Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Mechanisms of anterior cruciate ligament injury in World Cup alpine skiing: a systematic video analysis of 20 cases.
Author(s):	Bere, T., Florenes, T. W., Krosshaug, T., Koga, H., Nordsletten, L., Irving, C., Müller, E., Reid, R. C., Senner, V., & Bahr, R.
Publication Details (add citation and DOI number)	Bere, T., Florenes, T. W., Krosshaug, T., Koga, H., Nordsletten, L., Irving, C., Müller, E., Reid, R. C., Senner, V., & Bahr, R. (2011). Mechanisms of anterior cruciate ligament injury in World Cup alpine skiing: a systematic video analysis of 20 cases. *The American Journal of Sports Medicine,* 39(7), 1421-1429. doi: 10.1177/0363546511405147

ABSTRACT

Background: There is limited insight into the mechanisms of anterior cruciate ligament injuries in alpine skiing, particularly among professional ski racers. This study was undertaken to qualitatively describe the mechanisms of anterior cruciate ligament injury in World Cup alpine skiing. **Methods:** Twenty cases of anterior cruciate ligament injuries reported through the International Ski Federation Injury Surveillance System for 3 consecutive World Cup seasons (2006-2009) were obtained on video. Seven international experts in the field of skiing biomechanics and sports medicine related to alpine skiing performed visual analyses of each case to describe the injury mechanisms in detail (skiing situation, skier behavior, biomechanical characteristics). **Results:** Three main categories of injury mechanisms were identified: slip-catch, landing back-weighted, and dynamic snowplow. The slip-catch mechanism accounted for half of the cases (n = 10), and all these injuries occurred during turning, without or before falling. The skier lost pressure on the outer ski, and while extending the outer knee to regain grip, the inside edge of the outer ski caught abruptly in the snow, forcing the knee into internal rotation and valgus. The same loading pattern was observed for the dynamic snowplow (n = 3). The landing back-weighted category included cases (n = 4) where the skier was out of balance backward in flight after a jump and landed on the ski tails with nearly extended knees. The suggested loading mechanism was a combination of tibiofemoral compression, boot-induced anterior drawer, and quadriceps anterior drawer.

Conclusions and Implications for practice:

Based on this video analysis of 20 injury situations, the main mechanism of anterior cruciate ligament injury in World Cup alpine skiing appeared to be a slip-catch situation where the outer ski catches the inside edge, forcing the outer knee into internal rotation and valgus. A similar loading pattern was observed for the dynamic snowplow. Injury prevention efforts should focus on the slip-catch mechanism and the dynamic snowplow.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Impact of skier actions on the gliding times in alpine skiing.
Author(s):	Federolf, P., Scheiber, P., Rauscher, E., Schwameder, H., Lüthi, A., Rhyner, H. U., & Müller, E.
Publication Details (add citation and DOI number)	Federolf, P., Scheiber, P., Rauscher, E., Schwameder, H., Lüthi, A., Rhyner, H. U., & Müller, E. (2008). Impact of skier actions on the gliding times in alpine skiing. *Scandinavian Journal of Medicine & Science in Sports,* 18(6), 790-797. doi: 10.1111/j.1600-0838.2007.00745.x

ABSTRACT

Alpine ski races are typically won by fractions of a second. It is therefore essential for ski racers to minimize air drag as well as ski-snow friction. In contrast to air drag, ski-snow friction during actual skiing has rarely been investigated so far. Two tasks, forward/backward leaning and edging of the skis, were selected, which (a) were expected to have an impact on ski-snow friction, and (b) could be executed while gliding in tucked position. Two hypotheses were tested: (H1) Run times are affected by forward or backward leaning. (H2) Run times are affected by edging of the skis. Four professional ski testers were recruited, who conducted a total of 68 runs of straight gliding. Execution of the tasks was documented by video recordings and by measuring the force application point on the skis of one tester. The findings of this study support (H2) but not (H1). There are indications that the increased run times for edging are caused by increased ski-snow friction.

Conclusions and Implications for practice:

From a performance point of view, it seems beneficial for ski racers to minimize edging in the gliding sections of a race.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Determination of the centre of mass kinematics in alpine skiing using differential global navigation satellite systems.
Author(s):	Gilgien, M., Spörri, J., Chardonnens, J., Kröll, J., Limpach, P., & Müller, E.
Publication Details (add citation and DOI number)	Gilgien, M., Spörri, J., Chardonnens, J., Kröll, J., Limpach, P., & Müller, E. (2015). Determination of the centre of mass kinematics in alpine skiing using differential global navigation satellite systems. *Journal of Sports Sciences,* 33(9), 960-969. doi: 10.1080/02640414.2014.977934

ABSTRACT

In the sport of alpine skiing, knowledge about the centre of mass (CoM) kinematics (i.e. position, velocity and acceleration) is essential to better understand both performance and injury. This study proposes a global navigation satellite system (GNSS)-based method to measure CoM kinematics without restriction of capture volume and with reasonable set-up and processing requirements. It combines the GNSS antenna position, terrain data and the accelerations acting on the skier in order to approximate the CoM location, velocity and acceleration. The validity of the method was assessed against a reference system (video-based 3D kinematics) over 12 turn cycles on a giant slalom skiing course. The mean (± *s*) position, velocity and acceleration differences between the CoM obtained from the GNSS and the reference system were 9 ± 12 cm, 0.08 ± 0.19 m · s^{-1} and 0.22 ± 1.28 m · s^{-2}, respectively. The velocity and acceleration differences obtained were smaller than typical differences between the measures of several skiers on the same course observed in the literature, while the position differences were slightly larger than its discriminative meaningful change.

Conclusions and Implications for practice:

The proposed method can therefore be interpreted to be technically valid and adequate for a variety of biomechanical research questions in the field of alpine skiing with certain limitations regarding position.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**
TITLE:	Model-based estimation of muscle and ACL forces during turning maneuvers in alpine skiing.			
Author(s):	Heinrich, D., v.d. Bogert, A., Mössner, M., Nachbauer, W.			
Publication Details (add citation and DOI number)	Heinrich, D., v.d. Bogert, A., Mössner, M., Nachbauer, W. (2023). Model-based estimation of muscle and ACL forces during turning maneuvers in alpine skiing. Sci Rep. 13(1):9026. Doi: 10.1038/s41598-023-35775-4			
ABSTRACT				

In alpine skiing, estimation of the muscle forces and joint loads such as the forces in the ACL of the knee are essential to quantify the loading pattern of the skier during turning maneuvers. Since direct measurement of these forces is generally not feasible, non-invasive methods based on musculoskeletal modeling should be considered. In alpine skiing, however, muscle forces and ACL forces have not been analyzed during turning maneuvers due to the lack of three-dimensional musculoskeletal models. In the present study, a three-dimensional musculoskeletal skier model was successfully applied to track experimental data of a professional skier. During the turning maneuver, the primary activated muscles groups of the outside leg, bearing the highest loads, were the gluteus maximus, vastus lateralis as well as the medial and lateral hamstrings. The main function of these muscles was to generate the required hip extension and knee extension moments. The gluteus maximus was also the main contributor to the hip abduction moment when the hip was highly flexed. Furthermore, the lateral hamstrings and gluteus maximus contributed to the hip external rotation moment in addition to the quadratus femoris. Peak ACL forces reached 211 N on the outside leg with the main contribution in the frontal plane due to an external knee abduction moment. Sagittal plane contributions were low due to consistently high knee flexion (> 60[Formula: see text]), substantial co-activation of the hamstrings and the ground reaction force pushing the anteriorly inclined tibia backwards with respect to the femur.

Conclusions and Implications for practice:

In conclusion, the present musculoskeletal simulation model provides a detailed insight into the loading of a skier during turning maneuvers that might be used to analyze appropriate training loads or injury risk factors such as the speed or turn radius of the skier, changes of the equipment or neuromuscular control parameters.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Three-dimensional knee joint loading in alpine skiing: a comparison between a carved and a skidded turn.
Author(s):	Klous, M., Müller, E., & Schwameder, H.
Publication Details (add citation and DOI number)	Klous, M., Müller, E., & Schwameder, H. (2012). Three-dimensional knee joint loading in alpine skiing: a comparison between a carved and a skidded turn. *Journal of Applied Biomechanics,* 28(6), 655-664. Doi: 10.1123/jab.28.6.655

ABSTRACT

Limited data exists on knee biomechanics in alpine ski turns despite the high rate of injuries associated with this maneuver. The purpose of the current study was to compare knee joint loading between a carved and a skidded ski turn and between the inner and outer leg. Kinetic data were collected using Kistler mobile force plates. Kinematic data were collected with five synchronized, panning, tilting, and zooming cameras. Inertial properties of the segments were calculated using an extended version of the Yeadon model. Knee joint forces and moments were calculated using inverse dynamics analysis. The obtained results indicate that knee joint loading in carving is not consistently greater than knee joint loading in skidding. In addition, knee joint loading at the outer leg is not always greater than at the inner leg. Differentiation is required between forces and moments, the direction of the forces and moments, and the phase of the turn that is considered.

Conclusions and Implications for practice:

Even though the authors believe that the analyzed turns are representative, results have to be interpreted with caution due to the small sample size.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Three-Dimensional Lower Extremity Joint Loading in a Carved Ski and Snowboard Turn: A Pilot Study.
Author(s):	Klous, M., Müller, E., & Schwameder, H.
Publication Details (add citation and DOI number)	Klous, M., Müller, E., & Schwameder, H. (2014). Three-Dimensional Lower Extremity Joint Loading in a Carved Ski and Snowboard Turn: A Pilot Study. *Computational and Mathematical Methods in Medicine,* 2014, 340272. doi: 10.1155/2014/340272

ABSTRACT

A large number of injuries to the lower extremity occur in skiing and snowboarding. Due to the difficulty of collecting 3D kinematic and kinetic data with high accuracy, a possible relationship between injury statistic and joint loading has not been studied. Therefore, the purpose of the current study was to compare ankle and knee joint loading at the steering leg between carved ski and snowboard turns. Kinetic data were collected using mobile force plates mounted under the toe and heel part of the binding on skies or snowboard (KISTLER). Kinematic data were collected with five synchronized, panning, tilting, and zooming cameras. An extended version of the Yeadon model was applied to calculate inertial properties of the segments. Ankle and knee joint forces and moments were calculated using inverse dynamic analysis. Results showed higher forces along the longitudinal axis in skiing and similar forces for skiing and snowboarding in anterior-posterior and mediolateral direction. Joint moments were consistently greater during a snowboard turn, but more fluctuations were observed in skiing. Hence, when comparing joint loading between carved ski and snowboard turns, one should differentiate between forces and moments, including the direction of forces and moments and the turn phase.

Conclusions and Implications for practice:

Hence, when comparing joint loading between carved ski and snowboard turns, one should differentiate between forces and moments, including the direction of forces and moments and the turn phase.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Quadriceps Muscle Function during Recreational Alpine Skiing
Author(s):	Kröll, J., Wakeling, J. M., Seifert, J. G., & Müller, E.
Publication Details (add citation and DOI number)	Kröll, J., Wakeling, J. M., Seifert, J. G., & Müller, E. (2010). Quadriceps Muscle Function during Recreational Alpine Skiing. *Medicine and Science in Sports and Exercise,* 42(8), 1545-1556. doi: 10.1249/MSS.0b013e3181d299cf

ABSTRACT

Purpose: Since the introduction of carving skis, muscle activity has been investigated primarily on expert-level skiers with respect to EMG intensities. The three-part aim of this recreational skiing study was to analyze functional differences within the quadriceps muscle, to analyze the topographical influence, and to apply a time-frequency analysis of the EMG intensities using wavelets. **Methods:** Seven female subjects performed two runs through a standardized corridor on a slope with different inclinations (13 degrees , 29 degrees , and 21 degrees). Knee angle and EMG of vastus lateralis (VL) and rectus femoris (RF) of the right leg were measured during the runs. The recorded EMG signal was resolved with a set of 10 wavelets (11-432 Hz) into a time-frequency space. Subsequently, the EMG intensity and mean frequency (MF) were calculated for different time windows (inside leg; outside leg). **Results:** For RF, a significantly higher MF (+15.5%, P = 0.009) but similar EMG intensities were detected in the inside leg compared with the outside leg. For VL, the MF (-9.6%, P = 0.053) and EMG intensities (-54.3%, P = 0.010) were lower in the inside leg compared with the outside leg. Both muscles responded with higher EMG intensities on increasing slope inclination (VL = 90.8%, P = 0.022; RF = 115%, P = 0.01). MF is not directly related to inclination.

Conclusions and Implications for practice:

Contrary to previously suggested coloading of the inside leg while carving, our results do not support this hypothesis for VL. However, the functional demand for RF in the inside leg is very high when skiing recreationally. The ability of a situation-dependent loading (RF as knee extensor) and unloading (RF as hip flexor) of the inside leg seems to be a crucial point with respect to specific fatigue during a skiing day.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**
TITLE:	Changes in quadriceps muscle activity during sustained recreational skiing.			
Author(s):	Kröll, J., Müller, E., Seifert, J. G., & Wakeling, J. M.			
Publication Details (add citation and DOI number)	Kröll, J., Müller, E., Seifert, J. G., & Wakeling, J. M. (2011). Changes in quadriceps muscle activity during sustained recreational skiing. *Journal of Sports Science and Medicine,* 10, 81-92. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3737900/			
ABSTRACT				

During a day of skiing thousands of repeated contractions take place. Previous research on prolonged recreational alpine skiing show that physiological changes occur and hence some level of fatigue is inevitable. In the present paper the effect of prolonged skiing on the recruitment and coordination of the muscle activity was investigated. Six subjects performed 24 standardized runs. Muscle activity during the first two (PREskiing) and the last two (POSTskiing) runs was measured from the vastus lateralis (VL) and rectus femoris (RF) using EMG and quantified using wavelet and principal component analysis. The frequency content of the EMG signal shifted in seven out of eight cases significantly towards lower frequencies with highest effects observed for RF on outside leg. A significant pronounced outside leg loading occurred during POSTskiing and the timing of muscle activity peaks occurred more towards turn completion. Specific EMG frequency changes were observed at certain time points throughout the time windows and not over the whole double turn. It is suggested that general muscular fatigue, where additional specific muscle fibers have to be recruited due to the reduced power output of other fibers did not occur. The EMG frequency decrease and intensity changes for RF and VL are caused by altered timing (coordination) within the turn towards a most likely more uncontrolled skiing technique.

Conclusions and Implications for practice:

Hence, these data provide evidence to suggest recreational skiers alter their skiing technique before a potential change in muscle fiber recruitment occurs.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Effect of ski geometry on aggressive ski behaviour and visual aesthetics: equipment designed to reduce risk of severe traumatic knee injuries in alpine giant slalom ski racing.
Author(s): Kröll, J., Spörri, J., Gilgien, M., Schwameder, H., & Müller, E.	
Publication Details (add citation and DOI number)	Kröll, J., Spörri, J., Gilgien, M., Schwameder, H., & Müller, E. (2016). Effect of ski geometry on aggressive ski behaviour and visual aesthetics: equipment designed to reduce risk of severe traumatic knee injuries in alpine giant slalom ski racing. *British Journal of Sports Medicine,* 50(1), 20-25. doi: 10.1136/bjsports-2015-095433

ABSTRACT

Background/Aim Aggressive ski-snow interaction is characterised by direct force transmission and difficulty of getting the ski off its edge once the ski is carving. This behaviour has been suggested to be a main contributor to severe knee injuries in giant slalom (GS). The aim of the current study was to provide a foundation for new equipment specifications in GS by considering two perspectives: Reducing the ski's aggressiveness for injury prevention and maintaining the external attractiveness of a ski racer's technique for spectators.

Methods Three GS ski prototypes were defined based on theoretical considerations and were compared to a reference ski (P_{ref}). Compared to P_{ref}, all prototypes were constructed with reduced profile width and increased ski length. The construction radius (sidecut radius) of Pref was ≥27 m and was increased for the prototypes: 30 m (P_{30}), 35 m (P_{35}), and 40 m (P_{40}). Seven World Cup level athletes performed GS runs on each of the three prototypes and P_{ref}. Kinetic variables related to the ski-snow interaction were assessed to quantify the ski's aggressiveness. Additionally, 13 athletes evaluated their subjective perception of aggressiveness. 15 sports students rated several videotaped runs to assess external attractiveness.

Results Kinetic variables quantifying the ski's aggressiveness showed decreased values for P_{35} and P_{40} compared to P_{ref} and P_{30}. Greater sidecut radius reduced subjectively perceived aggressiveness. External attractiveness was reduced for P_{40} only.

Conclusions and Implications for practice:

Conclusions This investigation revealed the following evaluation of the prototypes concerning injury prevention and external attractiveness: P_{30}: no preventative gain, no loss in attractiveness; P_{35}: substantial preventative gain, no significant loss in attractiveness; P_{40}: highest preventative gain, significant loss in attractiveness.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Sidecut radius and kinetic energy: equipment designed to reduce risk of severe traumatic knee injuries in alpine giant slalom ski racing.
Author(s): Kröll, J., Spörri, J., Gilgien, M., Schwameder, H., & Müller, E.	
Publication Details (add citation and DOI number)	Kröll, J., Spörri, J., Gilgien, M., Schwameder, H., & Müller, E. (2016). Sidecut radius and kinetic energy: equipment designed to reduce risk of severe traumatic knee injuries in alpine giant slalom ski racing. *British Journal of Sports Medicine,* 50(1), 26-31. doi: 10.1136/bjsports-2015-095463

ABSTRACT

Background Kinetic energy (E_{kin}) increases with speed by the power of 2 and is considered a major risk factor for injuries in alpine ski racing. There is no empirical knowledge about the effect of ski geometry on E_{kin}. Consequently, the aim of this study was to investigate the influence of sidecut radius on the progress of E_{kin} while skiing through a multigate section in giant slalom (GS).

Methods 5 European-Cup level athletes skied on three different pairs of GS skis varying in sidecut radii (30, 35 and 40 m). Each athlete's position over time within a six gate section (including flat and steep terrain) was captured by the use of a differential Global Navigational Satellite System. E_{kin}, speed, time and path length were analysed for each pair of skis used.

Results When using skis with greater sidecut radius, average E_{kin} was significantly lower over the entire six gate section, but not locally at every turn cycle. Particular decreases of E_{kin} were observed for both turns on the flat terrain, as well as for the turn at the terrain transition and the first turn on the steep terrain. The observed decreases in E_{kin} were found to be primarily explainable by increases in turn time.

Conclusions and Implications for practice:

Conclusions With respect to typical sport mechanisms that cause severe knee injuries, using skis with greater sidecut radius potentially provides additional injury preventative gain, particularly in specific areas within a run. However, this injury preventative gain during falls in GS should not be overestimated.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	Physiology / Medicine	Education Pedagogy (didactic)	Psychology/ Sociology/ Philosophy	Environment protection

TITLE:	Injuries and illnesses in a cohort of elite youth alpine ski racers and the influence of biological maturity status and relative age: a two-season prospective study.
Author(s): Müller, L., Hildebrandt, C., Müller, E., Oberhoffer, R., & Raschner, C.	
Publication Details (add citation and DOI number)	Müller, L., Hildebrandt, C., Müller, E., Oberhoffer, R., & Raschner, C. (2017). Injuries and illnesses in a cohort of elite youth alpine ski racers and the influence of biological maturity status and relative age: a two-season prospective study. *Open Access Journal of Sports Medicine,* 8, 113-122. Doi: https://doi.org/10.2147/OAJSM.S133811

ABSTRACT

Studies on injuries and illnesses involving youth ski racers younger than 15 years are lacking in the literature. The aim of this study was prospectively to assess the incidence, prevalence, and severity of traumatic and overuse injuries, as well as illnesses of elite youth ski racers with regard to sex, biological maturity status, and relative age.

Subjects and methods: A prospective, longitudinal cohort design was used to monitor the anthropometrics, training characteristics, traumatic and overuse injuries, and illnesses of 82 elite youth ski racers (51 males, 31 females, age 9–14 years) over 2 consecutive years. The exact training exposure (skiing and athletic) was recorded. Relative age and estimated biological maturity status were assessed.

Results: Relatively low injury incidence or prevalence (traumatic, 0.86/1,000 hours of training; overuse, 0.28/1,000 hours) and comparably high illness prevalence (2.4/athlete) were reported. The knee was the most commonly affected body part (traumatic injuries 36.5%, overuse injuries 82%). A high number of bone fractures were revealed (46%), while no stress fractures occurred; 66% of the illnesses were respiratory tract infections. No differences were found between males and females, the differing maturity groups, or relative age quartiles. Early-maturing athletes had comparably low traumatic and overuse-injury rates. Relatively younger athletes had low traumatic injury rates.

Conclusions and Implications for practice:

The injury-prevention measures implemented in the training process of youth ski racers seem to contribute to a low incidence of injury. Biological maturity status should be considered in the training process to prevent injuries in late-maturing athletes.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Is there a contextual interference for sub-elite alpine ski racers learning complex skills?
Author(s): Magelssen, C., Haugen, P., Reid, R., Gilgien, M.	
Publication Details (add citation and DOI number)	Magelssen, C., Haugen, P., Reid, R., Gilgien, M. (2022). Is there a contextual interference for sub-elite alpine ski racers learning complex skills? Front Bioeng Biotechnol, 15:10:966041 Doi: 10.3389/fbioe.2022.966041
ABSTRACT	

Scientific understanding of the contextual interference effect stems mainly from studies on unskilled participants learning artificial laboratory tasks. Although one goal of such studies is to extrapolate the findings to include real-world learning situations such as sports, this generalization is not straightforward. This study tested the contextual interference effect with 66 sub-elite, competitive alpine ski racers who learned a new movement pattern-the pumping technique to increase velocity in slalom-by practicing this skill in three different slalom courses over a 3-day training period. The interleaved group practiced all three courses each day in a semi-random order. In contrast, the blocked group practiced only one course each day, which was randomized and counterbalanced across the participants in this group. A retention test was delivered 72 h after the last practice day. In contrast to our hypothesis, the interleaved group did not display significantly better retention than the blocked group. The interleaved group's performance was also not significantly attenuated during skill learning compared to the blocked group.

Conclusions and Implications for practice:

Our results underscore the importance of conducting motor learning experiments in natural environments to understand the conditions that facilitate learning beyond the laboratory environment.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	The possibility of predicting the performance of advanced ski elements based on the performance of basic ski elements.
Author(s): Martinceviv, I., Cigrovski, V.	
Publication Details (add citation and DOI number)	Martinceviv, I., Cigrovski, V. (2023). The possibility of predicting the performance of advanced ski elements based on the performance of basic ski elements. Kineziologija, 55(1)154-161 Doi: 10.26582/k.55.1.18
ABSTRACT	

The aim of this research was to predict the success of the performance of advanced ski elements based on the level of performance of basic ski elements, with the ultimate purpose of improving training programmes for alpine ski beginners. The sample of participants consisted of 250 students of the Faculty of Kinesiology University of Zagreb who attended their mandatory classes of the university study subject of Skiing in the academic year 2021/22. The sample of variables consisted of the grades the students earned for their performance of four exam elements, two basic ski elements and the other two belonging to the advanced ski elements group. The basic ski elements were uphill turn (UT), for which the mean of two grades was taken for further analysis due to its performance to both sides – left and right, and snowplough turn (SPT). Advanced ski elements were parallel turn (PT) and short turn (ST). Besides descriptive statistics for each variable, two ordinal logistic regression models were constructed for determining the relationship between the performance of short turn based on the level of performance of snowplough turn, on the one hand, and on the other, between the performance of parallel turn based on the performance of uphill turn. The results of the first ordinal logistic regression analysis (short turn performance based on snowplough performance) showed the existence of a statistically significant linear association of the two ski elements performance (b=2.15, SE=0.72, p=.03). Similar results were obtained in the second ordinal logistic regression analysis for the other pair of ski elements (parallel turn performance based on uphill turn performance): b=2.36, SE=0.24, p<.001.

Conclusions and Implications for practice:

Well acquired dynamic motor stereotypes, reflected in good performance of basic ski elements, are the basis for good performance of advanced ski elements, therefore skipping any step in the teaching process based on progression could have a negative impact on achieving the desired goals.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	A comprehensive comparison and validation of published methods to detect switch during Alpine skiing.
Author(s):	Martinez, A., Snyder, C., Moore, S. R., Stöggl, T.
Publication Details (add citation and DOI number)	Martinez, A., Snyder, C., Moore, S. R., Stöggl, T. (2021). A comprehensive comparison and validation of published methods to detect switch during Alpine skiing. *Sensors (Basel)*, 21(7):2573. doi: 10.3390/s21072573

ABSTRACT

The instant of turn switch (TS) in alpine skiing has been assessed with a variety of sensors and TS concepts. Despite many published methodologies, it is unclear which is best or how comparable they are. This study aimed to facilitate the process of choosing a TS method by evaluating the accuracy and precision of the methodologies previously used in literature and to assess the influence of the sensor type. Optoelectronic motion capture, inertial measurement units, pressure insoles, portable force plates, and electromyography signals were recorded during indoor treadmill skiing. All TS methodologies were replicated as stated in their respective publications. The method proposed by Supej assessed with optoelectronic motion capture was used as a comparison reference. TS time differences between the reference and each methodology were used to assess accuracy and precision. All the methods analyzed showed an accuracy within 0.25 s, and ten of them within 0.05 s. The precision ranged from ~0.10 s to ~0.60 s. The TS methodologies with the best performance (accuracy and precision) were Klous Video, Spörri PI (pressure insoles), Martinez CTD (connected boot), and Yamagiwa IMU (inertial measurement unit). In the future, the specific TS methodology should be chosen with respect to sensor selection, performance, and intended purpose.

Conclusions and Implications for practice:

In the future, the specific TS methodology should be chosen with respect to sensor selection, performance, and intended purpose.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Analysis of the biomechanical characteristics of different swinging techniques in alpine skiing.
Author(s):	Müller, E.
Publication Details (add citation and DOI number)	Müller, E. (1994). Analysis of the biomechanical characteristics of different swinging techniques in alpine skiing. *Journal of Sports Sciences,* 12(3), 261-278. doi: 10.1080/02640419408732172

ABSTRACT

As a consequence of the increase in popularity of skiing as a leisure sport, ski teaching has become an important pedagogic and economic issue. Unfortunately, most ski teaching curricula lack a thorough evaluation of the most important swinging techniques. Therefore, this study analyses the biomechanical characteristics of swinging techniques in alpine skiing. The data were collected using biodynamic, kinematic and electromyographic methods, employing 21 test skiers, all of whom were state-certified Austrian ski instructors. For all techniques, the individual turns were divided into a steering phase and an initiation phase. In the main, the fundamental differences between the single techniques became apparent in the initiation phase. There it seemed useful to distinguish between turns with 'up-unweighting' and turns with 'down-unweighting'. It was found that turns with up-unweighting were initiated either from the downhill ski only or from both skis. Turns with down-unweighting were used primarily on mogul pistes and in deep powder snow. Finally, some conclusions for training methodology are given.

Conclusions and Implications for practice:

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Comparisons of the ski turn techniques of experienced and intermediate skiers.
Author(s):	Müller, E., Bartlett, R., Raschner, C., Schwameder, H., Benko-Bernwick, U., & Lindinger, S.
Publication Details (add citation and DOI number)	Müller, E., Bartlett, R., Raschner, C., Schwameder, H., Benko-Bernwick, U., & Lindinger, S. (1998). Comparisons of the ski turn techniques of experienced and intermediate skiers. *Journal of Sports Sciences,* 16(6), 545-559. doi: 10.1080/026404198366515

ABSTRACT

We compared selected kinematic variables for four different ski turn techniques performed by five experienced and five intermediate male skiers. The four ski turn techniques were the upstem turn, the downstem turn, the parallel turn and the parallel step turn. Each turn was divided into the initiation phase and the first and second steering phases. Most of the statistically significant differences ($P < 0.05$) between the two groups were found for the initiation phases of the four turns. Both the hip axis-hand axis angle and the edging angle of the uphill ski were significantly different between the two groups for the upstem turn at the beginning of the initiation phase. For the downstem turn, significant differences between the groups were found at the start of the initiation phase for the hip axis-hand axis angle, the shoulder axis-fall line angle, and the edging angle of the uphill ski. The standard deviation of the distance between the tips of the two skis over the second steering phase also differed significantly between the two groups. For the parallel step turn, significant differences were found at the start of the initiation phase for the edging angle of the downhill ski and the downhill ski to movement direction angle. Significant differences were also found for the edging angle of the downhill ski in the middle of the second steering phase and the shoulder axis to movement direction angle at the end of this phase. For the initiation phase of the parallel turn, significant differences were found for the timing of setting the ski pole, the uphill knee angle at the start of this phase and the range of the knee angle of the uphill leg from the start to the end of this phase. For this turn, significant differences between the two groups were also found for the edging angle of the downhill ski in the middle of the second steering phase and the shoulder axis to movement direction angle at the end of this phase.

Conclusions and Implications for practice:

One of the reasons it was possible to identify a few significant differences only for the turns analysed, was the variability within the intermediate group: for most of the variables analysed, the standard deviation was much higher for the intermediate than for the experienced group.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Biomechanical aspects of new techniques in alpine skiing and ski-jumping.
Author(s):	Müller, E., & Schwameder, H.
Publication Details (add citation and DOI number)	Müller, E., & Schwameder, H. (2003). Biomechanical aspects of new techniques in alpine skiing and ski-jumping. *Journal of Sports Sciences,* 21(9), 679-692. https://doi.org/10.1080/0264041031000140284
ABSTRACT	

There have been considerable changes in equipment design and movement patterns in the past few years both in alpine skiing and ski-jumping. These developments have been matched by methods of analysing movements in field conditions. They have yielded new insights into the skills of these specific winter sports. Analytical techniques have included electromyography, kinetic and kinematic methods and computer simulations. Our aim here is to review biomechanical research in alpine skiing and ski-jumping. We present in detail the techniques currently used in alpine skiing (carving technique) and ski-jumping (V-technique), primarily using data from the authors' own research. Finally, we present a summary of the most important results in biomechanical research both in alpine skiing and ski-jumping. This includes an analysis of specific conditions in alpine skiing (type of turn, terrain, snow, speed, etc.) and the effects of equipment, materials and individual-specific abilities on performance, safety and joint loading in ski-jumping.

Conclusions and Implications for practice:

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Biological Maturity Status Strongly Intensifies the Relative Age Effect in Alpine Ski Racing.
Author(s):	Müller, L., Müller, E., Hildebrandt, C., & Raschner, C.
Publication Details (add citation and DOI number)	Müller, L., Müller, E., Hildebrandt, C., & Raschner, C. (2016). Biological Maturity Status Strongly Intensifies the Relative Age Effect in Alpine Ski Racing. *PLoS One,* 11(8), e0160969. doi: 10.1371/journal.pone.0160969

ABSTRACT

The relative age effect (RAE) is a well-documented phenomenon in youth sports. This effect exists when the relative age quarter distribution of selected athletes shows a biased distribution with an over-representation of relatively older athletes. In alpine ski racing, it exists in all age categories (national youth levels up to World Cup). Studies so far could demonstrate that selected ski racers are relatively older, taller and heavier. It could be hypothesized that relatively younger athletes nearly only have a chance for selection if they are early maturing. However, surprisingly this influence of the biological maturity status on the RAE could not be proven, yet. Therefore, the aim of the present study was to investigate the influence of the biological maturity status on the RAE in dependence of the level of competition. The study investigated 372 elite youth ski racers: 234 provincial ski racers (P-SR; high level of competition) and 137 national ski racers (N-SR; very high level of competition). Anthropometric characteristics were measured to calculate the age at peak height velocity (APHV) as an indicator of the biological maturity status. A significant RAE was present among both P-SR and N-SR, with a larger effect size among the latter group. The N-SR significantly differed in APHV from the P-SR. The distribution of normal, early and late maturing athletes significantly differed from the expected normal distribution among the N-SR, not among the P-SR. Hardly any late maturing N-SR were present; 41.7% of the male and 34% of the female N-SR of the last relative age quarter were early maturing. These findings clearly demonstrate the significant influence of the biological maturity status on the selection process of youth alpine ski racing in dependence of the level of competition. Relatively younger athletes seem to have a chance of selection only if they are early maturing.

Conclusions and Implications for practice:

These findings clearly demonstrate the significant influence of the biological maturity status on the selection process of youth alpine ski racing in dependence of the level of competition. Relatively younger athletes seem to have a chance of selection only if they are early maturing.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	The relationship of heart rate and lactate to cumulative muscle fatigue during recreational alpine skiing.
Author(s):	Seifert, J. G., Kröll, J., & Müller, E.
Publication Details (add citation and DOI number)	Seifert, J. G., Kröll, J., & Müller, E. (2009). The relationship of heart rate and lactate to cumulative muscle fatigue during recreational alpine skiing. *Journal of Strength and Conditioning Research,* 23(3), 698-704. doi: 10.1519/JSC.0b013e3181a2b55e

ABSTRACT

Common indices of fatigue may not respond similarly between downhill skiing and other activities because of the influence of factors such as snow conditions, changing terrain, and skiing style. The purpose of this study was to investigate the relationship and predictors of common fatigue indices during downhill skiing. Ten healthy female recreational skiers skied for 3 hours under standardized conditions. Feedback on heart rate (HR) and finishing time were given to each skier at the end of each run to maintain a relatively stable load. A chronic stress score (Cstress) was calculated from creatine kinase (CK), cortisol, and isometric endurance. Finishing times and HR from runs 2, 12, and 24 were similar. Heart rate averaged 82% of HRmax. Heart rate was an insignificant predictor ($p = .65$) and was poorly correlated ($r = 0.16$) to Cstress. Blood lactate (LA) was a significant predictor of the Cstress ($p = 0.05$; $r = 0.62$). Pre- to post skiing peak forces were not different ($p = 0.62$), but skiers experienced a significant decrease in isometric endurance from 106.1 +/- 29.6 to 93.2 +/- 24.0 seconds. Endurance decreased by 13%, whereas cortisol and CK increased by 16 and 42%, respectively. Isometric contraction endurance and blood LA were significant predictors of overall stress. Individual compensation mechanisms and skiing style contributed to highly variable responses during skiing.

Conclusions and Implications for practice:

Whereas HR may indicate stress within a given run, it is not a significant indicator of Cstress and fatigue during recreational alpine skiing. However, the cumulative stress variables and LA can be used in field testing of skiers. It is suggested that LA is a practical on-hill marker of chronic stress.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Grade and speed have greater influence on HR and RPE than ability, sex, and age in alpine skiing.
Author(s): Seifert, J., Stöggl, T., Scheiber, P., Heizinger, E., & Müller, E.	
Publication Details (add citation and DOI number)	Seifert, J., Stöggl, T., Scheiber, P., Heizinger, E., & Müller, E. (2017). Grade and speed have greater influence on HR and RPE than ability, sex, and age in alpine skiing. *Journal of Sports Science,* 35(5), 419-425. doi: 10.1080/02640414.2016.1167935
ABSTRACT	The purpose of this study was to investigate the influence of ski slope grade, skiing speed, skiing ability, sex, and age on HR, RPE, and energy expenditure responses during recreational alpine skiing. Thirty-eight participants were divided by age, sex, and skiing ability. Instructor- and self-paced skiing conditions were conducted on 10° and 19.8° slopes. Skiing HR was recorded, RPE collected at the end of each run, and energy expenditure calculated. The pertinent results of this study demonstrate that the interactions of grade × speed, speed × age, and grade × age and the main effects of speed and grade significantly influenced %HRmax, mean HR, RPE, and energy expenditure during skiing. When %HRmax is taken into account, the older skiers skied at a greater relative intensity than the young skiers. The sex, age, and skiing ability main effects did not have a significant influence on mean HR, RPE, and energy expenditure. These data demonstrates that increased speed and grade results in increased physiological stress. Using mean, HR data may not be the best option for assessing physiological stress during exercise in the older athlete as it does not account for the influence of the ageing process.
Conclusions and Implications for practice: These data demonstrates that increased speed and grade results in increased physiological stress. Using mean, HR data may not be the best option for assessing physiological stress during exercise in the older athlete as it does not account for the influence of the ageing process.	

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Perceived key injury risk factors in world cup alpine ski racing-an explorative qualitative study with expert stakeholders.
Author(s):	Spörri, J., Kröll, J., Amesberger, G., Blake, O. M., & Müller, E.
Publication Details (add citation and DOI number)	Spörri, J., Kröll, J., Amesberger, G., Blake, O. M., & Müller, E. (2012). Perceived key injury risk factors in world cup alpine ski racing-an explorative qualitative study with expert stakeholders. *British Journal of Sports Medicines,* 46(15), 1059-1064. doi: 10.1136/bjsports-2012-091048
ABSTRACT	

Background: There is limited knowledge about key injury risk factors in alpine ski racing, particularly for World Cup (WC) athletes. **Objective:** This study was undertaken to compile and explore perceived intrinsic and extrinsic risk factors for severe injuries in WC alpine ski racing. **Methods:** Qualitative study. Interviews were conducted with 61 expert stakeholders of the WC ski racing community. Experts' statements were collected, paraphrased and loaded into a database with inductively derived risk factor categories (Risk Factor Analysis). At the end of the interviews, experts were asked to name those risk factors they believed to have a high potential impact on injury risk and to rank them according to their priority of impact (Risk Factor Rating). **Results:** In total, 32 perceived risk factors categories were derived from the interviews within the basic categories Athlete, Course, Equipment and Snow. Regarding their perceived impact on injury risk, the experts' top five categories were: system ski, binding, plate and boot; changing snow conditions; physical aspects of the athletes; speed and course setting aspects and speed in general.

Conclusions and Implications for practice:

Severe injuries in WC alpine ski racing can have various causes. This study compiled a list of perceived intrinsic and extrinsic risk factors and explored those factors with the highest believed impact on injury risk. Hence, by using more detailed hypotheses derived from this explorative study, further studies should verify the plausibility of these factors as true risk factors for severe injuries in WC alpine ski racing.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Course setting and selected biomechanical variables related to injury risk in alpine ski racing: an explorative case study.
Author(s):	Spörri, J., Kröll, J., Schwameder, H., Schiefermüller, C., & Müller, E.
Publication Details (add citation and DOI number)	Spörri, J., Kröll, J., Schwameder, H., Schiefermüller, C., & Müller, E. (2012). Course setting and selected biomechanical variables related to injury risk in alpine ski racing: an explorative case study. *British Journal of Sports Medicines,* 46(15), 1072-1077. doi: 10.1136/bjsports-2012-091425

ABSTRACT

Background: Course setting has often been discussed as a potential preventative measure in the World Cup ski-racing community. However, there is limited understanding of how it is related to injury risk. **Objective:** This study was undertaken to investigate the effect of increased horizontal gate distance on energy-related and injury mechanism-related variables. **Methods:** During a video-based three-dimensional (3D)-kinematic field measurement, a top world-class racer performed giant slalom runs at two course settings with different horizontal gate distances. A full-body segment model was reconstructed in 3D and selected biomechanical parameters were calculated. **Results:** For the analysed turn, no significant differences were found in turn speed for increased horizontal gate distance. However, a large effect size was observed for speed reduction towards the end of the turn. Turn forces were by tendency higher at the beginning and significantly higher towards the end of the turn. Additionally, significant differences were found in higher inward leaning, and large effect sizes were observed for a decreased fore/aft position after gate passage.

Conclusions and Implications for practice:

On the basis of the data of this study, no final conclusion can be made about whether, for a section of consecutive turns, increasing horizontal gate distance is an effective tool for speed reduction. However, this study pointed out two major drawbacks of this course setting modification: (1) it may increase fatigue as a consequence of loading forces acting over a longer duration; (2) it may increase the risk of out-of-balance situations by forcing the athlete to exhaust his backward and inward leaning spectrum.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Potential Mechanisms Leading to Overuse Injuries of the Back in Alpine Ski Racing: A Descriptive Biomechanical Study.
Author(s):	Spörri, J., Kröll, J., Haid, C., Fasel, B., & Müller, E.
Publication Details (add citation and DOI number)	Spörri, J., Kröll, J., Haid, C., Fasel, B., & Müller, E. (2015). Potential Mechanisms Leading to Overuse Injuries of the Back in Alpine Ski Racing: A Descriptive Biomechanical Study. *The American Journal of Sports Medicine,* 43(8), 2042-2048. doi: 10.1177/0363546515588178
ABSTRACT	

Background: Overuse injuries of the back are a common complaint among top athletes and of competitive alpine skiers in particular. However, there is limited understanding about the sport-specific causes of these injuries that is essential for their prevention. This study was undertaken to describe the sport-specific, overall trunk kinematics and skiers' loading during giant slalom turns and to assess the plausibility of the hypothesis that a combination of frontal bending, lateral bending, and/or torsion in the loaded trunk might be a potential mechanism leading to overuse injuries of the back in alpine ski racing. **Methods:** Eight European Cup-level athletes performed giant slalom runs with 2 different pairs of skis (varying in length, width, and sidecut). They were analyzed with respect to selected kinematic variables related to spinal disc loading. The overall trunk movement components (frontal bending, lateral bending, and torsion) were measured using 2 inertial measurement units fixed on the sacrum and sternum. Total ground-reaction forces were measured by pressure insoles. **Results:** During the turn phase in which the total ground-reaction forces were the greatest (up to 2.89 times the body weight), the highest average values of frontal bending (38.7°), lateral bending (14.7°), and torsion (7.7°) in the trunk occurred. Similar magnitudes were observed when skiing on longer, giant slalom skis with less width and sidecut.

Conclusions and Implications for practice:

The typical loading patterns of the back in alpine ski racing include a combined occurrence of frontal bending, lateral bending, and torsion in the loaded trunk. Because these factors are known to be related to high spinal disc loading, they may be considered important components of mechanisms leading to overuse injuries of the back in alpine ski racing. Prevention measures should aim to control and/or reduce the magnitude of frontal bending, lateral bending, and torsion in the trunk, as well as the peak loads, while skiing.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Sidecut radius and the mechanics of turning-equipment designed to reduce risk of severe traumatic knee injuries in alpine giant slalom ski racing.
Author(s): Spörri, J., Kröll, J., Gilgien, M., & Müller, E.	
Publication Details (add citation and DOI number)	Spörri, J., Kröll, J., Gilgien, M., & Müller, E. (2016). Sidecut radius and the mechanics of turning - equipment designed to reduce risk of severe traumatic knee injuries in alpine giant slalom ski racing. *British Journal of Sports Medicine,* 50(1), 14-19. doi: 10.1136/bjsports-2015-095737

ABSTRACT

There is limited empirical knowledge about the effect of ski geometry, particularly in the context of injury prevention in alpine ski racing. We investigated the effect of sidecut radius on biomechanical variables related to the mechanics of turning.

Methods During a field experiment, six European Cup level athletes skied on three different pairs of giant slalom (GS) skis varying in sidecut radii (30 m, 35 m and 40 m). Using a video-based three-dimensional (3D) kinematic system, a 22-point body segment model of the athletes was reconstructed in 3D, and the variables ground reaction force, centre of mass (COM) speed, COM turn radius, ski turn radius, edge angle, fore/aft position and skid angle were calculated.

Results While steering out of the fall line after gate passage, ground reaction force significantly differed between the 30 m and 40 m skis and between the 35 m and 40 m skis. These differences were mainly explainable by larger COM turn radii when skiing on the 40 m ski. During the same turn phase, significant differences in ski turn radius also were found, but there were no differences in edge angle, fore/aft position and skid angle.

Conclusions and Implications for practice:

The sidecut-induced reduction in ground reaction force and the sidecut-induced increase in centre of mass and ski turn radius observed in this study provides indirect evidence of reduced self-steering of the ski. Self-steering plays a central role in the mechanism of anterior cruciate ligament rupture in alpine ski racing.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	Methodological and practical considerations associated with assessment of Alpine skiing performance using global navigation satellite systems.
Author(s):	Supej, M., Spörri, J., Holmberg, HC.
Publication Details (add citation and DOI number)	Supej, M., Spörri, J., Holmberg, HC. (2020). Methodological and practical considerations associated with assessment of Alpine skiing performance using global navigation satellite systems. Front Sports Act Living, 22(1)74. Doi: 10.3389/fspor.2019.00074

ABSTRACT

Reliable assessment of the performance of alpine skiers is essential. Previous studies have highlighted the potential of Global Navigation Satellite Systems (GNSS) for evaluating this performance. Accordingly, the present perspective summarizes published research concerning methodological and practical aspects of the assessment of alpine skiing performance by GNSS. Methodologically, in connection with trajectory analysis, a resolution of 1-10 cm, which can be achieved with the most advanced GNSS systems, has proven to provide acceptable accuracy. The antenna should be positioned to follow the trajectory of the skier's center-of-mass (CoM) as closely as possible and estimation of this trajectory can be further improved by applying advanced modeling and/or other computerized approaches. From a practical point of view, effective assessment requires consideration of numerous parameters related to performance, including gate-to-gate times, trajectory, speed, and energy dissipation. For an analysis that is both more comprehensive and more easily accessible to coaches/athletes, video filming should be synchronized with the GNSS data. In summary, recent advances in GNSS technology already allow, at least to some extent, precise biomechanical analysis of performance over an entire alpine skiing race course in real-time. Such feedback has both facilitated and improved the work of coaches.

Conclusions and Implications for practice:

Thus, athletes and coaches are becoming more and more aware of the advantages of analyzing alpine skiing performance by GNSS in combination with advanced computer software, paving the way for the digital revolution in both the applied research on and practice of this sport.

Co-funded by the
Erasmus+ Programme
of the European Union

Original Article Abstract

Select the appropriate scientific discipline (s) (refereeing for children, alpine skiing, snowsports)				
Biomechanics Motor Control	**Physiology / Medicine**	**Education Pedagogy (didactic)**	**Psychology/ Sociology/ Philosophy**	**Environment protection**

TITLE:	The waist width of skis influences the kinematics of the knee joint in Alpine skiing.
Author(s):	Zorko, M., Nemec, B., Babic, J., Lesnik, B., Supej, M.
Publication Details (add citation and DOI number)	Zorko, M., Nemec, B., Babic, J., Lesnik, B., Supej, M. (2015). The waist width of skis influences the kinematics of the knee joint in Alpine skiing. J Sports Sci Med, 14(3):606-19. PMID: 26336348

ABSTRACT

Recently alpine skis with a wider waist width, which medially shifts the contact between the ski edge and the snow while turning, have appeared on the market. The aim of this study was to determine the knee joint kinematics during turning while using skis of different waist widths (65mm, 88mm, 110mm). Six highly skilled skiers performed ten turns on a predefined course (similar to a giant slalom course). The relation of femur and tibia in the sagittal, frontal and coronal planes was captured by using an inertial motion capture suit, and Global Navigation Satellite System was used to determine the skiers' trajectories. With respect of the outer ski the knee joint flexion, internal rotation and abduction significantly decreased with the increase of the ski waist width for the greatest part of the ski turn. The greatest abduction with the narrow ski and the greatest external rotation (lowest internal rotation) with the wide ski are probably the reflection of two different strategies of coping the biomechanical requirements in the ski turn. These changes in knee kinematics were most probably due to an active adaptation of the skier to the changed biomechanical conditions using wider skis. The results indicated that using skis with large waist widths on hard, frozen surfaces could bring the knee joint unfavorably closer to the end of the range of motion in transversal and frontal planes as well as potentially increasing the risk of degenerative knee injuries. The change in the skis' waist width caused a change in the knee joint movement strategies, which had a tendency to adapt the skier to different biomechanical conditions. The use of wider skis or, in particular, skis with a large waist width, on a hard or frozen surface, could unfavourably bring the knee joint closer to the end of range of motion in transversal and frontal planes as well as may potentially increase the risk of degenerative knee injuries.

Conclusions and Implications for practice:

The overall results of the abduction and internal rotation in respect to turn radii and ground reaction forces indicated that the knee joint movements are likely one of the key points in alpine skiing techniques. However, the skiing equipment used can still significantly influence the movement strategy.