Cross country (XC) skiing is one of the most demanding sports showing up a large variety and a multiplicity of determinants of performance. There are two basic skiing techniques, the classical style and skating style. However, both techniques include up to five sub techniques that are applied, depending on the snow conditions, skiing speed and shape of the terrain that mostly consists of a mixture of flat parts, steep and moderate uphill sections, and downhill segments. During a race athletes have to switch between those techniques a several hundred times, leading consequently to a steady change in physiological and mechanical demand. The single techniques use both the upper and lower body to various extents. Especially with the recent introduction of sprint races in the World-Cup series, very new facets of training and testing enter the field of research. Altogether, XC skiing is determined by multiple of factors such as aerobic and anaerobic capacity, power, strength, speed, technical level, tactical behaviour, mental strength, etc. This variety in XC skiing constitutes a challenge for athletes, coaches and scientists, and gives wide scope for research. One of the major challenges in XC skiing can be seen in the standardization process of testing concepts. Owing to the strong influence of external conditions like changing snow, temperature and wind conditions on test results, it is difficult to obtain standardized tests with reliable and valid results. But also when using roller skis in outdoor conditions, the friction and rolling resistance partly changes drastically. Depending on the roller ski type and the wheel material, air temperature and tarmac temperature, together with wet or dry conditions, strongly influence test performance. Hence, the possibility to get reliable test results at different weather conditions is rather low. Test concepts in a laboratory setting, where stable conditions are guaranteed, seem to be the best solution to achieve standardized and reliable test results in XC skiing. Therefore various treadmill-based roller-ski tests, specific strength training devices and appropriate field tests were developed, investigated on reliability and checked on validity. For the XC skiing sprint a competition simulation was performed to get information on physiological loading and relationships between physiological and biomechanical variables to performance. Additionally, biomechanical analysis on single XC skiing techniques, current and maybe future technical and technological developments using kinematic, kinetic and electromyopgraphic methods were performed. Finally, the most stable and strongest performance related variables were extracted. In total these test concepts and achieved results should provide a scientific basis for reasonable testing and training for XC skiing.

Keywords: Testing, Physiology of Exercise, Biomechanics