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 (IV) 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 1992/93. Replies were received from 205 players with a mean age of 27.6 years (range 18-40) and a volleyball experience of 10.6 years (range 0-35). A total of 310 injuries were reported; 194/116 in EV/NEV, 24/26 in IV/BV. Most injuries in BV were in the upper extremity (30%), whereas lower extremity injuries (51%) were dominant in IV. There was a higher risk of shoulder injuries (p<0.05) in BV. In BV most injuries occurred in field defense (32%), whereas in IV, 83% of injuries occurred in the spiking (34%). Spiking was the cause of most injuries in EV and IV. In BV, BV and IV, there was a higher risk of ankle injuries (p<0.001) in NEV compared to EV. 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 completed a respiratory health questionnaire that was modified to ask specific questions about their medical history, the occurrence of respiratory symptoms during exercise, and the amount of training they did. The overall prevalence of the 738 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, 17.0% of National Swimmers, 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 (24.3%), 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 warmth, warmth, 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.

Predicting stress fractures (SF) in military training is the first step in reducing the significant impact of these injuries on military training programs. The purpose of this study was to develop and evaluate the ability to predict subsequent SF based on the incoming fitness and activity profile of male U.S. Marine Corps recruits undergoing basic training. During a two week period all new arrivals were entering basic training (N=1238) were asked to participate; 1136 consented. A short 10 item questionnaire was administered querying the recruits about their current fitness and activity levels prior to entering basic training. Based on this information as well as on a 1.5 mile run, the recruits were assigned a priori to high (18.7%) or low (81.3%) risk SF. The results of the physical training, 43 subjects (incidence 3.8%) developed SF as diagnosed by clinical presentation and confirmed by radiograph and/or medical history. Furthermore, 10 subjects were classified by SF recruiters SF risk category. SF incidence among the high risk recruits as compared to the low risk recruits (RR=2.52, 95% CI 1.82-3.47). 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.

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 CK-i still showed a normal resting ATP level after a series of isometric twitch contractions (1Hz). However, twitch force dropped quickly to 25% after 9 twitches (1Hz) or to 55% after 9 contractions (1Hz), whereas force stabilized and even slightly increased (Van Derlaus et al., Cell 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 fatiguing contraction sequence of 5s duration (stimulation frequency 100Hz, 35°C), and series of 20 repeated maximal contractions within 3s, either isometric (150 ms) or dynamic (66ms). Surprisingly, the force of the force decay during the 3s contraction sequence was similar in the control 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 control mice the force of the MM-CK deficient muscles did not significantly decrease. These results suggest that the CK-system plays an important role in maintaining a high level of contractile output during the second of exercises.

441 FATIGUE IN MALIGNANT HYPERPYERHOMATIC (MH) AND NORMAL (N) FORCING SKELETAL MUSCLES.
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Excitation-contraction coupling (ECC) of MH muscles is abnormal in that function of the sarcoplasmic reticulum Ca2+ release channel is altered by a mutation in the ryanodine receptor gene. Since impaired ECC may play a role in skeletal muscle fatigue, we compared the fatigue characteristics of normal (N) and MH 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 bundles failed in series (time for peak tetanic tension (T2) to fall to 75% of control: 1.64±0.19 min in N and 1.32±0.13 min in MH). Full recovery of both twitch and tetanus in both N and MH occurred in 2-3 min. For T2 (strength deficit of 25%) required <15 min. In the slowly fatiguing bundles, time to 25% decrease in T2 in the fast fatiguing bundles were not different for MH (10.6±1.1 min) and N (10.2±0.3 min) and recovered in <15 min. The possibility that the basis for the differences 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 MEDIAN FREQUENCY IS DECREASED IN WEAKENED QUADRICEPS MUSCLES.

Needle EMG studies have documented a decreased firing rate of all 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 >5%, P<0.05) for at least 3 months due to either maximal isometric contractions. In addition, 7 control subjects without weakness (<2%) were tested to examine the effect of dominance. The MF of the SEMG of the vastus lateralis (VL) and the vastus medialis (VM) was computed for second 5-10 (5 chosen for peak tension without fatigue) during 3 maximal contractions. The means of the three trials was analyzed statistically. The injured group had a significantly lower MF in the VM (2.4 v 6.4 Hz, P<0.05) with a similar trend in the VL. The control group trended toward lower MF of both VL and VM in the dominant leg. The injured group had a 4 dominant side vs non-dominant injured legs. There was a significant interaction between weakness and dominance (P<0.05). This suggests that the 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.