

HOW TO WORK ON MEANINGFUL QUESTIONS IN ELITE WINTER SPORTS: A FIVE-STEP EBP PROCESS APPLIED TO SKI CROSS INJURY PREVENTION

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SO WHAT!?

- Build a strong relationship between coaches and sport scientists first — it is the base of every successful project.
- Work along five steps: relevant question → available evidence → setup → parameters & statistics → communication of results.
- Return results in a form coaches actually use — the interactive ski cross dashboard puts four seasons of injury data into coaches' hands and grows every season.

INTRODUCTION

Most sport-science research is experimental and laboratory-based. Its applied outcome for elite sport is questionable², its transfer to elite settings is limited³, and p-values and conclusions depend on sample size⁴. In elite winter sports such as ski cross (SX), weather, terrain and snow conditions make field research even harder — and incidences are too few to reach statistical significance. Coaches, however, work in an $n = 1$ world: waiting to be 95% sure means being left behind⁴. Applied settings therefore need a **suitable research design** — and a process for asking **meaningful questions**.

EVIDENCE-BASED PRACTICE (EBP)

EBP is the fusion of **coaches'** expertise and experience, **athletes'** values and **research evidence** to improve the **decision-making process** related to elite sport performance⁴.

AIM & QUESTION

How can meaningful questions in elite winter sports be asked and solved? We present the **five-step EBP process** and demonstrate it on a real project: quantifying potential injury situations in SX across four World Cup seasons^{6,7}.

METHOD — THE FIVE-STEP PROCESS OF DEVELOPING EBP³

GENERIC PROCESS³

A. Identification of the relevant question

Communication with stakeholders; clear delimitation of what will be implemented, and by when.

B. Check available evidence

Other sports and studies with similar needs.

C. Choose a setup

Feasible in the real setting; capture as many environmental factors as possible.

D. Choose parameters to investigate & statistics

Relevant level of precision; surrogate measures to increase the sample size; suitable statistical methods.

E. Communication of results to stakeholders

Appropriate language and form to present results.

APPLIED: SX INJURY DASHBOARD

SX ranks among the **highest-injury-risk** World Cup disciplines⁸, yet injuries become known only after the fact. With the Swiss-Ski SX team we asked: where and why do risky situations occur?

Official injury reports are **rare and retrospective**; four master's theses⁹ each covered one slice — valuable, but partial and underpowered.

Systematic **video analysis** of all World Cup races 2018/19–2021/22 (13 venues, incl. Beijing 2022), stored in one event-level database, drillable down to the sub-obstacle.

Surrogate measures of injury risk: crash, out-of-balance, contact, rank shift⁸. Rates per athlete-hour (true exposure) and % per passage; effects of obstacle, sex, venue and heat phase.

An **interactive dashboard** for the coaching staff: pooled for statistical power, drillable for detail — it grows and gains power every season (Fig. 3).

Fig. 1 — The process of asking meaningful questions and strategies to solve them in winter-sports field research³, shown with its application in the SX injury dashboard project.

RESULTS — WHAT THE PROCESS DELIVERED IN SKI CROSS

For almost every category and obstacle type, men have a higher incident rate than women, with **contact** being the most prevalent difference (Fig. 2) — crashes are the one consistent exception. The highest crash rates occur during direction changes, while **out-of-balance events cluster on jumps** ($p < .05$ – $p < .001$). At the sub-obstacle level, flat/GS-turn entries and bank-turn exits are the crash hotspots. Venue and heat-phase differences persist after exposure normalization.

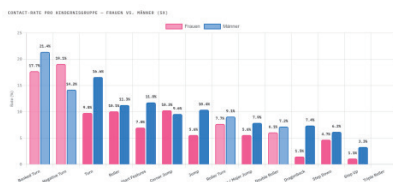


Fig. 2 — Sub-obstacle level: events by sex, four seasons pooled.

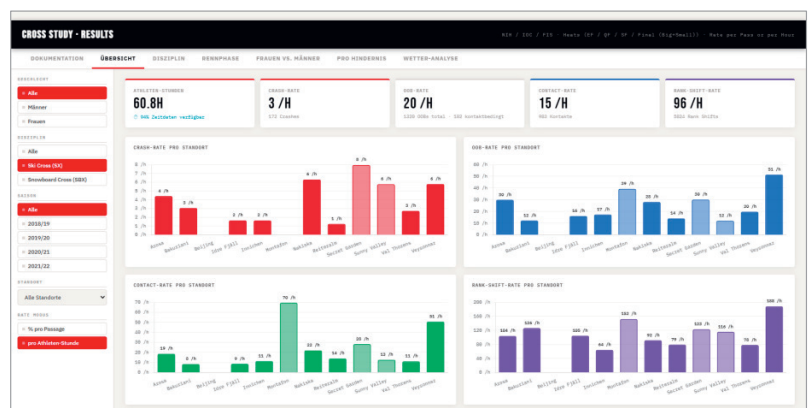


Fig. 3 — The live dashboard (step E): pooled overview, filters, drill-down per obstacle and venue.

CONCLUSION

The five-step process turned a broad safety concern into statistically powered, actionable answers — because stakeholders were involved from step A on, and results were returned in a form coaches use daily (step E). **Collaboration between coaches and research & development throughout implementation is key**; the process presented should guide future applied projects in elite sports.

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