Physiological demands in top level female team sports with a special focus on handball

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Introduction
Women’s performance levels have increased dramatically during the past decades. Training programs and skill acquisition have reached new heights. Competitions is both exciting and entertaining. This is especially true for team sports. In most aspects of physiology and performance, men and woman fall along a continuum of personal characteristics and physical performances. Most athletic events were originally designed for men to play and therefore designed for their body type. As women differ in their mean muscle mass, muscle power, strength, speed, and a lot of other aspects from men, it is important to investigate the gender-specific demands of each sport for the development of sports-specific training programmes and for the identification of talent identification programmes.

Duration of matches in team sports varies between 50 min and more than 90 min, depending on the kind of sports. They are characterised by intermittent strains with maximal and sub-maximal exercise intensities, and with incomplete recovery phases in between. Demands on cardiovascular system might be nearly maximal during the matches in accumulating high intensity phases. Energy metabolism varies according to the intensity and duration of the match. Individual response mainly depends on performance level, which principally is independent of gender.

Investigations in female team sports

10 – 15 years ago VO$_{2\text{max}}$ values of female team players have been shown to be 50.8 ml/min/kg in touch football, 43.2 - 47.9 ml/min/kg in soccer, 47.9 ml/min/kg in hockey, and 43.8 - 47.3 ml/min/kg in rugby (O’Connor 1995). Probably VO$_{2\text{max}}$ values have increased and are much higher now. In an own investigation we determined VO$_{2\text{max}}$ values around 49 ml/kg/min and 51 ml/min/kg in the Spanish and German handball national team, respectively, and around 44 ml/min/kg and 51 ml/min/kg in a Spanish and German first league team, respectively. VO$_{2\text{max}}$ values in top-level international handball teams are even much higher. They have been around 51 ml/min/kg in the Norwegian team in 1995 (Jensen et al. 1997) and are now around 56 ml/min/kg in the actual Norwegian national team.

These data indicate that international female handball has increased dramatically in it’s dynamic and intensity in the last years. The exact demands of modern female top level handball, however, have not been investigated systematically. Therefore, scientifically well based training programs do not exist and might not be deduced so far. We analysed some physiological demands of actual top level international handball matches for the development of recommendations concerning performance characteristics and training necessities of players.

Own investigation in handball

7 matches of the German female national team during the European Championship in 2004 in Hungary were recorded on video. The real play times of each player, e. g. the time when the ball was in the match and the player was on the field, as well as the duration of highly intensive match phases were analysed. 14 of 16 players of the German team (age: 26.6 ± 3.8 yrs, height: 176.0 ± 7.4 cm, weight: 70.4 ± 6.8 kg) agreed to wear heart-rate-monitoring belts (Polar, team system) during the matches. Heart rates (HR) were recorded every 5 sec. For further analysis mean HR of the real playing phases of 5 of the 7 matches of each player were calculated so far in 12 players. Individual maximal HR had been determined prior to the tournament during a shuttle-run test. Velocity corresponding to 4 mmol/l lactate concentration (v4) had been determined in a preceding incremental field test (start at 2 m/s, increase by 0.4 m/s every 5 min).

Results
Mean time of one attack from all matches was 23.0 ± 1.9 sec.. The highly intensive phases of attack had a mean duration of 5.8 ± 0.4 sec.. Number of attacks was 28.2 ± 2.8 per half time. The players had a mean action time of 41.4 ± 15.2 min, mean HR was 161.7 ± 11.9 1/min, corresponding to 86.9 ± 5.5 % of maximum HR. V4 was 3.3 ± 0.3 m/s. Interestingly, we found a high and highly significant negative correlation between v4 and mean percent HR during the matches (r=-0.96, p<0.01).

Conclusion
Cardiopulmonary demands were very high in all players in all matches, over wide periods near the individual maximum heart rate. To our knowledge it could be demonstrated for the first time in a team sport, that individual load during a highly demanding tournament is the higher the worse developed is basic endurance capacity (v4). This clearly demonstrates the necessity of basic endurance training and the development of a high maximum oxygen uptake in international top level handball. Although these data have been taken in handball, it is very probably that the same correlations might be demonstrated in other team sports with comparable energetic demands. We conclude, that a well developed basic endurance capacity is necessary for international top level team sports.

References