Objective To identify differences between injured and uninjured athletes for ACWR based on workload quantity, magnitude, and weighted magnitude.

Design Matched-pair cohort.

Setting Youth basketball.

Participants Fifty (25F, 25M; 16.5 years; 66.2 kg; 173.5 cm) basketball players on four high school teams.

Assessment of Risk Factors A wearable device (VERT® Classic) was used to record jump count and jump height for all participants during practices and games throughout the 17-week season.

Main Outcome Measurements Ten athletes were diagnosed with either patellar or Achilles tendinopathy, and were matched by height and weight with teammates that had no injuries. ACWRs were calculated weekly for three workload types: jump count, jump height, and jump height weighted for tendon damage. Paired t-tests compared mean ACWR of injured and uninjured athletes for each measure of workload.

Results There was no significant effect of injury status for jump count ACWR (injured mean (95% CI): 1.077 (1.011–1.132), uninjured: 1.025 (0.906–1.162); $p=0.121$) or jump height ACWR (injured: 1.079 (1.015–1.136), uninjured: 1.018 (0.886–1.155); $p=0.081$). ACWR with jump height weighted for tendon damage was higher for injured (1.075 (0.929–1.243)) compared to uninjured athletes (0.939 (0.729–1.266); $p=0.045$).

Conclusions Athletes with patellar or Achilles tendinopathy have a greater ACWR than uninjured athletes when workload is calculated as jump height weighted based on tendon properties. This result was not apparent when ACWR was based on the number of loading cycles or the unweighted loading magnitude. Future research into overuse injury prevention should consider the damage accumulation in biological tissue due to repetitive loading.

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MONITORING WORKLOAD TO EVALUATE INJURY RISK: THE IMPACT OF MISSING DATA

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Background The acute: chronic workload ratio (ACWR) is used to monitor workload, with both low and high ACWR associated with injury risk. Ignoring or imputing missing data points may influence ACWR calculations.

Objective To examine the effect of ignoring versus imputing missing data on ACWR.

Design Cohort, longitudinal.

Setting Youth basketball.

Participants Fifty (25F, 25M; 16.5 years; 66.2 kg; 173.5 cm) basketball players on four high school teams.

Assessment of Risk Factors Participants wore a jump counter (VERT® Classic) to record external workload during practices and games throughout the 17-week season.

Main Outcome Measurements Two datasets were created: missing data were ignored, and missing data were imputed using a machine learning algorithm based on typical jump counts for the individual, team and sex. The distribution of ACWR was compared between datasets using a two-sample Kolmogorov-Smirnov test. Pearson correlations were used to assess how the ACWR for the ignored and imputed datasets relate to the difference between the percent of missing acute and chronic data.

Results The distribution of ACWR was significantly different between the ignored and imputed datasets ($D=0.164$, $p<0.001$). The ignored dataset had 40% more cases of $ACWR<0.5$ and 97% more cases of $ACWR>2.0$ than the imputed dataset. There was a significant moderate association between ACWR and the difference between the percent of missing acute and chronic data for the ignored dataset ($\rho=0.617$, $p<0.001$). When more acute than chronic data are missing, ACWR is low; when more chronic than acute data are missing, ACWR is high. There was no relationship between missing data and ACWR for imputed data ($\rho=0.061$, $p=0.147$).

Conclusions When missing data are ignored, ACWR is dependent on the quantity of missing acute and chronic data. Additionally, ignoring rather than imputing missing data is likely to result in more extreme ACWR, which could influence evaluation of the relationship between workload and injury risk.

Poster Presentations

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THE IMPACT OF OVERHEAD SPORTS: ASSESSMENT OF SHOULDER RANGE OF MOTION IN 1ST LEAGUE PROFESSIONAL VOLLEYBALL PLAYERS

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Background Throwing is a highly skilled movement performed at the extremes of glenohumeral motion. The constant micro-trauma in the throwing shoulder challenges the physiologic limits of the surrounding tissues and leads to modifications in range of motion, due to osseous and soft tissue adaptations.

Objective We aimed to characterize the changes that occur in glenohumeral mobility in volleyball players, determining if these would be different compared to other overhead sports and if differences existed between the two shoulders.

Design This was a cross-sectional study, with clinical data collected from questionnaires and functional evaluation using a goniometer.

Setting The subject group consisted of volleyball players from the major league and/or the national team.

Participants The selection criterion was being a volleyball masculine athlete of a major competition without shoulder complaints; this enrolled a total of 66 professional males.

Interventions Bilateral range of motion (active and passive) was assessed with a goniometer, in both throwing and non-throwing shoulder. We also tested stability.

Main Outcome Measurements We measure forward elevation, extension, external and internal rotation. The specific tests were apprehension, anterior and posterior drawer, and the sulcus sign.

Results The dominant shoulder displayed significantly increased external rotation when compared with the non-dominant ($120.92^\circ \pm 14.85$ vs $106.78^\circ \pm 12.53$). Internal rotation was decreased by 11.99° in the throwing shoulder ($p=0.047$). Concerning forward elevation, a tendency for greater values was noted ($p=0.08$), with a higher degree in the throwing arm.

Conclusions Range of motion was different between shoulders. Our athletes had an increase in external rotation and a loss of internal rotation in the throwing shoulder, being concordant with what is described in other overhead sports. Furthermore, the dominant shoulder had a significant increase in forward elevation. These findings support the need of performing these evaluations to monitor the development of injuries, so that preventive measures can be taken.

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THE RELATIONSHIP BETWEEN SHOULDER PAIN, PHYSICAL EXAM FINDINGS, AND STRUCTURAL PATHOLOGY IN ELITE WHEELCHAIR ATHLETES

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Background Although athletes who are wheelchair users for both daily activity and sport participation are at high risk for shoulder injuries, little is known regarding the characteristics of shoulder injury in this population.

Objective To determine the relationship between shoulder symptoms (SS), physical exam findings (PEF), and structural pathology (SP) in elite wheelchair athletes competing in athletics and powerlifting

Design Cross-sectional study.

Setting Three international competitions.

Participants 80 elite wheelchair athletes competing in track ($n=40$), field ($n=19$) and powerlifting ($n=20$) who also used a manual wheelchair for daily mobility.

Assessment of Risk Factors A senior sports physiotherapist and musculoskeletal radiologist obtained measures of SS, PEF, and MSK ultrasound (MSK-U) findings. Relationships between measures and for sub-groups by sporting discipline were calculated. Age, duration of disability, and disability type were evaluated as independent risk factors for pain or structural pathology.

Main Outcome Measurements The Wheelchair Users Shoulder Pain Index (WUSPI), Physical Examination of the Shoulder Scale (PESS), and the ultrasound Shoulder Pathology Rating Scale (USPRS)

Results A total of 51 of 80 athletes reported dominant shoulder pain. PESS scores were 7.4 ± 6.7 , WUSPI 22.3 ± 26.9 and USPRS 5.2 ± 4.0 . A positive main effect was found for pain history on PESS ($F_{1,154} = 9.57$ $p = 0.002$, $\eta_p^2 = 0.06$) but no interaction with athlete sub-group ($F_{2,154} = 1.90$ $p = 0.15$, $\eta_p^2 = 0.02$). There were no USPRS score differences between sub groups, but track athletes had lower WUSPI scores and lower PESS scores. The WUSPI and PESS which were strongly correlated (0.71), while the USPRS which did not correlate with either the PESS (0.21) or WUSPI (0.20).

Conclusions Elite wheelchair athletes have a high prevalence of MSK-U pathology with low-moderate levels of SS and PEF. MSK-U findings do not correlate with SS or PEF. These findings are an important step to educate the development of targeted preventative measures.

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EVALUATION OF SPORT SPECIFIC ADAPTATIONS AT THE SHOULDER JOINT AND CORE ENDURANCE AMONG ELITE FEMALE VOLLEYBALL PLAYERS WITH AND WITHOUT OVERUSE RELATED SHOULDER PROBLEMS

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Background Yet published values outlining the differences of sport-specific adaptations at the shoulder joint between symptomatic (S) and non-symptomatic (nS) overhead athletes vary widely. Information defining the link between overuse injuries in relation to both shoulder joint and core endurance is also lacking.

Objective To evaluate if sport-specific adaptations at the shoulder joint are greater in volleyball players with shoulder problems and core stability would be associated with sport-specific adaptations at the shoulder.

Design Cross-sectional study.

Setting This study was performed during the indoor volleyball season 2017/2018 in coordination with the Swiss Volleyball Federation.

Patients (or Participants) 60 female volleyball players with and without overuse shoulder problems playing in a National League volleyball team.

Interventions (or Assessment of Risk Factors) Standardized clinical field tests for passive shoulder ROM in IR and ER, isometric strength of shoulder IR and ER, scapular dyskinesis test and core endurance test were performed during a test session of 1 h. The assessor was blinded to information on the players' current shoulder status.

Main Outcome Measurements Side, group and subgroup comparisons of ROM, strength, scapular control and core endurance and correlations between core endurance and ER strength deficit, strength ratio ER/IR and scapular dyskinesis were described.

Results All players showed significant adaptations in ROM, strength and scapular control of their dominant shoulder (Ds). Players in the S subgroup had significantly weaker IR strength than nS players (mean difference, 7 N; 95% CI, 0.54 to 13.05; $P \leq .034$; $r = 0.295$) and tended to have ER strength deficit. Furthermore, the lower the ER strength deficit, the better the core endurance in the side plank position (Ds: $r = 0.30$; 95% CI, 0.11 to 0.53; $P \leq .035$).

Conclusions Elite female volleyball players showed typical sport-specific adaptations in their dominant shoulder. Values of adaptations did only differ in strength and only between subgroups. Further studies need to quantify the association between core endurance and shoulder strength.