

Research article

## Comparison of temporal parameters of swimming rescue elements when performed using dolphin and flutter kick with fins - didactical approach

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### Abstract

The aim of this study was an analysis of the time required to swim to a victim and tow them back to shore, while performing the flutter-kick and the dolphin-kick using fins. It has been hypothesized that using fins while using the dolphin-kick when swimming leads to reduced rescue time. Sixteen lifeguards took part in the study. The main tasks performed by them, were to approach and tow (double armpit) a dummy a distance of 50m while applying either the flutter-kick, or the dolphin-kick with fins. The analysis of the temporal parameters of both techniques of kicking demonstrates that, during the approach to the victim, neither the dolphin ( $t_{\text{mean}} = 32.9\text{s}$ ) or the flutter kick ( $t_{\text{mean}} = 33.0\text{s}$ ) were significantly faster than the other. However, when used for towing a victim the flutter kick ( $t_{\text{mean}} = 47.1\text{s}$ ) was significantly faster when compared to the dolphin-kick ( $t_{\text{mean}} = 52.8\text{s}$ ). An assessment of the level of technical skills in competitive swimming, and in approaching and towing the victim, were also conducted. Towing time was significantly correlated with the parameter that linked the temporal and technical dimensions of towing and swimming (difference between flutter kick towing time and dolphin-kick towing time, 100m medley time and the four swimming strokes evaluation). No similar interdependency has been discovered in flutter kick towing time. These findings suggest that the dolphin-kick is a more difficult skill to perform when towing the victim than the flutter-kick. Since the hypothesis stated was not confirmed, postulates were formulated on how to improve dolphin-kick technique with fins, in order to reduce swimming rescue time.

**Key words:** Swimming, lifesaving, dolphin kick, fins, rescue tow.

### Introduction

The level of execution of rescue procedures, leading to life saving, determines the success of swimming rescues and depends on lifeguards' competencies (YMCA Lifeguard Manual: 2002). In this study the term "lifeguards' competencies" is understood to be the specific rescue skills performed in subsequent phases of swimming rescues: water entry, rescue swimming, diving, underwater swimming, holding the victim, towing and water exit. Previous studies have shown that approaching the victim, represents 20% of the total time of a swimming rescue, and 60% when towing is involved (Parnicki, et al., 1999a). This means that a lifeguard swims for the main part of the typical, non-equipment, swimming rescue. The effectiveness in swimming rescues can be considered

through the interdependence between, the level of individual swimming technique, and the time (velocity) of the performance (i.a. Burkett, 2010). A foundation for the development of rescue skills is a high level of swimming technique, developed by both in-water training, and on-land exercises (Wiesner, 2000; 2007).

The arguments cited below confirm the deeply rooted opinion that skilful use of fins leads to an increase in swimming velocity. Zamparo et al. (2002) researched that economy, total mechanical work, propulsion and mechanical efficiency during leg kick swimming, with the fins are higher compared with barefoot kicking. That means that the employment of the large surface area of the fin, its construction, material, shape and stiffness creates also optimal conditions for faster swimming also during water rescue. Colman, et al. (1997) concluded that dolphin-kick swimming speed with fins, or with a monofin, may increase swimming speed by 50% compared to no fin swimming. It has also been established that fins are used as a tool for "speed training" in competitive swimming (Soloviev, 1993) and in lifesaving (Colman et al., 1997; YMCA Lifeguard Manual: 2002). The use of fins enables faster swimming than barefoot swimming, and can result in an increase in swimming velocity in both rescue situations; approaching and towing the victim to shore (Abrales, 2006). Studies by the same author, suggest that the use of fins helps lifeguards delay the effects of fatigue observed in barefoot kicking (Abrales et al., 2007). Additionally, fin utility as a lifeguard's personal equipments are evidenced by their inclusion in the basic rescue package (YMCA Lifeguard Manual: 2002). The functional aspect of using fins in lifesaving rescue can also be confirmed by the fact that some of the events held in official lifeguard competitions are performed with fins (100m Manikin Tow with Fins, 100m Manikin Carry with Fins) (ILSF Competition Manual, 2011). Moreover, Silakiewicz et al. (2006) have shown that swimming rescues performed with the fins take about 17% less time in comparison with the time of bare foot rescues. The results of these studies highlight the potential for employing fins in order to decrease the time of swimming rescues.

However, from the perspective of the swimming rescue, it should be highlighted that use of fins is limited for several reasons. First, the time required to put the fins on and move to the water before beginning the approach, extends the duration of the first part of the swimming rescue, when compared to performing the same part of the

rescue without fins (Silakiewicz, et al., 2006). However, the time of towing is much faster with the fins, and finally the total time of the swimming rescue is shorter when using fins. Other limitations are linked with situations where the specifics of the swimming rescues require the modification of lifeguard behavior (e.g. using fins is unfounded where there are large waves, making it more conducive to breaststroke swimming when approaching the victim). Awareness of the abovementioned limitations should be kept in mind when preparing rescue procedures, including decisions concerning the rational use of fins. Scientific study of the crawl-kick and the dolphin-kick are focused on improving results in competitive swimming. Several studies have been published that focus on the use of the dolphin kick to improve the effectiveness of swimming starts and turns (Arellano, et al., 1999; Lyttle, et al., 1999; 2004; Sheeran, 1980). Research has also analyzed the use of the dolphin-kick when using a monofin (Rejman, 1999; 2006; Rejman et al., 2003, Rejman and Ochmann, 2007). The mechanisms of propulsion generation by the flutter kick and dolphin kick, while using fins, were also explained by Colman, et al. in 1997 and 1999. Measuring the propelling efficiency, Zamparo et al. (2006) have shown that swimming with a monofin (performed with dolphin-kick) is more efficient than swimming with the flutter-kick using single fins for each foot, of comparable surface area, allowing for a better economy, and thus a higher swimming speed. The results of research of swimming performance that investigate the advantage of using the dolphin-kick over the flutter-kick, for increasing swimming speeds, have not been transferred to studies focused on the shortening the time of rescue actions (approach and tow a victim to the shore). Also, the observation of competitive lifesaving (100m Manikin Carry with Fins), where the first part of the distance (underwater approach) is covered with the use of the dolphin kick, and the second part (the dummy carry) is performed using the crawl stroke, have not been used for seeking the effectiveness of swimming rescues in the simultaneous (dolphin) movements of the legs.

The aim of this study was to compare the techniques of approaching a victim followed by subsequent towing back to shore, while performing the flutter kick or the dolphin-kick with fins and to identify the fastest one. It was hypothesized that dolphin kick swimming, with the

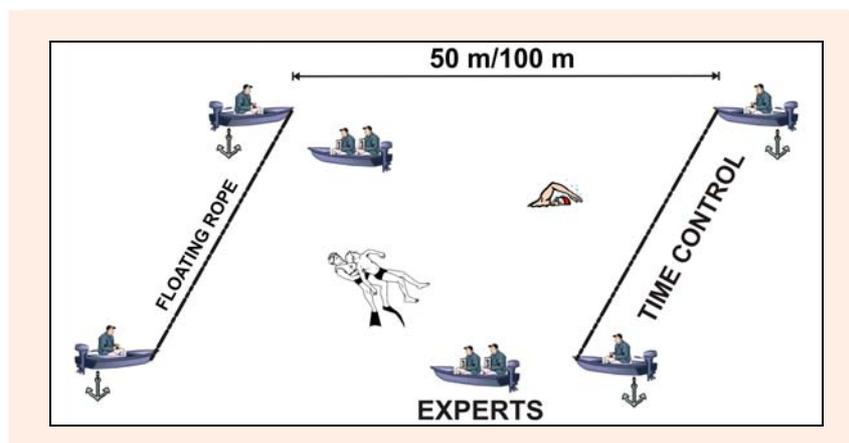
use of fins, leads to a reduction in the time of approaching the victim and towing them back to shore. The following research questions were answered in this study: 1) is the time of approach the victim using dolphin-kick with the fins, significantly shorter, in comparison to the time of swim to the victim using flutter-kick? And analogically - is the time of towing the victim using dolphin-kick with the fins, significantly shorter, in comparison to the time of towing them using flutter-kick? 2) Do the differences in the time of approach to the victim and towing time, resulting from the generation of propulsion by flutter-kick and dolphin-kick, correspond to the level of technical skill of lifeguards in the areas of competitive and rescue swimming?

## Methods

Eighteen male lifeguards took part in the research. Pearson correlation coefficients were used to compare the relationships between the subject's ages and somatic parameters. None of these relationships were significant. All the lifeguards completed the required qualifying criteria for the Junior Lifeguard Instructor Course conducted by the International Life Saving Federation (ILSF International Certificate, 2011) The widespread and identical ILSF's procedures for certification of the lifeguards' competencies (skills and knowledge), on each level of proficiency rationalizing an assumption that the lifeguards researched in this study presented a similar level of lifesaving proficiency.

All lifeguards submitted a declaration for voluntary participation in the research. All procedures followed the Helsinki Declaration of Human Rights were related to research.

The procedures for data collection required the lifeguards to complete two sets of tasks (Figure 1). The first of them was focused on the assessment of the temporal parameters of approaching and towing technique and swimming technique. The lifeguards swam: a 100m individual medley, a 50m front crawl to the victim using flutter-kick with fins, a 50m front crawl to the victim using dolphin-kick with fins, a 50m double armpit tow of a dummy using flutter-kick with fins and a 50m double armpit tow of a dummy using dolphin-kick with fins. The distances of each trial were estimated between two



**Figure 1.** Explanation of the experimental setup.

lane-lines which were fastened to anchored boats. A stopwatch was used to record the time taken to swim the required distances. The interdependency between swimming speed and the level of technical skills in swimming (i.a. Burkett, 2010), formed the foundation for validation of the diagnostic value of a juxtaposition of temporal parameters and the objective measures of an evaluation of competitive swimming/rescue techniques, in the context of the aims of this study. Consequently, the second group of tasks was performed by the lifeguards in order to evaluate their level of technical skills in competitive swimming, as well as in selected elements of lifesaving. Each subject was required to swim 100 meters of each of the four competitive strokes, i.e. Freestyle, Backstroke, Breaststroke and Butterfly. In addition, they were required to successfully complete a one-arm pull tow and double armpit tow over a distance of 100 meters.

Analyses of technical skills in competitive swimming, and lifesaving (approaching and towing the victim) were based on the Delphi technique, developed by Dalkey and Helmer (1963). These techniques are widely used and accepted as a method for achieving convergence of opinion solicited from experts within certain topic areas (Hsu and Sandford, 2007). Two independent experts in the fields of swimming and lifesaving evaluated the technique of the tasks mentioned above, through their own observation. The score of the evaluation (scaled from 2 (bad) to 5 (very good)) was based on the widely known criteria for standard techniques in the four swimming strokes, the one-arm pull tow and the double armpit tow. The standard of technique, as an outcome of scientific knowledge in biomechanics, is combined with the theory of motor learning (Burkett, 2010). Therefore, the experts evaluated the standard techniques of four swimming strokes (crawl, butterfly, breaststroke and backstroke) following the same, universally accepted criteria (i.e. high elbow position) which are described by Counsilman (1977), Maglischo (2003) and Czabański et al (2003). They also evaluated standard techniques of the one-arm pull, double armpit tow and tow; according the same principles (i.e. hyper-extension of the arm holding the victim) formulated by Abralde (2006), and the authors of the YMCA Lifeguard Manual (2002).

The lifeguards performed one trial of each task mentioned above. All trials were conducted in a lake (water temperature was 22°C). The subjects used the same type of standard multilayer lifesaving fins (medium level of stiffness, 0.65m long and 0.25 wide) and the same dummies provided by the researchers (both the fins and the dummies were compatible with the standards approved in the ILSF Competition Manual (2011). Additionally, each of the lifeguards' resting heart rate and post-exercise, fatigued heart rate were measured directly during and after each trial using a telemetric system (Polar RS100, Polar Electro). The changes in heart rate from pre-exercise to post-trial level verified how they exerted themselves for each trial (Table 1). The verification mentioned was based on estimation of the difference between absolute values of post-trial and pre-exercise heart rate in the individual trials. Raw data was excluded in cases where the average value of the aforementioned difference

was less than one standard deviation.

The onset of fatigue that would be expected from conducting repeated tests and its effect on the results of the study were the major determining factors for limiting each subject to a single trial of each of the seven tasks. Taking this into account, successive trials for each subject commenced only after heart rates returned to pre-exercise levels).

The T-student test has been used to compare the temporal parameters of dolphin-kick and flutter-kick with fins in lifesaving (approach the victim and tow) and the time of competitive swimming (100m individual medley). The foundation for these comparisons was justified by the same (temporal) dimension of parameters collected (approaching, towing and competitive swimming). Identification of statistically significant differences between the temporal parameters mentioned, allowed to research the relationships between them and the parameters of evaluation of swimming and rescue (approaching and towing) techniques. They were investigated using Spearman's correlation coefficients (sample size (n) < 30).

## Results

The low values of the variation coefficients of the scores obtained by the lifeguards in the technique tests, showed that lifeguards in the researched group presented a similar level of technical skills in crawl swimming ( $VC_{crawl} = 1.2\%$ ), in backstroke ( $VC_{backstroke} = 3.5\%$ ), in breaststroke ( $VC_{breaststroke} = 2.2\%$ ) and in butterfly ( $VC_{butterfly} = 3.1\%$ ) as well as in selected elements of lifesaving ( $VC_{one-arm\ pull\ tow} = 3.6\%$ ,  $VC_{double\ armpit\ tow} = 3.6\%$ ). Thus those results can be compared in the aspect of their reliability. It was also indicated that the scores of crawl swimming were higher ( $Mean_{crawl} = 4.8$ ) and less dispersed in comparison to butterfly swimming ( $Mean_{crawl} = 3.9$ ). The level of dispersion of the evaluation of towing techniques was almost the same as in butterfly swimming. The results mentioned can be interpreted as meaning that the lifeguards commit more errors in the butterfly/dolphin technique. Therefore, the level of the technical skills of butterfly/dolphin seems to be lower in comparison to crawl, both in competitive and rescue swimming.

The maximum heart rates after approaching and towing the victim presented in Table 1 correspond with the results of similar studies (Parnicki et al., 1999b). The results of two subjects indicated too low a difference in heart rate from pre-exercise to post-trial level. Because these lifeguards did not meet the assumptions of maximal exertion for each trial, their raw data were excluded from further analyses.

The mean values of the temporal parameters and the results of the comparison of the Student-t test in the study are presented in Figure 2 and Table 2. These results indicate that the recorded times taken by the subjects for approaching the victim using the dolphin-kick with fins did not significantly differ from the approach times with flutter kick. The values of the towing time for both variants of propulsive leg movement with fins (Figure 2), together with the significant differences between them (Table 2), imply that the lifeguards in the research group

**Table 1.** Mean values and Standard Deviation for heart rates (beats/min) and deviations from rest to post event. HR<sub>N</sub> – “normal” heart rate measured after warm-up; HR<sub>F</sub> – “fatigue” heart rate measured after each event; HR<sub>F</sub>-HR<sub>N</sub> – Difference between “fatigue” heart rate and “normal” heart rate; HR<sub>R</sub> - “at rest” heart rate measured 1min post-exercise.

FLUTTER KICK APPROACHING				DOLPHIN-KICK APPROACHING			
HR <sub>N</sub>	HR <sub>F</sub>	HR <sub>F</sub> -HR <sub>N</sub>	HR <sub>R</sub>	HR <sub>N</sub>	HR <sub>F</sub>	HR <sub>F</sub> -HR <sub>N</sub>	HR <sub>R</sub>
94.4 (15.6)	145.6 (16.9)	51.2 (18.8)	115.5 (13.5)	96.4 (13.5)	150.0 (21.8)	53.6 (18.7)	120.0 (17.4)
FLUTTER KICK TOWING				DOLPHIN-KICK TOWING			
HR <sub>N</sub>	HR <sub>F</sub>	HR <sub>F</sub> -HR <sub>N</sub>	HR <sub>R</sub>	HR <sub>N</sub>	HR <sub>F</sub>	HR <sub>F</sub> -HR <sub>N</sub>	HR <sub>R</sub>
98.8 (8.4)	142.8 (15.1)	44.0 (13.9)	113.2 (12.1)	100.0 (19.7)	154.0 (14.1)	54.0 (15.1)	124.2 (11.3)

performed the flutter kick tow 5,75s faster, compared to the dolphin-kick. It was also apparent that the time of approaching the victim using either the dolphin-kick or the flutter kick did not scientifically differentiate the lifeguards in the research group.

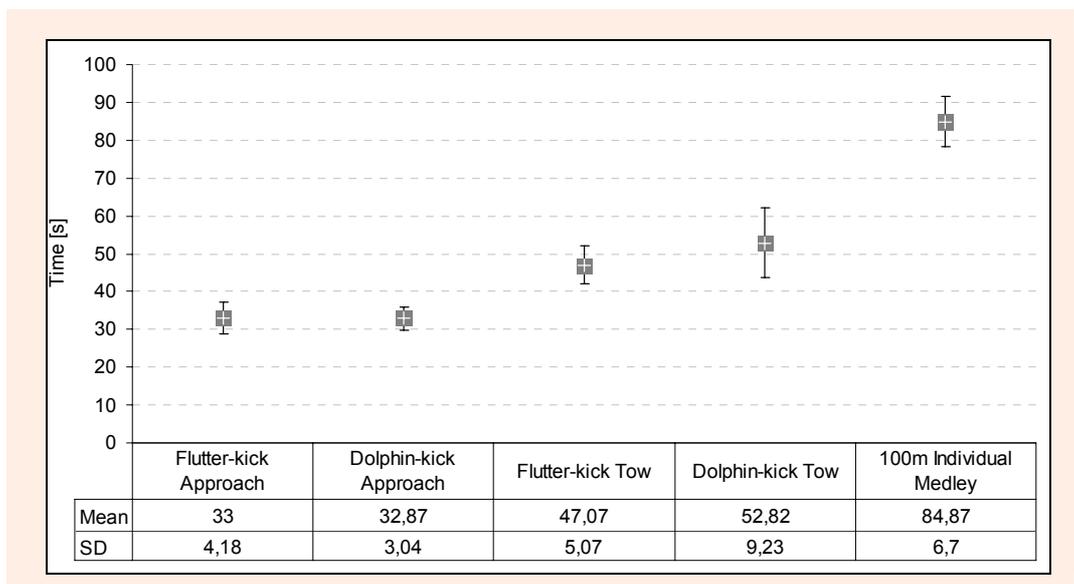
The significant values of Spearman’s correlation coefficient are presented in Table 3. Those results indicate that, when using dolphin-kick, the shortening of the towing time is significantly correlated to the decrease of the 100-m medley performance ( $r = 0.78$ ). In the same table, the significant values of the correlation coefficients between the absolute value of the difference between flutter kick towing time and dolphin-kick towing time and dolphin-kick towing time ( $r = 0.66$ ), 100m medley time ( $r = 0.65$ ) and the four swimming strokes evaluation ( $r = -0.54$ ), are presented. When assuming that the absolute values of differences between the towing times of both variants of kick, the results indicate that towing time using dolphin-kick with fins is linked to a high level of swimming and lifesaving (towing) skills. The lack of similar interdependency found in relation to flutter kick towing time, may be interpreted that the use of the dolphin-kick technique during towing the victim is a more difficult to realize than the use of flutter-kick. The correlation coefficient ( $r = -0.49$ ) demonstrates that the higher the competitive swimming speed (represented by 100m individual medley time), the better the level of competitive swimming technique (described by an average score of evaluation of the

four swimming strokes). The relationship mentioned was not significant enough to explicitly confirm the reliability of the procedure of evaluation of technical but it created premises to take such assumption.

### Discussion

It was found that the approach time to the victim, using the dolphin-kick with fins, was not shorter than the approach time when using the flutter-kick. The results also show that when using the double-armpit tow with fins, the task was accomplished faster when using the flutter-kick as compared to the dolphin-kick. It is evident that the hypothesis stated in this study was not confirmed. Therefore, the question of why dolphin kick swimming with fins is not as fast as the flutter kick when approaching and towing the victim should be discussed.

There are several arguments, drawn from competitive swimming, to indicate that the dolphin-kick produces a higher swimming velocity when compared to the flutter-kick. A number of authors have documented the fact that elite competitive swimmers choose to use the dolphin-kick at the start, and on each turn during all competitions (Colman, et al., 1997; 1999; Arellano, et al., 1999). Lyttle et al. (2000) have shown that during the underwater leg propulsion of the starts and the turns, swimmers score lower net drag forces using dolphin kick instead of flutter kick. In following this trend, the strategy of 100m



**Figure 2.** The results of comparison of temporal parameters of dolphin-kick and flutter-kick with fins in lifesaving (approach the victim and tow) and competitive swimming (100m individual medley) trials.

**Table 2.** Student T- test results for relationship between temporal parameters of dolphin-kick and flutter-kick with fins in lifesaving (approach the victim and tow) and time of competitive swimming (100m individual medley).

	Mean Difference	SD Difference	t	p
Flutter k. approaching time Dolphin-k. approaching time	.14	4.47	.12	.908
Flutter k. tow time Dolphin-k. tow time	-5.74	6.87	-3.24	.006
Dolphin-k. approaching time 100m individual medley time	-52.00	7.00	-28.78	.000
Flutter k. approaching time 100m individual medley time	-51.86	7.94	-25.30	.000
Dolphin-k. tow time 100m individual medley time	-32.05	7.74	-16.04	.000
Flutter k. tow time 100m individual medley time	-37.79	7.43	-19.69	.000
Flutter k. approaching time Flutter k. tow time	-14.07	3.83	-14.23	.000
Flutter k. approaching time Dolphin-k. tow time	-19.81	8.37	-9.17	.000
Dolphin-k. approaching time Flutter k. tow time	-14.21	4.61	-11.94	.000
Dolphin-k. approaching time Dolphin-k. tow time	-19.95	9.38	-8.23	.000

Manikin Carry with Fins, is performed by lifeguards during competition, by approaching the dummy from underwater using the dolphin-kick. However, it must be noted that the flutter-kick is used when the dummy is carried on the water's surface. Following this example, the lack of differences in approach time and the faster tow with flutter-kick, than with the dolphin-kick should be discussed through the prism of the impact of hydrodynamic conditions, in which the "lifeguard-victim" system works during double armpit tow in comparison to solo (approach) swimming. The depth of submersion and the torso angle of the lifeguard, and the victim being towed, is greater in comparison to solo swimming. As a consequence, the frontal area is enlarged and gives rise to greater frontal drag. In this unfavorable position, it is difficult to perform the dolphin kick because of the constraints placed on the movement of the hips and torso, crucial elements for increasing the effectiveness of the dolphin kick (Arellano et al., 1999; Maglischo, 2003). Additionally the position of the victim towed, positioning the shoulders at the lifeguards hip) radically limits the amplitude of the lifeguards' leg movement disturbing the optimal relationships

between amplitude and frequency of leg movements, which is required to achieve the highest propulsive effect when kicking with fins (Liu et al., 1997; Nicolas and Bideau, 2009). In the adverse conditions abovementioned, when frequency of reciprocating flutter-kick is already higher in comparison to the dolphin-kick, although less effective, appears to be justified.

A method to reduce the impact of hydrodynamic conditions on propulsion when towing, can be made with a choice of appropriate fins for the dolphin-kick. However, the results as to which fin type is best for competitive swimming, and for lifesaving rescue are inconclusive, (i.e. Abraldes et al., 2007, Pendergast et al., 2003b; Zamparo et al., 2006). It has been stated that the characteristics of the different fins (stiffness, surface, splits, vents etc.) cannot predict swimming performance (i.e. Zamparo et al., 2006). Analyses of dummy carry velocities also failed to demonstrate an effect associated with the type of fin used. It was concluded that, the size of the fins are probably more important than their rigidity, for carrying at short distance (25m) (Abraldes et al., 2007). In the present context, the optimization of fin characteristics,

**Table 3.** The value of Spearman's correlation coefficients illustrating the relationships between temporal parameters of dolphin-kick and flutter-kick with fins and 100m individual medley the parameters of assessment of the technical skill in lifesaving (approach the victim and tow) and in competitive swimming (evaluation of the four swimming strokes).

	Time			Evaluation score (average)	
	Flutter-kick. tow	Dolphin-kick. tow	Absolute value Flutter-k. tow – Dolphin-k. tow	100m individual medley	Four swimming strokes (average)
Flutter kick. Tow	x				
Dolphin-kick. Tow		x	0.66	0.78	
Absolute value Flutter-k. tow – Dolphin-k. tow		0.66	x	0.65	-0.54
100m individual medley		0.78	0.65	x	-0.49
Four swimming strokes (average)			-0.54	-0.49	x

Critical value of correlation coefficient (n=16)  $r^2 = 0.497$  ( $p < 0.05$ ).

considering the activity for which each fin has been designed (Abralde et al., 2007), seems to be a way to increase the efficiency of the dolphin-kick when approaching and towing the victim. It has been suggested that low frequency and deep leg kicks, with rigid fins, generate approximately the same thrust (and energy cost) as the flutter kick performed with flexible fins, at a higher frequency (Pendergast et al., 2003a). Zamparo et al. (2006) also found no differences between the efficiency of propulsion generated by small flexible fins and large stiff fins. In this context, shorter and flexible fins may compensate for low dolphin-kick amplitude (limited by the body of victim) by increasing frequency, and allowing for increasing the effort of the upward leg (fin) movements. During towing, the effect of propulsion generated by the long and stiff fins, is strongly limited when referring to vortex-induced thrust production under the body of the victim. Referring to the results of previous studies (Colman et al., 1999; Rejman et al., 2003) suggested that the structure of the vortex circulating over the shorter and more flexible surface of the fin is more stable, and its shape creates better conditions for "pushing back" (under the body of victim), the added mass of water.

The hydrodynamic conditions accompanying dolphin-kick towing also create changes in intra-cycle velocity, which would be expected to be higher than during the flutter-kick. The stability of intra-cycle velocity is one of the most important criteria for achieving maximal swimming speed (e.g. Dekerle et al., 2005; Nomura and Shimoyama, 2003; Keskinen, 1989; Rejman, 1999; Toussaint et al., 2006). In the conditions of dolphin-kick double armpit towing, the reduction of intra-cycle velocity fluctuations seems to be crucial for the reduction of energy expenditure of the lifeguard, which results from adverse inertial forces, accompanying unstable motions of his body and the body of the victim.

The results obtained and the arguments gathered in discussion suggest that the technique of double armpit tow with fins, using the dolphin kick, is more complicated than towing when using the flutter-kick. It was found that in the group of lifeguards tested, the approach and towing time, using a reciprocating flutter kick, does not differentiate between their lifesaving competences. Similarly, the temporal parameters recorded during dolphin-kick towing with fins (as opposed to flutter kick towing) were related to the parameters describing the technical level of swimming and lifesaving (towing) skills (Tables 2 and 3). In this context the adverse results of dolphin-kick towing in comparison with the flutter-kick can be interpreted as being the lack of the experience and an insufficient level of technical skill in dolphin-kick towing. This probably results from the fact that they, like most lifeguards, usually use the flutter kick technique when towing, which is requires a less complex set of specific rescue skills than the dolphin kick.

On the basis of these results, it may be possible to offer suggestions on how to improve the effectiveness of the dolphin-kick with fins during towing. These demands may be indicated by improvements in technique when adapting a monofin for use during towing. They are the following (1) Increase the dolphin-kick effectiveness by

emphasizing the upward kicking phase. This criterion works during towing when the movement of the biomechanical chain of the legs derives from minimal movement of the hip joints (Rejman, 2006). (2) Increase of dolphin-kick effectiveness during towing as a consequence of intensifying of downward leg (fin) movements. Increasing the effectiveness of the propulsion generated during the dolphin-kick, when towing, is possible through a reduction of the angle of flexion in the knee joint (Colman, et al., 1997; Rejman, 2006). (3) Increase of dolphin-kick effectiveness during towing as a consequence of equal propulsion generation during upward and downward movements of the fin. For towing the victim these criteria can be accomplished when the lifeguards concentrate on increasing the frequency of shank movement, when the displacement of the hip joint is maximally reduced (Rejman, 2006). The amplitude of the shank should be optimized within the limits indicated by the position of the victim. (4) Increase of dolphin-kick effectiveness during towing is a consequence of minimizing trunk movements. One of the crucial criterion for the quality of performing the dolphin-kick with fins or with a monofin (Colman, et al., 1999; Rejman, 2006), is extension of the upper body segment, when the arms are hyper-extended at the elbow joints, supporting the position of the victim above the hips and legs of the lifeguard, and facilitating his control over the towed body. Simultaneously, this reduces the drag on the surface of the lifeguard's back and allows for generating efficient propulsion, regardless to the limitation of leg amplitude. (5) The individual choice of fins, in terms of optimization of their characteristics, while providing a high efficiency of dolphin-kick when towing the victim. As previously discussed, because of the specificity of towing, the choice of shorter fins with medium stiffness by lifeguards seems to be the most advantageous.

## Conclusion

Analyses of the time required to approach and tow a victim, back to shore with the use of fins, did not confirm that the dolphin kick decreases the time of swimming rescues. During the approach to the victim, neither of the techniques under consideration (dolphin and flutter kicking), were comparatively more efficient. However, the time of towing performed using the flutter kick was significantly shorter compared to the time of towing with the dolphin-kick.

Temporal parameters recorded during dolphin-kick towing with fins (as opposed to flutter-kick towing) were related to the technical level of swimming and lifesaving (towing) skills. It allowed a more detailed examination of the conclusion that the flutter-kick was more useful than the dolphin-kick, due to the reduction of the time of swimming rescues with fins. The practice of dolphin-kicking in a rescue is rather exceptional for the lifeguards. This fact did not detract from the results, but allowed us to determine that they do not have enough skilled experiences to use the dolphin kick, performed in solo swimming (approaching the victim), to reduce the impact of the hydrodynamic conditions accompanying double-armpit

towing with the dolphin-kick. Consequently, the suggestion is to incorporate the use of dolphin kick technique, with fins, into the technical training of lifeguards.

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### Key points

- The source of reduction of swimming rescue time was researched.
- Time required to approach and to tow the victim while doing the flutter kick and the dolphin-kick with fins was analyzed.
- The propulsion generated by dolphin-kick did not make the approach and tow faster than the flutter kick.
- More difficult skill to realize of dolphin-kick than the flutter-kick was postulated.
- The criteria for how improve dolphin kick technique with fins were formulated.

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