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Side-to-Side Differences in the Arm of a Collegiate Pitcher Related to Strength and Flexibility

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PURPOSE: The purpose of this investigation was to assess the effect of sport-type on BMD among collegiate female athletes whom participated in either predominately lower and upper body or lower body sports.
METHODS: Fifty female NCAA Division I-A athletes volunteered to participate. Over half (*n* = 29) of the participants were upper and lower body athletes (volleyball, tennis, golf, cheerleaders, and softball) while the remainder (*n* = 21) were principally lower body athletes (soccer and track). All participants completed a demographic questionnaire, submitted to anthropometric measurements (height, weight, body mass index, and body fat %) and underwent four regional scans (right/left radius and ulna and right/left femoral neck) on a Hologic QDR 4500W (S/N 49865) software version 11.2:5 dual x-ray absorptiometry. A one-way multivariate analysis of variance was executed utilizing the T-scores from the four BMD sites as the dependent variables and the sport type as the independent variable.
RESULTS: *Wilk's Lambda* .810, $F(4, 45) = 2.64$, $p < .05$ determined that there were significant differences between the two sport types. An eta squared indicated that 19% of the variance in the multivariate of BMD was explained by sport type. There was a strong indication that the BMD of the upper body in soccer athletes was inferior to that of their lower body; although, the sample size was too small to differentiate which sport type contributed most to the variance.
CONCLUSIONS: These findings suggest that sport type does impact BMD. Subsequently, there is a site specific adjustment to BMD at areas which receive the most mechanical stress and inferior BMD at less active sites. Strength training and sport medicine specialists must be aware of such imbalances in order to protect athletes from debilitating injuries.

3619 Board #58 June 4, 9:30 AM - 11:00 AM

High Impact Loading Vs Repetitive Non-impact Loading And Radial Diaphysis Structure

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(No relationships reported)

High impact repetitive loading associated with most sports is beneficial to the skeletal system. However, Frost's "mechanostat" theory proposes that high magnitude loading and thus high impact sports are more beneficial to bone than low or non-impact sports.
PURPOSE: To determine if Division 2 collegiate volleyball players had stronger radial diaphyses than swimmers.
METHODS: Twenty-Three female athletes from the volleyball (n=11) and swim (n=12) squads and 8 female referents performed a maximum grip strength (GS). Studies have shown that no single variable can indicate bone strength and function (Jepsen, 2013) and therefore cortical area (Ct.Ar), cortical bone mineral density (cBMD), polar moment of inertia (J), bone strength (polar strength strain index, SSI) and muscle area were measured using peripheral quantitative computed tomography (pQCT) at the 33% of radial length. Volleyball represented an impact loading sport due to the high-velocity ball impacts on the hands and forearms. Swimming represented a repetitive non-impact loading due to the large number of repetitions with high joint moments due to the drag of the water. The teams and referent group were compared using One-way ANOVA.
RESULTS: Height, weight and % body fat were similar between the volleyball players and swimers. No significant differences were found between bone traits. The amount of bone (Ct.Ar) was similar (VB:80.0 ± 7.5, SW: 77.8 ± 9.1; mm2) but greater than the referent group. cBMD was similar between groups (VB: 1193.5 ± 13.4, SW: 1195.7 ± 20.5; mg/cm2) but interestingly the referent group had significantly higher cBMD (1217.8 ± 26.1) than the athletes. Moment of Inertia (J) and the SSI (measure of bone strength) were also similar between the teams. The distribution of bone (J) was 25% lower in the referent group. Muscle area and relative grip strength were similar between VB and SW.
CONCLUSIONS: Swimmers were not adversely affected by the non-impact loading of their sport at the radius potentially due to the high number of concentric muscle contractions (Nikander, 2006). Both teams had similar muscle mass and grip strength. The higher impact- lower repetition loading in volleyball and the higher repetition-lower impact loading in swimmers resulted in similar bone structure and strength that was greater than the referent group.

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Effects Of Playing Surfaces On Volumetric Bone Mineral Density In Adolescent Male Soccer Players

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(No relationships reported)

It has been well recognized that impact loading in sporting activity is highly associated with bone accretion. Recently, Carmona et al. showed that bone mass accretion was similar bone in prepubescent soccer players independently of the playing surface (artificial turf vs. non-grass ground surface). However, the osteogenic effects on volumetric bone mineral density (vBMD) generated by four different playing surfaces of the same sport are unknown.
PURPOSE: to investigate the effects over a soccer season in vBMD of male soccer players by playing surface.
METHODS: A total of 71 male soccer players (12.7±0.6 y) volunteered to participate in the study. 26 participants were training and playing on 2nd generation artificial turf, 16 on a 3rd generation artificial turf, 10 on a non-grass ground surface and 19 on natural grass (NG). vBMD, at 4 and 38% of the non-dominant tibia, was measured before and after season by peripheral quantitative computed tomography (Stratec XCT-2000 L pQCT scanner). Analysis of variance for repeated measures×2 (time) were performed to determine the effects of playing surface on vBMD controlling for pubertal status. Effect size were calculated according to the methods proposed by Cohen (small (f=0.1), medium (f=0.2), or large (f=0.4)).
RESULTS: A group by time interaction was found for vBMD at 38% of the distal tibia (p=0.029 and f=0.38). When pairwise comparisons were carried out, NG showed group by time interactions compared to 2nd generation artificial turf (782 to 804 mg/cm3 vs. 790 to 798 mg/cm3; p=0.007 and f=0.50), and to 3rd generation artificial turf (782 to 804 mg/cm3 vs. 784 to 788 mg/cm3; p=0.027 and f=0.35).
CONCLUSION: Soccer players training and playing in NG pitch showed better values in vBMD acquisition than those on 2nd and 3rd generation artificial turf. Despite previous studies presented no differences on bone mass accretion independently of the playing surface. Our results suggest that NG is the most recommended playing surface to improve vBMD in the non-dominant tibia.
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3621 Board #60 June 4, 9:30 AM - 11:00 AM

Side-to-side Musculoskeletal Differences In The Arm Of A Collegiate Pitcher Related To Strength And Flexibility

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Musculoskeletal adaptation is localized to areas of repeated mechanical loading. Participation in throwing-related sports has been positively correlated with bone strength in the throwing compared to non-throwing arm. Baseball pitching, requiring repetitive loading on the throwing arm provides a model to understand bone adaptation.
PURPOSE: To investigate upper extremity limb-to-limb differences in musculoskeletal strength adaptations to pitching in male collegiate baseball players.
METHODS: Peripheral quantitative computed tomography (pQCT) was used to assess bilateral arm bone and muscle strength outcomes among 10 collegiate men's baseball pitchers (age=19.9 ± 1.04 years) with an average of 13.6 ± 2.5 years of experience. Total and cortical bone volumetric density (ToD and CoD), and cortical bone mineral content (CoCnt), area (CoA), thickness (CoTh) and estimated bone strength (section modulus), along with muscle cross-sectional area (MCSA) were measured at the distal

(15%) and midshaft (50%) humerus, and midshaft (50%) radius sites. Isometric grip and shoulder external and internal rotation strength were assessed using digital dynamometer and manual muscle tester, respectively. Shoulder internal and external range of motion was measured with a digital goniometer.
RESULTS: Only at the humerus midshaft (50%) was bone strength higher in the pitching compared to non-pitching arm (31%, p<0.001), as a result of greater CoA (+28%, *p*<0.001) and CoThk (+24%, *p*<0.001), rather than CoD (+2%, *p*<0.05). MCSA was also greater at the humerus midshaft (+8.7%, *p*<0.001), but not at the radius midshaft site. Isometric muscle strength measures revealed no differences between limbs. Range of motion in external rotation was greater in the pitching arm (126.2 ±6.8 vs. 115.4 ±13.9 degrees; *p*=0.01), while internal range of motion was greater in the non-pitching arm (116.4 ±13.2 vs. 101.6 ±15.9 degrees; *p*=0.02).
CONCLUSION: Among male collegiate baseball pitchers, we showed that the pitching arm had significantly more robust bone parameters at the humerus midshaft compared to the non-pitching arm. While these findings are consistent with research showing side-to-side differences in loaded versus unloaded limbs in other sports. Future studies should investigate whether these differences exist at other measured sites.

3622 Board #61 June 4, 9:30 AM - 11:00 AM

Ethnic Differences In Bony Hip Morphology: A Cohort Of 445 Professional Soccer Players

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(No relationships reported)

PURPOSE: Prevalence differences between ethnicities in hip osteoarthritis (OA) are currently unexplained**.** We aimed to investigate whether the prevalence of specific bony hip morphological abnormalities differs between athletes of diverse ethnic background.
METHODS: Professional soccer players who presented for pre-participation screening were invited to participate. Ethnicity was registered and standardized anteroposterior pelvic and Dunn views were obtained. Cam and pincer deformity, and acetabular dysplasia were quantified using the alpha angle, triangular index and lateral center edge angle (LCEA). Regression analyses with generalized estimating equations were used to determine prevalence differences in hip morphology.
RESULTS: A total of 445 soccer players (890 hips) participated in the study, aged 25 (±4.9) years and representing the following ethnic groups: Arabic (59%), Black (24%), Persian (7%), Caucasian (6%), East Asian (2%) and other (2%). Prevalence of cam deformity (alpha angle>60°) ranged from 57.5% to 71.7% across four of the ethnic groups, but a significantly lower prevalence was found in the East Asians (18.8%, p=0.035). Large cam deformity (alpha angle>78°) was more prevalent in Caucasian (33.3%) than in Black soccer players (17.8%, p=0.041) and absent in the East Asian participants. Pincer deformity (LCEA>40°) was uncommon (3%) in all ethnicities. The prevalence of acetabular dysplasia (LCEA<20°) ranged between 8.0% to 16.7% apart from the Caucasian group where it was only 1.9% (p=0.036).
CONCLUSIONS: Cam deformity and acetabular dysplasia prevalence differed between ethnicities in this cohort of professional soccer players. These prevalence differences partly correlate with the varying hip OA prevalence in the ethnic groups studied

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3623 Board #62 June 4, 9:30 AM - 11:00 AM

The Relation Between Lumbar Disc Degeneration And Physical Characteristics In Male Asian Collegiate Basketball Players

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Lumbar disc degeneration (LDD) in athletes is induced by sport-specific mechanical stress and can easily lead to low back hernia and low back pain. The occurrence rate of LDD is 42.9% in US collegiate competitive basketball players. Despite the high risk for LDD in basketball players, studies on the possible risk factors for LDD are sparse, especially in Asian collegiate basketball players. As the average height of Asians is lower than that of people of major ethnicities in the United States and Europe, Asian basketball players may possess specific risk factors.
PURPOSE: The purpose of this study was to investigate the relation between LDD and physical characteristics in Asian male collegiate basketball players.
METHODS: The occurrence rate of LDD in 41 Japanese male collegiate basketball players (age, 19.3 ± 1.1 years; height, 176.8 ± 6.2 cm; weight, 70.8 ± 8.6 kg; body mass index, 22.6 ± 1.8 kg/m2; sporting experience, 10.1 ± 3.2 years) were evaluated. The range of motion (ROM) of the thoracolumbar spine, muscle tightness (finger floor distance, iliopsoas, heel buttock distance, straight leg raising, triceps surae), and general joint laxity (wrist, elbow, shoulder, knee, ankle, spine, hip) were also tested as indicators of physical characteristics. LDD was evaluated with T2-weighted magnetic resonance imaging of the lumbar spine. The degree of degeneration was classified into five grades according to the Pfirrmann classification, and a grade ≥ 3 was defined as degeneration. Significant differences between case and control values were verified with the t-test. A p-value of < 0.05 was considered statistically significant.
RESULTS: The prevalence of LDD among the basketball players in this study was 36.6% (15 of 41). We assigned the athletes to either the LDD group (n = 15) or the non-LDD group (n = 26), and found that height(180.3±6.3 vs. 174.7±5.2cm, p<0.01), weight(74.7±9.6 vs. 68.6±7.3kg, p<0.05), and thoracolumbar ROM(55.7±7.9 vs. 47.5±5.7°, p<0.01) were significantly higher in the LDD group than in the non-LDD group. There was no significant difference in other physical characteristics.
CONCLUSION: More height, heavy weight, and increased thoracolumbar ROM are possible risk factors for LDD in male Asian collegiate basketball players.

3624 Board #63 June 4, 9:30 AM - 11:00 AM

Bone Mineral Density In Collegiate Athletes And Non-athletes: Is Inactivity Promoting Osteopenia?

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(No relationships reported)

Bone mineral density (BMD) appears to be a robust predictor of fracture risk, peaking at 20-30 years of age and declining thereafter. Thus, college-aged students should demonstrate and attain peak bone mass to reduce osteoporotic fractures later in life.
PURPOSE: To compare bone mass and body composition in: 1) male and female collegiate athletes separated by sport and 2) athletes vs. non-athletes.
METHODS: In this cross-sectional study, 4 male (soccer, swimming, cross country, basketball) and 4 female (volleyball, swimming, cross country, and basketball) fall sports teams underwent whole-body dual energy x-ray absorptiometry (DXA) scans prior to their competitive season. Additionally, 23 incoming freshmen (non-athletes) underwent DXA scans prior to the fall semester.
RESULTS: No statistically significant (ANOVA) differences in total body (or regional) bone, lean or fat mass in either male or female cohorts between sports or vs. non-athletes. Male non-athletes (n=8) demonstrated the lowest BMD/ Z-scores (1.09±0.11g/cm²/-1.21±1.22) followed by swimmers (n=19;1.14±0.07g/cm²/-0.78±0.61), runners (n=11;1.17±0.07g/cm²/-0.41±0.59), soccer (n=20;1.26±0.06g/cm²/0.44±0.80) and basketball players (n=8;1.33±0.08g/cm²/no Z-score). Similarly, female non-athletes (n=15) demonstrated the lowest BMD/Z-scores (1.06±0.06g/cm²/-0.47±0.74) followed by swimmers (n=23;1.06±0.08g/cm²/-0.42±0.95), runners (n=10;1.09±0.05g/cm²/-0.18±0.64), volleyball (n=7;1.18±0.07g/cm²/0.94±0.90) and basketball players (n=13;1.21±0.10g/cm²/Z-score). Conversely, male non-athletes had the highest total percent body fat