Influence of aerobic and anaerobic variables on repeated sprint tests

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Abstract

This study aimed to determine the manner and degree to which aerobic and anaerobic variables influence repeated running sprint performance and ability. Twenty four males (sprinters = 8, endurance runners = 8 and physical active subjects = 8) performed in a synthetic track the following tests: 1) incremental test to determine the VO_2max and the maximum aerobic velocity (MAV); 2) constant velocity test performed at 110% of MAV to determine the VO_2 kinetics and the maximum accumulated oxygen deficit (MAOD); 3) repeated sprint test (10 sprints of 35-m interspersed by 20s) to determine sprint total time (TT), best sprint time (BT) and score decrement (Sdec). Between-groups comparisons and the correlations between variables were analyzed by one-way ANOVA with a Tukey post-hoc tests and Pearson correlation, respectively. TT was significantly different among all groups (sprinters = 49.5 ± 0.8 s; endurance = 52.6 ± 3.1 s; active = 55.5 ± 2.6 s) and Sdec was significantly lower in endurance runners as compared with sprinters and physical active subjects (sprinters = 8.9 ± 2.1%; endurance = 4.0 ± 2.0%; active = 8.4 ± 4.4%). TT correlated significantly with BT ($r = 0.85$, $p < 0.01$) and MAOD ($r = -0.54$, $p < 0.01$). Moreover, Sdec was significantly correlated with aerobic parameters (VO_2max, $r = -0.58$, $p < 0.01$; MAV, $r = -0.59$, $p < 0.01$; time constant tau, $r = 0.45$, $p = 0.03$). In conclusion, although the aerobic parameters have an important contribution to RS ability, RS performance is mainly influenced by anaerobic parameters.

KEY WORDS: Athletic performance; VO_2 kinetics; Maximum accumulated oxygen deficit; Sprinters; Endurance runners; Physical Education; Training.

Introduction

Intermittent sports are very popular and practiced by many people around the world. Such sports (e.g., soccer, rugby, tennis and others) require repeated sprint actions, that is, maximum or near-maximum efforts interspaced by short recovery times (< 60 seconds)[1-5]. Indeed, albeit the frequency/incidence of these actions are low[1, 5-7], these brief periods are normally the decisive moments of the game. For better performance in the repeated sprints (RS), it is necessary that the subject covers a certain distance as fast as possible (i.e., within the shortest time) at the first sprint and, then, be able to repeat a similar performance in a subsequent one[8]. However, the sprint total time increases throughout the RS, which determines the fatigue related with this activity. According to the above-cited evidences, some studies point out that RS involves the transfer of energy by the three energetic systems as well as periods of restitution and clearance of the substrates that influences the energy production[8-9]. Thus, this activity is dependent on the dynamic integration among the physiological systems (e.g., cardiovascular, respiratory and neuromuscular).

Several studies have observed that first sprint total time is the major determinant to RS[10-13] and, it is influenced by the anaerobic system[14]. However, there seems not to be a consensus regarding the importance of the anaerobic physiological aspects (i.e., cumulated oxygen deficit and blood lactate concentration at post-test) on RS performance, as others researches have demonstrated contradictory results[12, 15-17]. In addition to anaerobic parameters, Gaitanos et al.[18] highlighted that the aerobic parameters might influence the RS performance, insofar as, performing several RS with incomplete recovery increases the energy transfer by the oxidative metabolism. With this assumption, several researches using individuals with similar training profile analyzed the relationship between RS performance and various aerobic parameters (e.g., maximum aerobic velocity, VO_2max, physiological transition threshold and VO_2 constant time[10-11, 13, 15, 17, 19-22]). However, the results of these researches are far from conclusive, given that not all studies show significant correlations between the same aerobic parameter and the RS performance, as well as, none study demonstrated such relationship with different athletes[16, 23-24]. Thus, the effects of the aerobic and anaerobic variables on the RS performance are not elucidated in the literature.

Finally, in spite of the important elevated energy transfer of the anaerobic system on the RS performance, this transfer could increase the fatigue associated with this type of activity, given that, metabolic byproducts related with fatigue cumulates during the energy transfer by this energetic system[25-26]. Differently, some researches have demonstrated negative significant correlations between aerobic parameters and decrease in performance[10-11, 13, 15, 20]. Moreover, Dupont et al.[20] emphasized that the time constant of the VO_2 kinetics (tau) during submaximal exercise correlated with fatigue on the RS test, suggesting that the rapid activation of the oxidative system is an important mechanism to reduce the RS fatigue.

Understand the degree and how the different types of training (i.e., aerobic vs. anaerobic), as well as, each physiological characteristics influence performance and fatigue on the RS, are imperative for exercise prescription. Therefore, if one or more variables affect decisive actions in a determined sport, these must be worked in order to enhance performance.

Therefore, the present study aimed to compare the performance and the RS fatigue in sprinters, endurance runners and physical active subjects, as well as to correlate these variables with aerobic and anaerobic parameters. The hypothesis presented herein is that sprinters exhibit better performance on RS due to the superior anaerobic system; however, endurance runners would have a greater capacity to resist fatigue.

Method

Subjects

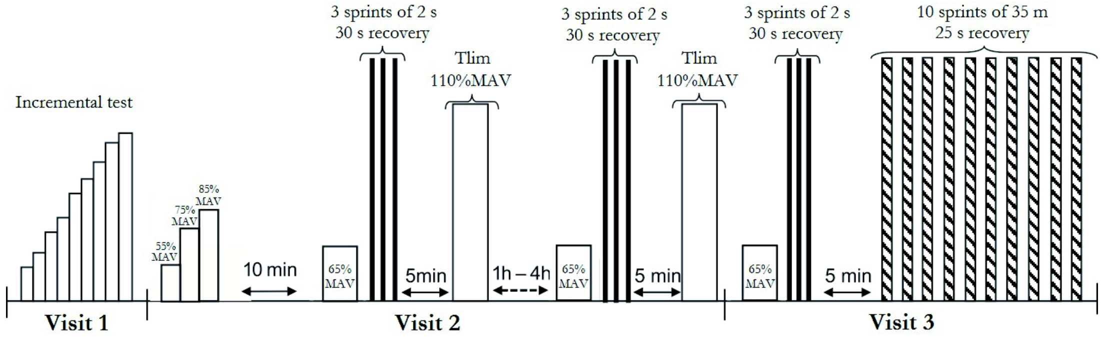
Eight sprinters (19 ± 4 years, 180 ± 7 cm, 77.9 ± 9.1 kg), eight endurance runners (29 ± 4 years, 176 ± 6 cm, 70.7 ± 8.1 kg) and eight physical active individuals (22 ± 1 years, 177 ± 5 cm, 76.8 ± 2.0 kg) participated in the present study. All subjects were free from any muscle skeletal injury, did no smoke and neither use any medication regularly.

The athletes trained five to six times per week with more than two years in the specific modality (i.e., sprint or endurance runners). The best performance (presented as mean and range interval) in the last six months before data collection for sprinters on the 100 m trial was 11.14 s (10.61 - 11.50 s) and for endurance runners on the 10-km was 35.9 min (31 - 38.1 min). The active subjects were physical education students, which typically engage in recreational activities (e.g., soccer, swimming and strength training) with a week frequency of three to five times, however, these did not participate in any specific physical activity regularly. All subjects were informed about the aims, procedures and possible risks associated with the present study. The study was approved by the Local Research Ethics committee n. 109.496/2012. For sample size estimation, it was utilized the procedures proposed by Hopkins[27] and significance level adopted was (α) 0.05 with a statistical power of 90%. The sample size was determined to detect statistical differences once the between-groups differences would be equal or greater to the double of the coefficient variation of measure.

Experimental design

All subjects performed, within a maximum four weeks period, three test on a synthetic athletics track: 1) incremental test; 2) maximum effort test at 110% of the maximal aerobic velocity (T110) and; 3) repeated sprints tests (RS) (FIGURE 1). The second and third tests were performed in a randomized order. All tests for the same individual were conducted on different day, however in the same time of the day. It is important to highlight that for the athletes, the experimental protocol was performed one to two weeks after the athlete's target competition. For all test, except the incremental, subjects performed a five minutes warm-up at moderate intensity (65% of maximum aerobic velocity) followed by three sprints of two seconds each. The sprints were interspaced by a 30 seconds submaximal running. Subjects were asked to arrive in the test well fed with light foods, avoid caffeine, as well as alcoholic beverages, and not engaged in extraneous physical activity 24 h before tests. Test were not performed in raining days to avoid the track to be wet, which could potentially decrease performance.

Subjects used a portable gas analyzer ($K4b^2$, Cosmed, Italy) for measure the cardiorespiratory variables (breath-by-breath) during the tests (except to the RS test). The gas analyzer was calibrated before each test according to manufacture instructions. Firstly, the O_2 and CO_2 analysis system were calibrated using room air with known O_2 (16%) and CO_2 (5%) concentration. Then, the turbine was calibrated with a syringe of 3-1 ($K4b^2$, Cosmed, Italy). Lastly, the delay was calibrated.



The visits 2 and 3 were performed in a randomized order. Further details are described in the method section.

FIGURE 1 - Experimental protocol.

Incremental test

The incremental test initiated with a velocity of 8.5 $km.h^{-1}$ and it was increased by 0.5 $km.h^{-1}$ every minute, until voluntary exhaustion. The running pace was controlled by sounds signals (bips) and "pvc" cones which were spread every 20 m on the track field. Subjects were verbally motivated to perform the test until voluntary exhaustion. The test was interrupted when subjects were not able to keep up the pace imposed by the protocol (i.e., delay greater to 2 m in three consecutives cones). The criteria to validate the test were: steady state (plateau) for VO_2 in spite of increases in velocity (i.e., differences in VO_2 < 150 $mL.mim^{-1}$) or if at least two of the following criteria were observed: 1) gas exchange ratio greater than 1.1; 2) visible exhaustion; 3) heart rate frequency at the final test within 10 bpm of the predicted maximum values (220 - age). The maximum oxygen consumption (VO_2max) was considered as the highest values ($mL.min^{-1}$) at intervals of 15 s and the maximum aerobic velocity (MAV) was calculated as the velocity attained in the last fully completed stage, added, if necessary, of the time fraction spent in the stage (i.e., in which occurred the exhaustion) multiplied by 0.5 $km.h^{-1}$.

Maximum effort test at 110% of the MAV (T110)

Subjects performed two maximum effort test at 110% of the MAV. The rest interval (passive rest) between tests was greater than one hour. Previously to test, three submaximal exercises of three minute each with relative intensities (i.e., 55, 75 and 85%) of the MAV were performed. The order of the submaximal exercises was progressive without any interval between them. Ten min after the submaximal exercises subjects performed the standardized warm-up protocol previously described in the experimental design section. After the warm-up, the subjects were instructed to rest for 5 minutes and then start the T110 protocol (i.e., at 110% of the MAV).

During the maximum effort tests, the subjects should have kept a constant velocity of 110% of the MAV until voluntary exhaustion, or until been told to interrupt the test due to not kept the required velocity (i.e., delay greater to 2 m in three consecutives cones). Time to exhaustion (Tlim) was considered as the highest time of effort, between two tests, in which the subject was able to keep the required velocity (i.e., 110% MAV). The test with the highest effort was used to determine the maximum accumulated oxygen deficit (MAOD).

Repeated sprints test (RS)

Three minutes after the standardized warm-up, described in the experimental design session, subjects performed two sprints of 35 m interspaced by two minutes of passive recovery and the best time on a single sprint was recorded. After five minutes of recovery, subjects performed the RS test, composed by 10 sprints of 35 m with 20 s rest interval (passive recovery) between them. All subjects were encouraged to perform all sprints as fast as possible. At the first sprint, subjects must have reached at least 95% of the time in the RS before test (warm-up). If any subject were not able to meet this criterion, the subject should rest for three minutes and then perform another attempt. At the first attempt, subjects run from the first to the second photocell (Speed Test 4.0, Cefise, Brazil) and then the direction was alternated. Five seconds before each sprint, subjects should assume the starting position (standardized foot position) and hold until the sound signal of the photocell to start.

Given that several tests have been used to measure the RS[8], and the present study did not intent to specify for any specific sport, the test protocol was based on the Gaitanos et al.[28] study. In short, these authors analyzed the energetic contribution of the first and last sprint on RS cycling (10 sprints of 6s with 30 s rest interval). Given that the present study used endurance runners which could show small declines on the RS performance, it was ensured that the recovery time between sprints would be always lower than 20 s. This procedure was adopted to ensure declines on performance between the RS[16, 24].

The measures of performance obtained from the test were: 1) best sprint time (BT); 2) total sprint time (TT) and; 3) score decrement (Sdec). The last one was calculated according to the equation[29]:

$$S_{dec}=100-\frac{\text{tempo do melhor } \textit{sprint} \text{ x } 10}{\text{tempo total acumulado}}\text{x}100$$

Oxygen deficit analysis

The oxygen deficit analysis was calculated on the T110 test as the difference between the oxygen demand at the corresponding velocity and the O_2 consumption during the test. The O_2 demand was calculated separately for each subjects according to the linear regression between VO_2 and velocity (i.e., determined at the submaximal exercises before the T110), as well as the VO_2 at rest. For the linear regression it was used the mean VO_2 value during the last 30 s in each submaximal exercise; regarding the VO_2 at rest, it was used the mean value during the 60 s before the start of the first T110. After that, the linear regression was extrapolated in order to determine the O_2 demand at the T110 velocity. Then, the O_2 demand was multiplied by the exercise time (i.e., Tlim) to calculate the total O_2 demand at the T110. Finally, the result of the difference between total O_2 demand at the T110 and the O_2 consumption throughout the T110 was considered as the maximum accumulated O_2 deficit (MAOD).

VO_2 analysis during exercise

The VO_2 response throughout exercise was analyzed on the T110. Initially, breath-by-breath O_2 data were examined to exclude erroneous data due to coughing and sneezing. All data points lying more than three standard deviation outside the local mean were excluded[30]. Then, the breath-by-breath VO_2 were linearly interpolated to give one value per second. Lastly, the data of the two transitions of each T110 were aligned, after that, it was calculated the VO_2 means values (i.e., data were aligned until exhaustion of the transition with the lower duration). The aspects described above aimed to reduce the "noise" and to accentuate the fundamentals characteristics of the physiological responses. The baseline VO_2 (VO_2base) was defined as the mean value during the last minute before the test start. The first 20 s of exercise were excluded of the adjust model (phase 1 - "cardiodynamic")[31]. The time-course response of VO_2, after the first 20 s of exercise, was described with an exponential component according to the following equation[32]:

$$VO_2(t) = VO_2base + Ax\left(1 - e^{-\left(\frac{t-TD}{\tau_1 on}\right)}\right)$$

Where: VO_2 (t) is the oxygen consumption at t; A is the VO_2 amplitude in the exponential component; TD is the time delay to the start of the exponential component; (tau) is the time constant of the exponential response that comprises the primary component.

Statistical analysis

Data are expressed as mean ± standard deviation (SD). For all tests the significant level adopted was 5%. Data normality were assessed through the Shapiro-Wilk test. The between-groups differences were analyzed by a one-way ANOVA with the post-hoc of Tukey. Furthermore, the effect size (Cohens' d) was calculated to determine the magnitude of the between-groups differences[33]. All subjects (i.e., allocated as a single group) were used in order to investigate the relationship between the RS variables and the physiological ones by Pearson correlation test (r). The magnitude of correlation between variables (i.e., RS variables and physiological ones) were considered as follows: < 0.1 = trivial; between 0.1 to 0.3 = small; between 0.3 to 0.5 = moderate; between 0.5 to 0.7 = strong; between 0.7 to 0.9 = very strong and; between 0.9 to 1.0 = almost perfect[33].

Results

Repeated sprints tests

TABLE 1 depicted the means values and the between-group comparison for the RS test. The one-way ANOVA revealed significant differences for all variables ($p < 0.01$). The post-hoc analysis demonstrated that the TT was significant different between-groups. Furthermore, sprinters showed significantly lower BT values as compared with the others two groups (i.e., endurance and physical active). Finally, both groups, sprinters and physical active subjects, demonstrated significantly higher Sdec when compared with the endurance runners.

TABLE 1 - Repeated sprint variables.

	Sprinters		Endurance runners		Actives	
Total time (s)	49.5 ± 0.8		52.6 ± 3.1		55.5 ± 2.6	
Sprint best time (s)	4.50 ± 0.14		5.05 ± 0.36		5.08 ± 0.29	
Sdec (%)	8.9 ± 2.1		4.02 ± 2.0		8.4 ± 4.4	
	Between-groups comparison (Effect size and p values)					
	Sprinters vs. Endurance		Sprinters vs. Actives		Endurance vs. Actives	
Total time (s)	-1.2	0.03*	-1.7	< 0.01*	-0.9	0.05*
Sprint best time (s)	-1.4	< 0.01*	-1.6	< 0.01*	-0.1	0.86
Sdec (%)	1.5	< 0.01*	0.2	0.74	-1.1	< 0.01*

Sdec: percentage performance decrease; * Significant between-groups difference ($p < 0.05$).

Anthropometric and physiological variables

The one-way ANOVA for between-groups comparison did not reveal any statistical difference for anthropometric variables, height and body mass ($p = 0.44$ and $p = 0.12$, respectively). However, the age of endurance runners were statistically higher as compared with the others two groups ($p < 0.01$). TABLE 2 depicted the physiological variables. The one-way ANOVA revealed significant between-groups differences for VO_2max, MAV, Tlim and MAOD ($p < 0.01$). When compared with sprinters and physical active subjects, endurance runners demonstrated significantly higher VO_2max and MAV values. Furthermore, the physical active subjects showed significantly higher VO_2max values as compared with sprinters. On the other hand, sprinters presented superior/higher values for MAOD and Tlim.

The model used to describe the VO_2 kinetics during exercise showed significant coefficient of determination ($p < 0.01$) between the VO_2 and the response of the model for all subjects ($r^2 = 0.84 \pm 0.1$). The values of the VO_2 kinetics during the T110 test exhibited significant differences only for tau ($p < 0.01$) (TABLE 2). The post-hoc analysis revealed that endurance runners showed lower values of tau when compared with sprinters and, a trend toward significant difference as compared with physical active subjects. However, this variable (i.e., tau) did not demonstrate significant difference between physical actives subjects and sprinters. The means values as well as the between-groups comparisons (i.e., physical active subjects, endurance runners and sprinters) for the VO$_2$ response at the T110 test are depicted in FIGURE 2.

TABLE 2 - Incremental test and 110% of the maximum aerobic velocity test variables.

	Sprinters	Endurance	Actives
VO$_2$max (mL.kg^{-1}.min^{-1})	51.2 ± 2.6	59.6 ± 2.6	54.9 ± 4.0
MAV (km.h^{-1})	14.8 ± 0.8	18.4 ± 1.3	15.4 ± 0.7
Tlim (s)	276 ± 35	157 ± 35	210 ± 26
MAOD (mL.kg^{-1})	65.1 ± 7.41	38.8 ± 13.8	41.4 ± 8.9
VO$_2$ kinetics			
VO$_2$base (mL·min^{-1})	515 ± 96	447 ± 69	476 ± 78
A (mL·min^{-1})	3087 ± 424	3398 ± 452	3285 ± 303
TD (s)	4.5 ± 5.5	8.6 ± 1.9	6.7 ± 1.5
"Tau" (s)	18.4 ± 5.4	11.3 ± 1.9	15.7 ± 3.5

	Between-groups comparison (Effect size and p values)					
	Sprinters vs. Endurance		Sprinters vs. Actives		Endurance vs. Actives	
VO$_2$max (mL.kg^{-1}.min^{-1})	-1.6	< 0.01*	-0.9	0.04*	1.2	0.02*
MAV (km.h^{-1})	-1.6	< 0.01*	0.8	0.42	1.7	< 0.01*
Tlim (s)	1.7	< 0.01*	1.5	< 0.01*	-1.3	< 0.01*
MAOD (mL.kg^{-1})	1.5	< 0.01*	1.6	< 0.01*	-0.2	0.87
VO$_2$ kinetics						
VO$_2$base (mL·min^{-1})	0.8	#	0.4	#	-0.4	#
A (mL·min^{-1})	-0.7	#	-0.5	#	0.3	#
TD (s)	-0.9	#	-0.5	#	1.0	#
"Tau" (s)	1.3	< 0.01	0.6	0.36	-1.2	0.08

VO$_2$max: oxygen maximum consumption;
MAV: maximum aerobic velocity;
VO$_2$base: oxygen consumption basal values;
Tlim: time to exhaustion at 110% of the maximum aerobic velocity;
MAOD: maximum accumulated oxygen deficit;
A, TD and Tau: amplitude, delay time and constant time on the VO$_2$ kinetics;
*Significant between-groups differences ($p < 0.05$);
#ANOVA p values.

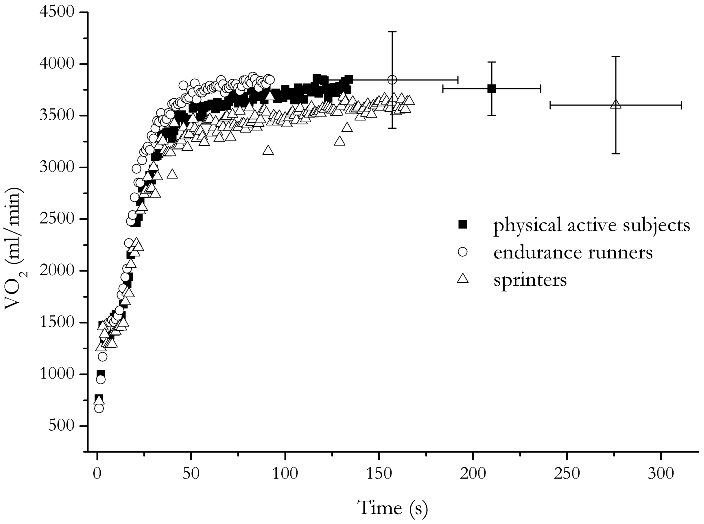


FIGURA 2 - Mean values regarding the oxygen consumption (VO$_2$) in physical active subjects, endurance runners and sprinters during the T110 test.

The mean values are restricted to the lower exhaustion time presented on each group.
The last point of each group represents the mean and standard deviation of the exhaustion time and of the VO$_2$ base + amplitude.

Correlation between variables

The values and the correlation magnitude of the TT and Sdec with the others variables measured in the present study are presented in TABLE 3. There was a significant correlation between TT and BT as well as for TT and MAOD. Furthermore, Sdec significantly correlated with the BT, VO_2max, MAV, MAOD and tau.

TABLE 3 - Correlation between the repeated sprint test and the physiological variables.

	BT		VO_2max		MAV		MAOD		"Tau"	
	r	p	r	p	r	p	r	p	r	p
TT	0.85^x	< 0.01	0.15	0.50	-0.24	0.25	-0.54^Y	< 0.01	-0.13	0.53
Sdec	-0.57^Y	< 0.01	-0.58^Y	< 0.01	-0.59^Y	< 0.01	0.48^z	0.02	0.45^z	0.03

TT: sprint total time; BT: best sprint time; Sdec: score decrement; VO2max: maximum oxygen consumption; MAD: maximum aerobic velocity; MAOD: maximum accumulated oxygen deficit; tau: constant time on the VO2 kinetics. x,y,z indicate significant correlation (very strong, strong and moderate, respectively).

Discussion

The present study aimed to determine the influence of the aerobic and anaerobic variables on performance as well as on the RS fatigue. Therefore, physiological and performance variables were compared among subjects with different training modalities experience (i.e., sprinters, endurance runners and physical actives subjects). The experimental design showed that the anaerobic training subjects (i.e., sprinters) presented superior RS performance; additionally, only the anaerobic variables (i.e., MAOD and best sprint time) correlated with RS total time. Furthermore, the present study showed that the variables related to the oxidative metabolism, such as VO_2 and MAV, help to reduce the fatigue in this type of exercise.

Previous studies, in healthy subjects and with a RS protocol composed by 10 sprints of 6 s with 30 s rest interval, estimated that during the first sprint the glycolytic system and the high energy phosphates contribute to approximately 40% and 46% of the total ATP production, respectively[8]. However, at the last sprint, the anaerobic glycolysis and the PCr contributes approximately to 9% and 49% of the total ATP production[8]. Indeed, the energetic contributions during exercise changes according to the type of subjects used[34], although, the above cited studies highlight the importance of the anaerobic capacity on the RS performance.

The present study demonstrated that one of common method used to analyze the anaerobic capacity (i.e., MAOD) correlated strongly and negatively with RS total time. That is, the higher the subjects' MAOD the lower will be its RS total time. However, Wadley and Le Rossignon[12] did not find significant correlation between the MAOD and RS performance (r = -0.31). These authors used Australian Rules football players (n = 17) and the RS test was composed by 12 sprints of 12 m interspaced with 20 s of recovery. The discrepancy between results are hard to reconcile, though they may be related to errors in the method used to measure VO_2, precluding to distinguish small differences within a homogeneous group[35]. In this sense, it may only be possible to observe significant correlations between MAOD and TT on a group of subjects with a substantial dispersion on the MAOD values. Yet, the lack of specificity of the MAOD protocol used by Wadley and Le Rossignon[12], that is, a treadmill test performed with inclination of 10%, may have reduced the study coefficient of correlation.

Albeit MAOD correlated with RS performance, it is important to highlight that the present study as well as others[10-11, 23] showed very strong correlations, or even almost perfect, between BT and/or maximal velocity of a single sprint with the RS performance. Therefore, suggesting that the maximum ATP production rate is one of the key mechanisms responsible for the performance on the RS.

It is important to highlight that consequently to the energy transfer by the glycolytic system, H+ ions and lactate are produced, inducing an intramuscular acidosis[36] and, consequently, performance decrease[25-26]. Additionally, albeit the importance of the MAOD on RS performance, we observed that this variable also moderately correlated with Sdec on the RS. Therefore, the present study highlights that the high-energy transfer of the anaerobic system, which positively affects performance, is one of the mechanisms responsible for the RS fatigue. On this basis, the mechanisms associated with the improvement of the buffering of these metabolites could decrease the influence of the acidosis on the RS, and consequently, augment the athletes' performance[16].

Until the present moment, few studies have observed that the aerobic parameters such as ventilatory threshold[15], VO_2max[15, 17, 19], MAV[11], velocity in which the VO_2max is reached (vVO_2max)[13], tau[19-20] were correlated with RS performance. However, the variables which significantly correlates are not always similar among studies, and thus, it is important to highlight that in the present study, as well as others, none aerobic variable correlated with the TT[10, 12, 16, 21-22, 24]. This is mainly observed in studies that used trained subjects with different physiological characteristics[16, 24]. Thus, these results suggest that the aerobic variables only seems to affect the RS performance when the subject's anaerobic parameters are similar. Furthermore, the aerobic variables may increases its importance when a sequence of RS is performed[2, 37]. Finally, these conclusions must take into account the RS protocol used, given that the higher the number of RS sprints, the greater is the importance of the aerobic parameters on the RS performance[20, 38].

Differently to RS performance, the ability to resist fatigue on the RS was greater in the endurance runners and, significantly correlated with the aerobic parameters measured in the present study (i.e., VO_2max, MAV and tau). VO_2max and MAV showed strong significant correlations with the Sdec. These results corroborates with previous ones[10-11, 13, 20], suggesting that VO_2max may increase the VO_2 amplitude during the RS and, consequently, increase the aerobic contribution on the RS performance[38]. Still, it is important to highlight that increases of these aerobic parameters seems to accelerate the phosphocreatine resynthesis, as well as, the clearance of metabolites derived from the sprints (e.g., H^+)[39-40], that is, important aspects to attenuate the fatigue on the RS[19, 23].

The rapid adjustment of VO_2 at the start of the exercise is another mechanism that could increases the aerobic contribution and, consequently, reduces the O_2 deficit during the RS test. On this base, some studies, though not all[11], observed positive correlations between tau on submaximal exercise and Sdec on RS test ($r > 0.60$)[19-20]. Indeed, the three aforementioned studies analyzed the kinetics of oxygen consumption with moderate intensities; yet this intensity does not show the same metabolic characteristic, as well as, the same adjust of the oxidative metabolism of the supra-maximal intensities[32]. In this sense, the present study used the tau at supra-maximal exercise (i.e., T110) and demonstrated a significant correlation, though of moderated magnitude, with the Sdec.

In summary, the present study demonstrated that sprinters have a superior RS performance as compared with endurance runners and physical active subjects. Additionally, RS total time only correlated with the anaerobic variables, therefore evidencing that the development of the anaerobic characteristics are relevant factors that must be worked in order to improve RS performance. Moreover, the present study highlighted that endurance runner's showed a lower fatigue on RS and that this variable is mainly attenuated by improvements of the aerobic variables, VO_2max and MAV.

Resumo

A influência de variáveis aeróbicas e anaeróbias no teste de "sprints" repetidos

O objetivo deste estudo foi determinar o modo e o grau com que variáveis aeróbias e anaeróbias influenciam o desempenho e a fadiga em "sprints" repetidos (RS) na corrida. Para este fim, participaram do estudo 24 homens, sendo oito corredores velocistas, oito corredores fundistas e oito sujeitos ativos. Em uma pista sintética de atletismo estes sujeitos foram submetidos aos seguintes testes: 1) teste incremental para determinação do VO_2max e da velocidade aeróbia máxima (VAM); 2) teste de velocidade constante realizado a 110%VAM para determinar a cinética do VO_2 durante exercício e o máximo déficit acumulado de oxigênio (MAOD); 3) teste de "sprints" repetidos (10 sprints de 35 m, intercalados com 20 s de recuperação) para determinar o tempo total dos "sprints" (TT), tempo do melhor sprint (TM) e a queda do desempenho em percentual (Sdec). Para analisar a diferença entre os grupos e as relações entre as variáveis foram utilizadas a análise de variância ANOVA "one-way", complementada pelo teste de Tukey, e a correlação de Pearson, respectivamente. O TT em RS foi diferente significativamente entre todos os grupos (velocistas, 49,5 ± 0,8 s; fundistas, 52,6 ± 3,1 s; ativos, 55,5 ± 2,6 s) e Sdec foi significativamente inferior em fundistas comparado aos outros grupos (velocistas, 8,9 ± 2,1%; fundistas, 4,0 ± 2,0%; ativos, 8,4 ± 4,4%). O TT foi correlacionado significativamente com o TM (r = 0,85, p < 0,01) e com o MAOD (r = -0,54, p < 0,01). Além disso, Sdec foi correlacionado significativamente com variáveis aeróbias (VO_2max, r = -0,58, p < 0,01; VAM, r = -0,59, p < 0,01; constante de tempo "tau", r = 0,45, p = 0,03). Portanto, conclui-se que apesar de índices aeróbios influenciarem na redução da fadiga em RS, o desempenho em RS é principalmente influenciado por características anaeróbias.

PALAVRAS-CHAVE: Desempenho esportivo; Cinética do VO_2; Máximo déficit acumulado de oxigênio; Velocistas; Fundistas; Educação Física; Treinamento.

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