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ORIGINAL RESEARCH

The influence of active breaks in the long jump on sports performance

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Abstract

The aim of the study was to identify the effect of the active pause between trials, on the performance of the long jump. The research was conducted in similar conditions to the competitions. Thirty athletes (18 women and 12 men) volunteer for this research and were divided into two mixed groups with an age range from 13-15 years (Mean: 13.87±0.75 years). We selected one group to maintain an active pause between the trials and instructed the other group to rest between the trials. In order to compare the effect of an active pause with the resting period significant parameters for the long jump were measured for this study, the speed of the run-up and the length of the jump performed, and also the athlete's Heart Rate (HR) before each trial. The study showed that there were significant correlations between HR and the speed of the run-up in the 5th (p=.018) and 6th (p=.005) trials and also between the HR and the performance of the long jump for the final two trials, whereas for the 5th (p=.044) and 6th (p=.028). Nevertheless, there were no significant correlations between the HR and the velocity of the run-up or the performance of the jump for the first four trials. An active pause between trials can determine an increase in the performance of the long jump and also is maintaining a constant speed index on the run-up.

Keywords: Active breaks, long jump, performance.

Introduction

The role of warm-up is to prepare athletes both physically and mentally for efforts of varying intensities and to improve sports performance and prevent injuries (Bishop, 2003). Sports warm-up can be defined as a period of preparation of the body to achieve performance in both competition and training (Hedrick, 1992). Traditional warm-up is usually composed of a period of aerobic exercise with a relatively low intensity followed by specific stretching exercises and specific sports (Safran et al., 1989). In most sports, warm-up aims to prepare the body for high-level performance and last but not least, sports warm-up reduces the risk of injury in both high-level competitions and training (Fradkin et al., 2010; Neiva et al., 2014; McGowan et al., 2015). In athletics, the normal warm-up has a period of preparatory exercises that last from half an hour to an hour, in order to participate in competition at an optimal level (Hedrick, 1992). The warm-up begins with a general, easy warm-up run, followed by mobility exercises and stretching. The specific part contains high-intensity runs (Hedrick, 1992), performed before participating in the competition. Many studies have investigated the effects of warm-up on sports performance by intervening on the content (general-specific), duration, and intensity of warm-up (Bishop, 2003; Neiva et al., 2014). We cannot say that we can discuss an optimal sports warm-up program. Warm-up exercises are usually composed of generalized and specific activities in the area of muscle strength, flexibility and endurance, and cardiovascular endurance (Vetter, 2007). Studies on warm-up techniques have shown that they are beneficial for performance, supporting the relevance of active warm-up in both individuals (Ayala et al., 2016; Neiva et al., 2014) and team

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sports (Zois et al., 2011). The warm-up seems to be dependent on a number of many factors, such as the type of sport practiced, the athlete's physical condition and experience, the tasks to be performed by the athlete, the atmospheric conditions and the competition regulations imposed by the organizer (McMillian et al., 2006).

In the long jump athletics event, it is characteristic that it takes place during three to six sessions of jumping performed by the athlete, and this implies the athlete's ability to maintain the warm-up acquired during the six sessions (Weidner & Dickwach, 2022). After each jump, the athlete generally has a break of 20-25 minutes between jumps in the first three attempts, during which time it is imperative that the body temperature and muscle temperature remain at optimal parameters to sustain high performance. Maintaining the initial warm-up is supported by the implementation of a specific warm-up protocol, consisting of high intensity running over short distances, specific mobility and stretching exercises, running and jumping exercises (Vetter, 2007). Given the importance that professional athletes place on warm-up, studies in this area of research seem to be limited, with few studies evaluating whether maintaining warm-up improves athletic performance (Fradkin et al., 2010). As a result, warm-up protocols are based on the experience of the athlete and the coach, rather than on a scientific argument (Bishop, 2003; Fradkin et al., 2010). Although the recommended heating components are widely undertaken, the importance of warming-up and maintaining it during athletic events is worth investigating, not knowing whether the warm-up is beneficial or not or what its effect is in preventing injuries or its effect on sports performance (Stewart & Sleivert, 1998). Bishop believes that warm-up improves performance by lowering oxygen deficiency and aerobic capacity can provide energy later in the effort (Bishop D., 2003). Similarly, other studies have shown that warming-up decreased oxygen deficiency and made a higher aerobic contribution (Guting et al., 1976; Jones et al., 2008; Bailey et al., 2009). Taking into account all these aspects, it can be concluded that a warm-up at a high intensity induced in response an accentuated fatigue, thus affecting the sports performance (Stewart, 1998; Zois et al., 2011; Zois et al., 2015).

It is very important that a good warm-up has a dosage that allows the body to be optimally prepared for the effort with a minimal effect on fatigue (Bishop et al., 2003; Neiva et al., 2014). Bishop (2001) believes that warming up to 3-5 minutes at medium intensity significantly improves short-term performance, but in order to have high performance, warm-up needs to be performed over a longer period of time. Researchers recommend that warm-up begin with 10-20 minutes of general cardiovascular warm-up, followed by stretching and sport-specific warm-up (Bishop, 2003).

What cannot be said for sure is that warming-up for a longer period of time would have a more positive effect on performance than performing a short warm-up. It is possible that a high intensity but short warm-up will raise the basic VO_2 as much as a long lasting general warm-up. Regarding the long jump, considering this hypothesis valid, we can say that maintaining the warm-up between jumps can be achieved with a short re-warming-up time and maximum efficiency (Van den Tillaar, 2017). The aim of the study was to identify the effect of the active break between jumps on the performance of the long jump, where the active break represented the maintenance of the warm-up acquired before the athletic test.

Methods

Experimental Approach to the Problem

The aim of the study was to identify the effect of the active break between trials on long jump performance. To achieve this aim we formulated several objectives: to identify the independent variables of the passive or active breaks on the dependent variable, the performance in the trial; to determine the evaluation methods and tools; to determine the linear correlations between heart rate and run up speed, heart rate and performance, run up speed and performance.

Subjects

A total of 30 (12 men and 18 women; Table 1) county-level junior athletes volunteered to participate in this experiment, with age range from 13-15 years (Mean=13.87±0.75 years), which was conducted in early 2021. None of the athletes included had any health problems at the time of testing. The subjects are high school students who have had no experience in athletic training. Subjects were fully informed of the protocol before the study began and informed consent was obtained from all subjects prior to testing, with the approval of the management of the institution where the testing took place and in accordance with current ethical standards in sports and research.

Table 1
Descriptives of age, height, weight, and body mass index (BMI).

Groups	Gender		Mean	Std. Deviation	Minimum	Maximum
Control (n=15)	Male (n=4)	Weight (kg)	70.00	4.55	64	75
		Height (cm)	182.25	5.32	176	189
		BMI	21.09	1.47	19.32	22.92
	Female (n=11)	Weight (kg)	63.36	6.56	51	75
		Height (cm)	157.82	47.07	17	177
		BMI	21.59	2.92	19.03	29.30
Experiment (n=15)	Male (n=8)	Weight (kg)	78.38	8.60	70	93
		Height (cm)	178.25	6.41	172	193
		BMI	24.67	2.44	21.60	29.39
	Female (n=7)	Weight (kg)	64.57	6.48	57	72
		Height (cm)	168.57	6.90	160	177
		BMI	22.80	2.81	19.82	28.13

General Protocol Design

The experiment was performed in February, and the testing was performed on the same day with the participation of the whole group. Subjects were instructed to avoid intense training 48 hours before the test. Prior to the start of the experiment, participants were randomly divided into two groups: the control group and the experiment group. The experiment consists of two phases. In the first phase, all subjects followed an identical warm-up protocol consisting of general warm-up with an easy run of 10 minutes followed by stretching exercises and joint gymnastics, and for the specific warm-up of the long jump, the subjects performed variants of running and jumping exercises. over distances of 30 meters, after which they performed four sprints of 85% intensity over a distance of 60 meters. The warm-up was followed by the measurement and recording of the heart rate of all participants.

In the second phase of the study, the subjects were divided into two groups as follows: one of the groups (control group) was instructed to pause between the long jumps, while the second group (experiment group) between the jump had the task of performing an active break, having the role of maintaining the warm-up, consisting of stretching and running launched twice repeated over a distance of 30 meters.

Tests

Simultaneously for the two groups the following parameters were registered: heart rate, run-up speed, performance of the jump. All subjects performed the run up on a distance of 30 meters. In order to reduce the stress of the long jumpers, a take-off area of one meter was delimited, so they did not have the obligation to detach according to the regulation from a board of 20 cm.

The oxiometer was used to record the data to measure heart rate, the electric cell to measure running speed, and the rangefinder was used to measure the length of the jump.

Statistical Analyses

First, we investigated whether there were significant differences between the results of the two groups (experiment and control) by using the active break as an independent variable during the 6 trials in the long jump test. The data obtained were statistically processed using the following statistical indicators: arithmetic mean, standard deviation, correlation coefficient. To verify the significance of the differences between the media, the independent `T` test was applied. The results showed that the differences between the groups were significant and also the results showed a significant correlation between the dependent variables (HR, run up speed and jump performance).

Results

Table 2 reports the aggregate data for males and females (mean + SD) for sprint, heart rate and jump performance after the 6 trials, performed by subjects of both groups, control experiment.

Heart Rate

Comparing the results between the control and experiment groups (Figure 1), it can be seen that the heart rate of the experiment group (both in women and men) is maintained during the 6 tests at values between 110-123 BPM, while the control group recorded a downward curve. from values of 113 BPM to values of 96 BPM, this indicates that the absence of active pause leads to a reduced heart rate.

Correlation values do not indicate a link between heart rate and performance for the control group, they vary between values 0.023 - 0.455 (Table 3).

Table 2

The men's and women's data for heart rate sprints and jumps following the 6 trials (mean±SD).

Group	Gender	Variables	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Control (n=15)	Male (n=4)	Heart Rate (bpm)	111.25±3.30	93.75±5.31	89.25±0.5	89.25±0.96	88.50±1.73	89.00±1.83
		Run up speed (sec.)	3.95±0.13	4.06±0.12	4.11±0.17	4.17±0.12	4.26±0.11	4.29±0.07
		Jump length (m)	4.72±0.38	4.58±0.34	4.53±0.4	4.45±0.44	4.38±0.50	4.30±0.44
	Female (n=11)	Heart Rate (bpm)	112.91±3.93	95.36±2.87	89.09±1.97	89.00±2.79	88.82±3.79	88.64±4.25
		Run up speed (sec.)	3.89±0.19	4.04±0.17	4.1±0.17	4.15±0.17	4.19±0.19	4.25±0.17
		Jump length (m)	4.97±0.68	4.82±0.71	4.71±0.68	4.67±0.71	4.59±0.72	4.54±0.71
Experiment (n=15)	Male (n=8)	Heart Rate (bpm)	113.50±4.89	118.13±2.35	118.88±1.95	120.38±3.16	120.88±1.81	122.63±2.39
		Run up speed (sec.)	4.03±0.23	3.99±0.24	4.01±0.24	4.01±0.23	4.02±0.23	4.01±0.25
		Jump length (m)	5.05±0.64	5.12 ±0.69	5.09±0.67	5.12±0.63	5.10±0.65	5.13±0.65
	Female (n=7)	Heart Rate (bpm)	108.71±4.57	115.86±2.79	118.14±2.41	119.43±3.65	121.14±2.97	122.57±2.37
		Run up speed (sec.)	4.08±0.21	4.03±0.20	4.04±0.2	4.04±0.20	4.04±0.21	4.05±0.24
		Jump length (m)	4.77±0.61	4.86±0.58	4.85±0.58	4.88±0.62	4.87±0.62	4.84±0.64

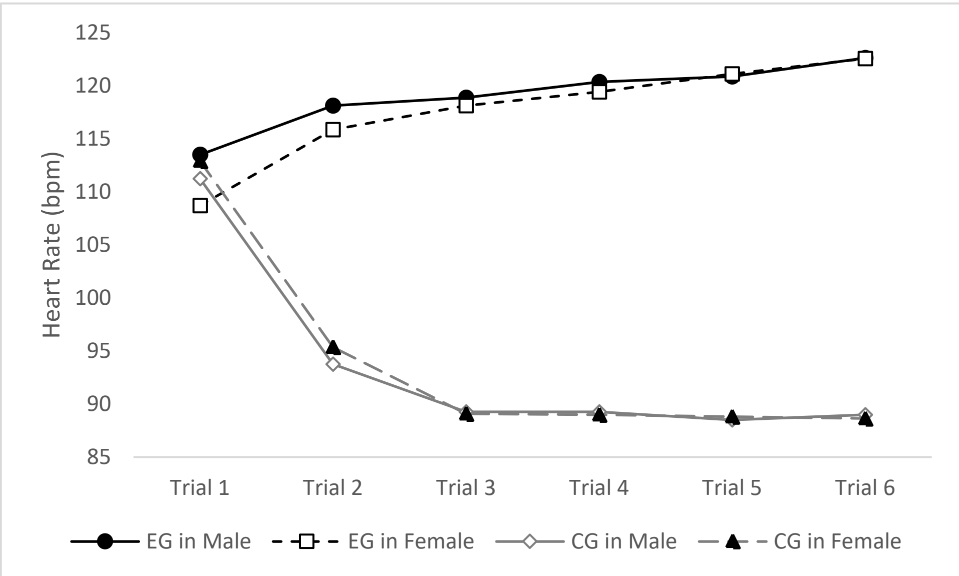

Figure 1. Heart rate values in EG and CG during the 6 trials.
EG: Experimental Group, CG: Control Group.

Table 3
Correlations between heart rate and performance on the Control Group.

		Jump Length 1	Jump Length 2	Jump Length 3	Jump Length 4	Jump Length 5	Jump Length 6
HR 1	r	-0.023	-0.046	-0.027	-0.030	-0.103	-0.117
	p	0.934	0.870	0.924	0.915	0.716	0.677
HR 2	r	-0.496	-0.455	-0.473	-0.448	-0.445	-0.478
	p	0.060	0.088	0.075	0.094	0.096	0.072
HR 3	r	0.019	0.028	-0.019	-0.023	0.042	0.018
	p	0.946	0.920	0.947	0.934	0.881	0.950
HR 4	r	0.303	0.341	0.301	0.310	0.340	0.310
	p	0.272	0.214	0.275	0.260	0.215	0.260
HR 5	r	0.030	0.054	0.021	0.031	0.068	0.048
	p	0.915	0.848	0.940	0.911	0.811	0.864
HR 6	r	0.035	0.097	0.063	0.044	0.102	0.110
	p	0.902	0.731	0.824	0.875	0.718	0.697

HR: Heart Rate.
** Correlation is significant at the 0.05 level (2-tailed).*
*** Correlation is significant at the 0.01 level (2-tailed).*

Table 4
Correlations between heart rate and performance on the Experiment Group.

		Jump Length 1	Jump Length 2	Jump Length 3	Jump Length 4	Jump Length 5	Jump Length 6
HR 1	r	-0.310	-0.333	-0.328	-0.333	-0.356	-0.306
	p	0.260	0.225	0.233	0.225	0.193	0.267
HR 2	r	-0.388	-0.417	-0.428	-0.410	-0.430	-0.390
	p	0.153	0.122	0.112	0.129	0.110	0.151
HR 3	r	-.757**	-.765**	-.780**	-.763**	-.792**	-.764**
	p	0.001	0.001	0.001	0.001	0.000	0.001
HR 4	r	-.615*	-.639*	-.651**	-.653**	-.672**	-.643**
	p	0.015	0.010	0.009	0.008	0.006	0.010
HR 5	r	-.531*	-.526*	-0.513*	-.549*	-.522*	-.527*
	p	0.042	0.044	0.050	0.034	0.046	0.043
HR 6	r	-.611*	-.666**	-.670**	-.654**	-.666**	-.649**
	p	0.016	0.007	0.006	0.008	0.007	0.009

HR: Heart Rate.
*** Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*

In this case (Table 4) we had negative correlations between heart rate and jump performance which could be translated by the fact that it can be expected that in subjects with higher heart rates to perform better. We must also take into account the fact that a correlation index shows collinearity and has no explanatory value in the sense that it can be said for the experiment group that the higher the HR, the better the performance can be expected, but not can say "if the HR is high the performance is better".

Maintaining a heart rate maintained at a high level allows the athlete to perform optimally and to exploit the possibilities of strength and speed as close as possible to the requirements of the event.

Table 5

Correlations between heart rate and speed on the Control Group.

		Run-up Speed 1	Run-up Speed 2	Run-up Speed 3	Run-up Speed 4	Run-up Speed 5	Run-up Speed 6
HR 1	r	-0.014	0.034	0.154	0.041	-0.139	-0.034
	p	0.962	0.905	0.585	0.884	0.620	0.904
HR 2	r	0.349	0.150	0.094	0.138	0.110	0.197
	p	0.202	0.593	0.738	0.624	0.696	0.481
HR 3	r	-0.109	-0.067	-0.056	-0.104	-0.023	0.013
	p	0.699	0.812	0.842	0.712	0.936	0.965
HR 4	r	-0.448	-0.237	-0.217	-0.179	-0.178	-0.150
	p	0.094	0.394	0.438	0.524	0.526	0.593
HR 5	r	-0.201	-0.017	-0.036	0.010	0.081	0.181
	p	0.473	0.952	0.898	0.971	0.774	0.519
HR 6	r	-0.123	0.022	-0.029	0.050	0.183	0.183
	p	0.662	0.938	0.918	0.861	0.513	0.513

HR: Heart Rate.
*** Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*

Table 6

Correlations between heart rate and run-up speed on the Experiment Group.

		Run-up Speed 1	Run-up Speed 2	Run-up Speed 3	Run-up Speed 4	Run-up Speed 5	Run-up Speed 6
HR 1	r	0.391	0.405	0.393	0.398	0.444	0.410
	p	0.150	0.134	0.147	0.142	0.098	0.130
	n	15	15	15	15	15	15
HR 2	r	.537*	.582*	.570*	.569*	.602*	.579*
	p	0.039	0.023	0.026	0.027	0.018	0.024
	n	15	15	15	15	15	15
HR 3	r	.784**	.837**	.822**	.845**	.856**	.834**
	p	0.001	0.000	0.000	0.000	0.000	0.000
	n	15	15	15	15	15	15
HR 4	r	.655**	.679**	.624*	.682**	.670**	.638*
	p	0.008	0.005	0.013	0.005	0.006	0.010
	n	15	15	15	15	15	15
HR 5	r	.623*	.583*	.580*	.601*	.579*	.629*
	p	0.013	0.022	0.024	0.018	0.024	0.012
	n	15	15	15	15	15	15
HR 6	r	.574*	.638*	.582*	.634*	.597*	.588*
	p	0.025	0.011	0.023	0.011	0.019	0.021
	n	15	15	15	15	15	15

HR: Heart Rate.
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

In the case of the control group (Table 5), those who do not have an active break, the figures do not show a correlation / connection between heart rate and speed. The correlations are small and insignificant, 0.014-0.17. In the control group, at the first measurement of the heart rate we have significantly higher values than at the other measurements, due to the fact that the heart rate was measured immediately after the general warm-up.

A strong correlation from a statistical point of view was also recorded between heart rate and run-up speed in the case of the experimental group (Table 6), those with active pause. This suggests that, maintaining the HR at optimal levels during the 6 trials involves a constant speed index.

Run Up Speed

Comparing the results between the run-up speed of and the length of the jump (Figure2,3), significant differences can be observed between the control group and the experiment group in both women and men. Differences between groups suggest that high speed leads to better or constant performance. The values of speed and jump length in the experiment group remain constant, while in the experiment group the speed indices decrease (the recorded values increase 3.9s-4.4s) and the jump performance decreases (5.00m-4.50m).

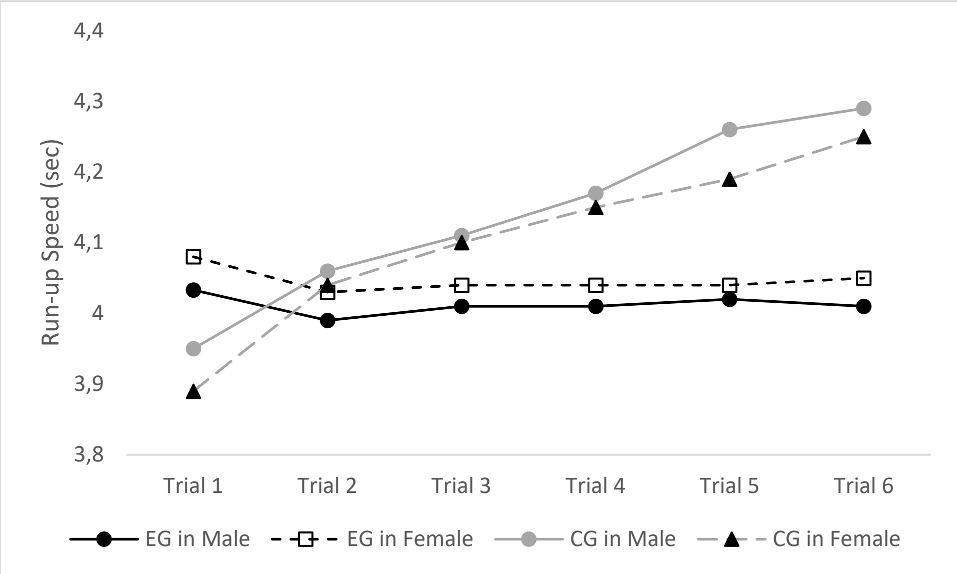

Figure 2. Run-up speed in males and females.
EG: Experimental Group, CG: Control Group.

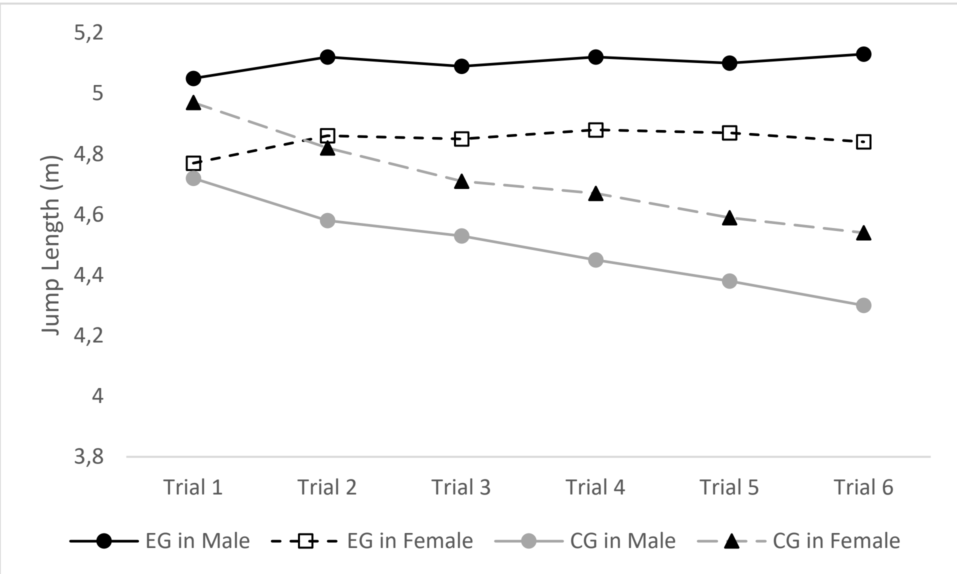

Figure 3. Jump length in Males and females.
EG: Experimental Group, CG: Control Group.

Table 7

Correlations between speed and performance on the Experiment Group.

		Jump Length 1	Jump Length 2	Jump Length 3	Jump Length 4	Jump Length 5	Jump Length 6
Run-up Speed 1	r	-.898**	-.889**	-.909**	-.906**	-.898**	-.898**
	p	0.000	0.000	0.000	0.000	0.000	0.000
	n	15	15	15	15	15	15
Run-up Speed 2	r	-.900**	-.903**	-.919**	-.906**	-.905**	-.900**
	p	0.000	0.000	0.000	0.000	0.000	0.000
	n	15	15	15	15	15	15
Run-up Speed 3	r	-.897**	-.893**	-.912**	-.899**	-.895**	-.893**
	p	0.000	0.000	0.000	0.000	0.000	0.000
	n	15	15	15	15	15	15
Run-up Speed 4	r	-.911**	-.906**	-.927**	-.919**	-.911**	-.913**
	p	0.000	0.000	0.000	0.000	0.000	0.000
	n	15	15	15	15	15	15
Run-up Speed 5	r	-.875**	-.875**	-.895**	-.886**	-.890**	-.878**
	p	0.000	0.000	0.000	0.000	0.000	0.000
	n	15	15	15	15	15	15
Run-up Speed 6	r	-.905**	-.892**	-.911**	-.906**	-.899**	-.900**
	p	0.000	0.000	0.000	0.000	0.000	0.000
	n	15	15	15	15	15	15

HR: Heart Rate.
*** Correlation is significant at the 0.01 level (2-tailed).*

Table 8

Comparisons in HRs, run-up speeds and jump length between the groups.

	Equality of Variances					Mean	Std. Error	Interval of the	
Variables	F	Sig.	t	df	p	Difference	Difference	Lower	Upper
HR 1	2.662	0.114	-0.725	28	0.474	-1.200	1.654	-4.589	2.189
HR 2	1.968	0.172	19.173	28	0.000*	22.133	1.154	19.769	24.498
HR 3	0.876	0.357	41.885	28	0.000*	29.400	0.702	27.962	30.838
HR 4	1.209	0.281	29.249	28	0.000*	30.867	1.055	28.705	33.028
HR 5	2.045	0.164	30.904	28	0.000*	32.267	1.044	30.128	34.405
HR 6	1.807	0.190	30.175	28	0.000*	33.867	1.122	31.568	36.166
Run-up Speed 1	0.924	0.345	2.014	28	0.054	0.14600	0.07251	-0.00252	0.29452
Run-up Speed 2	0.812	0.375	-0.535	28	0.597	-0.03800	0.07100	-0.18343	0.10743
Run-up Speed 3	0.472	0.498	-1.072	28	0.293	-0.07600	0.07087	-0.22118	0.06918
Run-up Speed 4	0.678	0.417	-1.956	28	0.061	-0.13400	0.06851	-0.27434	0.00634
Run-up Speed 5	0.408	0.528	-2.566	28	0.016*	-0.18200	0.07093	-0.32730	-0.03670
Run-up Speed 6	1.718	0.201	-3.249	28	0.003*	-0.23467	0.07223	-0.38262	-0.08672
Jump Length 1	0.086	0.771	0.062	28	0.951	0.01400	0.22595	-0.44884	0.47684
Jump Length 2	0.008	0.928	1.064	28	0.297	0.24733	0.23252	-0.22896	0.72363
Jump Length 3	0.033	0.857	1.400	28	0.172	0.31733	0.22659	-0.14681	0.78148
Jump Length 4	0.005	0.942	1.726	28	0.095	0.39600	0.22944	-0.07399	0.86599
Jump Length 5	0.005	0.946	1.964	28	0.060	0.46067	0.23460	-0.01989	0.94122
Jump Length 6	0.103	0.751	2.217	28	0.035	0.52067	0.23482	0.03966	1.00167

* p<0.05

Strong and significant negative correlations, -0.890 to -0.919, at a higher level than in the control group. The lower the value in the speed variable, the better performance we can expect. The run-up speed is directly conditioned by the maintenance of the warm-up during the 6 attempts, ensuring a constant speed, an aspect which leads to higher performances.

The independent t-test showed that there were significant differences between HR and the speed of the run up between in the 5th (p=.018) and 6th (p=.005) trials and also between the HR and the performance of the long jump for the final two trials, where for the 5th (p=.044) and 6th (p=.028). Nevertheless, there were no significant differences between the HR and the velocity of the run-up or the performance of the jump for the first four trials. An active pause can determine an increase in performance of the long jump on average with 0.32 cm with the final trial being improved by 0.52 cm in comparison with the control group.

Conclusions

The study did not aim to create a warm-up protocol or one to maintain warm-up between jumps, but still the athletes followed a protocol composed of general and specific warm-up, as Van den Tillaar et al. (2017) have already shown that only using a general heating causes a low performance, compared to a warm-up that includes general and specific parts. In addition, Neiva et al. (2015) showed that sports performance was lower when no warm-up was included, compared to a warm-up that swimmers perform regularly. Therefore, these protocols were not included in our study.

From the recorded data it can be said that maintaining the warm-up during the six jumps through an active break can improve sports performance, although we found support for our hypothesis, it is important to note that, attention must be paid to the effort, so that it does not lead to fatigue which would reduce sports performance.

Our findings suggest that active brake intervention is effective, maintaining constant speed indices during run-up and at the same time a high heart rate also has an impact on speed run-up. No significant differences were found between jump performance (jump length) and physiological parameters (heart rate).

All these aspects lead to an optimal motor and physiological behavior of the athlete, that supports sports performance both in competition and in training. The results support our hypotheses. Most importantly, they support hypothesis that active pause can determine an increase in performance of the long jump. The calculated t-value is (-3.24), and the p-value is less than 0.05 (p = 0.003) at the run-up speed and at the jump performance t value is (2.21) and p value less than 0.05 (p=0.03).

The study conducted by us cannot be generalized, given the small number of subjects, but provides objective arguments for conducting other research in the direction of the issue under discussion.

Authors' Contribution

Study Design: HC, LM; Data Collection: HC; Statistical Analysis: HC; Manuscript Preparation: HC, LM; Funds Collection: LM.

Ethical Approval

The study was approved by the ethical committee of Institutions Organizing Doctoral Studies (24/16.04.2021) and it was carried out in accordance with the Code of Ethics of the World Medical Association also known as a declaration of Helsinki.

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Conflict of Interest

The authors hereby declare that there was no conflict of interest in conducting this study.

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