437 THE INJURY PATTERN IN VOLLEYBALL. A COMPARATIVE STUDY.
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The aim of this study was to analyze the pattern of injuries in volleyball players, by comparing elite (EV) and non-elite (NEV) players, female (FV) and male (MV) players. Furthermore, comparisons were made between players of indoor (EV) and beach (BV) volleyball - a new and rapidly growing activity. Questionnaires were distributed to 33 teams in four different competition leagues before the beach season 1993 and the indoor season 1993/94. Replies were received from 205 players with a mean age of 27.6 years (range 18-40) with a volleyball experience of 10.6 years (range 1-29). A total of 310 injuries were reported: 194 (62.3%) in EV/NEV, 31(10.3%) in FV/MV and 42(13.9%) in BV. Most injuries in BV were in the upper extremity (46.5%), whereas lower extremity injuries (53%) were dominant in EV.

There was a higher risk of shoulder injuries in BV (p<0.05) to EV. A higher risk of ankle injuries (p<0.05) to EV. In BV most injuries occurred in field defence (39.3%) whereas higher percentages were observed in MV in field attack (41.1%) and FV in free play (42.9%). In BV, most injuries occurred during spiking (34.8%), while in EV, the cause of most injuries in EV and MV was in FV. There was a higher risk of ankle injuries (p<0.05) in EV compared to BV. We conclude, that the injury pattern is different in IV compared to BV, while there are minor differences between EV and NEV and no evident differences between FV and MV. The injury risk is higher in NEV than in EV.

438 ADVERSE RESPIRATORY HEALTH EFFECTS OF COMPETITIVE SWIMMING: THE PREVALENCE OF SYMPTOMS AND ILLNESSES IN A COHORT OF 738 SWIMMERS.
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The purpose of this study was to estimate the prevalence of respiratory symptoms and illnesses in a cohort of 738 competitive swimmers. Each of the swimmers filled out a respiratory health questionnaire that was modified to ask specific information about their medical history, the occurrence of respiratory symptoms during exercise, and the amount of training they did. The overall prevalence of swimmers was 13.6%. There was, however, a significant difference among the three groups of competitive swimmers that we identified. This included 10.6% of Age Group Swimmers, 11.1% of National Qualifiers, and 20.6% of International Level Swimmers. The prevalence of swimming-related symptoms included sneezing (45.0% of participants), difficulty breathing (39.4%), coughing (36.4%), sore eyes (36.6%), headaches (35.9%), sore throats (27.1%), wheezing (26.3%), chest tightness (24.8%), and chest congestion (22.8%). All of the symptoms, except for sore eyes, were strongly associated with a swimming-related exposure. We also identified a number of gender- and age-related differences for several of the swimming-related symptoms. Female swimmers were more likely to cough, feel congested, have difficulty breathing, and experience headaches. Male swimmers were more likely to feel worn-out, need more rest, wheeze, have chest tightness, or difficulty breathing, sore throats, and headaches. A majority of the swimmers reported that their symptoms were less severe, less noticeable, or absent if they spent several days away from the swimming pool.

439 PREDICTING STRESS FRACTURES DURING RIGOROUS PHYSICAL TRAINING USING SIMPLE MEASURES OF PHYSICAL FITNESS AND ACTIVITY.
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Predicting stress fractures (SF) in military trainees is the first step in reducing the significant impact of these injuries on military training programs. The purpose of this study was to predict future SF in basic training based on the incoming fitness and activity profile of male U.S. Marine Corps recruits undergoing basic training. During a two-week period all entering basic training (N=1238) were asked to participate; 1138 consented. A short 10 item questionnaire was administered querying the recruits about their medical history prior to entering basic training. Based on this information as well as a 1.5 mile test the recruits were assigned a priori to high (18.7%) or low (81.3%) risk of SF. Physical fitness, injury history, and SF risk were assessed in a training, 43 subjects (incidence 3.8%) developed SF as diagnosed by clinical presentation and confirmed by radiograph and/or physical therapy. Risk factors by SF recruit's SF risk category. SF incidence among the high risk group compared to the low risk group (RR=2.52, 95% CI 1.02-5.47). Our data suggest that the risk of SF during rigorous physical training is increased by poor physical fitness and low levels of physical activity prior to training.

440 DIFFERENTIAL MUSCLE FATIGUE DURING CONTINUOUS AND REPEATED CONTRACTIONS IN MM-CREATINE KINASE DEFICIENT MICE.
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The importance of the creatine kinase (CK) reaction lies in the buffering of the ATP concentration in active skeletal muscles. Skeletal muscle of mice lacking MM-CK still showed a normal ATP concentration at the lowest level after a series of isometric twitch contractions (1Hz). However, twitch force dropped quickly to 50% after 5 s twitches (1Hz) or to 30% after 5 s contractions (4Hz), whereas force stabilised and even slightly increased (Van Den Dungen et al., Cell 74: 261-263, 1993). To test the need for buffering of ATP by the CK-system in the present study control and MM-CK deficient skeletal muscles were fatigued in situ using different types of exercise (one continuous maximal voluntary contraction of 6s duration (stimulation frequency 100Hz; 35°C), and series of 20 repeated maximal contractions within 6s, either isometric (150 ms) or dynamic (60ms)). Surprisingly, the amount of force decay during the 6s continuous contraction was similar in the deficient and control mice. In the series of repeated contractions the force of the control muscles decayed slowly between the 10th and the 20th contraction to 85% (isometric) and 55% (dynamic). In contrast, in the deficient mice the force of the lowest contraction was 60% and 55% (isometric and dynamic, respectively), but remained unchanged during the further 19 contractions. The main conclusion from this study is that role of the CK-system during a continuous isometric contraction seems to be small or absent, in contrast, during a series of repeated contractions, during which peak energetic fluxes are higher, the CK-system seems important in maintaining a high level of substrate output during the start of exercise.

441 FATIGUE IN MALIGNANT HYPERTERMIC (MH) AND NORMAL (N) PORCINE SKELETAL MUSCLES.
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Excitation-contraction coupling (ECC) of MH muscles is abnormal in that the sarcolemmal receptor Ca2+ release channel is altered by a mutation in the ryanosin receptor gene. Since impaired ECC may play a role in skeletal muscle fatigue, we examined the fatigue characteristics of MH (MM-CK deficient) and N pig muscles. Small bundles of intact fibers were fatigued using: 1) high frequency stimulation to induce action potential failure, and 2) lower frequency stimulation to induce metabolic alterations. In response to high frequency (100 ms trains, 200 Hz, 1/sec) both N and MH muscles fatigued similarly in the first 30s of stimulation (time for peak tetanic tension (PT) to fall to 75% of control: 1.6±0.19 min in N and 1.32±0.13 min in MH). Full recovery of both twitch and tetanic in both MH and N muscles occurred in 5 min. Lower frequency stimulation (100 ms trains, 100 Hz, 1/sec) separated both MH and N bundles into two groups: 1) bundles that fatigued in <45 s, and 2) bundles that required <15 min. In the slowly fatiguing bundles, time to 25% decrease in PT, for MH (52.3±2.3 min) was significantly shorter than for N (94.1±11 min). Times to 25% decrease in PT, in the fast fatiguing bundles were not different for MH (51.6±1.1 min) and N (101.2±2 min). Recovery in N occurred in <15 min. The possibility that the basis for the difference in time to fatigue of the fast and slow fatiguing groups was a difference in fiber type composition of bundles is being investigated. The more rapid fatigue in MH muscles may be due to differences in cellular Ca2+ regulation. Supported by NIH AR41270.

442 SURFACE EMG MEDIUM FREQUENCY IS DECREASED IN WEAKENDED QUADRECEPS MUSCLES.

Needle EMG studies have documented a decreased firing rate of motor units in skeletal muscle following immobilization. Surface EMG (SEMg) analysis of muscle weakened by injury or surgery can be analyzed for its frequency content via the Fast Fourier Transformation (FFT). The median frequency (MF) obtained describes shifts in firing rates of recruited motor units. Therefore, we examined the SEMG in 8 pain-free patients who had quadriceps weakness strength deficit (P<0.01) on the injured side during short (<5 second) maximal isometric contractions. In addition, 7 control subjects without weakness performed 2-3 (so chosen for peak tension without failure) during 3 maximal contractions. The mean of the three contractions analyzed statistically. The injured group had a significantly lower MF in the weak (N=4.4±0.5 Hz, P<0.05) with a similar trend in the weak VL. The control group tended toward lower MF of both VL and VM in the dominant leg. The injured group had 4 dominant and non-dominant injured legs. There was a significant interaction between weakness and dominance (P<0.05), so that weakness and dominance were both associated with a lower MF during maximal contraction. (in the injured leg, this may reflect loss of recruitment) of high frequency motor units or a generalized decrease in firing rate of all motor units and parallels the findings in other muscle groups using needle electrodes.

443 C-19 POSTER MUSCLE FATIGUE.