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Performance analysis of elite lifesavers during competition: effects related to gender, turn of competition, and age category

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	Alex Nicolae Ungureanu
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Response to Reviewers:	Reviewer #1: Please add comments you don't mind the author seeing. General comments Under participants it would be good to know the minimum number of participants in any combination of gender, age group and stage of competition. Eg the finals for some disciplines have low frequencies so even if senior / junior and male / female are split 50:50, there would be fewer than 7 participants in some cells of the analysis. The statistics are still valid if this is above 5. Good inter-operator agreement checking of the method. Answer: thanking the reviewer for his/her suggestion, we implemented the specific number of cases related to significances in the Results section of the new version. However, for a better understanding of the data management, we had already reported (in the first version) the following period in the Statistical Analysis section: "due to the absence of data related to young female athletes performing finals in the Manikin Tow with Fins - 100 m specialty, only the main effect was calculated". For each of the remained interactions (i.e., gender X age group X stage of competition) related to the single six specialties, a minimum of 6 cases was always guaranteed. Specific comments Figure 2 contains some very small charts. I suggest spreading these over two landscaped pages. Answer: according to this suggestion, we spread Figure 2 over two landscaped pages. The reference Stallman and Hillman is missing from the reference list. Answer: we implemented the missing reference.

Performance analysis of elite lifesavers during competition: effects related to gender, turn of competition, and age category.

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Abstract

The aim of this study was to analyze elite lifesavers' official performances according to specific intermediate times recorded during each specialty, and comparing them in relation to genders, turns of competition (qualifications; finales), and age (seniors; youths) categories. For this purpose, the intermediate times of 825 (female: 423, male: 402) individual performances were recorded by means of the official stopwatch of championship and two video cameras synchronized with the official stopwatch of competition. A linear mixed-effects model was applied to verify subgroup differences ($p \leq 0.05$). For single specialty, differences emerged for each observed variables ($p \leq 0.001$). Differences (p range: < 0.001 – 0.03) were confirmed for the interactions with specific intermediate times, excepting for those in "Manikin Tow with Fins - 100 m" with each variable, in "Manikin Carry with Fins - 100 m" with age, and in "Obstacle Swim - 200 m" with gender and age. Therefore, elite lifesaving coaches will be able to benefit from the results of this study, considering specific performances, avoiding any generalization, and promoting more aware training sessions.

Key words: aquatic sports, lifesaving, video analysis, swimming performance, intermediate times.

1. Introduction

Lifesaving is an aquatic discipline originated to provide a service to society and human life. Nevertheless, competitive lifesaving has become a very popular sport over the last century, promoting new and effective techniques (Booth, 2000). Guidelines, rules, and regulations for competitive lifesaving at youth and senior levels, in swimming pools and open water, have been officially established at national and international contests (International Life Saving Federation (ILSF), 2019). Italy is one of the founding nations of the ILSF, and elite (i.e., both youth and senior lifesavers included) Italian Lifesaving Championships are regularly organized in line with the international rules, consisting of ocean and pool events (Federazione Italiana Nuoto (FIN), 2019). For the latter type of competition, six individual specialties (and other three competed as team) are performed.

In the "Manikin Carry - 50 m" specialty, the lifesaver swims 25 m freestyle, then dives to recover a submerged manikin to the surface within 5 m of the pick-up line, and finally carries the manikin to touch the finish wall of the pool. In "Manikin Carry with Fins - 100 m", the lifesaver swims 50 m freestyle wearing fins, then recovers a submerged manikin to the surface within 10 m of the turn wall, and finally carries the manikin to touch the finish wall of the pool. In "Rescue Medley - 100 m", the lifesaver swims 50 m freestyle to turn, dive, and swim underwater to a submerged manikin located at 17.5 m from the turn wall, then surfaces the manikin within the 5 m pick-up line, and finally carries it the remaining distance to touch the finish wall. In "Manikin Tow with Fins - 100 m", the lifesaver swims 50 m freestyle with fins and rescue tube; after touching the turn wall, and within the 5 m pick-up zone, the lifesaver fixes the rescue tube correctly around a manikin and tows it to the finish. In "Obstacle Swim - 200 m", the lifesaver swims the 200 m course passing eight times under the immersed obstacles (located at 12.5 m from the two poolside, at the bottom of pool) to touch the finish wall of the pool. Finally, in "Super Lifesaver - 200 m", the lifesaver swims 75 m freestyle and then dives to recover a submerged manikin; successively, the lifesaver surfaces the manikin within the 5 m pick-up zone, and carries it to the turn wall; after touching the wall the lifesaver releases the manikin; finally, in the water, the lifesaver wears fins and rescue tube and swims 50 m freestyle, and after touching the wall, and within the 5 m pick-up zone, fixes the rescue tube correctly around a manikin and tows it to the finish (International Life Saving Federation (ILSF), 2019). Usually elite Italian Lifesaving Championships are planned into two consecutive days of competition (i.e., qualifications in the mornings; finals in the afternoons). The eight best swimmers (youth athletes potentially included) for each specialty at the qualifications could access to the finals “A”, whereas the eight youth best ones (excluding eventual youth athletes already qualified into the final “A”) could participate in the “youth finals”.

Research on lifesavers has been focused on psychological aspects such as the ability of minimizing the occurrence of anxiety in dangerous circumstances to favour an effective decision making (Avramidis, 1998; Avramidou, Avramidis, & Pollman, 2007). Moreover, lifesaving has been also studied for the leg techniques adopted during performance. In particular, Rejman et al. (2012) have demonstrated that “dolphin leg” is less convenient than “crawl leg”, despite the first swimming technique could be considered as valuable training practice. Similarly, in a more recent study (Abraldes, Stallman, Soares, & Queiroga, 2014), the lifesaver’s speed and fatigue index in the 4x25 m carrying manikin test have been evaluated by comparing breaststroke, scissors, flutter, and dolphin kicks, clearly reporting that the first two kick techniques are more convenient to maximize speed and minimize fatigue index than the others.

However, at present, research on lifesaving is quite limited and mainly focused on rescue, whereas no study has been provided on competitive performance, which is a sport discipline characterized by specific techniques. In fact, Stallman and Hillman (2012) highlighted that lifesavers in real rescue and competitions are characterized by different swimming techniques such as the positioning of their head up to see the victim during a rescue, and downward to swim as fast as possible during a competition.

Regardless of rescue and competitive sport discrimination, lifesaving combines elements of swimming, rowing, surfing, and running. Also, over time the lifesaving skills have been developed into competitive sport events for all ages (Avramidou et al., 2007). Nevertheless, no specific reference on the competitions of this sport discipline has been yet provided, highlighting the need of investigations to obtain substantial information and practical applications for training. In fact, not only swimming, but also technical drills are fundamental in this sport. As consequence, performance analyses focused on specific phases can be enormously useful for lifesaving coaches, and strength and conditioning trainers who aspire to apply more aware and effective training exercises.

Thus, the aim of this study was to investigate elite Italian lifesavers’ performances during the elite national championships by considering specific intermediate times of each specialty, and comparing them in relation to genders, turns of competitions (qualifications; finales), and age categories (seniors; youths). In particular, it has been hypothesized that intermediate times recorded for the six lifesaving specialties are strongly different (i.e., with medium or large effect sizes; ESs) between: i) male and female; ii) qualification and final turns of competitions; and iii) youth and elite categories.

2. Methods

Participants

The local Institutional Review Board approved this study to analyze the lifesavers' performances of the 2017 elite Italian Championships (Milan, April 22-23, 2017; between 9 a.m. and 7 p.m. in both days). Six-hundred-forty-seven lifesavers (332 female, 20±1 years; 315 male, 21±1 years) which participated in the Championships were recruited for this study. In particular, the distribution of participants in relation to each specialty, gender, turn of competition, and age category are reported in table 1.

Table 1. Distribution of participants at the 2017 elite Italian Lifesavers Championships for each specialty and in relation to gender, turn of competition, and age category.

Specialty	Gender		Turn of competition		Age category		Total
	Female	Male	Qualifications	Finals	Youth	Senior	
Manikin Carry - 50 m	73	59	101	31	54	78	132
Manikin Carry with Fins - 100 m	68	88	124	32	81	75	156
Rescue Medley - 100 m	73	71	113	31	68	76	144
Manikin Tow with Fins - 100 m	83	61	116	28	67	77	144
Obstacle Swim - 200 m	63	71	103	31	64	70	134
Super Lifesaver - 200 m	63	52	89	26	51	64	115

According to the elite Italian coaches and physical trainers, the lifesavers participating in the elite Italian Lifesaving Championships usually perform a minimum of four to a maximum of eight 120-180 min training sessions per week (physical training included), with at least 3 years of previous swimming practice.

Measures

A total of 825 individual performances (423 from female, and 402 from male lifesavers) were recorded by means of the official stopwatch of competition, and one or two video cameras (GoPro HERO 3, GoPro, Inc., San Mateo, California, USA; sampling at 30 Hz) specifically positioned (at a height of 10 m, and a distance of 10 m from the pool, along the 50-m side of the swimming pool) in relation to each single competition specialty (Figure 1). In particular for the:

1) "Manikin Carry - 50 m" specialty, a camera was fixed at 35 m from the start wall, to register two intermediate times (0-35, 35-50 m);
2) "Manikin Carry with Fins - 100 m", a camera was fixed at the middle point of the 50 m pool, to register two intermediate times (50-75, 75-100 m), after recording a first intermediate time (0-50m) by means of the official stopwatch of competition;
3) "Rescue Medley - 100 m", a camera was fixed at 40 m from the starting pool, to register two intermediate times (0-60, 60-100 m);
4) "Manikin Tow with Fins - 100 m", a camera was fixed at 45 m from the starting pool, to register two intermediate times (50-55, 55-100 m), after recording a first intermediate time (0-50m) by means of the official stopwatch of competition;
5) "Obstacle Swim - 200 m", four intermediate times (0-50, 50-100, 100-150, 150-200 m) have been exclusively recorded by means of the official stopwatch of competition;
6) "Super Lifesaver - 200 m", two cameras were fixed at 5 and 45 m from the starting pool, to register four intermediate times (100-105, 105-150, 150-155, 155-200 m), after recording two beginning intermediate times (0-50, 50-100 m) by means of the official stopwatch of competition.

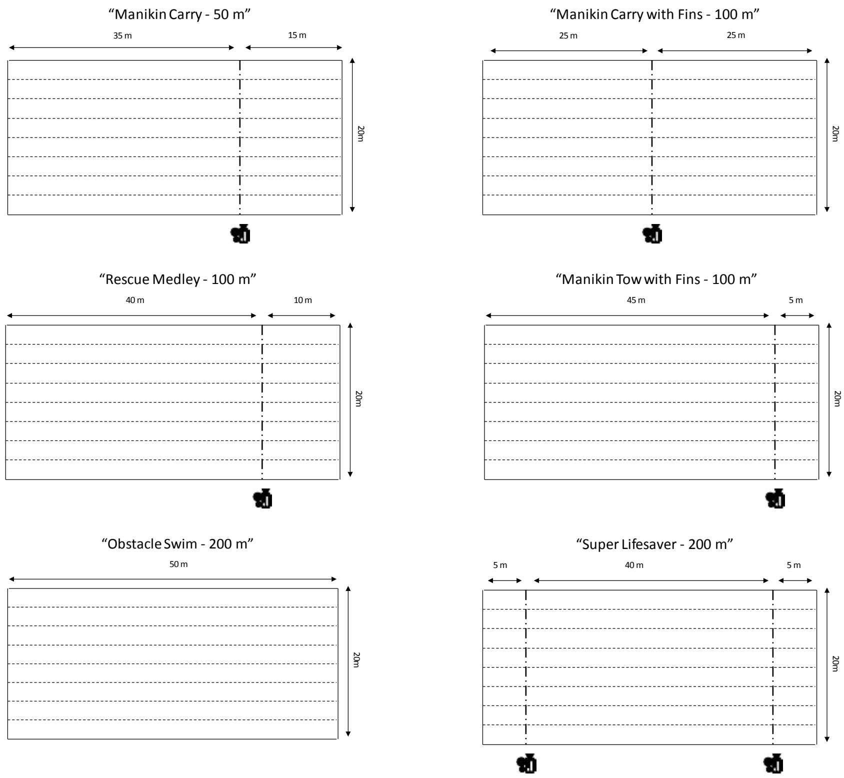


Figure 1. Operational setups of cameras in relation to each of the six specialties performed at the elite Italian Lifesaving Championships (start line at the left board of the pool reported in figure).

Design and procedures

The operator focused the cameras to cover each performance phase of the entire competition, thus allowing to synchronize the stopwatches of each camera with the official stopwatch of competition (managed by technical officials), by means of commercially available software (Dartfish ProSuite, Fribourg, Switzerland), according to a previous study (Lupo, Capranica, Cugliari, Gomez, & Tessitore, 2016).

To avoid inter-observer variability, a single observer (with more than two years of experience) managed the videotapes to record each performance time. However, to assess reliability, the analyst, who completed this study, investigated a randomly chosen part of lifesaving championships twice, where each observation was separated by 14 days, showing a perfect intra-observer test-retest reliability (Intraclass Correlations, ICC = 1).

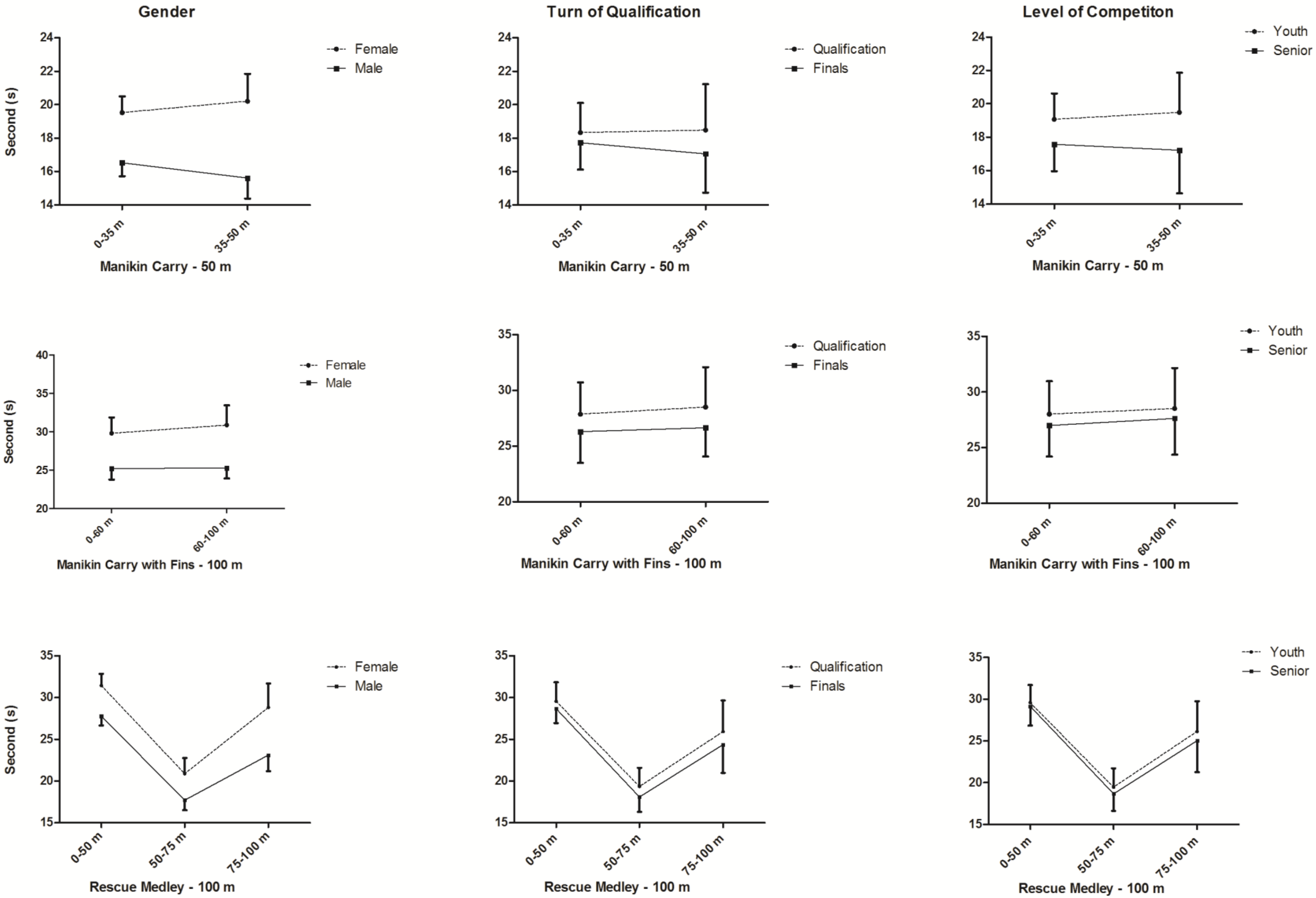
Statistical Analysis

A linear mixed-effects model was applied to each specialty to determine differences in performance times according to genders, turns of competition, age categories. Specifically, the depended variable was the time performance recorded in each specialty, whereas fixed effects were Gender, Turns of Competition, Age categories, time (e.g., intermitted time performance) and their interactions. In order to account error for repeated measure for the same subject, participants were considered as random intercept effect. Only the interactions Time x Gender, Time x Turns of Competition and Time x Age were considered. In case of significance, post hoc pairwise comparisons were performed using Tukey correction. Due to the absence of data related to young female athletes performing finals in the Manikin Tow with Fins - 100 m specialty, only the main effect was calculated. The level of significance was set at 5% ($p < 0.05$). All data were analyzed using statistical package R (version 3.5.2; R Core Team, 2018) with the packages "lme4" (Bates, Mächler, Bolker, & Walker, 2015) and "emmeans" (Lenth, 2019).

3. Results

Means and standard deviations of intermediate time performance for the analyzed elite Italian Lifesaving Championships are plotted for gender, turn of competition, and age category (Figure 2).

The Table 2 reports the estimated mean difference and the main effect of Genders, Turns of Competition, Age categories for each competition specialty. For all considered competition specialties a significant main effect of Genders, Turns of Competition, Age categories was observed.


Gender
Turn of Qualification
Level of Competiton
Second (s)
Female
Male
Qualification
Finals
Youth
Senior
0-35 m
35-50 m
Manikin Carry - 50 m
0-60 m
60-100 m
Manikin Carry with Fins - 100 m
0-50 m
50-75 m
75-100 m
Rescue Medley - 100 m

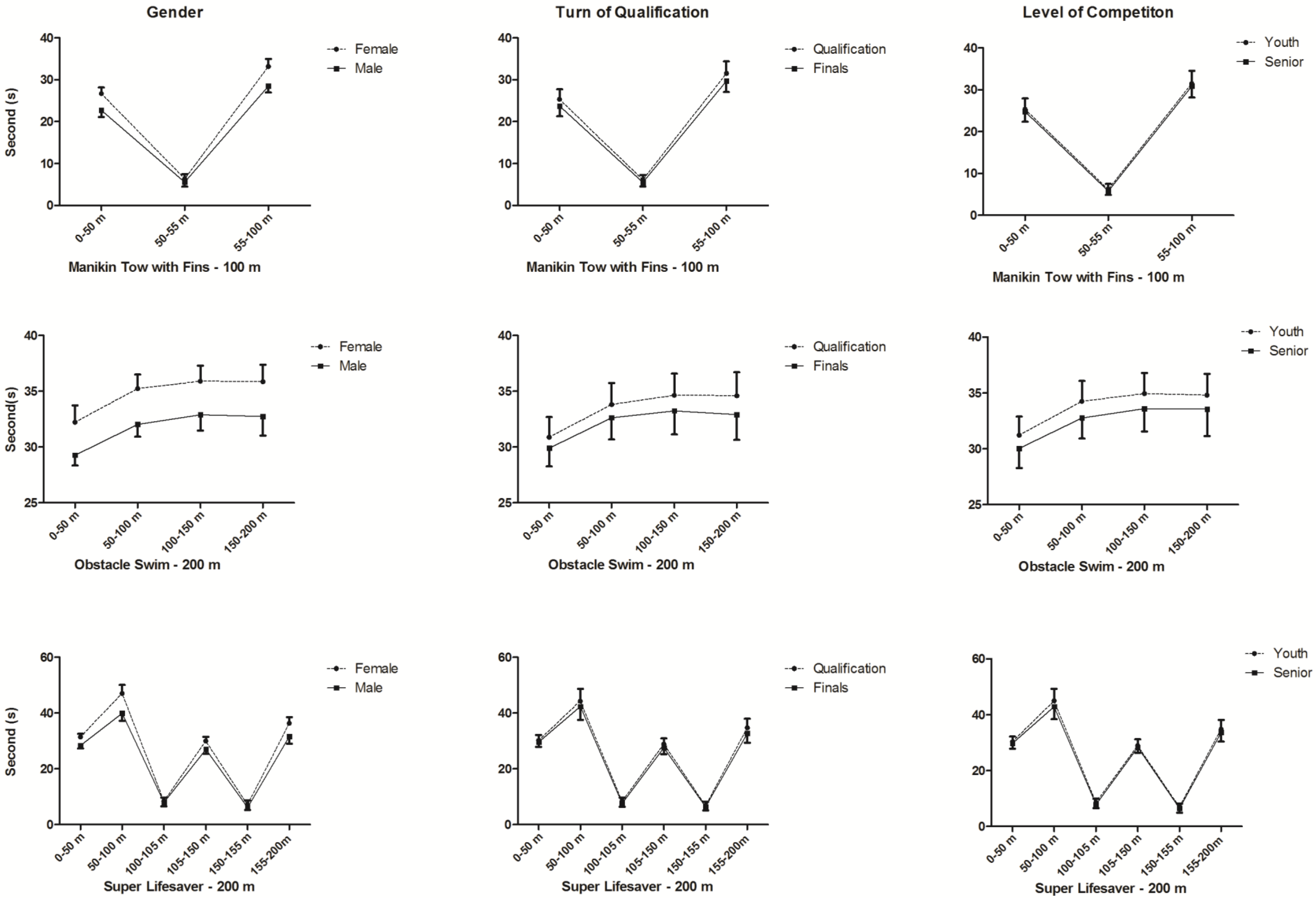

Gender
Turn of Qualification
Level of Competiton
Female
Male
Qualification
Finals
Youth
Senior
Second (s)
Second(s)
0-50 m
50-55 m
55-100 m
Manikin Tow with Fins - 100 m
Manikin Tow with Fins - 100 m
Manikin Tow with Fins - 100 m
0-50 m
50-100 m
100-150 m
150-200 m
Obstacle Swim - 200 m
Obstacle Swim - 200 m
Obstacle Swim - 200 m
0-50 m
50-100 m
100-105 m
105-150 m
150-155 m
155-200m
Super Lifesaver - 200 m
Super Lifesaver - 200 m
Super Lifesaver - 200 m

Figure 2. Means and standard deviations of intermediate time performance of the elite Italian Lifesaving Championships in each specialty and in relation to gender, turn of competition, and age category.

Table 2. Estimated mean Difference (95% CI) of the time performance of each specialty, in relation to genders, Turn of qualification and Age groups.

	Gender		Turn of qualification		Age	
Specialty	Estimated mean Difference (95% CI)	p	Estimated mean Difference (95% CI)	p	Estimated mean Difference (95% CI)	p
Manikin Carry - 50 m (s)	-3.44 (-3.84, -3.04)	<0.001	-1.03 (-1.43, -0.63)	<0.001	-1.04 (-1.44, -0.64)	<0.001
Manikin Carry with Fins - 100 m (s)	-4.81 (-5.38, 4.25)	<0.001	-1.61 (-2.18, -1.05)	<0.001	-1.52 (-2.09, -0.96)	<0.001
Rescue Medley - 100 m (s)	-4.06 (-4.55, -3.56)	<0.001	-1.59 (-2.08, -1.10)	<0.001	-1.44 (-1.93, -0.193)	<0.001
Manikin Tow with Fins - 100 m (s)	-2.92 (-3.27, -2.58)	<0.001	-1.67 (-2.18, -1.17)	<0.001	-0.88 (-1.29, -0.48)	<0.001
Obstacle Swim - 200 m (s)	-3.09 (-3.48, -2.7)	<0.001	-1.46 (-1.85, -1.06)	<0.001	-1.00 (-1.39, -0.61)	<0.001
Super Lifesaver - 200 m (s)	-3.36 (-3.88, -2.88)	<0.001	-1.19 (-1.67, -0.72)	<0.001	-1.31 (-1.79, -0.84)	<0.001

In terms of interactions related to Manikin Carry - 50 m, significant Time x Gender (F = 23.586, p < 0.001), Time x Turns of competition (F = 12.485, p < 0.001) and Time x Age (F = 4.774, p = 0.03) were observed. In particular, post-hoc analysis showed that male performances resulted better at 0-35 m (estimated mean difference = -2.80 s; 95%CI (-3.43, -2.18); p < 0.001) and 35-50 m (estimated mean difference = -4.07 s; 95%CI (-4.69, -3.45); p < 0.001) in comparison with female counterpart. Moreover, athletes in finals resulted better at 35-50 m (estimated mean difference = -1.49 s; 95%CI (-2.11, -0.87); p < 0.001) in comparison with those of qualification. Finally, senior performances resulted better at 0-35 m (estimated mean difference = -0.75 s; 95%CI (-1.37, -0.13); p = 0.01) and 35-50 m (estimated mean difference = 2.28 s; 95%CI (-1.95, -0.70); p < 0.001) than those of youth subgroup.

On the contrary, despite no significant Time interactions were observed for Manikin Carry with Fins - 100 m, Gender x Age resulted significant (F = 4.283, p < 0.001). In particular, it was reported that male senior athletes (n = 49) reported better performances than senior gender counterparts (n = 32; estimated mean difference = - 4.219 s; 95%CI (-3.14, -5.30); p < 0.001), male young athletes (n = 39) reported better performances than young gender counterparts (n = 36; estimated mean difference = - 5.408 s; 95%CI (-6.44, -4.37); p < 0.001), and female senior athletes reported better performances than female age counterparts (estimated mean difference = - 2.12 s; 95%CI (-3.19, -1.05); p < 0.001).

Considering Rescue Medley - 100 m, significant Time x Gender (F = 35.699, p < 0.001), Time x Turns of competition (F = 3.449, p = 0.033) and Time x Age (F = 7.621, p < 0.001) were reported. In particular, male athletes were better at 0-50 m (estimated mean difference = - 3.46 s; 95%CI (-4.35, -2.57); p < 0.001), 50-75 m (estimated mean difference = - 3.09 s; 95%CI (-3.98, -2.20); p < 0.001), and 75-100 m (estimated mean difference = - 5.61 s; 95%CI (-6.50, -4.72); p < 0.001) in comparison with female counterpart. Athletes in final reported better performance at 0-50 m (estimated mean difference = - 1.20 s; 95%CI (-2.09, -0.31); p = 0.002), 50-75 m (mean difference = -1.53 s; 95%CI (-2.42, -0.64); p < 0.001) and 75-100 m (mean difference = -2.04 s; 95%CI (-2.93, -1.15); p < 0.001). Senior performances were better at 0-50 m (estimated mean difference = -0.95 s; 95%CI (-1.84, -0.06); p = 0.02), 50-75 m (estimated mean difference = -1.22 s; 95%CI (-2.11, -0.33); p < 0.001) and 75-100 m (estimated mean difference = -2.15 s; 95%CI (-3.04, -1.26); p < 0.001) than those of youth lifesavers.

For Manikin Tow with Fins - 100 m, only Time x Gender (F = 89.671, p < 0.001) and Time x Turns of competition (F = 3.548, p = 0.03) resulted significant. However, because of the absence of data related to young female athletes performing finals in this specialty, only the main effect was reported.

Considering Obstacle Swim - 200 m, a significant Time x Turns of competition ($F = 5.443$, $p = 0.001$) and Turn of competition x Age ($F = 7.394$, $p < 0.001$) were observed. Athletes in finals reported better performance at 0-50 m (estimated mean difference = -1.13 s; 95%CI (-1.83, -0.44); $p < 0.001$), 50-100 m (estimated mean difference = -1.32 s; 95%CI (-2.01, -0.69); $p < 0.001$), 100-150 m (estimated mean difference = -1.53 s; 95%CI (2.22, -0.83); $p < 0.001$), and 150-200m (estimated mean difference = -1.85 s; 95%CI (-2.54, -1.15); $p < 0.001$) than in the qualification turns. In addition, senior and young athletes reported better performances (i.e., total time of specialty) in finals (senior n = 15; young n = 16) than in qualifications (senior n = 55; young n = 48). In addition, a significant interaction emerged also between turn of competition and age ($F = 7.127$, $p < 0.001$). In particular, it was reported that both senior (estimated mean difference = - 1.992 s; 95%CI (-2.72, -1.26); $p < 0.001$) and young athletes reported better performances in finals (estimated mean difference = - 0.918 s; 95%CI (-1.65, -0.19); $p = 0.007$) than in qualifications (n = 48), and senior athletes reported better performances than young ones in finals (estimated mean difference = - 1.534 s; 95%CI (-2.43, -0.64); $p < 0.001$).

Finally considering Super Lifesaver - 200 m, significant Time x Gender ($F = 58.559$, $p < 0.001$), Time x Turns of competition ($F = 4.527$, $p < 0.001$) and Time x Age ($F = 6.986$, $p < 0.001$) were observed. Male performances resulted better at 0-50 m (estimated mean difference = - 2.87 s; 95%CI (-4.13, -1.62); $p < 0.001$), 50-100 m (estimated mean difference = 7.28s; 95%CI (-8.54, -6.03); $p < 0.001$), 105-150 m (estimated mean difference = - 3.23 s; 95%CI (-4.56 -2.04); $p < 0.001$), and 155-200m (estimated mean difference = - 5.03 s; 95%CI (-6.28- 3.77); $p < 0.001$), but not in 100-105 m and 150-155 m in comparison with female counterpart. Final lifesavers reported better performances compared with those of qualifications, for 50-100 m (estimated mean difference = -2.00 s; 95%CI (-3.25, -0.74); $p < 0.001$), 105-150 m (estimated mean difference = -1.34 s; 95%CI (-2.60, -0.08); p < 0.001and 155-200 m (estimated mean difference = -2.00 s; 95%CI (-3.25, -0.74); $p < 0.001$), but not for 0-50 m, 100-105 m, 105-150 m, and 150-155 m. Finally, senior lifesavers reported better performances than youth ones, for 50-100 m (estimated mean difference = -2.92 s; 95%CI (-4.17, -1.66); $p < 0.001$) and 155-200 m (estimated mean difference = -1.66 s; 95%CI (-2.91, -0.40); $p = 0.001$), but not for 0-50 m, 100-105 m, 105-150 m, and 150-155 m.

4. Discussion

To our knowledge, this study aimed at analysing official lifesaving performances for the first time. In fact, considering that there is no research on lifesaving disciplines, the information of the present paper can provide a useful picture of this aquatic sport in relation to genders, turns of competition, and age categories.

In line with the experimental hypothesis, the main finding of the present study is that lifesaving competition has a significant impact on the observed variables. In fact, for each specialty, performances related to male, senior and finalist athletes resulted better than those reported by the gender and age, and turn of qualification counterparts, respectively.

According to literature (Chiodo et al., 2012; Knechtle, Baumann, Knechtle, & Rosemann, 2010), the better results of male performances in the gender comparison could have been easily expected. Nevertheless, the consideration of specific competition phases (i.e., in "Manikin Carry with Fins - 100 m", and "Obstacle Swim - 200 m") did not confirm the absoluteness of this tendency, highlighting how the presence of technical drill phases can make more complex the lifesaving performance analysis with respect to swimming, which can be easily associated with different strength levels between genders.

For the comparisons regarding the turn of competition, the better final performances reported in the present study resulted controversial if compared to what usually happens in other sport competitions characterized by similar competition schedules (i.e., more turns of competition in a unique day). For example, in taekwondo championships, no difference between qualifications and finals was reported in terms of intensity, speculating that athletes need of performing at a high intensity even during qualifications to avoid exclusion (Chiodo et al., 2011). On the contrary, successful lifesavers seem to have the opportunity to control their performance during the qualification turns to preserve efforts potentially useful for finals. However, this effect is absent for the first intermediate time of the "Manikin carry - 50 m" trial and for the "Manikin carry with fins - 100 m" in general, reducing the absoluteness of this finding, and highlighting the need of further analyses.

Considering that elite swimmers use to get their peak performance quite early (Rüst, Knechtle, & Rosemann, 2012), especially if compared with other sport athletes (Allen & Hopkins, 2015; Boccia et al., 2018), it is not surprising that young lifesavers demonstrated to be able to register performance similar to adult ones (i.e., in "Manikin Carry with Fins - 100 m", "Obstacle Swim - 200 m", and three intermediate times of "Super Lifesaver - 200 m"), even obtaining one of the eight best absolute times (i.e., enter the finals "A").

In addition to these findings, the present study reported significances for all interactions between gender and age related to the "Manikin Carry with Fins - 100 m" specialty, excepting for male youth and senior performances. In addition, for “Obstacle Swim - 200 m”, significances emerged for all interactions between turn of qualification and age, excepting for qualification performances of youth and senior lifesavers. Therefore, despite only for these two specialties and with partial interactions (i.e., not confirmed by other results), it could be suggested that lifesaving performance is not always influenced by the discrimination of youth and senior athletes.

From a methodological point of view, the present study reported a limitation about the recording of the performance times, which was obtained by means of the official stopwatch of Championships and those of the two used cameras. In fact, despite the last devices were synchronized with the official time of competition, they recorded at 30 Hz of sampling, whereas the official stopwatch was set at 100 Hz. Nevertheless, the perfect intra-observed reliability reported by the analyst suggests that this analysis can be considered satisfactory. In addition, this study considered a national competitive contest, recruiting only Italian athletes. Therefore, further studies on international lifesaving championships are needed to confirm or contradict the present findings, promoting analyses of different competition levels (i.e., World and European Championships), categories of swimmers (i.e., finalists, best ranked athletes, etc.), and competitive conditions (i.e., morning versus afternoon trials, indoor versus outdoor competitions, etc.). Finally, similarly to previous performance analyses (Casolino et al., 2012; Lupo, Capranica, Ammendolia, Rizzuto, & Tessitore, 2012; Lupo et al., 2016), an integrated approach (i.e., technical analysis, pace strategy, physiological parameters, monitoring of internal loads) on lifesaving competitions and training sessions could provide the most valuable contribute to the knowledge of this sport.

5. Conclusion

The present study represents the first attempt to analyse lifesaving official performance in relation to athletes’ gender, turn of competition, and age category. Strong effects emerged in the comparison between male and female performance, whereas minor emphases can be associated with the comparisons between qualification and final turns of competition, and senior and youth age categories. Nevertheless, these data constitute a valuable reference for coaches, conditioners, and sport scientists to be highly aware about the lifesaving performances in relation to specific competitive phases. Moreover, in terms of practical applications, even though stroke length is relevant for swimming speed also among different youth categories (Tsalis et al., 2012), training sessions orientated to improve players’ strength could crucially contribute to be successful in competition. For this objective, common swimming (i.e., repetition of longer or equal swimming competitive distance) and dry-land workouts could be useful. In particular, for the last training area, squat and countermovement jump, and pull-up exercises were recognized as valuable exercises for improving strength of lower and upper limbs in swimming, respectively (Crowley, Harrison, & Lyons, 2018; Pérez-Olea, Valenzuela, Aponte, & Izquierdo, 2018), favouring the hypothesis that dry-land workouts could generate improvements also in lifesaving, contributing to improve both swimming and technical parts of competition.

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Abstract

The aim of this study was to analyze elite lifesavers' official performances according to specific intermediate times recorded during each specialty, and comparing them in relation to genders, turns of competition (qualifications; finales), and age (seniors; youths) categories. For this purpose, the intermediate times of 825 (female: 423, male: 402) individual performances were recorded by means of the official stopwatch of championship and two video cameras synchronized with the official stopwatch of competition. A linear mixed-effects model was applied to verify subgroup differences ($p \leq 0.05$). For single specialty, differences emerged for each observed variables ($p \leq 0.001$). Differences (p range: < 0.001 – 0.03) were confirmed for the interactions with specific intermediate times, excepting for those in "Manikin Tow with Fins - 100 m" with each variable, in "Manikin Carry with Fins - 100 m" with age, and in "Obstacle Swim - 200 m" with gender and age. Therefore, elite lifesaving coaches will be able to benefit from the results of this study, considering specific performances, avoiding any generalization, and promoting more aware training sessions.

Key words: aquatic sports, lifesaving, video analysis, swimming performance, intermediate times.

1. Introduction

Lifesaving is an aquatic discipline originated to provide a service to society and human life. Nevertheless, competitive lifesaving has become a very popular sport over the last century, promoting new and effective techniques (Booth, 2000). Guidelines, rules, and regulations for competitive lifesaving at youth and senior levels, in swimming pools and open water, have been officially established at national and international contests (International Life Saving Federation (ILSF), 2019). Italy is one of the founding nations of the ILSF, and elite (i.e., both youth and senior lifesavers included) Italian Lifesaving Championships are regularly organized in line with the international rules, consisting of ocean and pool events (Federazione Italiana Nuoto (FIN), 2019). For the latter type of competition, six individual specialties (and other three competed as team) are performed.

In the “Manikin Carry - 50 m” specialty, the lifesaver swims 25 m freestyle, then dives to recover a submerged manikin to the surface within 5 m of the pick-up line, and finally carries the manikin to touch the finish wall of the pool. In “Manikin Carry with Fins - 100 m”, the lifesaver swims 50 m freestyle wearing fins, then recovers a submerged manikin to the surface within 10 m of the turn wall, and finally carries the manikin to touch the finish wall of the pool. In “Rescue Medley - 100 m”, the lifesaver swims 50 m freestyle to turn, dive, and swim underwater to a submerged manikin located at 17.5 m from the turn wall, then surfaces the manikin within the 5 m pick-up line, and finally carries it the remaining distance to touch the finish wall. In “Manikin Tow with Fins - 100 m”, the lifesaver swims 50 m freestyle with fins and rescue tube; after touching the turn wall, and within the 5 m pick-up zone, the lifesaver fixes the rescue tube correctly around a manikin and tows it to the finish. In “Obstacle Swim - 200 m”, the lifesaver swims the 200 m course passing eight times under the immersed obstacles (located at 12.5 m from the two poolside, at the bottom of pool) to touch the finish wall of the pool. Finally, in “Super Lifesaver - 200 m”, the lifesaver swims 75 m freestyle and then dives to recover a submerged manikin; successively, the lifesaver surfaces the manikin within the 5 m pick-up zone, and carries it to the turn wall; after touching the wall the lifesaver releases the manikin; finally, in the water, the lifesaver wears fins and rescue tube and swims 50 m freestyle, and after touching the wall, and within the 5 m pick-up zone, fixes the rescue tube correctly around a manikin and tows it to the finish (International Life Saving Federation (ILSF), 2019). Usually elite Italian Lifesaving Championships are planned into two consecutive days of competition (i.e., qualifications in the mornings; finals in the afternoons). The eight best swimmers (youth athletes potentially included) for each specialty at the qualifications could access to the finals "A", whereas the eight youth best ones (excluding eventual youth athletes already qualified into the final "A") could participate in the "youth finals".

Research on lifesavers has been focused on psychological aspects such as the ability of minimizing the occurrence of anxiety in dangerous circumstances to favour an effective decision making (Avramidis, 1998; Avramidou, Avramidis, & Pollman, 2007). Moreover, lifesaving has been also studied for the leg techniques adopted during performance. In particular, Rejman et al. (2012) have demonstrated that "dolphin leg" is less convenient than "crawl leg", despite the first swimming technique could be considered as valuable training practice. Similarly, in a more recent study (Abraldes, Stallman, Soares, & Queiroga, 2014), the lifesaver's speed and fatigue index in the 4x25 m carrying manikin test have been evaluated by comparing breaststroke, scissors, flutter, and dolphin kicks, clearly reporting that the first two kick techniques are more convenient to maximize speed and minimize fatigue index than the others.

However, at present, research on lifesaving is quite limited and mainly focused on rescue, whereas no study has been provided on competitive performance, which is a sport discipline characterized by specific techniques. In fact, Stallman and Hillman (2012) highlighted that lifesavers in real rescue and competitions are characterized by different swimming techniques such as the positioning of their head up to see the victim during a rescue, and downward to swim as fast as possible during a competition.

Regardless of rescue and competitive sport discrimination, lifesaving combines elements of swimming, rowing, surfing, and running. Also, over time the lifesaving skills have been developed into competitive sport events for all ages (Avramidou et al., 2007). Nevertheless, no specific reference on the competitions of this sport discipline has been yet provided, highlighting the need of investigations to obtain substantial information and practical applications for training. In fact, not only swimming, but also technical drills are fundamental in this sport. As consequence, performance analyses focused on specific phases can be enormously useful for lifesaving coaches, and strength and conditioning trainers who aspire to apply more aware and effective training exercises.

Thus, the aim of this study was to investigate elite Italian lifesavers' performances during the elite national championships by considering specific intermediate times of each specialty, and comparing them in relation to genders, turns of competitions (qualifications; finales), and age categories (seniors; youths). In particular, it has been hypothesized that intermediate times recorded for the six lifesaving specialties are strongly different (i.e., with medium or large effect sizes; ESs) between: i) male and female; ii) qualification and final turns of competitions; and iii) youth and elite categories.

2. Methods

Participants

The local Institutional Review Board approved this study to analyze the lifesavers' performances of the 2017 elite Italian Championships (Milan, April 22-23, 2017; between 9 a.m. and 7 p.m. in both days). Six-hundred-forty-seven lifesavers (332 female, 20±1 years; 315 male, 21±1 years) which participated in the Championships were recruited for this study. In particular, the distribution of participants in relation to each specialty, gender, turn of competition, and age category are reported in table 1.

Table 1. Distribution of participants at the 2017 elite Italian Lifesavers Championships for each specialty and in relation to gender, turn of competition, and age category.

Specialty	Gender		Turn of competition		Age category		Total
	Female	Male	Qualifications	Finals	Youth	Senior	
Manikin Carry - 50 m	73	59	101	31	54	78	132
Manikin Carry with Fins - 100 m	68	88	124	32	81	75	156
Rescue Medley - 100 m	73	71	113	31	68	76	144
Manikin Tow with Fins - 100 m	83	61	116	28	67	77	144
Obstacle Swim - 200 m	63	71	103	31	64	70	134
Super Lifesaver - 200 m	63	52	89	26	51	64	115

According to the elite Italian coaches and physical trainers, the lifesavers participating in the elite Italian Lifesaving Championships usually perform a minimum of four to a maximum of eight 120-180 min training sessions per week (physical training included), with at least 3 years of previous swimming practice.

Measures

A total of 825 individual performances (423 from female, and 402 from male lifesavers) were recorded by means of the official stopwatch of competition, and one or two video cameras (GoPro HERO 3, GoPro, Inc., San Mateo, California, USA; sampling at 30 Hz) specifically positioned (at a height of 10 m, and a distance of 10 m from the pool, along the 50-m side of the swimming pool) in relation to each single competition specialty (Figure 1). In particular for the:

1) “Manikin Carry - 50 m” specialty, a camera was fixed at 35 m from the start wall, to register two intermediate times (0-35, 35-50 m);
2) “Manikin Carry with Fins - 100 m”, a camera was fixed at the middle point of the 50 m pool, to register two intermediate times (50-75, 75-100 m), after recording a first intermediate time (0-50m) by means of the official stopwatch of competition;
3) “Rescue Medley - 100 m”, a camera was fixed at 40 m from the starting pool, to register two intermediate times (0-60, 60-100 m);
4) “Manikin Tow with Fins - 100 m”, a camera was fixed at 45 m from the starting pool, to register two intermediate times (50-55, 55-100 m), after recording a first intermediate time (0-50m) by means of the official stopwatch of competition;
5) “Obstacle Swim - 200 m”, four intermediate times (0-50, 50-100, 100-150, 150-200 m) have been exclusively recorded by means of the official stopwatch of competition;
6) “Super Lifesaver - 200 m”, two cameras were fixed at 5 and 45 m from the starting pool, to register four intermediate times (100-105, 105-150, 150-155, 155-200 m), after recording two beginning intermediate times (0-50, 50-100 m) by means of the official stopwatch of competition.

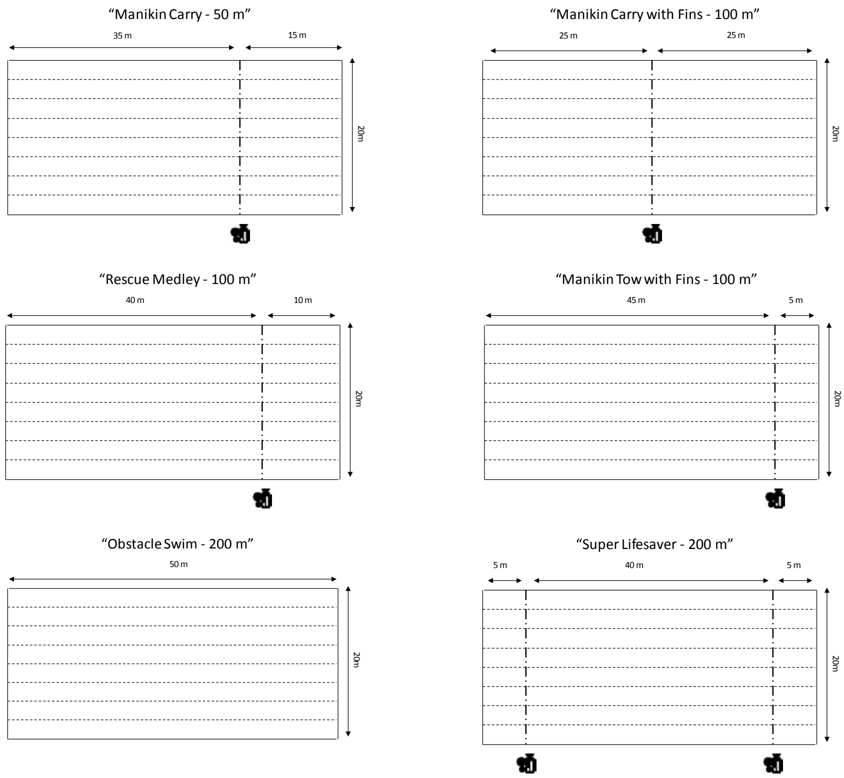


Figure 1. Operational setups of cameras in relation to each of the six specialties performed at the elite Italian Lifesaving Championships (start line at the left board of the pool reported in figure).

Design and procedures

The operator focused the cameras to cover each performance phase of the entire competition, thus allowing to synchronize the stopwatches of each camera with the official stopwatch of competition (managed by technical officials), by means of commercially available software (Dartfish ProSuite, Fribourg, Switzerland), according to a previous study (Lupo, Capranica, Cugliari, Gomez, & Tessitore, 2016).

To avoid inter-observer variability, a single observer (with more than two years of experience) managed the videotapes to record each performance time. However, to assess reliability, the analyst, who completed this study, investigated a randomly chosen part of lifesaving championships twice, where each observation was separated by 14 days, showing a perfect intra-observer test-retest reliability (Intraclass Correlations, ICC = 1).

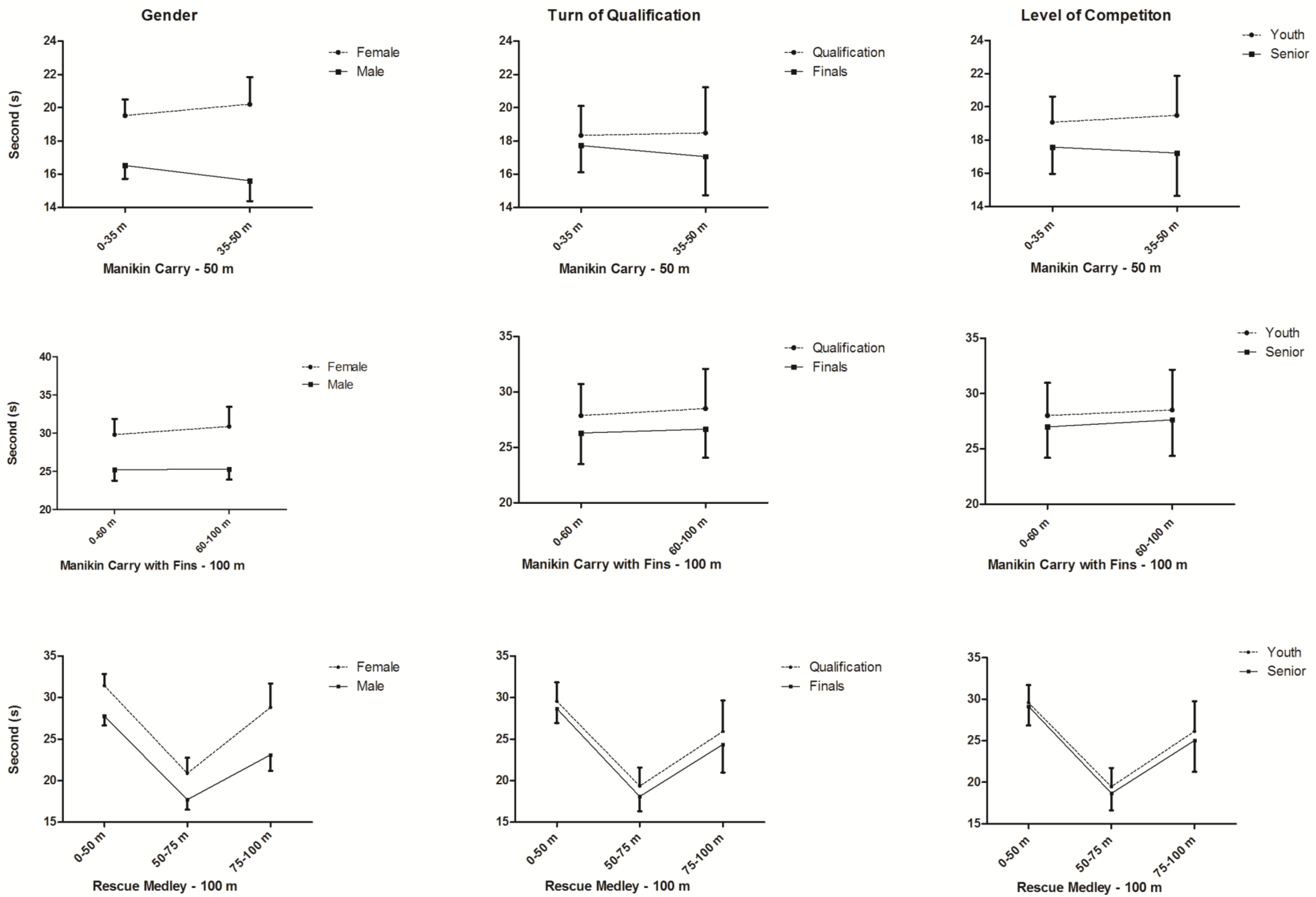
Statistical Analysis

A linear mixed-effects model was applied to each specialty to determine differences in performance times according to genders, turns of competition, age categories. Specifically, the depended variable was the time performance recorded in each specialty, whereas fixed effects were Gender, Turns of Competition, Age categories, time (e.g., intermitted time performance) and their interactions. In order to account error for repeated measure for the same subject, participants were considered as random intercept effect. Only the interactions Time x Gender, Time x Turns of Competition and Time x Age were considered. In case of significance, post hoc pairwise comparisons were performed using Tukey correction. Due to the absence of data related to young female athletes performing finals in the Manikin Tow with Fins - 100 m specialty, only the main effect was calculated. The level of significance was set at 5% ($p < 0.05$). All data were analyzed using statistical package R (version 3.5.2; R Core Team, 2018) with the packages "lme4" (Bates, Mächler, Bolker, & Walker, 2015) and "emmeans" (Lenth, 2019).

3. Results

Means and standard deviations of intermediate time performance for the analyzed elite Italian Lifesaving Championships are plotted for gender, turn of competition, and age category (Figure 2).

The Table 2 reports the estimated mean difference and the main effect of Genders, Turns of Competition, Age categories for each competition specialty. For all considered competition specialties a significant main effect of Genders, Turns of Competition, Age categories was observed.



Gender
Turn of Qualification
Level of Competiton
Female
Male
Qualification
Finals
Youth
Senior
Second (s)
0-35 m
35-50 m
Manikin Carry - 50 m
0-60 m
60-100 m
Manikin Carry with Fins - 100 m
0-50 m
50-75 m
75-100 m
Rescue Medley - 100 m

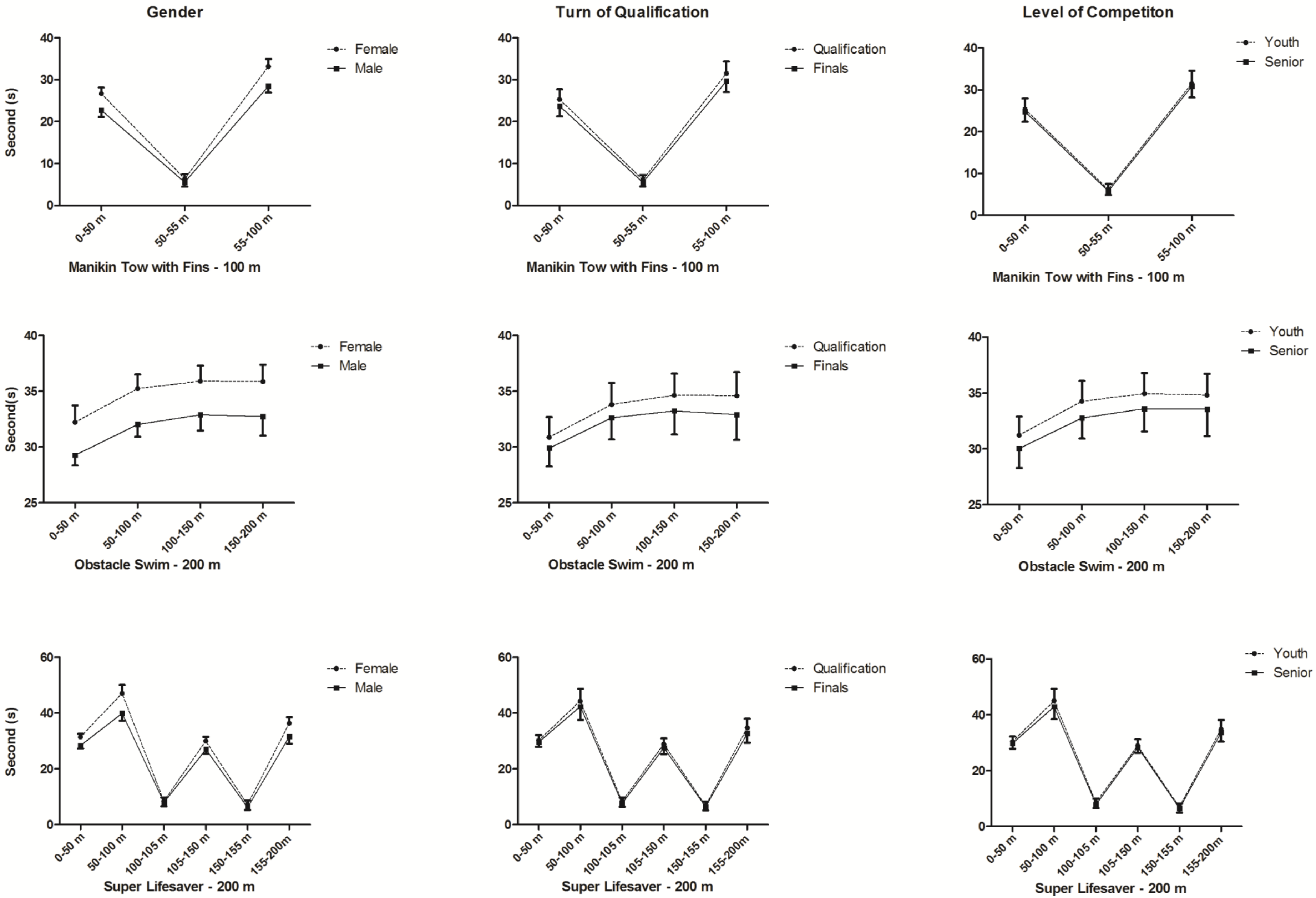

Gender
Turn of Qualification
Level of Competiton
Second (s)
Female
Male
Qualification
Finals
Youth
Senior
0-50 m
50-55 m
55-100 m
Manikin Tow with Fins - 100 m
Manikin Tow with Fins - 100 m
Manikin Tow with Fins - 100 m
Second(s)
0-50 m
50-100 m
100-150 m
150-200 m
Obstacle Swim - 200 m
Obstacle Swim - 200 m
Obstacle Swim - 200 m
Second (s)
0-50 m
50-100 m
100-105 m
105-150 m
150-155 m
155-200m
Super Lifesaver - 200 m
Super Lifesaver - 200 m
Super Lifesaver - 200 m

Figure 2. Means and standard deviations of intermediate time performance of the elite Italian Lifesaving Championships in each specialty and in relation to gender, turn of competition, and age category.

Table 2. Estimated mean Difference (95% CI) of the time performance of each specialty, in relation to genders, Turn of qualification and Age groups.

	Gender		Turn of qualification		Age	
Specialty	Estimated mean Difference (95% CI)	p	Estimated mean Difference (95% CI)	p	Estimated mean Difference (95% CI)	p
Manikin Carry - 50 m (s)	-3.44 (-3.84, -3.04)	<0.001	-1.03 (-1.43, -0.63)	<0.001	-1.04 (-1.44, -0.64)	<0.001
Manikin Carry with Fins - 100 m (s)	-4.81 (-5.38, 4.25)	<0.001	-1.61 (-2.18, -1.05)	<0.001	-1.52 (-2.09, -0.96)	<0.001
Rescue Medley - 100 m (s)	-4.06 (-4.55, -3.56)	<0.001	-1.59 (-2.08, -1.10)	<0.001	-1.44 (-1.93, -0.193)	<0.001
Manikin Tow with Fins - 100 m (s)	-2.92 (-3.27, -2.58)	<0.001	-1.67 (-2.18, -1.17)	<0.001	-0.88 (-1.29, -0.48)	<0.001
Obstacle Swim - 200 m (s)	-3.09 (-3.48, -2.7)	<0.001	-1.46 (-1.85, -1.06)	<0.001	-1.00 (-1.39, -0.61)	<0.001
Super Lifesaver - 200 m (s)	-3.36 (-3.88, -2.88)	<0.001	-1.19 (-1.67, -0.72)	<0.001	-1.31 (-1.79, -0.84)	<0.001

In terms of interactions related to Manikin Carry - 50 m, significant Time x Gender (F = 23.586, p < 0.001), Time x Turns of competition (F = 12.485, p < 0.001) and Time x Age (F = 4.774, p = 0.03) were observed. In particular, post-hoc analysis showed that male performances resulted better at 0-35 m (estimated mean difference = -2.80 s; 95%CI (-3.43, -2.18); p < 0.001) and 35-50 m (estimated mean difference = -4.07 s; 95%CI (-4.69, -3.45); p < 0.001) in comparison with female counterpart. Moreover, athletes in finals resulted better at 35-50 m (estimated mean difference = -1.49 s; 95%CI (-2.11, -0.87); p < 0.001) in comparison with those of qualification. Finally, senior performances resulted better at 0-35 m (estimated mean difference = -0.75 s; 95%CI (-1.37, -0.13); p = 0.01) and 35-50 m (estimated mean difference = 2.28 s; 95%CI (-1.95, -0.70); p < 0.001) than those of youth subgroup.

On the contrary, despite no significant Time interactions were observed for Manikin Carry with Fins - 100 m, Gender x Age resulted significant (F = 4.283, p < 0.001). In particular, it was reported that male senior athletes (n = 49) reported better performances than senior gender counterparts (n = 32; estimated mean difference = - 4.219 s; 95%CI (-3.14, -5.30); p < 0.001), male young athletes (n = 39) reported better performances than young gender counterparts (n = 36; estimated mean difference = - 5.408 s; 95%CI (-6.44, -4.37); p < 0.001), and female senior athletes reported better performances than female age counterparts (estimated mean difference = - 2.12 s; 95%CI (-3.19, -1.05); p < 0.001).

Considering Rescue Medley - 100 m, significant Time x Gender (F = 35.699, p < 0.001), Time x Turns of competition (F = 3.449, p = 0.033) and Time x Age (F = 7.621, p < 0.001) were reported. In particular, male athletes were better at 0-50 m (estimated mean difference = - 3.46 s; 95%CI (-4.35, -2.57); p < 0.001), 50-75 m (estimated mean difference = - 3.09 s; 95%CI (-3.98, -2.20); p < 0.001), and 75-100 m (estimated mean difference = - 5.61 s; 95%CI (-6.50, -4.72); p < 0.001) in comparison with female counterpart. Athletes in final reported better performance at 0-50 m (estimated mean difference = - 1.20 s; 95%CI (-2.09, -0.31); p = 0.002), 50-75 m (mean difference = -1.53 s; 95%CI (-2.42, -0.64); p < 0.001) and 75-100 m (mean difference = -2.04 s; 95%CI (-2.93, -1.15); p < 0.001). Senior performances were better at 0-50 m (estimated mean difference = -0.95 s; 95%CI (-1.84, -0.06); p = 0.02), 50-75 m (estimated mean difference = -1.22 s; 95%CI (-2.11, -0.33); p < 0.001) and 75-100 m (estimated mean difference = -2.15 s; 95%CI (-3.04, -1.26); p < 0.001) than those of youth lifesavers.

For Manikin Tow with Fins - 100 m, only Time x Gender (F = 89.671, p < 0.001) and Time x Turns of competition (F = 3.548, p = 0.03) resulted significant. However, because of the absence of data related to young female athletes performing finals in this specialty, only the main effect was reported.

Considering Obstacle Swim - 200 m, a significant Time x Turns of competition ($F = 5.443$, $p = 0.001$) and Turn of competition x Age ($F = 7.394$, $p < 0.001$) were observed. Athletes in finals reported better performance at 0-50 m (estimated mean difference = -1.13 s; 95%CI (-1.83, -0.44); $p < 0.001$), 50-100 m (estimated mean difference = -1.32 s; 95%CI (-2.01, -0.69); $p < 0.001$), 100-150 m (estimated mean difference = -1.53 s; 95%CI (2.22, -0.83); $p < 0.001$), and 150-200m (estimated mean difference = -1.85 s; 95%CI (-2.54, -1.15); $p < 0.001$) than in the qualification turns. In addition, senior and young athletes reported better performances (i.e., total time of specialty) in finals (senior n = 15; young n = 16) than in qualifications (senior n = 55; young n = 48). In addition, a significant interaction emerged also between turn of competition and age ($F = 7.127$, $p < 0.001$). In particular, it was reported that both senior (estimated mean difference = - 1.992 s; 95%CI (-2.72, -1.26); $p < 0.001$) and young athletes reported better performances in finals (estimated mean difference = - 0.918 s; 95%CI (-1.65, -0.19); $p = 0.007$) than in qualifications (n = 48), and senior athletes reported better performances than young ones in finals (estimated mean difference = - 1.534 s; 95%CI (-2.43, -0.64); $p < 0.001$).

Finally considering Super Lifesaver - 200 m, significant Time x Gender ($F = 58.559$, $p < 0.001$), Time x Turns of competition ($F = 4.527$, $p < 0.001$) and Time x Age ($F = 6.986$, $p < 0.001$) were observed. Male performances resulted better at 0-50 m (estimated mean difference = - 2.87 s; 95%CI (-4.13, -1.62); $p < 0.001$), 50-100 m (estimated mean difference = 7.28s; 95%CI (-8.54, -6.03); $p < 0.001$), 105-150 m (estimated mean difference = - 3.23 s; 95%CI (-4.56 -2.04); $p < 0.001$), and 155-200m (estimated mean difference = - 5.03 s; 95%CI (-6.28- 3.77); $p < 0.001$), but not in 100-105 m and 150-155 m in comparison with female counterpart. Final lifesavers reported better performances compared with those of qualifications, for 50-100 m (estimated mean difference = -2.00 s; 95%CI (-3.25, -0.74); $p < 0.001$), 105-150 m (estimated mean difference = -1.34 s; 95%CI (-2.60, -0.08); $p < 0.001$and 155-200 m (estimated mean difference = -2.00 s; 95%CI (-3.25, -0.74); $p < 0.001$), but not for 0-50 m, 100-105 m, 105-150 m, and 150-155 m. Finally, senior lifesavers reported better performances than youth ones, for 50-100 m (estimated mean difference = -2.92 s; 95%CI (-4.17, -1.66); $p < 0.001$) and 155-200 m (estimated mean difference = -1.66 s; 95%CI (-2.91, -0.40); $p = 0.001$), but not for 0-50 m, 100-105 m, 105-150 m, and 150-155 m.

4. Discussion

To our knowledge, this study aimed at analysing official lifesaving performances for the first time. In fact, considering that there is no research on lifesaving disciplines, the information of the present paper can provide a useful picture of this aquatic sport in relation to genders, turns of competition, and age categories.

In line with the experimental hypothesis, the main finding of the present study is that lifesaving competition has a significant impact on the observed variables. In fact, for each specialty, performances related to male, senior and finalist athletes resulted better than those reported by the gender and age, and turn of qualification counterparts, respectively.

According to literature (Chiodo et al., 2012; Knechtle, Baumann, Knechtle, & Rosemann, 2010), the better results of male performances in the gender comparison could have been easily expected. Nevertheless, the consideration of specific competition phases (i.e., in “Manikin Carry with Fins - 100 m”, and “Obstacle Swim - 200 m”) did not confirm the absoluteness of this tendency, highlighting how the presence of technical drill phases can make more complex the lifesaving performance analysis with respect to swimming, which can be easily associated with different strength levels between genders.

For the comparisons regarding the turn of competition, the better final performances reported in the present study resulted controversial if compared to what usually happens in other sport competitions characterized by similar competition schedules (i.e., more turns of competition in a unique day). For example, in taekwondo championships, no difference between qualifications and finals was reported in terms of intensity, speculating that athletes need of performing at a high intensity even during qualifications to avoid exclusion (Chiodo et al., 2011). On the contrary, successful lifesavers seem to have the opportunity to control their performance during the qualification turns to preserve efforts potentially useful for finals. However, this effect is absent for the first intermediate time of the “Manikin carry - 50 m” trial and for the “Manikin carry with fins - 100 m” in general, reducing the absoluteness of this finding, and highlighting the need of further analyses.

Considering that elite swimmers use to get their peak performance quite early (Rüst, Knechtle, & Rosemann, 2012), especially if compared with other sport athletes (Allen & Hopkins, 2015; Boccia et al., 2018), it is not surprising that young lifesavers demonstrated to be able to register performance similar to adult ones (i.e., in “Manikin Carry with Fins - 100 m”, “Obstacle Swim - 200 m”, and three intermediate times of “Super Lifesaver - 200 m”), even obtaining one of the eight best absolute times (i.e., enter the finals “A”).

In addition to these findings, the present study reported significances for all interactions between gender and age related to the “Manikin Carry with Fins - 100 m” specialty, excepting for male youth and senior performances. In addition, for "Obstacle Swim - 200 m", significances emerged for all interactions between turn of qualification and age, excepting for qualification performances of youth and senior lifesavers. Therefore, despite only for these two specialties and with partial interactions (i.e., not confirmed by other results), it could be suggested that lifesaving performance is not always influenced by the discrimination of youth and senior athletes.

From a methodological point of view, the present study reported a limitation about the recording of the performance times, which was obtained by means of the official stopwatch of Championships and those of the two used cameras. In fact, despite the last devices were synchronized with the official time of competition, they recorded at 30 Hz of sampling, whereas the official stopwatch was set at 100 Hz. Nevertheless, the perfect intra-observed reliability reported by the analyst suggests that this analysis can be considered satisfactory. In addition, this study considered a national competitive contest, recruiting only Italian athletes. Therefore, further studies on international lifesaving championships are needed to confirm or contradict the present findings, promoting analyses of different competition levels (i.e., World and European Championships), categories of swimmers (i.e., finalists, best ranked athletes, etc.), and competitive conditions (i.e., morning versus afternoon trials, indoor versus outdoor competitions, etc.). Finally, similarly to previous performance analyses (Casolino et al., 2012; Lupo, Capranica, Ammendolia, Rizzuto, & Tessitore, 2012; Lupo et al., 2016), an integrated approach (i.e., technical analysis, pace strategy, physiological parameters, monitoring of internal loads) on lifesaving competitions and training sessions could provide the most valuable contribute to the knowledge of this sport.

5. Conclusion

The present study represents the first attempt to analyse lifesaving official performance in relation to athletes' gender, turn of competition, and age category. Strong effects emerged in the comparison between male and female performance, whereas minor emphases can be associated with the comparisons between qualification and final turns of competition, and senior and youth age categories. Nevertheless, these data constitute a valuable reference for coaches, conditioners, and sport scientists to be highly aware about the lifesaving performances in relation to specific competitive phases. Moreover, in terms of practical applications, even though stroke length is relevant for swimming speed also among different youth categories (Tsalis et al., 2012), training sessions orientated to improve players' strength could crucially contribute to be successful in competition. For this objective, common swimming (i.e., repetition of longer or equal swimming competitive distance) and dry-land workouts could be useful. In particular, for the last training area, squat and countermovement jump, and pull-up exercises were recognized as valuable exercises for improving strength of lower and upper limbs in swimming, respectively (Crowley, Harrison, & Lyons, 2018; Pérez-Olea, Valenzuela, Aponte, & Izquierdo, 2018), favouring the hypothesis that dry-land workouts could generate improvements also in lifesaving, contributing to improve both swimming and technical parts of competition.

6. References

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