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Despite Modern Navigation Tools, Getting Lost When Hiking is Common – an Analysis from the Swiss Alps

Running head: getting lost & mountain hiking

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Abstract

Introduction

Mountain hiking has gained increased attraction. Although at a first glance it seems to be a low risk sport, there are always some mountaineering emergencies with alarming the rescue patrols due to causes such as falls, illnesses, blocking or losing their way. Especially for losing their way the newest technical equipment such as GPS-watches or altimeters should be helpful, making such cases less likely and less severe.

Material & Methods

In the period from 2009-2018 (10 years of observational period) 1,393 Mountain Accidents were identified by losing their way from the SAC (Swiss Alpine Club) Central Registry. In order to quantify the severity of injuries NACA Scores (National Advisory Committee for Aeronautics Score) were used. Descriptive analysis of the number of losing their way and the age distribution were calculated. In addition, the average annual NACA Scores were calculated. Linear regression in order to identify the existence of a potential trend with calculation of coefficient of determination over time for the number of events and the NACA Scores were calculated. For 1,201 events details of the underlying mechanism (causes such as fog, weather change, night) were identified from the records, which were used in order to group and classify accordingly.

Results

On average, there were 139.2 ± 16.8 cases of losing their way per year, whereby the number of events did not significantly change over time (cases = 0.3394 * time + 137.33 / R2 = 0.0038). The average NACA score was low with 0.37 ± 0.07 and in addition did not significantly increase or decrease over time (NACA Score = 0.002223 * time + 0.38674 / R2 = 0.0098). Concerning the distribution of age, a peak of cases was identified in the age groups of 50-60-year old's and 20-30-year old's.

Discussion

The aim of this study was to analyze causes and consequences of losing their way during mountain hiking. It was suggested, that due to technical gadgets a decrease of the average annual number should be identified. In around 20 percent clear hints were found that increased map

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reading skills would have been necessary to prevent an emergency. Therefore, it is not only recommended to use modern tools but also to regularly practice in order to know how to use them when forcefully necessary.

Introduction

Mountain hiking is becoming more and more popular and one can assume that today around 100 million mountain hikers are active each year [1-10]. In addition, this activity is very well suited for families as community experience in nature within a group [11]. At a first glance minor dangers may be suspected in mountain hiking and positive aspects seem to preponderance [12,13]. From a physiological point mountain hiking can be taxed as endurance sports with a stimulation of cardiovascular and musculoskeletal system, whereby uphill mainly cardiovascular system is stimulated and downhill musculoskeletal with eccentric muscle activity [12,13,14]. When trying to classify emergency events falls, illnesses or losing their way can be mentioned [1-10]. Losing their way represents a cognitive dysfunction of the hiker with a false judgment of conditions ongoing with a potential misinterpretation of the map [9,10]. Such events should be less likely due to the recent technical developments. On the one hand, maps have massively improved, are constantly updated and are now in terms of precision and general standards of very high quality. The high quality should make tour planning easier. Recommendations by for example SAC (Swiss Alpine Club) should in combination with the maps allow estimating time for a tour adequately. Relatively easy adaptable concepts such as the performance km recommended by for example the SAC proposes to calculate required time dependent from the absolved height in the ascent and descent as well as the horizontal distance [9,10]. For hiking tours without major technical difficulties for one km of horizontal distance and for 100 meters in elevation a quarter of an hour is recommended to calculate. The same accounts for down-hill walking for every 200 vertical meters, other calculation methods are possible (Tobler Rule, Naismith Rule, Langmuir Concept)[9,10,15,16,17].

Furthermore, the development of orienteering tools such as GPS watches or altimeters should allow to always locate the current position on a map allowing to develop a fast strategy to relocate their position and to aim for a secure point such as a cottage or a track [18,19,20]. In addition, altimeters and GPS became significantly cheaper over the last years which should make orientation easier making it much less likely to lose their way when mountain hiking. It is likely to suggest that these technical improvements yielded to a decrease of cases of losing their way while mountain hiking. With the nowadays very precise GPS devices (± 5 meter) point of location should always be possible to record. Furthermore, making an alarm call should with the new mobile phones be almost always possible in consequence reducing potential injuries yielding to the possibility to rescue mountain hikers in healthy or at least in only minimally injured conditions. The above-mentioned yield to the aim of the study. To analyze the cases of losing their way during hiking in terms of causes and consequences in detail over the last decade in the Swiss Alps. As hypothesis with potential falsification, it is (i) first postulated that the number of cases of lost mountain hikers has not changed over the last decade and second (ii) that the severity of injuries did not change [21].

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- **Material & Methods**

Procederes

Retrospective analyzes of mountaineering emergencies while hiking in the Swiss Alps in the period from 2009-2018 were conducted. Based on the encompassing material of SAC central registry of the Swiss Alpine Club mountain emergencies were analyzed while hiking concerning the number, the severity (operationalized with NACA Score), age distribution and the potential causes and consequences. The term mountain emergency is defined as an event in which a mountain hiker used special emergency organizations respectively an alarm call was made which also includes illnesses or evacuations of not injured persons. The SAC central registry entails data from the Schweizerische Rettungsflugwacht (REGA), Air Glaciers Lauterbrunnen, Air Glaciers Sanenland, Registery SAC, the KWRO (Kantonale Walliser Rettungsorganization), Schnee- und Lawinen for schungsinstitut Davos and from the cantonale policy registries. In this period 11,220 persons were saved by the respective organizations [4,5]. Every mountaineering emergency case entailed the place, the rescue organization, the age, the living place and in most cases a short description concerning causes and consequences and, in most cases, some medical details, but at least NACA-Score [22].

Analyzed Population

In the period from 2009-2018 (10 analyzed years) totally 11,220 mountain emergencies while hiking were analyzed. 1,883 Blocking cases (Blocking refers to all emergencies in which mountaineers are no longer able to continue their tour on their own due to exhaustion, excessive demands, material loss or other mishaps). 2,143 cases can be attributed to a disease, 4,900 cases were falls. The fourth largest group with about one sixth respectively 837 male (60.01 percent) and 556 female (39.99 percent) yielding to a total sample of 1,393 cases classified as loosing it's way. The remaining cases cannot finally categorized or are due to rare causes such as: lightning / electric shock, hanging (rope, tree), earth crushing/pinching, crevasse accident, collision/collision, avalanche burial, rockfall/ice impact, animal impact (bee, snake), rock outcrop (Fig. 1) [3,4]. For the total of 1,393 cases of losing their way in 1,201 emergencies a case report existed, whereby 728 case reports were written in German and 473 in a Romance language (Italian, French, Roman-Roman). These case reports were subsequently analyzed, and it was tried to identify causes and consequences of losing their way.

NACA 0	No injury or disease.
NACA I	Minor disturbance. No medical intervention is required. E.g. slight abrasion.
NACA II	Slight to moderate disturbance. Outpatient medical investigation, but usually no emergency medical measures necessary. For example, fracture of a finger bone, moderate cuts, dehydration.
NACA III	Moderate to severe but not life-threatening disorder. Stationary treatment required, often emergency medical measures on the site e.g. femur fracture, milder Stroke, smoke inhalation.

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NACA IV	Serious incident where rapid development into a life-threatening condition can not be excluded. In the majority of cases, emergency medical care is required for example. Vertebral injury with neurological deficit, severe asthma attack; drug poisoning.
NACA V	Acute danger for example, third grade skull or brain trauma, severe heart attack,
NACA VI	Respiratory and or cardiac arrest
NACA VII	death

Tab. 1: *NACA-Score [17].*

Statistical Analysis

The evolution of the number of cases and associated NACA scores were analyzed descriptively by calculating linear least squares regression with the determination of the coefficient of determination (R^2) over time for the number of cases and the NACA score. Furthermore, the proportional share of the classified causes and consequences of the aberration was worked out in detail. Furthermore, the geographical distribution pattern (pre-alpine versus alpine) was calculated. Descriptive statistics (mean, median, skewness, kurtosis) were calculated for age and presented accordingly. Furthermore, the percentage was calculated for the most important causes and consequences of the cases of aberration [23-26]. The calculations were done with Microsoft Excel (Microsoft Inc., Redmond, Wash., USA) and Graphpad Prism (GraphPad Software, Inc., La Jolla, California, USA).

▪ Results

Table 2 shows the average annual cases as well as the average NACA score. NACA scores of losing their way is with an average of 0.37 ± 0.07 relatively low. Other causes of emergencies showed clearly higher average NACA scores (illnesses 3.7 ± 1.7 / falls 3.2 ± 1.4), others showed a similar severity (blocking 0.3 ± 0.7). The geographical breakdown shows that out of the total of 1,393 cases, 425 cases occur in the Alpine terrain (30.5 percent) and 968 (70.5 percent) in pre-alpine terrain. The additionally calculated linear regressions showed no trend of an increase of the number of cases over time with cases = 0.3394 * time + 137.33 (R^2 = 0.0038) and for the NACA Score over time with NACA Score = 0.002223 * time + 0.38674 / (R^2 = 0.0098). The demographic distribution shows an accumulation in the 50-60 year old's, but also in the 20-30-year old's, (Fig. 1). Concerning gender differences, interestingly NACA is around 0.15 lower in female versus male (female 0.29 ± 0.84 versus 0.44 ± 1.12 in male). However, forage for male with 48.4 ± 19.2 years versus female with 48.6 ± 18.41 years no significant difference can be detected.

Tab. 3 shows the causes and consequences that were tried to group in classes in order to detect patterns and frequencies of occurrence. Some causes only occurred once, for example mountain hiker with Alzheimer disease or juvenile diabetes and could not be attributed to a subclass.

	number per year	NACA Score (mean)
2009	139	0.29
2010	124	0.36
2011	169	0.49
2012	121	0.35
2013	122	0.41
2014	143	0.46
2015	164	0.38
2016	132	0.3
2017	146	0.4
2018	132	0.3
Mean whole decade	139.2 ± 16.8	0.37 ± 0.07

Tab. 2. *Average annual of cases with the average NACA score. Note the low average Naca score (between NACA 0 does not imply any injury or disease and NACA I with minor injury or dysfunction, usually requiring no emergency medical intervention such as bruising or mild abrasion.*

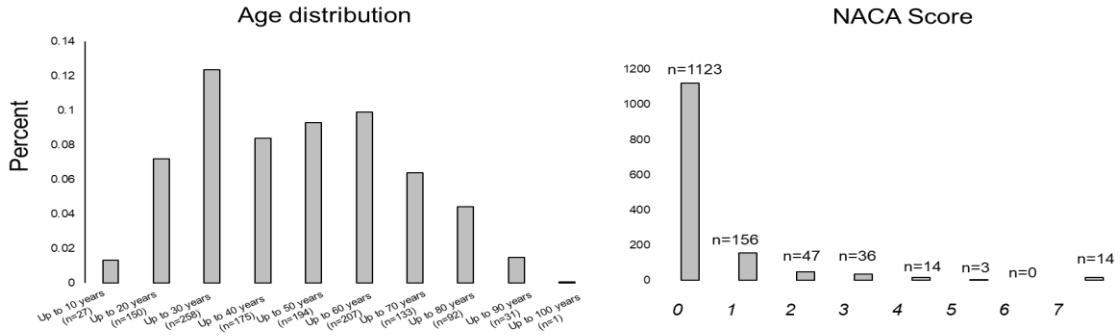

Fig. 1: (a) *The distribution pattern of cases of getting lost by age (b) the distribution of NACA Score*

generally difficult conditions	descent	78	6.5
	steepness	37	3.1
	forest	37	3.1
	snow	45	3.7
	storm/weather change	51	4.2
	Total	**248**	**20.6**
increased map reading skills necessary	pathless terrain	67	5.6
	fog	49	4.1
	beginning night	99	8.2

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	Total	**215**	**17.9**
subjective risk factors	tired	6	0.5
	anxiety	2	0.2
	exhaustion	25	2.1
	Total	**33**	**2.7**
suboptimal map reading behaviour	going further although not knowing place	76	6.3
	Total	**76**	**6.3**
consequences	blocked	135	11.2
	loosing general orientation	245	20.4
	Total	**380**	**31.6**

Tab. 3 *Causes and consequences of mountain hiking according to the case description. (Multiple mentioning possible) Overall n=1201*

Discussion

The aim of this study was to analyze causes and consequences of losing their way while mountain hiking over the last decade in the Swiss Alps. As hypothesis with potential falsification, it was (i) first postulated that the number of cases of lost mountain hikers has not changed over the last decade and second (ii) that the severity of injuries did not change. Therefore, the SAC central registry was analyzed from 2008-2018 in detail, whereby 1,393 cases could be attributed to the class of losing their way. For 1,201 cases a detailed case report concerning mechanism of losing their way was available. The first hypothesis seems to be disposable with 139.2 ± 16.8 cases in average whereby relationship between time and number showed almost no variance explanation with $R^2 = 0.0038$. However, an argument remains that there is a positive effect of the development of mountain equipment respectively these hindered an increase in the last ten years. It is likely to suggest that during the observational period the number of mountain hikers increased parallel to the members of the SAC and therefore around 4 percent per year [27]. Taking the ten-year observational period this would yield to an increase up to around 200 cases per year. However, the number of cases remains very stable during the observational period with around 140 cases per year. This stable number might not have increased due to the development in the technical equipment despite the suggested increase of mountain hikers during the observational period. The same accounts for the severity of injuries with an average NACA Score of 0.37 ± 0.07 in addition with only smallest explanation of variance over time ($R^2 = 0.0098$).

Concerning causes and consequences that could be identified from the registry fog, forest terrain, snow, night, lost track or path due to darkness, exhaustion or thunderstorm can be mentioned. From these hints it is likely to suggest that loss of card contact seems to be one major cause of getting lost. This seems to be more often in difficult conditions such as night, darkness or fog probably due to the increased technical requirements when reading the map. In principle, different forms of card-technical errors can be mentioned [28-32]. Undoubtedly, the behavior when errors occur should then be aimed at two targets: keep the damage at the current error as low as possible and to avoid subsequent errors [28-32]. Interestingly, in around 20 percent

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generally difficult conditions occurred such as snow, storm or weather change. The same counts for map reading skills, where also in around 20 percent increased map reading skills were identifiable from the case reports. That orienteering possibilities are strongly dependent from lighting conditions is obvious [28-32]. In such situations, only safe attack points often help, such as a prominent elevation, a long way, or a stream. In such cases, it is also helpful to carry a compass for positioning the Nord direction of the map [28-32]. Attack points should be used such as a ridge, a prominent nose, a way or a high-voltage line [28-32].

To summarize, it should be mentioned that in particular a lack of map reading skills seemed to be the cause of losing their way. It was possible in a substantial share of cases to identify increased technical map reading skills such as fog or dusk (Tab. 3). In general, mountain hikers who get lost are not seriously injured. Careful route planning with the addition of reserves combined with previously trained mapping skills should allow to move back into familiar and safe terrain. An accurate route planning with accurate marching time calculation, for example, with the concept of the performance kilometer is recommended in advance of mountain hiking tours.

Practical Implications

In addition to falls, illnesses and blockages, cases of getting lost are still the fourth most frequent cause of mountain emergencies despite the latest developments such as GPS watches or altimeters.

The number has not declined significantly in the last decade, suggesting that such modern support tools cannot fully substitute well-trained map reading skills. From the above it is recommended to carry out a conscientious, complete tour planning with realistic time calculation and critical self-assessment. At the same time, the card should be studied seriously, and the abilities of map reading should be specifically trained in advance [28-32].

The selection of the tour should also be adapted not only due to physical but also technical skills of map reading. The planning of alternative tours in order to be able to react accordingly, taking into account the constitution of the day and other environmental factors, is in addition recommended.

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