applied sciences

MDPI

Article

GNSS Applications to Assess Performance in Olympic Sailors: Laser Class

Israel Caraballo [1,2], Julio Conde-Caveda [1,2,*], Luka Pezelj [3], Boris Milavić [4] and José Castro-Piñero [1,2]

1 GALENO Research Group, Department of Physical Education, Faculty of Education Sciences, University of Cádiz, Cádiz, 11519 Puerto Real, Spain; israel.caraballo@uca.es (I.C.); jose.castro@uca.es (J.C.-P.)
2 Research Unit, Biomedical Research and Innovation Institute of Cádiz (INiBICA), 11519 Puerto Real, Spain
3 Faculty of Maritime Studies, University of Split, 21000 Split, Croatia; lpezelj@pfst.hr
4 Faculty of Kinesiology, University of Split, 21000 Split, Croatia; boris.milavic@kifst.hr
* Correspondence: julio.conde@uca.es

Abstract: Laser class is an Olympic sport in which technical and tactical variables are very important in the performance of the sailor. However, the variables that determine performance in a regatta have not been studied, and less so with Olympic sailors. Therefore, the main objectives of this study are to analyze the technical and tactical variables that differentiate sailors based on their level of performance and sex and determine the most important courses in a regatta. The sample consists of 159 Olympic sailors (67 females) of the Laser class, who participated in a World Cup. Velocity made good (VMG), distance, and maneuvers were evaluated using Global Navigation Satellite System (GNSS) devices in the upwind, downwind, and broad reach courses. VMG in upwind and downwind is the technical variable that determines performance in the Laser class. The VMG is decisive in the performance of elite female sailors in the upwind, downwind, and broad reach courses, while in elite male sailors, performance is mainly influenced by speed in upwind and downwind and the distance covered in upwind. The maneuvers do not determine sailing performance in any of the courses of a regatta.

Keywords: GNSS; performance; dinghy sailing; Olympic sailors

Citation: Caraballo, I.; Conde-Caveda, J.; Pezelj, L.; Milavić, B.; Castro-Piñero, J. GNSS Applications to Assess Performance in Olympic Sailors: Laser Class. *Appl. Sci.* **2021**, *11*, 264. https://doi.org/10.3390/app11010264

Received: 21 November 2020
Accepted: 28 December 2020
Published: 29 December 2020

1. Introduction

Dinghy sailing is a sport with specific characteristics, since performance will not only be determined by the level of physical fitness of the sailor, but also by the characteristics of the boat and the weather conditions [1,2]. Therefore, Olympic sailing is a complex sport in which performance is determined by the ability to understand and anticipate the weather conditions, having adequate equipment for the boat (e.g., quality sails), and the mastering of the technique and tactics [3]. In addition, the level of physical fitness of the sailor is part of the general performance, and the physical and physiological requirements (muscular strength, muscular endurance, and aerobic and anaerobic capacity) have changed due to the increase in the level of international competition and the modifications that resulted from the Olympic navigation format [4].

Among the different Olympic classes, the sailors in the Laser class are considered dynamic hikers, since, due to a high sailor-to-yacht weight ratio, they are required to sail the boat in a very dynamic manner [5]. This monohulled-type class was designed by Bruce Kirby in 1969 and it is manned by a single athlete [6]. The Laser class is a one-person keelboat: the weight of the boat is 59 kg, the overall length is 4.23 m, the beam length is 1.37 m and the sail in the Olympic category is different for men and women. Women compete in the Radial (5.76 m^2) category and men compete in the Standard (7.06 m^2) category. This is an Olympic class since 1996 and sailors compete under the One Design rule. The One Design class is controlled by World-Sailing® and the class rules are written to prevent any changes from the manufactured boat that might affect performance, ensuring that all the

competing boats are the same [7]. This rule states that all sailors must compete with the same boats and sails and, thus, under the same conditions.

In dinghy sailing, technique (velocity) and tactics (distance and maneuvers) determine factors related to performance in the regatta [8,9]. The sailor's technique determines the velocity of the boat, and the VMG on the windward and leeward courses is considered the most important variable in a regatta, since the courses of a dinghy sailing are relatively simple and well defined, and, in many windward-leeward courses, two legs are navigated, one windward (upwind) and the other one leeward (broad reach and downwind) [10,11]. The distance traveled during the regatta is a tactical variable that determines the performance of the sailor, since higher level sailors complete the course in shorter distances [8,9]. The maneuvers influence the performance of the boat, since speed decreases when they are carried out, thus the sailor must decide when to perform them, and he/she must do it efficiently in order to minimize the loss of speed [12].

Since 2003, GNSS have consolidated their application in different sports and provide very relevant information on the external load, the movements carried out, and the physical activity of the athlete in training and in competition [12–14]. Several studies have demonstrated the validity and reliability of these devices to record technical and tactical variables in the windsurfing and kitesurfing classes [8,9,15].

Regarding performance, several studies have analyzed the relationship between performance and the sailor's physical fitness [4,16], biomechanics [11,17–20], and psychological factors [21–23]. However, to our knowledge, not all aspects of technical and tactical performance have been thoroughly examined in dinghy sailing. The VMG, the distance traveled, and the maneuvers carried out in a regatta and their relationship with performance have only been evaluated in the windsurfing and kitesurfing classes [9–12], and it is still unknown which course (upwind, broad reach, and downwind) is the most decisive for performance. Therefore, the aims of this study are to analyze the relationship between performance (ranking) and technical-tactical variables in upwind, broad reach, and downwind courses.

2. Materials and Methods

2.1. Participants

The study sample consisted of 159 Olympic sailors (67 females) in the Laser class, with an age range of 17 to 45 years. The data were collected form World-Sailing® [24], which is the commercial entity of the International Sailing Federation (ISAF). However, this organization no longer exists.

2.2. Regatta

The analyzed regatta was the Hempel World Cup Series: Genoa (Italy, 2019). This regatta was a qualifying competition for the World Cup and also for participation in the Olympic Games, although only the results obtained in the ranking of this regatta were used. The VMG (knots), distance (km), maneuvers (number of maneuvers), and time (hours) variables were obtained through the SAP-Sailing® application [25]. This application uses a TracTrac® GNSS, which is placed on the sailor. The GNSS device weighed 60 g, and it included a mobile connection and a battery. The data transmission frequency was 5 Hz.

A total of 12 races were analyzed: 6 in the group of males and 6 in females. The wind speed ranges in the regatta were 3.5-8.3 and 4.1-8 knots in the female and male groups, respectively. The race course consisted of 6 legs (2 windward and 4 leeward): 2 upwind, 2 downwind, and 2 broad reach. The regatta race courses depend on the weather conditions and two types of courses were carried out (Figure 1): "In" and "Out". Both types of routes were carried out by males and females, and the regatta judges determined the realization of one or the other depending on the number of groups of sailors participating in the regatta and in each of the races.

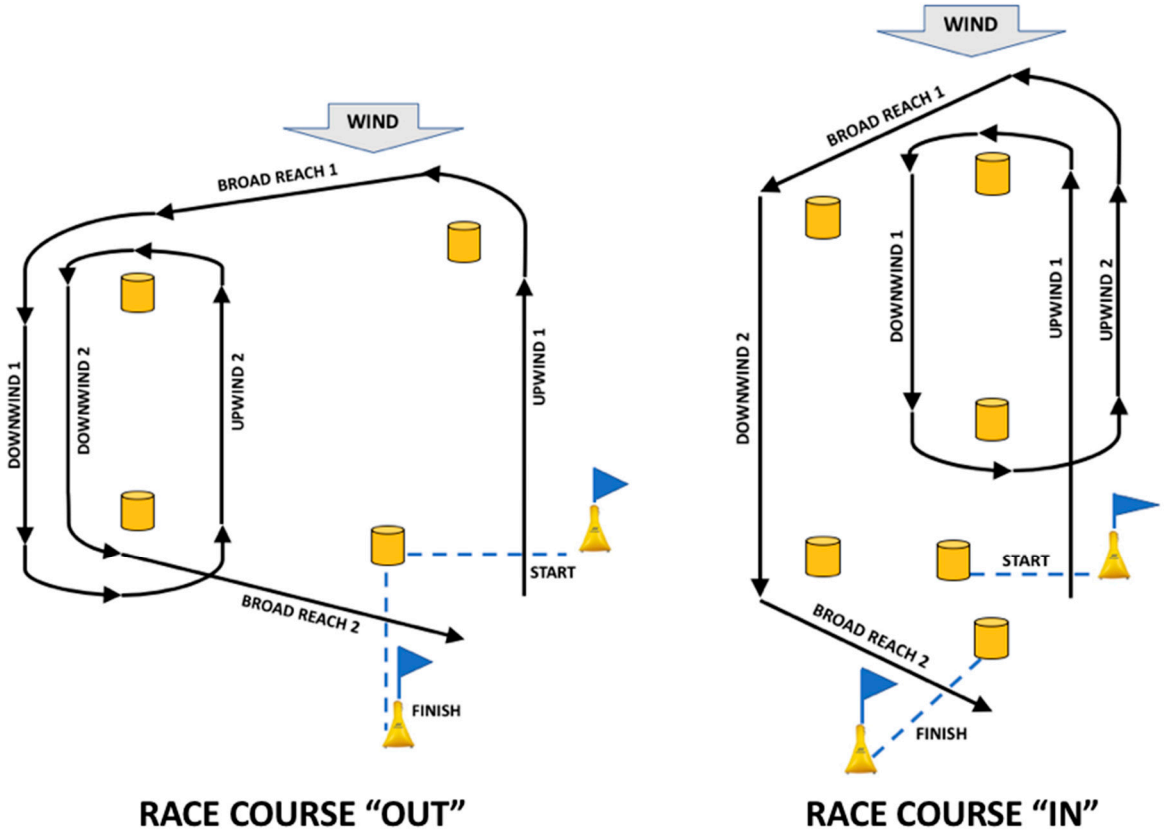

Figure 1. Regatta race courses.

2.3. VMG

VMG is defined as the speed that the boat reaches directly in windward and leeward courses, and it measures how fast the boat progresses in each of the courses and along the Rhumb line (Figure 2) [26]. This line is the straight line from the start point to the finish line, and it is the shortest distance to complete the course. VMG is a vector that measures a straight line to the next mark; therefore, in addition to speed, it also provides information about the distance between the boat and the destination point [27].

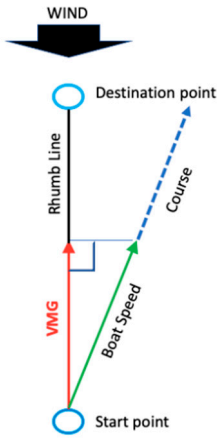

Figure 2. Velocity Made Good. Note: VMG = Velocity Made Good.

2.4. Maneuvers and Courses

The maneuvers are actions with which the sailors change the direction of the boat. When the maneuver is carried out against the wind, it is called "tack", and "jibe" when

navigating downwind or broad reach. During the tack, the boat changes direction as the bow passes through the wind, while the gybing is the stern. In both actions, the sails shift from the starboard or port side to the opposite side. Sailing courses are determined by the angle between the bow of the boat and the wind, and it is 45°, 120°, and 180° in upwind, broad reach, and downwind, respectively.

2.5. Statistical Analyses

The data are presented as means (M) and standard deviations (SD). The level of significance was seat at $p < 0.05$. The SPSS v20.0 software (SPSS Lead Technologies Inc.®, Chicago, IL, USA) was used for the statistical analyses. The data were subjected to a descriptive analysis and inferences; their normality was also verified using the Kolmogorov-Smirnov test. The total sample, i.e., female and male sailors, was divided into three groups on the basis of their performance level (ranking): high level (T1), medium level (T2), and low level (T3). In the upwind, downwind, and broad reach groups, we assessed differences on VMG, distance, and time by performance level groups (T1, T2, T3) in the total sample, females and males, using ANOVA. A Bonferroni correction was performed when statistically significant differences were detected. A nonparametric Kruskal-Wallis test was applied to establish differences in the cases that required it.

3. Results

Table 1 shows the analysis for each of the groups of sailors according to their level of performance in the regatta. It was observed that, in upwind course, the T1 sailors obtained greater VMG compared to the T2 and T3 sailors and also between the T2 and T3 groups. Similarly, the VMG was higher in group T1 compared to group T3 and between T2 and T3 in downwind. The high-level male sailors showed greater VMG compared to the other two groups of sailors in upwind and in the downwind course. Similarly, the females had greater VMG in upwind, and this same situation was observed when it was analyzed in the downwind course and in broad reach. With respect to distance, the sailors of group T1 traveled a shorter distance compared to the sailors of group T3 in upwind, although the analysis of the mean distance values did not show differences in downwind and broad reach. When the males group was assessed, it was observed that the high-level group showed a lower distance compared to the other sailors in upwind, and no differences were found in either downwind or broad reach courses. Regarding maneuvers in upwind, no differences were detected on the basis of the level of performance by the total sample, females or males, in any of the analyzed courses. In time spent upwind, the sailors in group T1 and T2 obtained lower values than group T3. The males of the high-level group showed shorter time in upwind, whereas the females of the same level obtained shorter time in broad reach.

Table 1. Data of mean velocity made good, distance, maneuvers, and time in upwind, downwind, and broad reach in groups of sailors with different performance levels (T1, T2, and T3) in the regatta.

Variables		Upwind			Downwind			Broad Reach		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
VMG (knots)	Female	$2.3 \pm 0.05_{A}$	2.2 ± 0.03	2.1 ± 0.2	$3.2 \pm 0.05_{A}$	$3.1 \pm 0.1_{C}$	2.9 ± 0.3	$4.1 \pm 0.1_{B}$	$3.9 \pm 0.2_{C}$	3.7 ± 0.4
	Male	$2.3 \pm 0.1_{B}$	$2.3 \pm 0.05_{C}$	2.2 ± 0.8	$2.9 \pm 0.1_{B}$	2.9 ± 0.1	2.8 ± 0.1	4.7 ± 1.1	4.3 ± 1^{C}	5.2 ± 1.5
	All	$2.3 \pm 0.06_{A}$	$2.3 \pm 0.05_{C}$	2.1 ± 0.1	$3.1 \pm 0.1_{B}$	3 ± 0.1^{C}	2.8 ± 0.2	4.5 ± 0.9	4.2 ± 0.8	4.6 ± 1.4
Distance (km)	Female	15.1 ± 0.3	15.3 ± 0.5	15.3 ± 1.3	10.2 ± 0.1	10.1 ± 0.2	9.9 ± 0.9	5.3 ± 0.1	5.5 ± 0.2	5.5 ± 0.4
	Male	$14.2 \pm 0.3_{B}$	$14.5 \pm 0.4_{C}$	14.9 ± 0.4	9.9 ± 0.2	10 ± 0.2	10 ± 0.3	5.4 ± 0.2	5.5 ± 0.1	5.4 ± 0.2
	All	$14.6 \pm 0.5_{B}$	14.8 ± 0.6	15.1 ± 0.9	10.1 ± 0.2	10 ± 0.2	9.9 ± 0.6	5.4 ± 0.1	5.5 ± 0.2	5.4 ± 0.3

Table 1. *Cont.*

Variables		Upwind			Downwind			Broad Reach		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
Maneuvers	Female	85.5 ± 13.1	82.4 ± 14.9	88.1 ± 17.5	143.3 ± 44.5	105.1 ± 39	128.5 ± 44.9	3.9 ± 2.1	4.2 ± 2.3	4.1 ± 2.1
	Male	120 ± 24.3	111.8 ± 21.5	125.8 ± 28.7	150.2 ± 33.4	150.1 ± 27.8	155.3 ± 41.3	5.3 ± 3.4	6.5 ± 3	7.9 ± 4.8
	All	106 ± 26.7	99.2 ± 23.8	109.9 ± 30.8	147.3 ± 0.3	130 ± 39.6	144 ± 44.4	4.7 ± 2.9	5.5 ± 2.9	6.3 ± 4.3
Time (hours)	Female	2.3 ± 0.05	2.4 ± 0.1	2.4 ± 0.2	1.5 ± 0.02	1.5 ± 0.05	1.5 ± 0.1	$0.6 \pm 0.02_{A}$	0.7 ± 0.05	0.7 ± 0.07
	Male	$2.1 \pm 0.1_{B}$	$2.1 \pm 0.1_{C}$	2.2 ±0.1	1.6 ± 0.1	1.6 ± 0.1	1.7 ± 0.1	0.6 ± 0.1	0.7 ± 0.1	0.6 ± 0.1
	All	$2.2 \pm 0.2_{B}$	2.2 ± 0.1	2.3 ± 0.2	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	0.6 ± 0.1	0.7 ± 0.1	0.7 ± 0.1

Data presented as M ± SD. [A]: statistically significant difference T1 vs. T2 and T3; [B]: statistically significant difference between T1 and T3; [C]: statistically significant difference between T2 and T3. VMG = Velocity Made Good. T1: high-level sailors; T2: medium-level sailors; T3: low-level sailors. [A,B,C] $p < 0.05$.

4. Discussion

The aims of this study were to investigate the technical (VMG) and tactical (distance and maneuvers) variables in order to determine their relationship with performance in the Laser class on the upwind, broad reach, and downwind courses and to identify sex differences, using GNSS devices. To our knowledge, this is the first study to evaluate technical and tactical performance in the laser class in a regatta, and it is also the first study to analyze the three types of courses developed during the competition (upwind, downwind, and broad reach).

The results of our study show that the most successful group of sailors (male and female) sailed faster (VMG) in the upwind and downwind legs compared to the less successful sailors. In previous studies, it has been observed that the elite sailors in the RS:X windsurfing class had a higher VMG on the upwind and downwind courses [8,9]. This could indicate that these sailors have a better technical level, which would allow them to handle the boat more efficiently to reach higher speeds, thus keeping the boat in a planning condition, thereby reducing its hydrodynamic resistance [28,29]. Some studies have shown that more successful sailors are faster and have a better pointing angle, which can be achieved only with a higher level of physical performance, as it is known that efficient hiking is related to boat speed and boat handling performance [12,30]. Therefore, and on the basis of our results, we could assert that, in our Laser class sailors, the higher the level of the sailor, the greater the VMG achieved in the upwind and downwind courses. Similarly, the greatest male sailors achieved a higher VMG in upwind and downwind compared to low-level sailors, and this difference was greater when the group of females was analyzed in upwind, downwind, and broad reach. Analyzing the speed in the different courses evaluated, it was observed that the sailors were faster in the broad reach course, followed by downwind and upwind. These results are in line with those obtained in kitesurfing class sailors [15,31]. This is the first study to determine the fastest course in the Laser class.

Regarding distance, and for the entire sample (males and females), differences between groups were only found in upwind. According to our results, other studies assert the importance of the upwind course, since elite sailors travel a shorter distance in this leg, and this is where they can establish a greater difference in the position of the race compared to other competitors [32,33]. Moreover, previous studies have shown that higher-level windsurfing sailors finished the race with a shorter distance in upwind [19]. In agreement with these results, it was observed that, in the male group, elite sailors covered a shorter distance in upwind, although distance was not a variable that differentiates performance in the group of females in any of the analyzed courses. A study with RS:X class sailors, where 94 races were analyzed (47 males' races and 47 females' races), it was observed that

race distance for males was greater than that for females [10]. If we compare our data with this study, it is observed that the maximum distance traveled in upwind by the best male sailors in our study is higher compared to the sailors of the same sex (14.9 vs. 11.7 km), and the same is true for the group of females (15.9 vs. 9.8 km). Therefore, this distance covered should be considered by coaches when planning the training of the sailors, since this would imply a greater physiological demand [34].

With respect to the maneuvers carried out, no significant differences were observed in upwind, downwind, or broad reach when analyzing the whole sample, the group of males and the group of females. Therefore, we can consider that the number of maneuvers is not a variable with which it is possible to differentiate the level of performance of Laser class sailors. Nevertheless, studies carried out in a simulator have shown that more experienced sailors perform fewer maneuvers to complete the course [35]. This difference in the results could be due to the fact that our study was carried out in a real regatta, while the mentioned study was carried out in a simulator, since during a regatta there are a series of circumstances, such as changes in wind speed and direction, which simulators cannot reproduce.

As regards time, our results show that there are only differences between the high-level group and the low-level group in upwind; however, it was observed that, in the male group, elite sailors obtained a shorter time in upwind. This suggests that they completed the upwind course in a shorter time, due to their greater VMG and shorter distance to complete this course. The elite female group presents shorter time in broad reach. This result could also be due to the fact that these groups obtained a higher VMG in this course. Some studies have shown that sailors who rank higher on upwind courses can establish strategies and tactics with minimal interference from their competitors and thus complete the course in a shorter time [36].

In our study, we can consider some limitations. Firstly, regarding the number of participants analyzed, the study sample consisted of only 92 males and 67 female elite sailors in Laser class World Championship events. However, this represents 80% of the total male and 100% of total female sailors who have participated in this regatta. Secondly, the variables have not been analyzed as a function of different wind speeds (light, medium, and strong). Moreover, future studies could be focused on the analysis of the technical and tactical variables in different wind conditions and specifically analyze each of the races that make up the regatta. It would have been interesting to perform a physical performance test in the hiking bench to verify that those who obtained better results also obtained a higher VMG. In our study, anthropometric variables such as height and weight were not taken into account, and with these data it would be possible to analyze their influence on the VMG of the boat.

5. Conclusions

This is the first study to analyze the VMG, distance, maneuvers, and time with GNSS devices in Laser class sailors and in a world championship regatta. The results of our study show that speed is the variable that determines the performance of a Laser class sailor on the upwind and downwind courses. Elite sailors have a greater command of the technique in the upwind and downwind courses, since they reach higher speeds on these courses. Elite male sailors are faster on upwind and downwind courses, while women are also faster on broad reach. Elite sailors travel a shorter distance on the upwind course. The maneuvers are not a variable that determines the performance of the sailor in any of the analyzed courses.

Author Contributions: Conceptualization, I.C. and J.C.-C.; methodology, L.P., B.M.; software, I.C., L.P., B.M.; validation, J.C.-C., J.C.-P. and I.C.; formal analysis, L.P. and B.M.; investigation, I.C.; resources, L.P. and B.M.; data curation, I.C.; writing—original draft preparation, I.C.; writing—review and editing, J.C.-C., J.C.-P., L.P. and B.M.; visualization, I.C.; supervision, J.C.-C. and J.C.-P.; project administration, L.P. and B.M.; funding acquisition, L.P. and B.M. All authors have read and agreed to the published version of the manuscript.

Funding: This work has been supported by The European University of the Seas (SEA-EU) project-(Erasmus+, European Universities; Ref 612468-EPP-1-2019-1-ES-EPPKA2-EUR-UNIV).

Institutional Review Board Statement: Ethical review and approval were waived for this study, due to all the data used in this study are publicly accessible, and these are in World-Sailing® and SAP-Sailing®.

Informed Consent Statement: Patient consent was waived due to all the data used in this study are publicly accessible, and these are in World-Sailing® and SAP-Sailing®.

Data Availability Statement: Publicly available datasets were analyzed in this study. This data can be found here: https://site-isaf.soticcloud.net/sailors/sailor_search.php?includeref=18856&sailorid=&sailorsurname=https://www.sapsailing.com/gwt/Home.html#StartPlace:nul.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Pluijms, J.; Cañal-Bruland, C.; Kats, S.; Savelsbergh, G. Translating key methodological issues into technological advancements when running in-situ experiments in sports: An example from sailing. *Int. J. Sports Sci. Coach.* **2013**, *8*, 93–103. [CrossRef]
2. Bernardi, M.; Quattrini, F.M.; Rodio, A.; Fontana, G.; Madaffari, A.; Brugnoli, M.; Marchetti, M. Phsyiological characteristics of America´s Cup sailors. *J. Sports Sci.* **2007**, *25*, 1141–1152. [CrossRef] [PubMed]
3. Spurway, N.; Legg, S.; Hale, T. Sailing physiology. *J. Sports Sci.* **2007**, *25*, 1073–1075. [CrossRef] [PubMed]
4. Bojsen-Møller, J.; Larsson, B.; Aagaard, P. Physical requirements in Olympic sailing. *Eur. J. Sport Sci.* **2015**, *15*, 220–227. [CrossRef]
5. Callewaert, M.; Boone, J.; Celie, B.; De Clercq, D.; Bourgois, G. Cardiorespiratory and muscular responses to simulated upwind sailing exercise in optimist sailors. *Pediatr. Exerc. Sci.* **2014**, *26*, 56–63. [CrossRef]
6. Caraballo, I.; Domínguez, R.; Guerra-Hernández, E.J.; Sánchez-Oliver, A.J. Analysis of sports supplements consumption in young Spanish elite dinghy sailors. *Nutrients* **2020**, *12*, 993. [CrossRef]
7. ILCA. Laser Class Rules. 2012. Available online: http://www.laserinternational.org/wp-content/uploads/2020/03/2020-ILCA-CLASS-RULES.pdf (accessed on 21 November 2020).
8. Blackburn, M. Physiological responses to 90 min of simulated dinghy sailing. *J. Sports Sci.* **1994**, *12*, 383–390. [CrossRef]
9. Hagiwara, M.; Ishii, Y. Analysis of racing factors in windsurfing under light wind: 3725 Board #164 June 4, 9:30 AM–11:00 AM. *Med. Sci. Sports Exerc.* **2016**, *48*, 1040.
10. Anastasiou, A.; Jones, T.; Mullan, P.; Ross, E.; Howatson, G. Descriptive analysis of Olympic class windsurfing competition during the 2017–2018 regatta season. *Int. J. Perform. Anal. Sport* **2019**, *19*, 517–529. [CrossRef]
11. Day, A.H. Performance prediction for sailing dinghies. *Ocean Eng.* **2017**, *136*, 67–79. [CrossRef]
12. Castagna, O.; Brisswalter, J.; Lacour, J.-R.; Vogiatzis, I. Physiological demands of different sailing techniques of the new Olympic windsurfing class. *Eur. J. Appl. Physiol.* **2008**, *104*, 1061–1067. [CrossRef] [PubMed]
13. Edgecomb, S.J.; Norton, K.I. Comparison of global positioning and computer-based tracking systems for measuring player movement distance during Australian Football. *J. Sci. Med. Sport* **2006**, *9*, 25–32. [CrossRef] [PubMed]
14. Cummins, C.; Orr, R.; O'Connor, H.; West, C. Global positioning systems (GPS) and microtechnology sensors in team sports: A systematic review. *Sports Med.* **2013**, *43*, 1025–1042. [CrossRef] [PubMed]
15. Caimmi, G.; Semprini, G. Heart rate and GPS data analysis of kiteboarding course racing during the Italian Championship. *Sport Sci. Health* **2017**, *13*, 79–85. [CrossRef]
16. Vogiatzis, I.; Andrianopoulos, V.; Louvaris, Z.; Cherouveim, E.; Spetsioti, S.T.; Vasilopoulou, M.; Athanasopoulos, D. Quadriceps muscle blood flow and oxygen availability during repetitive bouts of isometric exercise in simulated sailing. *J. Sports Sci.* **2011**, *29*, 1041–1049. [CrossRef]
17. Bourgois, J.G.; Boone, J.; Callewaert, M.; Tipton, M.J.; Tallir, I.B. Biomechanical and physiological demands of kitesurfing and epidemiology of injury among kitesurfers. *Sports Med.* **2014**, *44*, 55–66. [CrossRef]
18. Boyas, S.; Guével, A. Influence of exercise intensity and joint angle on endurance time prediction of sustained submaximal isometric knee extensions. *Eur. J. Appl. Physiol.* **2011**, *111*, 1187–1196. [CrossRef]
19. De Vito, G.; Di Filippo, L.; Felici, F.; Marchetti, M. Hiking mechanics in laser athletes. *Med. Sci. Res.* **1993**, *21*, 859–860.
20. Sekulic, D.; Medved, V.; Rausavljevi, N.; Medved, V. EMG analysis of muscle load during simulation of characteristic postures in dinghy sailing. *J. Sports Med. Phys. Fit.* **2006**, *46*, 20–27.
21. Bojsen-Møller, J.; Larsson, B.; Magnusson, S.P.; Aagaard, P. Yacht type and crew-specific differences in anthropometric, aerobic capacity, and muscle strength parameters among international Olympic class sailors. *J. Sports Sci.* **2007**, *25*, 1117–1128. [CrossRef]
22. Vangelakoudi, A.; Vogiatizis, I.; Geladas, N. Anaerobic capacity, isometric endurance, and Laser sailing performance. *J. Sports Sci.* **2007**, *25*, 1095–1100. [CrossRef] [PubMed]
23. Vogiatzis, I.; Tzineris, D.; Athanasopoulos, D.; Georgiadou, O.; Geladas, N. Quadriceps oxygenation during isometric exercise in sailing. *Int. J. Sports Med.* **2008**, *29*, 11–15. [CrossRef] [PubMed]
24. World Sailing. 2019. Available online: https://site-isaf.soticcloud.net/sailors/sailor_search.php?includeref=18856&sailorid=&sailorsurname= (accessed on 6 October 2020).

25. SAP-Sailing. 2019. Available online: https://www.sapsailing.com/gwt/Home.html#StartPlace:nul (accessed on 21 November 2020).
26. Caraballo, I.; Alías, A. *Preparación Integral Física y Psicológica del Regatista*, 1st ed.; Dykinson: Madrid, Spain, 2019; pp. 27–28.
27. Castagna, O.; Vaz Pardal, C.; Brisswalter, J. The assessment of energy demand in the new Olympic windsurf board: Neilpryde RS:X®. *Eur. J. Appl. Physiol.* **2007**, *100*, 247–252. [CrossRef] [PubMed]
28. Gourlay, T.; Martellota, J. Aero-Hydrodynamics of an RS: X Olympic Racing Sailboard. *Cmst. Curtin. Edu. Au.* **2011**, *1*, 1–17.
29. Jansen, A.; Van Deurse, B.; Howe, C. The aerodynamics of sailing apparel. *Procedia Eng.* **2012**, *34*, 50–55. [CrossRef]
30. Tan, B.; Aziz, A.R.; Spurway, N.C.; Toh, C.; Mackie, H.; Xie, W.; Wong, J.; Fuss, F.K.; Teh, K.C. Indicators of maximal hiking performance in Laser sailors. *Eur. J. Appl. Physiol.* **2006**, *98*, 169–176. [CrossRef]
31. Vercruyssen, F.; Blin, N.; L'Huillier, D.; Brisswalter, J. Assessment of physiological demand in kitesurfing. *Eur. J. Physiol.* **2009**, *105*, 103–109. [CrossRef]
32. Guével, A.; Maïsetti, O.; Prou, E.; Dubois, J.J.; Marini, J.F. Heart rate and blood lactate responses during competitive Olympic boardsailing. *J. Sports Sci.* **1999**, *17*, 135–141. [CrossRef]
33. Ma, Y.; Tang, Y.; West, N.; Zhang, Z.; Lin, S.; Zheng, Q. Numerical investigation on trimming of a single sail in a regatta. *Sport Eng.* **2016**, *19*, 81–90. [CrossRef]
34. Cunningham, P.; Hale, T. Physiological responses of elite Laser sailors to 30 minutes of simulated upwind sailing. *J. Sports Sci.* **2007**, *25*, 1109–1116. [CrossRef]
35. Araújo, D.; Serpa, S. Toma de decisión dinámica en diferentes niveles de expertise en el deporte de vela. *Rev. Psicol. Deporte RPD* **1999**, *8*, 103–115.
36. Fajen, B.; Riley, M.A.; Turvey, M.T. Information, affordance, and the control of action in sport. *Int. J. Sport Psychol.* **2008**, *40*, 79–107.