

Proceedings of the Ninth International Congress on Science and Skiing (ICSS) – Saalbach/Hinterglemm March 2023

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EDITORIAL

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ABSTRACT

Winter sports play a crucial role across individuals of all age groups, whether professional athletes or recreational enthusiasts and holds benefits in terms of health and well-being with considerable economic and touristic importance. Besides these benefits challenges arise as equipment safety, athlete preparation to perform on highest level and prevent from injury, rehabilitation, sustainability, equipment optimization, training and testing concepts, to name a few. In this context, the International Congress on Science and Skiing (ICSS) has been a regular pivotal gathering for over 20 years. The ICSS was hosted first time in 1996 in St. Christoph am Arlberg and celebrated in 2023 the 9th conference in Saalbach/Hinterglemm (Austria). The ICSS gathers sport scientists, medical doctors, coaches, sport & tourist managers, company representatives, students and athletes around the world with up to 250 participants from more than 15 nations with inspiring keynote and invited speaker lectures, as well as calls for more than 120 oral and poster presentations. Selected contributions were critically reviewed to be published in this special issue in *Current Issues of Sport Science*. The content of these articles also demonstrates the broad spectrum of contributions of all fields and disciplines in winter sports – in particular, for Alpine skiing, cross-country skiing, ski mountaineering and more overarching topics about load monitoring and equipment technology.

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Introduction

Winter sports play a crucial role across individuals of all age groups, whether professional athletes or recreational enthusiasts. The movement in nature holds significant benefits in terms of health and well-being (e.g. Müller, Gimpl, Kirchner, et al., 2011; Müller, Gimpl, Pötzelsberger, et al., 2011; T. Stöggl et al., 2016; T. L. Stöggl et al., 2016, 2017) and has considerable economic and tourism importance. However, alongside these benefits, several challenges arise, including improvements in equipment safety, athlete preparation for maximal sport performance and for injury prevention and rehabilitation, sustainability, the drive towards more environmentally friendly materials, and the optimization of equipment, training and testing concepts to push athletes to their performance limits amidst climate change, to name a few. In this context, the International Congress on Science and Skiing (ICSS) has been a regular pivotal gathering for over 20 years.

The ICSS was first hosted in 1996 in St. Christoph am Arlberg (Austria) by the Department of Sport and Exercise Science of the University of Salzburg. Founder of the ICSS initiative and long-time president was Prof. Erich Müller. Since this time, the ICSS was hosted six times in St Christoph/Arlberg (Austria; 1996, 2000, 2007, 2010, 2013, 2016), once in Aspen/Snowmass (US; 2004) and once in Vuokatti (Finland; 2019). The ICSS is, to date, the largest congress in the field of ski science. In 2023 the 9th ICSS was held for the first time in Saalbach-Hintertglemm (Austria) – host of the Alpine Skiing World Championships in 2025.

The ICSS gathers sport scientists, medical doctors, coaches, sport & tourist managers, company represen-

tatives, students and athletes around the world with up to 250 participants from more than 15 nations. The congress program provides inspiring keynote and invited speaker lectures, as well as calls for more than 120 oral and poster presentations in the field of winter sports (Alpine skiing, cross-country skiing, ski jumping, Nordic combined, biathlon, freestyle skiing, ski mountaineering, snowboard etc.) and various scientific disciplines (training science, physiology, biomechanics, sports technology, sport pedagogics, sports psychology, sociology, marketing & media, etc.). The highlights of the 2023 ICSS congress were the four keynotes presented by Hans-Christer Holmberg (Sweden), John Seifert (USA), Vesa Linnamo (Finland), and Nils Haller (Germany) and the presentation of the Young Investigator Award (YIA). The YIA Scientific Committee, headed by Stefan Lindinger, selected Christoph Thorwartl as the winner of the ICSS 2023 presenting a novel methodology and sensor technology to analyze the ski-snow interaction in relation to the lean angle, radial force and curvature while Alpine skiing on-snow. In addition, a special session was hosted by the Fédération Internationale de Ski (FIS) by the FIS-Athlete Health Unit with the topic “Recent efforts towards injury prevention in snow sports”, to debate the most recent concepts and strategies to reduce the risk of injury in Alpine skiing. Out of the 120 presentations, selected contributions were critically reviewed to be published in this special issue in *Current Issues of Sport Science (CISS)*. The content of these articles also demonstrates the broad spectrum of contributions of all fields and disciplines in winter sports.

Overview of the ICSS 2023 Special Issue

With respect to Alpine skiing Gallimore et al. (2024) focused on the identification of the optimal racing line for top male athletes on the famous S-curved segment – the Brüggli S – of the world-cup downhill FIS World Cup track Lauberhorn in Switzerland by application of GNSS-tracking. The maximum curvature in the first curve was shown to be strongly correlated with the maximum curvature of the second curve. For the athletes under investigation, the overall best racing line was characterized by a defined ratio of the maximum curvature of the first to the second curve. Menhorn et al. (2024) presented an automatic gate-to-gate time recognition system using neural networks based on audio recordings in slalom skiing. The solution utilized a convolutional neural network (CNN) to predict gate locations using the audio signals generated upon gate contact. The majority of predictions demonstrate high accuracy, falling within a range of thousandths of a second. Finally, Hummel et al. (2024) used data of inertial measurement units (IMUs) to estimate the ski orientation. With their procedure, they were able to measure roll angles of the ski with high accuracy compared with a 3D motion capture system.

Prominent during the ICSS 2023 was the recently introduced Olympic discipline Ski Mountaineering (SKIMO) with several scientific contributions. As an example, Turczyn et al. (2024) focused on the effects of the application of a heel riser on kinematics, psychological strain and muscle activity during SKIMO in on-snow field conditions. They found distinct changes in body kinematics and rating of perceived exertion when using a riser height compared with no riser, however these alterations were not mirrored by measures of muscle activity (EMG) and heart rate.

For cross-country skiing Larsson et al. (2024) analyzed the aspect of the flow field around the skier – a topic that was so far almost untouched by scientific research in cross-country skiing. In their study they investigated the possibility of using particle tracking velocimetry for visualization and measurement of the flow field

around cross-country skiers while roller skiing on a treadmill in a wind tunnel. It was found that the experimental approach has the potential to provide detailed insights, both qualitatively and quantitatively, into the flow field dynamics. On a more sport-sociological area, Aalberg et al. (2024) examined the pathways of development of world-class ski performance in cross-country skiers and freeskiers by applying of a digital questionnaire. The main outcomes of this study were that there are similarities in athletes' entrance to the main sport, specialization age and total amount of training, while at the same time, differences were observed in their training history regarding the organization of training. In contrast to cross-country skiers, freeskiers seem to be more self-organized and more involved in additional activities besides their main sport.

The winter sport discipline overarching topic of load monitoring was touched on by Haller et al. (2024). This contribution presented an overview about the various aspects of load monitoring in general and in particular for winter sports. This review summarizes the general knowledge from various sports about training load and its effects on injuries and illnesses is. After outlining the fundamentals of load monitoring, common monitoring tools, such as neuromuscular performance tests, heart rate measures, blood-based biomarkers, and questionnaires are presented and their potentials and pitfalls in the application are presented. Finally, also Lockwood et al. (2024) focused on a topic that can be applied for several types of winter sports – in particular where laces are applied. In their publication, the design and build of a portable apparatus for measuring lace tension is presented. The apparatus was designed to be (i) portable, (ii) able to accommodate different types of footwear, lace materials, and lacing patterns, and (iii) able to measure lace tension while the footwear was secured on the foot. In summary, the apparatus was able to provide reliable measurements of lace tension while satisfying the design criteria. It is envisioned that the apparatus can be used for ongoing investigations across different types of footwear and laces (e.g. cross-country skiing boots).

We trust that you will find the articles informative, innovative, and inspiring, and hope that they motivate you for your next winter sports related research idea.

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Data availability statement

All relevant data are within the paper.