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Impact Analysis of Low Oxygen Repeated Sprints on Basketball Speed and Endurance Skill Training

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Abstract: Basketball is a fast, intense and flexible sport. Most of the time, players need to change tactics flexibly in a short time. For players, basketball is a physical and mental sport, so players are more easily to muscle fatigue, which affects their reaction speed and judgment. Therefore, this paper explores the influence of a low-oxygen repetitive sprint training method on players' speed and endurance training. The results show that blood lactic acid level in the hypoxic group is higher than that in the normoxic group before 7 minutes, while after 7 minutes, blood lactic acid level in the hypoxic group is lower than that in the normoxic group, and the lactic acid elimination rate in the hypoxic group is much higher than that in the normoxic group as a whole, the lactic acid elimination rate in men's group is generally higher than that in the female group; Branched-chain amino acids show an upward trend within 1-9 minutes, and the rate of increase is faster and faster, and the content of branched-chain amino acids in the hypoxic group is higher than that in the normoxic group; The maximal oxygen uptake of the men's group is higher than that of the women's group, and the maximal oxygen uptake of the low oxygen group is higher than that of the normal oxygen group. The above research can provide a theoretical basis for the scientific training of basketball players and meanwhile it provides a powerful reference for the research of more effective training methods.

Keywords: Basketball; Hypoxia; Speed-endurance; Training

1. Introduction

Basketball is a highly aerobic sport, flexible tactics and continuous intense exercise make the body produce a lot of lactic acid, and the branch chain of amino acids in blood will be reduced. Lactic acid is the product of the body's anaerobic breathing. When the amount of lactic acid in the blood accumulates to a certain value, it will make the players feel tired and sore, resulting in the sluggishness of the players' reaction and slow movement speed. At the same time, the carbohydrate in the body cannot meet the current consumption, so the body began to gradually consume fat, amino acids and other substances, branch chain amino acids can be detected lower in the blood. These characteristics of basketball are very similar to racing sports. In the process of competition, it is necessary to repeat some actions for many times periodically. In addition to physical strength, it is also necessary to ensure the stability of psychological and tactical skills and strong tactical execution [1]. Finally, the physical characteristics of Asians are quite different from those of Americans, Africans and Europeans. Due to these reasons, it needs to strengthen the speed and endurance skill training of basketball players.

Chinese basketball players are generally trained by endurance running, but the training effect is not obvious. Low oxygen repeated sprints were first proposed by Faiss R and initially applied to the training of cyclists. They train athletes' speed and endurance by repeatedly sprints back and forth under low oxygen conditions. He Lianyuan and others: explore the effect of repeated-sprint training on the speed-endurance of basketball players in hypoxia environment, and the results show that repeated sprints with low oxygen content could improve the eliminating speed of lactic acid and thus improve the endurance of basketball players. Xu Xiangfeng, Shen Youqing and others have studied the effect of repeated sprint training under hypoxia conditions on rowers, and the results showed that repeated sprint training with hypoxia could effectively improve the speed of rowers and increase the recovery rate of blood lactic acid. Based on the similarities between the above sports and basketball sports, this study applies low-oxygen repeated sprint training to ball training, and explores the influence of low-oxygen repeated sprint training on the speed and endurance of basketball players and its principle, so as to provide a more scientific and effective training method for contemporary Chinese basketball players, and also provide a powerful reference for researching more effective training methods.

1.1. Experimental subject

A university town in a region of Zhejiang, each university selects 32 basketball players, and they have been

trained for 2~3 year, of which, there are 16 boys and 16 girls. Their physical examinations show that they are all healthy, and the physical condition is similar in both male and female groups. Men and women are randomly divided into normal oxygen group and hypoxia group. The specific information can be seen in table 1.

Table 1. The basic information of athletes

Group	Gender	No.	Age (year)	Height (cm)	Weight (kg)
Normoxia	male	8	20±1.2	183±0.7	70±0.3
	female	8	20±1.5	175±0.2	52±0.4
Hypoxia	male	8	20±1.7	182±0.3	69.3±0.5
	female	8	20±1.4	174±0.3	52±06

1.2. Test instrument

900BZ folding multifunctional physical examination machine, Biosen Cline series of glucose and lactic acid analyzers, Germany small low oxygen training room (Loxyroom system), Austria HEAD spinning, sports laboratory (measurement of maximal oxygen consumption), branched-chain amino acid (BCAA) detection kit of BioVision.

1.3. Theory

Branched-chain amino acid (BCAA) detection kit of BioVision mainly based on enzyme-linked immune reaction, the products of oxidation and deamination of branched chain amino acids can produce color reaction with the probe in the reagent, and then through the measurement of absorbance, the content of branched chain amino acids in blood can be measured. Biosen Cline series of glucose and lactic acid analyzers: by wrapping lactate oxidase in a semi-permeable membrane, a semi-permeable membrane allows only substances smaller than a glucose molecule to pass through and react with it.

1.4. Experimental methods and procedures

1) Firstly, according to the number of people in table 1, conduct random grouping, there are 8 men and 8 women in the low-pressure group; while there are 8 men and 8 women in the atmospheric pressure group. 2）After entering the test lab, the athletes are allowed to rest calmly for half an hour and then their heart rate, weight and height are measured. And according to the weight of each athlete, calculate the weight of repeated sprints (formula: 0.075*weight (kg). 3) Prepare the sterilizing equipment, blood collection equipment, blood preservation equipment, adjust the measuring equipment, and athletes wear heart rate rings. 4）The hypoxic group enter the hypoxic training room (Low oxygen system). The normoxic groups warm up with a power bike for 10 minutes prior to the test session at normal pressure. Then five groups of repeated sprint training are conducted, 50m sprint back and forth and five times counted as a group, after finishing sprint, each group rest 20s, in the sprint process, the weight increase in multistep, the female group, from 100W load, after each group finishing, add 10W load, that of the last group is increased to 140W load. The male group, from 130W load, after each group finishing, add 10W load, the last group is increased to 170W load. After sprinting, let the runners on the treadmill for active recovery at 1m/s for 20 minutes. During the athletes' resumption of training, blood samples (30u l) are collected at 1, 3, 5, 7, 9 and 30 minutes respectively for the measurement of lactic acid content, and the branched-chain amino acid test requires blood to be cryogenically preserved and sent to a biochemical laboratory for determination. The same experiment is done three times a week for five weeks. The normoxic and hypoxic groups are trained in the same way [2].

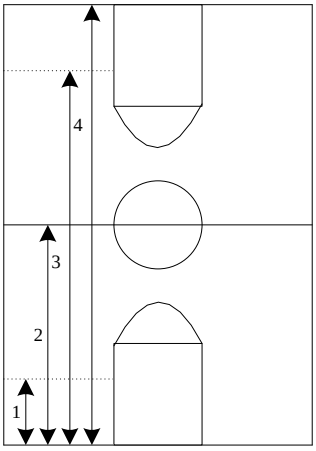

Figure 1. Basketball court test chart

1.5. Speed-endurance test

It mainly uses two ways, which can be compared with each other. They are shuttle run test and the maximum oxygen consumption test (Vo2Max), research shows that the best oxygen is proportional to human endurance and the maximum oxygen consumption can determine the maximum endurance of the human body. The first is to measure speed-endurance by shuttle run: the four groups of athletes are tested for initial speed and endurance before training, then after finishing repeated sprint training in each time, conduct shuttle run test, and all these are played on the basketball court in figure 1. The athletes are required to complete the test in the route of 1, 2, 3 and 4 on the standard basketball court with the maximum speed of turning back and forth, after finishing shuttle run test. Each group will rest for 15 minutes and continue to the next test. A total of 3 groups of parallel tests will be conducted. After the test, blood samples of athlete at 1, 3, 5, 7, 9 and 30 minutes are used for lactate eliminating

efficiency experiment and the determination of blood branch chain amino acid content. The second "maximal oxygen consumption" test: In the test lab, indoor-cycling is conducted, and through the respiratory mask link tester, the oxygen consumption of each athlete is measured [3].

1.6. Anaerobic power test

Calculate the load weight of each athlete according to the weight load mentioned above. First, let the athlete do 5 minutes of familiarization and warm-up exercise on the tested anaerobic bicycle, adjust the bike to the best condition according to personal requirements. The athletes are required to keep action specification during the test, and especially the hip cannot leave the cushion. Start the anaerobic power test, the rider must pedal as fast as possible for 30 seconds on the anaerobic bike. The test, like the speed endurance test, is done after repeated sprints with low oxygen levels. Each group is given a 20-minute break, and does three parallel experiments.

1.7. Measurement of blood lactic acid concentration

The instrument used is the Biosen Cline series glucose-lactic acid analyzer, and blood samples from athletes are collected after repeated sprints with low oxygen and repeated shuttle run, the collected blood samples are processed in accordance with the instructions and placed in the instrument. The instrument displays the current lactate value in the blood, and the lactate clearance rate can be determined after calculation. The formula is as follows: Δ blood lactic acid %= {(Blood lactic acid level before training − Blood lactic acid after training) mmol/L / Blood lactic acid level before training mmol/L} ×100% .

1.8. Statistic analysis

The data measured by the instrument is conducted statistics, and it will use excel 2007, SPSS19.0, the lactic acid number and branched-chain amino acid data of repeated sprint training and repeated shuttle run in hypoxia condition are analyzed by single factor analysis of variance (SPSS19.0).

2. Experimental Results

2.1. The average score of shuttle run

Table 2. Average score of shuttle run in five weeks（S）

Condition	Group	Beginning（before training）	The first week	The second week	The third week	The forth week	The fifth week
Hypoxia	Men	99.31±3.51	99.29±2.79	99.26±3.57	98.86±4.21*	97.59±3.45*	95.32±2.39**
	Women	102.57±2.24	102.56±5.27	101.25±3.87	100.82±3.46*	98.54±2.84**	97.37±2.49**
Normoxia	Men	99.32±2.41	99.30±2.58	99.29±4.28	99.10±5.13	98.96±3.75*	98.131±2.47*
	Women	102.45±3.57	102.43±2.63	102.19±4.89	102.13±5.29	99.98±4.26*	98.16±1.23*

*P<0.05, **P<0.01, the value in each group is compared with the initial value.

As can be seen in table 2, under hypoxic conditions, there are significant differences in the improvement of performance of the men and women groups after the third week of training, while in normoxia, the significant differences of men and women groups begin only at the forth week respectively, and it can be clearly seen that low oxygen repeated sprint training can effectively improve the speed of the shuttle run, at the same time, it also shows the improvement of speed endurance.

2.2. The average score of low oxygen repeated sprint training

Table 3. The Average score of low oxygen repeated sprint training in five weeks (s)

Condition	Group	Beginning（before training）	The first week	The second week	The third week	The forth week	The fifth week
Hypoxia	Men	6.98±0.53	7.15±0.48	7.29±0.36	7.43±0.29*	7.56±0.51*	7.69±0.56**
	Women	6.47±0.24	6.53±0.43	6.67±0.27	6.74±1.31*	6.91±0.31*	7.18±0.49**
Normoxia	Men	6.64±0.45	6.68±1.38	6.71±0.28	6.75±0.73	6.79±0.75*	6.83±0.37*
	Women	6.45±0.37	6.48±0.31	6.53±0.48	6.60±0.35	6.65±0.27*	6.78±0.42*

*P<0.05, **P<0.01, the value in each group is compared with the initial value

From table 3, the average scores of hypoxic repeated sprint training in men's and women's group with hypoxic are significantly different in the third week and begin to appear extremely significant differences in the fifth week. The average scores of hypoxic repeated sprint training in both men's and women's groups begin to show significant differences in the fourth week. The results show that repeated sprints with low oxygen levels can improve running speed of athlete.

2.3. Changes in blood lactic acid concentration

Table 4. Lactic acid levels in the blood after repeated sprints training (mmol/L)

Group	Beginning(before training)	In a moment	3 (Minute)	5(Minute)	7(Minute)	9(Minute)	30(Minute)
Men	14.38±1.27	13.06 ±1.78	15.41±2.10*	16.31±1.87*	15.75±1.86**	15.54±2.63*	14.43±1.56
Women	14.29±1.38	13.04±1.31	14.67±1.27	15.46±1.31*	15.91±1.31**	15.31±1.52*	14.25±1.18
Men	12.83±1.36	14.12 ±4.22	14.69 ±3.43	15.11±4.03	16.02±3.91	16.72±5.72	12.85±1.37
Women	12.56±1.62	14.48±1.31	14.53±2.48	15.51±2.35	16.00±1.27	16.65±1.27	12.78±1.42

*P<0.05, **P<0.01, the value in each group is compared with the initial value

As can be seen from table 4, after repeated sprint training, the blood lactic acid content in Hypoxic men's group show a significant difference at 3 minutes, and reach an extremely significant difference at 7 minutes. However, after repeated sprint training, the blood lactic acid content in Hypoxic women's group show a significant difference at 5 minutes, and reach an extremely significant difference at 7 minutes. Compared with the normoxic group, the total blood lactic acid content in the hypoxic group is higher than that in the normoxic group before 7 minutes and lower than that in the normoxic group after 7 minutes. There is no significant difference in normoxic data, and the change of blood lactic acid is not very significant.

2.4 The change of lactic acid clearance rate

Table 5. Blood lactic clearance rate after repeated sprint training and shuttle run test（%）

Condition	Group	In a moment	3(Minute)	5(Minute)	7(Minute)	9(Minute)
Hypoxia	Men	8.44±14.52	10.99±9.64	14.16 ±8.52	13.04 ±8.89**	6.39 ±14.05
	Women	8.04±8.31	10.67±8.27	14.46±5.37	12.91±8.31**	6.31±12.52
Normoxia	Men	-10.12±19.80	-1.00±20.44	-8.83 ±17.82	-13.71 ±16.59	-16.49 ±29.22
	Women	-9.98±15.31	-1.53±20.48	-8.51±12.35	-13.00±16.27	-16.65±21.27

*P<0.05, **P<0.01, the value in each group is compared with the initial value

As can be seen from table 5, after repeated sprint training and shuttle run test, the blood lactic acid clearance rates in Hypoxic men's and women's groups are higher those of normoxia, and the maximum clearance rate reaches at 7 minutes, which also corresponds to the lactic acid content in the blood. However, after repeated sprint training and shuttle run, the blood lactate clearance rate of the normoxia group shows negative growth. The blood lactic acid clearance rate of hypoxic group and normoxic group show a trend of first high and then low, and the blood lactic acid clearance rate of men in hypoxic group and normoxic group is faster than that of women in the same group.

2.5. Measurement of maximal oxygen uptake

Table 6. The maximum oxygen uptake of an athlete

Condition	Group	The maximum oxygen uptake (ml/min)
Hypoxia	Men	4111±3.45
	Women	3604±4.23
Normoxia	Men	3996±5.12
	Women	3404±2.38

It can be seen from table 6 that the maximal oxygen uptake of the hypoxic group is much higher than that of the normoxic group. Moreover, the maximal oxygen uptake of the men in both the hypoxic and normoxic groups is nearly 500ml/min higher than that of the women.

2.6. Branched-chain amino acid changes in blood

Table 7. Branched chain amino acid content in blood after low oxygen repeated sprints（nmol/ml）

Condition	Group	Beginning（before training）	In a moment	3(Minute)	5(Minute)	7(Minute)	9(Minute)	30(Minute)
Hypoxia	Men	427.8±5.37	428.4±4.78	429.8±3.10	431.5±4.87	441.3±2.86	458.9±2.63**	428.6±3.62
	Women	426.2±3.38	427.1±3.41	428.5±5.27	430.6±3.13	439.8±4.51	457.3±5.53**	427.9±3.51
Normoxia	Men	417.5±6.10	418.6±2.32	422.8±3.43	429.5±5.13	434.5±7.13	441.2±4.21	418.1±3.22
	Women	418.9±3.32	419.1±5.31	422.9±2.48	429.5±4.35	436.7±4.21	445.3±4.17	419.3±4.27

*P<0.05, **P<0.01, the value in each group is compared with the initial value

As can be seen from table 7, after low oxygen repeated sprint training, branched chain amino acid contents in blood of Hypoxic men's and women's groups show a significant difference at 9 minutes, the content of branched-chain amino acids in hypoxic group is higher than that in normoxic group. The blood content of branched-chain amino acids in both hypoxic and normoxic groups show an upward trend in the first nine minutes, and the rate of increase is faster and faster. After nine minutes, due to the recovery of physical strength, the content of branched-chain amino acids gradually decrease, and reach the level at the beginning of training at 30 minutes[4].

3. Conclusions

This paper is to study the effect of low oxygen repeated sprints on basketball speed endurance, the training speed, blood lactic acid, maximal oxygen uptake and branch chain amino acid content of athletes are measured after the experimental training. From the above results, it can be seen that low oxygen repeated sprint training can effectively improve the running speed of athletes, and repeated sprint training under normal oxygen condition can also improve the running speed of athletes to a certain extent, but the enhancing effect is not significant. And the improvement rate is generally between 2% and 5%, while under hypoxic conditions improvement rate can increase to 9%. But that's only relatively visible from the surface. Physiological experiment is conducted to measure blood lactic acid and lactic acid elimination rate and branch chain amino acid of athletes after low oxygen repeated sprint training. The lactic acid elimination rate in the hypoxic group is significantly higher than that in the normoxic group, and the lactic acid consumption in normoxia group is negatively correlated after repeated sprint training with hypoxic. The lactic acid elimination rate is in direct proportion to the speed endurance of athletes, indicating that repeated sprint training with hypoxic can effectively improve the speed endurance of athletes; The branched-chain amino acids of the hypoxic group are also higher than those of the normoxic group in general, and the branched-chain amino acids are increasing at a faster and faster rate between 1 and 9 minutes. When an athlete is low on energy and glucose, the body starts a second energy conversion mechanism, consuming fat or amino acids. The increase of branched-chain amino acid content can provide energy for athletes, and studies have shown that the content of branched-chain amino acid during extreme sports is positively correlated with the speed endurance of athletes; the results of maximum oxygen uptake show that repeated sprints with low oxygen can increase maximum oxygen uptake of athletes, and the maximal oxygen uptake is also positively correlated with the speed endurance of athletes. Therefore, low oxygen repeated sprint training can effectively improve the speed endurance of athletes. It is suggested that colleges and universities can take low oxygen repeated sprints training to improve the training effect.

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