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EVALUATION OF MISTAKES IN BACKSTROKE SWIMMING

OVREDNOTENJE NAPAK PRI HRBTNEM

ABSTRACT

Purpose. We tried to determine the perceptions of experienced swimming teachers and coaches (hereinafter "experts") regarding common mistakes in backstroke swimming. Moreover, we compared their evaluation with the evaluation of participants with no professional expertise in teaching/coaching swimming (hereinafter »non-experts«). **Methods.** 70 participants were recruited and divided either in the experts group (E) or in the non-experts group (NE). Group E consisted of 21 swimming coaches (11 males and 10 females; ages 34 ± 11 years) with the certificate of Slovenian Swimming association and with lengthy experience (at least 10 years) in teaching and coaching swimming. 49 undergraduate students (29 males and 20 females; ages 18 ± 1 years) without any teaching or coaching experiences in swimming were assigned to Group NE. They were asked to mark 42 mistakes that most commonly occur in backstroke swimming. They evaluated these mistakes on a seven-point scale of importance for backstroke swimming performance. **Results.** For 27 of 42 mistakes significant differences existed in evaluations between both groups. Group NE marked them with a significantly lower score, i.e. as less important than Group E. **Conclusion.** In light of the results obtained by Group E, a scale of importance of mistakes for backstroke swimming was established. This scale could be used for future swimming teachers' preparation in a way to understand the principles of backstroke with greater ease. Moreover, it could help swimming teachers and coaches classify swimmers according to their backstroke technique performance.

Keywords: swimming, learning, qualitative analysis, evaluation

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IZVLEČEK

Cilj. Z raziskavo smo želeli ugotoviti ocene plavalnih učiteljev in trenerjev (plavalnih strokovnjakov – E skupina) o pomembnosti najpogostejših napak pri hrbtnem. Njihove ocene smo primerjali z ocenami študentov Univerze v Ljubljani, Fakultete za šport (NE skupina), ki niso imeli znanja in izkušenj iz poučevanja plavanja. **Metode.** 21 plavalnih učiteljev in trenerjev (11 moških in 10 žensk; starost 34 ± 11 let z vsaj 10 letnimi delovnimi izkušnjami) ter 49 študentov (29 moških in 20 žensk; starost 18 ± 1 let) je ovrednotilo 42 napak na sedem stopenjski lestvici po pomembnosti. **Rezultati.** Pri 27 od 42 napak so bile ocene pri NE skupini statistično pomembno nižje od ocen pri E skupini, torej so jih vrednotili kot manj pomembne. **Zaključki.** Na osnovi median ocen skupine E smo izdelali lestvico napak po pomembnosti. Ta lestvica omogoča lažje razumevanje pravilne tehnike hrbtnega in je lahko v pomoč pri usposabljanju in izobraževanju bodočih plavalnih učiteljev in trenerjev. Ob tem lahko predstavlja tudi kriterij za razvrščanje plavalcev v ravni glede na njihovo znanje hrbtnega.

Ključne besede: plavanje, učenje, kvalitativna analiza, ocenjevanje

INTRODUCTION

The contemporary origin of technique analysis in sport lies in coaching, as there was a need for coaches to improve the performance of their athletes. Mainly, there are two different approaches for such analysis i.e. quantitative and qualitative (Lees, 2002). Quantitative technique analysis relies on biomechanical data collections methods. It is ideal for a detailed investigation of some part of sports technique, but it is less suitable for establishing characteristics of whole movement. On the contrary, the qualitative analysis of technique is carried out by observation and subjective judgement. Beside phase and temporal analysis, the "critical feature" is one of the models for the movement observation (Lees, 2002). It is defined as "the parts of phase of a movement which can be at least modified to achieve a goal" (Arend and Hinggins, 1976). Considering the goal of an appropriate athlete's demonstration of the particular movement, the diagnosis or identification of technique errors is needed knowledge for coaches (Lees, 2002).

Competitive swimming is based on achieved times for a selected swim distance. Therefore, quantitative analyses are the most widely used by swim coaches. Besides measuring swim times, they are usually obtained by measuring stroke rate, stroke length, stroke index, index of coordination as well as breathing frequency. Moreover, the methods of quantitative analysis could also involve video-based techniques from which kinematics and kinetics can be derived from direct measurements of velocity and force by using various velocities and forces transducing devices (Sanders et al., 2006).

However, in some cases a quantitative approach could not reflect the progress in the athlete's swimming technique. Indeed, a coach's feedback to a swimmer often relies on qualitative observation. Commonly, coaches conduct the technique analysis themselves, through observation and qualitative assessment using the naked eye and video playback (Lees, 2002; Wilson, 2008). A key advantage of this is low cost and easy to implement with large numbers of athletes (Mooney et al., 2016). Qualitative assessment is therefore based on the coach's own knowledge and experience. They have to identify the technique mistakes and remediate them. However, the first step requires an appropriate preparation and a background knowledge, such as understanding: 1.) the ideal form of a movement in each phase, and 2.) the importance of the particular mistake to technique performance. The presentations of correct form of swimming techniques are well known in written, diagrammatic as well as in pictorial form. Coaching manuals tend to rely on the sequential breaking down of a selected movement into its various phases and templates based on expert performance (Lees, 2002). In this regard, it is surprising that the research of Pion and co-workers (1988) has been, according to our knowledge, the only attempt of an evaluation of a swimming technique, i.e. breaststroke, by using mistakes assessment so far. Therefore, the purpose of this study was to determine the perceptions of experienced swim teachers and coaches regarding common mistakes in backstroke swimming. Moreover, we compared their evaluation with the evaluation of participants with no professional expertise in teaching/coaching swimming.

METHODS

Participants

70 participants were recruited and divided in either a group of experts (Group E) or in a group of non-experts (Group NE). Group E was comprised of 21 swimming coaches (11 males and 10 females; ages 34 ± 11 years) with the certificate of Slovenian Swimming association and with lengthy experience (at least 10 years) in teaching and coaching swimming. Group NE was comprised of 49 participants (29 males and 20 females; ages 18 ± 1 years). These non-experts

were undergraduate students without any experiences in teaching or coaching swimming. All participants had received written and oral instructions before the beginning of the study and had given their informed written consent. The institutional review board (Ethics Committee of University of Ljubljana, Faculty of Sport) approved the study protocol. The study was conducted according to the principles expressed in the Declaration of Helsinki.

Procedures

A self-administered questionnaire was distributed to all participants. Categories of questions included 1) teaching experiences and 2) importance of various mistakes of backstroke. The latter category was related to the assessment of a particular mistake in terms of its importance in the training program of an advanced swimmer, i.e. a potential competitive swimmer. In this way, the participants were asked to mark 42 mistakes that most commonly occur at backstroke swimming (Maglischo, 2003). Mistakes were grouped according to body position, kicking, stroking, and coordination. Before the data collection, each mistake was presented to participants by using video clips or pictures. Thereafter they evaluated them on a seven-point scale in regard of their importance for backstroke swimming performance (table 1).

Table 1. Table depicting 7-point scale of importance.

SCORE	LEVEL OF IMPORTANCE
1	Not at all important
2	Low importance
3	Slightly important
4	Moderately important
5	Considerably important
6	Very important
7	Extremely important

Statistical analyses

The majority of data presented in the results are descriptive in nature. Statistical analyses were carried out by using IBM SPSS Statistics 21.0. Based on participants' evaluation, the median (Mdn) and mean score as well as the interquartile range (IQR) were calculated for each mistake. In order to investigate whether differences existed in evaluation scores between Group E and Group NE, a Mann-Whitney U test was conducted. A significance level of 0.05 was used for all analyses. Due to the median scores obtained by Group E, the scale of importance of mistakes for backstroke swimming was established.

RESULTS

Considering the aim of the study only the results of the E group backstroke mistakes evaluation are presented in the following figures. The mistakes are ranked from the least to the most important in all figures. The results of the NE group are presented below the figures, when they statistically differed from the results of the E group.

The participants were asked to evaluate six mistakes in backstroke body position. Figure 1 displays the marking results of Group E.

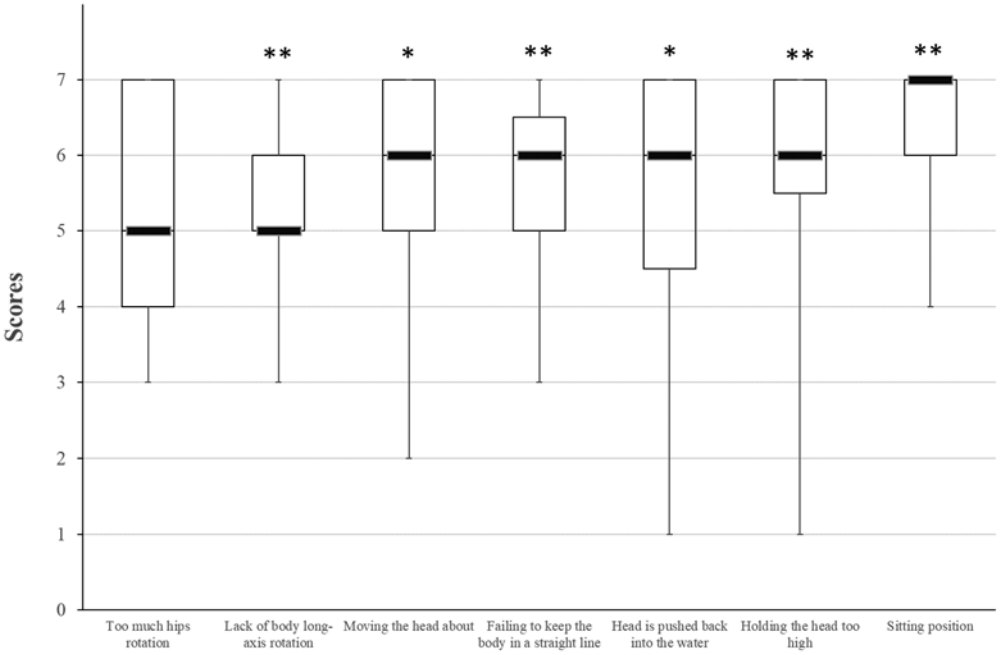

Figure 1. Box plot summarising Group E scores of backstroke body position mistakes. Median score (-), interquartile range (box), range between minimum and maximum scores (⊥T) are displayed for each mistake. ** and * denote significant difference $p < .01$ and $p < .05$, respectively, compared to Group NE (Mann-Whitney U test).

There were significant differences in the evaluation scores between both groups regarding several backstroke body position mistakes. In relation to median scores, Group NE evaluated mistakes such as: *Lack of body long-axis rotation* (Mdn = 4, IQR = 2 in Group NE; Mann-Whitney's U = 183,5; $p < .01$), *Moving the head about* (Mdn = 5, IQR = 3 in Group NE; Mann-Whitney's U = 341; $p < .05$), *Failing to keep the body in a straight line* (Mdn = 5, IQR = 2 in Group NE; Mann-Whitney's U = 279.5; $p < .01$), *Head is pushed back into the water* (Mdn = 5, IQR = 2 in Group NE; Mann-Whitney's U = 347.5; $p < .05$), *Holding the head too high* (Mdn = 5, IQR = 2.5 in Group NE; Mann-Whitney's U = 271.5; $p < .01$), and *Sitting position* (Mdn = 6, IQR = 1 in Group NE; Mann-Whitney's U = 282.5; $p < .01$) significantly lower than Group E.

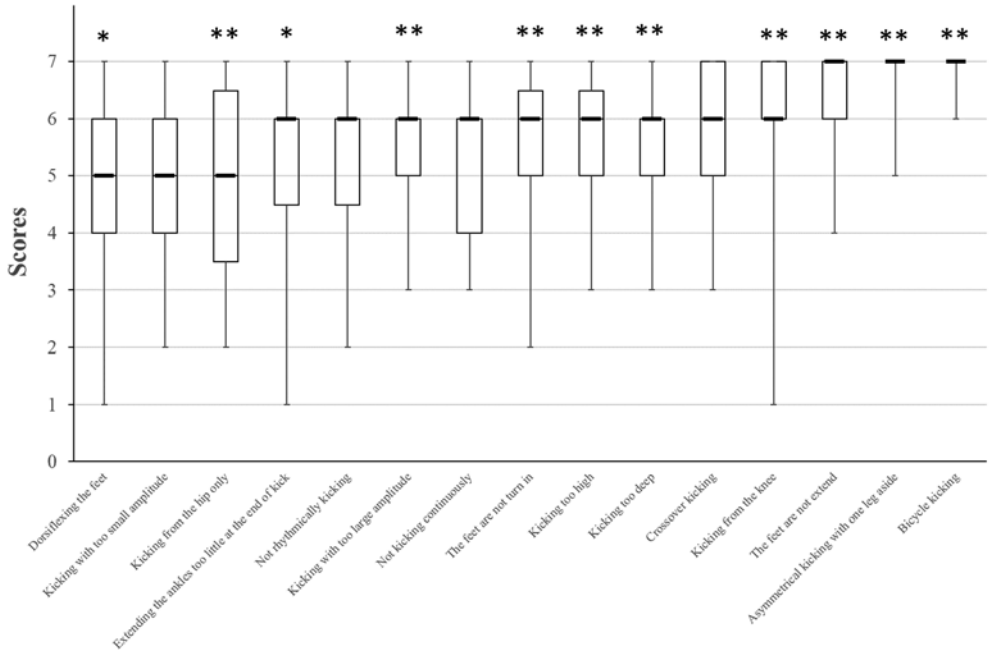

Figure 2. Box plot summarising Group E scores of backstroke kicking mistakes. Median score (-), interquartile range (box), range between minimum and maximum scores (⊥T) are displayed for each mistake. ** and * denote significant difference $p < .01$ and $p < .05$, respectively, compared to Group NE (Mann-Whitney U test).

Figure 2 displays the results of the evaluation of kicking mistakes marked by Group E. There was a significant difference in median scores between both groups across several backstroke kicking mistakes. Mistakes such as: *Dorsiflexing the feet* (Mdn = 4, IQR = 3 in Group NE; Mann-Whitney's U = 334; $p < .05$), *Kicking from the hip only* (Mdn = 4, IQR = 2 in Group NE; Mann-Whitney's U = 317.5; $p < .01$), *Extending the ankles too little at the end of kick* (Mdn = 5, IQR = 1 in Group NE; Mann-Whitney's U = 364; $p < .05$), *Kicking with too large amplitude* (Mdn = 3, IQR = 3 in Group NE; Mann-Whitney's U = 162; $p < .01$), *The feet are not turn in* (Mdn = 3, IQR = 2 in Group NE; Mann-Whitney's U = 138.5; $p < .01$), *Kicking too high* (Mdn = 4, IQR = 2 in Group NE; Mann-Whitney's U = 299; $p < .05$), *Kicking too deep* (Mdn = 5, IQR = 3 in Group NE; Mann-Whitney's U = 278; $p < .05$), *Kicking from the knee* (Mdn = 5, IQR = 1.5 in Group NE; Mann-Whitney's U = 181; $p < .01$), *The feet are not extend* (Mdn = 5, IQR = 3 in Group NE; Mann-Whitney's U = 176.5; $p < .01$), *Asymmetrical kicking with one leg aside* (Mdn = 6, IQR = 3 in Group NE; Mann-Whitney's U = 250; $p < .01$) and *Bicycle kicking* (Mdn = 5, IQR = 3 in Group NE; Mann-Whitney's U = 182.5; $p < .01$) were marked significantly higher in Group E compared to Group NE.

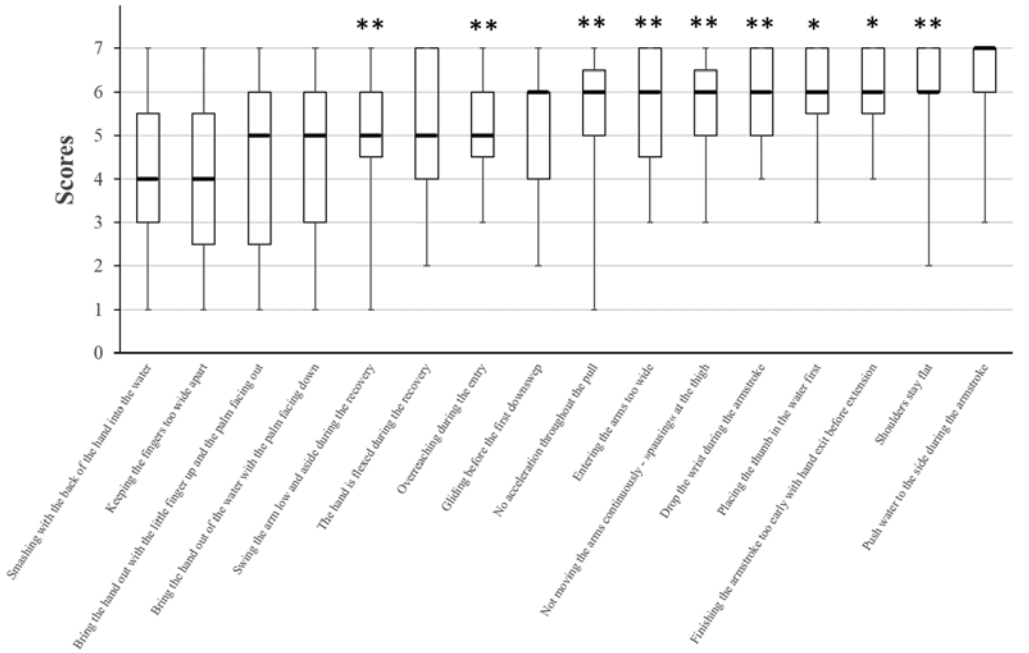

Figure 3. Box plot summarising Group E scores of backstroke arm stroking mistakes. Median score (-), interquartile range (box), range between minimum and maximum scores (⊥T) are displayed for each mistake. ** and * denote significant difference $p < .01$ and $p < .05$, respectively, compared to Group NE (Mann-Whitney U test).

A summary of evaluation scores of backstroke arm stroking mistakes obtained by Group E is presented in Figure 3. The effect of mistakes such as: *Swing the arm low and aside during the recovery* (Mdn = 4, IQR = 2 in Group NE; Mann-Whitney's U = 277; $p < .01$), *Overreaching during the entry* (Mdn = 3, IQR = 1 in Group NE; Mann-Whitney's U = 180.5; $p < .01$), *No acceleration throughout the pull* (Mdn = 4, IQR = 2 in Group NE; Mann-Whitney's U = 238; $p < .01$), *Entering the arms too wide* (Mdn = 5, IQR = 2 in Group NE; Mann-Whitney's U = 279; $p < .01$), *Not moving the arms continuously* - »pausing« at the thigh (Mdn = 4, IQR = 3 in Group NE; Mann-Whitney's U = 279.5; $p < .05$), *Drop the wrist during the armstroke* (Mdn = 5, IQR = 2 in Group NE; Mann-Whitney's U = 285; $p < .01$), *Placing the thumb in the water first* (Mdn = 4, IQR = 3.5 in Group NE; Mann-Whitney's U = 283,5; $p < .05$), *Finishing the armstroke too early with hand exit before extension* (Mdn = 5, IQR = 2,5 in Group NE; Mann-Whitney's U = 332; $p < .05$) and *Shoulders stay flat* (Mdn = 4, IQR = 1 in Group NE; Mann-Whitney's U = 116; $p < .01$) on swimming performance was evaluated as significantly more important in Group E than in Group NE.

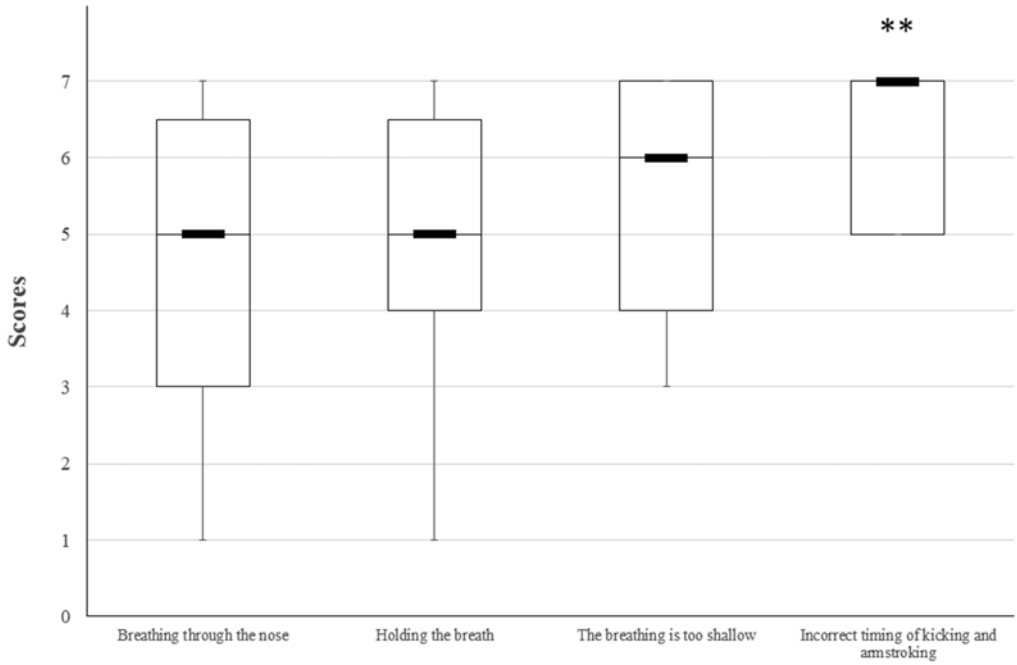

Figure 4. Box plot summarising Group E scores of breathing and coordination mistakes. Median score (-), interquartile range (box), range between minimum and maximum scores (⊥T) are displayed for each mistake. ** denote significant differences compared to Group NE (Mann-Whitney U test; $p < .01$).

Figure 4 shows that there was a significantly higher median score in Group E than in Group NE (Mdn = 5, IQR = 2) regarding the mistake *Incorrect timing of kicking and arm stroking* (Mann-Whitney's U = 196.5; $p < .01$). Table 2 summarizes all evaluated backstroke mistakes due to the level of importance.

Table 2: The scale of importance of mistakes for backstroke swimming.

	LEVEL OF THE BACKSTROKE MISTAKES IMPORTANCE			
	Moderately important	Considerably important	Very important	Extremely important
BODY POSITION		*Too much hips rotation, Lack of body long-axis rotation*	*Moving the head about, Failing to keep the body in a straight line, Head is pushed back into the water, Holding the head too high*	*Sitting position*
KICKING		*Dorsiflexing the feet, Kicking with too small amplitude, Kicking from the hip only*	*Extending the ankles too little at the end of kick, Not rhythmical kicking, Kicking with too large amplitude, Crossover kicking, Not kicking continuously, The feet are not turn in, Kicking too high, Kicking too deep kicking from the knee*	*The feet are not extended, Asymmetrical kicking with one leg aside, Bicycle kicking*
ARMSTROKING	*Smashing with the back of the hand into the water, Keeping the fingers too wide apart*	*Bring the hand out with the little finger up and the palm facing out, Swing the arm low and aside during the recovery, Bring the hand out of the water with the palm facing down, The hand is flexed during the recovery, Overreaching during the entry*	*Gliding before the first downsweep, Drop the wrist during the armstroke, Placing the thumb in the water first, No acceleration through the pull, Entering the arms too wide, Not moving the arms continuously - »pausing« at the thigh, Finishing the armstroke too early with hand exit before extension, Shoulders stay flat*	*Push water to the side during the armstroke*
BREATHING AND COORDINATION		*Breathing trough nose, Holding the breath*	*Breathing is too shallow*	*Incorrect timing of kicking and arm stroking*

DISCUSSION

The purpose of this study was to determine the perceptions of experienced swim teachers and coaches regarding common mistakes in backstroke swimming. Moreover, we compared their evaluation with the evaluation of participants with no professional expertise in teaching/coaching swimming. Both group of participants marked 43 mistakes. Despite the scale range spanning from 1 to 7 they evaluated the mistakes mostly with scores ranging from 3 to 7 only. This was expected due to fact that we have chosen mistakes already discussed in existing literature (Maglischo, 2003). Swimmers can apply a particular swimming technique in a slightly different way. This is known as an individual's style. However, there are specific aspects in each swimming technique performance that are categorically wrong. These were referred to as mistakes in the present study. There were significant differences in evaluations between both groups in evaluations of 27 out

of 43 mistakes. Non-experts scored them with a significantly lower score (from 1 to 3 median scores; Figures 1, 2 and 3), i.e. as less important than Group E. To our knowledge, this is the first study that compared the evaluation of mistakes in movement between observers with different experiences. Previous studies showed that the non-experts are not able to distinguish between different levels of movement performances to the same degree as the expert observers (Aglioti, Cesari, Romani, Urgesci, 2012; Tomeo, Cesari, Aglioti, Urgesi, 2013; Zamparo, Carrara, Cesari, 2017). Indeed, the experienced teachers and coaches possessed a wide range of experiences and knowledge regarding the causes and consequences of a particular mistake. They gained their experiences by the recurrent processes of observing, analysing and correcting many swimming performances during the process of swimming techniques acquisition. Visual analytic skills and particularly errors of movements could be improved by special training of qualitative technique analysis. (Wilkinson, 1991; Gangstead, Beverige, 1984). Therefore, the results of Group E could be implemented in the program of preparation for future swimming teachers in a way to understand the principles of backstroke with greater ease. Moreover, presented scale (Table 2) could help swimming teachers and coaches classify swimmers according to their backstroke technique performance.

The backstroke is the only swimming technique performed with the swimmer in the supine position. The most important learning challenges are related to maintaining a proper body position. Therefore, it is not surprising that Group E marked *Holding the head too high* and *Sitting position* as the biggest mistakes in body position (Figure 1). Swimmers who hold the head too high generally flex the hip as well and swim with the body inclined down. These mistakes increase the drag. In addition, they have to use the armstroke and leg kicking in a way to support a high head position, which reduces the propulsion. Instead of the propulsion movement, they swim with pushing down with the arms and kicking too deep (Maglischo, 2003). In addition to the horizontal body position, the body roll is the next important component of the proper body position, especially in relation to shoulders movements (Figure 3). The swimmers should roll the body from side to side, between 30° and 45° from a flat position in the same direction of the arm movements (Maglischo, 2003). Thus, they should bring the shoulder out of the water as they begin the recovery with each arm and submerge it during the propulsion period. This enables them to stay in good lateral alignment without moving the head about.

The most important kicking mistakes are *Bicycle kicking* and *kicking without feet extension* (Figure 2). At *Bicycle kicking,* swimmers push the thighs upward and forward against the water during the upbeat, and therefore produce additional drag that slows forward speed (Maglisho, 2003). *Kicking without feet extension* produces less propulsion and increases drag. The reason for this mistake usually lies in poor ankle flexibility. Indeed, Opplinger et al. (1986) showed that swimmers had a better ankle flexibility than non-swimmers.

According to the markings of Group E, the biggest armstroke mistake is to *Push water to the side* (Figure 3). This is usually caused by mistakes such as *Shoulder stay flat* (Figure 1) and *Entering arms too wide* (Figure 3). Swimmers who enter the arms in the water too wide usually continue the armstroke by pushing water to the side and disrupt their lateral alignment. The force they apply serves only to increase resistive drag and decelerate forward speed (Maglischo, 2003). Indeed, the entry of the hand outside of the shoulder axis led to a decrease of the entry and catch phase (Chollet et al., 2006). These mistakes prevented the deep hand sweep that prepares the propulsion and were regularly associated with the dorsal position without body roll (Richardson et al., 1980). The beginners shorten the entry and catch phase to rest on the water (i.e. to maintain the

upper body and the head on the surface) instead of plunging their hand deeper to find a resistive mass of water (Chollet et al., 2006). The increase in backstroke competitive performance level is characterized by the prolongation of the entry, catch, and pull phases, i.e. without mistakes like finishing the armstroke too early, with hand exit before extension (Lerda, Cardelli, 2003). A longer entry and catch phase could streamline the body and limit imbalances, thus reducing drag (Chollet et al., 2000). This partly accounted for the greater stroke length of the more expert swimmers, which is a factor in stroke efficiency (Costill, Kovaliski, Porter, Fielding, and King, 1985; Hay, Guimaraes, 1983). The next important armstroke mistake is related to maintaining a continuous propulsive force and to reduce the propulsive fluctuations throughout the stroke phases, i.e. the ability that is necessary for optimal competitive backstroke performance (Formosa, Sayers, Burkett, 2014). Ideal inter-arm coordination provides continuous propulsion between the two arms actions. (Maglischo, 2003). Therefore, it was expected that the mistake categorised as *Not moving the arms continuously,* often resulting in „pausing" at the thigh, was evaluated as important at the present study.

The mistake categorised as *Incorrect timing of kicking and armstroking* usually occurred as a consequence of other mistakes such as *Kicking too deep* and *„Pausing" the armstroke at the thigh*. Lerda and Cardeli (2003) showed that superior performance level in the backstroke was accompanied by a modification in arm and leg synchronization. More expert swimmers used six-beat kicking rhythm, i.e. they executed six leg kicks during each stroke cycle. This synchronization allowed a greater direct contribution of the legs to propulsion (Hollander, De Groot, Van Ingen Schenau, Kahman, & Toussaint, 1988). In contrast, the greater number of kicks per stroke used by the less experienced group of swimmers was associated with specific arm movement modification in a way to maintain a streamline body position. Thus, the quantification of the mode of stroke organization in the backstroke indicated the technical skill of the swimmer (Lerda, Cardelli, 2003).

CONCLUSION

Group NE marked most of the backstroke mistakes as less important than Group E. In light of the results obtained by Group E, a scale of importance of mistakes for backstroke swimming was established. This scale could be used for future swimming teachers' preparation in a way to understand the principles of backstroke with greater ease. Moreover, it could help swimming teachers and coaches classify swimmers according to their backstroke technique performance.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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