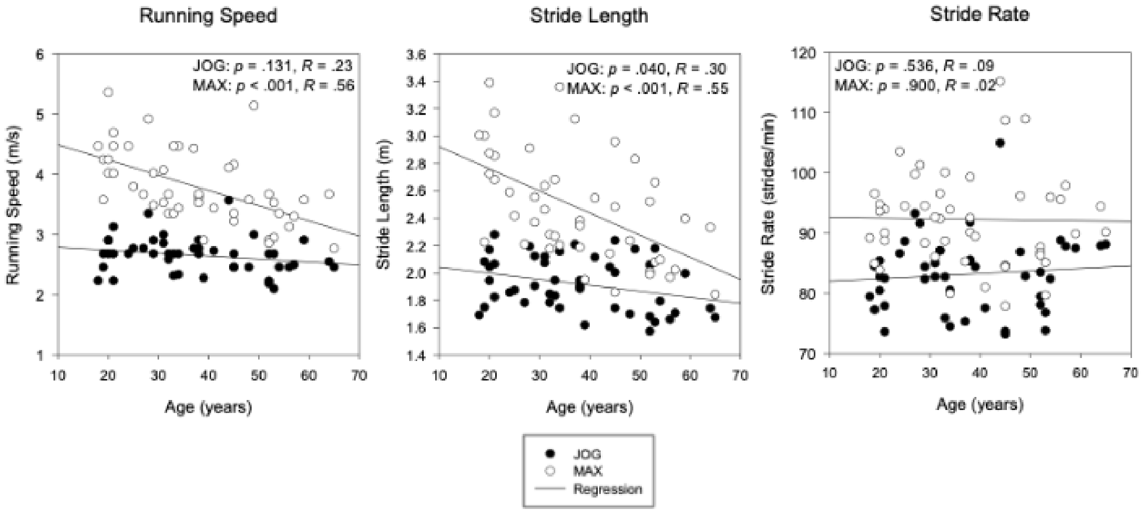
Figure 1. Correlations between age and running speed, stride length, and stride rate.



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Exercise Selection And Fastball Velocity: Relationships In Collegiate Pitchers

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In collegiate and professional baseball, fastball velocity is inversely correlated with opposing batting average. Although the importance of velocity is widely accepted, there is no consensus on the exercises that most accurately predict it.

PURPOSE: To examine relationships between fastball velocity and isotonic power output in diverse exercise motions.

METHODS: We recorded fastball velocity in 13 collegiate baseball pitchers using Rapsodo (Rapsodo Inc., USA) and conducted comprehensive biomechanical testing with Proteus (Proteus Motion Inc., USA). Players underwent baseline testing, followed by a 6-week training intervention, and were then retested. At both assessments, players completed 6 repetitions at 12 lb of magnetic resistance on 8 upper limb exercises (unilateral and bilateral biceps curl, triceps extension, horizontal row, and horizontal press) and 3 trunk and lower limb exercises (straight-arm trunk rotation, lateral bound, and vertical jump). Mean peak power (watts) across all repetitions was tabulated for each movement. Simple linear regressions evaluated associations between fastball velocity and power output for each movement at both time points.

RESULTS: Subjects were 20.3 ± 1.3 years of age and had a mean fastball velocity of 85.4 ± 4.2 mph. At baseline, the only exercise that significantly predicted velocity was lateral bound ($p = 0.033$). Mean lateral bound power was 165.1 ± 20.0 watts, and each additional watt predicted a 0.1 mph increase in velocity ($R^2 = 0.164$; 95% CI of β: 0.008 to 0.171). At follow-up, other positive relationships emerged. Each additional watt of power in lateral bound ($p = 0.003$; $R^2 = 0.313$; 95% CI of $\beta = 0.016$ to 0.071), two-handed triceps extension ($p = 0.012$; $R^2 = 0.453$; 95% CI of $\beta = 0.013$ to 0.082), two-handed horizontal press ($p = 0.029$; $R^2 = 0.363$; 95% CI of $\beta = 0.009$ to 0.140), and straight-arm trunk rotation ($p = 0.013$; $R^2 = 0.232$; $\beta = 0.008$ to 0.060) associated with increased fastball velocity.

CONCLUSIONS: At baseline, lateral leg power appeared to be the dominant contributor to pitching velocity. Following a training intervention, variability in upper limb power output exhibited relationships with performance. Coaches and training staff may consider focusing on these exercises in training prescriptions for collegiate pitchers.

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Shock Attenuation Wavelet Transform Of Dominant Leg During A Fatiguing Run

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Running is associated with a high incidence of knee injuries. Neuromuscular fatigue is considered as main risk factor, suggesting that the body in a fatigued state is less able to attenuate impact forces sufficiently. This could lead to overloading and eventually injuries.

PURPOSE: Analyse vertical accelerations frequencies at the tibia (vTA) and sternum (vSA) with a Wavelet Transform to get insight in shock attenuation (SA) strategy of the body during a fatiguing run.

METHODS: 6 recreational runners (3F/3M, age 29.2 ± 12.8 years, height 182.8 ± 8.0 cm, weight 74.5 ± 7.5 kg , running >10 km per week for >1 year; uninjured in last 6 months; heel strikers) ran until exhaustion on a treadmill at 103% of their average 8 km race speed. Data were obtained overground on a 10-meter runway before and after the fatigue protocol with IMUs and an embedded 3D force plate. vTA and vSA were analyzed during stance with a Wavelet Transform (fig. 1), focusing on lower (0-9 Hz) - mid (10-25 Hz) - high (26-50 Hz) pseudo-frequency ranges, and impact (initial contact to first vTA peak instant times two) and active phase in time domain. SA was calculated in decibels (dB) from the vTA and vSA coefficient magnitudes.

RESULTS: Mean SA significantly decreased between non-fatigued and fatigued state in the lower pseudo-frequency range for both impact phase (-3.58 ± 0.89 to -2.52 ± 1.17 dB, $p = 0.009$) and active phase (-3.75 ± 0.93 to -2.73 ± 1.18 dB, $p = 0.007$). Other pseudo-frequency ranges showed no significant change ($p > 0.05$).

CONCLUSIONS: The body seems less able to attenuate low frequencies in fatigued state in both impact and active phase, indicating less attenuation by active attenuation mechanisms (joint motion with eccentric muscular contraction). This may be caused by a smaller range of motion or greater knee stiffness in fatigued state, possibly leading to future injuries. High frequencies are still well attenuated, SA by passive structures seem minimally affected by fatigue.

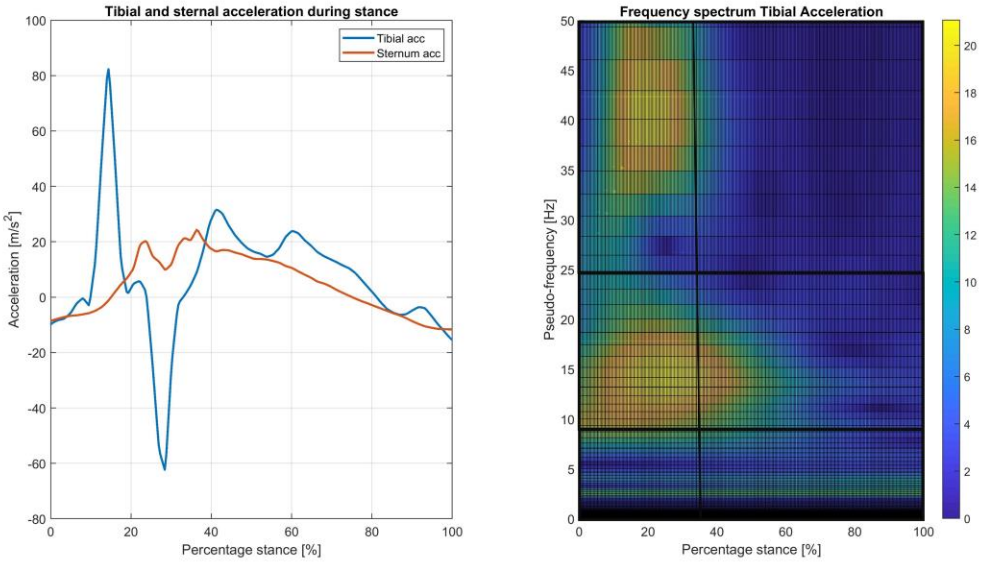

Fig. 1: Example vTA and vSA in time domain (l) and Wavelet Transform (r) during stance of one fatigued state trial. Areas of impact (>10 Hz) are present, lower frequency range is less visible. Black lines mark frequency ranges (hor.) and impact/active phase (vert.).

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Identifying Risk Factors For Head Impact Exposure In High School Football Using A Validated Instrumented Mouthguard

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Head impact sensor technology is evolving, and recent advances include the design and validation of instrumented mouthguards that accurately measure head impact kinematics. The use of such devices, in conjunction with video-based impact detection algorithms, can be useful in elucidating the true nature of head impact exposure in contact sports such as American football.

PURPOSE

To characterize patterns of head impact exposure in high school football using a validated instrumented mouthguard sensor.

METHODS

High school football athletes (n=116) wore Stanford instrumented mouthguards (the “MiG2.0”) during practices and games in their 2018 and 2019 Fall seasons. A validated impact detection algorithm made specifically for the MiG2.0 in American football was used to filter out false-positive accelerative events recorded by the MiG2.0 devices. Peak linear acceleration (PLA) and peak rotational acceleration (PRA) of verified head impacts were saved for analyses. Helmet model, level of competition (JV or varsity), body mass index (BMI), age, and prior concussion history were also recorded at the beginning of each season for each athlete.

RESULTS 66969 events were recorded by the MiG2.0 sensors across 888 athlete exposures. The impact detection algorithm determined that 713 events were true head impacts. Athletes wearing Riddell Speedflex helmets sustained head impacts of lower PRA than those wearing VICIS Zero1 helmets ($p<0.01$). Athletes with a previous concussion history sustained head impacts of lower PLA than those without ($p<0.04$). No statistically significant differences were found between peak kinematics of head impacts between athletes of varying age, BMI, or level of competition. Higher number of previous concussions, varsity competition, and higher BMI were associated with more frequent head impacts ($p<0.036$).

CONCLUSION The MiG2.0 instrumented mouthguard sensor, when used with a validated impact detection algorithm, is an effective tool for characterizing head impact exposure in high school football. In our cohort, concussion history and helmet model affected the severity of head impacts sustained by athletes, and the in vivo performance of helmets may differ from previous reports of laboratory helmet testing. Athletes with more football experience may sustain head impacts more frequently.

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Do Runners Fatigue Similarly? Peak Accelerations And Vertical Stiffness During A Fatiguing Treadmill Run

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Peak accelerations tend to increase with running-induced fatigue. Increased lower body stiffness might cause this increase with fatigue. However, a stiffer lower body and higher peak accelerations can increase the impact on passive structures in the body (i.e. cartilage) resulting in overuse injuries.

PURPOSE:To investigate peak accelerations and vertical stiffness during a fatiguing run.

METHODS:7 trained runners (5M/4F, 29.4±12.2 years, 1.8±0.1 m, 71.3±10.4 kg) ran on a constant velocity (3.5±0.9 m/s) on an instrumented treadmill (1000 Hz) until perceived exertion. Inertial measurement units on both tibia and the pelvis measured accelerations (240 Hz). Vertical peak accelerations of the tibia and pelvis, and vertical stiffness (maximal vertical ground reaction force / vertical pelvis displacement during stance) were averaged over 50 steps for both sides of the body at the start and end of the run. Pelvis and tibial accelerations were low pass filtered with 45 and 60 Hz respectively. Pelvis acceleration was integrated twice and low pass filtered with 20 Hz to get vertical pelvis displacement. Paired sample t-tests were used to statistically test differences between the start and end of the run. The largest percentual increase and decrease for all parameters was also computed.

RESULTS:See Table 1. The fatigue protocol lasted 19.4±11.4 minutes.

CONCLUSIONS:This study showed large interindividual responses to fatigue, resulting in no significant changes in any of the investigated parameters on a group level. The large interindividual response is shown by changes in parameters into opposite directions. For instance, peak tibial acceleration increased in one subject with 32.3% while it decreased with 24.8% in another subject. Hence it is advised to move away from group-level analyses when investigating running-induced fatigue and development of overuse injuries, and towards analysing individual runners or subgroups of runners who respond similar to fatigue.