DEVELOPMENT AND APPLICATION OF A SIMULATED ALTITUDE CABIN

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The purpose of this study was to examine the techniques of simulated altitude cabin developed by the Shandong Sports Science Center, China. Blood lactate of two male and two female long distance taking the contrast test of the same exercise load of Monark 829 bicycle and treadmill both in and out of the cabin was measured. Hemoglobin of four elite walk runners who lived in the cabin with the altitude of 3,000m for 14 hours every day and took the training out of the cabin in the rest of the time was also measured. Results showed that the value of blood lactate for same athlete after exercise load in the cabin is obviously higher than those outside of cabin, and that the mean value of hemoglobin of the four elite athletes increased 1.3g/dl before and after the test. It is concluded that the manufacture of the simulated altitude cabin is successful in simulating actual altitude training.

KEY WORDS: mimicked altitude cabin, altitude training, lactate, hemoglobin

INTRODUCTION: Sports scientists and coaches have been paying more and more attention to simulated altitude training for recent years. As a specific training means, it can increase exercise load of athletes and also improve their oxygen carrying capacity just as the effect of actual altitude. The first simulated altitude cabin in China has manufactured successfully by Shandong Sports Science Center recently. It is composed of two parts, one is training main cabin and the other is transient subsidiary cabin. The overall dimensions of the cabin are 12.4m long, 3.8m wide and 3.5m high with total areas of 47.1m². It can simulate the altitude environment of 0-6000m high. It is one of the biggest simulated altitude cabins in the world. In order to examine the quality and effects of the cabin, the main technical parameters were tested and the effects of tentative application was detected. The testing results were gained through the present study.

METHODS: 1. The quality of the simulated altitude cabin is an important part in this study. For this reason, Changing rate of pressure, Stability of pressure, Oxygen content and CO2 content were selected as the main testing technical parameters to compare with the designed technical parameters of the cabin.

1.1 The test of Changing rate of pressure (CRP)

The designed technical parameter of changing rate of pressure is > 0.0017Mpa/min. The calculation of change rate of pressure is defined as follows:

$$CRP = \frac{\left|(-\ 0.159Mpa)\right|}{Time\_used\_to\_reach\_the\_value}$$

The testing procedures were, firstly to close external door at both ends, open the two doors between the training cabin and the transient cabin and start the vacuum pump. When the pressure in the cabin reaches –0.0059 Mpa (equal 6000m high) shut off the vacuum pump and record operation time. The test was repeated three times.

1.2 The test of stability of pressure

The range of change of the pressure is limited ±5% between the set-up value and the actual value according to the designed technical parameter. Three parameters of -0.059Mpa, -0.049Mpa and –0.030Mpa were selected as the testing pressure points. Pressure adjustable meter were adjusted to take the test of pressure value. There are 118 scales from 0 to - 0.059 Mpa in the pressure meter. 5% of 118 scales equals 6 scales. If the pressure is around - 0.059Mpa within ±6 scales, it is qualified. With the same rules, the qualifications lies in - 0.049 changing within ±5 scales and - 0.03Mpa within ±3 scales.

1.3 The tests of Oxygen content and CO2 content

The relative proportion of Oxygen content and CO2 content of the gas is the same with natural environment at the sea level. The proportion of Oxygen content is 21% and the error< ±5%. The CO2 content is in the range among 400ppm~500ppm.

2. In order to test the application effects of the cabin, an experiment was designed and conducted. The experiment included two parts, one was to examine the effects of training in the cabin and living outside, and the other was to determine the effects of living in the cabin and training outside.

2.1 In the first part of the experiment, two male and two female long distance runners (all had over 2 years training experience) were recruited to take the test in Monark 829 bicycle and treadmill at the same exercise load both in and out of the cabin. When the test was performed in the cabin, the altitude 2000m was mimicked. The test protocols for cycling ergometer and treadmill are presented in Table 1. The blood lactate was used to assess the exercise capacity. Measurement points of blood lactate were before test, immediately, 3, 5 and 7 minute post the exercise test.

Table 1 The Test Protocol in Cycling Ergometer and Treadmill Both In and Out of the Cabin for the Long Distance Runners

Item		Sex	Test Contents
Monark Bicycle	829	M	Initial load 50w, progressive increase of 50w per minute, speed 50r/m, lasting 21 minutes, power 350w.
		F	Initial load 25w, progressive increase of 50w every 3 minutes, speed 50r/m, lasting 14 minutes, power 175w.
Treadmill		M	Initial speed 10km/h, slope 1°, progressive increase of 0.6km/h every one minutes, lasting running 15’25”.
		F	Initial speed 9km/h, slope 1°, progressive increase of 0.6km/h every one minutes, lasting running 13’30”.

2.2 In the second part of the experiment, four elite walk runners (all had over 4 years training experience) participated in the test. They lived in the cabin mimicked the altitude of 3,500m from P.M.7:00 to A.M. 9:00 every day and took the training out of the cabin in the rest of the time for three weeks. The level of the hemoglobin was used to assess the training

effects.

RESULTS AND DISCUSSION: The test results of main technical parameters of the cabin are showed in Table 2 to Table 5.

Table 2 The Testing Result of the Change Rate of Pressure (CRP)

Test	Time (min.)	CRP (Mpa/min.)	Result
1	22	0.0027	Qualified
2	18	0.0033	Qualified
3	20	0.0029	Qualified

Table 3 The Testing Result of Stability

Pressure Point (Mpa)	Pressure Change (Scale)	Result
-0.059	+3.5 ~ -2.1	Qualified
-0.049	+3.5 ~ +2.0	Qualified
-0.030	+1.5 ~ -3.0	Qualified

Table 4 The Test of Oxygen Content

Pressure Point (Mpa)	Content (%)	Result
-0.059	20.9	Qualified
-0.049	20.8	Qualified
-0.030	20.8	Qualified

Table 5 Testing Result of CO2 Content

Pressure Point (Mpa)	Content (ppm)	Result
-0.059	456	Qualified
-0.049	461	Qualified
-0.030	451	Qualified

The testing results in the four main technical parameters showed that the quality of the cabin is qualified and the main technical parameters have reached the designed requirement.
The testing results from the experiments in athletic subjects are shown in Table 6 and Table7.

Table 6 The Testing Results of Blood Lactate (mmol/L) by Means of " Plains Living and Altitude Training"

Item	Name	Cabin	Before	Immediately	3min	5min	7min
829 Bicycle	Feng (F)	Outside	1.8	8.4	9.9	9.3	9.3
		Inside	1.8	10.2	11.1	10.8	10.8
	Zhao (F)	Outside	1.5	9.0	9.0	8.4	7.5
		Inside	1.5	9.9	11.7	10.8	11.7
Treadmill	Zhang(F)	Outside	0.9	8.4	9.9	9.3	8.7
		Inside	0.9	9.0	9.6	9.6	9.3
	Li (M)	Outside	1.2	6.3	5.7	6.0	5.4
		Inside	1.5	9.9	11.4	10.8	12.9
Mean difference value of in and out:			.075	1.725	2.325	2.1	3.15

From Table 6 it was showed that the elevation of blood lactate for the same athlete after exercise test in the cabin were considerably higher than those measured value in the exercise test of outside of cabin. The decrease of blood lactate in the recovery period in the cabin was slower than that outside of cabin. It indicated that the altitude environment can affect the metabolism of skeletal muscle. The level of blood lactate and the capacity of lactate resistance of the athletes could be improved by the application of mimicked altitude. The mimicked altitude training can be also used for increasing the training intensity.

Table 7 Effect of the Method of "Altitude Living and Plains Training" on the Index of Hemoglobin (g/dl)

Name	The day before the test	Max. Value of test	The day after the test	Differential value before and after the test
Li	14.5	15.8	15.8	+1.3
Liu	15.1	16.8	16.8	+1.7

Wang	14.9	16.4	15.9	+1.0
Yu	14.5	16.2	15.7	+1.2
Mean	14.75	16.3	16.05	+1.3

From Table 7, we can find an increase of 1.3 g/dl in the mean value of hemoglobin after the three weeks training compared with the measurement pre training. It indicated that the method of “altitude living and plains training” can produce an obvious effect on increasing the level of hemoglobin for athletes.

CONCLUSION:

1.The simulated altitude cabin developed by Shandong Sports Science Center is reliable and valid.
2. The effect of the simulated altitude cabin was like the effects gained from actual altitude training.
3. Three weeks of training in the simulated altitude training cabin resulted in an increase in training intensity, and improvement in the capacity of oxygen transport in athletes.

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