DO ASTRONAUTS HAVE A HIGHER RATE OF ORTHOPEDIC SHOULDER CONDITIONS THAN A COHORT OF WORKING PROFESSIONALS?

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Background and Purpose

Occupational surveillance of astronaut shoulder injuries began with operational concerns at the Neutral Buoyancy Laboratory (NBL) during Extra Vehicular Activity (EVA) training. NASA has implemented several occupational health initiatives during the past 20 years to decrease the number and severity of injuries, but the individual success rate is unknown. Orthopedic shoulder injury and surgery rates were calculated, but classifying the rates as normal, high or low was highly dependent on the comparison group. The purpose of this study was to identify a population of working professionals and compare orthopedic shoulder consultation and surgery rates.

Subject Populations

NASA astronauts from the first class selected in 1959 to 2013 and their medical data from selection data through December 31, 2014 were included in the analysis (N=338; 286 males and 52 females). To match the two populations by patient age, both populations were limited to patients between the ages of 25 and 65 years.

The comparison population cohort consisted of individuals (n=347,540; 166,412 males and 181,128 females) enrolled in a global services health maintenance organization (HMO) insurance plan that was in effect from September 1996 to June 2006. A private, independent physician association of 62 orthopedic surgeons was the exclusive provider of all orthopedic services for the HMO. Plan members and their dependents were enrolled in this HMO through their employers, which included public school districts, petrochemical companies, shipping companies, manufacturing and distribution companies, and engineering companies in the greater Houston area. Participants in the HMO were employees with a mix of blue and white collar positions.

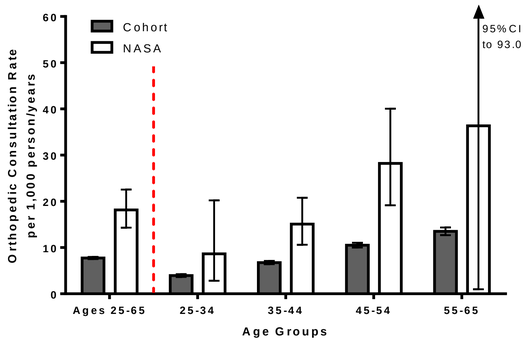
Descriptive Statistics for NASA and Cohort

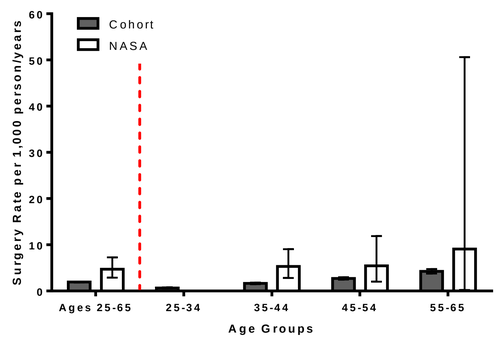
	Females		Males	
	NASA	**Cohort**	**NASA**	**Cohort**
Number	52	181,128	286	166,412
Age at entry mean±SD [range]	32.9±3.6 [26.1 – 46.7]	39.1±9.9 [25.0 – 64.9]	34.7±3.6 [25.2 – 45.3]	40.0±10.1 [25.0 – 64.9]
Follow-up (years) mean±SD [range]	12.3±7.3 [0.6 – 32.5]	1.8±1.7 [0 – 9.4]	10.9±6.2 [0.2 – 42.3]	1.8±1.8 [0 – 9.4]
Orthopedic Shoulder Consultations:				
Number (%)	6 (11.5%)	2024 (1.1%)	52 (18.2%)	2809 (1.7%)
Age at consultation mean±SD [range]	41.8±6.8 [34.6 – 52.9]	44.7±9.4 [25.0 – 64.9]	41.9±6.1 [28.4 – 58.3]	45.9±9.7 [25.0 – 64.9]
Years to consultation mean±SD [range]	7.6±5.9 [1.5 – 16.4]	2.1±1.8 [0 – 8.3]	6.0±5.5 [0.2 – 24.4]	2.1±1.8 [0 – 8.2]
Orthopedic Shoulder Surgery:				
Number (%)	2 (3.8%)	343 (0.2%)	16 (5.6%)	713 (0.4%)
Age at surgery mean±SD [range]	Not shown	49.0±8.7 [25.7 – 64.7]	44.1±6.3 [35.5 – 59.3]	47.1±9.4 [25.2 – 64.7]
Years to surgery mean±SD [range]	Not shown	1.8±1.7 [0 – 9.35]	8.9±5.4 [0.7 – 18.5]	2.4±2.0 [0 – 8.6]

Methods

All data were prospectively collected and retrospectively reviewed through the NASA Flight Medicine Clinic or the independent physician association as orthopedic care was provided. Medical records were queried for patients with musculoskeletal injuries or conditions involving the shoulder, upper arm or trapezius. Treatment was classified as surgical if it required anesthesia, open treatment or percutaneous fixation at any time during the patient's course of treatment. All non-surgical treatment provided by an orthopedist was classified as an orthopedic consultation and was defined as a first visit to an orthopedist for a shoulder condition or injury. Survival analysis (Cox Proportional hazards) was used to model the time to orthopedic shoulder consultation or surgery while adjusting for age. Separate models were calculated for males and females due to the low number of females in the NASA population.

Orthopedic Shoulder Consultation and Surgery Rates (per 1000 person/years)

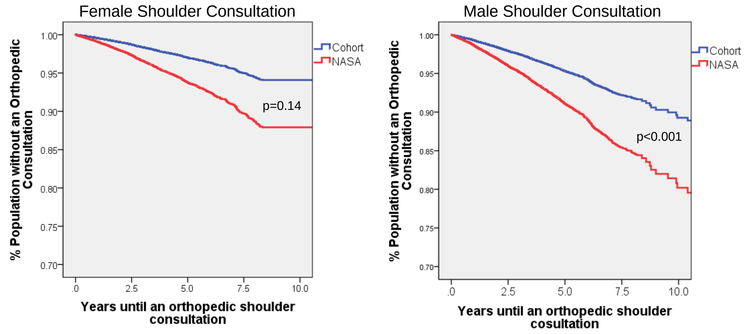


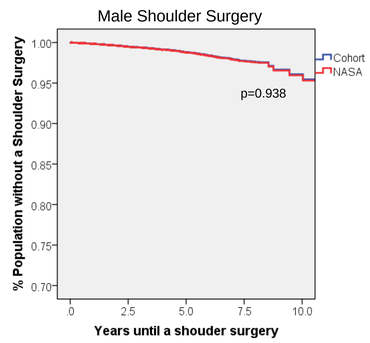


Results

Age was a significant (p<0.001) predictor of orthopedic shoulder consultation for females and increased the hazard by 5.3% per year. Differences between rates of orthopedic shoulder consultations were not observed in females between the NASA and cohort population, but this could be due to the low numbers in the female NASA population. In the male comparison, age (p<0.001) and cohort group (p<0.001) were significant predictors of orthopedic shoulder consultations. Males in the NASA cohort had a 94% increased hazard of an orthopedic shoulder consultation, and age increased the hazard by 3.2% per year for males. Shoulder surgery rates were only compared for the males as only 2 surgeries were performed in NASA females during the study period. In males, for each additional year of age the hazard of shoulder surgery increased by 4% (p<0.001). The hazard of shoulder surgery was not significantly different between males in the NASA and comparison cohorts (p=0.938).

Survival Plots for Shoulder Consultations and Surgery





Summary and Forward Work

A variety of occupational health initiatives have been implemented to manage shoulder injuries over the past 20 years at NASA. The lack of data on each initiative makes it difficult to attribute changes in the rates of shoulder injuries over the years to specific initiatives. However, the rates of orthopedic shoulder surgery in males are similar to a population of working professionals. This suggests that the initiatives are effectively preventing or lessening the severity of shoulder injuries, resulting in fewer injuries progressing to surgical outcomes.