

Half of Emergency Calls in Hikers are Injuries from Falls in 50-70 Year-Olds

Die Hälfte der Notfälle beim Bergwandern sind Stürze bei 50-70-Jährigen

Summary

- › **Introduction:** Hiking has increased in popularity and it is suggested that 2 million hikers visit the Swiss Alps per year. Although intuitively the risk of a mountain accident seems to be small, reports of severe traumas and even death can be found.
- › **Material & Methods:** The study was designed as retrospective analysis of a ten-year period from 2009-2018. In total, 11,120 mountain accidents were analyzed.
- › **Results:** From 2009-2018, a total of 11,220 mountain hiking accidents was identified. The highest share with around 45 percent were falls. These were mainly in the summer months July and August and in the sub-sample of 50-70 year-old mountain hikers. Furthermore, with around 20 percent illness (mainly cardiovascular) evident, and around 13 percent were due to losing the way. The localization pattern of injury presents as follows: head and skull (14.5%), shoulder (14.5%), ribs/thorax (7%), multiple trauma including pelvis and abdomen (1.2%), leg (14.5%), knee (15.4%) feet (36.9%). A total share of two-thirds are the traumas of lower extremity, around one-seventh are multiple traumas or head & skull, implying that less than 20 percent were life-threatening injuries.
- › **Discussion:** Basically, beside other factors, the massive proportion in elderly of falls (50-70 years old) is a consequence of decreasing postural stability. As a consequence, hikers can profit from strength training in advance of difficult hiking tours.

KEY WORDS:

Eccentric Training, Injury Pattern, Lower Extremity, Mountain Emergencies

Introduction

There is growing enthusiasm for outdoor sports and recreation (3, 4, 10, 11, 18, 31, 33). It is assumed, that around 100 million tourists visit the alps per year (3, 4, 10, 11, 18, 30, 33). For Switzerland estimations exist that around 2 million mountain hikers are active per year (18, 19, 20, 21, 33). Hiking is understood as walking on a foot, forest, mountain or alpine track or trackless terrain making it

Zusammenfassung

- › **Hintergrund:** Bergwandern erfreut sich großer Beliebtheit und man kann davon ausgehen, dass pro Jahr rund zwei Millionen Bergwanderer in den Schweizer Alpen unterwegs sind. Obwohl das Verletzungsrisiko intuitiv gering ist, finden sich trotzdem immer wieder schwere Verletzungen oder gar Todesfälle. Dies führt zur Zielsetzung, die Ursachen und Folgen von Bergnotfällen beim Bergwandern zu analysieren.
- › **Material & Methoden:** Die letzten zehn Jahre (2009-2018) wurden anhand des Zentralregisters des Schweizerischen Alpen Clubs ausgewertet, wobei eine Grundgesamtheit von 11 220 Bergnotfällen, die sich während dem Bergwandern ereigneten, analysiert werden konnten.
- › **Resultate:** Als klar häufigste Ursache für einen Einsatz der Rettungskräfte konnten Stürze mit rund 45 Prozent identifiziert werden. Diese treten vor allem in den Sommermonaten im Kollektiv der 50-70-Jährigen auf. Weiter sind mit rund 20 Prozent eine Erkrankung zu nennen (häufig kardiovaskuläre Affektion), bei rund 13 Prozent lag ein Verirren vor. Die Aufteilung nach Lokalisation der Verletzung präsentiert sich wie folgt: Kopf und Schädel-Hirntrauma (14,5%), Schulter (14,5%), Rippen/Thorax (7%), Polytrauma inklusive Becken und abdominelles Trauma (1,2%), Bein (14,5%), Knie (15,4%) und Fuss (36,9%). Total imponieren somit rund 2/3 Traumen der unteren Extremität, Polytraumen und Kopf- und Schädel-Hirntraumen machen rund 1/7 aus, was entsprechend verdeutlicht, dass schwerere Verletzungen weniger als 1/5 der Bergnotfälle betreffen.
- › **Diskussion:** Es findet sich eine Häufung von Stürzen im Alter der 50-70-Jährigen, was vermutlich neben anderen Gründen auf die verminderte Gangfähigkeit zurückzuführen ist. Entsprechend könnten ältere Bergwanderer von einem Kraft- und Gleichgewichtstraining profitieren.

SCHLÜSSELWÖRTER:

Exzentrisches Training, Verletzungsmuster, Untere Extremität, Bergnotfälle

necessary to pass scree, spring blocks as well as snow fields or to climb over short parties such as ridges but does not include the passing of glaciers or rock climbing with a rope (18, 33). In Switzerland, this encompasses hiking trails (yellow marks and yellow signposts), mountain trails (red-white-red marks) as well as alpine routes (blue-white-blue marks) (18, 33). >

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Table 1

Age Distribution for the different classes (blocking, illness, lose one's way, falls).

AGE CLASS	FALLS		LOSE ONE'S WAY		BLOCKING		ILLNESS		TOTAL	
	PERCENTAGE	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE	NUMBER
0	0.0	2	0.0	0	0.0	0	0.0	0	0.0	2
10	2.0	96	2.1	27	2.7	46	1.4	30	2.0	199
20	5.4	258	11.8	150	9.9	170	5.6	118	7.1	696
30	7.0	335	20.3	258	21.7	373	4.8	101	10.8	1067
40	8.1	390	13.8	175	18.8	323	5.6	116	10.2	1004
50	13.9	664	15.3	194	15.1	260	9.6	200	13.4	1318
60	21.6	1036	16.3	207	14.5	250	17.5	365	18.8	1858
70	23.8	1139	10.5	133	9.6	166	24.7	517	19.8	1955
80	14.4	691	7.3	92	4.9	85	23.0	481	13.7	1349
90	3.6	171	2.4	31	2.7	47	7.1	148	4.0	397
100	0.2	9	0.1	1	0.1	1	0.6	13	0.2	24
Total ages		4791		1268		1721	1	2089		9869
Missing values of age		109		125		112		51		397

From a physiological point, mountain hiking is a very gentle form of physical activity in order to improve the efficiency and capacity of the cardiorespiratory system (17, 23, 25, 37). Especially in elderly due to its gentleness mountain hiking is a very good possibility in order to be physical active. (13, 17, 23, 37). Mountain hiking allows over several hours to stimulate cardiovascular system and to develop protective effects on metabolic and musculoskeletal system for example by inhibiting low-grade inflammation present in many illnesses often found in elderly (13, 17, 23, 37). Regular mountain hiking improves postural stability helping to prevent falls in later decades of life (6, 12, 14). Unfortunately, despite all these positive aspects hiking has injury and other risks (1, 11, 22, 36, 37). For example, current conditions in the mountains are still signed by a lot of old snow in lower areas of the mountains and the warm and sunny summer weather attracts many mountain hikers into these regions normally snow free at this time of the year creating risky constellations (21). Fields with old snow can become dangerous, especially when below a creek is flowing, fields end in a scree or a slope is at the end (21). In the morning and in the shadow these snow field are still hard but become fast wet and slippery during the day making for example snow bridges to dangerous traps (21). In consequence, around 48 deathly accidents per year happen while mountain hiking in the Swiss alps (20). Focusing on the evidence site, most evaluations in mountain sports during the summer season concentrated on climbing or mountaineering accidents; however, specific data on mountain hiking accidents and the circumstances for the Swiss Alps and its surrounding area does not exist. (9, 15, 16, 28, 29). This yields to the aim of the study to analyze causes and mechanism of accidents while hiking.

Material & Methods

Analyzed Population

Accidents while hiking from 2009-2018 in Switzerland were analyzed. During these ten years 11220 persons were rescued by an emergency organization in Switzerland or in the close border regions (Schwarzwald, Vorarlberg, Veltlin etc.).

To define, a mountain accident encompasses all events making it necessary for persons to make usage of a mountain emergency organization with its respective launch. In consequence, this also encompasses persons in the nature that were uninjured or were suffering from illnesses or an evacuation due to losing its one way was necessary.

Procedures

The study assessed retrospectively the accidents during hiking in Switzerland in the period from 2009-2018. Raw data was from the encompassing registry of the Swiss Alpine Club for mountain accidents during 2009 to 2018, but also entailed accidents while hiking in the pre-alps. In this encompassing registry all events using an emergency organization are recorded. In consequence, the registry also entails records from mountain bike, climbing, skiing or paragliding accidents, however these accidents were in one of the first step excluded. The central register contains data from the schweizerischen Rettungsflugwacht (REGA), Air Glaciers Lauterbrunnen, Air Glaciers Sanenland, Register SAC, der KWRO (Wallis), Schnee- und Lawinenforschungsinstitut Davos as well as the cantonal Policy registries. Each record of a mountaineering accident entailed the place, the emergency organization, the age, the living place as well as a short case report with in most cases medical background information. Based on this information it was tried to classify the injuries according to the recommended patterns by UIAA (Union Internationale Des Associations D'alpinisme) and Burtcher et al. 2008 (4, 27).

The following classification scheme was consecutively used: head & skull trauma / shoulder injuries / ribs & thorax injuries / polytraumas inclusive pelvis & abdominal traumas / leg injuries / knee injuries / foot injuries.

Statistical Analysis

Accidents while hiking were first categorized concerning causes of emergency calls. These were further analyzed concerning regional distribution pre-alpine versus alpine and concerning main areas in Switzerland. For the largest group of falls

Table 2

Seasonal Distribution of falls (n=4900). In the high season of mountain hiking in summer most falls can be detected.

MONTH	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN	SD
January	7	4	16	11	9	9	7	10	22	7	10,2	5,2
February	6	2	18	4	5	4	7	8	10	15	7,9	5,1
March	6	8	10	7	3	7	12	6	19	10	8,8	4,4
April	7	18	19	14	11	13	18	9	27	24	16,0	6,4
May	21	21	24	29	11	16	21	28	28	40	23,9	8,0
June	46	43	44	53	37	61	62	36	74	93	54,9	18,0
July	115	118	92	84	133	87	120	137	102	143	113,1	21,2
August	136	111	115	114	106	93	124	131	106	123	115,9	12,9
September	69	68	69	62	51	81	52	86	44	105	68,7	18,3
October	38	45	54	34	30	44	38	35	72	74	46,4	15,6
November	11	5	20	13	4	11	24	8	13	15	12,4	6,2
December	0	5	6	3	8	1	30	46	11	8	11,8	14,7
Total	462	448	487	428	408	427	515	540	528	657	4900,00	74,2

descriptive statistics (Mean, Median, Skew, Kurtosis) were calculated for the age and the seasonal distribution (35). Furthermore, changes of number of falls over time were analyzed and a regression analysis with least square methods and coefficient of determination (R^2) was calculated (33). Calculations were conducted with Microsoft Excel (Microsoft Inc., Redmond, Washington, USA) and Graphpad Prism (GraphPad Software, Inc., La Jolla, California, USA).

Results

In the time frame 2009-2018 (10 analyzed years) a total of 11220 persons were evacuated during mountain hiking. Concerning the regional distribution 16.7 percent were in canton Wallis, 17 percent in canton Bern, 16.5 percent in canton Graubünden yielding to over fifty percent of mountain accidents while hiking in the three big mountain cantons. Further 12.71 percent in Tessin, 12.70 percent in central Switzerland (UR, SZ, OW, NW, ZG, LU), 10.2 percent in eastern Switzerland (SG, AI, AR), in the small canton Glarus 2.6 percent and in consequence further approximately 30 percent in an area with a high share of pre-alpine or alpine terrain. 7.8 percent in the western part (Suisse Romandie) without Wallis (VD, GE, NE, FR, JU), 1 percent in Nord-western Switzerland (BS, BL, SO) and less than 1 percent in Aargau/Zürich/Schaffhausen. Around 2 percent of mountaineering accidents of the mentioned emergency organizations were in the close border regions (Schwarzwald, Vorarlberg, Veltlin etc.) 7316 mountain accidents could be taxed as happening in the alpine area (65.2%) and 3904 (34.8%) in the pre-alp area, whereby in principle geographic criteria were used by rescue organizations to separate pre-alpine versus alpine.

Trying to categorize all 11220 cases in the time frame of 2009-2018 around 1883 cases (16.5 percent) are in the category of Blocking (Blocking are all emergency cases in which exhaustion, excessive demand, loss of material or other misfortunes do not allow hikers to finish their tour alone). Another 19.2 percent respectively 2143 cases can be attributed to an illness, which were most often cardiovascular events. To lose one's way another 1393 cases respectively 12.5% can be counted. Definitely the largest class were the falls with 4900 cases counting for 44.1 percent. For the most important categories of falls average age was 58.8 ± 18.98 years, whereby the classes between 50 and 60

and the class between 60 and 70 years-old were most often found. Median was 62.15 year (Skewness=0.63 / Kurtosis=-0.16) further implying that most of the affected hikers were between 50 and 70 year-old (28) (Table 1). The relative peak of falls is also further supported by in depth analysis of relative share of causes in an age class. In total 19.8 percent of all accidents are in the age between 60-70, however even 23.8 of falls are in this age class emphasize the high relevance of falls. Focusing on the development of falls over time in the analyzed period from 2009-2018 results in an average of 490 ± 74.2 falls per year. In 2009 a total of 462 falls was identified, this number increased in 2018 up to 657 falls making an average annual increase of 14 percent. An additional calculated linear regression for the whole period ($y=17.3x+394.7$, $n=4900$) revealed a high coefficient of determination of $R^2=0.502$ as indicator of a high explanation power. Majority of falls was in the summer months July and August. (Table 2)

Besides the mentioned classes (falls, blocking, illnesses, losing its way) the rest of mountaineering accidents while hiking are difficult to order in. Rare causes were identified such as lightning strike, overwhelming, jamming, collision, avalanche (snow or rubble), rockfall, biting of a snake, bee sting, rock cutting.

Trying to classify the analyzes into localization of injury the following pattern can be identified: head & skull trauma (14.5%), shoulder (14.5%), ribs & thorax (7%), polytraumas inclusive pelvis & abdominal traumas (1.2%), leg injuries (14.5%), knee injuries (15.4%) and foot (36.9%). A total of around two third are traumas of the lower extremity, poly traumas & head- and skull traumas are around one seventh indicating that more severe injuries are less than one fifth of all mountain emergencies while hiking. Concerning deathly accidents while hiking an average of 47.8 ± 13.3 of deadly accidents can be mentioned in the last ten years. For comparison mountaineering can be mentioned with a total of 30 ± 12.5 accidents (2). Taking the assumption of 2 million mountain hikers per year an annual rate of 2.39 deadly accidents can be calculated.

Discussion

The aim of the study was to analyze mountain accidents while hiking. For the period of 2009-2018 a total of 11220 mountain accidents while hiking was identified, which could be classified >

into falls (45 percent), illnesses (20 percent), blocking (17 percent), losing the way (13 percent) and other seldom reasons. A total share of two-thirds are the traumas of lower extremity, around one seventh are multiple traumas or head & skull implying, that less than 20 percent were life-threatening injuries whereby the disproportionately high share of 50-70 yr. olds has to be considered. High relevance of falls is in line with findings from others and reasons are numerous ranging from a break of snow bridges in spring and early summer, lacking of step security in steep passages, not optimal shoes with lack of grip, slipping of wet rock or balance lost as a consequence of fatigue or overestimation of own abilities with lack of care when downhill walking (9). To keep in mind, mountain tracks are often exposed at some points, losing its own way with the most fatal consequence of a down fall can happen easily (18, 34). Especially changes of weather are challenging: in foggy conditions even easy mountain tracks can become to an immense challenge with view of only some meters (1). Concerning deadly accidents, a rate of 2.39 deaths per 100,000 hikers annually can be reported, which is lower compared to values calculated for example by Burtscher (2007) with 4 deaths per 100,000 hikers annually (5). One risk factor for Sudden Cardiac death (around 50 per cents of all deadly accidents while hiking) is a lack of acclimatization (5). Reasons for the detected lower ratio might be that in Switzerland lots of parts are between 500-1000 meter altitude making the difference of height probably smaller, while in consequence reducing the risk of inadequate acclimatization. Furthermore, distance to hiking areas is shorter maybe allowing to better acclimatize.

Trying to understand the increase of average falls per year also the total of more mountain hikers has to be kept in mind. In comparison, in the Swiss Alpine Club an increase in members of around five percent can be noted for the analyzed time period explaining at least some of the increases of falls in line with findings from others (16, 31). Furthermore, probably more and more untrained persons hike further explaining the increase. From the statistical analysis is further detectable, that falls and illnesses are more often in elderly hikers, whereas lose one's way and blocking are more likely in younger hikers (20-50 years). Other reasons responsible for the peak of falls (higher shares in the 50-70 year old's in Table 1) might be dehydration, extended reaction time especially after an overnight stay at high altitude reduced cardiovascular fitness and especially the decrease of postural stability (6, 12, 14, 26). The motoric control and the sense of balance are not as good as in a young person and a young person could maybe a bad step better preserve. However, further investigations are needed to clarify which are the main reasons for the falls to establish the best countermeasures. Despite that training of balance or trunk stability previously to large hiking tours might make sense (6, 12, 14). Furthermore, from other side hints exist that falls often happen while hiking down and in consequence while performing eccentric muscle work (9). Eccentric training could be well-trained previously even for affected people with cardiovascular affections due to its low-share of cardiovascular system able to improve stability while downhill walking (7, 8, 17).

Limitations

Methodically, statistics from SAC-central registry was analyzed, having all mountain accidents registered which entails all accidents while hiking when rescue patrols were alarmed. This implies that very small injuries are not registered due to the fact that such injuries are self-treated or by the family doctor with previous self-confinement. In consequence analysis encompasses at least middle events of severity. Attenuating this argument, a high share of mountain hikers is between 50-70 years old probably having a low tolerance for alarming rescue patrols.

Practical Implications

Falls are most likely in elderly hikers between 50-70 years old. In more than two third this yields to a trauma of the lower extremity. Most of the falls take place in ages with a tendency of decreasing postural stability. In consequence also elderly humans avid of mountain hiking could profit from a strength and balance training increasing postural stability in order to prevent falls. Due to hints that especially when downhill walking most of the injuries occur especially eccentric training (braking muscle work) could be a very senseful opportunity of prevention of falls while parallel only using a small share of cardiovascular system allowing also in these ages often affected elderly persons to absolve a reasonable training. ■

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Conflict of Interest

The authors have no conflict of interest.

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