28th ECSS Anniversary Congress, Paris/France, 4-7 July 2023

V2 cross-country skiing technique variations assessed through principal movement discriminants extracted from wearable sensor data

Debertin, D.

University of Innsbruck

INTRODUCTION:
Cross-country (XC) skiing experts (instructors, coaches) describe precise technique forms, e.g. V2 technique, and distinct variation/deviation patterns from the technique ideal. These qualitative decriptions have high practical value, e.g. for the communication between coach and athlete, however, they are difficult to quantify, limiting their applicability for research or technology development. The current study utilizes and expands technique analysis approaches based on principal component analysis of kinematic data [1,2] and applies them to analyse V2 technique variations in XC skiing. The aim of this proof-of-concept study was to determine sensitivity for 14 distinct V2 technique variations.
METHODS:
Ten experienced XC skiers (5 females, age 30±8y, national or FIS licenced as instructor or athlete) performed the V2 technique according to curriculum guidelines [3] and according to 14 technique variations, each represented through two opposite extremes: weight shift (forth/back, up/down, lateral/centered), inward/outward upper body rotation, closed/opened legs, flat/canted ski strike, flat/canted ski off, long/short gliding phase, raised/lowered head, lowered/lifted heel, highly extended/flexed elbows, lowered/lifted elbows, maximal/minimal arm swing, closed/opened hands. The skiers' body segment movements were recorded using a full-body wearable sensor system (Xsens, Enschede, NL; 240Hz). For each technique variation, a principal component analysis (PCA) was calculated on centered and normalized kinematic data yielding principal movements (PMs) [2] that were dominanted by the variance produced by the two opposite variation extremes. Three left-right step cycle sequences were extracted and then averaged for each subject. These averaged PM scores were normal distributed (Shapiro-Wilk) and effects of the technique variation (3 levels: extreme(-); guideline V2 technique; extreme(+)) could therefore be tested using rmANOVAS (a=.05). Sensitivity was quantified through effect sizes (np2).
RESULTS:
Eleven out of the 14 technique variations showed significant differences in their waveform means, with the largest effects found for horizontal weight shift (np2= .906), arm swing (np2 = .803) and elbow flexion/extension (np2 = .785).
CONCLUSION:
The current study proved sensitivity for 11 of 14 distinct technique variation/deviation patterns. The three variations for which our approach was not sensitive included variations for which a more sofisticated analysis might be promising, but also variations poorly represented in the current sensory signals (e.g. raised/lowered head) for which hardware adaptations might be needed. In conclusion, our approach utilizes the knowledge and skills of skiing experts and makes them accessible for research and technology development.

References
[1] Gløersen et al., J Sport Sci, 2018, 36(2), 229-237.
[2] Debertin et al. Front Bioeng Biotechnol, 2022, 10.
[3] Bläse et al., Offizieller DSV-Lehrplan Skilanglauf. Motorbuch Verlag, 2013.

Topic: Training and Testing

Presentation Oral

European Database of Sport Science (EDSS)

Supported by SporTools GmbH

35053