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Biomechanical Analysis of Collegiate Baseball: Training Implications for Enhancement of Pitching Endurance

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Endurance is critical to a starting pitcher's success. However, the repetition of pitching stress can decrease performance and increase risk of injury in later innings. Improving arm endurance likely enhances late-game performance. **PURPOSE:** To evaluate predictors of mechanical endurance in collegiate pitchers. **METHODS:** 10 Division-1 pitchers were tested using Proteus technology (Boston Biomotion, Inc.). They completed 6 sets of 5 pitches; each set changed in resistance, ranging from ½ to 5 lbs. Endurance was a calculation of the ability to preserve power in each set on a continuous scale of 0.00 (0% preservation) to 1.00 (100% preservation). Mean endurance was the mean value of all 6 sets. Proteus also assessed biceps curls, triceps extensions, internal and external rotation, and horizontal adduction and abduction. Pitchers were tested during the 2017 season and data were compared to in-game performances. Linear regressions tested the relationships between endurance, performance on other tests, and in-game statistics. **RESULTS:** Pitchers were 72.0 ± 2.7 inches in height, had a mean fastball velocity of 84.6 ± 3.9 mph, a mean earned run average (ERA) of 5.8 ± 2.8, and a mean endurance of 97.7 ± 1.9%. Endurance was unrelated to class year ($p=0.857$) and was not related to anthropometric measurements, including height ($p=0.460$), weight ($p=0.188$), arm length ($p=0.350$), and leg length ($p=0.464$). Maximum squat strength ($p=0.917$), fastball velocity ($p=0.832$), and three-dimensional measurement of pitch range of motion ($p=0.730$) were also unrelated to pitch endurance. Biceps curl endurance ($p=0.035$) and triceps extension explosiveness ($p=0.089$) of the dominant arm correlated with pitching endurance. These relationships lost significance on non-dominant arm for curls ($p=0.241$) and extensions ($p=0.187$). Given a larger sample, other associations may be found; of interest, there may be relationships between endurance and innings per appearance ($\beta= 0.353$, $R^2=0.196$; $p=0.232$) and ERA ($\beta= -0.559$, $R^2=0.149$; $p=0.305$). Post-hoc power analyses revealed samples of 30 and 38 respectively to reach significance (power=0.80; $p=0.05$). **CONCLUSIONS:** Fatigue results from repetitive overhead throwing, elevating risk of overuse injuries. Use of Proteus may provide modes of exercise unrecognized by traditional baseball training.