

Performance model in fixed bench rowing to predict the outcome in competition

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Abstract:

Fixed-bench rowing presents technical and tactical particularities that could influence the pacing strategy in a different way. This study aims to analyse the average pace of fixed-bench rowing boats and establish a predictive model to estimate the regatta outcome. A methodology was employed for the purpose of collecting and analyzing data obtained from official competitions to discern the optimal pacing strategies and their correlation to overall performance. A total of 662 boats were analysed in 58 regattas held during the 2020, 2021 and 2022 seasons of the Eusko Label Liga. The variables were the final ranking, the average pacing in each regatta section, the total time, the round and the street. The Spearman's Rho correlation was used to confirm the relationship between the average pacing in each section and the total time of the regatta. In round 3, there is a higher correlation between the average pace and the outcome in section 1 ($r = 0.641$) and in section 3 ($r = 0.620$). A model prediction was developed using multiple linear regression to predict the outcome of the regatta ($p < 0.01$). The round and the average pace performed in section 3 (2778-4167 m) were the two variables predicting the outcome. Statistical power analysis using G*Power 3.1 showed a medium effect size ($f^2 < 0.35$). The results confirm that in the first part of the regatta (0-1389 m), the average boat paces are faster than in the other three sections. The findings can help fixed-bench rowing teams to establish pre-competition strategies to improve the performance of their teams.

Key Words: Traditional rowing, performance prediction model, average pacing, regatta outcome, fixed-bench rowing.

Introduction

Performance analysis in endurance sports has been a field of growing interest within sports science, particularly in disciplines where effort distribution and biomechanical efficiency play a determining role in competitive performance. There is an increasing interest in modelling race pace and its impact on final results in fixed-bench rowing, as the ability to sustain an ideal pace during the race is crucial for achieving peak performance (Garland, 2005; Muehlbauer et al., 2010).

Previous studies have shown that in Olympic rowing the pacing strategy follows a parabolic pattern, characterized by an initial phase of high intensity, followed by a progressive deceleration in the intermediate segments and an increase in speed in the last meters of the event (Greene et al., 2009; Ofoghi et al., 2011; Turnes et al., 2019). Muehlbauer et al. (2010) examined split times during the 2008 Olympic regatta, revealing that the majority of boats demonstrated a rapid pace in the initial 500 meters, a decline in speed during the middle segments, and a notable acceleration in the concluding phase of the event.

A further study carried out by Garland (2005) at the world rowing championships also demonstrated a U-shaped or parabolic pacing pattern, wherein the most successful rowers effectively managed their efforts throughout the entirety of the race. The data indicated a strong relationship between superior final times and consistent average speed along with heightened acceleration capacity in the final 500 meters. Furthermore, Penichet-Tomás & Pueo (2017) observed that finalists, as opposed to those disqualified in earlier stages, exhibited a more even rhythm in the central portion of the race, thereby reducing speed losses and enhancing paddle power efficiency. These findings indicate that the management of fatigue and strategic allocation of effort are key factors affecting ultimate performance.

From an analytical perspective, the use of advanced statistical tools not only allows for the description of performance patterns but also enables the generation of predictive models that facilitate the estimation of race times based on key variables such as average speed, effort distribution, and biomechanical characteristics of the team. In the field of sports statistics, rowing performance modelling has been approached with linear regression and analysis of variance methods, which have proven to be effective in predicting race times and assessing the influence of different pacing strategies on the result (Ofoghi et al., 2013). For example, in simulation studies with regression models, variability in average speed has been found to be one of the most robust predictors of

performance, suggesting that strategies that minimize the decrease in pace in the intermediate legs may be key to improving finish times (Otter et al., 2015; Riechman et al., 2002).

Fixed-bench rowing, unlike Olympic rowing, presents technical and tactical particularities that could influence the pacing strategy in a differentiated way. In this modality, the coordination between the members of the boat and the environmental conditions, such as the influence of weather and wind, can significantly modify the dynamics of the effort during the regatta (Murray et al., 2018; Yan et al., 2021).

In Olympic rowing, aerobic capacity and power are key determinants, but in fixed-bench rowing, stability and equipment synchronization become even more relevant, potentially affecting the distribution of effort throughout the race. (Barrett & Manning, 2004; Buckeridge et al., 2015; Penichet-Tomás & Pueo, 2017). Although there have been advancements in the knowledge of pacing strategies in elite rowing, no research has been found in the available literature that focuses on modelling average pacing in stationary rowing boats or suggests a predictive model using actual competition data.

Therefore, the aim of the present study is to analyse the average pace of fixed-bench rowing boats and establish a predictive model to estimate the regatta outcome. A method will be used that focuses on gathering and analysing data from official competitions to identify the best pacing strategies and how they relate to overall performance. It is expected that the findings will contribute to the knowledge of effort distribution in this discipline and provide practical tools for coaches and athletes in the optimization of competitive strategies.

Material & methods

Participants

A total of 662 boats were analysed in 58 regattas held during the 2020, 2021 and 2022 seasons of the Eusko Label Liga (league organized by the Association of Traineras Clubs, ACT). The data were obtained from the official website of the Eusko Label Liga (<https://www.euskolabelliga.com/>), as was done previously in other related research (González-García et al., 2023; Muehlbauer et al., 2010). The data published in this portal were used only for the realization of this research. The study was approved by the ethics committee of the Universidad Isabel I de Castilla (Code Ui1-PI074).

Measure

The variables considered in the study were the final ranking (based on the position occupied by the boat at the end of the regatta), the average pacing in each regatta section (4 sections were established with a distance of 1389 m per section: S1, S2, S3 and S4), the total time, the round in which each boat participates (3 rounds were established, depending on the general classification of the season at the time of the regatta: round 1 (R1), position 9th to 12th; round 2 (R2), position 5th to 8th; and round 3 (R3), position 1st to 4th, and the street where the boat rowing (4 streets were established in each round: ST1, ST2, ST3 and ST4).

Data collection and analysis

For the 3 nautical miles (5556 m) rowing distance, split times in the following sections (S) or the race were obtained: 0-1389 m (S1), 1389-2778 m (S2), 2778-4167 m (S3), and 4167-5556 m (S4). All analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 24.0. Basic descriptive statistics (mean, standard deviation and standard error of mean) were calculated. The Kolmogorov-Smirnov statistical test confirmed the absence of normality.

The correlation of Spearman Rho was used to verify the relationship between the average pacing in each section and the total time of the regatta. Multiple linear regression was used to develop a model that predicted the outcome of the regatta. Statistical power analysis G*Power 3.1 (Faul et al., 2009) was used to determine the power statistical and the effect size of the model. Statistical significance was set at $p < 0.01$.

Results

The average speeds of a total of 662 boats were analysed. The ranking of the teams was established based on the total time of each boat. In S1, the lowest average pace was 4 min and 46 s, achieved by the boats that finished second in the final ranking. In S2, the lowest average pace was 4 min and 51 s, attained by the boats that finished first in the final ranking. In S3, the lowest pace was 5 min and 7 s, reached by the boats that finished second. In S4, the lowest average pace was 5 min and 8 s, accomplished by the boats that finished first. All boats had higher average paces in the last two sections of the race (S3 and S4). In the total time per race, the boats that finished in first place had an average pace 4 s slower than those that finished in second place.

The differences in average pace between the first and last-place finishers were 15 s in S1, 17 s in S2, 15 s in S3, 7 s in S4, and 54 s in the overall average race pace. The average speeds recorded in the four sections (S1, S2, S3, and S4) and the total average speed of the race, considering the final ranking of each boat, are described in Table 1.

Table 1. Average pacing of each section depending on the outcome of the regatta.

Final Rank	S1		S2		S3		S4		Total time	
	Mean ± SD	± SE	Mean ± SD	± SE	Mean ± SD	± SE	Mean ± SD	± SE	Mean ± SD	± SE
1	04:47	± 00:04	04:51	± 00:03	05:12	± 00:02	05:08	± 00:08	20:00	± 00:04
	00:34		00:30		00:22		01:05		00:31	
2	04:46	± 00:04	04:54	± 00:04	05:07	± 00:06	05:16	± 00:10	20:04	± 00:04
	00:34		00:30		00:45		01:18		00:31	
3	04:47	± 00:04	04:56	± 00:04	05:14	± 00:03	05:13	± 00:08	20:10	± 00:04
	00:35		00:30		00:23		01:07		00:31	
4	04:49	± 00:04	04:55	± 00:03	05:14	± 00:03	05:15	± 00:08	20:15	± 00:04
	00:34		00:28		00:23		01:07		00:33	
5	04:47	± 00:04	04:57	± 00:04	05:13	± 00:03	05:21	± 00:10	20:19	± 00:04
	00:38		00:35		00:25		01:18		00:31	
6	04:50	± 00:04	05:00	± 00:04	05:16	± 00:02	05:16	± 00:08	20:23	± 00:04
	00:35		00:31		00:22		01:05		00:32	
7	04:53	± 00:04	05:00	± 00:04	05:18	± 00:03	05:07	± 00:09	20:20	± 00:11
	00:35		00:30		00:23		01:08		01:25	
8	04:55	± 00:04	05:04	± 00:03	05:20	± 00:02	05:14	± 00:07	20:34	± 00:04
	00:32		00:26		00:21		00:55		00:31	
9	04:55	± 00:05	05:00	± 00:04	05:21	± 00:03	05:19	± 00:09	20:37	± 00:04
	00:38		00:30		00:23		01:10		00:30	
10	04:55	± 00:05	05:02	± 00:04	05:22	± 00:03	05:19	± 00:09	20:40	± 00:04
	00:37		00:29		00:23		01:09		00:30	
11	04:55	± 00:05	05:02	± 00:04	05:23	± 00:03	05:27	± 00:10	20:51	± 00:04
	00:39		00:32		00:24		01:12		00:34	
12	05:02	± 00:04	05:08	± 00:03	05:27	± 00:03	05:15	± 00:07	20:54	± 00:05
	00:28		00:22		00:19		00:48		00:33	

Note: S: Section; SD: Standard deviation; SE: standard error of mean

The average speeds of the boats in R1 are higher compared to the average speeds of R2 and R3. The average paces of R2 boats are higher than the average paces of R3. An exception is made for the average boat pace in S4, where R2 boats had an average pace one second lower than that of R3 boats in the same section.

All boats recorded the lowest average pace in S1. R1 boats achieved the highest average pace in S3 at 5 min and 19 s. R2 boats had the highest average pace in S3 at 5 min and 18 sec. R3 boats maintained the highest average pace in S4 with 5 min and 16 s. In terms of overall average pace, R3 boats had a pace that was 13 s slower than R2 boats. R2 boats recorded an average pace that was 9 s slower than R1 boats.

The results of average paces according to the competition street are very similar across each section. Regarding total average paces, the lowest average pace was recorded in ST3 (20 min and 21 s), which is 7 s less than the highest average pace achieved in ST4 (20 min and 28 s). Considering total average paces per section, S1 (4 min and 51 s) had a pace that was 8 s lower than the average pace in S2 (4 min and 59 s). The average pace in S2 was 18 s slower than the average pace in S3 (5 min and 17 s). The highest average pace was noted in S3, but it was only 1 second higher than the average pace in S4 (5 min and 16 s). An overall average pace of 20 min and 24 s was established as a reference for all boats. The average speeds of each segment of the race, considering the round and the street in which each boat competes, are detailed in Table 2.

Table 2. Average pacing of each section depending on the round and the competition street.

variables	S1		S2		S3		S4		Total time	
	Mean ± SD	± SE	Mean ± SD	± SE	Mean ± SD	± SE	Mean ± SD	± SE	Mean ± SD	± SE
R1	04:54	± 00:02	05:03	± 00:01	05:19	± 00:01	05:17	± 00:04	20:34	± 00:03
	00:35		00:29		00:23		01:05		00:52	
R2	04:52	± 00:02	04:59	± 00:02	05:18	± 00:01	05:15	± 00:04	20:25	± 00:02
	00:34		00:30		00:22		01:05		00:35	
R3	04:48	± 00:02	04:53	± 00:02	05:13	± 00:02	05:16	± 00:05	20:12	± 00:02
	00:36		00:30		00:32		01:12		00:33	
ST1	04:51	± 00:02	04:58	± 00:02	05:17	± 00:01	05:16	± 00:05	20:24	± 00:02
	00:35		00:30		00:23		01:08		00:34	
ST2	04:51	± 00:02	04:59	± 00:02	05:16	± 00:02	05:18	± 00:05	20:25	± 00:02
	00:35		00:29		00:33		01:08		00:34	
ST3	04:51	± 00:02	04:59	± 00:02	05:17	± 00:01	05:11	± 00:05	20:21	± 00:04
	00:35		00:29		00:23		01:05		00:58	
ST4	04:51	± 00:02	04:59	± 00:02	05:16	± 00:01	05:18	± 00:05	20:28	± 00:02
	00:36		00:31		00:24		01:07		00:38	
Total	04:51	± 00:01	04:59	± 00:01	05:17	± 00:01	05:16	± 00:02	20:24	± 00:01
	00:35		00:30		00:26		01:07		00:42	

Note: S: Section; R: Round; ST: Street; SD: Standard Deviation; SE: Standard Error

The boats competing in R1 correspond to the lowest-ranked boats in the final ranking. The results indicate that no boats competing in R1 are ranked first. The tendency for R1 boats is to rank between 9th and 12th. Of the total number of boats, 46 of them have qualified in last place. In R2, the tendency of the boats is to qualify between 5th and 8th place, with 41 boats in R2 qualifying in 7th place. In R3, the tendency of the boats is to qualify between 1st and 4th place, with a total of 48 boats qualifying in 1st place. The quantity of boats eligible for each position as determined by the final ranking is specified in Figure 1.

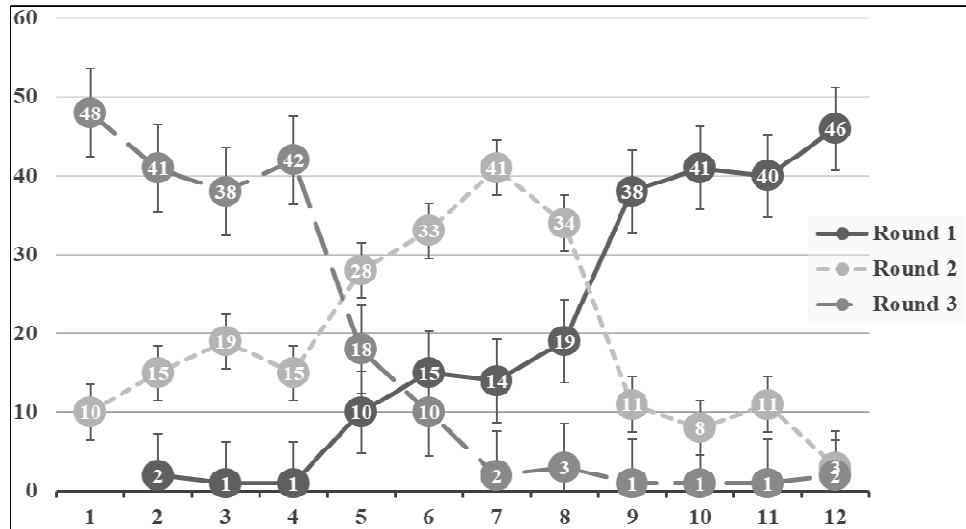


Figure 1. Number of boats in each final regatta ranking depending on the round.

There is a generalized correlation between the average paces set in each section and each round as well as the overall average paces per race (Table 3). The effect size in all cases was large ($f^2 \geq .50$). In all three rounds, the effect size was greater concerning the average paces set in S1 and S3. Therefore, there is a higher correlation between the average paces in S1 and S3 regarding the average paces at the end of the race. In R3, there is a greater correlation between the average pace and the outcome in S1 ($r = .641$) and in S3 ($r = .620$).

Table 3. Correlations between regatta average pacing and the outcome depending on the round.

	Section	min	max	R	σ^2	Spearman's Rho (r)	1- β	f^2
Round 1 (n = 227)	1	02:26	06:00	03:34	1280.276	0.539**	1	.73
	2	02:58	06:03	03:05	895.373	0.383**	1	.61
	3	04:02	06:19	02:17	532.246	0.533**	1	.73
	4	00:02	10:19	10:17	4289.345	0.307**	1	.55
Round 2 (n = 228)	1	02:30	05:53	03:23	1163.818	0.575**	1	.75
	2	02:54	06:13	03:19	924.436	0.384**	1	.61
	3	03:55	06:17	02:22	517.268	0.554**	1	.74
	4	04:09	10:14	06:05	4251.327	0.346**	1	.58
Round 3 (n = 207)	1	02:31	06:07	03:36	1340.812	0.641**	1	.80
	2	02:52	05:48	02:56	906.304	0.410**	1	.64
	3	00:21	06:18	05:57	1024.091	0.620**	1	.78
	4	03:45	10:18	06:33	5308.786	0.255**	.99	.50
Total (n = 662)	1	02:26	06:07	03:41	1259.903	0.592**	1	.76
	2	02:52	06:13	03:21	921.557	0.415**	1	.64
	3	00:21	06:19	05:58	686.531	0.576**	1	.75
	4	00:02	10:19	10:17	4581.793	0.328**	1	.57

Note: n = Cases analysed; σ^2 = Variance; r = Spearman's correlation; 1- β = Statistical power; f^2 = Effect size; ** $p < 0.01$

The regression statistics between race time and the average pace of S1 resulted in an R^2 value of 0.189 (SE = 0.042); between race time and the average pace of S2, $R^2 = 0.148$ (SE = 0.049); between race time and the average pace of S3, $R^2 = 0.208$ (SE = 0.056); and between race time and the average pace of S4, $R^2 = 0.003$ (SE = 0.024).

The regression line for S3 shows the highest correlation with the final race time. The average pace in S3 correlates positively with the final time set in the regatta. In contrast, the average pace obtained in S4 does not correlate with the final race time. The regression statistics between the final race time and the total average paces of each section are displayed in Figure 2.

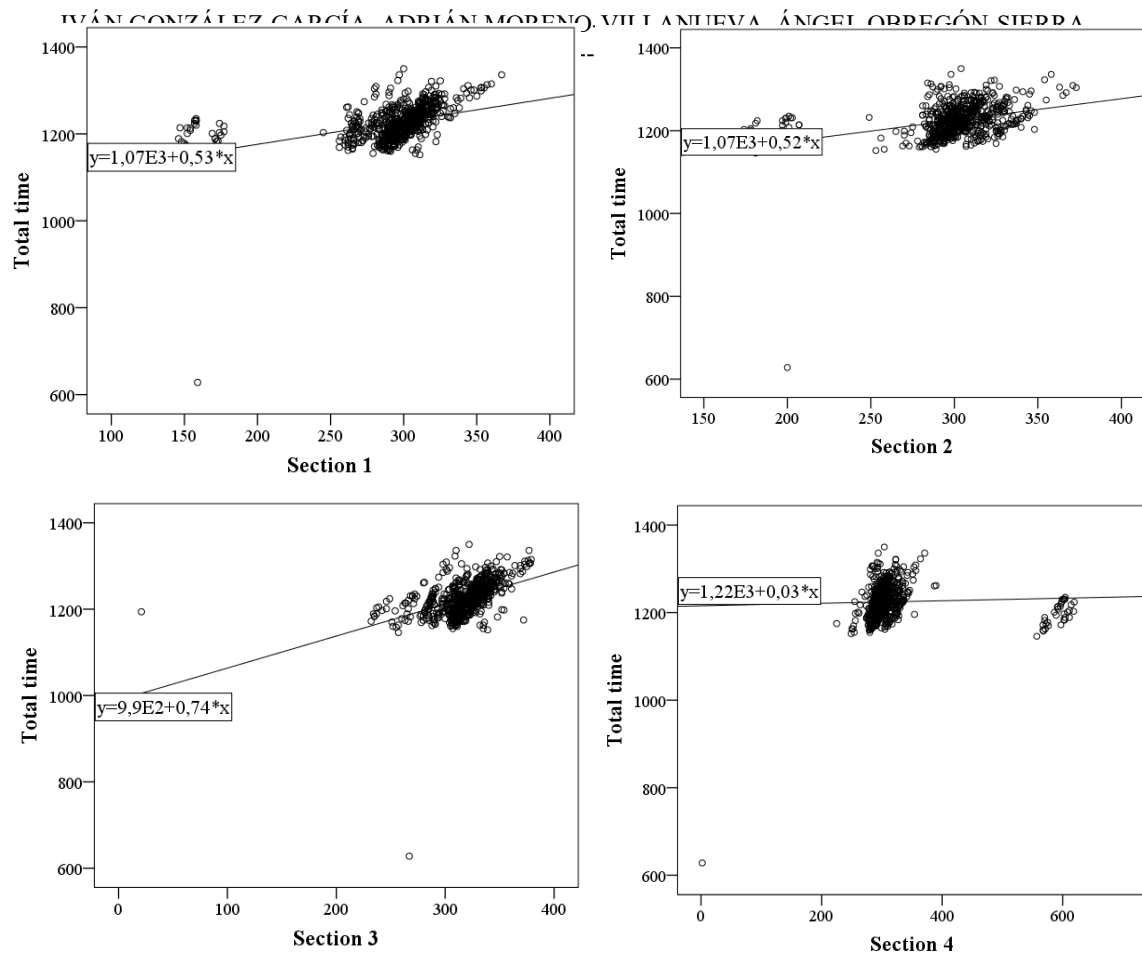


Figure 2. Regression line and equation between the total average pacing and the average pacing per section.

In the multiple linear regression analysis, the proposed model did not include the street and the average pace of S2 as predictor variables for the outcome of the regatta (Table 4). However, the round in which the boat participates, and the average pace achieved in S3 were the two variables that showed the highest probability of predicting the outcome, with a medium effect size ($f^2 < 0.35$), although they explained only 23%.

If the average pace of S4 is added to the model, these three variables explain 42% of the variability in the final race result. Model 4, which consists of the round and the average paces of S3, S4, and S1, predicted up to 75% of the final race result ($f^2 > 3$). The final model derived from the analysis was:

$$\text{Race time (s)} = 415.595 - (5.402 \times \text{Round}) + (0.403 \times \text{S3}) + (0.786 \times \text{S4}) + (1.519 \times \text{S1})$$

Table 4. Stepwise multiple linear regression model to predict the outcome of the regatta.

	F	R ²	Adj. R ²	B	SE	β	t	p	1- β	f^2
Model 1	30.274 (1, 660)	.044	.042	1246.389	4.260		292.549	0.01**	.97	.04 ^a
Round				-11.008	2.001	-.209	-5.502	0.01**		
Model 2	164.779 (2, 659)	.235	.233	1015.234	18.407		55.155	0.01**	1	.30 ^b
Round				-8.659	1.800	-.165	-4.810	0.01**		
Section 3				.714	.056	.440	12.837	0.01**		
Model 3	220.463 (3, 658)	.427	.424	699.561	26.574		26.325	0.01**	1	.73 ^c
Round				-6.489	1.566	-.123	-4.144	0.01**		
Section 3				1.333	.064	.820	20.923	0.01**		
Section 4				.364	.025	.579	14.848	0.01**		
Model 4	861.035 (4, 657)	.752	.751	415.595	19.994		20.786	0.01**	1	3.01 ^c
Round				-5.402	1.032	-.103	-5.236	0.01**		
Section 3				.403	.053	.248	7.674	0.01**		
Section 4				.786	.022	1.250	36.355	0.01**		
Section 1				1.519	.052	1.267	29.343	0.01**		

Note: SE: Standard Error; 1- β = Statistical power; f^2 =Effect size (^asmall, ^bmedium, ^clarge) ** $p < 0.01$

Dicussion

As other researchers have observed (Binnie et al., 2023; Morris & Phillips, 2009; Watts et al., 2024), quantifying the environmental influence on rowing is extremely complex, so in this study we have focused on statistically analysing the times of the clubs participating in the first division of the Eusko Label League. The results have shown a significant relationship between the average times in the different sections of the regatta and outcome. It has been observed that the boats that obtain better classifications have lower average speeds in all the sections, especially in the first (S1) and third (S3), which suggests that these sections have an important weight in the overall performance of the regatta.

These results align with those obtained by Ofoghi et al. (2011) in their study on mobile bench rowing, which found that intermediate times can predict the outcome of the regatta. Likewise, Brown et al. (2010) determined that 78% of winning teams set the fastest time at the halfway point of the race, and 100% of winning teams ranked among the top three at that same stage. This suggests that, at highly competitive levels, victory greatly depends on securing a strong position in the early phases of the race, thereby limiting the chances for significant changes in the later part. As stated by Martins et al., (2022) pacing represents a tactical component of rowing, and more experienced teams exhibit improvements in the biological, technical, and tactical aspects of performance. Indeed, Brown et al. (2010) note that differences in effort regulation throughout competition vary by competitive level. While at national and sub-elite levels, there are greater fluctuations in pace and an increase in effort during the final stretch of the race, at elite levels, the predominant strategy is to maintain a more stable and efficient pace from the start. This aligns with what was observed in the present study, where the top-ranked boats demonstrated lower paces in S1 and S3, thereby ensuring a sufficient margin to manage effort in the last section of the race without the need for a significant change in final pace. The optimal race pacing strategy may vary depending on the duration and type of race (Dimakopotjlotj et al., 2018; Khamros et al., 2024).

The strategy during the race influences the average times of each section and outcome. The strategy employed by a leading boat will differ, as it can observe its competitors and even affect the paddlers behind its wave (Kleshnev & Nolte, 2011). A peculiar finding is noted in the last leg, where the boats in the intermediate round (R2) record a slightly lower average pace than those competing in the honour round (R3). This contrasts with the average speeds observed in the earlier sections of the race. This characteristic can be explained by the fact that the first boats to compete (R1 and R2) do not have access to the final times of the teams rowing in the last round. Therefore, the boats in R1 and R2 are obliged to maintain a high pace until the end of the race, without any reference to their positions compared to the best boats. In contrast, teams in the last round (R3), knowing the previous times of their rivals, can manage their effort in the final part of the race. If not strictly necessary, these teams can secure their position without the need for maximum effort, as observed by Chu et al., (2023). This phenomenon could be related to the race strategy noted in previous studies on mobile bench rowing, where it was found that the winners typically move ahead to maintain that position and not expend too much energy in the last 500 m (Ofoghi et al., 2011). This tactic of increasing speed in the first leg of the race to establish and maintain a lead throughout has been described as the reversed J-shaped pacing strategy in several studies (Khamros et al., 2024; Martins et al., 2022; Muehlbauer et al., 2010).

On the other hand, the distance of each section differs in mobile bench rowing compared to fixed bench rowing. This aspect determines the race strategy and the distribution of effort of the rowers in each section of the regatta. The distance over which each mode is raced is one of the main drawbacks when comparing studies of mobile bench rowing with studies of fixed-bench rowing. Most research involving laboratory testing in mobile bench rowing develops 2000 m tests (da Silva et al., 2021; Gee et al., 2013; Huerta et al., 2022; Gee et al., 2016; Jiali Li et al., 2023; Quidel-Catrilelbún et al., 2024; Willwacher et al., 2021), which is a short distance to establish a direct relationship between the results of fixed bench rowing. This difference must be considered when comparing the two modalities, as there are physiological variables that can affect running pace. In mobile bench rowing studies (Khamros et al., 2024; Kleshnev & Nolte, 2011; Smith & Hopkins, 2011), the first section is always the fastest, the next two sections are slower, and in the last 500 m, the speed increases. In the present research, a faster average boat pace is established for S1, although it is maintained in a more stable manner in the other race sections compared to mobile bench studies. In the study by Astridge et al., (2024), they evaluated the differences in total time or percentage of predicted speed between 1500 m and 2000 m races. They observed less variance in pacing at the 1500 m distance compared to the 2000 m and a flatter pacing strategy. This aspect is relevant in fixed-bench rowing, as distances longer than 5000 m mean that the pacing strategy set in each section can have a greater influence on the outcome compared to mobile bench rowing.

The correlation analysis revealed that the average paces of the first and third lengths (S1 and S3) show the strongest relationship with the outcome in all rounds. Likewise, the proposed regression model has identified the round in which one competes and the average paces in lengths 1, 3, and 4 (S1, S3, and S4) as the best predictors of the outcome, with an explanatory power of 75%. This aspect demonstrates that maintaining a constant pace during the competition increases the chances of victory (Astridge et al., 2024). The average pace in each section and the race structure influence the outcome of the race. Therefore, the round in which the team competes is also a major factor in the final ranking. It has been found that boats in the first round tend to occupy positions 9th-12th, boats in the second-round positions 5th-8th, and boats in the third-round positions 1st-4th. This pattern suggests that the league system used is fair, as the overall ranking is consistently reflected in the

positions achieved in each race. Teams competing in the more advanced heats are more likely to achieve better results, indicating that the competition format distributes teams appropriately according to their level of performance.

It should be noted that the formation of the rounds in the league is based on the leader board for Saturday's race only, as Sunday is formed based on the results of the previous day. In this sense, teams that manage to position themselves in the first round not only have better average paces, but they may also benefit from a more favourable competitive context, which influences their overall performance and the shaping of Sunday's heats. This finding aligns with previous studies, such as that of González-García et al. (2023), who also identified that higher-level teams tend to record lower times throughout the competition. Other interesting data obtained includes the average times for each position in the league, which allow us to establish a possible predicted time for the participants. This information could be useful for comparing performance between teams, as studied by Kimmins & Tsai, (2021) in international competitions. With these baseline times, teams can evaluate their performance before the league starts and make strategic decisions based on their pre-race results. For example, if a team observes that its times in preparatory races are within the range of the teams that typically compete in the first round, it could adjust its training schedule or modify its strategy to improve its performance and aim for a better ranking. In this way, the analysis of average times would not only allow us to predict trends in competition but would also provide teams with a valuable tool for decision-making and optimization of sporting performance.

Despite these limitations, the findings of this study provide valuable information on the determinants of performance in fixed-bench rowing regattas. Firstly, the study is based on statistical data from official competitions, which implies that uncontrolled variables, such as weather or strategic conditions of each team, as well as the different racecourses, are also present in the final times. In addition, no biomechanical or physiological aspects of the rowers have been analysed, which could provide a more detailed view of the distribution of effort in each phase of the regatta. The size, weight, and characteristics of the fixed-bench rowing competition differ from those of mobile-bench rowing. More research is needed in fixed-bench rowing to adapt competition strategies to the physiological, biomechanical, and environmental characteristics of the sport.

Conclusions

This study investigated the average rhythms of the Eusko Label League fixed-bench rowing boats during the 2020, 2021, and 2022 seasons. The results confirm that in the first part of the regatta (0-1389 m), the average boat paces are faster than in the other three sections. The average paces established by the boats in section 1 and section 3 show a greater correlation with the outcome of the race. Therefore, longer times in S1 and S3 will lead to an increase in the outcome of the regatta. It would be advisable for the speed set on the boat during S3 (2778-4167 m) not to decrease compared to the average pace maintained in the other sections of the race. Secondly, the results show that boats competing in the last round (R3) have the fastest average paces in all sections. The teams in this round are the highest ranked in the standings. Additionally, they benefit from competing last, as they are aware of the times set by other boats in the different sections before the competition. Thirdly, no relationship was established between the average paces recorded in each section and the street on which they compete. Likewise, no direct relationship was found between the racing street and the final time of the race. Fourth, the round in which the team competes will have a direct influence on the outcome of the race. This suggested the importance of being ranked as high as possible in the season ranking or in the pre-race regatta. Finally, the model for predicting the outcome of a race establishes the average pace in section 3 and the round in which the team competes as the first two predictors of the outcome. The results of this study can serve as a reference for rowers, coaches, and sports researchers to establish pre-competition strategies to develop the performance of their teams.

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