Diving	1
M Basketball	5
W Basketball	3
Field hockey	3
Wrestling	3
M Gymnastics	2
W Gymnastics	4
M Soccer	4
W Soccer	3
W Volleyball	9
M Cross country	1
W Cross country	2
Softball	2
Baseball	3
M Track and field	4
W Track and field	5
M Rifle	1
W Rowing	1
M Swimming	3
W Swimming	5
M Tennis	3
W Tennis	2
Non–collegiate athlete group (n = 100)	
Basketball	7
Soccer	8
Volleyball	6
Baseball	6
Field hockey	4
Tennis	6
Gymnastics	5
Swimming	10
Ice hockey	4
Competitive cycling	15
Physical activity regularly	24
Army ROTC	5

M, men's; ROTC, Reserve Officers' Training Corps; W, women's.

athletes completed fewer sit-to-stand repetitions than nonathletes, with a mean difference of 4.32 repetitions ($F_{(1, 198)}$ = 6.59; P = 0.01; η_p^2 = 0.37; 1 − β = 0.72). For the push-up test, former Division I athletes completed fewer push-ups than those who were not former athletes, with a mean difference of 8.91 repetitions ($F_{(1, 198)}$ = 7.35; P = 0.01; η_p^2 = 0.48; 1 − β = 0.771). Table 3 provides descriptive statistics for the physical fitness assessments.

DISCUSSION

Overall, the former Division I athletes performed worse on the physical fitness assessment measures. This may indicate that these areas should be targeted first when creating treatment and prevention programming. Previous physical limitations mentioned by the former athletes may be attributed to a previous injury or interest in participating in activity or loss of identity.[13,23,24] Transitioning from a high-level elite athlete to a recreational athlete is challenging. Many athletes may want to continue to participate at that high level of sport activity but are unable to because of pain, injury, or lack of competitive sport leagues.[13,24] By not being able to compete at that high level or having the aspect of competition, former athletes may choose to do nothing. This in turn creates a more sedentary individual who cannot perform as well on a physical fitness test, has more fat than lean mass, and in general completes less physical activity every week. Research has shown that exercise identity and athletic identity are positively related to physical activity and significantly predict physical activity participation.[34]

Previous studies have shown that as an individual ages, a 5% to 15% reduction in aerobic activity ability is expected.[36,47] However, other research has suggested that individuals who maintain high-level training will have less than a 5% decline in aerobic activity.[32,33] Highly trained athletes who become more sedentary later in life have a greater than average reduction in aerobic capacity with age.[47] These results support this current study, with former athletes having slower mile times than the non–collegiate athlete group. A decline in aerobic capacity has been attributed to a dramatic reduction in exercise volume and training intensity.[18,20] The results have been replicated in other investigations.[20,47] Numerous publications have shown that reduced physical activity significantly and explicitly increases an individual's risk for developing conditions such as type 2 diabetes, cardiovascular disease, and obesity.[26,30,48] These data are so convincing that the Centers for Disease Control and Prevention lists physical inactivity as a potential cause for a number of chronic diseases.[6]

Strength is another measure that has been shown to decline with age, particularly after age 50 years.[30,38,50] However, individuals who can incorporate weight training into their physical activity can maintain leg press, chest press, and lumbar strength.[38] The strength tests utilized in this study were a push-up and sit-to-stand test. Former athletes had lower values for both strength measures compared with the nonathlete group. This may be due to the physical limitations and pain in those joints associated with previous injury. The sit-to-stand test involves a squatting motion that puts stress on the knees, hips,

Table 3. Descriptive statistics for the physical fitness assessment by group

	Mean (95% CI)	SD	Effect Size (95% CI)
1-mile walk[a]			
Athlete	16.03 (15.75, 16.02)	1.54	1.73 (1.40, 2.05)
Nonathlete	13.61 (13.47, 14.02)	1.24	
Sit-to-stand[a]			
Athlete	17.97 (16.77, 19.16)	5.79	0.72 (0.43, 1.01)
Nonathlete	22.29 (21.09, 2.48)	6.14	
Push-up[a]			
Athlete	21.87 (18.04, 25.77)	9.39	0.92 (0.63, 1.22)
Nonathlete	30.78 (26.91, 31.68)	9.82	
Half sit-up			
Athlete	49.59 (47.18, 52.00)	6.26	0.05 (–0.22, 0.33)
Nonathlete	49.96 (47.55, 52.37)	7.18	
Back scratch			
Athlete	–3.68 (–5.46, –1.89)	–1.33	0.22 (–0.05, 0.50)
Nonathlete	–3.97 (–5.75, –2.18)	–1.25	
Sit and reach			
Athlete	25.79 (23.85, 30.06)	8.51	0.04 (–0.24, 0.31)
Nonathlete	26.13 (24.19, 27.72)	9.85	
Percent body fat[a]			
Athlete	28.47 (27.11, 29.84)	6.88	1.09 (0.79, 1.39)
Nonathlete	20.89 (19.53, 22.26)	6.97	
Aerobic exercise[a]			
Athlete	1.5 (1.07, 1.93)	2.2	1.75 (1.41, 2.06)
Nonathlete	5.8 (5.27, 6.33)	2.7	
Anaerobic exercise[a]			
Athlete	0.5 (0.25, 0.75)	1.3	1.71 (1.38, 2.03)
Nonathlete	2.9 (2.61, 3.19)	1.5	

[a]Statistical difference between groups, $P < 0.05$.

and ankles. The push-up test is a full body movement placing stress on the arms, shoulders, and wrist/hand.

Many competitive athletes and an increasing number of middle-aged and older individuals who want to participate in regular vigorous activities question whether participation in sports or exercise programs increases their risk of developing osteoarthritis or accelerates degeneration of joints with minimal osteoarthritis. However, moderate habitual exercise does not increase the risk of developing osteoarthritis, and carefully selected sports and exercise programs improve strength and mobility in older people and people with mild and moderate osteoarthritis.[12,25]

Being overweight or obese continues to be a major health concern in the United States. According to results from the 2003-2004 National Health and Nutrition Examination Survey, 66% of the population is overweight, and nearly a third is obese.[29] Based on these data, it may not be surprising that a majority of our former athletes were categorized as above average for percent body fat. Even in the nonathlete group, 40% of the participants were categorized as above-average percent body fat. The obesity epidemic in the United States appears to be occurring in former athletes as well as the general population. This is especially true for athletes who play American football. High school,[51] collegiate,[28,39] and professional[42] football players have gradually increased in size over the past several decades. Similar body composition results to those found in this study have been reported in retired National Football League (NFL) lineman.[42] In the early 1990s, a survey conducted on retired NFL players revealed that linemen have a 52% greater risk of cardiovascular-related death than the general population.[3]

In this current study, percent body fat was used as the dependent variable, taking into consideration the relationship of fat and lean mass. If individuals can maintain moderate to high physical activity, total body weight remains stable, with percent body fat increasing 2% over 20 years.[33] However, athletes who have a decline in their activity and participate in low-intensity exercise increased their total weight 6.3 kg and percent body fat 3.7%, indicating that a significant reduction in physical activity may account for the change in body composition seen in this previous study[33] as well as the current study. Former athletes indicated that they currently participate in less physical activity and have a higher percentage of body fat than nonathletes. Former athletes who competed with a body mass index more than 30 kg/m^2 had 2 times the risk of mortality from cardiovascular disease compared with other players.[2] Former male collegiate athletes in this study had a mean percent body fat of 33.4%, whereas non–collegiate athlete men had a mean percent body fat of 19.9%. For women, the differences were not as prominent (25.8% for athletes vs 22.5% for nonathletes).

There are several limitations to this study. The former athletes do not represent all athletes in the NCAA student-athlete population, as a majority come from the same institution. These results may not extend to the other divisions of the NCAA or to professional athletes. There was also insufficient sample size to evaluate sport-specific results. Selection bias may have occurred; individuals who are more interested in health and exercise or in the pain and limitations they have may have been inclined to volunteer for the study. A majority of former athletes who volunteered felt limited completing sport/recreational activity, which may not represent all Division I athletes and may have possibly influenced the significant differences found.

CONCLUSION

Highly competitive athletes train for many years to reach the elite level, and when the high-level regular training stimulus is removed, there is an impact on them psychologically and physiologically. Without the sense of competition, athletes may not want to participate in any activity. Former collegiate athletes performed worse on the physical fitness assessments and also had a higher percent body fat compared with noncollegiate athletes.

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