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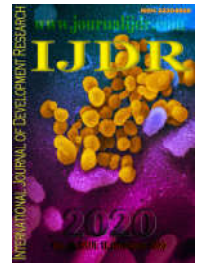
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RESEARCH ARTICLE

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SPECIFIC HIGH-INTENSITY INTERVAL TRAINING FOR JIU-JITSU

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ABSTRACT

Known as HIIT (High-Intensity Interval Training) or high-intensity interval training is at the top of current training. This type of training allows athletes to exercise longer in high intensity and not the other way around. The main objective of this work is to provide a tool for physical education professionals and trainers to evaluate their jiu-jitsu fighters specifically through an adaptation of interval training to jiu-jitsu, and can also obtain parameters through a targeted methodology, such as the fighter's specific endurance index test. The methodology also consists of promoting during the test, active recovery and a high cadence in the executions of movements, this recovery will also promote a higher oxygen consumption with close effort/pause, being considered as short HIIT, with values in the subjective scale of effort perception of 6 to 20, corresponding to high-intensity interval training. According to all the results obtained we can verify that it is an evaluation tool that complies with the requirements of an activity characterized as short intensity interval training, with active recovery, so it has higher caloric expenditure in the training section, as well as oxygen consumption and even a higher average heart rate in training because the subjective perception of mean effort among the subjects tested was 16 on the Borg scale. It is concluded that this proposal meets the initial objectives and will, in addition, this concept can be used for any type of physical activity and various types of sports gestures, thus being an excellent tool for teachers and technicians, and can also be used as part of a structure of physical preparation for combat modalities in several specific phases of training.

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INTRODUCTION

Known as HIIT (High-Intensity Interval Training) is at the top of current training. This type of training allows athletes to exercise longer in high intensity and not the other way around. It's not just a short-term workout with high intensity, as some coaches tend to exemplify, as HIIT goes far beyond that. The main objective of this work is to provide a tool so that physical education professionals and trainers can evaluate their jiu-jitsu fighters specifically through an adaptation of interval training to jiu-jitsu, and can also obtain parameters through a targeted methodology, such as the fighter's specific endurance index test.

This work aims to correlate high-intensity training with the proposal of muscle fatigue test with specific Jiu-jitsu movements. Despite having directed the test to the sport of grab combat as is jiu-jitsu, this methodology can go beyond that, moreover, because each coach having prior knowledge of his modality can through this methodology, develop their parameters of analysis according to the specific temporality that is desired, as well as the relevant sports gestures, where it is intended to increase training in search of improvement, which should be constant, because the evolution of methods and parameters goes in great strides, and all the tools that can contribute to the athlete gain improvement in efficiency and

effectiveness in the execution of movements, can make a difference. A stronger athlete, tougher, faster and still performing the moves to perfection, will certainly have more chances to succeed in the challenges that await him, so it is necessary a continuous evaluation of the results. Observation and an in-depth study, done in detail, on the type of combat sport that will be worked, are fundamental since each has its motor gestures and its characteristics of energy demand, which must be in agreement because the specificity of training can make a difference.

GENERAL OBJECTIVES: Present a tool to evaluate the fighter's specific resistance index, in addition to correlating temporality, specific movements to high-intensity interval exercises, suggesting that it also has the benefits of interval training and its energetic characteristic, but with the advantage of movements being directed specifically to jiu-jitsu.

SPECIFIC OBJECTIVE: Calculate the specific resistance index of the fighter, offering an evaluation tool where in addition to observation in improving training, the coach can implement other tools such as heart rate controls before, during and after each evaluation and also control the absolute number of repetitions, thus being able to observe improvements in anaerobic capacity, improvements in cardiovascular efficiency, speed and efficiency in the execution of techniques. Also with regard to the objective, I intend to offer a tool that does not necessarily perform the same exercises that were used in this work, the coach through this tool can and should have the freedom to create their movements, but maintaining a configuration similar to interval training, because it is what is closest to the combat sports that have intermittent efforts and with this, the teacher can use in various types of exercises and combinations according to the technical proposal to be worked, that is, a universal tool, which provides a technical and physical work at the same time, but with parameters of measurement and control of data where it can evaluate the evolution. Another very interesting factor regarding this work is that it can also be used for athletes and fighters who are not yet at a high-performance level, provided that the sports gestures are suitable for the level of training that is their group.

EXPECTED RESULTS

It is expected that this study will be introduced into the academic environment an efficient muscle fatigue control tool for jiu-jitsu fighters. In addition to being able to be used as high-intensity interval training with high values on the Borg scale. This tool should provide technical and physical work at the same time, however, with parameters of measurement and control of data, where it is possible to evaluate the evolution both in the physical part, as well as execution of movements with greater speed, seeking greater technical efficiency in the execution of the sports gesture. The academic environment, physical activities and physical preparations in general, still lack specific methodologies for the day-to-day of the coach. I understand that technology such as video analysis for comparison and measurement of results, is a methodology with greater precision, but this tool is expected to practical answers that can be combined with feedback from comparative videos of the training, for an evaluation regarding athletes who crave high performance, where more detailed adjustment can make a difference in the final result of planning. I hope that these results can be compared even with videos of participation in competitions.

Accompany the team throughout the process, it is essential, because the feedback after a competition is necessary so that we can make important adjustments, and at the same time, show your athlete, the hits and where he can improve, so that with this, you can extract as much of the possible performance, according to the characteristics of your fighter. One observation that I should emphasize is that the ideal would be, for physiologists and physical trainers, who intend to work with any other type of modality, who follow the same line of work, researching and raising information, and in the same way that I did with jiu-jitsu should be done with any sport of combat. Currently, there are studies for virtually all major combat sports modalities, and we have a vast research material, and this tool can certainly be adapted to each study because it is adaptable to different modalities and objectives. After all, it has a specific concept and not a specific form.

METHODS

Checking the specific fatigue threshold index, this means, according to researchers, that is "the ability to perform efficiently, the workload prescribed to overcome fatigue in predetermined conditions defined by a competitive sports activity". In other words, I will test directly, to what extent participants can maintain a high-intensity level of specific Jiu-Jitsu movements for some time before they reach a state of neuromuscular fatigue. The term defined in the physiology of a temporary decrease in muscle performance is generally seen as a failure to maintain the expected strength or power over time. This submaximal physical effort with short breaks portrays exactly the environment of a Jiu-Jitsu fight. Indirectly, we are also testing the coordination, agility, endurance and isometric strength of the participants. Through this methodology, it is expected as the first hypothesis, to be able to evaluate the muscle fatigue index, and to obtain an excellent tool for specific evaluation of jiu-jitsu fighters, besides being used as interval training of high intensity specific for jiu-jitsu. A second remote hypothesis would be that the training does not present any relevant and comparative factor for the muscle fatigue index, and no correlation to a high-intensity interval training.

The methodology also consists of promoting during the test, active recovery and a high cadence in the execution of movements, this recovery will still promote a higher oxygen consumption with close effort/pause, being considered as short HIIT, with values in the subjective scale of perception of effort from 6 to 20, corresponding to high-intensity interval training. It will be observed as a priority, comparing the first SET in general, compared by age group, because the characteristics of the energy expenditures of the first SET are practically anaerobic and such characteristics are determinant in a fight.

PROCEDURE: A large group was separated to perform the test with 100 fighters who underwent the specific muscle fatigue test for jiu-jitsu, it was necessary a small training area of four square meters with a partner of the same weight category. All test participants must be wearing a Jiu-Jitsu kimono. To collect the data, a sheet of the scorecard must be printed earlier, and the calculation of the test result must be done with a calculator or Excel spreadsheet. Before the test, the participants will make a targeted and specific warm-up, being 20 seconds for each session (exercise), with continuous movements with an interval of 20 seconds between each exercise, thus performing the same movements that will be

performed in the evaluation. However, this specific heating has a motor adaptation character for the test and elevation of the heartbeat, so it should be performed at moderate speed totaling 120 seconds of specific heating. The test consists of three different exercises; each exercise will be performed for 20 seconds (as many repetitions as test participants can perform during this period, maintaining the appropriate form), following an Isometric Active Recovery Time of 20 seconds per exercise, which in the following table will always be the fourth photo of each movement.

RELATIONSHIP BETWEEN EFFORT / PAUSE: IART (Isometric Active Recovery Time), means rest interval time, relevant in this modality, with percentage values of 39.51%. (No one is able to blow all the time). The IART refers to the temporal physical aspect related to the fact that, even at rest or recovery, the fighter continues to keeping handgrip strength (grip) in the opponent's gi (Paiva, Leandro (2015). *Olhar clínico nas lutas, artes marciais e modalidades de combate. Rio de Janeiro: OMP. Pg 56*).

The test will be performed in 3 (three) passages in the circuit, this concludes what we call SET, every 1 for 120 seconds and the same procedure will be repeated for SET 2 and SET 3 totaling 360 seconds or 6.0 min. The maximum number of repetitions in each exercise and each SET will be analyzed, which will later be calculated using the muscle fatigue index formula.

The original table of the Paiva and Del Vecchio test of fatigue resistance index whereas evaluation parameters consist of:

- 0 to 0.5 low fatigue resistance;
- 0.51 to 0.8 moderate fatigue resistance
- Above 0.81 high fatigue resistance

However, it was empirically adapted in the table below because it considered better visualization, however, the main parameters were maintained.

Table 1. Fatigue resistance parameters, Adapted by the authors (2020)

Categories:	
From 0 to 0.3	Unsatisfactory
From 0.31 to 0.5	Weak
From 0.51 to 0.8	Average
From 0.81 to 1,0	Good
Above 1,0	Excellent

Form of collection of results of the Fighter-Specific Muscle Fatigue Index.

The formula was also maintained as follows (The result of the muscle fatigue test will be obtained by averaging the total number of repetitions of set 2 and set 3 divided by the total number of repetitions of set 1.)

Muscle fatigue index

$$= \frac{\text{Total number of repeats from Set 2} + \text{Total number of repeats from Set 3}}{2 \times \text{Total number of repeats in SET 1}}$$

- * Muscle fatigue -----
- * Absolute result SET 1 -----
- * Absolute result SET 2 -----

- * Absolute result SET 3 -----
- * Borg scale.(6 a 20) -----

SURVEY PARTICIPANTS: The subjects of this research are all Jiu-jitsu practitioners and graduates in the black belt, male gender aged 27 to 50 years of national competitive level. All have more than 10 years of practice in jiu-jitsu.

SCENARIO: The test was carried out in a controlled environment in a space intended for martial arts practice on 50 mm tatami plates.

RISKS AND DIFFICULTY FOUND: All physical activity, especially when it comes to high-intensity interval training, will always bring risks regarding the high rates of heart rate, reaching the submaximal and maximum zones. Due to this aspect, all participants for safety had to be properly authorized to practice sports. We had to select as previously reported, practitioners with more than 10 years of practice in the modality, which consequently brought a lower risk margin with regard to injuries or deficiencies in the execution of movements.

The verification of parameters such as heart rate and Vo2 Max., are important follow-up factors that will certainly promote a detailed adjustment before, during and after training, observing, which is still considered that during, will act as a follow-up of the preparation process, and is directly linked to the result and safety of the proposed training system, but in this trial, due to the large number of participants, we chose to verify and evaluate the effort by subjective perception of exertion, the known and also efficient Borg scale. We worked with the Borg scale in the values of the table from 6 to 20, where we had to divide groups of only 20 fighters per test battery so that one could have safety in the subjective evaluation of the effort. To reduce the margin of error in evaluations, we chose to always use the same evaluators.

RESULTS

Statistical treatment: For descriptive characteristics (SEP 1, SEP 2, SEP 3) and as dependent variables (Mov 1, Mov 2 and Mov 3), descriptive statistics (Number of repetitions (n), minimum values, maximum, amplitude, mean and standard deviation) are used. The correlation between the Mov values of the 3 scales was calculated and analysis was performed, followed to test the significance of the differences between SET and Mov in each category of mean, amplitude and standard deviation. Tables 2, 3 and 4 can be concluded that the difference in age groups directly affects the total number of repetitions of the muscle fatigue test, and a higher standard deviation can be observed for older fighters.

Table 5 shows the results of the tests of the fatigue strength parameters. Regarding the above results, from 20 to 29 years, if we add the mean of the overall sum of each SET (rounds), we can observe that the number of repetitions was falling during the test, which already shows evidence of muscle fatigue. We can conclude with these top 3 tables that the difference in age group will directly influence the number of total repetitions of the muscle fatigue test and we can still observe a greater standard deviation for older fighters 48+44+43= 135 Total with a standard deviation of 2.5 for the first set (round), 0.8 for the second and 4.7 for the third.

Age: _____
 Weight: _____
 Height: _____

	Mov 1 (20'') Sprawl +Double leg	Rest (Fourthphoto) secs.(20)	Mov 2 (20'') Kimura sit up	Rest (Fourthphoto) secs.(20)	Mov 3 (20'') Knee on belly	Rest between Sets (fourth photo of each move) secs.(20)
Set 1						
Set 2		secs.(20)		secs.(20)		secs.(20)
Set 3		secs.(20)		secs.(20)		secs.(20)

All exercises should be done as soon as possible while maintaining the technical quality of the movement

Final Result

Sig.
 *Borgscale.....
 (6 to 20)

Sig.

Note: this formula was used in each of the 100 fighters



Figure 1. Guidelines for activity

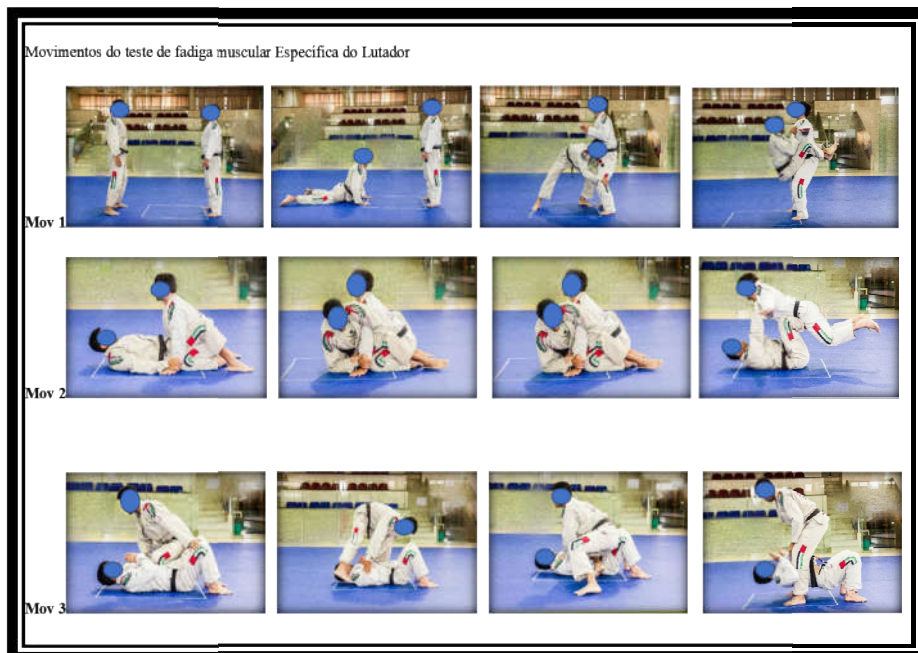


Figure 1. All the movements of the test



Figure 2. Start of the test

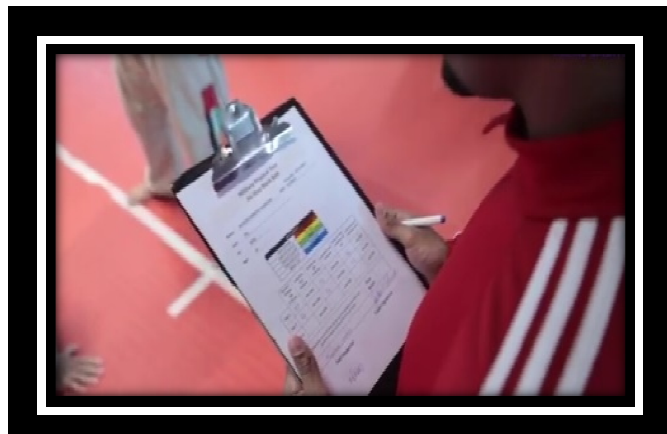


Figure 3. Data collection form



Figure 4. Movement Isometric Rest Interval 3



Figure 5. Isometric Movement Rest Interval 1

Regarding the above results, from 30 to 29 years, if we add the mean of the general sum of each SET (rounds), we can observe that the number of repetitions was also falling during the test and there is evidence again of muscle fatigue. However, the results are lower in Amplitudecadence (repetitions) compared to the previous $41+37+37 = 115$ with a standard deviation of 4.3 for the first Set (round), 3.9 for the second and 4.6 for the third. Regarding the above results, from 40 to 49 years, if we add the mean of the overall sum of each SET (rounds), we can observe that the number of repetitions was also falling during the test and there is evidence again of muscle fatigue. However, the results are lower in cadence (repetitions) compared to the previous $20+28+16 = 104$ with a standard deviation of 5.3 for the first Set (round), 5.6 for the second and 4.0 for the third.

Muscle fatigue index: The results found in the muscle fatigue index were not significant differences in relation to the age of the participants, this fact is due that this Index is obtained in relation to the athlete himself, that is, he competes against himself with each evaluation. Concerning this indicator, we can conclude that in this personalized result, the parameters that should be considered should be better with each evaluation, and not for another individual. However, with regard to the number of repetitions, we can observe and have a different view. An individual may have the same muscle fatigue index as the previous result, but with a higher movement rate and how the index is calculated in relation to sets, it is important that this aspect is considered in such a way that a fair and consistent assessment is obtained.

Example:

Athlete 1 obtained in the SEP 1, 10 repetitions, SEP 2, 10 repetitions and SET 3 10 repetitions with a total of 30 repetitions. If we calculate the index of muscle fatigue, we will find the result of 1 as index (excellent). Athlete 2 obtained in the SEP 1, 15 repetitions, SEP 2, 15 repetitions and SET 3, 15 repetitions with a total of 45 repetitions. If we calculate the index of muscle fatigue, we will also find the result of 1 as index (excellent). However, despite the same index of muscle fatigue, we will note that Athlete 2 was much higher in the number of absolute repetitions than Athlete 1. We can see in the table that the mean Borg scale was 16 and the mean muscle fatigue index was 0.89. That's why this interesting tool allows us to analyze both the Index individually and also compare results between participants. The proposed activity is predominantly aerobic with high participation of lactic anaerobic and anaerobic metabolisms.

ANALYSIS OF RESULTS

Regarding the previous Table, some data can be analyzed so that we can draw some conclusions regarding this configuration of specific exercises with regard to high-intensity interval training. The mean subjective perception of exertion that was found was 16 on the Borg scale. from 6 to 20. According to Del Vecchio (2019), these values would be sufficient to consider this type of activity as high-intensity interval training and with regard to this hypothesis, the response would have been very promising. With regard to the cadence of movements, where it will later be discussed and related to the Muscle Fatigue index, I chose to make a comparison of the 3 movements of the first SET in a global way, and compare it with the first SET by age group.

Table 2. Statistical data Subjects 20 to 29 years old

20to 29 Years		SET 1				SET 2				SET 3			
STATISTICS	Age	Mov 1	Mov2	Mov3	Total	Mov 1	Mov 2	Mov3	Total	Mov 1	Mov 2	Mov 3	TOTAL
Number (n)	3	3	3	3	3	3	3	3	3	3	3	3	3
Minimum	27	11	17	16	45	9	18	14	43	9	16	14	40
Maximum	29	12	21	18	51	12	20	15	45	12	20	18	50
Aplitude	2	1	4	2	6	3	2	1	2	3	4	4	10
Average	28	12	19	17	48	11	19	14	44	10	17	16	43
Standard deviation	0,9	0,5	1,7	0,9	2,5	1,2	0,8	0,5	0,8	1,2	1,9	1,7	4,7

Table 3. Statistical data. Subjects30 to 39 years old

30 to 39 Years		SET 1				SET 2				SET 3			
STATISTICS	Age	Mov 1	Mov2	Mov3	Total	Mov 1	Mov 2	Mov3	Total	Mov 1	Mov 2	Mov 3	TOTAL
Number (n)	65	65	65	65	65	65	65	65	65	65	65	65	65
Minimum	30	8	13	10	32	6	8	8	29	5	6	8	27
Maximum	39	14	22	20	50	14	20	18	48	11	23	18	49
Aplitude	9	6	9	10	18	8	12	10	19	6	17	10	22
Average	35	11	16	14	41	10	15	13	37	9	15	13	37
Standard deviation	2,8	1,4	2,0	1,6	4,3	1,4	2,1	1,7	3,9	1,4	2,5	2,1	4,6

Table 4. Statistical data. Subjects 40 to 49 years old

40 to 49 Years		SET 1				SET 2				SET 3			
STATISTICS	Age	Mov 1	Mov 2	Mov 3	Total	Mov 1	Mov 2	Mov 3	Total	Mov 1	Mov 2	Mov 3	TOTAL
Number (n)	31	31	31	31	31	31	31	31	31	31	31	31	31
Minimum	40	6	12	9	28	6	3	8	19	5	9	9	26
Maximum	48	14	23	18	48	11	19	18	47	11	16	17	42
Aplitude	8	8	11	9	20	5	16	10	28	6	7	8	16
Average	43	10	16	12	38	9	14	11	33	8	13	12	33
Standard deviation	2,8	1,7	2,6	2,4	5,3	1,2	2,8	2,4	5,6	1,2	1,6	2,3	4,0

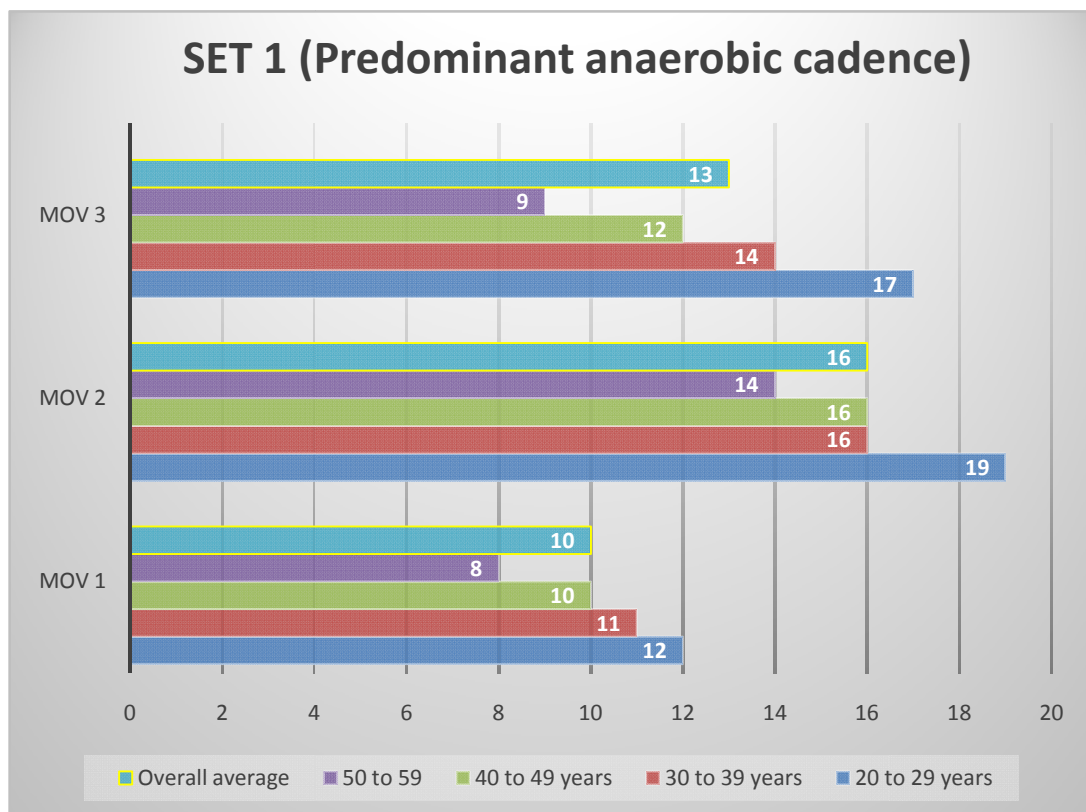


Figure 7. Graph of the number of repetitions (cadence) of the first SET.

Table 5. Test results of muscle fatigue assessment

N	ID	MOV 1	MOV 2	MOV 3	SET 1.	MOV 1	MOV 2	MOV 3	SET 2.	MOV 1	MOV 2	MOV 3	SET 3.	INDEX	BORG
1	27	12	21	18	51	12	18	14	44	12	20	18	50	0,92	14
2	29	11	20	16	47	9	19	15	43	9	16	15	40	0,88	15
3	29	12	17	16	45	11	20	14	45	10	16	14	40	0,94	17
4	30	9	14	14	37	8	12	12	32	7	10	11	28	0,81	17
5	30	9	16	15	40	9	15	14	38	9	6	15	30	0,85	18
6	30	12	18	13	43	11	17	12	40	11	16	14	41	0,94	15
7	31	12	18	15	45	11	17	14	42	11	15	16	42	0,93	15
8	31	12	16	12	40	9	15	9	33	8	4	9	31	0,8	17
9	31	12	20	14	46	11	17	12	40	10	18	14	42	0,89	14
10	31	13	17	15	45	12	17	15	44	11	17	13	41	0,94	16
11	31	10	16	14	40	9	15	13	37	9	15	14	38	0,94	16
12	31	11	15	14	40	10	15	13	38	10	15	14	39	0,96	16
13	31	12	19	16	47	10	18	14	42	11	19	17	47	0,95	16
14	32	12	16	16	44	10	15	16	41	9	15	17	41	0,93	16
15	32	12	17	13	42	10	16	12	38	10	15	12	37	0,89	16
16	32	14	20	16	50	14	16	14	44	11	15	14	40	0,84	16
17	33	12	20	15	47	11	17	15	43	11	15	14	40	0,88	18
18	33	14	18	12	44	9	18	13	40	9	14	13	36	0,86	17
19	33	12	18	16	46	11	16	14	41	10	14	10	34	0,82	17
20	34	12	22	15	49	10	18	13	41	10	19	12	41	0,84	17
21	34	10	17	16	43	8	17	15	40	8	17	14	39	0,92	15
22	34	12	18	13	43	10	18	12	40	10	17	10	37	0,9	15
23	34	9	14	12	35	8	12	10	30	7	12	10	29	0,84	16
24	34	10	17	14	41	9	16	12	37	9	14	13	36	0,89	16
25	34	12	20	14	46	11	16	12	39	11	15	13	39	0,85	15
26	34	10	20	20	50	10	20	18	48	11	20	18	49	0,97	14
27	35	8	17	13	38	7	15	13	35	8	14	13	35	0,92	16
28	35	13	17	14	44	10	18	11	39	8	17	16	41	0,91	16
29	35	10	14	12	36	9	13	8	30	9	12	9	30	0,83	16
30	35	12	17	14	43	9	17	12	38	10	15	12	37	0,87	16
31	35	12	19	15	46	11	15	13	39	11	15	14	40	0,86	15
32	35	12	14	13	39	12	14	12	38	10	15	12	37	0,96	16
33	35	11	17	14	42	12	15	13	40	11	17	13	41	0,96	15
34	36	11	18	14	43	11	16	13	40	11	14	13	38	0,91	16
35	36	10	16	14	40	9	13	14	36	10	13	15	38	0,93	15
36	36	10	13	13	36	11	10	12	33	10	10	12	32	0,9	14
37	36	12	15	13	40	12	15	12	39	11	14	11	36	0,94	16
38	36	10	15	12	37	10	14	12	36	8	15	11	34	0,95	15
39	36	11	18	14	43	10	18	12	40	9	19	14	42	0,95	17
40	37	12	18	15	45	11	16	15	42	10	15	15	40	0,91	17
41	37	9	16	13	38	9	13	13	35	8	13	12	33	0,89	15
42	37	9	14	12	35	9	13	11	33	8	13	12	33	0,94	15
43	37	11	16	16	43	10	16	15	41	9	15	16	40	0,94	15
44	37	9	13	12	34	8	14	11	33	8	13	11	32	0,96	17
45	37	9	15	13	37	8	15	13	36	7	15	13	35	0,96	17
46	38	10	17	14	41	10	17	14	41	8	15	12	35	0,93	15
47	38	11	16	14	41	9	14	12	35	9	13	12	34	0,84	17
48	38	11	17	14	42	10	16	13	39	10	16	13	39	0,93	14
49	38	11	15	15	41	8	14	14	36	8	13	13	34	0,85	17
50	38	10	15	13	38	10	14	12	36	8	14	12	34	0,92	15
51	38	8	13	11	32	7	12	10	29	5	13	11	29	0,91	15
52	38	8	13	11	32	7	12	10	29	7	12	10	29	0,91	14
53	38	12	18	12	42	10	17	11	38	10	15	13	38	0,9	15
54	38	10	16	12	38	9	14	10	33	8	11	8	27	0,79	18
55	38	11	20	12	43	11	17	11	39	9	15	15	39	0,91	14
56	38	9	14	11	34	9	14	10	33	8	14	10	32	0,96	15
57	38	8	13	12	33	8	14	10	32	8	12	10	30	0,94	16
58	38	10	17	14	41	9	17	14	40	9	15	13	37	0,94	16
59	38	11	15	13	39	10	13	13	36	10	15	14	39	0,96	14
60	38	11	15	13	39	9	14	14	37	9	13	14	36	0,94	15
61	38	10	16	12	38	9	15	13	37	8	16	12	36	0,96	16
62	39	10	16	11	37	6	15	10	31	6	14	9	29	0,81	19
63	39	12	18	14	44	10	8	14	32	11	23	14	48	0,91	15
64	39	13	16	14	43	11	17	13	41	11	15	11	37	0,91	15
65	39	11	15	13	39	9	14	14	37	9	13	14	36	0,94	15
66	39	9	15	13	37	8	16	12	36	8	15	11	34	0,95	17
67	39	11	16	14	41	9	16	14	39	10	16	13	39	0,95	15
68	39	10	17	13	40	8	15	13	36	9	15	14	38	0,93	15
69	40	14	17	17	48	10	19	18	47	11	12	17	40	0,91	16
70	40	11	17	18	46	10	17	17	44	10	16	16	42	0,93	16

Contine...

69	40	14	17	17	48	10	19	18	47	11	12	17	40	0,91	16
70	40	11	17	18	46	10	17	17	44	10	16	16	42	0,93	16
71	40	9	23	12	44	6	16	11	33	7	16	11	34	0,76	19
72	40	10	17	13	40	8	14	11	33	8	13	12	33	0,83	17
73	40	10	19	16	45	8	16	14	38	8	15	16	39	0,86	16
74	40	11	18	12	41	9	17	11	37	9	15	12	36	0,89	17
75	40	7	15	11	33	8	13	10	31	7	13	10	30	0,92	14
76	40	10	17	13	40	9	14	11	34	8	13	10	31	0,81	15
77	40	10	16	14	40	10	14	13	37	9	14	13	36	0,91	15
78	40	10	13	13	36	9	14	12	35	9	14	11	34	0,96	15
79	40	9	15	10	34	8	13	11	32	7	13	12	32	0,94	15
80	41	12	21	11	44	10	14	9	33	9	14	9	32	0,74	19
81	41	10	13	16	39	9	12	11	32	8	12	11	31	0,81	16
82	41	12	17	14	43	11	15	11	37	9	14	11	34	0,83	17
83	41	9	14	10	33	8	3	8	19	7	12	10	29	0,73	19
84	41	8	12	11	31	7	10	9	26	7	10	11	28	0,87	15
85	41	13	17	17	47	10	17	16	43	9	15	17	41	0,89	16
86	42	10	16	14	40	9	15	13	37	8	15	11	34	0,89	17
87	43	9	16	11	36	9	13	11	33	9	14	11	34	0,93	14
88	43	9	14	10	33	8	12	8	28	8	11	10	29	0,86	15
89	43	10	14	11	35	8	13	11	32	8	14	12	34	0,94	14
90	45	11	15	12	38	9	15	12	36	10	13	12	35	0,93	16
91	45	8	13	10	31	8	12	10	30	7	11	9	27	0,92	15
92	45	10	14	11	35	10	14	10	34	9	13	10	32	0,94	16
93	45	10	15	13	38	9	15	14	38	10	14	12	36	0,97	15
94	46	9	14	13	36	9	14	12	35	8	13	11	32	0,93	15
95	47	8	19	10	37	9	13	9	31	8	13	9	30	0,82	17
96	47	9	12	10	31	8	10	9	27	8	9	10	27	0,87	16
97	47	7	13	9	29	6	11	9	26	7	12	10	29	0,95	16
98	48	6	12	10	28	6	11	9	26	5	12	9	26	0,93	14
99	48	10	17	13	40	8	14	12	34	8	13	15	36	0,88	16
100	50	8	14	9	31	7	13	10	30	6	9	9	24	0,87	17

N (Number of Participants), ID (Age), M (Movement).

20 to 29 years old 30 to 39 years old 40 to 49 years old above 50

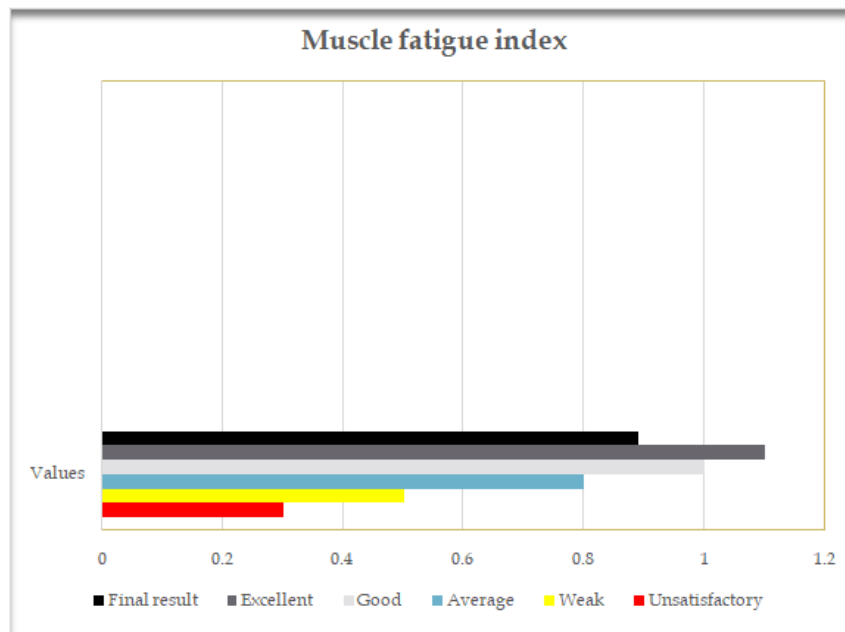


Figure 8. Graph of the average muscle fatigue index

The choice of this cadence of the first movement, which is between 0 and 20 seconds, means work with energy consumption of 82% anaerobic and 18% aerobic that is of paramount importance for the modality in question because it has a determining character within a sport of grab combat as is jiu-jitsu. We should not confuse determinant with predominant, because as shown in the Table of energy expenditures verses, working time, what will prevail after 75 seconds or 1 minute and 15 seconds is aerobic consumption with 51%.

In the measurement of our second movement, it is still with higher anaerobic energy expenditure with 55%, it is a very relevant check with regard to the determining characteristics within a fight. Only then, at the end of the third movement that we will have an inversion with 40% anaerobic, which is still a high value, from this point the predominance of energy expenditure will be aerobic, but with the high demand for glycolytic metabolism.

Anaerobic abilities can determine the outcome of combat, as the fighter needs to develop them, thereby increasing their ability, for example, to exchange footprints, explosions of movements that can lead to a comfortable position to achieve victory falls applications and submissions at crucial moments within a fight. In the chart below you can see the average cadence (number of repetitions) in SET 1 of the overall result, compared with the mean by age group. We can observe that when comparing all the results together, we obtained a general mean of the movement cadence, we found a significant difference when compared by age group mainly in MOV 1 (Sprawl + Double leg). Next, we can see a large difference still, but in the category 20 to 29 years in relation to the general average, however from 30 to 39 and 40 to 49 years there was no significant difference, while in the age group 50 to 59 there is a significant difference in the movement cadence in MOV 2 (Kimura sit up). Finally, the cadence difference is rising again in the first two age groups from 20 to 29 years and 30 to 39 years, but this time it was balanced with the category of 40 to 49 years, however once again the category 50 to 59 signaled lower cadence in MOV 3 (Knee on belly). We can observe that in relation to the general observation of the cadence of the whole SET 1, the age group can influence the number of total repetitions, which in turn is directly linked to the speed of movement execution, suggesting that younger athletes have higher power for exercises that have predominantly anaerobic energy expenditure.

Regarding the proposed muscular fatigue test, at the end of all SETs, a general average of 0.89 specific muscle fatigue index was observed for jiu-jitsu, where this value in the Table represents one good resistance to muscle fatigue, this fact may be correlated with all subjects tested having more than 10 years of practice and being experienced black belts and who are already familiar with all movements, however, high values were found in the subjective perception of exertion scale, a general average of 16, evidence that at the end of the test, the efforts were in the proportion of submaximal to maximum, and had anaerobic predominance, because only the first SET had anaerobic predominance.

Conclusion

According to all the results obtained we can verify that it is an evaluation tool that complies with the requirements of an activity characterized as circuit training, with active recovery, so it has higher caloric expenditure in the training section, as well as oxygen consumption and even a higher average heart rate in training because the subjective perception of mean effort among the subjects tested was 16 on the Borg scale. Studies indicate that this configuration promotes a higher lactate production and even more when recovery periods are short, close to 30 seconds that was the case of physical activity in question. Regarding the use of this tool as an assessment of specific muscle fatigue, all subjects had a general decrease in the cadence of movements, which is already observed a Fatigue and muscle wear during the test, despite the good performance of all participants, the tool suggests that the degree of experience and level of trainability can directly influence the results. We can also observe that older athletes have a considerably lower cadence than younger athletes. This difference is not so marked when we observe the values of the Fatigue index, this is explained because the index is a relationship of the athlete with himself and not in comparison with the others.

What will differentiate one athlete from another and can be used as a reference is directly linked to the cadence of movement's number of repetitions. We can conclude then that, in addition to being able to evaluate the muscle fatigue index, we can also evaluate the number of repetitions per SET, as a measurement parameter in the increase in the speed of movement execution for a given time, as well as aspects related to the technical quality of movements, through the descriptive observatory method. Indirectly, we can evaluate the number of repetitions per set, allowing evaluating the speed and technical quality of the movements with an excellent connection between the test and the modality.

(Technique, Endurance, Flexibility, Speed, Strength).

Nines important factors that highlight the relevance of the work

- Numerically points of results;
- Quantifies and reports performance;
- Rate participants;
- Analyzes strengths and weaknesses;
- Gets numbers to draw a plan;
- Has total connection with the activity;
- Checks progress;
- Motivates participants through reports;
- It is based on scientific evidence.

It is concluded that this proposal meets the initial objectives and will, in addition, this concept can be used for any type of physical activity and various types of sports gestures, thus being an excellent tool for teachers and technicians, and can also be used as part of a physical preparation structure for combat modalities in several specific phases of training.

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