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MODIFICATION OF THE SPECIFIC CONCONI TEST FOR SWIMMERS

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Abstract: We presented The Conconi Test is currently used to detect the lactic anaerobic threshold non-invasively, but so far it has only been used on land, and the conditions in the aquatic environment are completely different. Furthermore, swimming requires an effort that is incomparable to running, since swimmers are in contact with the water all the time and the effort is distributed differently. In the case of swimmers, 70% of the effort falls on the arms and 30% on the legs, which represents a big difference compared to the effort of running on land.
The objective of the present study is to determine the specific anaerobic threshold for swimmers using the bases established by Francesco Conconi (1982). The heart rate will be used as an indicator, a starting time with respect to the effort perception formula of Maglischo (2009) and the starting point of the anaerobic threshold will be established at 70% intensity, up to 85% as closure and as a critical point for the development of the study.
Keywords: Lactic anaerobic threshold, pulse, step control (swimming pace), formulas.

INTRODUCTION

Conconi test, as mentioned above, is used to determine the anaerobic lactic threshold on land. Its application method involves taking distances of 400 meters and, at the end of the distance, the pulse is immediately taken either manually or by a pulse meter. The test can be repeated by reducing the time to perform the distance again and taking the pulse continuously. Conconi (1982) indicates that there will come a time when the pulse will normalize despite the intensity increasing. The second measurement that shows the same pulse values indicates that the anaerobic threshold has been detected. However, in relation to swimmers, there are some sources that indicate that they must swim 100 meters and take their pulse in the same way, but the starting point of the time with which they must start, nor the rest times, are not determined. and it is also worth clarifying that up to the time of this research, no literature related to the Conconi test applied directly to swimming has been found. Additionally, it is important to determine the specific anaerobic threshold for swimmers, since wear and tear occurs in a different way than other sports.

During national competitions, swimmers can enter 1 to 8 events not including relays. These tests can be duplicated due to the preliminaries taking place in the morning and, if they advance to the finals, taking place on the same day. Therefore, swimmers can compete in up to 16 competitions (prelims and finals), with two, three or even six events per day. This represents an incredible effort for swimmers, as they must learn to distribute their energy throughout the entire competition. Determining your anaerobic threshold will help make the training more intelligent and for the coach to adjust it throughout the season, and thus the swimmer assimilates the training consciously and unconsciously, intelligently distributing his energy when competing.

The following research study takes a quote from the author Ranzola (1988) in his book "Sports training planning", where it is established that:

> *"…A test must be applied every three weeks since there are changes in the body. "These changes allow us to correct and perfect the training process."*

To carry out this research, tests were carried out from June 22 to October 28, 2022, during the five months in which the test modification was applied. Around six samples were carried out only with the 100 meter freestyle test (crawl).

Application dates
June 22, 2022
July 13, 2022
August 5, 2022
August 26, 2022
October 7, 2022
October 28, 2022

Table 1. Test application dates

METHODOLOGY

PROCEDURE

The research carried out was of a qualitative experimental type, carried out in a 25-meter pool with a distance of 100 meters in front crawl, focusing on national-level swimmers with experience (at least 5 years) and 15 years and older, since lactic acid is produced at these ages. In addition, it was sought that the swimmers had skills to control their swimming pace (Navarro, 1973), which was essential for the accuracy of the test. The pulse that was taken was in the carotid artery, since the aim was to establish an immediate reference point and allow the swimmers to learn to take their pulse. In many cases, finding the radial pulse can be more complicated, unless you have some prior experience (Smith et al., 2018).

The method used consisted of establishing as a first step the ideal percentage to start the test, which is generally between 70% (entry to aerobic work) and 85% (anaerobic threshold) (Navarro, 2012). Second step, Maglischo's (2009) effort perception formula was used; the percentages at which work would be done were determined, increasing the effort every 2% in each repetition, which gave a total of 15 repetitions to reach the threshold point. lactic anaerobic.

Example:

The swimmer's best time of 1:00:00 becomes 60 seconds.

The 60 seconds are multiplied by 0.10, 0.20, 0.30, 0.40, these figures indicate 90%, 80%, 70%, and 60% respectively.

But for the application of the following method it was applied as follows:

Multiple	Percentage	Multiple	Percentage
0.30	70%	0.14	86%
0.28	72%	0.12	88%
0.26	74%	0.1	90%
0.24	76%	0.08	92%
0.22	78%	0.06	94%
0.2	80%	0.04	96%
0.18	82%	0.02	98%
0.16	84%		

Table 2. Table of intensity percentages for swimmers.

It is important to note that, although the method proposed by Conconi was initially followed, during the research other conditions were established through Karvonen's formula (1957). To determine the threshold, the heart rate was used as indicated by Conconi (1982), evaluating only two repetitions to obtain the result of the pulse that would mark the threshold. However, unlike other occasions, in this research the Karvonen formula (1957) was applied as a third step to determine the percentages of heart rate between 70% and 85% and this heart rate zone was established as the range of work to determine the effort.

Through the Karvonen formula it tells us the following:

Maximum heart rate

220 – age (Men)

226 – age (women)

The result gives us the total heart rate

FCT – FR (Rest Frequency) = F d Re (Reserve Frequency)

F of Re x 0.90, 0.80, 0.70, 0.60, 0.50 (90%, 80%, 70%, 60%, 50% respectively) the result is added with the FCR and from there the percentages of the pulsation intensities are determined.

Example:

Age	60	
%	70%	85%
15	166	188

Men

Table 3. Example of the pulses for men, the yellow color indicates the beginning of the pulses and the orange color indicates the age.

Age	60	
%	70%	85%
15	162	183

Women

Table 4. Example of the table for women

This is an example of how a 15-year-old can determine their heart rate in the work area based on specific percentages.

Once the start time and heart rate have been established, the fourth step is to determine the rest time between repetitions, which is 30 seconds. This rest interval is known as the entry to aerobic work (Navarro, 2012), but is not adjusted due to the gradual increase in intensity between 100 meter repetitions.

The application process is carried out considering the 15 total repetitions that gradually increase in intensity, along with the heart rate work zone and rest times.

Once all of the above has been established, the following procedure is followed:

1. First of all, the age, resting pulse and the swimmer's best swimming time in the 100 meter test are taken into account.

2. Once these data have been taken, the necessary calculations are made and once done, the swimmer must learn the times to mark between repetitions, the test is carried out after a warm-up.

3. The first sample (inside the pool, without diving) of the 100 meters is carried out, and the heart rate is taken immediately after finishing a repetition, counting up to 15 seconds and multiplying the result by four. Then they rest for the remaining 15 seconds and start again, until the swimmer tolerates it.

It is important to highlight two things in relation to the 100 meters and the pulses: firstly, it is crucial that the times recorded between repetitions coincide with those requested by the formulas, with an error range of tenths up to a maximum of one and a half seconds. Secondly, you must constantly monitor that the heart rate is within the work zone indicated by the Karvonen formula.

The sample was carried out on eight national level swimmers, who have more than five years of experience in competitions and training, and who range in age from 15 to 18 years.

According to Leminszka et al. (2010), "the challenge is to define a methodology to measure or predict the lactate level in a non-invasive way, establishing correlations between various physical parameters with the purpose of determining the concentration of lactic acid in the blood." The goal is to achieve an accuracy of at least 80% effectiveness compared to the results obtained using conventional invasive meters. In this sense, doctors and trainers suggest that a non-invasive measurement must meet these effectiveness indices." (Leminszka et al., 2010). Therefore, it is crucial that the measurement performed in the context of this current study be as accurate as possible with the use of proposed mathematical formulas as the primary means for the detection of anaerobic threshold levels in a non-invasive manner.

RESULTS

Heart rate: Heart rate is a crucial indicator for swimming training. In order to help coaches identify ideal swim paces and heart rate percentages for men and women, precise tables are presented below. Specifically, the tables detail the recommended pulse

percentages, which range between 70% and 85% for both sexes. Additionally, a chart is provided that allows the coach to quickly identify his or her swimmer's heart rate during a particular event. Consequently, these tools can be useful to optimize swimmers' performance during their training and competitions.

FC	15 s'	FC result
20	4	80
21	4	84
22	4	88
23	4	92
24	4	96
25	4	100
26	4	104
27	4	108
28	4	112
29	4	116
30	4	120
31	4	124
32	4	128
33	4	132
34	4	136
35	4	140

FC	15 s'	FC result
36	4	144
37	4	148
38	4	152
39	4	156
40	4	160
41	4	164
42	4	168
43	4	172
44	4	176
45	4	180
46	4	184
47	4	188
48	4	192
49	4	196
50	4	200
51	4	204

Table 5. Table of pulses by the multiple of 4

Table of male-female pulse rates: In the tables presented below, you can find the pulse rates established for ages between 15 and 25 years. To determine the heart rate percentages of swimmers based on their age, the 220-age maximum heart rate formula is used and the Karvonen formula is applied to identify the recommended working range for performing the test. Additionally, the following table presents the recommended range for women between the ages of 15 and 25, using the 226-age formula to determine their working range. These tools can be helpful in establishing an appropriate and safe training plan for swimmers based on their age and fitness level.

Men

Pulses

Age	60		62		64		66		68		70		72		74	
%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%
15	162	183	162	184	163	184	163	184	164	184	165	185	165	185	166	185
16	161	182	161	183	162	183	163	183	163	184	164	184	164	184	165	185
17	160	182	161	182	161	182	162	182	163	183	163	183	164	183	164	184
18	159	181	160	181	161	181	161	182	162	182	162	182	163	183	164	183
19	159	180	159	180	160	180	161	181	161	181	162	181	162	182	163	182
20	158	179	159	179	159	180	160	180	160	180	161	181	162	181	162	181
21	157	178	158	178	159	179	159	179	160	179	160	180	161	180	162	180
22	157	177	157	178	158	178	158	178	159	179	160	179	160	179	161	179
23	156	176	157	177	157	177	158	177	158	178	159	178	160	178	160	179
24	155	176	156	176	156	176	157	177	158	177	158	177	159	177	159	178
25	155	175	155	175	156	175	156	176	157	176	158	176	158	177	159	177

Pulses

Age	76		78		80		82		84		86		88		90	
%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%
15	166	186	167	186	168	186	168	187	169	187	169	187	170	187	171	188
16	166	185	166	185	167	185	167	186	168	186	169	186	169	187	170	187
17	165	184	166	184	166	185	167	185	167	185	168	185	169	186	169	186
18	164	183	165	183	165	184	166	184	167	184	167	185	168	185	168	185
19	164	182	164	183	165	183	165	183	166	183	167	184	167	184	168	184
20	163	181	163	182	164	182	165	182	165	183	166	183	166	183	167	184
21	162	181	163	181	163	181	164	181	165	182	165	182	166	182	166	183
22	161	180	162	180	163	180	163	181	164	181	164	181	165	182	166	182
23	161	179	161	179	162	179	163	180	163	180	164	180	164	181	165	181
24	160	178	161	178	161	179	162	179	162	179	163	180	164	180	164	180
25	159	177	160	177	161	178	161	178	162	178	162	179	163	179	164	179

Table 6 and 7. Table of percentages of times for men, the yellow color indicates the beginning of the pulses and the orange color indicates the age.

Women

Pulses

Age	60		62		64		66		68		70		72		74	
%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%
15	166	188	166	189	167	189	168	189	168	190	169	190	169	190	170	190
16	165	188	166	188	166	188	167	188	167	189	168	189	169	189	169	190
17	164	187	165	187	166	187	166	188	167	188	167	188	168	188	169	189
18	164	186	164	186	165	186	165	187	166	187	167	187	167	188	168	188
19	163	185	164	185	164	186	165	186	165	186	166	186	167	187	167	187
20	162	184	163	184	163	185	164	185	165	185	165	186	166	186	166	186
21	162	183	162	184	163	184	163	184	164	184	165	185	165	185	166	185
22	161	182	161	183	162	183	163	183	163	184	164	184	164	184	165	185
23	160	182	161	182	161	182	162	182	163	183	163	183	164	183	164	184
24	159	181	160	181	161	181	161	182	162	182	162	182	163	183	164	183
25	159	180	159	180	160	180	161	181	161	181	162	181	162	182	163	182

Pulses

Age	76		78		80		82		84		86		88		90	
%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%	70%	85%
15	171	191	171	191	172	191	172	192	173	19	174	192	174	193	175	193
16	170	190	170	190	171	191	172	191	172	191	173	191	173	192	174	192
17	169	189	170	189	170	190	171	190	172	190	172	191	173	191	173	191
18	168	188	169	189	170	189	170	189	171	189	171	190	172	190	173	190
19	168	187	168	188	169	188	170	188	170	189	171	189	171	189	172	189
20	167	187	168	187	168	187	169	187	169	188	170	188	171	188	171	189
21	166	186	167	186	168	186	168	187	169	187	169	187	170	187	171	188
22	166	185	166	185	167	185	167	186	168	186	169	186	169	187	170	187
23	165	184	166	184	166	185	167	185	167	185	168	185	169	186	169	186
24	164	183	165	183	165	184	166	184	167	184	167	185	168	185	168	185
25	164	182	164	183	165	183	165	183	166	183	167	184	167	184	168	184

Table 8 and 9. Table of percentages of times for women, the yellow color indicates the beginning of the pulses and the orange color indicates the age.

ANALYSIS

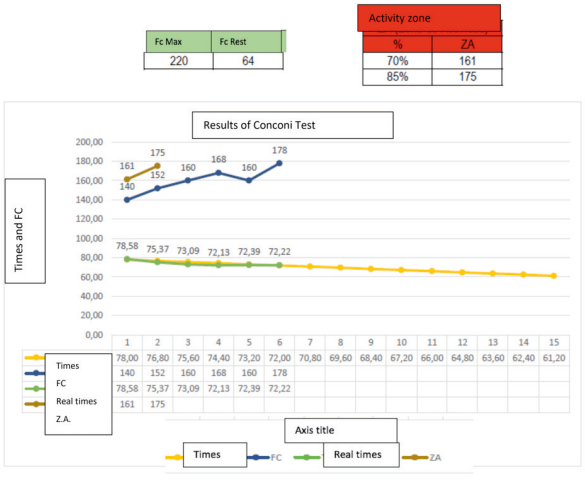
In the following graphs, different data related to the test are presented, including the pulses obtained by applying the Karvonen formula, which are shown in brown lines. Additionally, the test results line is presented in blue during the test. In the lower lines, the times (in seconds) that must be marked according to the Maglischo effort perception

PERCENTAGE OF TIMES

Times	Percentage of times in seconds														
	70%	72%	74%	76%	78%	80%	82%	84%	86%	88%	90%	92%	94%	96%	98%
00:50,00	01:05,00	01:04,00	01:03,00	01:02,00	01:01,00	01:00,00	00:59,00	00:58,00	00:57,00	00:56,00	00:55,00	00:54,00	00:53,00	00:52,00	00:51,00
00:51,00	01:06,30	01:05,28	01:04,26	01:03,24	01:02,22	01:01,20	01:00,18	00:59,16	00:58,14	00:57,12	00:56,10	00:55,08	00:54,06	00:53,04	00:52,02
00:52,00	01:07,60	01:06,56	01:05,52	01:04,48	01:03,44	01:02,40	01:01,36	01:00,32	00:59,28	00:58,24	00:57,20	00:56,16	00:55,12	00:54,08	00:53,04
00:53,00	01:08,90	01:07,84	01:06,78	01:05,72	01:04,66	01:03,60	01:02,54	01:01,48	01:00,42	00:59,36	00:58,30	00:57,24	00:56,18	00:55,12	00:54,06
00:54,00	01:10,20	01:09,12	01:08,04	01:06,96	01:05,88	01:04,80	01:03,72	01:02,64	01:01,56	01:00,48	00:59,40	00:58,32	00:57,24	00:56,16	00:55,08
00:55,00	01:11,50	01:10,40	01:09,30	01:08,20	01:07,10	01:06,00	01:04,90	01:03,80	01:02,70	01:01,60	01:00,50	00:59,40	00:58,30	00:57,20	00:56,10
00:56,00	01:12,80	01:11,68	01:10,56	01:09,44	01:08,32	01:07,20	01:06,08	01:04,96	01:03,84	01:02,72	01:01,60	01:00,48	00:59,36	00:58,24	00:57,12
00:57,00	01:14,10	01:12,96	01:11,82	01:10,68	01:09,54	01:08,40	01:07,26	01:06,12	01:04,98	01:03,84	01:02,70	01:01,56	01:00,42	00:59,28	00:58,14
00:58,00	01:15,40	01:14,24	01:13,08	01:11,92	01:10,76	01:09,60	01:08,44	01:07,28	01:06,12	01:04,96	01:03,80	01:02,64	01:01,48	01:00,32	00:59,16
00:59,00	01:16,70	01:15,52	01:14,34	01:13,16	01:11,98	01:10,80	01:09,62	01:08,44	01:07,26	01:06,08	01:04,90	01:03,72	01:02,54	01:01,36	01:00,18
01:00,00	01:18,00	01:16,80	01:15,60	01:14,40	01:13,20	01:12,00	01:10,80	01:09,60	01:08,40	01:07,20	01:06,00	01:04,80	01:03,60	01:02,40	01:01,20
01:01,00	01:19,30	01:18,08	01:16,86	01:15,64	01:14,42	01:13,20	01:11,98	01:10,76	01:09,54	01:08,32	01:07,10	01:05,88	01:04,66	01:03,44	01:02,22
01:02,00	01:20,60	01:19,36	01:18,12	01:16,88	01:15,64	01:14,40	01:13,16	01:11,92	01:10,68	01:09,44	01:08,20	01:06,96	01:05,72	01:04,48	01:03,24
01:03,00	01:21,90	01:20,64	01:19,38	01:18,12	01:16,86	01:15,60	01:14,34	01:13,08	01:11,82	01:10,56	01:09,30	01:08,04	01:06,78	01:05,52	01:04,26
01:04,00	01:23,20	01:21,92	01:20,64	01:19,36	01:18,08	01:16,80	01:15,52	01:14,24	01:12,96	01:11,68	01:10,40	01:09,12	01:07,84	01:06,56	01:05,28
01:05,00	01:24,50	01:23,20	01:21,90	01:20,60	01:19,30	01:18,00	01:16,70	01:15,40	01:14,10	01:12,80	01:11,50	01:10,20	01:08,90	01:07,60	01:06,30
01:06,00	01:25,80	01:24,48	01:23,16	01:21,84	01:20,52	01:19,20	01:17,88	01:16,56	01:15,24	01:13,92	01:12,60	01:11,28	01:09,96	01:08,64	01:07,32
01:07,00	01:27,10	01:25,76	01:24,42	01:23,08	01:21,74	01:20,40	01:19,06	01:17,72	01:16,38	01:15,04	01:13,70	01:12,36	01:11,02	01:09,68	01:08,34
01:08,00	01:28,40	01:27,04	01:25,68	01:24,32	01:22,96	01:21,60	01:20,24	01:18,88	01:17,52	01:16,16	01:14,80	01:13,44	01:12,08	01:10,72	01:09,36
01:09,00	01:29,70	01:28,32	01:26,94	01:25,56	01:24,18	01:22,80	01:21,42	01:20,04	01:18,66	01:17,28	01:15,90	01:14,52	01:13,14	01:11,76	01:10,38
01:10,00	01:31,00	01:29,60	01:28,20	01:26,80	01:25,40	01:24,00	01:22,60	01:21,20	01:19,80	01:18,40	01:17,00	01:15,60	01:14,20	01:12,80	01:11,40

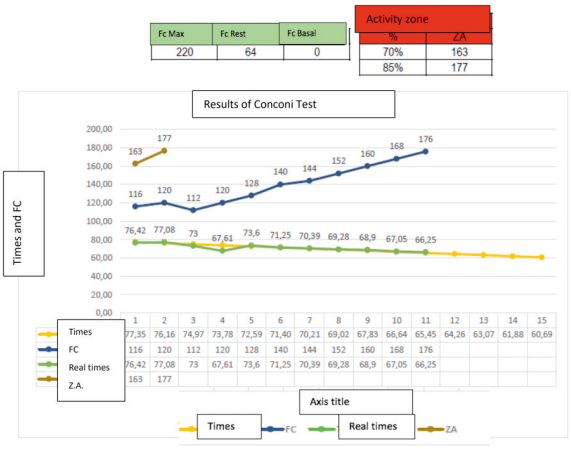
Table 10: Table of percentages of the times that swimmers have to perform when the test is carried out, the initial time and the percentages of time that they must perform during the repetitions from 70% to 98%, based on the formula of perception of Maglischo's effort.

formula are represented in yellow, while the green line that overlaps the yellow line indicates the times recorded during the test by the swimmer. This way, the results obtained can be compared and the swimmer's performance during the test can be evaluated.



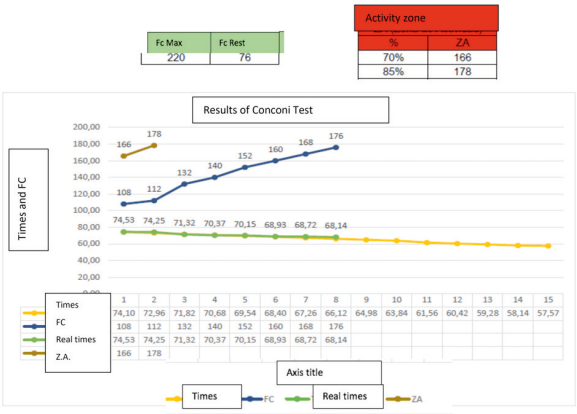
Subject 1 (Male): Best time in 100 front crawl of 1:00.00

It can be seen that in the case of subject 1, the times obtained (swimming pace) using the formulas are remarkably close to the requested values. In addition, a slight excess of three beats is evident in the heart rate recording. However, this discrepancy is insignificant in the context of the test, since the subject completes the test, which supports his claim to have reached his anaerobic threshold. Furthermore, he managed to do six repetitions at most, an indicator of his anaerobic lactic threshold.



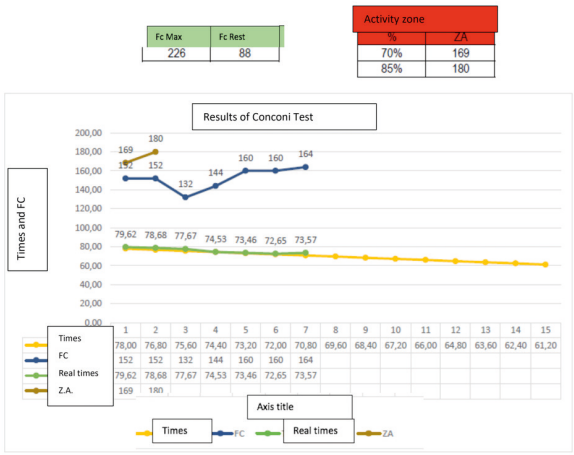
Subject 2 (Male): Best time in 100 crawl of 00:59.50

From the analysis of subject 2, it is observed that, during the course of the 11 repetitions, only in the fourth repetition is it below the pre-established time, evidencing faster performance. However, as far as heart rate is concerned, it remains within the range prescribed by Karvonen's formula for maintaining the threshold, registering a heart rate lower than that projected by the aforementioned formula. Additionally, the recorded times conform to the expectations established by the Maglischo formula. This set of results suggests a satisfactory level of performance for the subject, supported by the execution of a total of 11 repetitions and the ability to withstand high intensity loads in training. At this point his anaerobic lactic threshold is 6 repetitions.

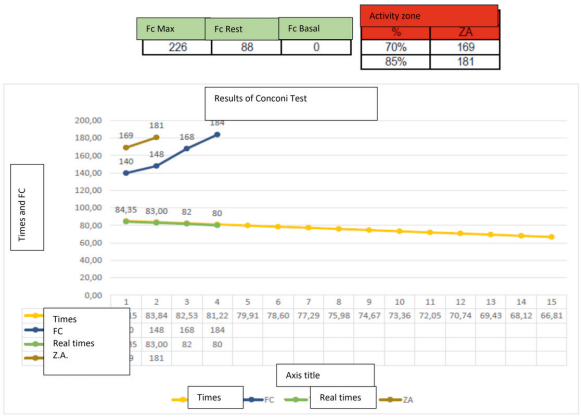


Subject 3 (Male): Best time in 100 front crawl of 00:57.00

Subject 3 tells us that he has an average predisposition for resistance to training loads, therefore, we could say that he has an average training predisposition. As well as the requested times, the swimming pace agrees with what was proposed by Maglischo. And his lactic anaerobic threshold is eight repetitions.



Subject 4 (Female): Best time in 100 front crawl of 01:00.00



Subject 5 (Female): Best time in 100 front crawl of 1:05.50

From the analysis of subject 5, an initially reduced disposition is deduced in this period of the season, which suggests a possible limitation in his resistance. This observation leads us to consider the likelihood that your profile favors a shorter duration, lower intensity training approach or alternatively, an approach that gradually increases workload over a longer period of aerobic training and may increase your endurance. Your anaerobic lactic threshold is four repetitions.

CONCLUSIONS

From the five subjects previously exposed, it appears that their timings resemble the parameters requested by the Maglischo formula. In relation to the application of the Karvonen formula, it is noted that the heart rate measurements are mostly within the predetermined range, despite the fact that in some instances there were slight deviations that barely exceed the established limits. In this context, it is plausible to affirm that, so far, the evaluation is consistent with the use of the aforementioned formulas.

Addressing the above, we can establish three results of the aforementioned modification.

Taking into consideration, the aforementioned, three relevant results of the aforementioned modification can be identified.

Firstly, by analyzing the number of repetitions that swimmers are able to perform, it is possible to predict whether they are more predisposed to speed or long-distance tests at the time of the season in which the test is performed. According to the number of repetitions, it can be established that sprinters usually perform 3 to 6 repetitions, semi-distance runners 6 to 9, and distance runners 9 to 11. It must be noted that this number of repetitions can vary depending on the training. to which the swimmer is subjected. Additionally, at the beginning of each season, the swimmer's resistance level can be determined based on the number of repetitions he performs. If the number of repetitions is low, it indicates that the swimmer has a tendency toward short-duration training, while if the number is high (more than 8-9), his or her resistance level is higher and he or she can work with greater mileage or higher intensities to improve your time.

Secondly, by identifying the maximum number of repetitions that a swimmer can perform without reaching fatigue (90% workouts), overtraining and the possible consequences of muscular stress or chronic fatigue can be prevented, which can be detrimental to long term for swimmer performance.

Finally, by evaluating the swimmer's use of swimming pace in training, it is possible to determine if the swimmer is aware of how to use his energy intelligently and not deplete it in a single event. This way, the coach can dose the training loads appropriately to avoid overtraining or overloading the swimmer depending on the number of repetitions he or she achieves during the test.

LIMITATIONS

Although it is true that this work was carried out with a small sample of swimmers, the proposed objective was achieved, which was to find the anaerobic threshold zone using the Karvonen formula. Despite the sample size, the authors are satisfied with the results obtained and the observations made in this research.

RECOMMENDATIONS

It is important to note that this study can be useful for the 100-meter butterfly and 100-meter breaststroke events. However, it must be taken into account that the speed and acceleration of the strokes, as well as the number of strokes (stroke cycle) necessary to achieve the desired times, are also critical factors that directly influence the swimmer's performance. A more detailed focus on these aspects could help swimming coaches optimize swimmers' energy use during these tests. However, this would require a subsequent study specifically focused on these factors.

However, the need to carry out future research with a larger sample universe is recognized, which would allow obtaining a

more complete and precise view of the results. Therefore, other researchers are invited to continue exploring this line of research in order to obtain even more significant and useful results for the development of sports swimming.

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