

Risk of Chronic Disease and Disability in Former Competitive Collegiate Athletes

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Abstract

Excessive, high-intensity training regimens in collegiate athletics place athletes under chronic stress that increases susceptibility to injuries, overtraining, and long-term limitations in activity and disability. The purpose of this study was to investigate the effects of prior participation in collegiate athletics on activities of daily living, physical activity limitations, and the development of chronic disease in a population of former Division I athletes. Former Division I college athletes were followed for a period of 5 years after baseline testing. Athletes were surveyed concerning injuries incurred during participation in all varsity sports. Also included were questions about current health and activity status, and physical limitations. Blood pressure, resting heart rate, body composition, and body weight were measured at baseline, and reported 5 years later. Significant increases from baseline in reported physical activity limitations were present in female softball, basketball, volleyball, soccer and track athletes ($p < .01$). Significant increases from baseline in reported physical activity limitations were present in male football, basketball, baseball, and track athletes ($p < .01$). The percentage of athletes reporting daily activity limitations was 38% and 43%, for females and males, respectively ($p < 0.01$). The percentage of athletes reporting physical activity limitations was 47% and 58% for female and male athletes, respectively ($p < 0.01$). Significant increases in blood pressure, resting heart rate, body weight and body composition were seen in both endurance and power athletes who previously had reported an injury. These data suggest that collegiate athletics participation may result in a substantial physical cost, and indicate a potential long-term risk associated with participation in collegiate athletics.

Keywords: Activity limitations; Disability; College athletes; Injuries; Chronic disease

Introduction

Health benefits are associated with moderate intensity exercise. It is well known that there is a relationship between regular physical activity and decreased risk of heart disease, cancer, stroke, osteoporosis, and diabetes. Chronic diseases are directly linked with obesity, and body fat is controlled, in part, through physical activity. The cardiovascular system functions more efficiently and the body is better suited to fight disease when it is physically fit [1]. Benefits begin to decline when physical activity includes overtraining and high-intensity exercise. The risk of traumatic injury is increased, health benefits are reduced, and immunity is impaired due to the extreme stress on the body. Chronic stress on the body and the increased susceptibility to injuries and overtraining are related to the highly intensive training programs required to be successful in collegiate athletics.

Prior research indicates that injuries during college athletic participation may limit athletes' ability to participate in physical activity as they age, and may also limit the athletes' future activities of daily living [2]. Researchers indicate that the reporting of limitations in daily activity and physical activity in later life by former athletes is significantly more than the non-athlete alumni controls. Former collegiate athletes reported playing or practicing while sick or injured in 73% of the cases, which is significantly greater than intramural athletes. This research has been repeated and results have been similar in several different sports [3-5]. It is reported that power athletes have more disability due to injury than other athletes [4].

The purpose of this study was to determine the effect of competing in college athletics and sustaining an injury has on physical capabilities and disease risk over a period of 5 years post-graduation or cessation from varsity collegiate athletics I (Appendix A). Athletes sustaining injuries during collegiate athletics may not rest or recover appropriately, and some chronic injuries are never properly rehabilitated until the athlete's career is complete. Thus, it was hypothesized that injured athletes would have increased limitations in daily life, limitations during physical activity, and increased in body composition, weight, resting

heart rate and blood pressure. The second purpose of the study was to determine if the athletes who suffered impaired functional capabilities and restricted activity after competition were at an increased risk for chronic disease in later life.

Methods

Subjects

The sample was made up of alumni from three NCAA Division I Institutions ($n=435$). The sample was composed of athletes from men's and women's basketball, tennis, track and field, cross country, swimming, men's football, women's soccer, baseball, softball, volleyball, and women's gymnastics.

Procedures

The athletes' body composition, weight, height, blood cholesterol level, resting heart rate, and blood pressure were determined in their final year of competition at their respective universities. Athletes also completed a survey indicating athletic history, injuries, limitations due to exercise, and their current exercise habits. The athletes agreed through informed consent to allow follow-up questions and surveys. A follow-up survey was sent to the subjects 5 years after they completed their college athletic career. The survey asked the athletes to report disease, and disease risk factors. Those who responded to the survey were asked for permission to conduct a follow-up interview, during

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Category	Surveys Returned	Mean Age	Gender (M/F)	Major Injuries (%)	Chronic Injuries (%)	Physical Activity Limitations (%)	Daily Limitations (%)	Aerobic Exercise (hrs/Week)	Anaerobic Exercise (hrs/Week)
Athletes*	374	41.1	76% 24%	50%	52%	36%	21%	3.9	2.1
Controls	2991	43.5	52% 49%	10%	11%	6%	4%	1.4	3.0

Table 1: Descriptive Statistics.

Condition	Comparison	Percent	Pearson Chi-Square	Significance
Daily Limitations	Repeated Measures	15%/33%	n/a	p<.001
Physical Activity Limitations	Repeated Measures	23%/44%	n/a	p<.001
High Blood Pressure	Repeated Measures	15%/39%	n/a	p<.001
High Cholesterol	Repeated Measures	7%/18%	n/a	p<.001
Daily Limitations**	Chronically injured vs. uninjured athletes	38%/12%	21.56	p<.001
Physical Activity Limitations**	Chronically injured vs. uninjured athletes	45%/16%	24.53	p<.001
Daily Limitations**	Athletes with major injuries vs. uninjured athletes	36%/11%	23.54	p<.001
Physical Activity Limitations**	Athletes with major injuries vs. uninjured athletes	58%/9%	39.65	p<.001
Daily Limitations**	Power *vs. other athletes	35%/8%	15.320	p<.001
Physical Activity Limitations**	Power *vs. other athletes	52%/18%	14.605	p<.001

*Power athletes were men's football, women's gymnastics, and men's and women's track sprinting/field events.

**Data from the follow-up survey was used to compare within athletes.

Table 2: Summary of Results.

which they were asked detailed questions regarding their current disease risk factors. The initial and follow-up surveys were constructed using a web-based survey (Online Survey Solutions, Perseus Express, Perseus Development Solutions, USA) administered online.

The subjects were emailed a link to the survey along with instructions and an informed consent form. By choosing to click on the link to participate in the survey, participants provided informed consent for this study. One survey per email address was allowed so that duplicate surveys were not submitted. The survey included questions to determine the exercise habits of the athletes. Current exercise was classified as either aerobic or anaerobic exercise (defined below). They were asked about their cardiovascular endurance exercise and how often the exercise was performed each week. They were asked whether they performed muscular strength and endurance exercises, and how often the exercises were performed each week. The survey asked questions to determine whether each respective group's exercise habits were affected by former injuries and to determine which sports were impacted the most by former injuries.

The initial baseline measurements of the athletes were determined by researchers. Standard anthropometric data were collected. Body composition was measured using the 3-site formula with Lange calipers. Blood pressure and blood cholesterol were measured initially by researchers in the Physiology Laboratory. In the follow-up, data were obtained through self-report, as many athletes were unable to return to the laboratory after 5 years. The questionnaire was constructed to measure injuries incurred due to participation in athletics, limitations in exercise and daily activities, and chronic disease risk of male and female athletes.

For the purposes of this questionnaire, an athlete was defined as a person who competed in a National Collegiate Athletics Association (NCAA) sanctioned sport. Endurance sports were defined as men's and women's cross-country, track and field distance events, and swimming. Mixed sports were defined as men's baseball, women's softball, men's and women's tennis, women's soccer, and men's and women's basketball. Power sports were defined as men's football, women's gymnastics, and men's and women's track sprinting and field events. Aerobic exercise was defined as activities such as walking, running, cycling, and swimming, golfing with no cart, aerobic dance, or using cardio equipment at the

gym. Lifting weights, sprinting, interval training, circuit training, plyometric training, basketball, racquetball, tennis, and competing in a sport were classified as anaerobic activities on the survey, although some of these activities could also be classified as mixed activities.

Blood pressure was considered high if the athlete was prescribed anti-hypertensive medication, or if the athlete had a measurement of greater than 140 mmHg systolic or 90 mmHg diastolic, confirmed on at least 2 occasions. Athletes were asked to return to the laboratory if the initial blood pressure was considered high, for confirmation. In the follow-up report, the subjects were asked if they had been diagnosed with hypertension by a doctor, whereby they self-reported the data. Blood cholesterol levels were considered high if total cholesterol was reported at a level of 200 mg/dl or higher, or if the subject was diagnosed with or was taking medication for hyperlipidemia

Statistical analyses

Statistical analysis included descriptive statistics and frequency distributions, Chi-square tests, and cross-tabulations. The alpha level was set at p<0.01. Chi-square tests were employed to evaluate significant differences between athletes and non-athletes. Chi-square was also used to test individual sports for significant differences. ANOVA with repeated measures was also used in analyzing the significance of changes over time in athletes in variables. The alpha level was set at p<.05.

Results

The initial testing was administered to a sample of 435 athletes. The number of athletes who were included in the follow-up survey was 257. The follow-up return rate was 59.1%. Invalid contact information accounted for the decrease in participation. Descriptive statistics are reported in Table 1. Results are summarized in Table 2. The returned surveys by sport are reported in Table 3.

Significant increases from baseline in reported physical activity limitations were present in female softball, basketball, volleyball, soccer and track athletes (p<.01). Significant increases from baseline in reported physical activity limitations were present in male football, basketball, baseball, and track athletes (p<.01). The percentage of athletes reporting daily activity limitations was 38% and 43% for

	Sport	Total Surveys returned	Total Surveys returned (%)	Daily Limitation	Daily Limitation (%)	Physical Activity Limitation	Physical Activity Limitation (%)	RHR Increase	Weight Increase	Body Fat Increase	Blood Pressure Increase	Blood Cholesterol Increase
	Football	68	26.5	27	39.7	39	57.4	23	48	35	32	15
	Basketball	35	13.6	8	22.9	11	31.4	21	19	21	10	4
	Baseball	31	12.1	9	29	13	41.9	18	21	23	12	8
	Softball	22	8.6	12	54.5	15	68.2	17	15	17	16	7
	Golf	18	7	3	16.7	4	22.2	11	9	11	4	2
	Track Field Events	17	6.6	6	35.3	6	35.3	12	11	12	7	2
	Track Sprints	15	5.8	4	26.7	6	40	9	8	5	5	2
	Track long distance	13	5.1	4	30.8	6	46.2	9	6	7	5	1
	Cross-country	11	4.3	2	18	3	27.3	7	4	5	0	0
	Volleyball	9	3.5	2	22	3	33	5	4	3	2	1
	Soccer	8	3.1	2	25	2	25	5	4	5	3	2
	Tennis	6	2.3	4	66.7	2	33	4	3	3	2	1
	Swimming	2	0.8	0	0	1	50	1	1	1	0	0
	Gymnastics	2	0.8	2	100	2	100	1	2	2	1	1

Table 3: Follow-up Athlete Response to Variables by Sport.

females and males, respectively ($p < 0.01$). The percentage of athletes reporting physical activity limitations was 47% and 58% for female and male athletes, respectively ($p < 0.01$).

Former athletes were asked to indicate the number of years they competed in their sport. About 75% reported that they competed 4 yrs in college, which was expected due to subject selection. The next highest percent of athletes reported they competed for 5 yrs (17%), while 5% reported competing for 3 yrs, and 3% indicated they had competed for 2 yrs. The athletes were asked about the years they competed prior to college. The majority of the athletes competed between 4 and 13 yrs before they entered college athletics. The athletes were also asked about professional competition. While 5% indicated they spent between 1 and 3 yrs competing in professional athletics, the majority of athletes reported that they never competed at the professional level.

The majority of athletes reported that they had practiced with an injury while they were competing in college athletics (79%). The results indicated that 54% of former athletes had major injuries while competing in collegiate athletics, and 56% reported chronic injuries during college athletics. Thirty-three percent of the athletes reported limitations in their daily living and 44% reported physical activity limitations, both due to prior athletic injuries.

When examining individual sports for the percent of major injuries, cross tabulations indicated that football represented 58% of the major injuries reported for all the sports. Of the former football players, 67% reported a major injury. While examining each sport for the number of chronic injuries within each, football represented 41% of the total injuries and 51% of the football players reported a chronic injury.

Discussion

One of the key motivations for this study was to determine the “physical costs” of sport participation. Determining the risks of incurring a long-term disabling condition as a result of competitive collegiate athletic participation is important for the long-term health of athletes. Disability and/or limitations in daily living as well as limitations during physical activity are common in former college athletes [2]. This disability may include a reduced ability to perform physical activity, and since activity is essential to health, well-being, and quality of life, risk of chronic diseases and/or disorders such as anxiety and depression may be increased.

Limitations are recognized in this study. As is the case with most surveys, the subjects interpreted the questions themselves. Problems may have arisen in the interpretation of exercise habits. The athletes may have felt that they were limited in what they would like to do in regards to physical activity, but they may have had a much different idea about what amount of physical activity should be performed. Athletes who train intensely for several years may continue to train at a higher level than the average person. Athletes may have a much different idea about what moderate activity is than non-athletes, and they may have a different perspective on intensity than the average person. Athletes may feel they have “limitations” when they cannot perform at the same extreme intensity they maintained in college. In short, their perception of limitation may differ considerably from a non-athlete’s perceptions of limitations. Also, there were problems with sampling due to the limited access to personal contact information. Lastly, there were problems with obtaining a large enough sample to compare each sport or gender.

Athletes completing the follow-up reported substantially more limitations 5 yrs after completing collegiate athletic participation. The higher reported rates of injury by athletes who report limitations are similar to prior research [2]. Another important point is that athletes often feel pressure to return to their sport as soon as possible. About 79% of the athletes reported practicing with an injury or illness, which is also similar to prior research [2], and it is indicative of the chronic stress placed on athletes in collegiate programs. Athletes may, therefore, not have adequate healing time. This fact in itself could lead to future or chronic injury [1]. In particular, osteoarthritis is highly associated with joint injury and may be a major factor in the limitations that athletes’ experience after competition is behind them [1,6].

The rate of reported disability was increased 5 years post-athletic participation. This may shorten average life expectancy since the scientific literature has shown that continued physical activity helps to prevent chronic diseases, which are the leading cause of death in the United States [7,8]. This may be an unanticipated and overlooked cost of athletics. Disease risk factors such as high cholesterol and high blood pressure were significantly increased in athletes 5 yrs after competition. Changes in reported body fat percentage and body weight were statistically significant, but due to limitations in collecting and obtaining data, body weight and body composition were self-reported in the follow-up questionnaire. Regardless, the data along with reported limitations is a significant finding that may indicate a risk of chronic disease and decreased life expectancy in college athletes.

The number of athletes reporting injury and limitations was high. Athletes may be sacrificing their future physical activity for approximately 4 yrs of collegiate participation. Paffenbarger and Lee [8] found that competing in athletics during college was not protective against cardiovascular disease (CVD) unless an active lifestyle was maintained following competitive years. Sedentary college-aged individuals who became active later in life had a lower risk of CVD than former student athletes who reduced or stopped activity. Current physical activity is more important than prior participation in athletics for disease prevention [7]. Wyshek [9] compared the long-term health of women college graduates, college athletes, and a comparison group of non-athletes. Those not engaging in regular exercise at the time of the study had a high risk of disease, regardless of group.

Prior athletic participation is not protective against disease [7-12]. A few years of athletic competition appears to bear a significant price. If the athlete is unable to exercise in the future due to limitations, they may be unable to enjoy moderate physical activity, compete in athletic events, and may become overweight or obese. They may be occupationally or vocationally limited if they experience chronic physical disabilities. They may also pay a personal price if they are not able to teach their children the sport they love if they have trouble throwing a ball. It is very difficult to definitively measure quality of sports participation, given the likelihood of chronic injury and/or limitations that detract from productivity and overall enjoyment of life.

Athletes reported exercising aerobically more than anaerobically in the follow-up questionnaire. Athletes reported 3.6 hrs per week of aerobic exercise and 1.8 hrs of anaerobic exercise. Activities such as sprinting, racquetball, tennis, and basketball, in addition to resistance training, were included in the anaerobic category. It is likely that the athletes may have stayed away from stressful activities that included changes of direction or fast movements due to the prior injury and resultant limitations placed on their joints.

The power athletes (men's football, women's gymnastics, and men's and women's track sprinting and field events) reported physical activity limitations more frequently than other athletes. Because football players made up 15% of the total reported physical limitations, and 57.4% of all football players reported physical limitations, these results may not be indicative of gymnastics or track sprint and field events. The number of reported limitations and injuries was high in sports that are classified as endurance or mixed sports, but the fact that the football players made up 27% of the returned surveys may have impacted the results. The number of surveys returned by other sports was not high enough to draw sport-specific conclusions about the extent of limitations.

Conclusions

Sports are an important part of American culture, but the long-term risks are rarely considered. Increased risk of disability, obesity, and chronic disease may be what a competitive athlete, especially a football player, will face in the future. Data will be continually collected, and this population of athletes will be followed in the future to continue

to determine the detrimental effects that college athletic participation may have on future ability to engage in physical activity and on the future risk of chronic disease. The price many athletes pay to compete is high, though decisions made by college-aged individuals are not always made with the knowledge that their participation may impact their future quality-of-life. Based on this study, some athletes sacrifice their future quality-of-life for their athletic participation in collegiate sport. Additional studies in the future are needed to quantify the extent of disease risk and to make comparisons across each sport. Additional studies should also focus on how an athlete's future activity level is impacted, and on establishing a causal effect between abuse on the body due to injury and little recovery during collegiate athletics and chronic diseases in later life.

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