

The use of hyperoxia to accelerate recovery the organism after the floor exercises routines in artistic gymnastics

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ABSTRACT

The research deals with the use of inhalation of concentrated oxygen in the regeneration interval after anaerobic load in Artistic Gymnastics. The aim of research's realization was to diagnose the impact of inhalation of concentrated oxygen (hyperoxia) on the recovery's duration on reaction of heart rate and the level of the lactate in capillary blood after the floor exercises. The experiment was implemented on three members of nation team of Slovakia in artistic gymnastics. During the experiment's realization, the heart rate of gymnasts was continuously monitored. One minute after each specific load and after 3-, 7- and 15-minute recovery, we applied measurements of the lactate levels in capillary blood. The experimental factor was anonymous inhalation of concentrated oxygen respectively air (in form of placebo) during the rest. Gymnasts regenerated after each specific load by the form of inhalation of concentrated oxygen or placebo. Diagnostics' results after floor exercises of all professional gymnasts suggest on decrease of anaerobic cover after oxygen's inhalation and faster lactate's remetabolisation when comparing with placebo's inhalation. The lactate curve tended downward from the 1st minute in recovery with inhalation of concentrated oxygen. On the contrary inhaling placebo made lactate curve rise till 3rd minute, resp. till 7th minute and then tended downwards. It was also exhibited the decrease of heart rate the average 10 beats per minute less with oxygen's inhalation when compared with placebo's inhalation in 1st, 2nd and 3rd minute after floor exercises routines. According to this information we can consider that the inhalation of hyperoxic mixture was a method to accelerate the recovery after specific load of elite gymnasts.

KEY WORDS: floor exercise, heart rate, hyperoxia, lactate, placebo, recovery

DOI: <https://doi.org/10.24040/sjss.2024.9.suppl.155-162>

INTRODUCTION

Artistic Gymnastics is an Olympic sport. Men's gymnastics includes six events. The duration of the exercises on individual apparatuses varies, depending on their nature, from 6

seconds on vault to 70 seconds on floor exercise according to the rules of artistic gymnastics (1). The duration of the floor routine in senior gymnasts is 67 seconds (2). Gymnastics is characterized by a strong

preference for anaerobic metabolism. This specific load often exposes the gymnasts' organism to strong anaerobism, which can reduce the quality of the next performance. Athletes often seek ways to suppress the negative metabolic effects of anaerobic metabolism. One viable alternative could be the inhalation of oxygen concentrates - hyperoxia (3,4,5) when mentioned authors have confirmed the positive impact of hyperoxia on the athletes' body. Sports theory generalizes the common knowledge that lack of oxygen impairs performance and prolongs recovery. As a result of this claim, the question arises as to whether the opposite is also true. The reason should be increased oxygen saturation of blood and tissues and lower anaerobic activity of working muscles, which accelerates subsequent recovery and return to baseline values. One-time or repeated short-term applications of concentrated oxygen or hyperoxic mixtures have a transient effect on increased oxygen saturation of tissues, which can be used to accelerate regeneration during intermittent loads (6).

GOAL

The effect of inhalation of concentrated oxygen (hyperoxia) during recovery on the

We know that during intense muscular exertion, lactic acid ($C_3H_6O_3$) is produced, which immediately dissociates into lactate ($C_3H_5O_3$), i.e., the lactate anion (La^-) and hydrogen cation (H^+), which is the primary cause of acidosis in the body during exertion. The human body can resynthesize lactate itself into glycogen. Havlíčková et al. (7) confirms that during (after) anaerobic work, a sufficient supply of oxygen must be ensured to enable the resynthesis of energy sources and the elimination of acidosis. In the sports training of gymnasts, it is important to maintain the quality and complexity of the performed elements. The effort to maintain the high quality of the performance of the elements leads to high muscle load and subsequently to energy exhaustion associated with muscle weakness. We assume that hyperoxia can accelerate the recovery time between specific loads in gymnasts. Therefore, we decided to use the case study in our research as a basis for further application of hyperoxic mixtures in the training process.

response of the cardiovascular system and the level of lactate in capillary blood after a floor routine in elite gymnasts.

MATERIALS AND METHODS

The study monitored 3 gymnasts – subject 1 = 22.53 years; subject 2 = 20.47 years; subject 3 = 23.17 years. Weekly training load was 25

hours. It included two phases per day, 6 days a week. All gymnasts are members of the Slovak national team in men artistic

gymnastics. At the time of monitoring, they were preparing for the European Championships.

Table 1 Somatometric parameters

Subjects	Height (cm)	Body Mass (kg)	BMI	Fat (kg)	Fat (%)
1	171	71.2	24.3	4.4	6.2
2	175	76.1	24.8	6.7	8.8
3	176	70.6	22.8	5.3	7.5

PROTOCOL

We implemented the experiment during the training process in a specialized gymnastics gym in Bratislava during morning training units from 10:00 to 12:00. The air temperature in the gym was 23°C. In all measurements, we observed the same research time, gym temperature, and the same warm-up and warm-up before the set. The session began with 20 minutes of general warm-up, followed by specific warm-up of 20 minutes, 30 minutes of passive rest before the first measurement and 30 minutes before the second measurement. The specific load consisted of the floor exercise routine.

During the experiment, the heart rate of gymnasts was continuously monitored (Polar). We measured lactate levels in capillary blood

(Lactate Pro 2 LT-1730) after each specific load after the 1st, 3rd, 7th, and 15th minute of recovery. Lactate Pro 2 LT-1730, according to the manufacturer, measures lactate concentration in capillary blood with an accuracy of 3%. (8). The experimental factor was anonymous inhalation of concentrated oxygen respectively air (in form of placebo) during the resting period. Gymnasts regenerated after each specific load using inhalation of concentrated oxygen (New Life Intensity 2x10 l.) or placebo. The oxygen concentrator contained 90 - 95% oxygen and a placebo of 20 - 21% of oxygen.

The study was approved by the Ethics Committee of the Matej Bel University and conducted in accordance with the Declaration of Helsinki.

RESULTS

We detected the response of the organism on specific load by the measurement of heart rate (HR) and blood lactate concentration (BLC) according to the predetermined

methodology. We present the outcome values in the following tables.

Table 2 shows data with inhalation of concentrated oxygen which caused the greater decrease of HR after the routine - in the 1st minute by 6 beats per minute (27%) in

the 2nd minute by 12 beats per minute (20%)
and in the 3rd minute by 8 beats per minute

(11%) - than decreases of HR after inhalation
of placebo.

Table 2 Heart rate comparisons in subject 1.

S.M. Floor	HR Oxygen (bpm)	HR after load - recovery (bpm)	HR after load - recovery (%)	HR Placebo (bpm)	HR after load - recovery (bpm)	HR after load - recovery (%)	Recovery Oxygen - Placebo (bpm)	Recovery Oxygen - Placebo (%)
before load	124			120				
after load	175			173				
after 1 min.	153	22	13	157	16	9	6	27
after 2 min.	114	61	35	124	49	28	12	20
after 3 min.	99	76	43	105	68	39	8	11
after 4 min.	95	80	46	96	77	45	3	4
after 5 min.	93	82	47	95	78	45	4	5
after 6 min.	93	82	47	93	80	46	2	2
after 7 min.	90	85	49	93	80	46	5	6
after 15 min.	88	87	50	90	83	48	4	5

During recovery time with inhalation of concentrated oxygen the curve of lactate levels had upward tendency from 4.9 mmol.L⁻¹ up to 5.3 mmol.L⁻¹ then downward tendency

to 3.5 mmol.L⁻¹. After performance with inhalation of placebo had lactate curve only upward tendency during measured recovery time (Table 3).

Table 3 Comparisons of blood lactate concentration in subject 1.

S.M. Floor	BLC Oxygen (mmol/L)	BLC after load - recovery (mmol/L)	BLC after load - recovery (%)	BLC Placebo (mmol/L)	BLC after load - recovery (mmol/L)	BLC after load - recovery (%)
after 1 min.	4.9			5.1		
after 3 min.	5.3	-0.4	-8	5.8	-0.7	-14
after 7 min.	5.0	-0.1	-2	7.1	-2.0	-39
after 15 min.	3.5	1.4	29	5.2	-0.1	-2

Table 4 Heart rate comparisons in subject 2.

I.V. Floor	HR Oxygen (bpm)	HR after load - recovery (bpm)	HR after load - recovery (%)	HR Placebo (bpm)	HR after load - recovery (bpm)	HR after load - recovery (%)	Recovery Oxygen - Placebo (bpm)	Recovery Oxygen - Placebo (%)
before load	128			130				
after load	181			183				
after 1 min.	156	25	14	168	15	8	10	40
after 2 min.	116	65	36	126	57	31	8	12
after 3 min.	116	65	36	119	64	35	1	2
after 4 min.	114	67	37	110	73	40	-6	-9
after 5 min.	115	66	37	114	69	38	-3	-5
after 6 min.	112	69	38	110	73	40	-4	-6
after 7 min.	110	71	39	106	77	42	-6	-9
after 15 min.	101	80	44	103	80	44	0	0

Table 4 shows data with inhalation of concentrated oxygen which caused the greater decrease of HR greater after the routine in the 1st minute by 10 beats per

minute (40%) in the 2nd minute by 8 beats per minute (12%) than decreases of HR after inhalation of placebo.

Table 5 Comparisons of blood lactate concentration in subject 2.

I.V. Floor	BLC Oxygen (mmol/L)	BLC after load - recovery (mmol/L)	BLC after load - recovery (%)	BLC Placebo (mmol/L)	BLC after load - recovery (mmol/L)	BLC after load - recovery (%)
after 1 min.	6.1			5.9		
after 3 min.	5.7	0.4	7	6.3	-0.4	-7
after 7 min.	5.6	0.5	8	4.7	1.2	20
after 15 min.	3.0	3.1	51	3.7	2.2	37

During recovery time with inhalation of concentrated oxygen the curve of lactate levels had a downward tendency from 6.1 mmol.L⁻¹ down to 3.0 mmol.L⁻¹. After performance with inhalation of placebo had lactate curve upward tendency up to the 3rd minute then it tended downwards (Table 5).

Table 6 shows data with inhalation of concentrated oxygen which caused the greater decrease of HR was greater after the routine in the 1st minute by 9 beats per minute (41%) in the 2nd minute by 11 beats per minute (33%) and in following minutes than after inhalation of placebo.

Table 6 Heart rate comparisons in subject 3.

M.A. Floor	HR Oxygen (bpm)	HR after load - recovery (bpm)	HR after load - recovery (%)	HR Placebo (bpm)	HR after load - recovery (bpm)	HR after load - recovery (%)	Recovery Oxygen - Placebo (bpm)	Recovery Oxygen - Placebo (%)
before load	115			118				
after load	185			183				
after 1 min.	163	22	12	170	13	7	9	41
after 2 min.	152	33	18	161	22	12	11	33
after 3 min.	136	49	27	145	38	21	11	23
after 4 min.	118	67	36	127	56	31	11	16
after 5 min.	112	73	40	120	63	34	10	14
after 6 min.	110	75	41	119	64	35	11	15
after 7 min.	100	85	46	117	66	36	19	22
after 15 min.	93	92	50	100	83	45	9	10

During recovery time with inhalation of concentrated oxygen the curve of blood lactate concentration had a downward tendency from 8.6 mmol.L⁻¹ down to 3.5

mmol.L⁻¹. After performance with inhalation of placebo had lactate curve upward tendency up to the 3rd minute then it tended downwards (Table 7).

Table 7 Comparisons of blood lactate concentration in subject 3.

M.A. Floor	BLC Oxygen (mmol/L)	BLC after load - recovery (mmol/L)	BLC after load - recovery (%)	BLC Placebo (mmol/L)	BLC after load - recovery (mmol/L)	BLC after load - recovery (%)
after 1 min.	8.6			8.5		
after 3 min.	8.5	0.1	1	10.1	-1.6	-19
after 7 min.	6.8	1.8	21	7.5	1.0	12
after 15 min.	3.5	5.1	59	4.7	3.8	45

CONCLUSIONS

Sports performance in senior gymnasts requires high demands on their body due to high anaerobic load, which can reduce the quality of subsequent performance. The research included elite sports gymnasts representing Slovakia. The load after the floor exercise routine on the cardiovascular system reached a maximum value of 173 to 185 beats per minute and the blood lactate concentration value from 4.9 mmol.L⁻¹ po 8.6

mmol.L⁻¹ Kaufmann et al. (9) also found similar values, they monitored the response to load of 9 elite gymnasts aged 23.2 ± 2.5 years after performing a floor routine. Their maximum heart rate was 186 ± 11 bpm, and the maximum blood lactate concentration reached 5.19 mmol.L⁻¹

In our research we used the inhalation of enriched oxygen or placebo after a specific exercise as an experimental stimulus. The results of our research indicate that targeted

inhalation of oxygen concentrates can help reduce the response of the cardiovascular system and metabolize lactate more rapidly after a specific anaerobic load. When comparing heart rate with immediate inhalation of enriched oxygen, the value decreased from the first minute in the recovery process. Also, the level of lactate in the blood was lower with inhalation of enriched oxygen, right at the 3rd minute of sampling compared to inhalation of placebo.

We found the positive influence of inhalation of oxygen concentrate on the immediate effect of loading the gymnast's organism in faster recovery and in a shortened time to readiness for the next maximum load.

We see this method of recovery in the regeneration process between repeated loads as a possibility to intensify the training process of top gymnasts.

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