REVIEW ARTICLE

For the sake of personal security in the mountains – from the perspective of innovative agonology

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Abstract

Background and Study Aim: For years, in the Tatra Mountains, avalanches have been claiming human lives and property: in 1938 the snow avalanche from Marchwiczna Pass in the Rybiego Potoku Valley killed 1 person and affected another one and the avalanche's blast broke the windows and moved a stove in a mountain shelter; in 1956 the snow avalanche under the Kondratowy Wierch in the Goryczkowa Valley destroyed another mountain shelter and killed 5 people inside; in 2003 under the Rysy peak in the Rybiego Potoku Valley killed 8 people and affected 1 person. The aim of this study is knowledge about areas most prone to avalanche in Polish part of the Tatra Mountains from the perspective of their specificity and concern for personal safety of potential tourists visiting these places in the future.

Material and Methods: The research was conducted using the Snow Avalanche Event Analysis. The Snow Avalanche Event Analysis consists of 6 steps: studying the avalanches, collecting the global data, gathering the local data, comparing the data, assessing the risk, computing the effects. To perform analysis, the authors obtained information from secondary sources on the number of tourists visiting Tatra National Park in 2021 and data on the occurrence of snow avalanches in the Tatra Mountains in the years 1855-2021. The authors applied the Snow Avalanche Event Analysis only in the Polish part of the mountain range, because the Slovak Tatranský Národný Park closes all hiking trails above the mountain shelters in the Slovak part of the Tatras every year from 1 November to 15 June.

Results: The most avalanche-prone areas in the Polish part of the Tatra Mountains are (risk indicators in brackets): Rybiego Potoku Valley (0.020020%), Roztoki Valley and Pięciu Stawów Polskich Valley (0.006252%), Gąsienicowa Valley (0.004765%).

Conclusions: Authors verified positively the formulated research hypothesis: 'The most avalanche-prone area in Polish part of the Tatra Mountains is the Rybiego Potoku Valley'. The authors successfully applied the SAEA (this time on the example of the Tatra Mountains), which entitles us to recommend this research tool as useful in fulfilling the scientific and social mission of innovative agonology.

Key words: mountain rescue service • Snow Avalanche Event Analysis • Tatra Mountains • Tatra National Park • TOPR

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EM-DAT – in 1988, the **Centre for Research on the Epidemiology of Disasters (CRED) launched the Emergency Events Database (EM-DAT)**. EM-DAT was created with the initial support of the World Health Organisation and the Belgian Government. The main objective of the database is to serve the purposes of humanitarian action at national and international levels. The initiative aims to rationalise decision making for disaster preparedness, as well as provide an objective base for vulnerability assessment and priority setting. EMDAT contains essential core data on the occurrence and effects of over 22,000 mass disasters in the world from 1900 to the present day. The database is compiled from various sources, including UN agencies, nongovernmental organisations, insurance companies, research institutes and press agencies [9].

Tatra Mountains (Tatry) – the highest mountain range of the Carpathian located in the central-south of Poland and in the central-north of the Slovak Republic. The total area of the Tatra Mountains is 785 km^2. Bears, chamois and marmots are the most characteristic fauna of the Tatras [42-53].

Tatra Mountain Volunteer Search and Rescue (Tatrzańskie Ochotnicze Pogotowie Ratunkowe, TOPR) – TOPR is a public benefit organization which main task is a rescue of human life in the Tatra Mountains in Poland. It was founded in 1909. TOPR uses an emblem and badge depicting a blue cross on a white field with a brown band. Under the cross is a mountain pine branch [65].

Tatra Mountain Service – Voluntary Corps (Tatranská horská služba – dobrovoľný zbor, THS–DZ) – THS-DZ is a civil association of volunteer mountain rescuers who perform rescue and preventive-educational activities in the territory of the High Tatras in Slovakia [63].

Mountain Rescue Service (Horská záchranná služba, HZS) – HZS is established by Act no. 544/2002 Coll. on the Mountain Rescue Service. It is a state budget organization managed by the Ministry of the Interior of the Slovak Republic. HZS has several various regional centers for mountain areas [64].

INTRODUCTION

Agonology, in a narrow sense, is a synonym for the general theory of struggle [1], while in a wide sense it is the science of struggle [2, 3]. Roman Maciej Kalina, the promoter of innovative agonology, in his biography in the journal *Current Alzheimer Research* defines "innovative agonology" as applied science, dedicated to evidence-based complementary cognitive-behavioural promotion, prevention and therapy of all dimensions of health, and ennoblement of activities enhancing the ability to survive. In his work dedicated to the prospect of an effective defence of peace and unrestricted freedom of scientists he underlined that people still cannot cope with the age-old problem – struggle with themselves, with their agonistic nature [4]. It is reasonable to assume that one important manifestation of man's agonistic nature is precisely to undertake risky expeditions into dangerous mountain areas, and that the epidemiology of tragic events is not a deterrent. Thus, the perspective of innovative agonology is understood as the methodological possibility of explaining and grounding this phenomenon at the borderline with other sciences. The optimal guide is precisely the language of this new applied science [5]. The human struggle against the forces of nature is thus one of the cases where, according to Jarosław Rudniański [6], man legitimately uses the word 'struggle' or its synonyms. Since such words are legitimate, all the more so the science of struggle.

Events associated with natural forces are natural disasters, including avalanches [7]. An avalanche is defined by M. Jagiełło as 'sliding down of snow masses' [8]. The EM-DAT (see glossary) defines the avalanche more broadly as 'a large mass of loosened earth material, snow, or ice that slides, flows or falls rapidly down a mountainside under the force of gravity' [9]. Their definitions are similar to the notion of snow avalanche formulated by W. Niemiec [10] and V. Spusta et al. [11] but they precise that the rapid downslope movement concerns only snow (not snow and ice) and its distance is minimum 50 meters. Kociánová et al. [12] add that an avalanche can bury, injure or kill humans and European Avalanche Warning Services emphasize the volume of avalanche that exceeds 100 m^3 [13].

Snow avalanches occur in very high mountains like the Himalayas where an avalanche occurred on Pumori peak killing 19 people on 25 April, 2015 [14, 15] or in high mountains like the Apennines where the avalanche appeared on Gran Sasso d'Italia and caused 29 deaths on 18 Jan, 2017 [16]. Snow avalanches can also appear in mid-height mountains like Karkonosze or Bieszczady [17, 18].

In 1938 in the Tatra Mountains, the snow avalanche from Marchwiczna Przełęcz in the Rybiego Potoku Valley killed 1 person and affected another one. The avalanche's blast broke the windows and moved the stove in a hostel. In 1956 the snow avalanche under the Kondratowy Wierch in the Goryczkowa Valley destroyed another hostel and killed 5 people inside. Another snow avalanche in 2003 under the Rysy peak in the Rybiego Potoku Valley killed 8 people and affected 1 person [8, 19].

For the sake of personal safety [20-22] of visitors the authors investigated the issue of avalanche-prone areas in the Polish part of the Tatra Mountains and verified whether the Rybiego Potoku Valley is the most avalanche-prone area. Authors applied the Snow Avalanche Event Analysis only in this part of Mountains because the Slovak Tatranský Národný Park (TANAP) closes all hiking trails above the shelters in the Slovak part of the Tatra Mountains every year from November 1 to June 15 [23].

The aim of this study is knowledge about areas most prone to avalanche in Polish part of the Tatra Mountains from the perspective of their specificity and concern for personal safety of potential tourists visiting these places in the future.

MATERIAL AND METHODS

We applied the snow avalanche event analysis. It is based on the method of proof that uses deductive reasoning that is appropriate to analytical activities. The SAE analysis consists of 6 steps [16].

Step 1 – study of the avalanches. We studied the area literature for the examined of the Tatra Mountains as well as field work [7, 24-27]. We used the definition of the snow avalanche event (SAE – see glossary) [16]. We searched the Scopus database with combinations of keywords: 'snow avalanche' and 'mountain rescue service' [28] and we obtained only 2 results. However they were excluded because they did not concern the avalanche hazard of the Tatra National Park [29, 30].

Step 2 – collecting the global data. We searched the well-established International Disaster Database (EM-DAT) run by School of Public Health at Université Catholique de Louvain in Belgium, with the keyword 'avalanche' to build the table with avalanche events that occurred from 1900 to 2021 throughout the world, in order to identify avalanche cases in Poland [9]. The search yielded no results concerning Poland.

Step 3 – collecting local data. We obtained information from secondary sources on the number of tourists visiting the Tatra National Park (TPN) in 2014-2021 period [31]. We used data on the occurrence of snow avalanches in the Tatra Mountains in the 1855-2021 period, recorded by chroniclers and rescuers of the Polish public benefit organization: the Tatra Mountain Volunteer Search and Rescue (Tatrzańskie Ochotnicze Pogotowie Ratunkowe – TOPR) [32, 33, 27, 8, 19, 34-37].

Step 4 – data comparison. We compared the occurrence of avalanches in the Tatra Mountains in the 1855-2021 period, with the SAE criterion to reject phenomena which do not fulfil the SAE definition or occurred beyond the research area. We also compared the EM-DAT data with the list of events recorded by local chroniclers and rescuers.

Step 5 – evaluating the risk. We used the risk assessment methodology, understood as the probability of occurrence of an adverse event with its effects in a given time [38, 39]. We determined the probability by calculating the frequency of occurrence (fo), according to the formula: fo = (number of SAE in avalanche prone area / examined time interval) ×100% [16].

Step 6 – computing the effects. We calculated effects in the spreadsheet, summing up the total number of victims in a given avalanche prone area (deaths and affected), and dividing it by the sum of the monthly number of tourists visiting TPN for tested avalanche prone area in the examined period of time in the months when the snow avalanches occurred and can occur: January-June and September-December. We obtained a risk indicator for a given examined avalanche prone area, multiplying the probability each time by the effects of the occurrence of SAE in the examined avalanche prone area – the higher the risk, the more avalanche prone area is [16].

We edit this narrative review in the likeness of the original paper.

RESULTS

Snow avalanches

From 1900 to 2021 according to the EM-DAT 120 avalanches were recorded (Table 1). Only disasters that met at least one of the following criteria were entered: 10 or more human casualties; and/or 100 or more people affected/injured/homeless; and/or declaration of a state of emergency by a given country; and/or an appeal for international assistance. Sometimes secondary criteria such as significant damage are also taken into account. According to EM-DAT, snow avalanches killed more than 5.5 thousand people and affected more than 100 thousand people worldwide in the examined period and caused more than 1.5 billion damages in US $ [9].

The most deadly were Marmolada avalanches that were observed in the Dolomites in Italy in 1916.

Tatra National Park, TPN (Tatrzański Park Narodowy) – a national park located in the Polish part of the Tatra Mountains. It covers an area of 211.97 km² [54-57, 59].

Tatra National Park, TANAP (Tatranský národný park) – a national park located in the Slovak part of the Tatra Mountains. It covers an area of 738 km² [58].

Snow avalanche – rapid downslope movement of a mix of snow and ice [7-13].

Snow avalanche event (SAE) – the rapid movement of large masses of snow down the slope to a distance of at least 50 meters which causes death and/or suffering of people and animals [16].

Risk – probability of the occurrence of an adverse event and its effects in a given time [38, 39].

Table 1. Avalanches (snow and debris) registered by the EM-DAT in the years 1900-2021 according to the number of events [9].

Continent	Events	Deaths	Total affected	Damages (in thousand US $)
Asia	71	3,882	92,969	72,806
Europe	41	1,442	14,947	1,442,206
North America	4	150	22	0
South America	4	83	154	0
Africa	0	0	0	0
Oceania	0	0	0	0
Total	**120**	**5,557**	**108,092**	**1,515,012**

Figure 1. In the Tatra Mountains (photo by Zbigniew Piepiora).

They killed approx. 10000 people [40]. Strangely enough, Marmolada avalanches were not recognized by the EM-DAT database [9]. Moreover, avalanches in the database are not divided into types (snow and debris), and the database does not differentiate different types of avalanches according to their size [41].

Characteristics of the examined area

The Tatras (Figure 1) are the highest uplift in the Carpathian arc. They are located on the border between Poland and Slovakia. The entire area covered by the Tatras is 785 km^2, with only 175 km^2 on the Polish side. The span of the range is 55 km, the width is 20 km and the length of the main ridge, not including the ridge of the Bielskie Tatras, is 75 km. Geographically, the Tatras are divided into the Bielskie Tatras, the High Tatras, the Western Tatras and the Siwy Wierch Massif. The High Tatras are the highest part of the studied mountain range, with alpine relief strongly transformed by glacial action. They are characterized by soaring peaks with steep slopes (slopes exceeding 45° occupy 13.1% of the Tatra area) and perpetual snows, which occur in basins, but on a small scale. The Western Tatras have milder relief due to the presence of a large number of rocks prone to erosion [42-46].

Glacial action, karst processes and river activity are noticeable in the relief. [47, 48]. The line of the Tatra Mountains runs in a zigzag pattern, forming several turns. From the ridge line, short arms ranging from 2 to 9 km in length diverge. This unique structure of the Tatra Mountains is related to the fact that its main ridge is very high and there are no major depressions or passes in the range. Both the main arms of the Tatras and the small ribs are separated from each other by valleys of different sizes [49, 50]. Many streams and brooks flow through the Tatra valleys. Their length does not usually exceed 15 km [51-53]. The massif is located in the zone of transitional warm temperate climate. A characteristic feature of the climate of the Tatras is the vertical variability that results in the formation of climatic floors. The Tatras, together with the northern chain of the Carpathian Mountains, form a border wall for

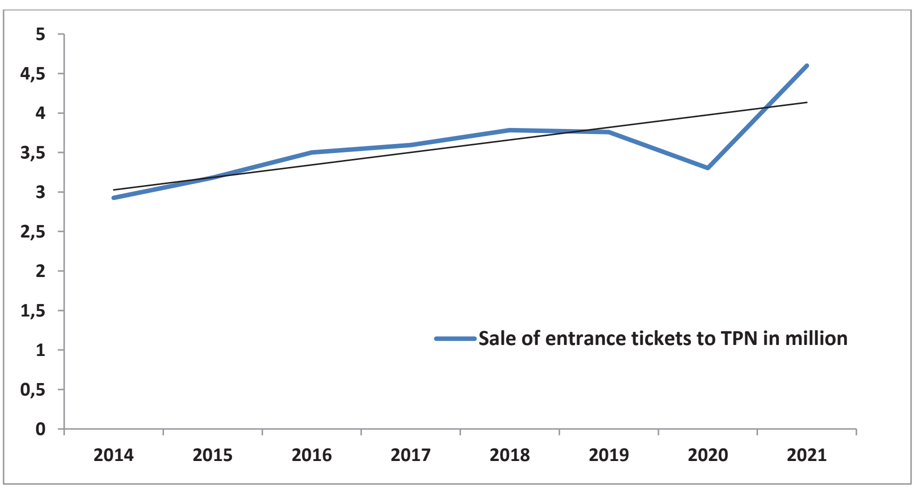

Figure 2. Yearly number of tourists visiting Tata National Park in the years 2014-2021 (2020 effect of the COVID-19 pandemic). Source: [31].

the climatic relations of Europe. These ranges block the winds blowing from the Atlantic Ocean, causing water vapour to condense. The amount of precipitation decreases with increasing distance from the mountain range [49, 53]. There are two national parks in the Tatra Mountains: the Tatranský Národný Park (on the Slovak side) and the Tatra National Park (on the Polish side) [54-59]. A compensation in 2021 against 2019 is visible. The reduction in tourism was due to the COVID-19 pandemic [60, 61] (Figure 2).

TANAP closes all hiking trails above the mountain shelters in the Slovak part of the Tatras every year from 1 November to 15 June [23]. On the Polish side, the following sections of trails are closed for the winter period (from 1 December to 15 May) due to nature protection [62]: 1. Przełęcz w Grzybowcu - Wyżnia Przełęcz Kondracka: the red route (a fragment of the route Strążyska Valley - Giewont); 2. Tomanowa Valley - Chuda Przełączka: the green route; 3. Dolina Pięciu Stawów Polskich - Świstówka Roztocka - Morskie Oko: the blue route.

On the Slovak side of the Tatra Mountains, lifesaving activities are carried out by: Tatranská horská služba – dobrovoľný zbor, THS–DZ (the Tatra Mountain Service – Voluntary Corps), and Horská záchranná služba, HZS (the Mountain Rescue Service) [63, 64]. In the area of the Polish part of the Tatra Mountains, these activities are carried out by Tatrzańskie Ochotnicze Pogotowie Ratunkowe (Tatra Mountain Volunteer Search and Rescue) [65], which celebrated its 110th anniversary in 2019 [36]. It operates on the basis of the Safety and Rescue in the Mountains and on Organized Ski Areas Act of 18 August 2011 [Journal of Laws 2011 no. 208 item 1241] and the Law on Associations [66, 67].

The Roztoki Valley and the Pięciu Stawów Valley are analysed together, because they are two scenically different floors of one and the same valley, starting below Świnica peak and flowing into the valleys of the Białka River. In the years 1855-2021, there were registered 162 snow avalanches (Table 2). They not occured only in October, July, and August. The snow avalanches killed 121 people and affected 304 persons (physically and mentally). Most people died in avalanches in the Rybiego Potoku Valley (Figure 3 and 4) 35 persons. The largest number of people were affected also in the Rybiego Potoku Valley 118 people. We noted that none of snow avalanches recognized in Table 2 was registered in EM-DAT because they did not meet the EM-DAT criteria: 10 or more people dead; 100 or more people affected; the declaration of a state of emergency; a call for international assistance [9].

Table 2. Statistics of snow avalanche events registered in the Tatra Mountains in the years 1855-2021 according to the number of SAE's.

Snow avalanche prone area	Avalanches		SAE's		Deaths		Affected		Total deaths & affected	
	n	%*	n	%**	n	%***	n	%****	n	%^
Dolina Rybiego Potoku	57	35.19	54	37.76	35	28.93	118	38.82	**153**	**36**
Dolina Roztoki and Dolina Pięciu Stawów Polskich	35	21.60	30	20.98	30	24.79	56	18.42	**86**	**20.24**
Dolina Gąsienicowa	22	13.58	19	13.29	17	14.05	32	10.53	**49**	**11.53**
Dolina Goryczkowa	13	8.02	11	7.69	10	8.26	31	10.20	**41**	**9.65**
Dolina Kościeliska	12	7.41	12	8.39	14	11.57	36	11.84	**50**	**11.76**
Dolina Chochołowska	12	7.41	6	4.20	4	3.31	14	4.61	**18**	**4.24**
Dolina Kondratowa	5	3.09	5	3.50	5	4.13	7	2.30	**12**	**2.82**
Dolina Małej Łąki	3	1.85	3	2.10	1	0.83	5	1.64	**6**	**1.41**
Dolina Olczyska	2	1.23	2	1.40	2	1.65	1	0.33	**3**	**0.71**
Dolina Pańszczyca	1	0.62	1	0.70	3	2.48	4	1.32	**7**	**1.65**
Total	**162**	**100**	**143**	**100**	**121**	**100**	**304**	**100**	**425**	**100**

*share of no. of avalanches in total no. of avalanches; **share of SAE's in sum of SAE's; ***share of deaths in sum of deaths; ****share of affected in sum of affected; ^share of total affected in sum of total affected.
Source: [32, 33, 27, 52, 8, 19, 34-37].

Figure 3. The Rybiego Potoku Valley – Czarny Staw pod Rysami and fragment of the Morskie Oko lake can be seen in the weather window (photo by Zbigniew Piepiora).

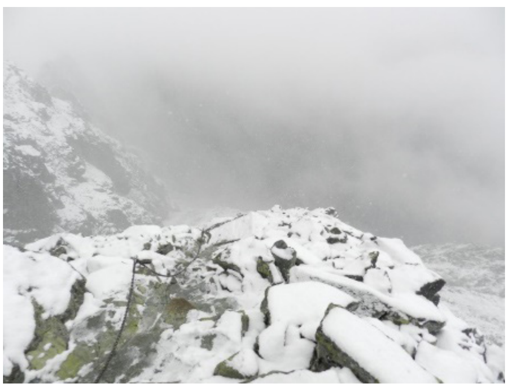

Figure 4. The red trail to Rysy in the Rybiego Potoku Valley (photo by Zbigniew Piepiora).

The most snow avalanche-prone areas are: Chochołowska Valley, Gąsienicowa Valley, Goryczkowa Valley, Kondratowa Valley, Kościeliska Valley, Małej Łąki Valley, Olczyska Valley, Pańszczyca Valley, Roztoki Valley and Pięciu Stawów Polskich Valley, Rybiego Potoku Valley (Table 2).

Totalled 4.6 million tickets sold in 2021 [31]. The Olczyska Valley was associated the Jaworzynka entrance because the Siklawiczny Żleb (Żleb Roja) descends to the Olczyska Valley and next to it there is the blue trail from the Jaworzonka, not from Olczyska entrance. We assumed that half of tourist traffic goes to the Roztoki Valley and Pięciu Stawów Polskich Valley and the rest – to Rybiego Potoku Valley. We assumed that 33% of tourist traffic from the Kasprowy Wierch goes to the Goryczkowa Valley, and the other 33% to the Gąsienicowa Valley. The remaining areas prone to snow avalanche were ascribed to entrances that were closest to them (Table 3).

The higher the risk, the more prone the snow avalanche area. We calculated the following risk indicators for the examined snow avalanche areas: Chochołowska Valley (0.000282%), Gąsienicowa Valley (0.004765%), Goryczkowa Valley (0.001687%), Kondratowa Valley (0.000354%), Kościeliska Valley (0.001118%), Małej Łąki Valley (0.000238%), Olczyska Valley (0.000021%), Pańszczyca Valley (0.000142%), Roztoki Valley and Pięciu Stawów Polskich Valley (0.006252%), Rybiego Potoku Valley (0.020020%). The highest risk of a snow avalanche event occurred in the Rybiego Potoku Valley, which is the most snow avalanche prone area in the Polish part of the entire Tatra Mountains (Table 4).

Table 3. Tourist traffic in the Tatra National Park and the snow avalanche prone areas according to the number of persons (in the months I-VI and XI-XII in 2021).

Ticket sales points (entrances)	The total tourist traffic in 2021		Snow avalanche prone area
	%	Persons	
Łysa Polana (Palenica Białczańska)	10.81	497,205	50% Dolina Roztoki and Dolina Pięciu Stawów Polskich, 50% Dolina Rybiego Potoku
Kościeliska	7.03	323,317	Dolina Kościeliska
Kasprowy Wierch	6.38	293,548	33% Dolina Goryczkowa, 33% Dolina Gąsienicowa
Dolina Chochołowska	5.01	230,514	Dolina Chochołowska
Jaworzynka	3.67	168,816	Dolina Olczyska
Dolina Strążyska	3.51	161,403	
Kalatówki	2.22	102,063	Dolina Kondratowa
Wierch Poroniec	1.68	77,406	
Dolina Białego	1.57	72,230	
Goryczkowa	1.39	64,161	Dolina Goryczkowa
Mała Łąka	0.99	45,470	Dolina Małej Łąki
Nosal	0.69	31,632	
Zazadnia	0.64	29,615	Dolina Pańszczyca
Sucha Woda	0.45	20,836	Dolina Gąsienicowa
Cyrhla	0.31	14,172	
Olczyska	0.28	12,784	
Dolina Lejowa	0.08	3,659	
Total according to TPN*	**100**	**4,600,025**	

*Including also: e-tickets, 7-days tickets, 7-days; 6 days tickets, citizens, exempted, ski tourers, the Big Family Card
Source: [31].

Table 4. Risk assessment in avalanche prone areas according to the risk indicator.

Snow avalanche prone area	Number of events:				Tourists	Indicator		
	SAE's	deaths	affected	total	n	probability [%]	effects**	risk indicator [%]
Dolina Rybiego Potoku	54	35	118	153	248,603	32.530	0.000615	0.020
Dolina Roztoki and Dolina Pięciu Stawów Polskich	30	30	56	86	248,602	18.072	0.000346	0.006
Dolina Gąsienicowa	19	17	32	49	117,707	11.446	0.000416	0.005
Dolina Kościeliska	12	14	36	50	323,317	7.229	0.000155	0.001
Dolina Goryczkowa	11	10	31	41	161,032	6.626	0.000255	0.002
Dolina Kondratowa	5	5	7	12	102,063	3.012	0.000118	0.0003
Dolina Chochołowska	6	4	14	18	230,514	3.614	0.000078	0.0003
Dolina Małej Łąki	3	1	5	6	45,470	1.807	0.000132	0.0002
Dolina Pańszczyca	1	3	4	7	29,615	0.602	0.000236	0.0001
Dolina Olczyska	2	2	1	3	168,816	1.205	0.000018	0.00002
Total	**143**	**121**	**304**	**425**	**1,675,739**			

*SAE/166 ×100%; **total/n of tourists ***probability X effects

DISCUSSION

A factor that increases the risk index is inadequate preparation for mountaineering in winter conditions, such as inadequate clothing and equipment, failure to check the weather forecast, or inadequate route planning. Furthermore, bravado or risky behaviour, such as mountaineering during risk of avalanche or walking off the trail, increases the risk index (Figure 5). Sometimes this happens unintentionally by unthinkingly following trails that someone may have marked off the trail. When in the mountains, you should always obey the rules and regulations in place. The mountains should be treated with humility, as you never know what may happen along the trail: suddenly, your stay in the mountains may turn into an unexpected battle with the elements and your own weaknesses [8, 36].

Figure 5. Risky behaviours in the Tatra Mountains – a man in shorts and a person outside the trail (photo by Zbigniew Piepiora).

Snow avalanches are caused by the heavy snowfalls on steep slopes that result from gravity pull [68]. The effects of snow avalanches, especially injuries and damages, are related to the expansion of human settlement, land use, and infrastructure into areas which are at risk from snow mass instability. The rising popularity of winter sports constitutes a particular problem for emergency services as to how to maintain public safety without placing unnecessary restrictions on access to mountainous regions [69]. Anyone who leaves the designated route, enters an area that is not protected from avalanche danger. This means that outside trails and high-altitude areas an avalanche can descend anytime [70, 18].

The increasing scale of interest in mountaineering shown in this review, alongside with the risks (numbers documenting deaths and negative health effects), lead to the conclusion that the prevention standards in place are inadequate. The attention paid to innovative agonology in this work has a methodological justification. The basic method of this new applied science (which has only been promoted in the global science space since 2016 [71]) is a complementary approach. Moreover, agonology in its broadest sense is, after all, a science of struggle [1, 6, 2-5]. At the same time, the controlled environment rule formulated by Jarosław Rudniański [6] is universally applicable. This rule is particularly meaningful in the struggle against dangerous nature and one's own weaknesses of those who, due to lack of adequate preparation and disregard for high mountain conditions, take unjustified risks.

CONCLUSIONS

The most dangerous places in the Polish part of the entire Tatra Mountains are the following: Rybiego Potoku Valley, Roztoki Valley and Pięciu Stawów Polskich Valley, Gąsienicowa Valley. We verified positively the hypothesis formulated at the beginning: 'The most prone avalanche area in Polish part of the Tatra Mountains is Rybiego Potoku Valley'. Furthermore, we applied positively the Snow Avalanche Event Analysis in the Tatra Mountains as the method of research of innovative agonology.

In the future, the research should focus on estimating the risk indicators for the years 1855-2021 for specific locations in the Rybiego Potoku Valley, e.g., Rysy, Mięguszowieckie Szczyty, Żleb Żandarmerii; and in other Tatra valleys. To verify that Rybiego Potoku Valley is one of the most avalanche-prone and dangerous areas in Polish mountains, further research is needed on the occurrence of snow avalanches in the Polish mountains and the tourist movement in the vicinity of snow avalanche-prone areas.

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