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Swimmer Dropout Rate: A Survival Analysis

Pedro Sobreiro[1,2*], Alfredo Silva[1,2], Ana Conceição[1,2,3], Hugo Louro[1,2,3], Abel Santos[1,2], Paulo Pinheiro[4] & Pedro Guedes de Carvalho[3]

[1] Sport Sciences School of Rio Maior, ESDRM-IPSANTARÉM, Rio Maior (Portugal).
[2] Life Quality Research Center, CIEQV, Santarém (Portugal).
[3] Research Center in Sports Sciences, Health Sciences & Human Development, CIDESD, Vila Real (Portugal).
[4] Universidade Aberta, Lisbon (Portugal).

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***Corresponding author:**
Prof. Pedro Sobreiro*
sobreiro@esdrm.ipsantarem.pt

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Abstract

The length of time that a swimmer frequents a particular sports facility, using the records held by the facilities have often been under-used. We examined various behavioral variables associated with time of attendance until the point of dropout using swimmers' records. 6,749 swimmers were used in this study. The survival analysis focused on the time interval between the moment they became a customer until either the end of the study or the moment when the customer relationship ended (dropout). The Kaplan-Meier estimator was used to gather information as to when dropout would occur; Cox regression and the Logrank test provided statistical comparisons between the groups. The results showed that the swimmers' likelihood of retention beyond 12 months was 53% and the median swimmer's survival time was 14 months. The cohort of customers signing up for more than two sessions per week was likely to stay longer, and the greater the number of visits, the longer the customers were likely to continue (> 40 visits increases the survival probability up to 91.86%). Good sports management practice requires improvements in customer retention; by monitoring the variables of survival rates, we will improve management strategies for sustainability through pre-emptive actions to increase retention.

Keywords: aquatic center management, physical activity, retention, survival analysis, swimmer dropout rate.

Introduction

Sports and physical activity are undertaken by all age groups, in various places and with different objectives.

However, every year a large number of people around the world cease to continue attending their sports facility, which contributes to the loss of customers (Elasri Ejjaberi et al., 2015), lowering health levels and reducing financial sustainability. Wade et al. (2020) calculated the dropout rate from physical activity to be around 44.7% after a 12-weeks program. In Portugal, it was found that the average swimmer dropout rate over four seasons was 26.45% (Monteiro et al., 2016). Swimming is the fourth most popular activity in Portugal with 65,499 individuals (IPDJ, 2019).

Retention policies contribute simultaneously to two important management goals: first (i) to promote swimming development, the achievement of results in competitions and the achievement of healthy lifestyles, thereby contributing to customer satisfaction and commitment; second (ii) to enhance the sustainability of the sports organization. Thus, it is clear that retaining customers is a crucial factor for pool owners and sports organizations (Howat & Crilley, 2007) and expansion of sport activities (Tuero del Prado & González Boto, 2015).

The existing literature on swimming identifies swimmer dropout as one of the main issues that coaches and sports managers have to face nowadays (Fraser-Thomas et al., 2008; Monteiro et al., 2017, 2018; Salguero et al., 2003). However, studies on psychosocial factors and processes relating to dropout remain scarce (Monteiro et al., 2017). In the past, surveys were used to understand swimmer behavior, e.g. reasons for joining, maintenance, change and dropout (Marrero et al., 1999). Nowadays, however, center managers have access to swimmer data and behavioral records that have not been used previously to predict swimmer survival time (i.e. time until dropout) and, consequently, to identify methods to encourage survival.

The variety of factors and the multidisciplinarity of research into dropout have lacked a comprehensive approach. Little is known about the variables associated with a) the contractual relationship; b) attendance, such as non-attendance days, and number of visits per week; c) the practice of other activities and customer referrals; and d) gender and age.

These are some reasons why, in this research, we decided to take a different approach, addressing this gap in the literature and adopting a specific methodological approach to produce results of the greatest usefulness to sports managers.

However, this research has a twofold goal, because it was also designed to investigate and demonstrate the suitability of survival analysis as an instrument to enable sports managers to obtain a more in-depth insight into the factors contributing to swimmers' attendance rates.

Survival analysis, or more generally, time-to-event analysis, refers to a set of methods used to describe the probability of surviving past a specified point in time, or alternatively, the probability that an event of interest has not yet occurred by a point in time (Schober & Vetter, 2018), in our case the giving up of swimming practice.

The central aim of the study is to determine the retention level of swimmers using behavioral variables encountered in sports facilities, by reference to historical customer records.

Methodology

Through the use of 11 variables held on swimmers' records, the objective of this study was two-fold (a) to identify which variables contribute to retention in an aquatic center and (b) to estimate the probability of dropout occurring by a given time.

After a selective procedure, we hypothesized that retention (duration of practice) is influenced by (i) number of visits per week signed up for, (ii) number of enrolment renewals, (iii) month of enrolment, (iv) amount billed, (v) number of visits to the sports facility, (vi) number of average visits per week, (vii) days without attendance, (viii) number of other activities, (ix) number of customer referrals, and finally (x) age, and (xi) gender.

Why should we use survival analysis? Survival analysis is most effective when using data that aquatic center managers have about when events occur: how long did attendance last and what is the probability of dropout occurring when related to a set of variables of a group? The great advantage of using survival analysis lies in the fact that this method allows the prediction of something happening when the changes of that event happening differ systematically across a group. The coefficients in the Cox regression are related to the hazard where a positive coefficient represents a worse prognosis and at negative one a better prognosis. Survival analysis allows us to include information on covariates that would otherwise be omitted. Moreover, the use of the concept of 'censored' (e.g. the customer with an enrolment two months before the observational period ends without dropout), eliminates the bias of the non-survival analysis related to the discarding of information on unobserved events (customers without dropout), which create samples which are non-representative of the population studied.

Participants

We extracted records of 6,749 customers (female n = 3,503, mean age = 22.12, SD = 20.89 years; and males n = 3,246, mean age = 14.97, SD = 16.78 years) from a swimming pool; data corresponded to the period between June 1, 2014 and October 31, 2017. Data anonymity of the customers was ensured by removing all personal information before recovering data from the software used by the center.

The sports organization that manages the pool provides swimming activities with four objectives: i) learning to swim (beginner to adult), ii) fitness, iii) recreational swimming and iv) training for competitions. The main sports activities performed are swimming (61%), free-swimming (37.5%) and others such as adapted swimming, therapeutic swimming, and pregnancy swimming (1.5%).

An overall description of the analyzed data is given in Table 1.

Table 1
Variable Descriptive Statistics.

Variable		Description	Min	Max	Mean (SD)
Associated with the contractual relationship	cfreq	Number of weekly sessions signed up for	1	7	2.07 (1.82)
	nrenewals	Number of contract renewals	0	4	1.03 (1.06)
	imonth	Enrolment month	1	12	7.25 (3.17)
	tbilled	Total amount billed during the enrolment	0	1.293	161.77 (158.56)
Associated with the attendance behavior	nentries	Number of visits to the sports facility during enrolment	1	323	29.82 (35.39)
	maccess	Average weekly visits	0.01	3.94	0.60 (0.42)
	dayswfreq	Days without attendance before dropout until October 31, 2017	0	1.073	48.72 (73.42)
Other activities and references	nactivities	Number of activities other than swimming performed by the participant	1	3	1.07 (0.27)
	cref	Number of customer referrals	1	5	0.30 (0.55)
Socio-demographic	age	Age of the participants in years	0	88	18.65 (19.29)
	gender	Gender (0-female, 1-male)	0	1	0.42 (0.48)
Outcomes	months	Customer enrolment time in months	0	47	13.30 (10.91)
	dropout	Indicative of customers' commitment (0 = active, 1 = inactive)	0	1	0.57 (0.49)

Source: own elaboration.

Procedure and Statistical Analysis

The variables extracted from the software correspond to the time interval between becoming a customer until either the end of observation (31 October 2017) or the end of the customer relationship (dropout). The survival time in the dataset is represented by the number of months a user was enrolled at the swimming pool center, thus giving the timespan of the sports practice.

Data processing was conducted using Python (Continuum Analytics, 2016), Pandas (McKinney, 2010) and NumPy (Walt et al., 2011).

The Kaplan-Meier estimator was used to gather information about the dropout event and to estimate survival (Efron, 1988), based on the survival probabilities and corresponding to the time in which the events were observed (Bland & Altman, 1998).

Results

The probability of swimmer survival time in the first 12 months of practice is shown in Table 2 (column $p_i -_{\text{likelihood probability}}$) and the median survival time was 14 months. The likelihood of swimmers continuing with the sport beyond six months was 73.5%, which represents a risk of withdrawal of 26.5%, and an estimated survival time of 17 months. Swimmers' likelihood of retention beyond 12 months was 53.0 %, representing a higher risk of withdrawal (47%) with an estimated survival of 22 months after enrolment.

Table 2
Survival time probabilities during the first 12 months of attendance.

Event Month	Removed	Dropout	Censored	Risk of Dropout	p_i	Estimated survival (months)
0	5	5	0	6747	.999	14
1	127	52	75	6742	.992	14
2	758	241	517*	6615	.955	13
3	439	433	6	5857	.885	15
4	372	340	32	5418	.829	16
5	346	299	47	5046	.780	17
6	319	274	45	4700	.735	17
7	406	356	50	4381	.675	20
8	268	198	70	3975	.641	20
9	240	183	57	3707	.610	21
10	294	230	64	3467	.569	22
11	206	149	57	3173	.542	22
12	103	71	32	2967	.530	22

Note. Removed – the sum of customers with dropout and that are censored; Censored – the event did not occur during the period of this data collection; Risk of Dropout – number of customers at risk of dropout; pi – survival probability; Estimated Survival - months to survive in the sports facility.
*Corresponds to customers with two months of enrolment without the event of dropout during the time period corresponding to study (between June 1, 2014, and October 31, 2017), for example, customers enrolled in September 2017.
Source: own elaboration.

The number of enrolment renewals affected the survival rate of the swimmers, such that for each renewal the dropout is reduced by 84% (see Table 3 - hazard ratio = 0.16, $p < .01$).

Table 3
Results of the multivariate Cox´s regression.

Variable	Regression Coefficient	Hazard ratio	*p*
Age	0.01**	1.01	<.01
Gender	-0.04	0.96	.26
Dayswfreq	0.00	1.00	<.01
Tbilled	0.00	1.00	<.01
Maccess	0.60**	1.82	<.01
Nactivities	-0.04	0.96	.61
Nentries	-0.03*	0.98	<.01
Cfreq	-0.09*	0.92	<.01
Nrenewals	-1.84*	0.16	<.01
Nreferences	-0.03	0.97	.33
Imonth	-0.15*	0.86	<.01

Note. Impact of the variables on the survival time of the swimmers. *represent an increase in the survival time with $p < .005$ and **a decrease in the survival time with p .005.
Source: own elaboration.

The interpretation is as follows: the hazard ratio is obtained from the exponential of the regression coefficient and gives the effect size of the predictors.

Cox's regression was used to determine the impact of additional covariates on the survival time (Bewick et al., 2004), by analyzing customer behavior in the sports facility. A hazard ratio of 1 represents a null effect on survival time. The negative values in Cox's Regression Coefficient represent an increase in sports practice. The proportional hazard assumptions weren't tested, considering the hazard ratio as an average effect over the observation period (Stensrud & Hernán, 2020). The logrank was applied to the variables that impact the survival time, transformed into categories using quartiles to provide a statistical comparison of groups, where the exception was gender provide additional Socio-demographic analysis. The survival analysis was conducted using the package Lifelines (Davidson-Pilon et al., 2017). The period of the year, namely the enrolment month, was shown to have a positive effect on the survival time of swimmers (hazard ratio = 0.86, $p < .01$), see Table 3.

In contrast, average weekly visits, the number days without attendance and the total amount billed, were found to have a negative effect on the survival time of swimmers' activity, reducing the length of practice (hazard ratio = 1.82, $p < .01$; hazard ratio = 1, $p < .01$; hazard ratio = 1, $p < .01$), see Table 3.

Lastly, swimmers' age had a negative effect on the length of attendance, i.e., for each age increase, the survival of the swimmers is reduced by 1% (hazard ratio = 1.01, $p < .01$), see Table 3. Regarding the behavioral variables observed in the swimmer's records, associated with the contractual relationship, the number of weeks signed up for leads to a reduction of dropout risk, e.g., for each increase in weeks signed up for, there is a reduction in the dropout probability of 8% (hazard ratio = 0.92, $p < .01$), see Table 4.

Table 4
Results of the logrank test and survival for each group.

Variable	Group	Survival prob. 12 months	Survival median	Logrank test (χ^2)	*p*-value
age	Less than 5	54.9%	15	204.78	<.01
	5 to 10	64.89%	22		
	10 to 32	43%	10		
	More than 32	48.35%	11		
maccess	Less than 0.3	40.56%	9	294.44	<.01
	0.3 to 0.51	51.41%	13		
	0.51 to 0.80	59.80%	20		
	More than 0.80	62.44	21		
nentries	Less than 6	12.14%	4	3721.13	<.01
	6 to 17	28.53%	7		
	17 to 40	63.70%	17		
	More than 40	91.86%	39		
cfreq	1	53.77%	15	58.34	<.01
	2	48.34%	11		
	More than 2	62.83%	21		
nrenewals	0	1,90%	5	6264.73	<.01
	1	69.88%	16		
	2	85.49%	27		
	More than 2	99.91%	inf		
imonth	Quarter 1	51.95%	15	86.33	<.01
	Quarter 2	47.06%	11		
	Quarter 3	57.02%	16		
	Quarter 4	51.28%	13		
gender	Male (1)	54.57%	15	10.69	<.01
	Female (0)	51.47%	13		

Note. inf represents a value not possible to estimate. The enrolment months were grouped into quarter categories: Quarter 1 corresponds to month 1, 2 and 3: Quarter 2 months 4, 5 and 6; Quarter 3 months 7, 8 and 9 and Quarter 4 months 10, 11 and 12.
Source: own elaboration.

The group of swimmers signed up for more than two visits per week had a probability of survival of 12 months of 62.83% (cfreq), higher than the groups of swimmers who signed up for only 1 or 2 visits. The logrank test for the groups identifying the number of contracted visits per week was significant $\chi^2 = 58.34$, $p < .01$, indicating that survival is significantly different between one, two, and more than two, contracted visits per week (see Table 4).

There are significant differences between groups ($\chi^2 = 6264.73$, $p < .01$) in relation to contract renewals: when swimmers renew two or more contracts, the survival probability for 12 months is 85.49%, which is greater than the group renewing only once (see Table 4).

There are also significant differences between the groups ($\chi^2 = 86.33$, $p < .01$), in terms of the time of enrolment: the group of swimmers enrolling in the third quarter has a survival probability for 12 months of 57.02%, which is greater those the swimmers enrolling in other quarters (see Table 4).

Regarding those behavioral variables observed in the swimmers' records which have a positive effect on the reduction of dropout, for each increase in the number of visits, the dropout probability decreases by 2% (hazard ratio = 0.98, K < .01). The swimmers' group with more than 40 visits has a probability of surviving more than 12 months of 91.86%, which is greater than the other groups. There are significant differences between these groups ($\chi^2 = 3721.13$, $p < .01$), see Table 4.

Generally, the average number of visits per week did not have a positive effect on survival time. However, the results of the logrank test showed that the group of swimmers with a value greater than 0.80 average weekly visits has a 62.44% probability of surviving more than 12 months with a survival median of 21 months. There were significant differences between the groups ($\chi^2 = 294.44$, $p < .01$), see Table 4.

The swimmers' group with ages between 5 and 10 years showed a higher survival probability (64.89%), with a median survival of 22 months.

The logrank test for the groups related to age was significant $\chi^2 = 204.78$, $p < .01$, indicating that survival is significantly different between the age groups (see Table 4). Regarding gender the logrank test was significant $\chi^2 = 10.69$, $p < .01$ with differences between the genders. The summary of the main results is represented in Figure 1.

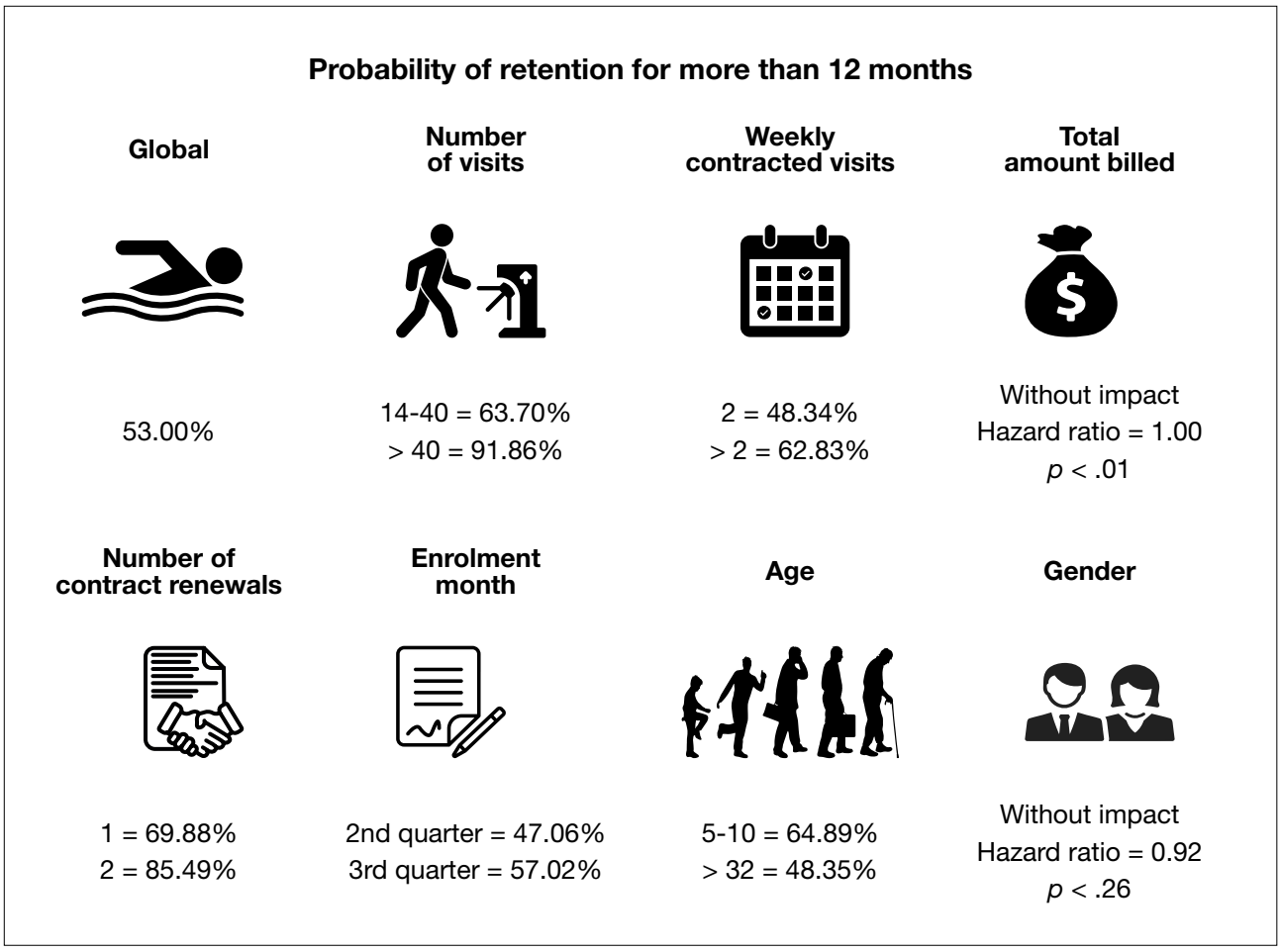

Figure 1
Study main results.

Discussion

The purpose of the study was (a) to identify which variables contribute most to retention by estimating the probability of dropout occurrence on a time scale and (b) to verify the suitability of survival analysis for this purpose. From the obtained results, we highlight six topics for discussion.

First, the swimmers' likelihood of retention beyond 12 months was 53.0%. The median swimmer's survival time was 14 months, different to the 36 months determined as the average membership duration for members of a fitness center (Zarotis et al., 2017). These results, calculated in different groups, reported differences in the logrank test. The median survival times, according to the different ages, were the following: until 5 years 15 months, between 5-10 years old 22 months; between 10-32 years old 10 months; and > 32 years old 11 months. The gender results also present differences with median survival time for males of 15 months and 13 months for females. Age and gender were also addressed in previous research identifying differences among genders and between age groups (Monteiro et al., 2018).

Considering the swimming pool center's utilitarian goal (of learning to swim from beginner to adult), the duration can be explained by the fact that after this period people have learned to swim, they have achieved their goal, and thus feel more independent and are able to withdraw.

Second, the number of contract renewals, and the time of year, namely the enrolment month: the number of visits signed up for influences the duration of attendance, and the number of contract renewals was confirmed as contributing to higher survival values. Significant differences were detected between each group of swimmers. The group that signed up for more than two visits per week had longer survival rates than the other groups (median survival of 21 months and a survival probability of 62.83%).

The number of visits signed up for had a positive effect on survival time, which can be explained by two aspects: first, the individual's intention to take regular exercise, related to the perceived benefits of regular practice of physical activity (in this case, the practice of swimming); second, higher levels of satisfaction of fundamental needs lead to greater desires to continue (Deci & Ryan, 2000), thereby giving rise to higher levels of retention.

Third, the number of renewed contracts affected the swimmers' survival time, so that, for each renewed contract, dropout was reduced by 84%. This suggests that when people perceive they are developing a skill in relation to an activity, they are more likely to develop an increased motivation to continue to develop that skill, in this case, swimming.

Fourth, the time of year in which an individual enrolled (enrollment month) contributed to an increase in duration of the swimmer's survival in the sport. The swimmers' group enrolling in the third quarter had a survival probability higher than those swimmers enrolling in other quarters. A likely explanation for this result may be that the sports season and the school year start at the end of the third trimester, being the period in which swimmers enroll for the sports season, and swimming classes are formed. This is also related to the satisfaction of fundamental need as individuals seek to satisfy their perceived relatedness to others in the community or, in this case, to individuals within swimming groups.

Fifth, the number of visits increase the survival rate of swimmers. Additionally, the results of the logrank test corroborate these results, suggesting significant differences between each group. The swimmers' group with more than 40 visits to the swimming pool had an increased survival probability (> 40 entries goes up to 91.86% for more than 12 months) than the swimmers' groups with fewer visits. Similar to previous studies, the number of visits has been related to a lower probability of withdrawal (Emeterio et al., 2019, 2016; Ferrand et al., 2010).

Although the average number of weekly visits did not have a positive effect on survival time, the logrank results show significant differences between the groups, showing that increasing average visits results in higher survival time. The swimmers' group with average weekly visits of more than 0.8 had an increased survival probability than the other groups. This result corroborates previous studies which showed that the number of weekly visits is associated with greater commitment in clubs and a lower probability of dropout (Emeterio et al., 2019; Ferrand et al., 2010). In addition, Ferrand et al. (2010) found that weekly attendance rates positively affect customer's intentions towards repurchase. The result can be better understood when there exist a) a higher weekly frequency and number of visits, b) improved learning of swimming techniques, thereby improving the perception of their skills, and increasing their motivation to continue.

Sixth, the results support the hypothesis that age influences the duration of practice. Previous literature has also identified age as a significant predictor for retention (Emeterio et al., 2016; Ferrand et al., 2010), which is confirmed with the lower survival in the two older groups used to calculate the logrank test. Emeterio et al. (2016) identified age (older or younger than 33 years) as having a significant effect on sports dropout. Adult swimmers, unlike younger swimmers, seem to have higher dropout rates: 36.51%, compared to the average of 26.45% (Monteiro et al., 2016). It is likely that the age variable in swimmers' records may have a positive

effect on dropout. We did not find significant predictive value of 'gender' in line with other studies (Emeterio et al., 2016, 2019).

Implications for sports managers

Considering there is an excessive amount of information, how can these results help managers of aquatic centers?

Survival analysis has advantages in determining the timing and variables related to dropout. The median survival time provides a crucial indicator to sports managers, identifying the exact time in which to take action, such as by defining an incentive plan whose implementation will reduce dropout rates.

The results show that the median swimmer's survival time was 14 months. To prevent dropout, when swimmers exceed the first few months, action needs to be taken to counteract negative outcomes, like impaired performance and dropout. This monitoring should be conducted with short surveys on key individual and social aspects of training sessions. In addition, strategies to avoid dropping out should include the development of tools (e.g., coach training, prevention programs on swimmer dropout management) to encourage customers' well-being and satisfaction through the evidence of individual skill gains. These actions should be developed according to some cohorts, targeting actions to early-stage swimmers and for those with more than 32 years old with a median survival time of 11 months, where the age group between 5-10 years old presents longer survival times (median of 22 months). Although the result among genders presents similar results regarding median survival times (13 and 15 months for females and males, respectively). This aspect could represent a similar approach in the timings to target preventive retention actions. This could limit the decrease in the risk of performance decline and sport dropout.

The results show that the number of contract renewals affects the survival time of swimmers, i.e., when swimmers renew more than two contracts, they have an increased survival probability of 85.49%, which is higher than the swimmers' group renewing only once. Sports managers can develop strategies to ensure membership renewal using sales techniques to guide swimmers towards goals and showcase acquired skills, thereby improving swimmers' motivation to continue through contract renewal (e.g., authorized filming before and after learning classes).

The moment at which an individual enrolls (in the third trimester) also contributes to the increased duration of the swimmer's survival in sports. This result suggests that sports managers should create temporary campaigns that include stimuli and benefits of various types (price, discounts, special offers) to promote swimmer enrolment during the third quarter of the year.

Our results also show that the number of visits contributes to increasing the survival rate of swimmers. The group of swimmers with more than 40 visits had a higher survival probability. This indicator has limitations as it can only be observed at the end of the year. Therefore, it is suggested that sports managers should use similar indicators by quarter or semester. Swimmers with indicators of a reduced score, increasing the likelihood of withdrawal, should be closely monitored. Technical and commercial staff should carry out actions to show off newly acquired skills in customers - to increase motivation with the corresponding effects on survival time gain. Staff and coaching attributes are essential for raising the swimmers' motivation level. These factors should lead to investment in skilled human resources and staff training, as increased pool access leads to retention of swimmers.

These results could assist in the design of different lines of action to reduce dropout with reference to different groups. Sports managers may be recommended to use this indicator as a criterion by which to divide people into distinct swimmer groups, with appropriate price, activity and interaction profiles to increase motivation, with appropriate timing for increasing the number of visits, which have been seen to be so critical to longer survival time.

Results confirmed that there was shorter survival in the two older groups used to calculate the logrank test, which identified significant differences between groups. Sports managers are encouraged to use the traditional age targeting criteria, to build swimmer groups by age (and expected benefits) incorporation appropriate exercises during lessons to achieve these benefits, increasing motivation, which in turn has effects on survival time. The oldest swimmer cohort segment should require more monitoring and additional actions to increase motivation and reduce the risk of withdrawal. Examples include providing the customers with an appropriate level of choice, explaining the rationale behind decisions, giving them opportunities to take the initiative, and allowing them to work independently to gain the benefits associated with their individual goals. In turn, sports managers should share this information with coaches, and support coaches' efforts to increase swimmer motivation.

However, our study had several limitations mainly related to the availability of swimmer data and behavioral records in the aquatic center where the data was collected. This aspect limited our analysis and did not allowed further developments using others cohort groups, representing overall trends in the cox regression and complemented with the logrank tests that allowed to deepen the survival

analysis within the analyzed groups. The sport managers should consider the importance of registering the dropout reason as an important factor to analyze deeply this thematic, allowing to improve the identification and creation of preventive actions to reduce dropout, which was not possible in the available data.

In summary, sports managers should consider the significant predictors of the number of contract renewals, enrolment month, number of weeks contracted, the total number of visits, average weekly visits and age as variables to inform their decisions. By doing so, they can draw up policies and plans of action designed to reward swimmers, with beneficial results.

Conclusions

Our investigation allowed us to draw four main conclusions:

1. The number of contract renewals, and the time of year, namely the enrolment month: the number of visits signed up for influences the duration of attendance, and the number of contract renewals was confirmed as contributing to higher survival values. Significant differences were detected between each group of swimmers.

2. The number of visits increases the survival rate of swimmers. Additionally, the results of the logrank test corroborate these results, suggesting significant differences between each group.

3. The number of renewed contracts affected the swimmers' survival time, so that, for each renewed contract, dropout was reduced by 84%.

4. The average number of weekly visits did not have a positive effect on survival time.

The logrank test allowed us to refine these conclusions giving insights into different groups created for each variable. The risks of dropout in different groups are different, and the timings as to when dropout is likely to occur give sports managers an indication of where to target their actions to improve retention.

The analysis of existing data provides full information for the sport managers to develop actions to reduce dropout. This allows identifying risk cohorts that should be targeted to increase aquatic centers sustainability and simultaneously contribute to longer periods developing physical activity.

Disclosure statement

No potential conflict of interest was reported by the authors.

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