

## Safety of Hiking Trails in the Malá Fatra Mtf.

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*Short report*

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### Abstract

The thesis aims to identify risky sections in the selected mountain area based on a statistical survey of the intervention activities of the Mountain Rescue Service, in the winter, when there is a continuous snow cover in the area. Based on this survey, we were able to further define the area where we assessed the current state of technical support. This work should contribute to increasing safety in the mountain area of Malá Fatra. The main points of the thesis include the characteristics of permanent danger in the mountains, the definition of the area, the assessment of the readiness of visitors in the event of an adverse event, and the proposal of measures. Based on cooperation with the Mountain Rescue Service, it was possible for statistical processing of rescue operations and subsequent expert consultation in evaluating the results.

**Keywords:** hiking trail; Malá Fatra; mountain area; Mountain Rescue Service; safety; tourism

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### 1 Introduction

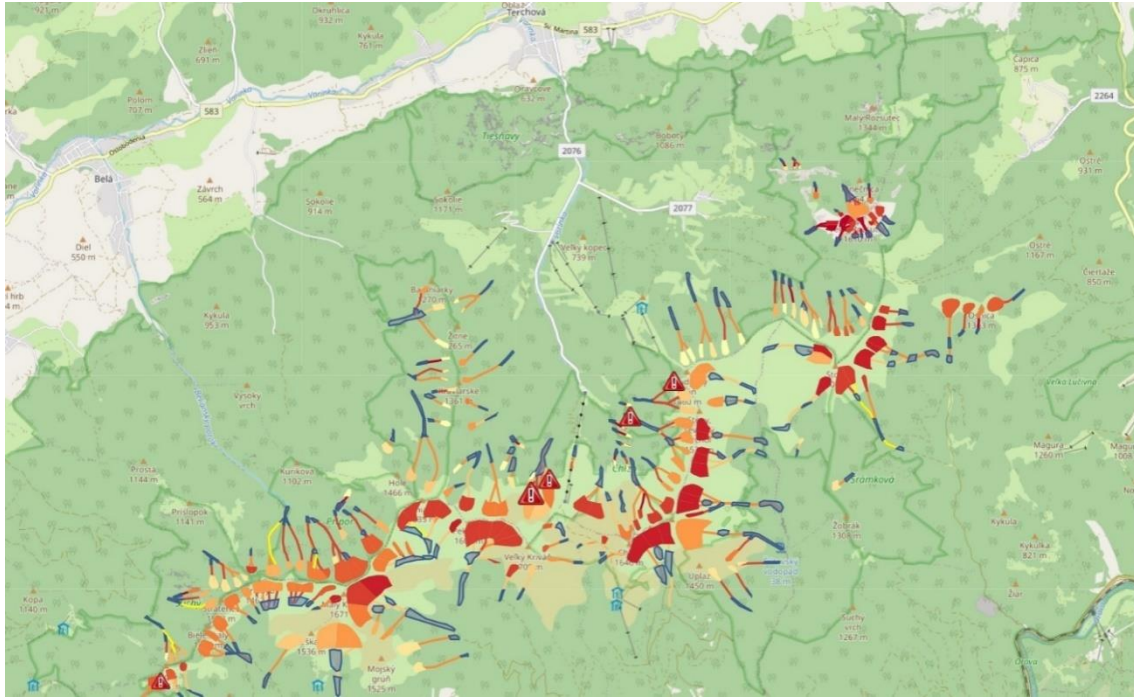
Mountains are an inherent part of our country and therefore there is no wonder that traffic still rises in them. In the current relaxed time and pandemic situations, a change in free time is visible. Embossed measures, closed shopping centers, cafés, restaurants and many other devices have expelled people into the nature. Some are looking for relaxation in the form of a walk in the fresh air, others like various forms of adrenaline breathtaking sports. Mountain hiking, ski mountaineering, skiing, paragliding and many other activities are becoming more and more popular. The mountains has earlier showed their strengths, also wrecking the most and most attractive athletes. And therefore the safety is paramount due to the increasing number of visitors to mountain areas on hiking trails.

The issue of work is focused on safety of hiking trails in Malá Fatra mountain area. An important part is a statistical survey of MRS intervention activity in terms of the number of interventions to specific accident situations in the area. Based on the outcome, we will assess the risk points of the areas, with the proposed measures should contribute to increasing security near the avalanche territories. The necessary part of the work in the draft measures was a professional consultation with members from the Malá Fatra Regional Center and also with the supervisor. Another objective is to propose measures to reduce these risks or full removal of safety deficiencies.

Based on the consultations with members of the MRS and experts in the area, it was also possible to consult proposed preventive, security measures that could contribute to increasing security. The proposal also includes a campaign for raising awareness of avalanche danger and a lot of else.

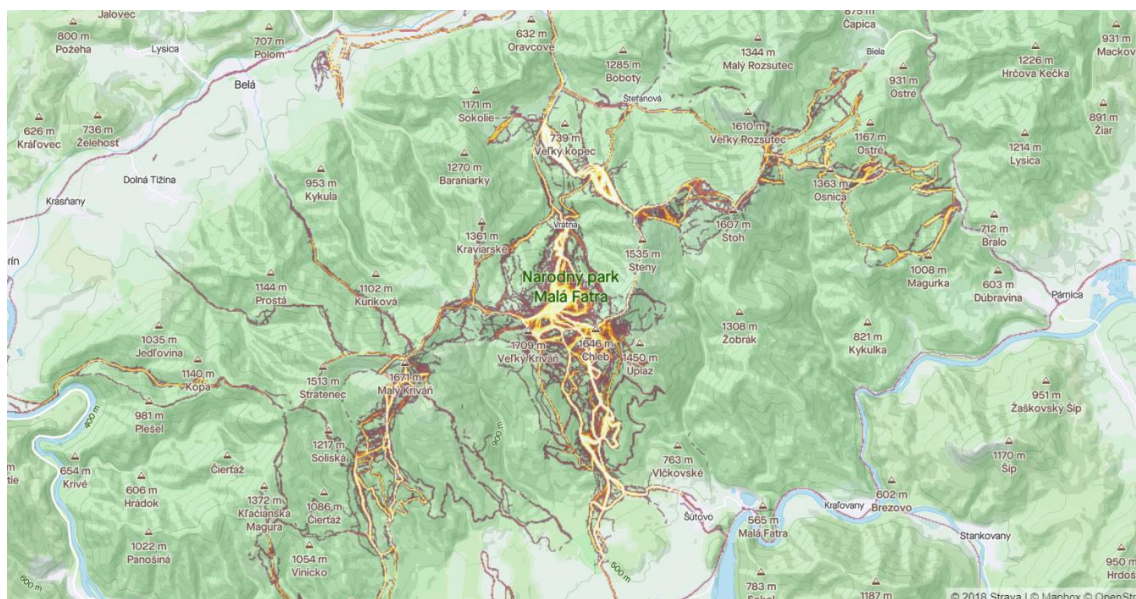
### Characteristics of mountain massive

In terms of permanent danger in a given mountain area, it is important to know territories with avalanche dangers. Krivánska Malá Fatra belongs to areas that create suitable conditions for the emergence of avalanche. More than half of the territory form Alpine meadows, dwarf mountain pines at 30% and forest stand 20%. For better advance, we will use Fig 1, available on [Avalanche.sk](http://Avalanche.sk), which includes all the necessary data such as cumulative and tear zones, transport zones, as well as their length, slope inclination and many other attributes needed (Žiak, 2016).



**Fig 1.** Avalanche map of Malá Fatra (Avalanche, 2021)

The region has high potential for tourism. Terchovská dolina has an incredibly varied natural potential that offers many options (Euro Dotácie, s. r. o., 2016). There are places that are searched for their interesting relief such as a Veľký Fatranský Kriváň, at a neighboring Malý Fatranský Kriváň, Bobota, Veľký Rozsutec and of course many others. Thus, Terchová village is a major starting point for Malá Fatra. To zoom in on the most visited parts of Malá Fatra, we will use the publicly available „Heatmap“ from the STRAVA application, see Fig 2. Heatmap is a worldwide heat map that records the user's movement using GPS. This data is displayed on one map and therefore we can see which places or routes are most frequently used (Urban, 2018). According to the recorded data, the avalanche areas that we could see on the avalanche map of Malá Fatra are also among the popular and searched places.



**Fig 2.** Most visited locations in Malá Fatra (Strava, 2021)

### 1.1 Winter season

The characteristic sign for the winter is snow, therefore the time-section of the intervention activity was set out in the defined area from 1 December to 1st April of the following year. There is a continuous snow layer in this period. Rescuers with professional competence for rescue activity in avalanche and also specialists perform regular snow cover measurement on eight observation sites. The results serve to assess the stability of the observed snow cover. Avalanche forecast is updated every day, we divide it into general and individual forecast. The general avalanche forecast is given based on the collected data of the Avalanche Prevention Center and informs us with the media on the current situation in the mountains. However, the degree of avalanche danger is published for the entire mountain area, not for its individual parts. It is for this reason that it is also necessary to make an individual avalanche forecast. It is an analysis of the area in which we are currently operating, or in which we plan to carry out activities. Avalanche Prevention Center of Mountain Rescue Service (APC MRS) cooperates with domestic avalanche level organizations such as high school technical and science focus, or Slovak Hydrometeorological Institute (SHMI). In addition to the organization mentioned, International Commission for Alpine Rescue (ICAR), also cooperates with Association of European Avalanche Services (Janiga et al., 2010).

#### 1.1.1 Marking and technical security

The ridge of Malá Fatra is labeled with a belt tourist brand with two white and one red belt in the middle. The ridge relief is significantly rugged, sharp, and diverse shape. For longer routes without turns and intersections, comfort signs are also used here, which are within 250 meters of each other. Marker pins are used in places where there are no suitable objects for placing markers. These pins are painted with a deep yellow color, which ensures good visibility, and their height is 1.5 meters. When crossing sidewalks, there are signposts that carry the function of an information element. Typically, the direction of the journey also occurs with the expected route time (Guldan et al., 1990).

In winter, bar marking is used annually at the ridge and facilitates the orientation especially in inclement weather such as a mist or dense snow. Bar marking is before winter controlled by MRS that oversees it, damaged and missing rods need to be replaced with new (Bárdy, 2021).

### 1.1.2 Security measures near the avalanche territory

Before the winter season, the avalanche boards are put into the terrain that warn visitors that the avalanche terrain begins behind the table. These boards are specifically on the edge of the Veľký Kriváň, in the Sedlo pod Suchým and in Príslop pod Suchým. Of course, the survey of the terrain is also carried out by the members of the MRS themselves, when they monitor, for example, avalanches fallen and the condition of the bar markings. The snow cover survey is usually carried out two to three times a week, depending on the amount of new snow fallen. These data are then sent to ACP MRS, where according to the data they determine the degree of avalanche danger (Bárdy, 2021)

#### 1.2 General movement principles for avalanche danger

The first basic rule is „don't go alone"! If we are alone, we risk not having anyone to help us in the event of an avalanche. On the other hand, large groups are not recommended either. If there is a group of skiers in a steep gutter, it is necessary for each of them to go down alone. When climbing a steep slope, it is recommended to adherence larger distances (Spolok horských vodcov, 2006).

Secondly, there is no need to underestimate your mandatory equipment, an integral part of which is an avalanche search device, avalanche shovel and probe. Before initiating any activity in the mountain environment, it is advisable to prepare adequate gear in relation to current terms. Checking the functionality of mandatory gear and putting the search apparatus into operation during the avalanche threat. Terrain's inspection - we plan our route with ridges, rugged slopes with terraces, trees and we try to avoid gutters and slopes that have a continuous snow cover (Toma et al., 2007).

In terms of security, the **International danger avalanche scale** is known. This scale specifies us possible mechanical or spontaneous emergence of an avalanche or place where the expected avalanche danger is.

**Tab 1.** International danger avalanche scale (author, according to: Lizuch, 2009)

Grade	1.	2.	3.	4.	5.
<b>Risk</b>	Small	Slightly	Increased	Big	Very big
<b>Snow Layers Stability</b>	Stable and well paved.	In extreme, steep places only slightly paved.	On many extreme places slightly paved.	Slightly paved on most avalanche territories.	Weakly paved and unstable.
<b>Probability of falling avalanche</b>	It is not expected. The exception is a small snow slides.	Possible landslides in mechanical load in extreme slopes.	The occurrence of avalanches at mechanical load in extreme slopes and possible spontaneous emergence of avalanche.	A spontaneous emergence of secondary and large avalanches.	Spontaneous release of large avalanches to less steep slopes.
<b>Restrictions</b>	Without	Not over 40°	Not over 35°	Not over 30°	NO!

## 2 Methods

The object of the research is mainly the intervention activity of the MRS, while we will examine the 5-year period of interventions based on information provided by members of the Regional Center of MRS Malá Fatra. In this work we will point out not only the current state of hiking trails in terms of safety, but also the readiness of visitors who are looking for recreational or adrenaline winter sports in the area.

The form of inquiry was used in the work, which belongs to the basic methods. Using the given method, we determined the readiness of visitors for undesirable events of the assessed area. The questionnaire was created via Google Form, which involved a total of 160 suitable respondents, which created 2400 input data for further statistical processing. Based on the survey, it is possible to find out the most visited localities, the most numerous sports activities, completed courses, ability to solve selected situations and much more. The methodology is based on a statistical survey. Statistical scientific discipline deals with the study of mass social phenomena and processes, it can also be phenomena such as biological or technical. Statistics mainly examine the quantitative side of the given phenomena, but we cannot put their qualitative side in the background. Typical features for statistics are that it deals with variable features, is expressed using numbers and finally uses computational techniques (Novák, 2008).

We used the possibility of personal consultations with experts from practice, which we could rank among the most effective sources. Based on their knowledge, experience, and skills, they provided us with the necessary information and the opportunity to consult on the proposed security measures.

## 3 Results and Discussion

We have addressed the Regional Center of MRS Malá Fatra for the statistical project, where they provided us about intervention activities in Krivánská Malá Fatra from 2014 to 2020. We have defined for the time period from 01.12. until 01.04 of the following year, because in the given time, the snow cover is in the mountain area. As this work deals with safety on hiking trails in the winter and our selection was narrowed down to the intervention activity in the open terrain (outside the slopes) were recorded 80 interventions, which in terms of examined statistical features shows 640 input data.

### 3.1 Definition of area

**Statistical question:** In which area have the most interventions been made?

**Statistical character:** area

**Character characteristics:** verbal - quantity

**Used method and its justification:** Simple sorting, which we use when sorting a word character that has less than 15 variations.

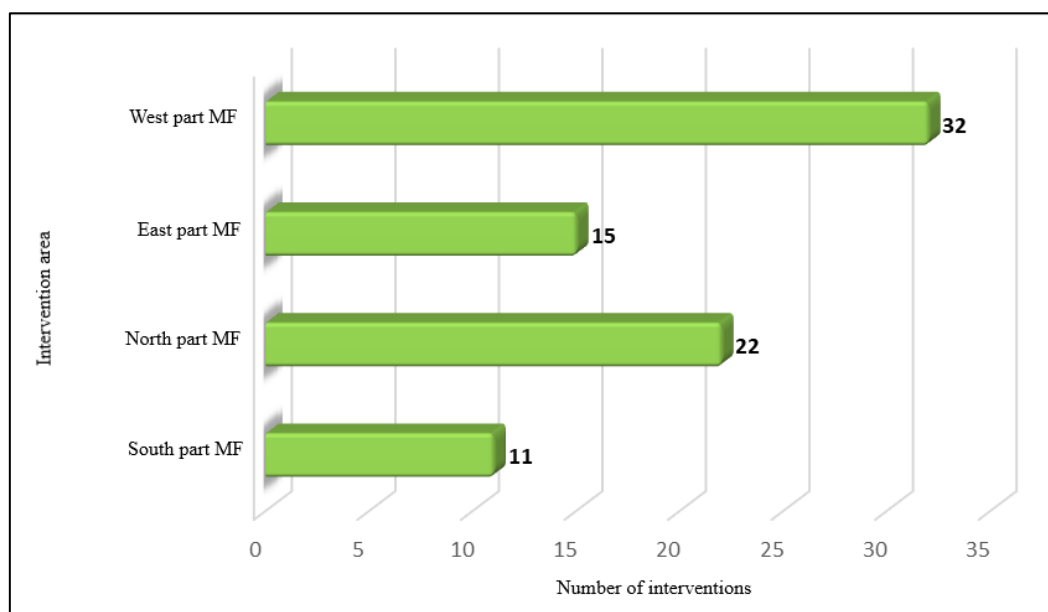
**Selecting graphic and table tools:** When solving a given statistical problem, we will use a table for simple sorting. The graphic tools use a bar graph and a pie chart (percentage distribution). Interventions that were carried out outside the ridge are also included according to the sides of the world as the northern and southern part, according to the Steny za Hromovým.

*Note:* Due to the large number of variations of the examined statistical feature, we decided to assign a sub-area to individual areas based on the following criterion:

- a) We imaginarily divided the ridge of Malá Fatra in half, while the dividing point is in Snilovský sedlo. Therefore, the individual places where the intervention activity was carried out on the ridge are divided into eastern and western parts according to the sides of the world.
- b) Interventions that were carried out outside the ridge are also included according to the sides of the world as the northern and southern part, according to the Steny za Hromovým.

**Tab. 2** Distribution of intervention activities by area

Subarea	Number of interventions		Cumulative abundance	
	Absolute	Relative	Absolute	Relative
South part MF	11	13,75	11,00	13,75
North part MF	22	27,50	33,00	41,25
East part MF	15	18,75	48,00	60,00
West part MF	32	40,00	80,00	100,00
<b>Total</b>	80	100,00	x	x



**Fig. 3** Displaying the number of interventions in the selected area

**Interpretation of the result:** Distribution of intervention activities by area - shows the number of interventions in individual parts of Malá Fatra. The fewest interventions were made in its southern part, with 11 interventions. On the other hand, most interventions were recorded in the western part, these are exactly 32 rescue operations from the total intervention activities of members of the Malá Fatra MRS.

### 3.2 Assessment of the intervention activity in terms of the cause of the intervention

**Statistical questions:** What is the most frequent cause of intervention and in which area?

**Statistical character:** cause, area

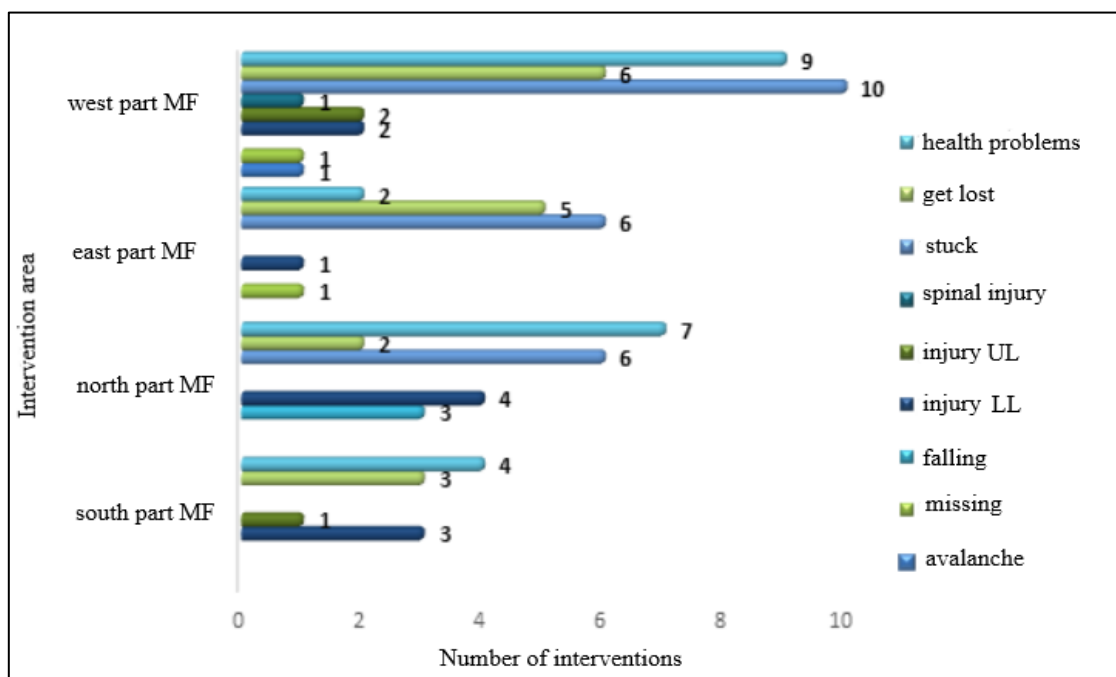
**Character characteristics:** verbal - quantity

**Used method and its justification:** Sorting in a combination of two word characters. We will use the given method because we need to see the absolute number of individual causes of the trip in the assigned subarea.

**Selecting graphic and table tools:** We will use a contingency table of empirical abundance and we will use a bar graph from graphic tools.

**Tab. 3** Contingency table of empirical abundance

Subarea	Avalanche	Missing	Falling	Injury LL	Injury UL	Spine injury	Stuck	Obstruction	Health problems	Total
South part MF	0	0	0	3	1	0	0	3	4	11
North part MF	0	0	3	4	0	0	6	2	7	22
East part MF	0	1	0	1	0	0	6	5	2	15
West part MF	1	1	0	2	2	1	10	6	9	32
<b>Total</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>10</b>	<b>3</b>	<b>1</b>	<b>22</b>	<b>16</b>	<b>22</b>	<b>80</b>



**Fig. 4** Display of the number of accidents in each area

**Interpretation of the result:** As can be seen in Tab 3, the most common cause of MRS intervention is stuck with health problems, and any changes in the human body, such as heart attack, nausea, and others considered as health problems.

### 3.3 Additional information

Six deaths occurred during the interventions, and not a single fatal accident occurred in the southern part and in the other parts in the same way, two at a time. Therefore, we did not rank this statistical feature as representative and we focused on more numerous causes than mentioned above, namely stuck, missing and health problems.

**Tab. 4** Intervention action in terms of accidents

Subarea	Injuries		Total
	Fatal	Other	
South part MF	0	11	11
North part MF	2	20	22
East part MF	2	13	15
West part MF	2	30	32
<b>Total</b>	<b>6</b>	<b>74</b>	<b>80</b>

**Summary:** Safety is important in every area, the complexity of rescue operations is difficult to assess, as each one of them is something specific. The force of nature is unpredictable and even if all safety measures are observed, there is a risk of injury, missing or other undesirable event. The greatest danger in winter is avalanche, but also a strong gust of wind associated with snow (Bárdy, 2021). The statistical survey of MRS intervention activities served us to define a part of the Malá Fatra mountain area. The area that we will deal with in the next part and assess its current state in terms of safety is the western part of the ridge of the mountain massif. According to the results of the survey, the most frequent trips in this area took place, with the main cause of the intervention being missing, getting stuck or health problems. The avalanche accident in number 1 occurred in the western part, but it is not a representative figure.

**Tab. 5** Identification of risk points in the selected area

Year	Number of rescued	Nationality	Intervention area	Subarea
2014	1	SK	Starý hrad	West part MF
2014	1	SK	Veľký Kriváň	West part MF
2015	1	SK	Chata pod Suchým	West part MF
2015	1	CZ	Veľký Kriváň	West part MF
2015	1	SK	Priehyb	West part MF
2016	1	PL	Biele Skaly	West part MF
2016	4	CZ	Biele Skaly	West part MF
2016	1	SK	Chata pod Suchým	West part MF
2016	1	SK	Malý Kriváň	West part MF
2016	1	CZ	Veľký Kriváň	West part MF
2016	4	SK	Pekelník	West part MF
2016	2	CZ	Snilovské sedlo	West part MF
2016	1	SK	Starohradská dolina	West part MF
2017	1	SK	Veľký Kriváň	West part MF
2017	1	CZ	Veľký Kriváň	West part MF



2017	2	CZ	Pekelník	West part MF
2017	6	SK	Malý Kriváň	West part MF
2017	3	SK	Malý Kriváň	West part MF
2017	5	CZ	Malý Kriváň	West part MF
2017	2	PL	Snilovské sedlo	West part MF
2018	1	CZ	sedlo Bublen	West part MF
2018	3	CZ	Pekelník	West part MF
2018	8	SK	Malý Kriváň	West part MF
2018	5	CZ	sedlo Bublen	West part MF
2019	1	SK	Veľký Kriváň	West part MF
2019	3	CZ	Pekelník	West part MF
2019	3	PL	Snilovské sedlo	West part MF
2019	1	SK	horná stanica Vrátna	West part MF
2019	1	SK	Chata pod Suchým	West part MF
2019	1	SK	rozhľadňa Špicák	West part MF
2019	1	CZ	Snilovské sedlo	West part MF
2020	1	SK	Hoblík	West part MF

As we can see, there were numerous trips to Chata pod Suchým, Veľký Kriváň, Malý Kriváň, Biele Skaly in the selected area, several rescue operations also took place in Snilovské sedlo or Pekelník. From the given table we can see that we have several nationalities represented here, from which we can conclude that the Malá Fatra National Park is being searched and popular not only with locals.

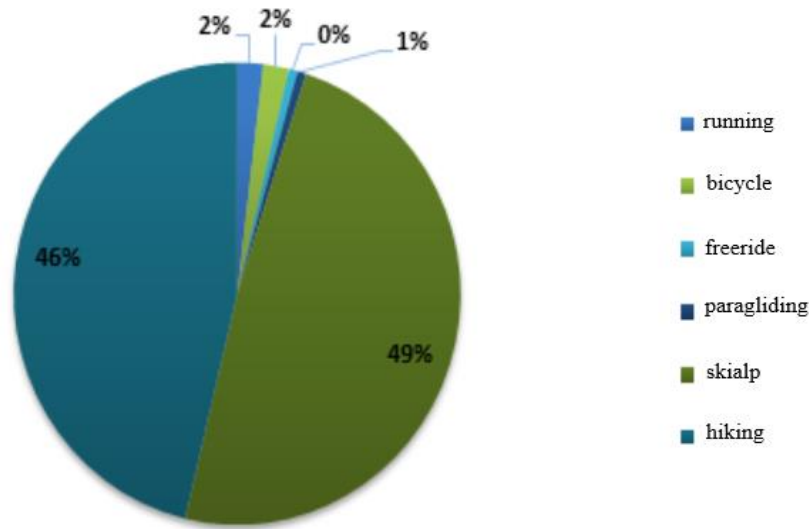
### 3.4 Evaluation of visitor readiness

Avalanches are affected by several factors, from solar radiation, wind direction and speed, air temperature, rainfall intensity, slope and exposure, snow cover humidity to the human factor. It is for this reason that we focused on assessing the readiness of visitors for undesirable events, because we can also influence the formation of avalanches by our behavior and actions (Lizuch, 2009).

We used the inquiry in the form of a questionnaire and focused on the following main questions:

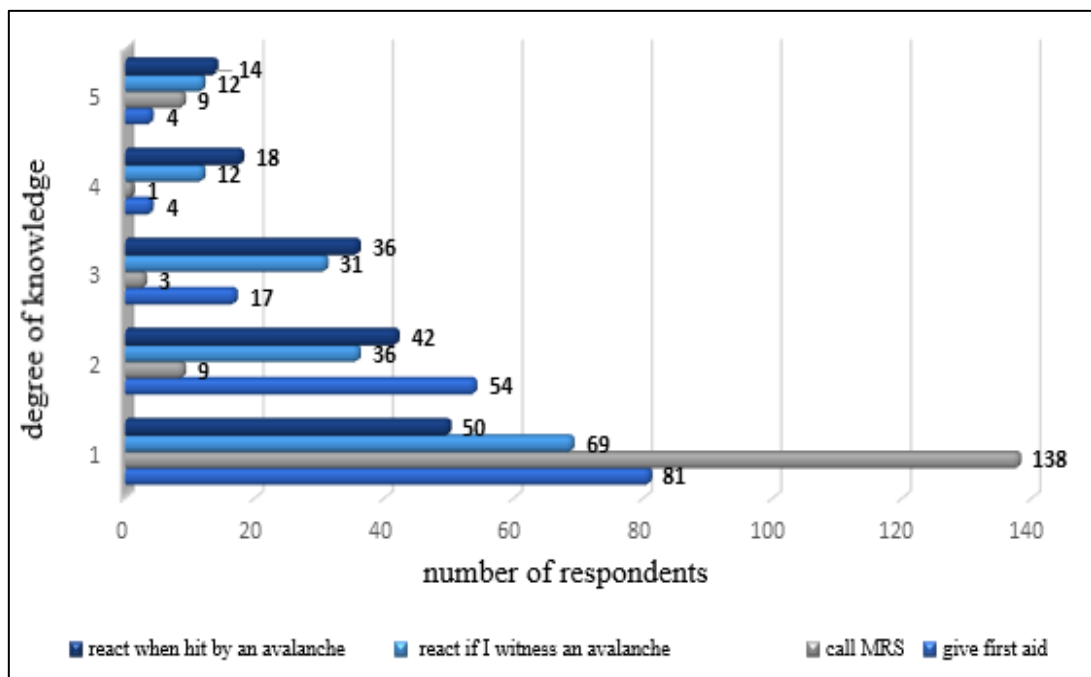
- What are the most frequently performed sports activities in the area?
- What knowledge and skills do visitors to the assessed area have when performing sports activities in selected situations?
- What equipment do they use in their activities?
- What is the satisfaction with the technical provision of hiking trails in the selected area?

In our survey, 160 respondents involved through the public online group of skialpinism and climbing, while the main condition was performing sports activities in the selected area. We assumed that the addressed group, which moves in an area with increased avalanche danger, will be able to respond to selected situations such as reporting an accident on the MRS line, or IRS, which is a reaction if we witness an avalanche accident.



**Fig. 5** The most frequently performed sports activities

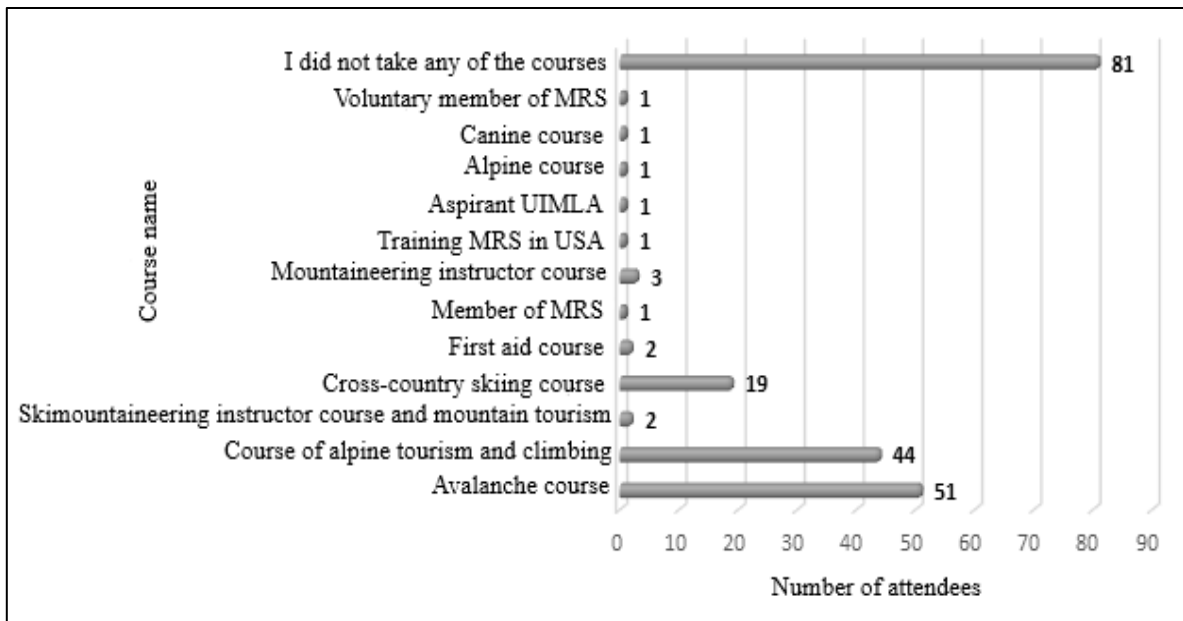
From the previous graph the most frequently performed sports activity in the selected area is ski mountaineering, represented by 46%. Skiing in extreme, steep, gutters pose a high risk of avalanches and the necessity in this activity is mandatory equipment, basic knowledge of avalanche danger and skills.



**Fig. 6** The ability to respond to selected situations

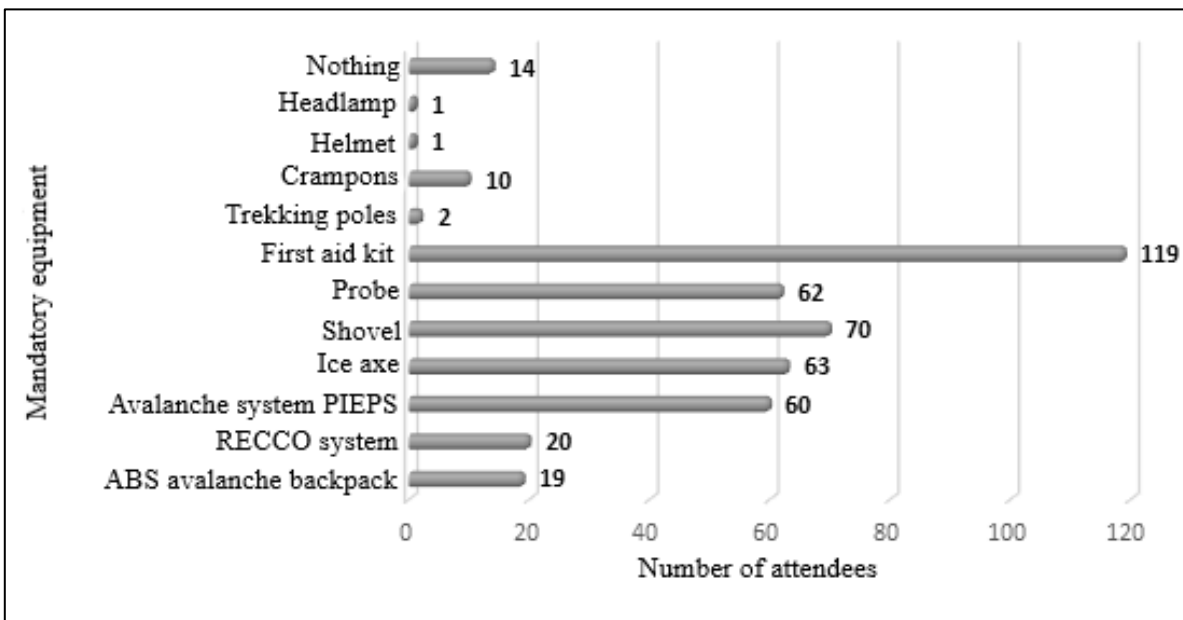
From that graph, we can see that only 50 interviewees can respond to the avalanche, 69 respondents can respond if the avalanche is witnessed. The first aid can give 81 respondents and the largest number of 138 people can report the situation at the MRS, or IRS. Another criterion for assessing readiness was completed courses, while the representation of courses suitable for the mountain environment was diverse. We also had a member of the MRS, a voluntary member of the MRS, or an International Mountain Leader (UIMLA).

Another criterion for readiness evaluations were graduated with courses that are needed in the alpine environment. These courses increase the knowledge of possible danger and increase the chances of survival in the event of an unfavorable event.



**Fig. 7** Completed courses

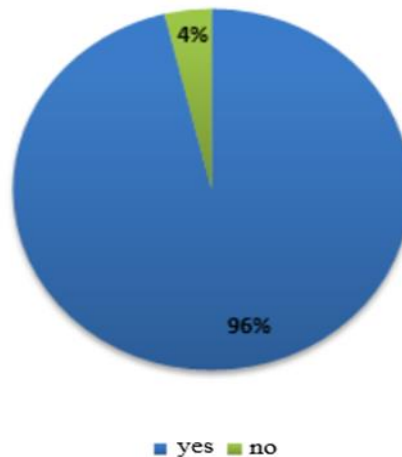
From the following graph we can see how many visitors from the interviewed group wear mandatory equipment. The first-aid kit has the largest representation, for the administration of first aid. Furthermore, the most used are the mattock, the probe, and the avalanche search system.



**Fig. 8** Mandatory equipment

Satisfaction with the technical provision of winter hiking trails can be interesting. As many as 96% of respondents are satisfied with the technical security and dissatisfaction is only with 4% who think

that the security is not suitable. We can say that safety is sufficient, so the human factor plays a role in accidents.

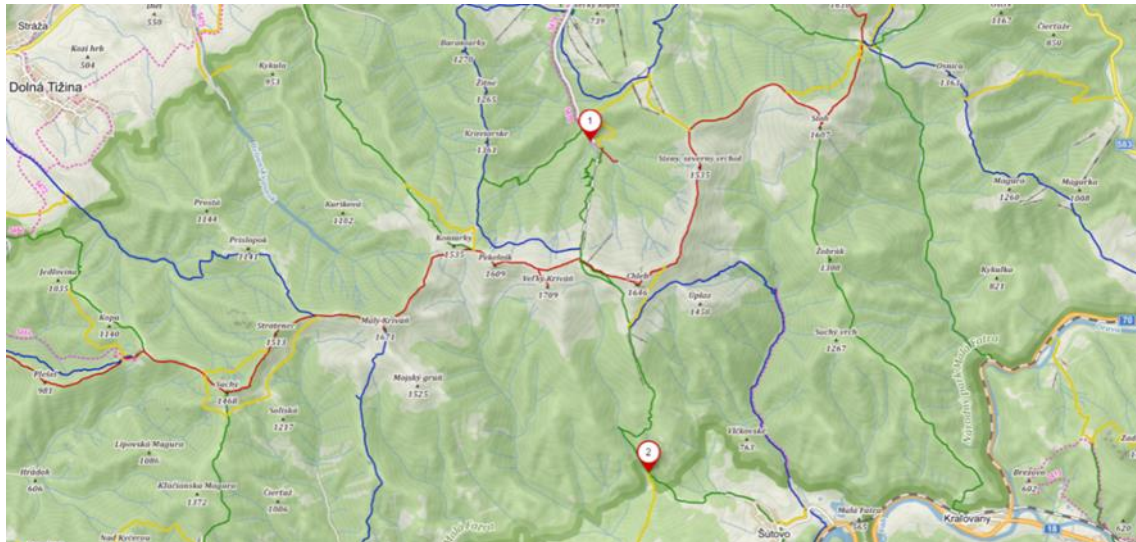


**Fig. 9** Satisfaction with technical security

### *3.5 Suggestions and recommendations*

As we have already mentioned, mandatory avalanche equipment is a priority for every ski alpinist. When hit by an avalanche, it can save our lives, or we can use it to help save a buried friend. It would therefore be appropriate to introduce a precautionary measure, such as in neighboring Austria, namely a fine for missing avalanche equipment such as PIEPS, avalanche shovel, probe of 300 EUR. It is the amount for which we can secure this basic equipment. It is also suitable to have an ABS avalanche backpack, which is increasingly part of the equipment, this backpack is one of the active elements of the equipment and works on the principle of a life jacket when drowning in water. When activating the backpack, an airbag is created, in the form of a large pillow, which perfectly protects our head and neck from mechanical damage. Another sought-after element is the RECCO system, which is built into a ski jacket, trousers, or other clothing, but these are already more financially demanding items. Nature is unpredictable, so it is necessary to have respect for it and it is important to always be prepared regarding the current situation in the mountains (Bárdy, 2021).

From the point of view of the high number of visitors in Malá Fatra even in the winter and the occurrence of avalanche danger, it would be appropriate to build a PIEPS CHECKPOINT control station. This project is in the initial phase of development, control points for the functionality of avalanche search engines are so far located only in the High Tatras in four places. In our case, they could be built in the main starting nodes, such as in Fig 16, where the lower station is cottage Vrátna (1) and Zajacová (2) (Bárdy, 2021).



**Fig. 10** Location PIEPS CHECKPOINT in selected areas (Mapy.cz, 2021)

In terms of preventive measures, we also consulted the controlled firing of avalanches, or technical support for the diversion or capture of the released avalanche. The mentioned avalanche shots in the Malá Fatra mountain area are carried out on the Oštiepková mulda, where the resulting snow prevails can endanger the ski slopes. In our assessed area there is no threat to the transport infrastructure, settlements, or ski slopes, therefore these controlled shots are not performed (Bárdy, 2021).

From the point of view of a statistical survey of the evaluation of the readiness of mountain visitors for adverse events, we would certainly include among the proposals campaigns that would serve to raise awareness of avalanche danger, mountain insurance, MRS activities or the need for mandatory equipment. It could be a suitable way; it is a way of addressing the public. Advertising is often associated with certain financial costs, but this type of visibility was used by MRS in cooperation with GENERALI Poist'ovňa, a. s when launching the mobile application MRS. Another way is a bumper, a specific type of ad that will appear on YouTube in the form of a short video or animation. Besides that, we could use information posters, cards, or banners, whether static or animated. These proposed campaigns should be engaging, concise and should carry the essential information we want to point out (Karkuš, 2016).

#### 4 Conclusions

Due to the increasing number of visitors to mountain areas and the more frequent search for adrenaline and winter sports, the risk of avalanche accidents also increases. This can be caused by several factors. From factors that directly affect the formation of avalanches, or the human factor that can affect the formation of avalanches by its indifference to safety measures, ignorance, or inexperience. From the information obtained, not every visitor care about their safety, or the safety of their companions, and therefore raising awareness of avalanches is a priority.

The basic goal was to assess the current state of the selected area, evaluate the readiness of visitors and then propose changes in the marking of winter hiking trails near avalanche areas. As we found out during the expert consultation with the members of the fire brigade Malá Fatra, the winter bar marking leads outside the avalanche area, while the summer tourist marking is invalid in the winter, so the proposals for changes to the marking are unfounded. Avalanche boards are placed on the ridge of Malá Fatra. The condition of the snow cover and the degree of avalanche danger is regularly updated on the official MRS website. Based on expert consultation with members of the MRS or experts from practice, we were able to evaluate the proposed safety measures such as building PIEPS CHECKPOINT stations in the starting nodes, building weather stations, building technical equipment to divert or capture the released avalanche and controlled avalanche blasting. Not all these proposals were accepted as they would not have the expected informative value. Despite some negative opinions, we believe that stricter security measures need to be laid down.

In conclusion, we will just remind you that there is no need to overestimate your strength or underestimate the power of nature, and in case of any questions about the current situation in the mountains, you can just inform the Regional Center of MRS in Malá Fatra, or their official website. It is also good to think about the general principles of safety and we need to think about mountain insurance, which can save us the financial inconvenience of MRS intervention. Despite taking some of the courses mentioned above, we are not heroes, and it is necessary to go to the mountain environment with respect.

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