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Portuguese Lifeguards Performance in Aquatic Rescue: An Exploratory Study

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Cover Page Footnote

The authors acknowledge and thank the lifeguards who participated in this study.

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Abstract

The objective of the study was to compare the performance of Portuguese lifeguards in two trials of simulated rescue at the beach within a regular continuous workday. Additionally, the study aimed to analyse the influence of experience and initial course syllabus on the rescue performance. A total of 86 Portuguese lifeguards (LG) participated in this study, 69 males and 17 females. The two simulated drowning occurrences were planned to occur at 50 meters from the coastline between 9.00h am and 18.00h pm. The weather conditions, the characteristics of the beach, wave amplitude were also controlled. The results were analysed through descriptive and comparative tests and pairwise comparisons. The rescue was performed in less than 6 minutes by 91.9% of the subjects, 5.8% between and 6-10 min and only 2.3% exceeded 10 minutes. No significant differences (p>0.05) were found on the total rescue time between trials and the number of ventilations. The number of training sessions at the beach during the lifesaving course was negatively correlated with a faster rescue trial (r= -0.218; p=0.004). The majority of the Portuguese LG in this study demonstrated the readiness required to conduct a full rescue in less than 6 minutes.

O objetivo do estudo foi comparar o desempenho dos nadadores-salvadores (NS) portugueses em dois ensaios de resgate simulado na praia em um dia de trabalho contínuo e regular. Além disso, o estudo teve como objetivo analisar a influência da experiência e do currículo inicial do curso no desempenho do resgate. Um total de 86 NS portugueses participaram neste estudo, 69 homens e 17 mulheres. As duas ocorrências simuladas de afogamento foram planeadas para ocorrer a 50 metros da costa, entre 9h e 18h. As condições climáticas, as características da praia, a amplitude da onda também foi controlada. Os resultados foram analisados através de testes descritivos e comparativos e comparações aos pares. O resgate foi realizado em menos de 6 minutos por 91,9% dos sujeitos, 5,8% entre 6 e 10 minutos e apenas 2,3% excederam os 10 minutos. Não foram encontradas diferenças significativas (p> 0,05) no tempo total de resgate entre os ensaios e o número de ventilações. O número de sessões de treino na praia durante o curso de nadador-salvador foi correlacionado com um teste de resgate mais rápido (r = -0, 218; p = 0,004). A maioria dos NS portugueses neste estudo demonstrou a prontidão necessária para realizar um resgate completo em menos de 6 minutos.

Keywords: rescue, CPR, lifeguards, drowning prevention,

Introduction

It is estimated that in Portugal there are 106 kilometers of supervised bathing areas and 315 kilometers of unguarded bathing areas. Available data from the Portuguese lifesaving authority, Instituto de Socorros a Náufragos (ISN), indicates that the rate of drowning mortality during summer seasons has lowered in recent years according to the Autoridade Maritima Nacional (AMN, 2016). During the seven summer bathing seasons between the years 2008-2014 a total of 25 people died on patrolled beaches. The highest number of drowning deaths was between 2008 and 2011 with 6 deaths. On unguarded beaches for the identical time period there were a total of 92 deaths. Before 2014 trained and paid lifeguards (LG) were not a recognised profession. In 2015 a governmental regulation implemented and recognized LG training as a profession, increasing the responsibility of each LG to be technically, physically, and psychologically ready to safeguard human life in every aquatic environment recognized as proper bathing places (Law n.º 88/2012, 30 March, 2012).

Portuguese law establishes that to be recognised as a lifeguard, an individual must be approved by completing the lifeguard course and certificated by the ISN. Briefly, the lifeguard's responsibilities and duties are to inform, prevent, help, and provide essential life support under any circumstances in official bathing areas, in public swimming pools, and other places where aquatic activities occur under mandatory surveillance (Law n.º 68/2014, 29th August, 2014).

During drownings, a faster rescue is correlated with a better outcome. It is assumed that a 56% risk of severe neurological injury when a person has been submerged between 6 and 10 minutes (Szpilman, Bierens, Handley, & Orlowski, 2012). Facing an unconscious drowning victim, the possibility to reverse the situation could increase three times if the lifeguard applies the first breaths in the water while holding the victim (Szpilman et al., 2012). So, it is of paramount importance that lifeguards are well acquainted with rescue procedures and are well trained to apply the rescue algorithm by starting the ventilation in the water, reducing the time of hypoxia, and restoring oxygen levels. When this is accomplished, it may be the difference between life and death. Usually on an unconscious drowning victim, ventilation is restored after the first breaths. If not, the lifeguard should tow the person to a safe and dry place to start CPR immediately (Fitz-Clarke, 2017).

The rescue algorithm adopted by Portuguese authorities (School of Maritime Authority, 2011) comprised three main components: recognition, planning, and action. During the recognition phase, the lifeguard facing an emergency should warn other lifeguards and the local lifesaving authorities. Afterwards, the LG should assemble the equipment quickly and must locate and check the number of victims. In this phase, the lifeguard must also evaluate the sea and environmental conditions. In the planning phase, the lifeguard must select the appropriate rescue method (e.g., reach, throw, wade, row, swim, tow) according to the available and appropriate equipment (e.g., float torpedo, rescue belt, rescue board, rescue stick, reel with rescue belt, circular floater). In the third and final action phase, the lifeguard must enter into the water with the rescue equipment, approach the victim using the appropriate swimming technique, address the situation from a safe distance (approximately 4 to 5 meters), and evaluate the victim’s state of consciousness. If the victim is conscious, the lifeguard should communicate with him, transmitting confidence and calm, and then rescue him to a safe location. As soon as possible the victim must be "delivered" to health care personnel, and then the LG should write the rescue report. If the victim is unconscious, the lifeguard should ask for help and begin the airway permeabilization, applying five ventilations and transport him as soon as possible to a safe place where the cardiopulmonary resuscitation compressions should start.

The objective of the study was to compare the performance efficacy in two simulated rescue interventions within a regular, continuous workday of Portuguese lifeguards at the beach. Additionally, we aimed to analyse the influence of other variables, namely the experience, the syllabus content of the initial course, and the mandatory number of training sessions at the beach and the environmental conditions at the moment of the simulated rescue. The respect for the security signals was estimated through the comparison between green and yellow flag conditions.

Method

Study Sample

This study was conducted on 18 beaches of Portugal (north, middle, and south), including the Portuguese Atlantic islands. Eighty-six lifeguards (69 males and 17 females), ages between 18 and 38 years working on the Portuguese maritime beaches, volunteered to participate in the study. Anthropometrics, age, body composition, the experience of the lifeguards, and physical activity level as well as volunteers who simulated drowning victims, were taken into account (Table 1).

Table 1

Mean and standard deviations of age anthropometric characteristics and experience level of the sample.

	Lifeguards	
	Male (n=69)	Female (n=17)
Age (years)	23,5 (4,1)	22,7(2,8)
Body mass (Kg)	75,4 (8,0)	59,2 (5,4)
Stature (cm)	178,4(7,1)	166,5(6,1)
BMI (Kg/m^2)	23,6 (0,22)	21,3 (0,42)
Experience (years)	3,2 (2,9)	3,4(2,7)

Note: The years of experience was determined by the number of working years as a LG and through their official certification every three years.

All participants were aware of the objectives of the study and gave informed and signed written consent. The study was developed and approved by the ISN director, the Portuguese legal authorities for lifesaving affairs. As inclusion criteria to take part in the study, the LG must be on duty during the entire bathing season in progress. On the experimentation day, they could not leave early, enter late, or be absent from the workplace to do external tasks or complementary duties.

Study Protocol

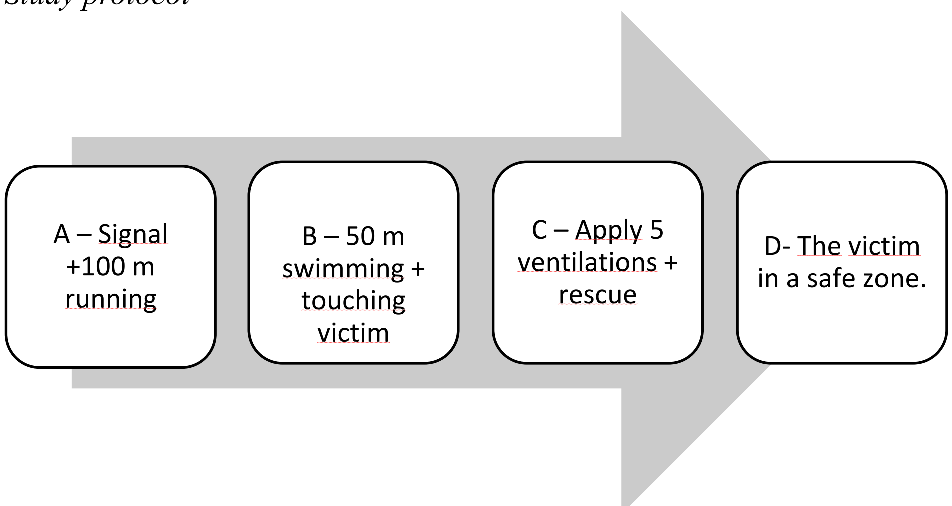
Upon the determination by the national Maritime Authority on the selected workday, the protocol was applied. The volunteer lifeguards needed to participate in two unconscious victim rescue situations: the first one in the morning and the second one during the afternoon. Two evaluators introduced the objectives of the study, and monitored the evaluation protocol. One recorded the time of the different steps while the other controlled whether each participant had complied with the objectives of each rescue phase. The evaluators privately informed the lifeguards that it would be a rescue simulation, and they would have to act according to the methodology for the rescue learned in the LG course. The evaluators reminded the LGs that they should start the rescue procedure after three long beeps. The rescue belt was chosen as the rescue equipment since it showed higher efficiency than the displacer torpedo (Palacios-Aguilar, 2008). After the starting signal, they had to run a total distance of 100 meters, covering 50 meters in front of a fixed spot on the beach where the lifeguard's equipment was placed so they could act they would in an emergency situation, and then turned right to run another 50 meters (these distances were marked in advance). When 'they entered the water', before diving, they put on the flippers, then swam a distance of 50 meters and rescued the victim by towing them to shore. The second evaluator had to randomly choose an individual of morphological similarity to the LG to act as an unconscious victim, to whom it was explained that when the lifeguard approached he had to simulate an unconscious state and remain limp simulating unconsciousness until the end of the drill. Each trial was conducted under either a green or yellow flag condition. The first intervention took place from 9 to 11AM and the second one from 5 to 8PM. These time frames were chosen because they were related to the beginning and end of a working day.

In order to confirm the weather and water temperature, the App "Beach in Direct" was consulted before each intervention. This application provided real-time information on weather conditions of the beaches at *http://praiaemdirecto.com*. A registration form was created to register all the data required. A group of 8 trained evaluators with expertise and skill in rescue, members of ISN and examiners of the lifeguard courses, constituted the research team.

The split and total time spent in the different phases of the simulated rescue were recorded in seconds and were considered as follows:

Step A from the first warning signal (1st whistle to alert) until the first foot touched the water. Step B entry into the water, and swim until make contact with the victim. Step C included the time to ask for extra help, applying the 5 simulated ventilations, and transporting the victim until reaching ground support. Step D corresponded to the remaining time spent in the rescue and transport of the victim to a safe zone to start the cardiopulmonary resuscitation simulation. The distance corresponded to approximately 50 meters from a designated border line.

Figure 1
Study protocol



The total time corresponded to the sum of the 4 steps described above (Figure 1). The location, morphology, sand's type (thick or thin), and signs of security information (coloured flags) about bathing conditions at the beach were registered. A specific form was designed to register the data for further analysis. This protocol was applied on 18 recognised beaches along the Atlantic coast and Portuguese Atlantic islands, Madeira and the Azores.

Statistical Analysis

The results are presented initially through descriptive statistics including the mean, standard deviation, maximum, and minimum. The normality of the data distribution (Shapiro-Wilk) and the homogeneity of variance (*Levene* test) were checked and confirmed. Inferential statistics included comparative and correlation analyses performed through pairwise t-tests and Pearson's correlation coefficients, respectively, or non-parametric equivalent tests when normality assumption was not met. The significance level for all analyses was set at $\alpha \leq 0.05$. All statistical analyses were performed using SPSS software version 21.

Results

The sample showed lifeguards had a low anthropometrics heterogeneity (coefficient of variation ≈9-12% for each anthropometric variable). The mean BMI showed that all males and females included in the study were classified as having normal weight; however, (BMI<25), the mean value of the simulate victims was close to the upper limit of this BMI category (ACSM,2018) (WHO, 1997) with 50,5% of the individuals characterized as overweight (25>BMI>30 which was in accordance to the BMI of the male Portuguese population.

Considering the experience of LG's activity, the study sample showed that 49 LG had not been certified as a lifeguard until the current year (< 3years), and the remaining 37 had already renewed their certification at least once (≥ 3years). Overall, the sample showed a mean experience of lifesaving activity of 5,6 (s.d.=3,2) years. The number of beach training sessions during the certification course averaged only 2,0 (0,9) for males and 2,3 (0,9) for females, respectively. The professional lifeguard experience was recorded through the national authority documentation (ISN). The adherence to regular physical activity showed that 63% of LG considered themselves as active and self-reporting that they exercised regularly in several sports. The split times in the different segments of the rescue trial for each sex and level of experience are presented in Table 2.

In both trials 91,9% of the LG performed the rescue in less than 6 minutes and only 2,3% exceeded 10 minutes. Regarding the total and split times no statistically significant differences were observed between the morning and the afternoon simulated rescue for each level of experience and for the total sample (Table2). Surprisingly, the performances of female LG showed significantly faster results than males in the second trial (t= 3,066; p=0,003). Moreover, the female LG also showed an improvement in the afternoon trial when compared to the morning (t=2,418; p=0,029). The main contribution to this improvement in results resulted from improvements in step A (t= 2,275; p=0,037) and partially in step C (t=1,901; p=0,077). The time spent until the LG was able to give the 5 rescue breaths was less than 1:30 min, and the total mean time needed to perform CPR was less than 5:00 min. As could have been expected, a strong association was found between the total rescue times in the two interventions (r = 0.880, p = <0.001). Nevertheless, the total rescue time, considering both interventions, showed a weak negative association with the number of training sessions in the sea during the certification course or mandatory qualifications (r= -0,218; p=0,004) which also could have been expected due to the two measures correlated.

Table 2
Lifeguard's performance according to level of experience and sex in the simulated rescue in morning (am) and afternoon (pm) sessions

	Experience level		Time A (m:ss)	Time B (m:ss)	Time C (m:ss)	Time D (m:ss)	Total time (m:ss)
AM	< 3 years		0:22 (0:08)	1:18 (0:41)	1:50 (0:52)	1:19 (0:51)	4:49 (1:53)
	≥ 3 years		0:22 (0:08)	1:18 (0:44)	1:46 (1:06)	1:04 (0:39)	4:42 (1:41)
	Total		0:22 (0:08)	1:17 (0:42)	1:48 (0:58)	1:12 (0:46)	4:42 (1:44)
	Sex	Males	0:22 (0:07)	1:20 (0:46)	1:48 (1:01)	1:12 (0:48)	4:47 (1:54)
		Females	0:23 (0:11)	1:08 (0:23)	1:48 (0:46)	1:13 (0:42)	4:24 (0:47)
PM	< 3 years		0:21 (0:08)	1:24 (0:55)	1:50 (0:45)	1:13 (0:58)	4:51(1:42)
	≥ 3 years		0:22 (0:07)	1:21(0:41)	1:38(0:39)	1:15 (1:11)	4:41(1:48)
	Total		0:21 (0:08)	1:22 (0:47)	1:44(0:42)	1:13 (1:13)	4:46 (1:44)
	Sex	Males	0:22 (0:07)	1:26 (0:50)	1:48 (0:43)	1:16 (1:09)	4:56 (1:51)
		Females	0:21 (0:08) [a]	1:08 (0:31)	1:34 (0:42)	1:06 (0:35)	4:01 (0:49) [a, b]

a) Females were faster in the afternoon; b) Females were faster than the males in the afternoon. Time split of each step and total rescue time (mm:ss). Values were expressed as means and standard deviations (Mean (SD))

Table 3
Total rescue time under different flag conditions in the morning (AM) and afternoon (PM) at the swimming place of the rescue drill (Mean (SD).

	Flag color	Time (s)	p
AM	Green (n=75)	4:32 (1:31)	0.030
	Yellow (n=7)	7:14 (2:32)	
PM	Green (n=77)	4:36 (1:38)	0.001
	Yellow (n=7)	6:50 (1:42)	

In the AM rescue, 91% of the LG were tested with the green flag and the remaining within yellow flag conditions. (Table 3). A total time difference in the rescue was found in both trials when the colour of the warning flag was considered (during AM: t=-2,772; p=0,03 and during PM: t=-3,464; p=0,001). Not surprisingly, the time spent in the rescue was longer under yellow flag in both trials since they were performed under more difficult conditions.

Our results showed that the overall conditions were similar. The air temperature (ºC) did not differ between trials (26,4 (4,5) and 26,9 (4,9) between morning and afternoon, respectively). The same could be observed in the seawater temperature (Cº) with 17,6 (3,3) and 17,7 (3,2), respectively, during the morning and afternoon trials. No other significant influences on the rescue trials were observed related to the characteristics of the beaches and the conditions of the sea because the main characteristics were very similar between the several beaches.

Discussion

To our knowledge, this is the first study in Portugal that has evaluated the lifeguards' performance during a workday in a simulated emergency condition performing a repeated rescue situation. It is worthy of note that the lifeguards in the study sample were relatively young despite the fact that the LG profession demands high levels of maturity and responsibility. The least experienced LG did not show a statistically significant worse rescue performance for either trials. Likewise, the more experienced LG did not show a significantly lower or more stable total rescue times although the descriptive differences appeared slightly in that direction. These data could mean that if we had greater statistical power in the study we might have noticed that the level of experience of the LG produced a slightly higher consistency in the rescue readiness, and higher resilience to the workday fatigue.

The consistency of the swimming skill competence should be noted. Those individuals who were faster in the first intervention tended also to be faster in the afternoon due to the strong correlation found between time trials. In the evaluation protocol the B and C steps were those where LG consumed a higher percentage of the total rescue time which highlighted the importance of the specific swimming rescue skills proficiency to correspond to the success in the rescue.

The Royal Life Saving Society of Australia, cited in another study (Reilly et al., 2006) recommended that in an emergency situation the lifeguard must reach or at least approach the victim in a minimum time of 3.5 minutes Another study had concluded that lifeguards must be able to return to the beach with the victim in 6.5 minutes what means less than 10 minutes to prevent the acute cerebral hypoxia (Reilly et al., 2006).

In a study with 40 Swedish LG with the objective to evaluate the time spent in the rescue (Claesson et al., 2011), the authors found that the LG spent an average of 83 seconds from entering the water until reaching the victim (100 m). The victim reached a safe place on the beach to perform CPR in 176 ± 33 seconds. It turned out that LG takes twice as much time to rescue and transport the victim than to reach the victim, and that male lifeguards were significantly faster than female lifeguards in that task.

Comparing our results with those of Claesson and colleagues (2011), we verified that the mean time to reach the victim (time B - from the water line to the victim), varied between 77 and 82 seconds (AM vs. PM respectively) over a distance of 50 m which was half the distance of the Swedish study. We believe that the Portuguese LG could manage to maintain the swimming speed and would probably reach similar values if tested over 100m. We applied the same reasoning to the performance of towing the victim when comparing the results of the studies.

Another important finding was the superior performances by the Portuguese female LG. Particularly at the second trial this gender group showed faster total rescue times. The possible explanation may be grounded in a sociological factor. The Portuguese females who aspired to be LG were very fit and perhaps more focused and motivated to demonstrate their skills in a male-dominated profession, as it is often observed in several professional activities and in the sport field.

To rescue an unconscious drowning victim, often the physical resources available were only propulsion of the lower limbs of the LG and sometimes one submerged arm. This suggested that LG could have an advantage if they underwent specific strength training, in particular of the lower limbs allowing an increase in the efficiency of the kick during the tow. Although the data in this study demonstrated that the Portuguese lifeguards had an adequate swimming level, in the authors' opinion there is always an opportunity to improve the rescue performance if swimming training sessions were a mandatory part of LG regular training during the year.

The results of this study showed that the LG who attended more sea training sessions during their initial certification course, while not statistically significant, tended to have descriptively reduced total times in both interventions. In spite of the weak correlation found, this result might point to a specificity advantage in the LG preparation syllabus of the initial certification course and thus reinforce that advantage of increasing the number of training sessions at the beach.

After examining the effect of the flag conditions over the total time spent in the rescue, a higher total rescue time of 2 to 3 minutes was found under the yellow flag. This result highlighted the importance to respect the security signals present at the beach areas because time to adequately rescue would be comprised.

The results of this study showed that a large proportion of the lifeguards tested were proficient to perform the rescue and transport the victim safely back to the beach to initiate CPR in less than 6-10 minutes. This positive finding could be related to the general fitness and the high proficiency in swimming of the LG. We do recognize that after the initial certification and hiring as LG there may be a lack of specific training in various aspects of lifeguard's competences, which could affect the subsequent performance of lifeguards including, for example, their running speed over the sand, swimming endurance and speed, and strength to perform specific rescue techniques.

The overall results showed that the performance of the Portuguese lifeguards does not vary substantially over the course of the working day. This may be considered an important positive finding because we found that between the morning and the afternoon of the testing day, LG performed very similarly. This consistency can be related to the fact that a large number of participants do regularly exercise. Therefore they were able to repeat demanding physical tasks. Despite the difference in the physical requisites of the LG-specific activity when compared to several sports, a general physical condition program ought to be followed.

Limitations

Some variations in morphological and body composition characteristics of the simulated unconscious victims could have imposed a variation in the rescue times results. Nevertheless, we adopted a more ecological approach to the rescue by using human victims rather than to use a manikin.

Our sample also was not balanced between the number of males and females. The selection of the beaches where the protocol was applied was partially random, and the research team did not know in advance who were the LG on duty. Although strictly close to the usual summer conditions on Portuguese beaches, the weather and water conditions perhaps should have been measured locally and not through the use of the online application. Due to the similarity in results, however, this was probably not a serious concern.

Conclusion

The results concluded that the large majority of the lifeguards who participated in this study could approach the victim in less than 3.30 min. and conduct a rescue transport to a safe zone to start CPR within 6-10 minutes overall. It was discovered that a proportion of the lifeguards didn't exercise regularly based on their self-reports. During the simulated scenario, a large majority of lifeguards fulfilled the rescue algorithm and did not fail at crucial points such as requesting secondary help or applying the initial five ventilations while still in the water. The lifeguards who were more familiar with the sea and had access to learning sessions during their training in the sea had somewhat better rescue proficiency.

The collected data emphasized the importance of respecting the flag indications to conduct rescues efficiently since under yellow flag conditions rescues were observed to be minutes slower in rescue time than when the flag was green. The requirements of the LG physical fitness should be adapted to the specific environment where they develop their activity, strengthening endurance and resistance capacities to assure general and specific physical conditioning associated with their professional functions. The results from the study may help the Portuguese Maritime Authority (ISN) to make decisions related to the graduate course contents and to implement a mandatory professional conditioning schedule, mainly during offseason, to promote the readiness of the LG during the year before they are called to work in aquatic environments.

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