WILDERNESS & ENVIRONMENTAL MEDICINE (2018) ▮, ▮▮▮–▮▮▮

ORIGINAL RESEARCH

Effect of Helmet Use on Traumatic Brain Injuries and Other Head Injuries in Alpine Sport

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Introduction—Sport helmet effectiveness in preventing traumatic brain injury (TBI) has been repeatedly questioned. This study assesses the effect of helmet use on risk of TBI and other types of head injury (OTHI) in alpine sports.

Methods—From 2012 to 2014, data on the injured population were collected by physicians in on-mountain clinics in 30 French ski resorts, and interviews were conducted on the slope to sample a noninjured control population. Two sets of cases (1425 participants with TBI and 1386 with OTHI) were compared with 2 sets of controls (2145 participants without injury and 40,288 with an injury to a body part other than the head). The effect of helmet use on the risk of TBI and OTHI was evaluated with a multivariate logistic regression adjusted for age, sex, sport, skill level, crash type, and crash location.

Results—Using participants without injury as control, we found that helmet wearers were less likely to sustain any head injury (odds ratio $[OR]_{TBI} = 0.65$; $OR_{OTHI} = 0.42$). When considering participants with an injury to another body part as control, the risk of OTHI was lower among helmet wearers (OR_{OTHI}: 0.61). However, no significant effect was found for the risk of TBI. Participants with low skill levels, those aged <26 and >50 years, snowboarders, and those involved in collision and in snowpark accidents were at higher risk of head injury.

Conclusion—This study confirms the effectiveness of helmets in protecting users from head injuries but questions their effects on TBI, especially concussion.

Keywords: ski, snowboard, concussion

Introduction

Head injury is the leading cause of death and catastrophic injury among skiers and snowboarders and accounts for 3 to 15% of winter sports-related injuries.[1] Since 1993, several helmet-wearing campaigns have been launched in France, focusing mainly on children. A growing awareness of head injuries, a reduction in the weight of helmets, and an improvement in the comfort of helmets have resulted in a spectacular increase in child helmet use (from 15% in 1995 to 97% in 2014) and, more recently, in adult helmet use (from 9% in 2005 to 59% in 2014).[2]

Ski helmets are designed to protect the head from penetration and to deform upon impact to absorb the impact energy and reduce head acceleration. The effect of using a helmet on the risk of sustaining a head injury has been studied previously in case control studies.[3–7] In 2010, Russel et al[6] conducted a systematic review of these studies and found that participants wearing helmets were significantly less likely to sustain a head injury (odds ratio [OR] 0.65, 95% confidence interval [CI] 0.52–0.80). In these studies, traumatic brain injuries (TBI) (defined here as concussion, severe TBI, and skull fracture) and the other types of head injuries (OTHI) such as lacerations, bruises, and face trauma were not differentiated, but their respective injury mechanisms differ. In skiing, TBI is usually induced by sudden deceleration of the head, whereas most OTHI

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Submitted for publication July 2017.

Accepted for publication November 2017.

are caused by the direct contact between the head and the surface of impact. A difference in the effect of the helmet regarding these different types of injury thus may be expected. This was recently highlighted by Dickson et al,[8] who suggest that helmets might protect against lacerations but have limited effectiveness against concussions.

In this work, we intend to use a case control study to evaluate the effect of helmet use and various confounding factors on the risk of both TBI and OTHI. Two hypotheses were tested: 1) the helmet reduces the risks of TBI and OTHI in the skiing population (control group = uninjured population), and 2) the helmet reduces the risks of TBI and OTHI when involved in a traumatic accident (control group = population with an injury to a body part other than the head).

Methods

STUDY POPULATIONS

The injured population

In most French ski resorts, injuries are treated on site at a local medical center. The data relating to this study were gathered in the medical facilities of 30 French ski resorts by the 50 physicians who contribute to the Médecins de Montagne epidemiological network. Among the injured individuals, 62% came to the centers on their own, and the others were delivered by the ski patrol (38%).[2] The only patients not seen in those centers were the most severely injured, who were directly transported to the nearest hospital (less than 0.2% of patients in 2009, according to an unpublished study based on the number of severe ski injuries treated in the hospitals of the Rhône-Alpes region). An injury was recorded when an Alpine sport participant consulted one of the resort's physicians who was part of the Médecins de Montagne group after a skiing or snowboarding-related accident. The type of injury was recorded, as was participant information (age, sex, sport, estimated skill level). Helmet use, type of crash (collision or not), and location (in a snow park or not) were also included in the survey. Data were collected over 3 seasons from 2011–2012 to 2013–2014. During that period, 49,398 injuries were recorded. All patients with missing information were excluded (n=6299 [15%]). The patients were divided into 3 groups: (case 1) those with a clinically diagnosed TBI including concussion, severe TBI, and skull fracture; (case 2) those with OTHI such as lacerations, bruises, and face trauma; and (control 2) those with an injury to a body part other than the head.

The study was approved by the regional ethical research committee (Comité de Protection des Personnes Sud Méditerranée I, Committee reference: RO – 2016/01).

The noninjured population (control 1)

From the 30 resorts included in the study, we selected a representative sample of 10 ski resorts from which to closely study the winter sports participants.[9,10] These ski resorts were selected according to 4 criteria defined by the French Ministry of Tourism: 1) geographic distribution; 2) annual revenue; 3) the type and altitude of the ski resort; 4) specific features (eg, having a snow park).

Interviews were conducted at the bottom of the ski slopes on 7 specific days of the season in each year in each resort (approximately 1000 interviews were conducted each year). As far as was possible, the interviewer stopped 1 in every 10 skiiers who went past and invited them to participate in the study. Sport, sex, age, self-assessed skill level, and helmet use were recorded. Interviewers reported that it was often difficult to interview children (often in ski classes). To avoid bias resulting from an underreported child population, we decided to exclude children under the age of 16 years from the study.

Additionally, to account for sampling bias, a systematic count of the general participants at the ski area was performed at the bottom of the slopes in each resort over 1 hour on each of the days the survey was conducted (approximately 40,000 skiers and snowboarders were counted each year). Sport, sex, and helmet use were recorded. The survey data were weighted according to the proportion of snowboarders and helmet wearers in the counted population.

THE CASE CONTROL STUDIES

To evaluate risk factors for head injury, case control studies were performed.

Case selection

Two sets of cases were included in the study. The first set (case 1) consists of patients with a clinically diagnosed TBI (n=1425) (skull fracture, minor and severe TBI). The second set (case 2) are patients with OTHI (n=1386) (lacerations, bruises, and face trauma).

Control selection

We also considered 2 control sets. The first group (control 1) is made up of 2145 noninjured skiers and snowboarders interviewed between 2012 and 2014.