MASTER I IDRETTSVITENSKAP 2022/2024
ORDINARY EXAM
IN
EXERCISE BIOLOGY AND SPORT PERFORMANCE ANALYSIS I (MA460)

SENSOR GUIDE

Seminar 1: Running economy, a physiological and biomechanical perspective (10 points)
Question: Identify factors that may improve running economy and explain the mechanisms by which such improvements may occur.

SENSOR GUIDE:
Students should refer to the information provided in the lecture, and consider how specific variables (e.g. stiffness, stride length, stride frequency, force variables, contact time) influence running economy. They should define the variables they discuss, explain how they can be measured, and consider how this may influence performance. They can relate theory about how running economy may be improved with the contributions of vertical force and horizontal force to oxygen uptake, as discussed in the lecture.

Seminar 2: Muscle mechanics (10 points)
Questions

1. During a running test, how can muscle architectural data be used to estimate the instantaneous force being produced? Your answer should include the concept of force-length-velocity potential seen in the lecture.
2. Explain the advantage and the disadvantage of a short Achilles tendon moment arm for a sprint runner.

SENSOR GUIDE:

1. During a running test, how can muscle architectural data be used to estimate the instantaneous force being produced? Your answer should include the concept of force-length-velocity potential seen in the lecture.
2. The expected answer should relate to muscle architecture data recorded during contraction with ultrasound. It should explain how instantaneous length and contraction velocity are related to FL and FV relationships, defining a force potential, which is lower than the maximal force potential. The latter should be linked to PCSA and specific tension. The answer should explain how the produced force can be calculated as a function of force potential, FL and FV.

Seminar 3: Oxygen transport and utilization during whole body maximal exercise (10 points)
Questions:

1. Explain how and to what extent the following organs limit maximal oxygen consumption during whole-body maximal exercise a) The lungs. b) The heart c) The blood d) The muscles
2. Oxygen delivery increases with endurance training. What are the mechanisms?

SENSOR GUIDE:

1) Explain how and to what extent the following organs limit maximal oxygen consumption during whole-body maximal exercise
   a) The lungs: In untrained to moderately trained individuals, the lungs (and ventilation) constitute more or less no limitations to the maximal oxygen uptake. The arterial oxygen saturation is kept close to 100%, meaning that the blood, even with higher lung capacity, could not take up more oxygen. However, in well-trained individuals, arterial oxygen saturation can fall close to or below 90% during maximal exercise, which would limit their maximal oxygen uptake.
   b) The heart: Maximal stroke volume multiplied by maximal heart rate constitutes the maximal cardiac output. The cardiac output determines, combined with the arterial oxygen content, the oxygen delivery to the exercising muscles, which is the most important limitation to maximal oxygen uptake. The most evident effect of endurance training is increased stroke volume and maximal cardiac output, which directly impact maximal oxygen uptake.
   c) The blood: The blood can limit the maximal oxygen uptake in two ways: 1) The haemoglobin concentration decides the upper limit for the arterial oxygen content and hence it influence oxygen delivery to the exercising muscles. 2) The total blood volume impacts the venous return to the heart and its filling. Hence, blood volume is of major importance for the stroke volume and maximal cardiac output.
   d) The muscles: For each litre of blood deliver approximately 200 ml oxygen to the muscles. The muscle can take up 70% - 95% of this oxygen (fractional oxygen extraction). The fractional oxygen extraction is determined by "qualities" in the muscle, mostly capillary density and mitochondrial volume. Endurance training has huge impact on these qualities.
2) Oxygen delivery increases with endurance training. What are the mechanisms?
   Training increases blood volume and the venous return to the heart which increases the stroke volume and the maximal cardiac output. Structural changes in the heart can also be observed, including increased left ventricular mass and cardiac compliance. Haemoglobin concentration is normally not effected by training, but increases during the first weeks of "altitude training".

Seminar 4: Biomechanics of overuse injuries (10 points)

Question: Discuss the challenges and limitations of research related to identifying biomechanical risk factors for overuse injury. Consider study design and provide examples to support your answers.

SENSOR GUIDE:

Students should refer to the information provided in the lecture, and discuss the common designs for injury research. These include cross-sectional/retrospective studies, prospective studies and RCTs. Challenges include participant numbers, inconsistent variables, inconsistent definitions and injury reporting, amongst others. Limitations include combining different injury sites, confounding factors, retrospective study design amongst others.

Seminar 5: Strength training for elderly (10 points)

Question: Discuss the possible effects of physical training on specific strength and the underlying mechanisms in an untrained 80-year-old participant.

SENSOR GUIDE:

In general, strength training has a good effect on both muscle strength and mass in elderly and over 12-week typical changes are around 20-30% increase in strength measured as 1RM

and 5-10% increase in muscle cross sectional area. (CSA). The larger increase in strength than in CSA points at an improved muscle quality which in this case can be termed specific strength (strength per muscle volume or CSA). In more isolated strength tests such as isokinetic or isometric knee extension, the increase in strength is closer to the increase in CSA and muscle mass, but still there are clear indications of improved specific strength. Impairments in aged muscle that can explain reduce specific strength and that probably are modifiable by physical exercise are intramuscular fat (IMAT), reduced protein quality (related to impaired mitochondrial function and protein quality control) and reduced muscle activation. How much these factors can be affected by training is still unclear, but there is documentations for training effects on all factors. Furthermore, the combination of strength and endurance training might have a better effect on some of these mechanisms than strength training alone due to the extra effect of endurance exercise on mitochondrial function and protein quality control.

Seminar 6: Integrated performance analysis (10 points)
Question: Explain differences in pacing pattern and energy system contribution during 30 min running on track versus 30 min cross-country skiing with varying terrain.

SENSOR GUIDE:
During running on a course, the pacing pattern is flat as the exertional load is identical. During XC skiing the pacing pattern is variable due to the fluctuations in terrain and speed. The average oxygen uptake is though similar for both events. However, due to the possibility to rest in the downhills, a skier can have a very high workload during uphill (typical 120-150% og VO2peak). Hence, is such part the XC skiers use a part of their anaerobic capacity which is recovered during the downhills.

Seminar 7: Performance analysis in Team sport (10 points)
Questions:

1. How can match analysis contribute to the training planning process?
2. Several contextual factors can influence the outcome of a match analysis. List three (3) possible factors.
3. A sprint in a typical match analysis is defined by a (so called) speed threshold (e.g. 25 km/h). What is the challenge with this definition when it comes analyzing the training load players are subjected to?

SENSOR GUIDE:

1. A match analysis of physical performance can inform decisions related to the load athletes need to be prepared for in competition (needs assessment). This is important in training planning.
2. Game location, quality of opposition, match status, match half
3. The use of speed thresholds in match analysis results in that everything before you reach the threshold (e.g. 7 m/s) does not count as a sprint. That means that even though you accelerate with full effort, the effort will not be categorized as a sprint as long as you are below the defined threshold. Measurements of accelerations may therefore be important to get a wider picture of the training load.