

## Patterns of Participation and Performance in Youth Baseball Players

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Baseball is a popular sport to play in the United States, with approximately 13-17 million athletes participating across all levels of competition. Youth (9-12 years) and adolescent (13-18 years) players comprise the majority of this population playing at the club and high school levels, yet less than 10% of research studies include athletes <18 years old. Despite increased awareness surrounding the risk factors associated with sports participation, youth and adolescent baseball players continue to report overuse injuries at alarming rates. The lack of high-quality research describing athletic performance and injury risk factors in young athlete populations poses a significant knowledge gap in the literature. The current study sought to establish upper extremity (UE) injury incidence and examined population-specific risk factors in a cohort of youth baseball players (Aim 1). The current study also examined the measurement properties of normalized isometric shoulder strength, using 5 separate methods to account for changes in physical growth and development over a 6-month period (Aim 2). Youth baseball players were examined for baseline participation and isometric shoulder strength data and then prospectively followed via coach and parent surveys. Athletic exposures (AE) and the presence of UE injuries were tracked for each player. Chi square analyses were used to compare the frequency of UE injuries based on position group, sports specialization status and participation in additional specialty training. Odds ratios, absolute, and absolute risk differences with 95% confidence intervals (CI) were calculated between groups for Aim 1. A subset of athletes (n = 58) was physically re-examined during the follow-up period to establish the reliability of each of the normalized isometric shoulder strength measures.

Repeated measures analyses of variance (ANOVA) were conducted to compare changes in isometric shoulder strength at 2 time points after normalizing to 5 separate measures of body size. Linear regression models were used to examine the relationships between normalized isometric shoulder torque measures and ball velocity in youth baseball players for Aim 2. Results showed that youth baseball players demonstrated an UE injury incidence rate of 16.3/1000 AEs. Specialized athletes, who comprised 83.0% of this cohort, demonstrated a 15.9% increase in absolute risk for developing an UE injury when compared to multi-sport counterparts. Following comparisons across 5 methods of normalization, only torque, defined as the measure of shoulder strength divided by the corresponding ulnar length, demonstrated excellent reliability and detected significant changes between shoulder strength in each of the 4 measures tested. Ulnar length was the most stable and reliable anthropometric measure evaluated in this study. Modest but significant correlations were observed between shoulder scaption torque, shoulder external rotation (ER) torque at 0° and ball velocity suggesting that these measures were the most useful predictors of throwing performance in 9-12 year old baseball players.