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AN ATTEMPT TO ASSESS THE EFFECTIVENESS OF A RESCUE AND STARTING JUMP AS PART OF ACTIVITIES CARRIED OUT IN DESIGNATED WATER AREAS DIRECTLY IN DEEP WATER

Marcin Kaca [1)], Piotr Siermontowski [2)]

[1)] University of Physical Education, Krakow, Poland
[2)] WSB Merito University Gdańsk, Faculty of Health, Poland

STRESZCZENIA / ABSTRACTS

Water rescue is constantly looking for solutions to improve the effectiveness of its operations. One of the elements of an action carried out directly in water is the rescue jump, whose effectiveness may determine the quality and success of the action taken. Therefore, a study was carried out to assess the effectiveness of a rescuer reaching a drowning person depending on the method of entry into the water. Comparisons were made between a traditional rescue jump (forward or stride entry) and a start jump used in sports. The observations also took into account factors related to the location of the operation (swimming pool, inland), the distance from the shore and the depth of immersion of the drowning person. The results show a significantly longer time for the rescuer to reach the drowning person after the rescue jump as compared to the start jump. Under standard swimming conditions, regardless of the distance and depth of immersion of the drowning person, all subjects reached the victim in the first attempt. Observations carried out in the conditions of designated inland water areas revealed comparable effectiveness in finding a simulated drowning person submerged to a depth of 2m and a significantly shorter time to reach them in favour of the start jump.
Keywords: water rescue, rescue jump, start jump, direct water rescue effectiveness.

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INTRODUCTION

The rules of conduct when assisting victims in an aquatic environment are constantly being systematised and described by numerous authors touching on the field of water rescue. In the literature it is possible to find descriptions of various techniques, ways and methods or tactics for carrying out rescue operations in water. This subject is addressed by well-known authors such as Przylipiak M., Witkowski M. [1], but also by authors more recent, e.g. Motylewski B. et al. and Błasiak P. et al. [2,3].

Over the past few years, researchers have been studying a wide range of options for implementing rescue measures thus developing new rescue standards. This has led to the selection of guidelines for water rescuers that take into account the various determinants directed towards a positive conclusion of the rescue operation. The authors conduct empirical observations of a wide range of variables that influence the effectiveness of a rescue operation, from the most frequently used, through the most effective and least burdensome, to the fastest [4,5,6,7,8]. With each successive publication, it is possible to resolve or come closer to resolving various disputes in the area of water lifeguard operations. This allows rescuers safeguarding water areas to carry out their duties in a more effective manner [9]. Therefore, the authors of the present study, while looking for unfavourable factors that may exist in rescue actions, raised an indisputable aspect that determines the carrying out of an effective and timely reaching of a drowning person. Maintaining visual contact while entering the water and reaching the drowning person was considered to constitute such a factor. Such an assumption imposes the water rescuer to use rescue jumping techniques and swimming with the head raised above the water surface.

Undeniably, this fact worsens the kinematic parameters of swimming and, consequently, increases the physical burden on the rescuer and the time it takes to evacuate the injured person from the water [8,10,11]. It has therefore become necessary to verify the assumption regarding the necessity for the rescuer to maintain constant visual contact when entering the water and reaching the drowning person. The results presented in this paper are therefore part of the current of research projects that will contribute in the future to the creation of the most effective ways to manage different rescue scenarios [12].

PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

The rapid reaching of the drowning person combined with their effective finding are the key elements initiating the operation carried out by the rescuer directly in the water, as they affect the success of the rescue efforts undertaken. Therefore, taking this correlation into account, the authors have attempted to evaluate the effectiveness of a rescue jump while maintaining visual contact with a drowning person in relation to a start jump associated with momentary submerging of the head under water as the main objective of the study.

The following research questions were posed to achieve this objective:

- Do the compared jumps into the water allow for an effective rescue operation?
- Are there significant differences perceived in the effectiveness of the water rescuer to reach the drowning person depending on the applied rescue jump, distance and depth of immersion of the simulated drowning person (SDP)?
- Are there significant differences in the time taken to reach a drowning person depending on the rescue jump used, the distance and the depth of immersion of the SDP?

RESEARCH METHOD AND MATERIAL

The main method in the present study was direct overt participant observation [13,14]. All trials subjected to observation consisted of subjects performing a sequence of rescue actions in the following order:

- entering the water (jump),
- swimming towards the simulated drowning person (SDP),
- diving with the SDP submerged below the water surface.

The study assessed both the efficiency of reaching the SDP, as determined by the lifeguard's raising it above the water surface, and the time taken to complete the entire test. Observations were carried out using a variable distance to be covered by the lifeguard (8m and 15m) and different depths of immersion of the SDP (0m and 2m). In addition, the study was conducted in varying types of designated water areas (swimming pool, inland) and using the immersion movement of the SDP from the water surface below the water surface. Thus, an attempt was made to determine the significance of the type of water entry method used by the water rescuer on the effectiveness and duration of the operation. A comparison was made between the rescue jump – SR (either forward or straddle, depending on the subjects' preference) and the standard start jump – SS. Therefore, the standard, common in water rescue, related to the necessity of constant observation of the drowning person during the action in the water, was also indirectly verified. The research project was carried out in two stages, starting with tests carried out in a standard swimming pool, and concluding with measurements taken in an inland body of water.

The location for the first part of the study was the Indoor Swimming Pool Complex (ZKP) of the Academy of Physical Education in Krakow (AWF), and it was conducted between December 2020 and April 2021. The study group consisted of AWF students who were certified as water lifeguards, and those who had completed the 50m distance swimming rescue crawl under 55s and could correctly perform the rescue and start jumps (assessed by credits from the study programme). The study sample group for the 15m distance achieved a sample size of 56, including 23 females and 33 males, and for the 8m distance 53, including 23 females and 30 males.

The second part of the study was conducted on inland waters between June and September 2021. In addition to AWF students, the study was attended by participants in the central training of the Water Volunteer

Rescue Service (WOPR) for the ranks of Senior Water Rescuer and WOPR Instructor. The location of the measurements in the first case was the AWF Water Sports Centre in Załęże on the Rożnowskie Lake, while in the second case it was the Tama Lifeguard Training Centre on the Rajgrodzkie Lake. The size of the sample group for the 15m distance was 62 people, including 14 women and 48 men, while for the 8m distance, 55 people, including 8 women and 47 men.

As a result of the lack of effective repetition of all the trials carried out in the inland area, the 15m distance was qualified for statistical analyses to compare the duration of the observed rescues with the sample comprising 42 persons including 12 females and 30 males, while on the 8m distance the sample size was 40 persons including 7 females and 33 males.

All tests were performed at intervals allowing the subjects to undertake the effort while fully rested. The warm-up was deliberately omitted to bring the measurement conditions closer to the real circumstances of a water rescuer. The subjects performed the tests without swimming goggles. The height of the wall to the water surface from which the observed lifeguard actions in the swimming pool started was 40cm. The distance from the wall to the water surface during the inland tests was 70cm.

DESCRIPTION OF THE TRIALS

In a study of the effect of jump applied (SS/SR) on the effectiveness and arrival time of the water rescuer to the SDP under standard swimming conditions, two trial variants were observed at each of the 8m and 15m distances (Fig. 1.):

1. with reaching the SDP remaining on water surface (8/0m and 15/0m);
2. with reaching the SDP immersed to the depth of 2m (8/2m and 15/2m);

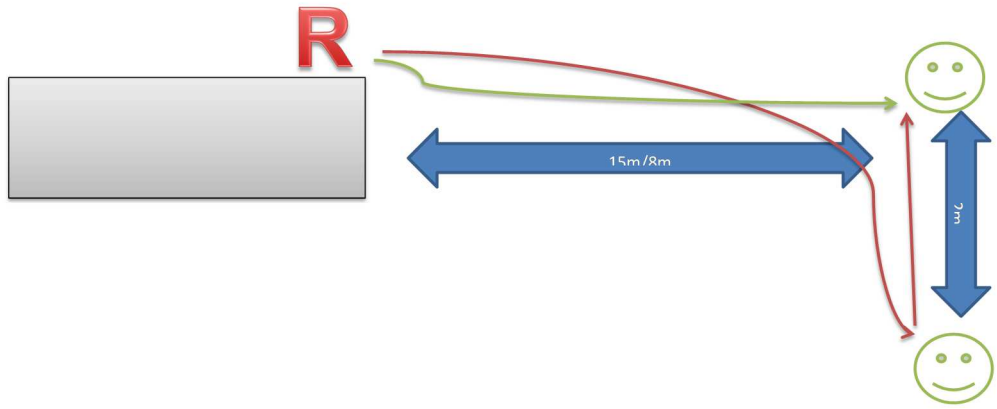

Fig. 1 Schematic of test trials carried out in a standard indoor swimming pool.

Tests carried out under inland water conditions involved measuring the arrival time to the SDP submerging from the water surface to a depth of 2m at the commencement of rescue operations. The floating SDP was attached to a system of pulleys and a rope with which the SDP was pulled below the water surface at the initiation of the action (Fig. 2). Measurements were taken at distances of 8m and 15m (8/2m and 15/2m) and using both of the jump types compared (SS, SR). The simulated drowning person – SDP was a 5l cylinder-shaped buoy wearing goggles, water cap and a yellow t-shirt.

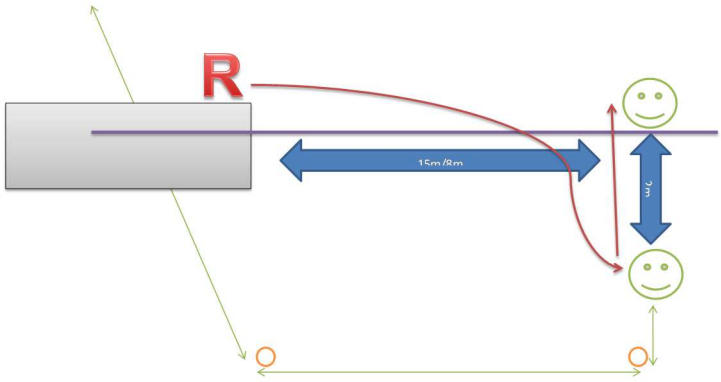

Fig. 2 Schematic of inland water trials.

Rys. 2 Schemat prób badawczych realizowanych na wodach śródlądowych.

In the measurement variants in which the simulated drowning person was submerged (swimming pool) or dived (inland) below the surface of the water, the test subjects were allowed three attempts to dive and search underwater (1,2,3) after which the action was stopped by recording a performance score of 0 (Table 2).

STATISTICAL ANALYSIS METHODS

The data collected from the surveys were uploaded, categorised and processed in Microsoft Excel® spreadsheet software. Results were calculated as arithmetic means and standard deviation. In order to determine the level of effectiveness of the rescuers in reaching the simulated drowning person, the samples with the corresponding dive numbers (0,1,2,3,1+2+3) were converted into percentage points in relation to the size of the study group (100%). In order to determine the magnitude of the differences in the results regarding the time to perform an effective action depending on the type of jump used, normal distributions of the results obtained were established (Shapiro-Wilk test), followed by a t-test for dependent samples. A statistical significance level of $p<0.05$ was assumed. Calculations were performed using the STATISTICA 13.3 programme.

ANALYSIS OF RESULTS

When tested under standard indoor swimming pool conditions, all rescuers (100%) reached the simulated drowning person on the first attempt. The average time taken by the subjects to cover a distance of 15m was found to be shorter in favour of the rescue action carried out using the start jump – SS in relation to the rescue jump – SR. The phenomena described and the differences in the results obtained concerned both the measurements in which the SDP was floating on the surface of the water (15/0m) and those in which it was immersed to a depth of 2m (15/2m), as well as analyses involving the entire study group (K+M) and also taking into account the gender factor of women (K) and men (M) separately (Fig. 3).

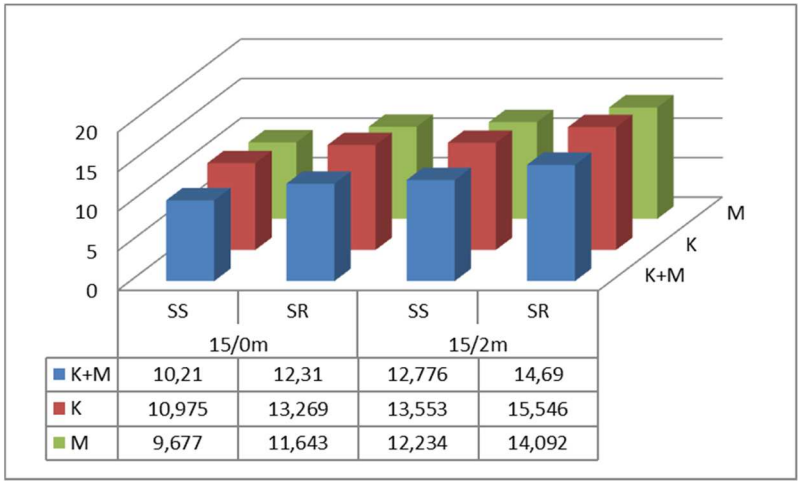

Fig. 3 Average times to cover a distance of 15m to a simulated drowning person (swimming pool).

The measurements carried out under the conditions of the swimming pool over a shorter distance (8m) provided different time values, but with an identical pattern of results in relation to each other. All lifeguards (100%) reached the simulated drowning person in the first attempt and, irrespective of the depth of the simulated drowning person (8/0m, 8/2m) performed this faster using the start jump – SS (Fig. 4).

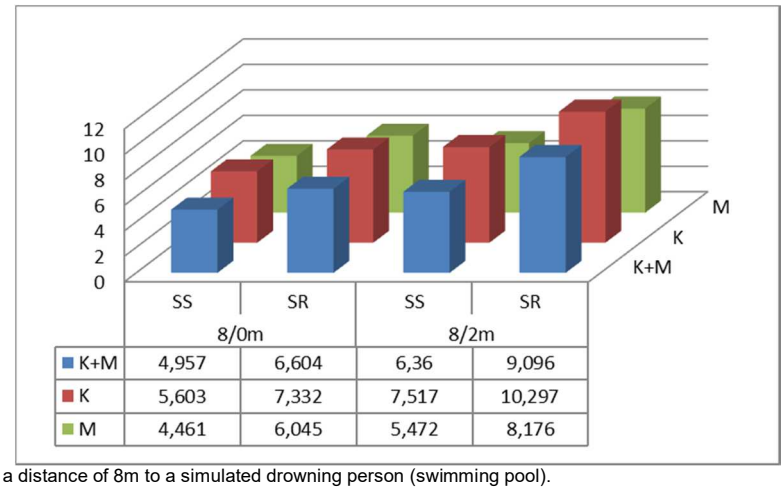

Fig. 4 Average times to cover a distance of 8m to a simulated drowning person (swimming pool).

Calculated differences in the mean times for rescuers to reach a simulated drowning person under the conditions of the swimming pool (Table 1) ranged from 1.584 for the men's group over a distance of 8m and a submersion depth of 0m (M, 8/0m) to 2.736 for the men's and women's groups together over the same distance to the SDP (8m) and a submersion depth of 2m (K+M, 8/2m). Comparisons of performance according to the type of water entry used in all cases proved statistically significant (t-test) in favour of the start jumps performed (Table 1).

Tab. 1

The t-test for dependent trials performed under swimming pool conditions (* p<0,05).

Trial Variant	Jump	Gender								
		F+M			F			M		
		mean	SD	difference	mean	SD	difference	mean	SD	difference
15/0m	**SS**	10.21	1.933	-2.1*	10.975	2.243	-2.294*	9.677	1.502	-1.965*
	SR	12.31	2.181		13.269	2.175		11.643	1.95	
15/2m	**SS**	12.776	2.771	-1.914*	13.553	3.369	-1.993*	12.234	2.157	-1.858*
	SR	14.69	3.038		15.546	3.347		14.092	2.694	
8/0m	**SS**	4.957	1.495	-1.647*	5.603	1.557	-1.728*	4.461	1.259	-1.584*
	SR	6.604	1.427		7.332	1.336		6.045	1.247	
8/2m	**SS**	6.360	2.457	-2.736*	7.517	2.755	-2.780*	5.472	1.786	-2.703*
	SR	9.096	2.351		10.297	2.498		8.176	1.777	

The tests conducted under inland water conditions provided important information on the efficiency of finding a drowning person being submerged below the water surface to a depth of 2m at the time of making a jump into the water initiating the rescue action (Table 2). The average for the entire study group (F+M), the effectiveness in finding the SDP underwater and bringing it above the water surface reached in percentage points values ranging from 72.58% in 15/2m actions after performing rescue jumps (SR) to 89.09% in 8/2m actions also following SR. In the 15m distance, a higher efficiency was perceived after SS (75.81%) in relation to SR (72.58%), while in the 8/2m rescue actions the efficiency after SS was found to be lower with 87.27% in relation to SR (89.09%). The differences marked, however, are very small (1.82% - 3.23%) and they alternate thus being inconclusive in expressing the advantage of the water jumps used. The subjects, regardless of the type of jump and distance, if they managed to find the SDP they most often accomplished this in the first dive attempt. A significantly higher percentage of subjects failed to find the SDP (dive no. 0 Tab. 2) in the 15m trial in relation to the shorter 8m trial. In the women's group, a significantly higher efficiency of rescue operations after the use of the jump start can be observed at both distances, reaching 100% in the 8m trial. The male group, on the other hand, showed a slight advantage in reaching the SDP in favour of SR.

Tab. 2

Skuteczność odnajdowania zanurzonej na głębokość 2m pozorowanej osoby tonącej wg kolejności nurkowania poszukiwawczego (N i %)

Trial		F+M						F						M					
		JN	Dive no.					JN	Dive no.					JN	Dive no.				
			0	1	2	3	1+2+3		0	1	2	3	1+2+3		0	1	2	3	1+2+3
15/2m	**SS**	**N(62)**	15	41	4	2	47	**N(14)**	3	9	1	1	11	**N(48)**	12	32	3	1	36
		%	24.18	66.13	6.46	3.23	75.81	**%**	21.43	64.29	7.14	7.14	78.57	**%**	25	66.67	6.25	2.08	75
	SR	**N(62)**	17	34	10	1	45	**N(14)**	7	6	1	0	7	**N(48)**	10	28	9	1	38
		%	27.42	54.84	16.13	1.62	72.58	**%**	50	42.86	7.14	0	50	**%**	20.83	58.33	18.75	2.08	79.17
8/2m	**SS**	**N(55)**	7	40	5	3	48	**N(8)**	0	7	1	0	8	**N(47)**	7	33	4	3	40
		%	12.73	72.73	9.09	5.45	87.27	**%**	0	87.5	12.5	0	100	**%**	14.89	70.21	8.51	6.38	85.11
	SR	**N(55)**	6	47	2	0	49	**N(8)**	1	7	0	0	7	**N(47)**	5	40	2	0	42
		%	10.91	85.45	3.64	0	89.09	**%**	12.5	87.5	0	0	87.5	**%**	10.63	85.11	4.26	0	89.36

(JN - unit of count)

The mean times for rescuers to successfully reach the SDP in each of the trials performed in midwater regardless of gender, distance or dive number were shorter after the use of the start jump (Figure 5, Table 3). The results of the midwater times in the 8/2m trials ranged from 7.963 in the M group after using SS to 15.044 in the K group after using SR. In the same water conditions but over a longer distance (15/2m), the mean times to reach the SDP were higher but the extreme values were reached by the same groups and in the same trials from 16.018 in group M after SS to 25.443 in group K after SR.

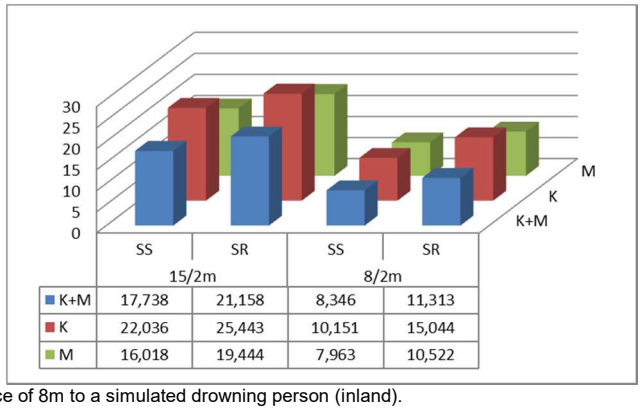

Fig. 5 Average times to cover a distance of 8m to a simulated drowning person (inland).

The compared times for performing a successful rescue in inland conditions depending on the type of water jump used showed varying magnitudes of differences ranging from 2.558 to 4.893 (Table 3). Statistical analysis using the t-test in all trial and group combinations carried out showed statistical significance at the $p<0.05$ level in the calculated differences in rescue execution times in favour of the use of SS.

Tab. 3

T-test for dependent trials performed in inland conditions (* $p<0.05$).

Trial variant	Jump	Gender								
		F+M			F			M		
		mean	SD	Difference	mean	SD	difference	mean	SD	difference
15/2m	**SS**	17.738	6.625	-3.420*	22.036	8.489	-3.407*	16.018	4.900	-3.426*
	SR	21.158	8.841		25.443	9.542		19.444	8.082	
8/2m	**SS**	8.346	4.466	-2.967*	10.151	7.368	-4.893*	7.963	3.641	-2.558*
	SR	11.313	5.258		15.044	8.939		10.522	3.876	

DISCUSSION AND CONCLUSIONS

The analysis of the results carried out made it possible to formulate answers to the research questions posed:

1. The types of jumps into the water (SS and SR) compared, regardless of the distance to be covered by the rescuer and the depth of immersion of the simulated drowning person (SDP), allow 100% effective operation under the conditions of a standard indoor swimming pool. All observed attempts were performed effectively in the first attempt at the swim and dive. The success rate achieved by the subjects in finding the SDP submerged below the surface of the inland water varied from 50% in the action carried out over a distance of 15m after rescue jump (SR) in the female group (K) to 89.36% over a distance of 8m also after SR in the male group (M).
2. Differences in the effectiveness of water rescuers in reaching the SDP depending on the type of jump used were noted. The observed differences do not show an explicit advantage in favour of any of the compared jumps, because depending on the applied combination of research groups (K+M, K, M) and the distance to be covered by the rescuer, they were interchangeably characterised by higher efficiency. Expressed in percentage points, the difference ranged from 1.32% to 4.25%, which, assuming a significance level of $p<0.05$, is within the range of statistical error. The exception were the comparisons for the women's group, where the magnitudes of the differences in effective reaching of the SDP, expressed in percentage points, clearly showed a higher effectiveness of SS over SR, reaching values of 12.5% in the rescue operation over a distance of 8m and 28.57% over a distance of 15m.
3. Irrespective of the gender of the rescuer, the distance and the depth of the simulated drowning person (SDP) immersion, all test

subjects reached the 'victim' significantly faster after the start jump.

The results obtained in this research reveal the necessity for further observations with improvements in methodology, as well as taking into account varying water, weather, distance and depth conditions or overlooked aspects of the rescue gear used by the rescuers. The effectiveness of rescuers reaching a drowning person in the swimming pool at 100% regardless of the type of jump used, the distance and depth of the SDP immersion and the significantly shorter time to complete this task after the start jump suggest the need to develop new standards for carrying out rescue operations especially in deep water areas allowing for the safe execution of SS. Consequently, consideration should also be given to the possibility of modifying the training programme for water rescuers by introducing the possibility of carrying out rescue operations without the need to maintain constant visual contact with the drowning person. The observed time differences in the actions starting an evacuation from inland water in favour of using a start jump in the current outline of the obtained results necessitate further empirical verification. Nonetheless, the results obtained illustrate the level of consistency of the rescue operation with constant observation of the drowning person in the form of a significant increase in the time it takes for the rescuer to reach the drowning person. The specificity of the swimming techniques and methods used in water rescue poses a considerable problem affecting the physical potential of the rescuer conducting operations in water [10,11,12]. Increased resistance together with the optimally maximum swimming speed of the water rescuer during direct action in water definitely increase the stimuli straining him/her physically [15]. In the perspective of the unpredictable duration and course of the action, rescuers who have taken action in the water should take into account the conclusions, which the authors of this study were able to construct.

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dr hab. med. Piotr Siermontowski, prof. AMW
Uniwersytet WSB Merito
Wydział Zdrowia
Aleja Grunwaldzka 238A
80-266 Gdańsk
nurdok@esculap.pl