The helmet: "Any effect on severe traumatic brain injury?"

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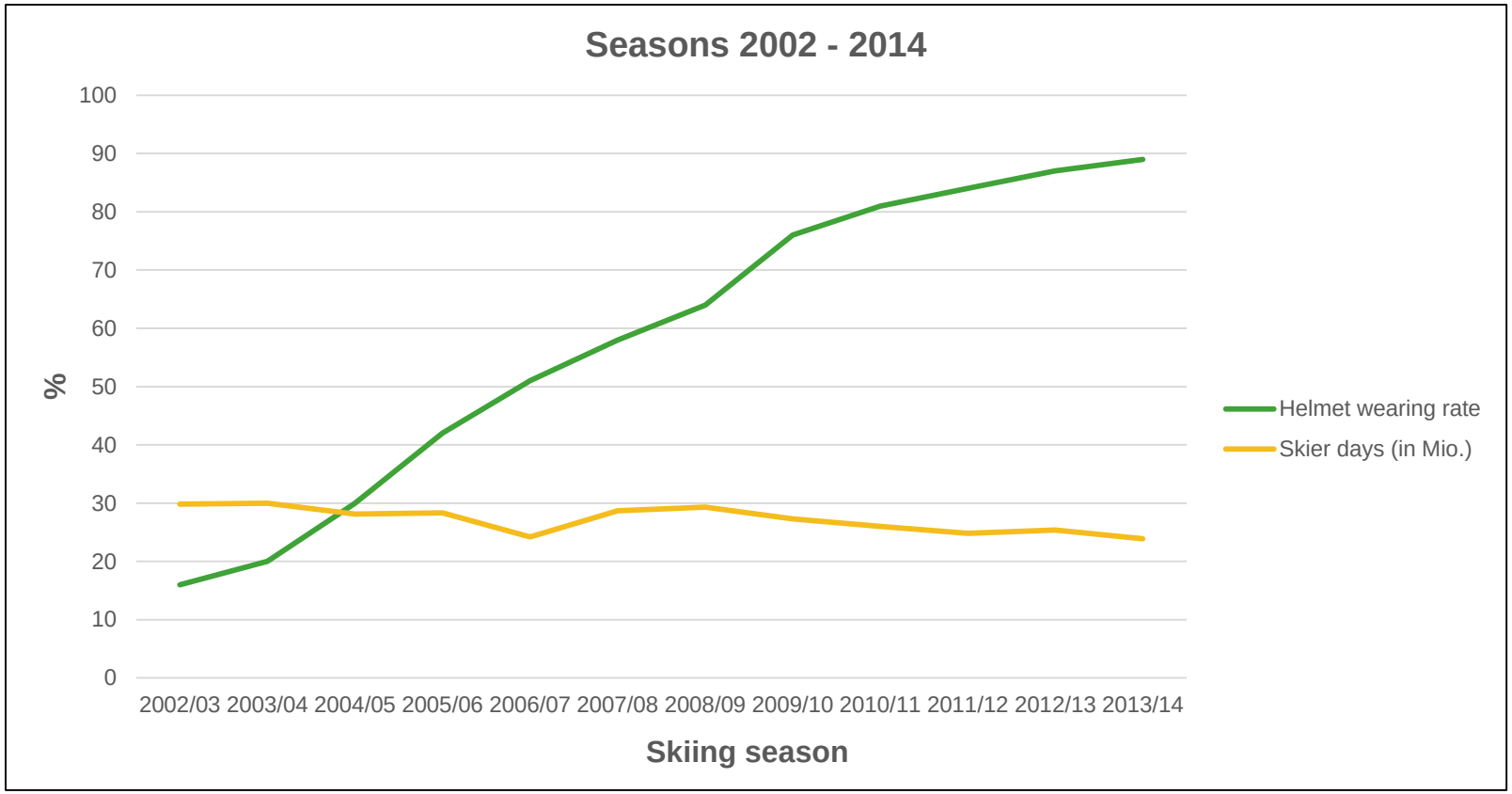
BACKGROUND

In Switzerland…

- **1,774 ski-lifts**
- **27 million skier days per year**
- **70,000 injuries per year**
- **Up to 20% traumatic brain injuries**

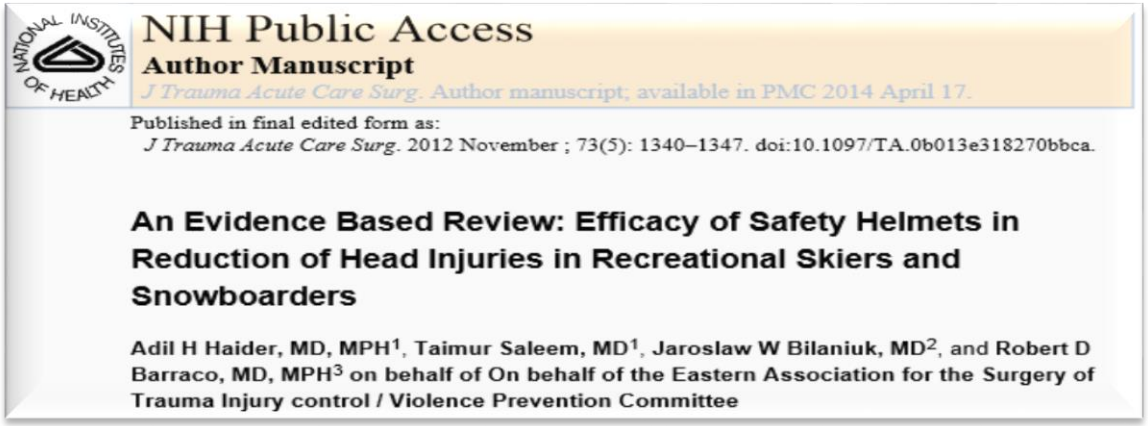
In Switzerland...



...or anywhere else

How protective?

Evidence



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J Trauma Acute Care Surg. 2012 November ; 73(5): 1340–1347. doi:10.1097/TA.0b013e318270bbca.

An Evidence Based Review: Efficacy of Safety Helmets in Reduction of Head Injuries in Recreational Skiers and Snowboarders

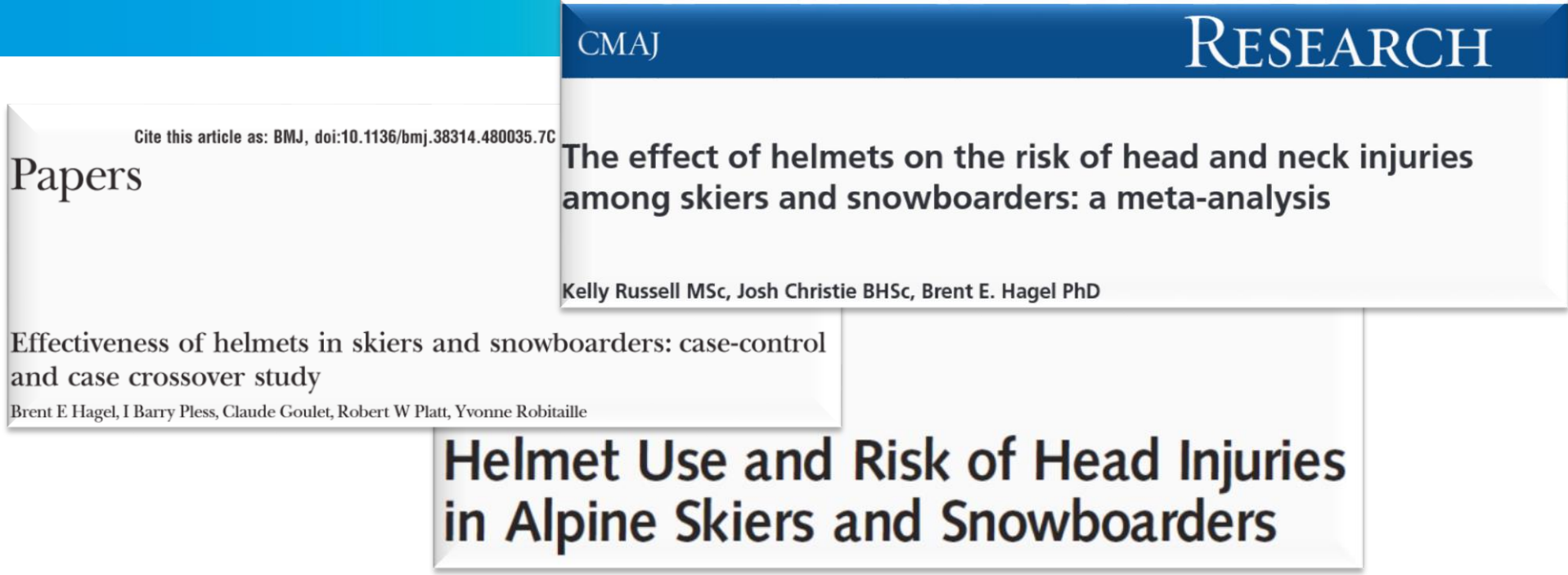
Adil H Haider, MD, MPH[1], Taimur Saleem, MD[1], Jaroslaw W Bilaniuk, MD[2], and Robert D Barraco, MD, MPH[3] on behalf of On behalf of the Eastern Association for the Surgery of Trauma Injury control / Violence Prevention Committee

Level I recommendation

*"Safety **helmets clearly decrease the risk and severity of head injuries in skiing and snowboarding** and do not seem to increase the risk of neck injury, cervical spine injury, or risk compensation behavior. Helmets are strongly recommended during recreational skiing and snowboarding."*

There is some evidence that wearing a helmet when skiing is useful in preventing the risk of TBI up to 60%

Sulheim S, Holme I, Ekeland A, Bahr R. Helmet use and risk of head injuries in alpine skiers and snowboarders. JAMA : the journal of the American Medical Association. 2006;295(8):919-24.



*Some recent studies suggested a **15% to 57% reduction of the odds ratio for head injuries in helmeted skiers and snowboarders** compared to those not wearing a helmet.*

Sulheim S, Holme I, Ekeland A, Bahr R: Helmet use and risk of head injuries in alpine skiers and snowboarders. J Amer Med Assoc 295:919-924, 2006

Russell K1, Christie J, Hagel BE: The effect of helmets on the risk of head and neck injuries among skiers and snowboarders: a meta-analysis. CMAJ 9:182:333-340, 2010

Hagel BE, Pless IB, Goulet C, Platt RW, Robitaille Y: Effectiveness of helmets in skiers and snowboarders: case-control and case crossover study. Brit Med J 330:281, 2005

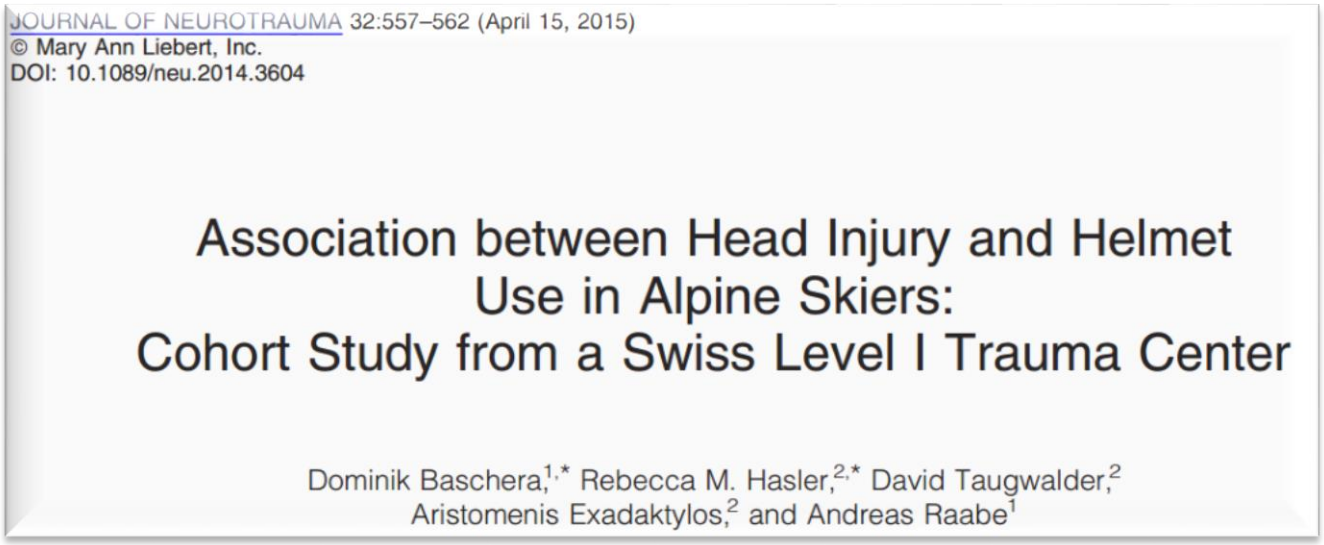
ORIGINAL ARTICLE

CrossMark

Cohort Study on the Association Between Helmet Use and Traumatic Brain Injury in Snowboarders From a Swiss Tertiary Trauma Center

Rebecca M. Hasler[1], Dominik Baschera[2], David Taugwalder[1], Aristomenis K. Exadaktylos[1], Andreas Raabe[2]

***Among the five patients who required neurosurgical interventions only one was wearing a helmet**; it is therefore unclear whether some neurosurgical interventions could have been avoided if the other four patients had been using helmets.*



JOURNAL OF NEUROTRAUMA 32:557–562 (April 15, 2015)

DOI: 10.1089/neu.2014.3604

Association between Head Injury and Helmet Use in Alpine Skiers: Cohort Study from a Swiss Level I Trauma Center

Dominik Baschera,[1,*] Rebecca M. Hasler,[2,*] David Taugwalder,[2] Aristomenis Exadaktylos,[2] and Andreas Raabe[1]

Despite the tremendous increase in helmet wearing rates over the last decade, ***no decrease in the amount and severity of head injuries*** *in alpine skiing has been detected.*

A comparison between patients with and without ***wearing a helmet showed no statistically significant increase for sustaining severe TBI****.*

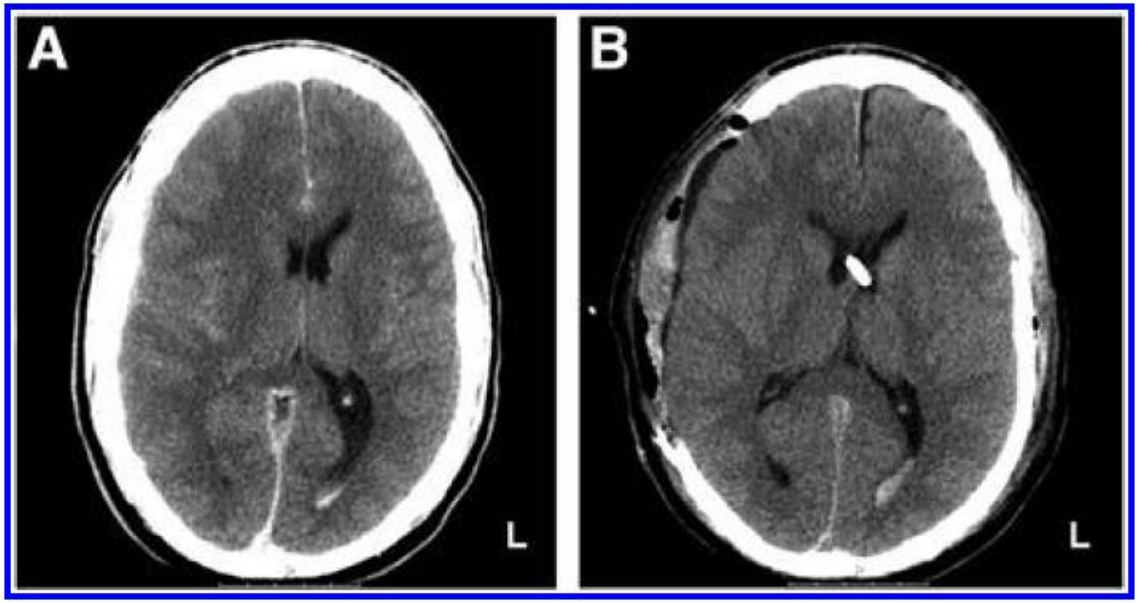
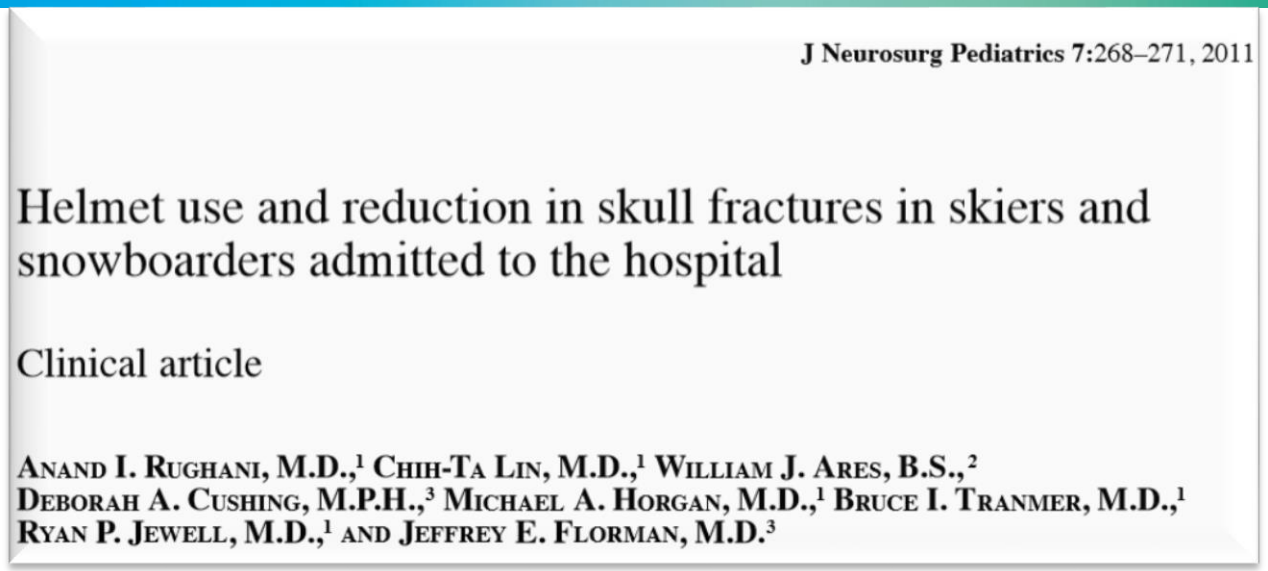


FIG. 2. This skier sustained a severe head injury after a fall from approximately 5 m after a ski jump. He wore a helmet at the time of the accident. At admission, his Glasgow Coma Scale was 3 and the initial computed tomography scan revealed intraventricular hematoma, subarachnoidal hemorrhage, and a thin acute subdural hematoma with diffuse swelling of the right hemisphere (**A**). An external ventricular drain was inserted in the emergency department, and a decompressive hemicraniectomy was performed (**B**). On follow-up, the patient had a Glasgow Outcome Scale of 5 (none or minor deficit).



J Neurosurg Pediatrics 7:268–271, 2011

Helmet use and reduction in skull fractures in skiers and snowboarders admitted to the hospital

Clinical article

Anand I. Rughani, M.D.,[1] Chih-Ta Lin, M.D.,[1] William J. Ares, B.S.,[2] Deborah A. Cushing, M.P.H.,[3] Michael A. Horgan, M.D.,[1] Bruce I. Tranmer, M.D.,[1] Ryan P. Jewell, M.D.,[1] and Jeffrey E. Florman, M.D.[3]

*One study comparing different injury patterns in a **paediatric population** of helmeted and unhelmeted skiers and snowboarders revealed non-significant trends to fewer epidural and subdural hematomas as well as a **significant difference of the occurrence of calvarial fractures**, which were more common in unhelmeted patients*

Rughani AI, Lin CT, Ares WJ, Cushing DA, Horgan MA, Tranmer BI, et al. Helmet use and reduction in skull fractures in skiers and snowboarders admitted to the hospital. Journal of neurosurgery Pediatrics. 2011;7(3):268-71.

ORIGINAL ARTICLE

Concussion Among Youth Skiers and Snowboarders
A Review of the National Trauma Data Bank From 2009 to 2010

Kelly R. Bergmann, DO, Andrew Flood, PhD,† Nathaniel S. Kreykes, MD,‡ and Anupam B. Kharbanda, MD**

Among youth skiers and snowboarders who present to trauma centers with a head injury, the likelihood of that injury involving a **concussion was not associated with helmet use.**

Entwicklung des Anteils Kopfverletzungen im Schneesport (pro 100 Verletzte) nach Sportart (Unfallland Schweiz), Wintersaisons 2005–2015[1, 2]

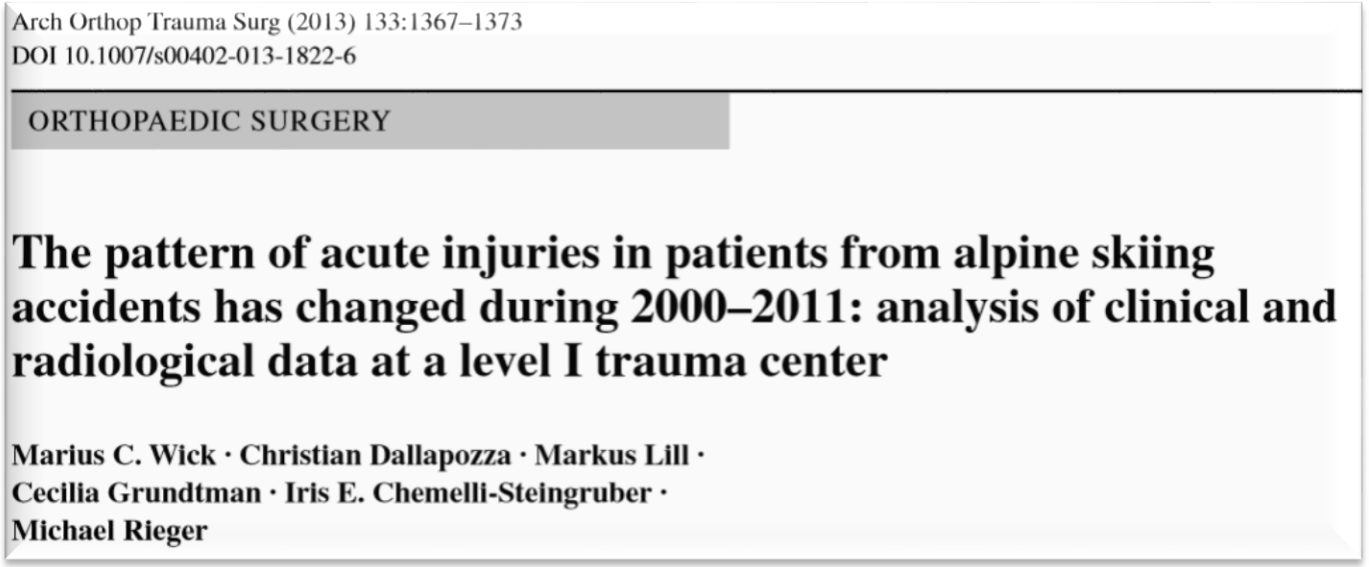
Saison	Skifahren	Snowboard-fahren	Anderer Schneesport	Total
2005/06	13	16	11	14
2006/07	17	15	14	16
2007/08	16	18	15	16
2008/09	13	17	10	14
2009/10	14	15	12	14
2010/11	15	18	14	16
2011/12	13	15	15	14
2012/13	15	16	16	15
2013/14	12	13	18	13
2014/15	13	14	16	14

[1] Erfasste Personen: Skifahren 56 028, Snowboardfahren 18 444, anderer Schneesport 5805

[2] Diese Zahlen beziehen sich auf die Schweizer Bevölkerung und ausländische Gäste.

Quelle: bfu, Statistik der Verletztentransporte im Schneesport USP.T.08

Unfallverhütung B-Bf. Entwicklung des Anteils Kopfverletzungen im Schneesport (pro 100 Verletzte) nach Sportart (Unfallort Schweiz), Wintersaisons 2005–2015 2015 [cited 20154 14/12/2015]. Available from: http://www.bfu.ch/de/Documents/04_Forschung_und_Statistik/02_Statistik/2015/PDF/D_USP.T.08.pdf



Arch Orthop Trauma Surg (2013) 133:1367–1373
DOI 10.1007/s00402-013-1822-6

ORTHOPAEDIC SURGERY

The pattern of acute injuries in patients from alpine skiing accidents has changed during 2000–2011: analysis of clinical and radiological data at a level I trauma center

Marius C. Wick · Christian Dallapozza · Markus Lill · Cecilia Grundtman · Iris E. Chemelli-Steingruber · Michael Rieger

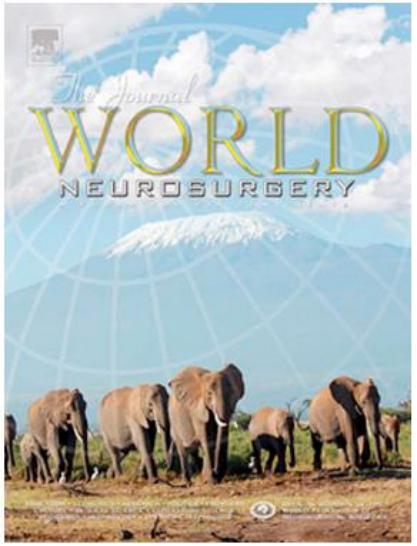
A radiological study from Austria found a decrease of the overall number of head injuries in alpine skiers over the same time period (2000-2011) but report an ***unchanged number of cerebral haemorrhages***

Wick MC, Dallapozza C, Lill M, Grundtman C, Chemelli-Steingruber IE, Rieger M. The pattern of acute injuries in patients from alpine skiing accidents has changed during 2000-2011: analysis of clinical and radiological data at a level I trauma center. Archives of orthopaedic and trauma surgery. 2013;133(10):1367-73.

Commentary on:

Cohort study on the association between helmet use and traumatic brain injury in snowboarders from a Swiss tertiary trauma center.

By Hasler et al. World Neurosurg xx:xx-xx, 2015



Helmet Use and Traumatic Brain Injury in Snowboarding

Philip E. Stieg and Kenneth Perrine

http://mimiandeunice.com/

Confounders

Different definitions of head injury and TBI

Severity grading is not uniform

Only certain age groups

Prehospital, ski patrol or insurance company data only

Biomechanics

Several studies measured impact forces but did **not find a direct correlation** between those findings and reported **concussion or concussive symptoms other than rotational forces**

Doubling the speed produces a **four-fold increase** in the energy of the **impact**

Greenwald RM et al. Head impact severity measures for evaluating mild traumatic brain injury risk exposure. J Neurosurgery. 2008;62(4):789-98;

Sabet AA et al. Deformation of the human brain induced by mild angular head acceleration. J Biomech. 2008;41(2):307-15.

Holbourn A, Mechanics of head injury. Lancet 2:430-441, 1943

EUROPEAN STANDARD **EN 1077**

NORME EUROPÉENNE

EUROPÄISCHE NORM August 2007

ICS 13.340.20

Impact with a speed up to 20-23km/h
(CE-EN 1077)

Risk compensation hypothesis

*Chi-square tests revealed that **ski helmet use did not significantly differ between self-reported risky and cautious people** (81% vs 83%).*

Ruedl G, Burtscher M, Wolf M, Ledochowski L, Bauer R, Benedetto KP, et al: Are self-reported risk-taking behavior and helmet use associated with injury causes among skiers and snowboarders? Scand J Med Sci Spor Epub 2013 Nov 14

Educating the medical community

Wearing a helmet does not decrease the need for a **thorough examination and diagnostics** after a TBI

First responders and slope-side medical staff should not hesitate to **transfer a rider to a specialized trauma unit** even if a helmet was in place

…and especially if the patient was **riding off-piste**

Conclusion

- **Helmets are recommended, but evidence for a reduction in severe TBI is lacking**
- **Future prevention programs should describe the risk of TBI among helmeted riders**
- **Educating the medical community**
- **Further advances in helmet technologies are warranted**

Thank you!

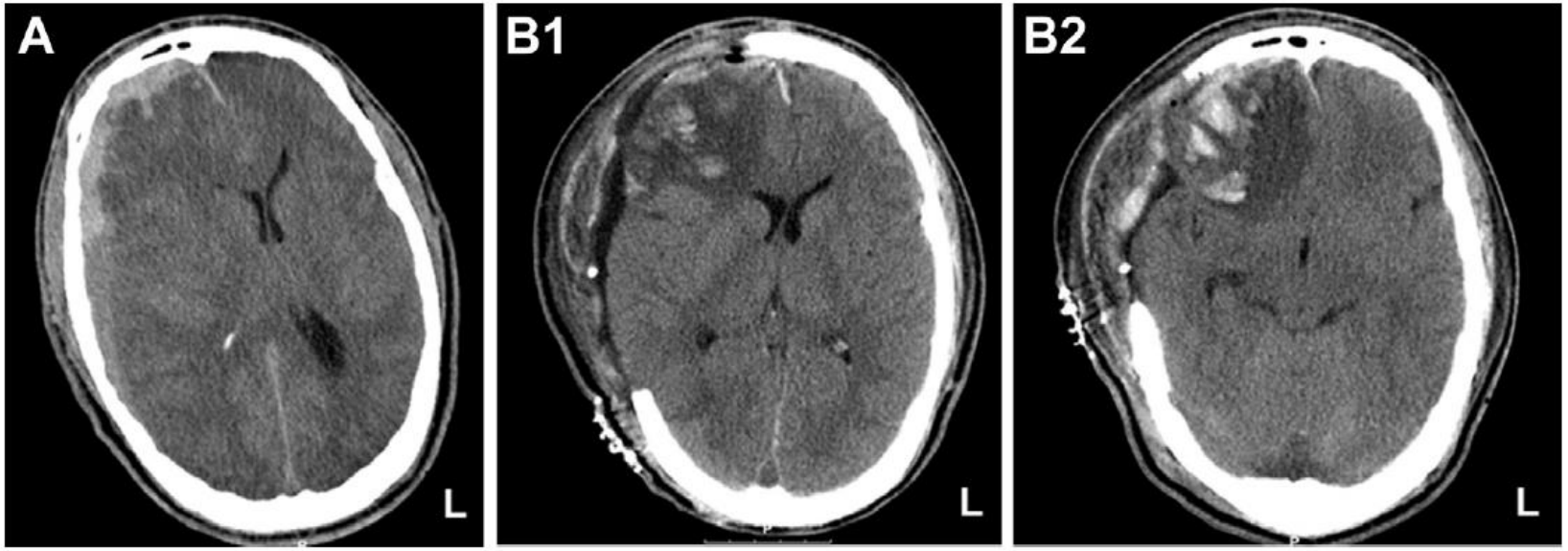


Figure 2. Computed tomography scans from a nonhelmeted snowboarder, who fell on a skiing slope. At admission the Glasgow coma scale score of this patient was 3, with anisocoria. The patient suffered from an acute subdural hematoma causing a midline shift more than 2 cm (**A**). After urgent decompressive hemicraniectomy the midline shift was almost normalized and the contusions were demarcated (**B1, B2**).

Table 1. Snowboarders with Need for Surgical Intervention due to Traumatic Brain Injury (TBI)

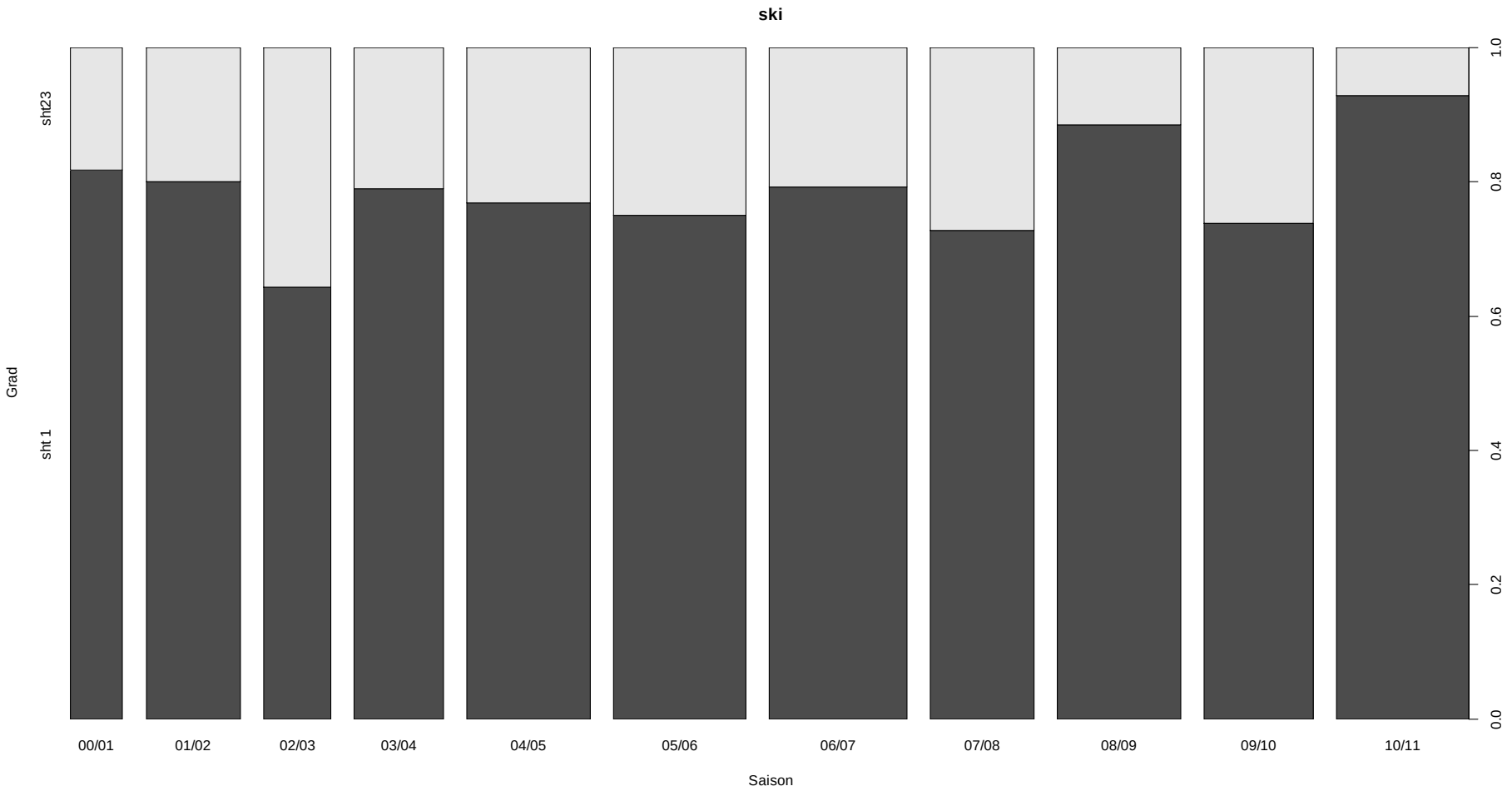
Age	Sex	Season	Place of Accident	Closed/ Open TBI	GCS*	Helmet	Loss of Consciousness	Main Lesion on CT Scan	Skull Fracture	Open/Closed TBI	Midline Shift >5 mm	Neurosurgical Intervention	Outcome (GOS)†
30	M	2004	On slope	Closed	4	No	Yes	Cerebral contusions	0	2	No	Parenchymatous ICP monitoring	5
35	M	2006	Park	Closed	3	No	Yes	Cerebral contusions	0	2	No	Osteoplastic craniotomy	LOF‡
23	F	2006	Off-piste	Open	3	Yes	No	Acute subdural hematoma	0	2	Yes	External ventricular drain	1§
24	M	2007	On slope	Open	15	No	Yes	Acute subdural hematoma	1	1	No	Parenchymatous ICP monitoring	5
22	M	2010	On slope	Open	3	No	Yes	Acute subdural hematoma	1	1	Yes	Osteoclastic craniectomy	5

ICP, intracerebral pressure.
*Glasgow coma scale (GCS) score.
†Glasgow outcome scale (GOS) score.
‡Lost to follow-up (LOF).
§Patient died due to his brain injury.

	Alpine skiers N=245 (68%)	Snowboarders N=117 (32%)
Helmet use (n [%])	78 (52%)	39 (53%)
AIS≥3 (n [%])	68 (28%)	22 (19%)
Open head injury (n [%])	13 (5%)	3 (3%)
Minor complicated (n [%])	58 (24%)	10 (9%)
Surgery (n [%])	30 (12%)	3 (3%)
GOS (median [IQR])	5 (5-5)	5 (5-5)

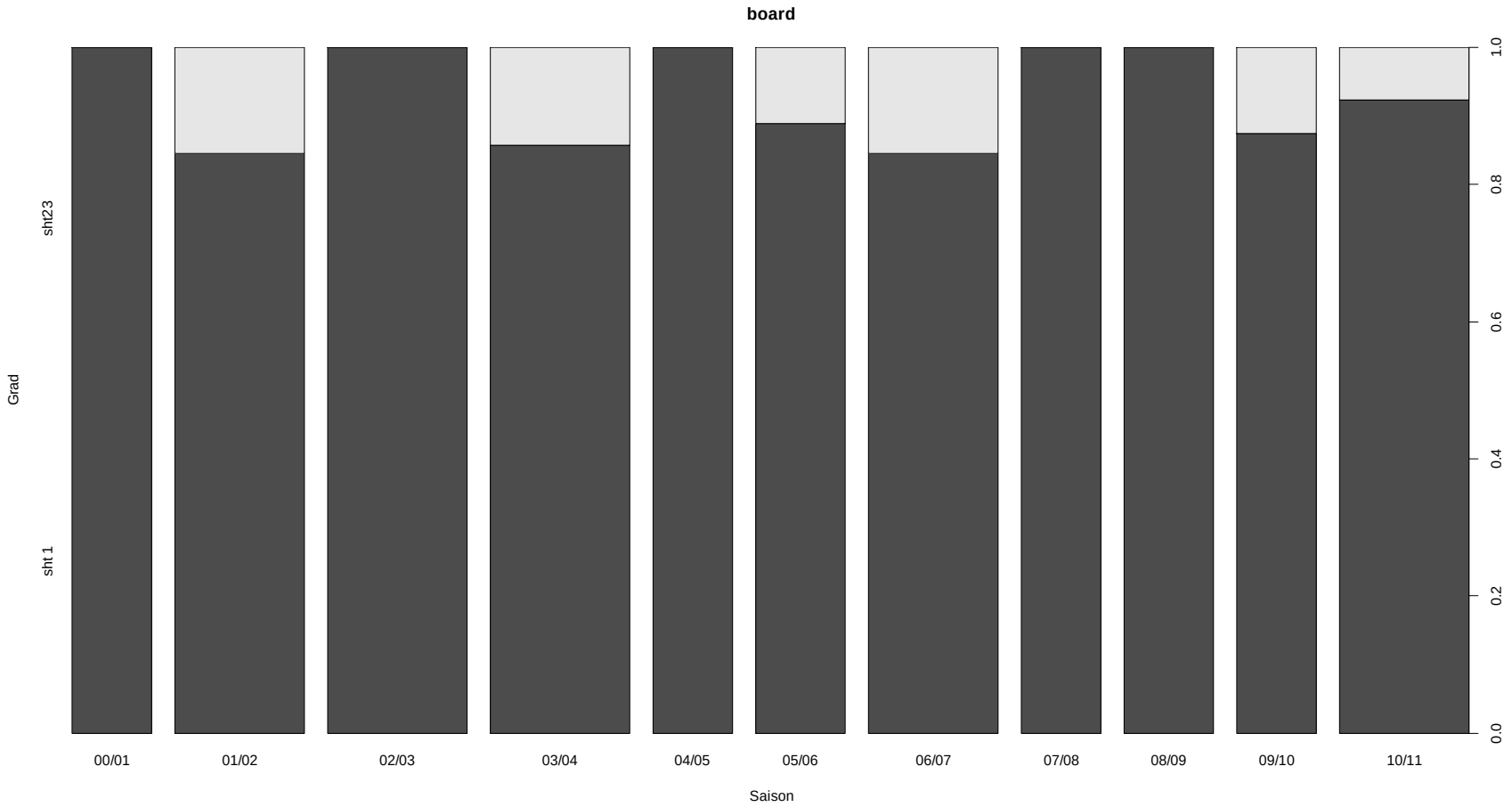
Alpine skiers

Proportion of mild versus moderate to severe TBI



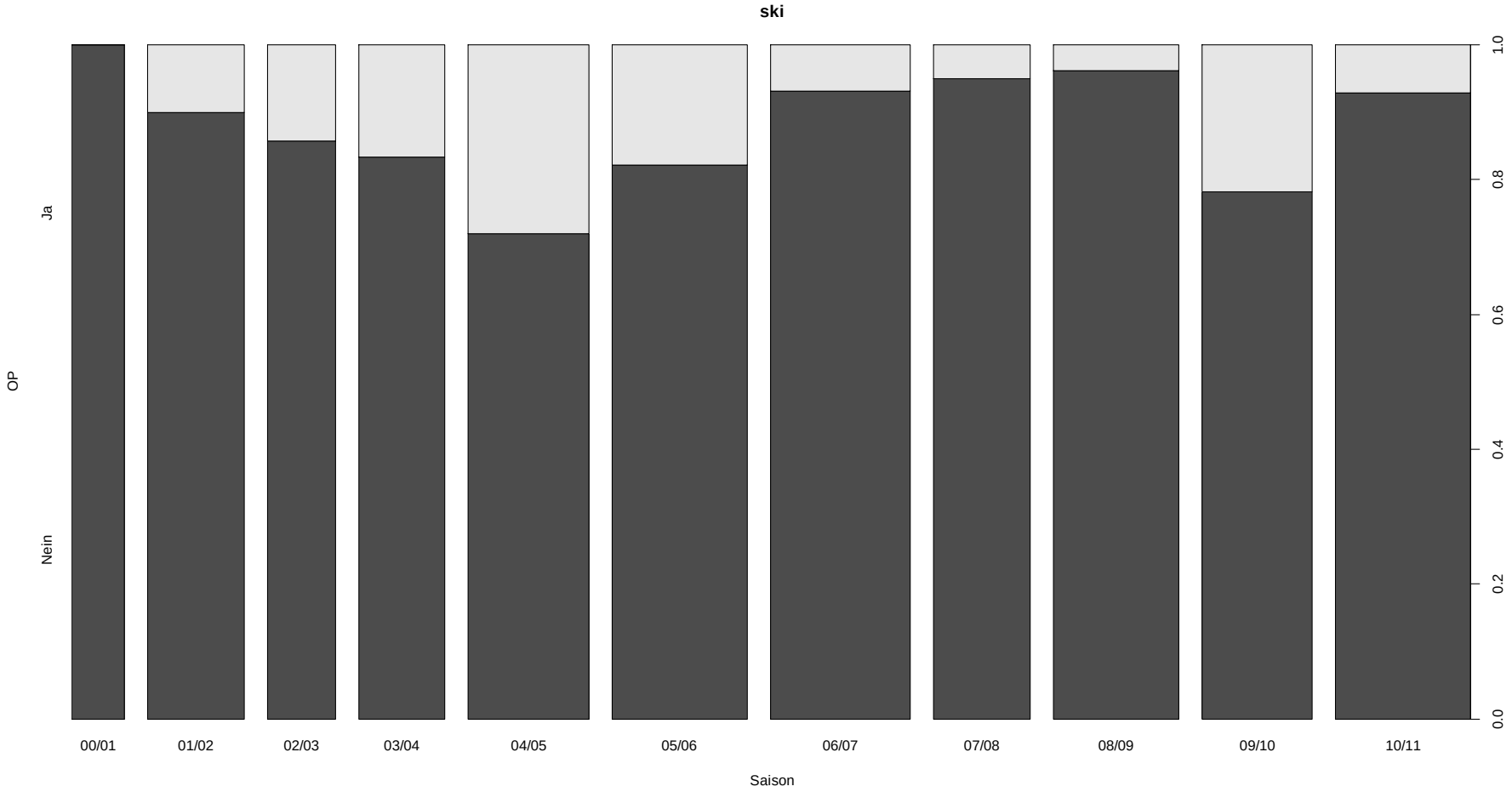
Snowboarders

Proportion of mild versus moderate to severe TBI



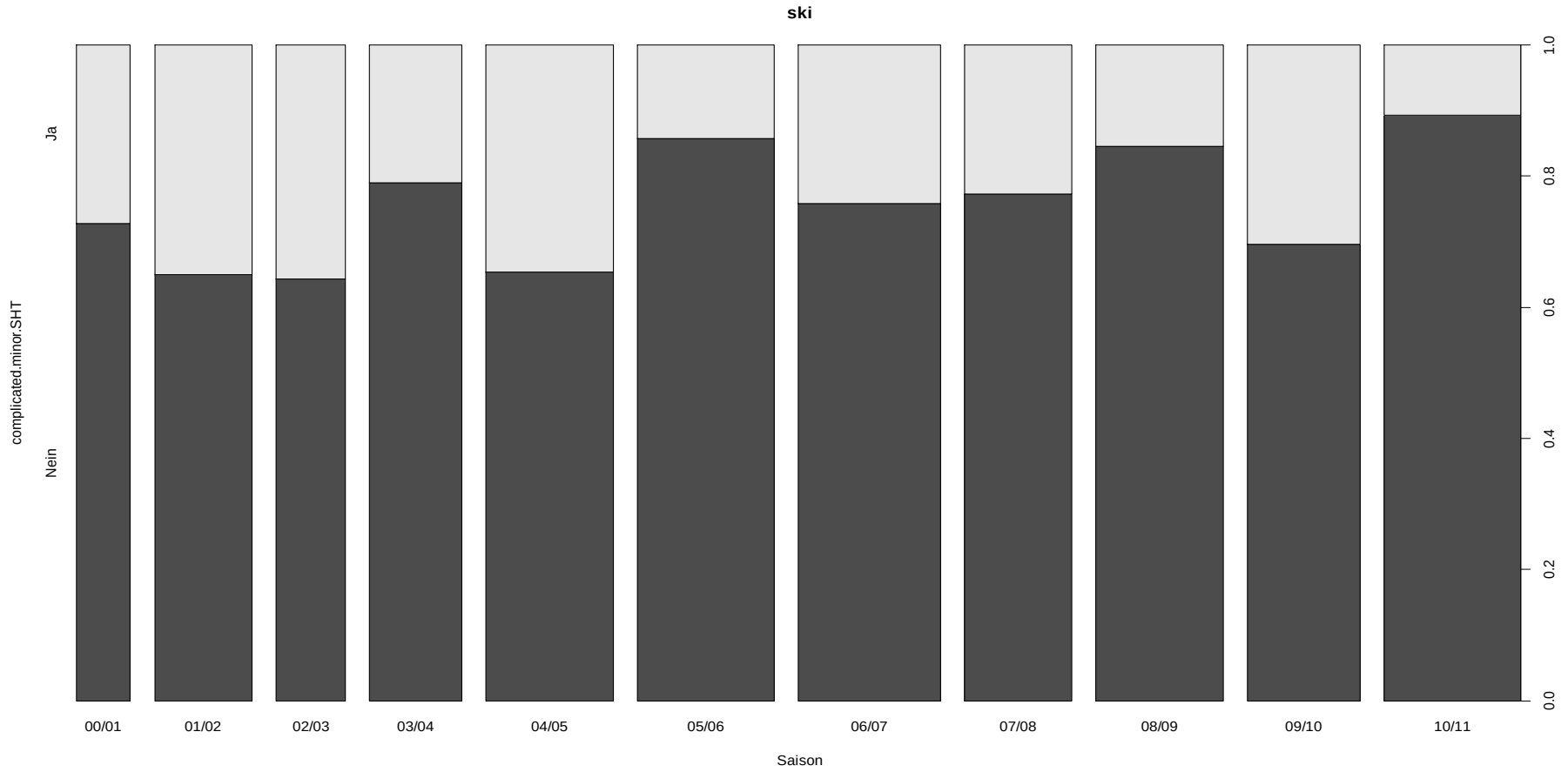
Alpine skiers

Proportion with surgery



Alpine skiers

Proportion with complicated minor head injury

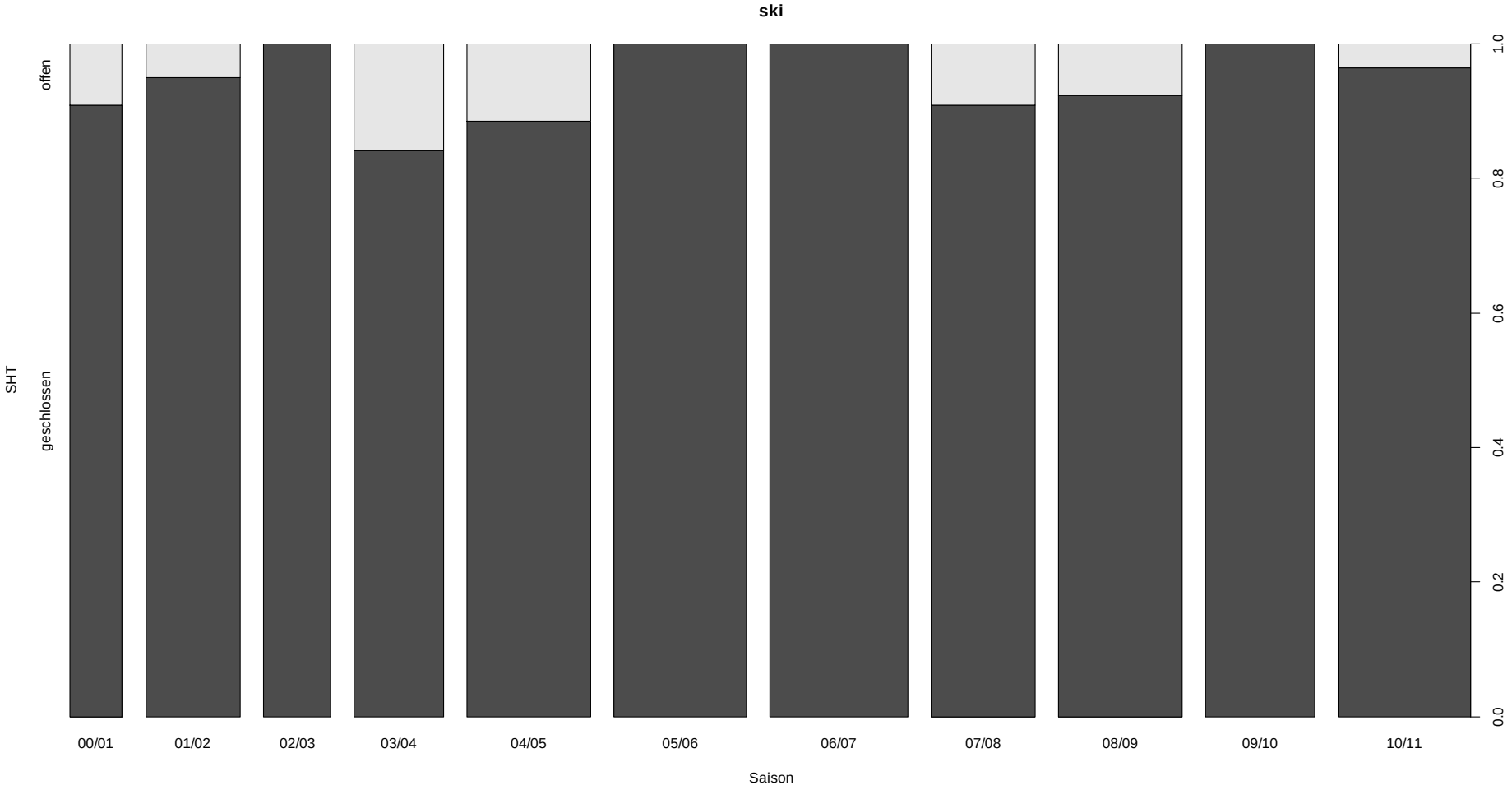


Outcome	Crude OR (95% CI)	Adjusted OR (95% CI)	P-value
Moderate to severe TBI			
alpine skiers	1.23 (0.52-2.92)	1.24 (0.52-2.94)	0.631
snowboarders	0.26 (0.05-1.39)	0.30 (0.05-1.67)	0.169
Open head injury			
alpine skiers	0.45 (0.08-2.56)	0.45 (0.08-2.57)	0.372
snowboardes	----	----	
Surgery			
alpine skiers	0.81 (0.30-2.23)	0.80 (0.29-2.24)	0.676
snowboarders	----	----	
Complicated minor TBI			
alpine skiers	0.92 (0.41-2.05)	0.91 (0.40-2.04)	0.818
snowboarders	----	----	
GCS (13-15 vs 3-12)			
alpine skiers	0.81 (0.34-1.92)	0.81 (0.34-1.92)	0.631
snowboarders	3.83 (0.72-20.38)	3.32 (0.60-18.37)	0.169
GOS (5 vs <5)			
alpine skiers	1.47 (0.32-6.83)	1.50 (0.31-7.16)	0.614
snowboarders	1.19 (0.16-8.97)	1.03 (0.13-8.12)	0.981

Outcome	Crude OR (95% CI)	Adjusted OR (95% CI)	P-value
Moderate to severe TBI			
alpine skiers	2.76 (0.75-10.2)	2.37 (0.63-8.86)	0.202
snowboarders	23.3 (3.52-153.5)	27.7 (3.26-235.3)	0.002
Open head injury			
alpine skiers	1.66 (0.35-7.95)	1.18 (0.24-5.88)	0.843
snowboarders	----	----	
Complicated minor TBI			
alpine skiers	2.22 (0.60-8.18)	1.89 (0.50-7.13)	0.350
snowboarders	----	----	

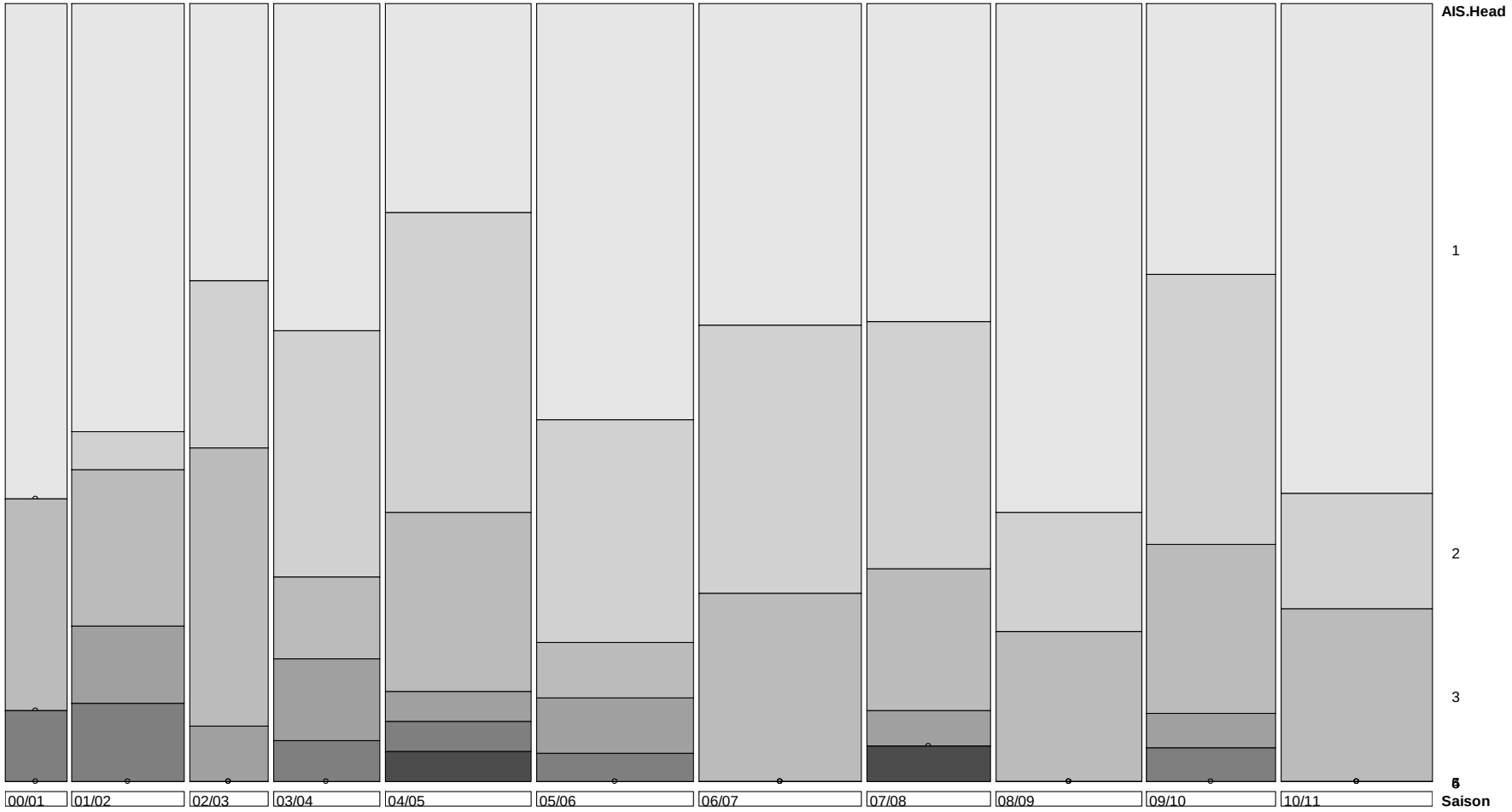
Alpine skiers

Open versus closed head injury



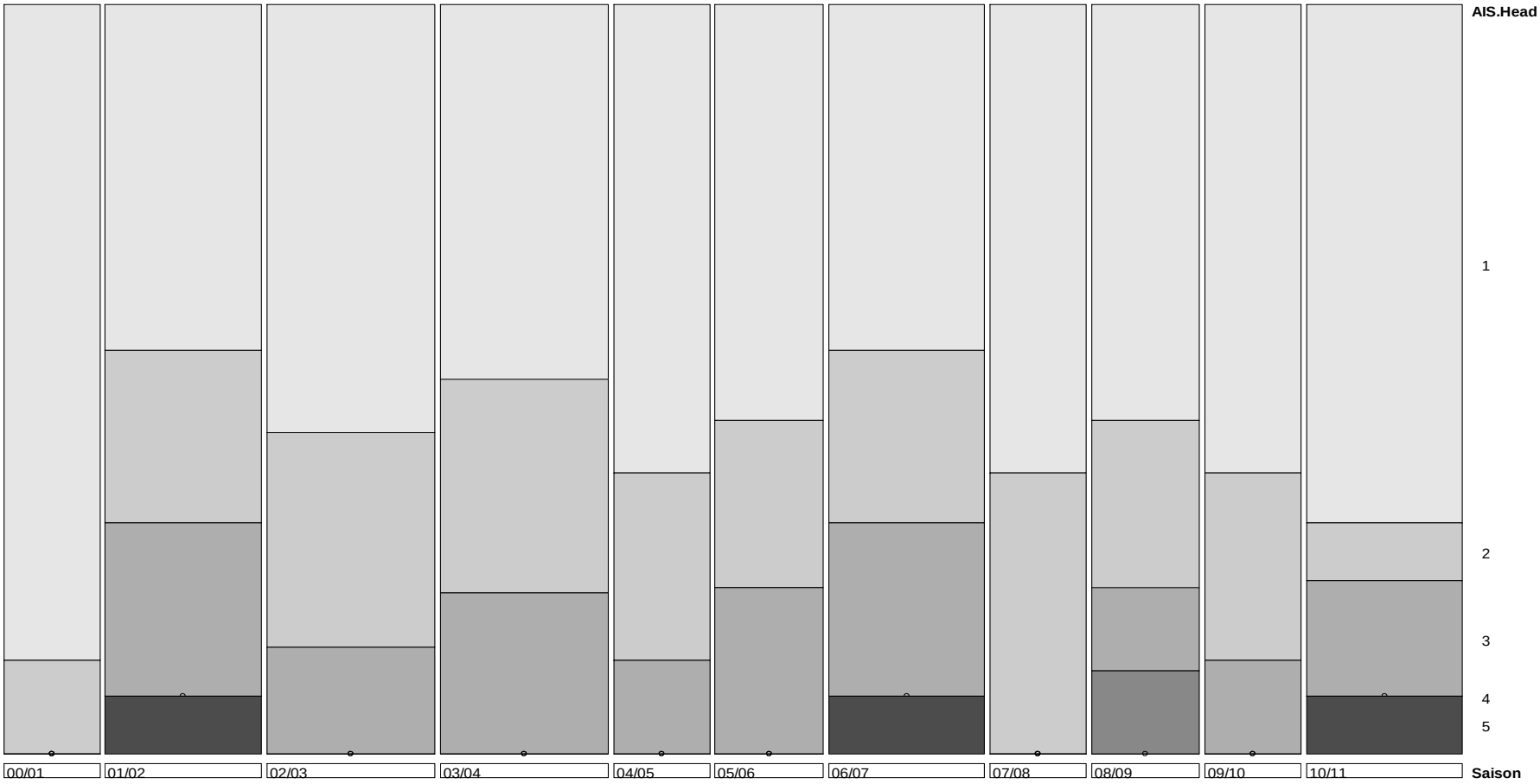
Alpine skiers

AIS head categories



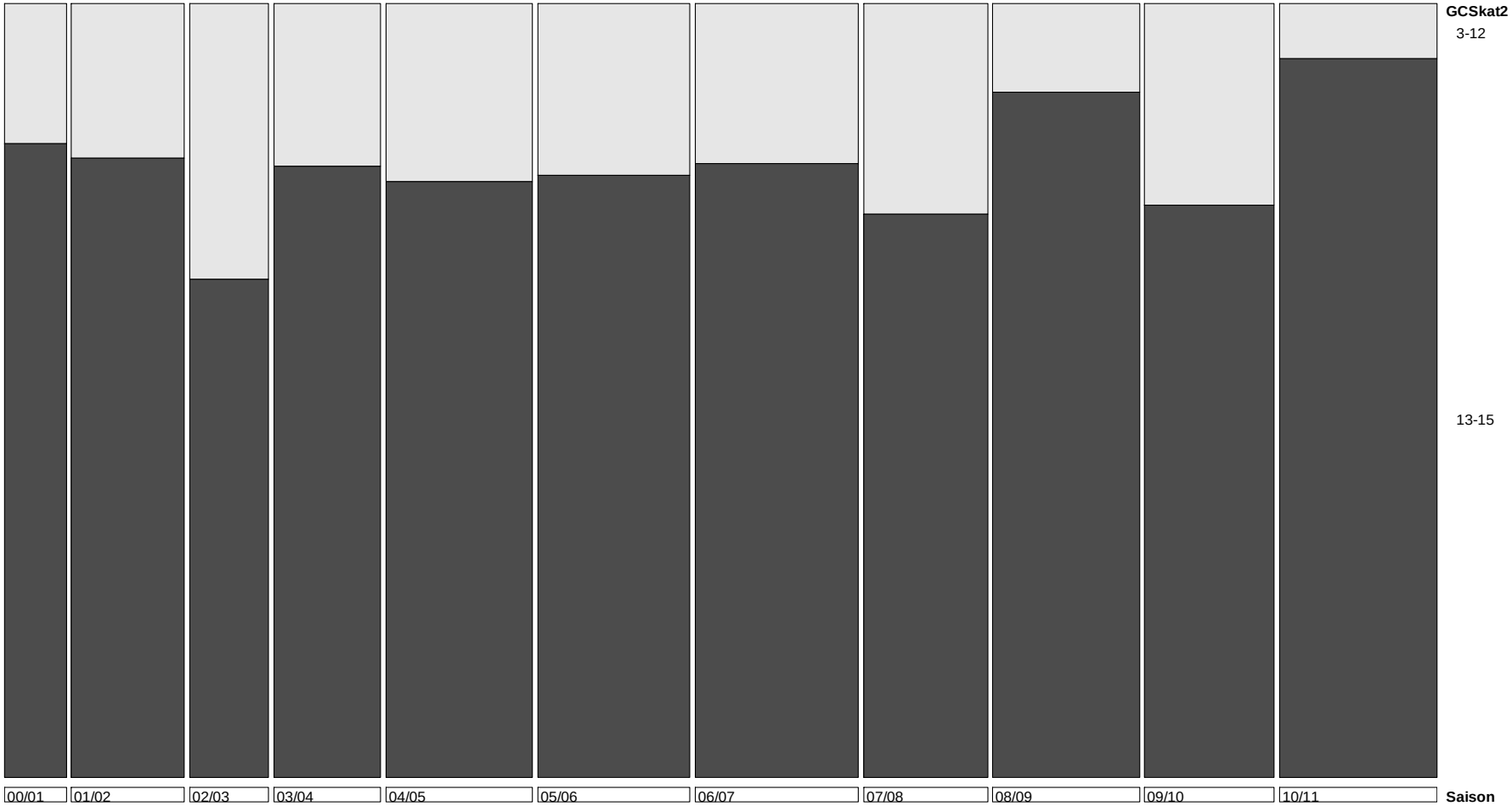
Snowboarders

AIS head categories



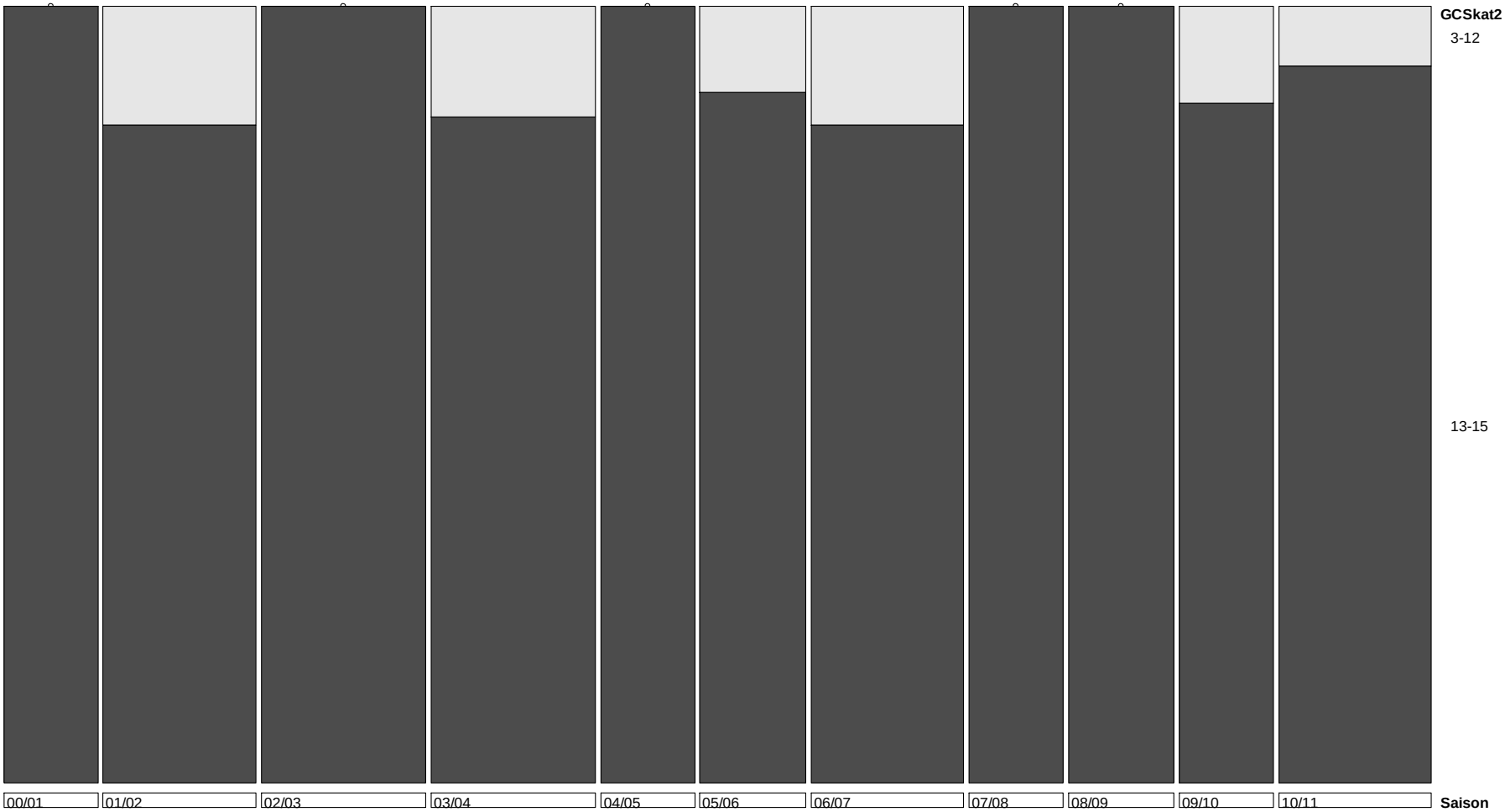
Alpine skiers

GCS 3-12 vs 13-15



Snowboarders

GCS 3-12 vs 13-15



Glasgow Outcome Scale

1. Death	Severe injury or death without recovery of consciousness
2. Persistent vegetative state	Severe damage with prolonged state of unresponsiveness and a lack of higher mental functions
3. Severe disability	Severe injury with permanent need for help with daily living
4. Moderate disability	No need for assistance in everyday life, employment is possible but may require special equipment.
5. Low disability	Light damage with minor neurological and psychological deficits.

GOS	Alpine skiers	Snowboarders
1	8 (3.3)	2 (1.7)
3	2 (0.8)	----
4	5 (2.0)	3 (2.6)
5	146 (59.4)	69 (59.0)