Ground reaction forces during halfpipe snowboarding

Matthias Thelen[1], Christian Merz[1,2], Lars Donath[3] ,Uwe Gustav Kersting[1,2],
[1]Institute of Biomechanics and Orthopaedics, German Sport University Cologne, Cologne, Germany
[2]Research Group Snowboard, Department Strength, Power & Technical Sports, Institute for Applied Training Science, Leipzig, Germany
[3]Institute of Training Science and Sports Informatics, German Sport University Cologne, Cologne, Germany
Email: m.thelen@dshs-koeln.de

Summary

The aim of the study was to investigate ground reaction forces during the different phases of halfpipe snowboarding rides. The highest loads do not occur during the landing phase, but rather during the transition phase. These findings contribute to a better understand of the sport and could help coaches to improve load management and develop specific strength training.

Introduction

The study of ground reaction forces (GRF) in sport has been a focus of biomechanical research for many years, with the potential to improve performance and prevent injury [1]. Despite the fact that the jumps of elite halfpipe snowboarders extend well beyond the 7 m height of the halfpipe, little is known about the forces that occur during halfpipe snowboarding. The halfpipe ride can be divided into five phases. The landing within the vertical wall, the transition to the flat, the ride through the flat, the transition to the rising wall and the take-off within the vertical wall. Therefore, the aim of this study is to investigate the GRF during these different phases of halfpipe snowboarding.

Methods

Six elite snowboarders participated in the study and performed a total of 60 rides (10 each) in a competition-ready superpipe. The vertical GRF was measured with an insole system (loadsoles, novel GmbH, Munich, Germany), while the local position of the snowboarder within the halfpipe was monitored with a position tracking system (Naos, Archinisis GmbH, Düdingen, Switzerland). Both systems had a sampling frequency of 200 Hz and were synchronised by cross-correlation and processed according to the method described by Thelen et al, 2024. Data analysis and statistics were performed using Python 3.9. The phases of the ride were categorised by the position tracking system, while the time of landing and take-off was determined by the insole system. A 4th order recursive Butterworth filter with a cut-off frequency of 20 Hz was used to reduce noise from uneven surfaces in the halfpipe. The progression of the vertical GRF was calculated as an average over rides. Peak vertical GRF was compared between the five phases using one-way ANOVA.

Results and Discussion

The following section presents preliminary results of 10 halfpipe snowboarding rides from one of the participants. Figure 1. A shows the progression of the mean vertical GRF during the 10 halfpipe snowboarding rides. Mean vertical GRF reach their maximum when the snowboarder is in the transition of the halfpipe (red shaded areas). Peak vertical GRF are significantly higher during the transition up than during landing, take-off or riding through the flats of the halfpipe (Figure 1. B). Interestingly, although halfpipe snowboarding is known for its spectacular high jumps, the results show that the highest loads do not occur during the landing phase, but rather during the transition phase. One possible explanation for this is that the top snowboarders are able to land in the still vertical part of the halfpipe so that the free fall merges seamlessly into the ride.

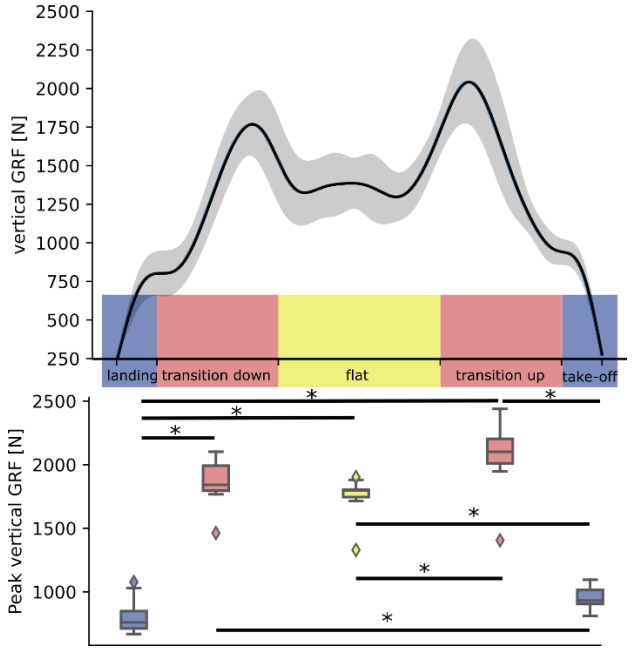

Figure 1: A: Progression of the mean vertical GRF ± 1sd during the different phases of halfpipe snowboarding. B: Peak vertical GRF during the different phases of halfpipe snowboarding.

Conclusions

In halfpipe snowboarding, peak loads are reached during riding through the transitions of the halfpipe. These findings contribute to a better understand of the sport and could help coaches to improve load management and develop specific strength training.

References

[1] Bartlett (2002). *Sports biomechanics*, Routledge
[2] Thelen et al. (2024). *ISBS Proceedings Archive 42.*