Research Focus

Alpine Space - Man and Environment

Alpine Sports

RISK AND PREVENTION

Annually, an estimated 40 million mountain tourists visit the Alps and there are more than 100 million such tourists worldwide. On the one hand mountaineering activities may contribute to well-being and longevity but on the other hand, these activities may also be associated with injury risk and serious cardiovascular events. (1,2) Our research focuses on the identification of risk conditions and developing preventive measures.

Sudden cardiac death (SCD) is the most frequent cause of death in males older than 34 years during leisure time activities at altitude such as downhill skiing and hiking. Prior myocardial infarction is a major risk factor for SCD. (Fig. 1) Regular physical activity including high intensity exercises are important preventive measures.(1)

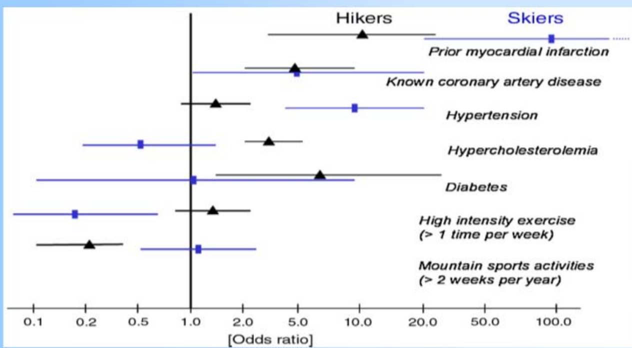

Fig. 1. Adjusted odds ratios (95% confidence intervals) regarding the prevalence of risk factors among mountain hikers and downhill skiers who had sudden cardiac death compared to controls.

Head and knee injuries are the most common injuries during alpine skiing.(3,4) Severe head injuries include traumatic brain injury, which is a leading cause of death among winter sport participants. In addition to helmet laws, education and increased public awareness can help to increase helmet use and to reduce the incidence and severity of brain injuries.(3,4) In recreational alpine skiing, injury risk of the anterior cruciate ligament (ACL) is 3 times greater in females. Bindings not releasing at the time point of accident occurred 2.6 times more in females than males.(5) Additionally, leg dominance seems to be a risk factor for non contact ACL injuries in female recreational skiers.(6) There is increasing evidence that different types of neuromuscular training can prevent ACL injuries, specifically in female athletes.

Acute mountain sickness (AMS) is the most common condition of high altitude illnesses.(7) Its prevalence varies between 15% and 80% depending on the speed of ascent, absolute altitude reached, and individual susceptibility. We found a higher AMS prevalence in the Eastern Alps (35%) compared to the Western Alps (25%).(7) The lower mountaineering experience of mountaineers in the Eastern Alps turned out to be the only factor for explaining their higher AMS prevalence. High-altitude headache (HAH) is the most frequent symptom in mountaineers suffering from AMS. In a large sample of mountaineers HAH was reported in 31% of study participants after the first overnight stay at altitude.(8) Logistic regression analysis revealed a migraine history, low arterial oxygen saturation, high ratings of perceived exertion and fluid intake below 2L to be independent risk factors for the development of high-altitude headache.

PERFORMANCE IN ALPINE SPORTS

Mountain sports activities and related environmental conditions represent very effective stimuli on aerobic exercise performance in amateur and elite athletes as well. An Olympic gold medal winner in cross country skiing demonstrated maximal oxygen uptake (VO2max) of 90.6 mL/min/kg (45 s average; 26 METs; 5.7 L/min).(9) But even more impressive than VO2max was his ability to exercise at a VO2 of 65 mL/min/kg (71.4% VO2max) at a lactate level of 1.6 mmol/L. At the self-selected maximal lactate steady state he consumed 78 mLO2/min/kg (85.7% VO2max) with a corresponding lactate level of 4.4 mmol/L. (Fig. 2). These values rank among the highest ever demonstrated in human beings.(9)

Long- and short-term exposures to altitude/hypoxia are used by athletes to improve exercise performance. Intermittent exposures of runners to hypoxia (2h at rest on 3 days/wk for 2 x 5 weeks) was accompanied by a more distinct response of running economy at the beginning of the pre-season compared to the beginning of the competition season. This may have practical implications on the planning of training.(10)

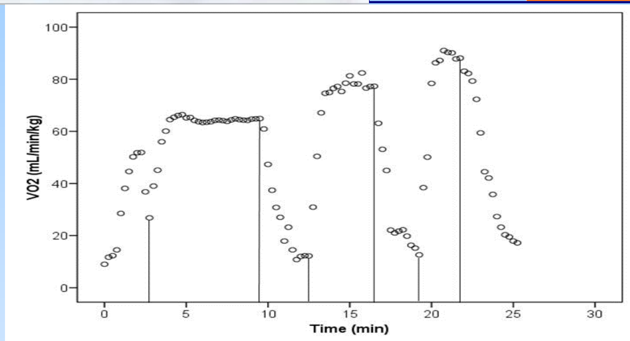

Fig. 2. The figure depicts the course of VO2 (15 s intervals) during three bouts of roller-ski exercise at various intensities (moderate, hard, and very, very hard)

EQUIPMENT AND MODELLING

Competitive and recreational sport on artificial ice tracks has grown in popularity. For track design knowledge is needed on the expected speed and acceleration of the luge on the ice track. Therefore, an approximate simulation model for luge to support the initial design of new ice tracks was developed.(11) The trajectory of the luge on the ice track was estimated using a quasi-static force balance and a 1d equation of motion was solved along that trajectory. The drag area and the coefficient of friction were determined by parameter identification using split times of the Whistler Olympic ice track. It was assessed in this parameter study that the safety of a new ice track is mainly ensured in the planning phase, in which the use of a simulation model is essential.

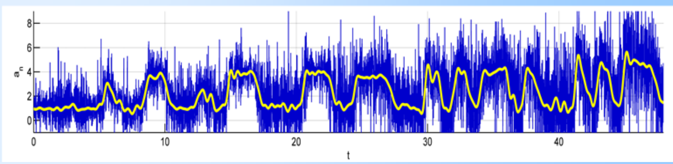

Fig. 3. Normal acceleration a_n [g] versus run-time t [s] in single luge at the Whistler ice track.

Start plays a critical role in sliding events and explains more than 55% of the variance of the final time in luge. Thus measurement and feedback training tool (Speedpaddler) for the arm strokes of high-performance luge athletes has been developed.(12) The construction is an aluminium alloy framework with a customary belt conveyor system, which is driven by two synchronized servo motors. Training is possible with constant speeds up to 12 m/s.

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