EVALUATION OF EMOTIONAL STATE, HEART RATE FREQUENCY AND SKIING TECHNIQUE IN SKI HIKING

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Abstract

Introduction. The aim of this study was to assess selected psychological, physiological and technical factors related to ski hiking in order to offer some recommendations for ski hikers and ski hike organisers. ***Material and methods***. The hike lasted 8 hours and the hikers covered a distance of 24 kilometres. The ski hikers' emotional state was assessed three times: before the ski hike, 1 hour after the hike and 16 hours after the hike. Their skiing technique was evaluated during the first part of the hike and at the end of the hike. The heart rate of the skiers was recorded over the course of the hike. The data were then processed and analysed statistically. ***Results***. When comparing the data collected for the selected factors during the ski hike, some significant correlations were found. A significant correlation was observed between the level of fear experienced before the ski hike and cycle length for the diagonal stride ($r=-0.791$, $p<0.05$), which meant that the hikers with poorer ski technique felt more afraid before the hike. However, these hikers also showed lower levels of sadness 16 hours after the hike ($r=0.804$, $p<0.05$). A significant negative correlation ($r=-0.849$, $p<0.05$) was found when comparing the average heart rate frequency and the level of anger experienced after the hike, that is the hikers who had a lower heart rate were angrier after the hike. The results helped to develop some important recommendations for ski hikers and ski hike organisers.

Key words: ski hike, emotional state, heart rate, cycle length, diagonal stride

Introduction

Various types of recreation activities which are performed to improve one's emotional state are becoming more and more popular. Running competitions organised in spring, summer and autumn, as well as skiing sporting events in winter, attract more and more competitors and spectators. However, it is often the case that the competitors are not fully aware of their abilities and they may suffer both physically and, most of all, psychologically due to participating in the competition.

Hiking or ski hiking seem to be more effective recreation activities, since there are no time limitations, which interfere with experiencing positive feelings in skiing and mass running competitions. Nowadays skiing is mainly performed either as part of competitions or as a recreational activity [1]; when used as a recreational activity, it should fulfil the main function of recreation, which is improving a person's emotional state.

Psychologist and researcher of emotions P. Ekman proposed a theory concerning 6 basic emotions (happiness, surprise, anger, sadness, fear and disgust), listing universal gestures for each emotion, but at the same time emphasising that there are many ways of expressing them [2]. Ekman also studied what types of facial expressions people have when experiencing different emotions [3]. Ekman's work was used in the FaceReader 3.0 software which was applied in this study [4, 5].

As far as evaluating skiing technique is concerned, skiing velocity can be used as its indirect indicator. In most cases greater velocity is achieved thanks to more economical movement; as is known from skiing biomechanics, skiers with greater velocity tend to have greater cycle length. Therefore, cycle length can be used as an indicator of skiing technique [6, 7, 8, 9, 15]. In this study cycle length for the diagonal stride, a technique which is commonly used during ski hikes, was measured [10].

The single most important physiological determinant of ski performance is maximal oxygen uptake. Heart rate frequency can be used as an indirect indicator of the maximal level of oxygen uptake during constant submaximal intensity exercise, and it was used for this purpose in this study [11, 12, 13, 14].

The assessment of technical and physiological factors and their correlation with emotional state were to help develop some recommendations for ski hikers and ski hike organisers.

Material and methods

The research was carried out in three stages. In the preparation stage the distance and route of the ski hike, and the part of the route where the skiing technique would be assessed were selected. The study involved assessing the skiers' emotional state, recording their heart rate during the ski hike, making video recordings twice during the hike and re-assessing their emotional state 1 hour after hike and on the next day, that is 16 hours after the hike. In the last stage the video recordings were analysed in order to assess the skiing technique and identify the emotional states of the participants and their intensity using FaceReader 3.0.

The distance covered during the ski hike was 24 kilometres and the hike lasted 8 hours. The first 3.5 hours of the ski hike consisted in skiing, then the skiers had a one-hour break to rest and have lunch, which was followed by another 3.5 hours of skiing. The degree of difficulty of the hike was average.

Heart rate recordings

In order to assess the changes in functional indicators, the skiers' heart rate was recorded. Each of the ski hike participants wore a Polar RS100x heart rate monitor with a GPS add-on so that the data could be recorded. The data recorders were synchronised before the ski hike and the heart rate of the skiers was measured at exactly the same time for each participant. The heart rate monitors were stopped after 3 hours of the hike, immediately before the rest and lunch break. The same procedure was performed at the beginning of the second part of the ski hike, immediately after the rest and lunch break.

The heart rate recordings were later synchronised using the Polar data synchronising device Polar FlowLink. The data are automatically sent to the web page polarpersonaltrainer.com, where they are available for further analysis. The heart rate recording frequency for the Polar RS100x model is every 5 seconds. On the polarpersonaltrainer.com website heart rate data are displayed in intensity zones. The time of activity for each preset heart rate zone is shown. The data used in this research were the average and maximal heart rate in the first part (before lunch) and in the second part of the hike (after lunch and until the end of the hike). These changes in the indicators were measured and some recommendations were made.

Video recording analysis

In order to assess the participants' skiing technique, they were filmed during the hike and the video recordings were analysed. The participants were filmed when skiing for 50 metres on a flat surface using the diagonal stride, which is the main technique used in ski hikes. The participants were asked to ski at average speed, as close as possible to the skiing speed of the group who participated in the hike. The ski hikers were filmed twice: at the 4th kilometre of the hike and the 4th kilometre before the end of the hike.

Video recordings were made using a Sony Handycam DCR-SR36 video camera. The videos were analysed using the video analysis program Kinovea. During video analysis the average cycle length was determined for the first and second test for each of the ski hike participants. The results of the analysis helped determine the participants' level of skiing technique and make recommendations once they were confronted with the assessment of the skiers' emotional state and heart rate recordings.

Emotional state assessment

The participants' emotional state before the ski hike and the changes in its indicators after the hike were also investigated. The assessment was carried out using FaceReader 3.0 (developed by Noldus Information technology, the Netherlands) and the Sport Emotion Questionnaire (SEQ). The basic feature of the FaceReader 3.0 program is providing a live analysis of facial expressions during an interview with the subject. The program includes six basics emotions (by P. Ekman) – happiness, surprise, anger, sadness, fear and disgust – as well as the state when a person's facial expression does not reveal any emotions, that is a neutral state. The skiers' emotional state was assessed three times: before the ski hike, 1 hour after the ski hike and on the next day, that is 16 hours after the ski hike.

Survey

Each time after the emotional state of the participants was assessed using FaceReader, the ski hikers were asked to fill in the Sport Emotion Questionnaire. The questionnaire included 22 emotions and the respondents had to rate to what extent they were experiencing the emotions listed by choosing one of the five degrees of emotions (e.g. “angry”) from the following scale: “not at all”, “a little”, “moderately”, “quite a bit”, “extremely”. After calculating the points for all the answers, the total number of points showed the level of anxiety, dejection, excitement, anger, and happiness experienced by the subjects.

Participants

Seven first year master level students (5 women and 2 men) from the Latvian Academy of Sport Education (LASE), aged 24-35 years, took part in the research. The level of the participants' skiing experience varied.

Data Analysis

The data from FaceReader 3.0, the heart rate recordings and the video analyses were analysed statistically. The data were assessed using Student's t-test for related groups. The correlations between the variables were tested by means of Pearson's correlation coefficient. Significant correlations were found and further recommendations were made.

Results and discussion

Changes in emotional state

The FaceReader 3.0 software includes P. Ekman's six basic emotions. During the assessment the program determines the intensity of the six basic emotions and records a neutral state when emotions are not identified. The intensity of emotions during the assessment is given in the form of numbers; the results show the percentage of assessment time when exact emotions were recorded.

The dynamics of the emotional state were determined based on the assessments which were carried out three times: before the ski hike, 1 hour after the ski hike and 16 hours after the ski hike on the next day.

Figure 1 shows the group's mean scores for particular emotions. The results show that before the ski hike 33% of the time when the assessment was done the participants' face revealed that they were in a neutral state and felt no positive or negative emotions. The percentage of time when positive emotions (happiness and surprise) were felt before the hike was 20% and 10%, respectively. Negative emotions (sadness, anger, fear and disgust) were felt 19% of the test time. In the second assessment the subjects were in a neutral state only 6% of the test time, which means that positive or negative emotions were detected for most of the assessment time. The level of positive emotions decreased after the ski hike to 10% for happiness of the test time and 8% for surprise. At the same time negative emotions were felt as much as 51% of the test time.

The third test, performed 16 hours after the hike, was conducted not only to investigate the changes in the emotions felt by the subjects, but also to confirm that positive emotions would be found for most of the test time on the next day after the ski hike. As can be seen from the table, the neutral state was recorded for 16% of the test time, so this percentage is almost twice as low as before the hike. Happiness was recorded for as much as 16% of the time, which is more than immediately after the hike. The results for negative emotions are lower and in two cases they are even lower than before the hike.

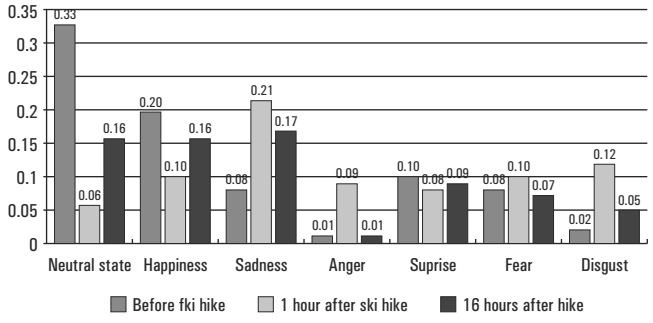

Figure 1. Results for particular emotions based on FaceReader (percentage of time when emotions were felt)

When analysing the results of the assessment of objective emotions carried out using FaceReader 3.0, it was found that that 1 hour after the hike the participants' facial expressions revealed more basic emotions than before the hike. At this time negative emotions dominated, but on the next day, 16 hours after the hike, the subjects mostly experienced positive emotions. The dominance of negative emotions 1 hour after the hike could have been caused by fatigue, so the emotions caused by the hike should be assessed the next day if this effect is to be ignored. The percentage of positive emotions felt increased with time.

After the subjects' emotional state was assessed using FaceReader 3.0, they were asked to fill in the Sport Emotion Questionnaire (SEQ), which was to probe their subjective assessment of their emotions. The results of the SEQ were different from the ones obtained using FaceReader 3.0. Although before the ski hike there were some signs of negative emotions, then one hour after the hike negative emotions were no longer being experienced and the level of positive emotions was almost as high as the maximum level (fig. 2).

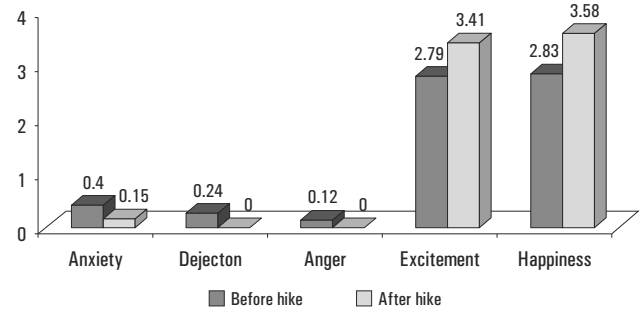

Figure 2. Results for subjective assessment of emotions using the Sport Emotion Questionnaire (mean scores)

To sum up the results of the assessment of the participants' emotional state, objective tests carried out using FaceReader showed an increase in the levels of six basic emotions 1 hour after the hike, however, these were mostly negative emotions. The reason why such results were obtained may be the participants' fatigue, which showed in their facial expressions. However, the assessment conducted 16 hours after the ski hike revealed an increase in positive emotions and decrease in negative ones. On the other hand, the subjective assessment of emotions showed a positive increase of emotions already 1 hour after the ski hike.

Changes in heart rate frequency

The changes in heart rate frequency were recorded during both parts of the hike, namely the first 3.5 hours and last 3.5 hours of the hike. As has been mentioned, there was a one-hour rest and lunch break between the two parts of the ski hike, during which heart rate frequency was not recorded. The mean heart rate frequencies were calculated and compared (fig. 3).

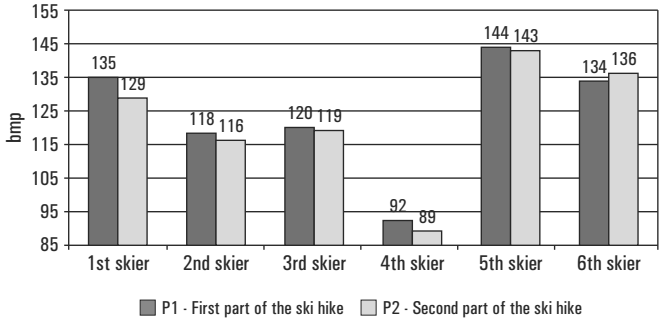

Figure 3. Mean heart rate frequency for all subjects

The mean heart rate frequencies were lower in the second part of the ski hike. The terrain of the ski hike was very similar in both parts of the ski hike, so the changes in heart rate are not likely to have been caused by terrain variations, but they could have been due to the 1 hour rest break and lunch. The ski hikers were able to rest and regain their energy, and this made their heart rate lower in the second part of the hike. Ski hikers and ski hike organisers should thus recognise the importance of rest breaks in prolonged ski hikes lasting up to 8 hours. If no breaks are taken, the skier can experience significant energy loss and a breakdown in their emotional state, and in this situation the recreation function of the hike will not be fulfilled.

Correlations between emotional state, heart rate frequency and skiing technique

After analysing the data related to emotional state, heart rate frequency and skiing technique, correlations between the data were sought. In several cases significant correlations were found. As they were observed for this group, they could potentially be found in other ski hikers. Nineteen significant correlations were found in the statistical analysis of the data, but only three of them were relevant and had practical implications for ski hikers and ski hike organisers.

Some of the correlations were interesting enough to be analysed more closely. There was a significant negative correlation between the subjects experiencing fear before the hike and their skiing technique. This means that the ski hikers with worse skiing technique felt more afraid before the hike than those with better skiing technique, with the length of the cycle for the diagonal stride serving as an indicator of skiing technique.

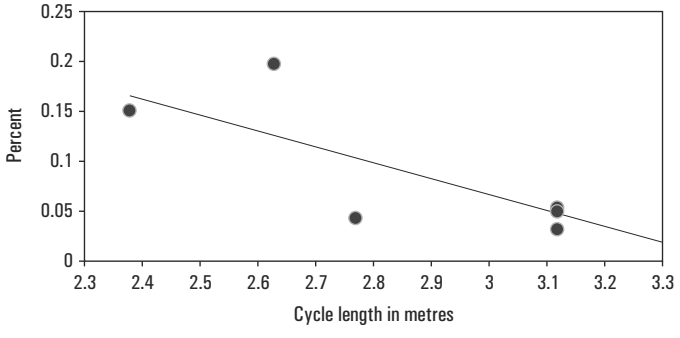

Figure 4. Mean cycle length for subjects experiencing fear before the hike ($r=-0.791$, $p<0.05$, $n=7$)

It also means that the skiers with better technique did not feel as afraid, or insecure, before the hike. It may even be the case that ski hikers with worse technique are in such a negative emotional state that they may decide not to participate the ski hike. However, having good skiing technique is very often not necessary in ski hiking and knowing only the basics of moving on skis is necessary. Another issue is choosing a suitable route and distance.

Another significant correlation with the level of skiing technique was found. There was a positive correlation between average cycle length and the feeling of sadness experienced on the next day after the hike. This means that the ski hikers with better skiing technique felt sadder the next day after the hike; it also means that the ski hikers with worse skiing technique did not feel as sad the following day. Going ski hiking thus resulted in the participants feeling positive emotions despite the fact that their ski technique needed to be improved.

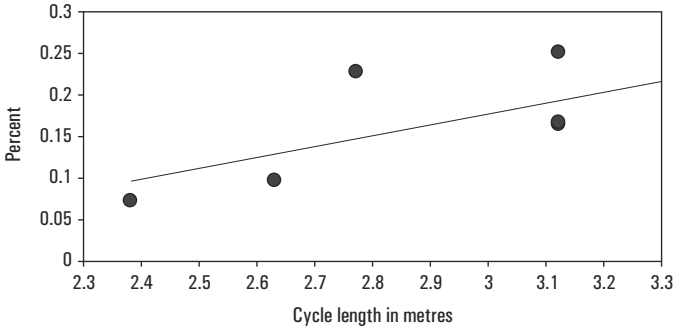

Figure 5. Mean cycle length for subjects experiencing sadness 16 hours after the hike ($r=0.804$, $p<0.05$, $n=7$)

Some important information was also found when comparing the data from the heart rate recordings and the emotion of anger felt after the ski hike. There was a significant negative correlation between the two. This means that the ski hike participants with lower average heart rates felt angrier 1 hour after the ski hike, and at the same time those with higher average heart rate showed fewer signs of anger. Based on these findings, it could be concluded that the ski hikers with lower heart rate frequency were skiing much more slowly than they were able to. These ski hike participants were probably forced to go more slowly or to adjust their pace to slower skiers, and the anger they felt after the ski hike had to do with their dissatisfaction with the hike.

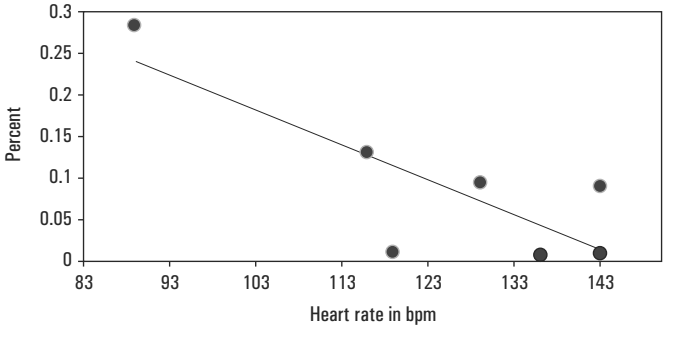

Figure 6. Mean heart rate for subjects experiencing anger 1 hour after the ski hike ($r=-0.849$, $p<0.05$, $n=7$)

The last correlation showed that it might be better if ski hikers go ski hiking as a group; however, the group should be composed of hikers with a similar level of skiing technique and in similar physical condition. In that way none of them will be forced to slow down or go faster, and they will be able to ski together as a group. If these conditions are met, ski hiking can fulfil its main function, which is increasing positive emotions.

Recommendations for ski hikers and ski hike organisers

Considering the correlations that were found between emotional state, heart rate frequency and skiing technique, some recommendations for ski hikers and ski hike organisers have been made, which can be particularly relevant for organising hikes for 6-12 people.

It may be the case that the positive influence a prolonged ski hike (lasting 6-8 hours) had on the emotional state of a hiker is experienced only on the day after the hike. A short time after the hike negative emotions can be expected to dominate, and to avoid this situation we would recommend that towards the end of the hike the hikers engage in activities which could have a positive effect on their emotional state. For example, 1 hour before the end of the hike they could play various games, including teambuilding ones.

In prolonged ski hikes it is very important to take a rest and lunch break lasting approximately 30-45 minutes to regain one's energy. Taking a break in the middle of the hike will help continue it with the same intensity. It is also important to take short breaks, lasting 3-5 minutes, every 20-30 minutes in order to have a drink or check the equipment. Thanks to taking such breaks the ski hikers will not get tired so fast, they will be able to enjoy the ski hike until the end, and their emotional state will not be negatively influenced by fatigue. It is worth emphasising that it is important to choose a route and distance suitable for the hikers, given their physical condition, to begin with.

Before the ski hike, organisers should give the participants with little skiing experience some encouragement. It is also of crucial importance that a suitable route and distance be chosen according the hikers' skiing experience. As the results of this study indicated, skiers with worse skiing technique felt more afraid before the hike, but they also felt even happier than those with more skiing experience.

When organising a ski hike for many participants (8-15 people), it is worth trying to make the group as homogenous as possible. If possible, the ski hikers should be split in two groups, one consisting of hikers with better skiing technique and physical condition, and the second group of hikers with less experience. The participants of this study who had better technique felt angrier after the ski hike than before it, which might have been due to the fact that the faster skiers were forced to go more slowly or even wait for the slowest ones. The fact that they felt such negative emotions meant that the activity had not fulfilled its recreational purpose.

Taking these recommendations into consideration can help make ski hiking a more effective recreation activity.

Conclusions

The following data were obtained in the assessment of emotional state, heart rate frequency and cycle length for the diagonal stride.

The percentage of time for which the neutral emotional state was recorded was 27% lower after 1 hour and 17% lower on the next day, 16 hours after the ski hike. The results showed that the intensity of particular emotions changed significantly. After the hike, the ski hikers' faces revealed more of the 6 basic emotions. One hour after the ski hike more negative emotions, such as sadness and disgust, were detected, but 16 hours after the hike the facial expressions of the hikers revealed fewer negative emotions and more positive ones. The subjective assessment of the hikers' emotional state (Sport Emotions Questionnaire, SEQ)

showed that the hike had had a positive influence on the emotions of its participants, as the scores for negative emotions were lower and the ones for positive emotions had increased.

The mean heart rate frequency and maximal heart rate were lower in the second part of the ski hike.

The cycle length for the diagonal stride was significantly lower in the second assessment during the ski hike.

When the data where compared, some significant correlations were found. There was a significant correlation between the ski hikers' level of fear before the ski hike and their results in cycle length testing ($r=-0.791$, $p<0.05$). This meant that the skiers with better technique felt less afraid and those with worse technique felt more afraid before the ski hike. There was also a correlation between worse technique and lower levels of sad emotions felt after the ski hike ($r=+0.804$, $p<0.05$). A significant correlation was also found when comparing average heart rate results with anger experienced after the ski hike ($r=-0.849$, $p<0.05$): ski hikers with lower average heart rate felt angrier after the ski hike.

Five important recommendations for ski hikers and ski hike organisers were made based on the research results. The recommendations concern the aspects that should be taken into account when organising ski hikes so that they can fulfil their recreational function, that is improve the emotional state of their participants.

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