

## ASSESSING RISKY BEHAVIOR BASED ON SURVEY RESEARCH AMONG MINE RESCUERS

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**Purpose:** The aim of the paper was to analyze risky behavior in the mining industry on the example of survey research among mine rescuers.

**Design/methodology/approach:** The analysis of risky behaviors concerned the mine rescue service crew in a selected hard coal mine. The author's method of synthetic assessment of risky behaviors was used for the research. The surveys was conducted during rescue training on a group of 30 mine rescuers, which accounted for 25% of the crew's record.

**Findings:** The article presents the results of a study of synthetic assessment of mine rescuers according to six problem areas (assessment parameters). The synthetic assessment of risky behavior is a method that allows individual assessment for each respondent in all areas. If one of the areas receives an abnormal rank, only one selected area can be re-evaluated after applying suggestions for improvement. Survey questionnaires consisting of closed-ended questions were used for each area. All respondents were given an option to give either affirmative or negative responses. Having obtained the sum of the assessment criterion ranks for each area, a synthetic assessment of risky behavior was interpreted for the surveyed mine rescuers. The summative assessment was then interpreted on a four-point scale: outstanding, satisfactory, normal, and abnormal. Out of the entire study group, only two subjects received an abnormal rating, each in one of the areas; the first respondent in the area of risky behavior, the second respondent in the area of risky behavior in situations of unbreathable air. For these two mine rescuers, detailed results for all areas were presented.

**Research limitations/implications:** The research was dedicated to working conditions underground, but they can be adapted to working conditions on the surface, as well as to the specificity of other rescue services (e.g. firefighters, rescuers).

**Practical implications:** The results of the research can be used as criteria for the selection of mine rescuers for the mine rescue service (rescue emergencies, rescue teams).

**Originality/value:** The publication contains original results of research on risky behavior of mine rescuers, and they are addressed to the management of mining plants.

**Keywords:** risky behavior, survey research, underground mining, mine rescue.

**Category of the paper:** research paper.

## 1. Introduction

Decisions about risky behavior are most often made at the time of danger (such as a fire, evacuation or accident), under time pressure (when a decision must be made immediately or quickly), under conditions of uncertainty or lack of complete information. Risky behavior is observed, for example, when self-rescuing or rescuing others, but such behavior is exhibited not only by those with a high propensity for risk.

In 2017, a monograph was published (Grodzicka), which presents a proposal for a synthetic assessment of the risky behavior of mine rescuers for six areas (assessment parameters). Another monograph (Grodzicka, Krause, Plewa) was published in 2021, proposing a methodology basis for analyzing risky behavior among mine rescuers. An example of the use of a synthetic assessment of the risky behavior of mine rescuers for the purpose of recruiting workers for the ventilation system has been shown in one publication (Grodzicka et al., 2022).

The provisions of the Geological and Mining Law (2011 as amended) and the Executive Order on Mine Rescue (2017 as amended) provide a legal basis for the organization of rescue drills in coal mines. In addition, in the regulation (2017 as amended) in § 60.6, the curricula of specialist courses include in particular issues related to e.g. natural and technical hazards (item 5), first aid to victims (item 7) and the psychology of behavior of mine rescuers and action leaders (item 8).

The leading entity professionally engaged in mine rescue in Poland is Centralna Stacja Ratownictwa Górniczego S.A (The Central Mine Rescue Station) in Bytom city, which conducts rescue operations in the mining industry; not only in mining plants. Due to its specialized staff and the necessary equipment at the plant, it can carry out operations according to the established rescue emergencies: mining and technical emergency, fire emergency, air inerting emergency, water emergency, measuring emergency, and emergency of mobile rescue lifts.

## 2. Outline of methodology for analyzing risky behavior

Based on the literature, studies of risky behavior mainly focus on occupational accident analysis, occupational risk assessment, management systems, and safety culture. In any workplace, occupational health and safety should be an important part of both company policy and management system. The current approach to consciously shaping human behavior in an organization is to raise the level of safety culture, which can be assessed by research and analysis on perceptions of safety issues and risks.

Risky behavior has been the subject or element of many publications, and the basic theoretical and methodological premises for analyzing risky behavior are discussed in the following compact publications (monographs and manuals), which deal with the following applications, among other issues (chronologically):

- general applications outside the mining industry, such as: Studenski (1996), Goszczyńska (1997), Studenski et al. (2004), Studenski (2004), Goszczyńska, Studenski et al. (2006), Odachowska et al. (2012), Farnicka, Izdebski, Wąż et al. (2014), Dubis et al. (2017), Kwiatkowska, Siudem et al. (2017),
- detailed applications inside the mining industry, such as: Grodzicka (2012), Szlajak, Grodzicka and Cichy-Szczepańska (2016), Grodzicka (2017), Krause, Grodzicka and Plewa (2021).

Basic assumptions regarding methodology analysis of risky behavior are as follows (Krause, Grodzicka, Plewa, 2021, p. 41):

- to raise problem questions that affect individuals and social groups,
- to adopt research assumptions, which include, for example, the object of study and period of analysis, and assessment of the level of safety,
- to select the type and scope of prospective or retrospective analysis as well as research methods according to the stage of behavior analysis.

The basic areas of analysis and corresponding problem questions for dealing with risky behavior are as follows (Krause, Grodzicka, Plewa, 2021, p. 41):

- person exposed (question: who is subject to the behavior?),
- effects of exposure (question: what is the effect of the behavior?),
- period of exposure (question: when does the behavior occur?),
- danger zone (question: where does the behavior occur?),
- causes of the threat (question: why does the behavior occur?),
- risk prevention (question: how to reduce the risk for the behavior?).

The basic research assumptions for analyzing risky behavior are as follows (Krause, Grodzicka, Plewa, 2021, p. 42):

- the object of study – most often it is an individual or a social group (population of exposed people), studied in terms of criteria such as gender, age, seniority, personality traits, temperament traits, attitudes towards risk, among other factors,
- period of analysis – most often it is the current state, such as the reporting year; it can be a longer or shorter period (if justified by regulations or needs),
- object of reference – most often it is a similar social group (similarity in terms of risk attitudes like risk aversion, risk indifference, risk propensity),
- reference period – most often it is a period of several years preceding an analysis; it can be longer or shorter (if justified by regulations or needs),

- collection of information – most often by means of document analysis, observation and survey methods (including interview and questionnaire techniques), other research methods can be used (as needed),
- hazard identification – most often using checklist methods, TOL (human-organization-technology) systematics and case studies; other research methods can be used (as needed),
- risk estimation – most often using psychological testing and the human reliability analysis (HRA) group of methods; other testing methods can be used (as needed).

Examples of research methods for analyzing risky behavior are as follows (Krause, Grodzicka, 2017, pp. 198-204):

- psychological tests – an indirect method of data collection, used to measure risk propensity and risky behavior; examples of tests include: test of attitudes towards risks, test of decision-making preferences, test of personal silhouettes, test of risky behavior, the multi-factor scale of risky behavior,
- survey – an indirect method of data collection, used to analyze risky attitudes and behaviors of employees; examples of survey methods and techniques include: questionnaire, interview, brainstorming, Delphi technique,
- observation – a direct method of data collection, used to analyze dangerous events and risky behavior; examples of research techniques include: direct and indirect, overt and covert, controlled and uncontrolled,
- case study – a method of detailed analysis of a single event or person, used to analyze dangerous events and risky behavior; sources of information include: document analysis, observation, survey,
- document analysis – an indirect or direct method of data collection, used to analyze dangerous events and risky behavior; examples of research techniques include qualitative, quantitative and formal analysis,
- checklists – a direct method of data collection, used to analyze the state of occupational health and safety, including the analysis of dangerous events and risky behavior, an example of inductive, qualitative and quantitative method; sources of information include observation, survey, document analysis,
- TOL systematics – a method of detailed classification of the causes of accident events, used for accident investigation and risk assessment (hazard identification), an example of a deductive, qualitative and quantitative method in terms of human error and risky behavior,
- HRA method – a method of detailed analysis of human reliability, used for risk assessment (risk estimation) and accident investigation, an example of inductive, qualitative and quantitative method in terms of human error and risky behavior; examples of research methods include: TESEO, THERP, HEART.

### 3. Material and methods

For the purpose of the article, the method of synthetic assessment of risky behavior was used according to the author's proposal published in one monograph (Grodzicka, 2017), where one should:

- conduct a survey of the prepared six questionnaires, with a total of 56 closed-ended questions,
- conduct an analysis of the results according to the procedure, taking into account the affirmative and negative answers,
- estimate the rank for each area,
- make interpretations according to the proposed evaluation criteria for the six preferred areas,
- make final conclusions.

The assessment of risky behaviors was verified on a group of mine rescuers, taking into account the following parameters – areas (Grodzicka, 2017, p. 163):

- knowledge acquired during rescue training,
- skills acquired during rescue drills,
- first aid skills,
- coping with occupational stress,
- risky behavior,
- risky behavior in situations of unbreathable air.

Basic assumptions for the survey – the survey was conducted during training for a group of 30 mine rescuers, which accounted for 25% of the register status and thus met the requirements of the survey sample. All respondents were informed how to complete the questionnaires. Once agreed, they proceeded to fill out 6 sheets according to the evaluation parameters for the following six areas.

Evaluation parameter *knowledge acquired during rescue training*. The survey was based on a survey questionnaire, prepared by the author, including 10 questions with Yes or No responses.

Criterion evaluation questions used (Grodzicka, 2017, pp. 124-130):

1. Do you happen to disobey health and safety regulations?
2. During your OSH training, did the instructor inform you of the occupational risks that occur in your job?
3. Did you notice your colleague's incompatible behavior with OHS regulations?
4. Do you use personal protective equipment?
5. Are you using the right equipment to perform the activities assigned to you?
6. Do you feel safe around your colleagues?
7. Do you happen to smoke cigarettes underground?

8. Do you pay attention to the expiration date of OSH equipment?
9. When you notice a significant violation of OSH regulations by your colleague, do you report it to your supervisor?
10. Do you happen to take shortcuts on your way back from work contrary to regulations?

Evaluation parameter *skills acquired during rescue drills*. The survey was based on a survey questionnaire, including 8 questions with Yes or No responses.

Criterion evaluation questions used (Grodzicka, 2017, pp. 134-138):

1. Do you think chamber training is frequent enough?
2. Do drills make you feel stress?
3. Do you feel more confident in action after drills?
4. Would you change anything in drills?
5. Do you feel that the training content presented by the trainer is clear and understandable to you?
6. Does it make it easier for you to understand the issues when the instructor combines theory and practice during the training sessions provided?
7. Do you yourself analyze the behavior of your colleagues who participated in the operations?
8. When performing a task, do you get disturbed knowing that the trainer, during chamber training, can make it difficult for you at any time through sound effects, temperature, etc.?

Evaluation parameter *first aid skills*. The survey was based on a survey questionnaire, including 10 questions with Yes or No responses.

Criterion evaluation questions used (Grodzicka, 2017, pp. 142-147):

1. Do you think you have a lot of knowledge in the field of premedical care?
2. Do you happen to provide first aid outside of work?
3. Do you analyze your behavior after the action?
4. Before making a decision to enter a danger zone, do you analyze it to see if it is correct?
5. Do you have a feeling of automatic performance during first aid?
6. Would you increase the number of training courses in pre-medical care?
7. When you hear from your colleagues "go get him", "he's injured", do you head toward the injured person without a second thought?
8. Knowing that you still have 100 m to the victim, conditions are getting worse and you have sagged, will you decide to return, saving your life?
9. Do you happen to think about your family when you take part in difficult operations?
10. Do you relieve your emotions on your loved ones after a rescue operation?

Evaluation parameter *coping with occupational stress*. The survey was based on a survey questionnaire, prepared by the author, including 9 questions with Yes or No responses.

Criterion evaluation questions used (Grodzicka, 2017, pp. 151-155):

1. Do you find working in mining stressful?
2. Do you find your job as a mine rescuer stressful?
3. Does your job affect your personal life?
4. Does the phone signal make you feel anxious?
5. Do you think about your family during the action?
6. Are you satisfied with your work?
7. Can you count on colleagues during a rescue operation?
8. Do you want to improve your skills?
9. Would you change your profession to a more secure one?

Evaluation parameter *risky behavior*. The survey was based on a survey questionnaire, prepared by the author, including 15 questions with Yes or No responses.

Criterion evaluation questions used (Grodzicka, 2017, pp. 55-62):

1. When you see a person who is unconscious, do you immediately begin administering premedical care?
2. Has frequent participation in training in first aid made you more confident in carrying it out?
3. Are you able to give first aid to even a very injured person without inhibition?
4. Do you fear for your life and health when administering first aid?
5. When taking part in a rescue operation, knowing that something could happen to you, do you think about your family?
6. Do you find any participation in rescue operations stressful?
7. Did you become a mine rescuer because you like risks?
8. Does risk give you an extra boost of excitement?
9. When participating in a rescue operation, do you feel safe knowing that your fellow rescue squad members are by your side?
10. Do you tend to analyze every time you make a decision to enter a danger zone to help other colleagues?
11. When you see an accident, will you make the decision to rescue the injured yourself?
12. Seeing the threat to the lives of others, will you wait for instructions from your superiors on what to do next?
13. Do you analyze the decisions you made after the rescue operation is over?
14. Do you need to de-stress after the operation is over?
15. Will you share your isolation apparatus with the person you are taking out of the danger zone?

Evaluation parameter *risky behavior in situations of unbreathable air*. The survey was based on a survey questionnaire, prepared by the author, with 5 parts of 5 questions each (25 in total), with Yes or No responses. The following are key questions for evaluating this

criterion – the need to ask key questions along with the description and situation sketch, which are included in Chapter 6 (Grodzicka, 2017, pp. 67-84):

1. For Part II – going to the passenger station you know that the passage of fire line I is longer, do you choose the passage of fire line II or III, knowing that there is a ban on the movement of the crew.
2. For Part III – knowing that there is an outflow of methane gas in the gallery and knowing that the dispatcher has ordered to wait for rescuers, you ask a colleague to reach the stranded miner together and lead him to clear air, using an escape apparatus.
3. For Part IV – after putting on the escape apparatus, you decide to retreat by a longer route, taking the electrician's escape apparatus with you to deliver it to him in case you meet him.
4. For Part V – you disobey the dispatcher's order and also remain in the alcove behind the wall, waiting with your colleague for rescuers, using the escape apparatus all the time.

Rank estimation based on (Grodzicka, 2017, pp. 165-170):

- Proposed criteria for evaluating the parameter "knowledge acquired during rescue training" – affirmative answers. Affirmative responses to survey questions 2-6, 8-9.  
Number of points obtained 7 Criterion rank 3 outstanding.  
Number of points obtained 5-6 Criterion rank 2 satisfactory.  
Number of points obtained 3-4 Criterion rank 1 normal.  
Number of points obtained 0-2 Criterion rank 0 abnormal.
- Proposed criteria for evaluating the parameter "knowledge acquired during rescue training" – negative answers. Negative responses to survey questions 1, 7, 10.  
Number of points obtained 3 Criterion rank 3 outstanding.  
Number of points obtained 2 Criterion rank 2 satisfactory.  
Number of points obtained 1 Criterion rank 1 normal.  
Number of points obtained 0 Criterion rank 0 abnormal.
- Proposed criteria for evaluating the parameter "skills acquired during rescue drills" – affirmative answers. Affirmative responses to survey questions 1, 3-7.  
Number of points obtained 6 Criterion rank 3 outstanding.  
Number of points obtained 5 Criterion rank 2 satisfactory.  
Number of points obtained 3-4 Criterion rank 1 normal.  
Number of points obtained 0-2 Criterion rank 0 abnormal.
- Proposed criteria for evaluating the parameter "skills acquired during rescue drills" – negative answers. Negative responses to survey questions 2, 8.  
Number of points obtained 2 Criterion rank 2 satisfactory.  
Number of points obtained 1 Criterion rank 1 normal.  
Number of points obtained 0 Criterion rank 0 abnormal.



- Proposed criteria for evaluating the parameter "first aid skills" – affirmative answers.  
Affirmative responses to survey questions 1-4, 6-8.  
Number of points obtained 7 Criterion rank 3 outstanding.  
Number of points obtained 5-6 Criterion rank 2 satisfactory.  
Number of points obtained 3-4 Criterion rank 1 normal.  
Number of points obtained 0-2 Criterion rank 0 abnormal.
- Proposed criteria for evaluating the parameter "first aid skills" – negative answers.  
Negative responses to survey questions 5, 9-10.  
Number of points obtained 3 Criterion rank 3 outstanding.  
Number of points obtained 2 Criterion rank 2 satisfactory.  
Number of points obtained 1 Criterion rank 1 normal.  
Number of points obtained 0 Criterion rank 0 abnormal.
- Proposed criteria for evaluating the parameter "coping with occupational stress" – affirmative answers. Affirmative responses to survey questions 6-8.  
Number of points obtained 3 Criterion rank 3 outstanding.  
Number of points obtained 2 Criterion rank 2 satisfactory.  
Number of points obtained 1 Criterion rank 1 normal.  
Number of points obtained 0 Criterion rank 0 abnormal.
- Proposed criteria for evaluating the parameter "coping with occupational stress" – negative answers. Negative responses to survey questions 1-5, 9.  
Number of points obtained 6 Criterion rank 3 outstanding.  
Number of points obtained 5 Criterion rank 2 satisfactory.  
Number of points obtained 3-4 Criterion rank 1 normal.  
Number of points obtained 0-2 Criterion rank 0 abnormal.
- Proposed criteria for evaluating the parameter "risky behavior" – affirmative answers.  
Affirmative responses to survey questions 1-3, 9-14.  
Number of points obtained 8-9 Criterion rank 3 outstanding.  
Number of points obtained 6-7 Criterion rank 2 satisfactory.  
Number of points obtained 4-5 Criterion rank 1 normal.  
Number of points obtained 0-3 Criterion rank 0 abnormal.
- Proposed criteria for evaluating the parameter "risky behavior" – negative answers.  
Negative responses to survey questions 4-8, 15.  
Number of points obtained 6 Criterion rank 3 outstanding.  
Number of points obtained 4-5 Criterion rank 2 satisfactory.  
Number of points obtained 3-4 Criterion rank 1 normal.  
Number of points obtained 0-2 Criterion rank 0 abnormal.

- Proposed criteria for evaluating the parameter "risky behavior in situations of unbreathable air" – negative answers. Negative responses to key survey questions.  
Number of points obtained 4 Criterion rank 3 outstanding  
Number of points obtained 3 Criterion rank 2 satisfactory  
Number of points obtained 2 Criterion rank 1 normal  
Number of points obtained 1 Criterion rank 0 abnormal

Interpretation according to the proposal of the evaluation criteria for the six preferred areas based on the summative assessment obtained from the criterion rank sum survey.

**Table 1.**

*Proposed summative evaluation (including affirmative and negative answers) for 5 parameters characterizing the behavior of mine rescuers: "knowledge acquired during rescue training", "skills acquired during rescue drills", "first aid skills", "coping with occupational stress", "risky behavior"*

Ordinal no.	Sum of evaluation criterion ranks for individual parameters	Interpretation of the summative assessment for individual parameters
1.	6	outstanding
2.	4-5	satisfactory
3.	2-3	normal
4.	0-1	abnormal

Source: Grodzicka, 2017, p. 170.

**Table 2.**

*Proposals for the final evaluation for the ranking of the evaluation of risky behavior of mine rescuers based on the average rank of the evaluation criterion for all 6 parameters determining the behaviors of mine rescuers*

Ordinal no.	The average rank of the evaluation criterion for all parameters	Interpretation of the final assessment for the risk behavior evaluation ranking
1.	Over 60%	normal
2.	Up to 60%	abnormal

Source: Grodzicka, 2017, p. 172.

A respondent with an abnormal rating (up to 60% of the desired responses) is subject to a reassessment of risky behavior to identify areas of higher risk and take improvement activities.

Conclusions were drawn and it was determined whether the surveyed respondents received an "incorrect" interpretation, i.e., the assessment should be repeated, as these people tend to engage in risky behavior.

If the respondent gets an abnormal rating, a detailed analysis of individual parameters (areas) should be carried out, areas of increased risk should be identified, and appropriate improvement measures should be taken, which consist of raising the level of safety culture, such as through awareness, talks, instruction, training, and practical exercises.

#### 4. An example of a survey research in the field of risky behavior

An analysis was made for each area after the survey. Each area involved the same 30 respondents, for which affirmative and negative responses, criterion rank and evaluation interpretation were correlated. Table 3 below shows the results of research on risky behavior.

**Table 3.**  
*Summary of survey results for the area of risky behavior*

No. of respondent	Responses		Criterion rank		Total	Interpretation of the assessment
	yes	no	yes	no		
1.	8	5	3	2	5	satisfactory
2.	6	3	2	1	3	normal
3.	7	4	2	1	3	outstanding
4.	8	6	3	3	6	normal
5.	5	4	1	1	2	normal
6.	4	4	1	1	2	normal
7.	4	5	1	2	3	normal
8.	7	4	2	1	3	normal
9.	6	4	2	1	3	normal
10.	8	4	3	1	4	satisfactory
11.	6	5	2	2	4	satisfactory
12.	7	3	2	1	3	normal
13.	9	6	3	3	6	outstanding
14.	4	4	1	1	2	normal
15.	3	4	0	1	1	abnormal
16.	5	3	1	1	2	normal
17.	7	5	2	2	4	satisfactory
18.	5	5	1	2	3	normal
19.	8	6	3	3	6	outstanding
20.	6	3	2	1	3	normal
21.	5	4	1	1	2	normal
22.	5	3	1	1	2	normal
23.	8	6	3	3	6	outstanding
24.	6	5	2	2	4	satisfactory
25.	6	4	2	1	3	normal
26.	4	5	1	2	3	normal
27.	7	5	2	2	4	satisfactory
28.	6	5	2	2	4	satisfactory
29.	4	4	1	1	2	normal
30.	6	5	2	2	4	satisfactory

Source: own work.

Table 4 includes a summary of survey results for all areas (parameters): knowledge acquired during rescue training, skills acquired during rescue drills, first aid skills, coping with occupational stress, risky behavior, risky behavior in situations of unbreathable air.

**Table 4.***Summary of test results for all areas (evaluation parameters)*

Ordinal no.	Evaluation parameter	Outstanding		Satisfactory		Normal		Abnormal	
1.	Knowledge acquired during rescue training	3	10%	12	40%	15	50%	0	0
2.	Skills acquired during rescue drills	0	0	8	27%	22	73%	0	0
3.	First aid skills	4	13.3%	10	33.3%	16	53.4%	0	0
4.	Coping with occupational stress	3	10%	13	43,4%	14	46.6%	0	0
5.	Risky behavior	4	13.3%	8	26.7%	17	56.7%	1	3.3%
6.	Risky behavior in situations of unbreathable air	1	3.3%	14	46.7%	14	46.7%	1	3.3%

Source: own work.

For the analyzed areas of "Risky Behavior" and "Risky Behavior in situations of unbreathable air", the following summary results were obtained: outstanding – 4 subjects and 1 subject, satisfactory – 8 subjects and 14 subjects, normal – 17 subjects and 14 subjects, abnormal – 1 subject and 1 subject.

Only two subjects received an abnormal rating in one of the areas, so a summary of the test results for all areas was made, as well as a summary of the assessment results for rescuers no. 15 (the "Risky Behavior" area) and no. 20 (the "Risky Behavior in situations of unbreathable air" area).

**Table 5.***Summary of evaluation results for rescuer no. 15*

Ordinal no.	Evaluation parameter	Affirmative answers		Negative answers		Summative evaluation		Interpretation of the assessment for the parameter
		N	%	N	%	yes	no	
1.	Knowledge acquired during rescue training	5	71.43	0	0	2	0	normal
2.	Skills acquired during rescue drills	3	50.00	1	50.00	1	1	normal
3.	First aid skills	4	57.14	2	66.66	1	3	normal
4.	Coping with occupational stress	1	33.33	3	50.00	1	1	normal
5.	Risky behavior	3	33.33	4	66.66	0	1	abnormal
6.	Risky behavior in situations of unbreathable air	0	0	3	75	0	0	satisfactory
The average rank of the evaluation criterion for all parameters						46.1%		
Interpretation of the final assessment for the risk behavior evaluation ranking						abnormal		

Note. N – number of responses, % – percentage of responses, yes – affirmative responses, no – negative responses.

Source: own work.

**Table 6.***Summary of evaluation results for rescuer no. 20*

Ordinal no.	Evaluation parameter	Affirmative answers		Negative answers		Summative evaluation		Interpretation of the assessment for the parameter
		N	%	N	%	yes	no	
1.	Knowledge acquired during rescue training	4	57.14	1	50.00	1	1	normal
2.	Skills acquired during rescue drills	3	50.00	1	50.00	1	1	normal
3.	First aid skills	6	85.71	2	66.66	2	2	satisfactory
4.	Coping with occupational stress	1	33.33	5	83.33	1	2	normal
5.	Risky behavior	6	66.66	3	50.00	2	1	normal
6.	Risky behavior in situations of unbreathable air	0	0	1	25.00	0	0	abnormal
The average rank of the evaluation criterion for all parameters					51.5%			
Interpretation of the final assessment for the risk behavior evaluation ranking					abnormal			

Note. N – number of responses, % – percentage of responses, yes – affirmative responses, no – negative responses.

Source: own work.

Summary of assessment results for six areas:

- For the area of "Knowledge acquired during rescue training," an outstanding rating was given to 10% of the respondents. This means that people have extensive professional knowledge, which they systematically increase and update during rescue training. 40.0% received a satisfactory rating – these respondents show an appropriate and reasonable approach to their job. 50.0% received a normal rating – these individuals are characterized by an ambitious and emotional approach to their job. There is no need for additional training in this area (no negative evaluation).
- For the area "Skills acquired during rescue drills," a 80% rating was given to 27.0% of the respondents, showing no increased confidence or doubt. 73.0% received a normal rating – these individuals are characterized by efficiency and effectiveness during rescue operations. There is no need for additional training in this area (no negative evaluation).
- For the area "First aid skills", 13.3% received an outstanding rating – the respondents have the skills to apply the knowledge acquired during the exercises to variable and difficult life-threatening conditions. 33.3% received a satisfactory rating – these people demonstrate a great deal of knowledge and skill combining theory and practice. 53.4% received a normal rating – these individuals are characterized by efficiency and effectiveness during rescue operations. There is no need for additional training in this area (no negative evaluation).
- For the area of "Coping with occupational stress," 10.0% received an outstanding rating – these respondents are characterized by their mastery of stress in variable and difficult rescue operations. 43.4% received a satisfactory rating – these people demonstrate a great deal of knowledge and skill combining theory and practice. 46.6% received a normal rating – these individuals are characterized by efficiency and effectiveness

during rescue operations. There is no need for additional training in this area (no negative evaluation).

- For the area of "Coping with occupational stress," 13.3% received an outstanding rating – these respondents are characterized by their mastery of stress in variable and difficult rescue operations. 26.7% received a satisfactory rating – these people demonstrate a great deal of knowledge and skill combining theory and practice. 56.7% received a normal rating – these individuals are characterized by efficiency and effectiveness during rescue operations. 3.3% received an abnormal rating, and additional training and reassessment of risky behavior was indicated.
- For the area of "Risky behavior in situations of unbreathable air," an outstanding rating was given to 3.3% of respondents who have extensive knowledge and regularly update their knowledge of risky behavior in non-breathable air situations. 46.7% received a satisfactory rating – these individuals take effective rescue and self-rescue actions. 46.7% received a normal rating – these individuals are characterized by efficiency and effectiveness during rescue operations. 3.3% received a normal rating – these individuals are characterized by efficiency and effectiveness during rescue operations.

## 5. Discussion of results

The issue of studying the level of safety culture in underground mining in terms of analyzing risky behavior was taken up, among others, by the following authors (chronologically):

- Grodzicka, Kulaga-Tetera and Musioł in their publication (2010), which discusses the results of a survey of miners employed in selected coal mine, used the standardized Test of Risky Behavior (TZR) by R. Studenski to assess miners' propensity to engage in risky behavior underground.
- Grodzicka in her publication (2011) presents the results of a study based on the survey method and interview technique among miners employed in a coal mine. She assessed the frequency of risky behavior among correspondent miners and their colleagues on the basis of the author's interview questionnaire.
- Martyka and Lebecki in their publication (2014) present the results of a survey of middle management and workers in manual positions at three coal mines. They pay particular attention to the conditions for improving safety culture and a program to modify risky behavior.
- Grodzicka in her publication (2015) presents the results of a study based on the survey method and questionnaire technique among mine rescuers employed in selected coal mine. She assessed the type and frequency of risky behavior among rescuers-miners on the basis of the author's survey questionnaire.

In this publication, based on the original proposal for a synthetic assessment of risky behaviors of mine rescuers (Grodzicka, 2017), an example of survey research in the field of risky behaviors has been developed.

Two areas received an abnormal rating for two subjects, so the article presents a summary of test results for all areas (Table 4) and for rescuers 15 and 20 (Tables 5-6).

Based on the sample analysis of risky behaviors of a mine rescuer, it can be concluded that: 2 areas ("risky behavior" for rescuer no. 15 and "risky behavior in situations of unbreathable air" for rescuer no. 20) urgently need to be corrected (abnormal evaluation). 3.3% received a normal rating – these individuals are characterized by efficiency and effectiveness during rescue operations.

Improvement activities are recommended (normal rating) for the 4 areas ("knowledge acquired during rescue training" for rescuers 15 and 20, "first aid skills" for rescuer 15, "coping with occupational stress" for rescuers 15 and 20, "risky behavior" for rescuer 20).

2 areas received a satisfactory rating ("skills acquired during rescue drills" for rescuer 20 and "risky behavior in situations of unbreathable air" for rescuer 15).

The results of the behavioral study will verify the areas that need improvement measures. The proposed method does not apply only to the individual, but also the results of the whole group can be presented. For management, an overall assessment of all employees presented collectively is by far the better solution, but the results of an individual employee and a selected area (parameter) can be presented at any time.

## 6. Final conclusions

The assessment of risky behavior was verified on a group of mine rescuers, taking into account the following parameters (areas):

- Knowledge acquired during rescue training – 10% of the outstanding rating, 40% of the satisfactory rating and 50% of the normal rating. No abnormal rating was received in this area.
- Skills acquired during rescue drills – 27% of the outstanding rating, 40% of the satisfactory rating and 73% of the normal rating. No abnormal rating was received in this area.
- First aid skills – 13.3% of the outstanding rating, 33.3% of the satisfactory rating and 53.4% of the normal rating. No abnormal rating was received in this area.
- Coping with professional stress – 10% of the outstanding rating, 43.4% of the satisfactory rating and 46.6% of the normal rating. No abnormal rating was received in this area.

- Risky behavior – 13.3% of the outstanding rating, 46.7% of the satisfactory rating, 46.7% of the normal rating, and 3.3% of the abnormal rating.
- Risky behavior is situation of unbreathable air – 3.3% of the outstanding rating, 46.7% of the satisfactory rating, 46.7% of the normal rating, and 3.3% of the abnormal rating.

Only two areas received an abnormal rating, i.e.: risky behavior and risky behavior in situations of unbreathable air. In both areas, an abnormal rating was obtained for only one rescuer, but not the same one.

A detailed summary for the two rescuers who received an abnormal rating in one of the two areas is shown below. The first rescuer received an abnormal rating in the "risky behavior" area and a satisfactory rating in the "risky behavior in situations of unbreathable air" area, and received a normal rating in the other areas. By contrast, the second rescuer received an abnormal rating in the area of "risky behaviors in situations of unbreathable air", a satisfactory rating in the area of "first aid skills," and received a normal rating in the other areas.

There was a preponderance of normal ratings for all areas and only the area of "skills acquired during rescue drills" received no outstanding rating.

In conclusion, it can be said that a synthetic assessment of risky behavior showed that the surveyed group is not risk-prone, and only for two subjects in two areas improvement measures can be applied, which involve raising the level of safety culture, such as through awareness-raising, talks, instruction, training, and practical exercises.

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