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Impact assessment of saline aerosols on exercise capacity of athletes

Stirbu Cătălina [a] *, Stirbu Cătălin [a], Sandu Ion [c]

[a] Gh. Asachi Tehnical University of Iassy, Romania
[b] Al. I. Cuza University of Iassy, Romania
[c b] Al. I. Cuza University of Iassy, Romania

Abstract

The treatment in natural salt mines (speleotherapy) was known since a very long time ago; the miners and other persons involved in these activities might have known about the great effects of the microclimate within salt mines upon human health, long before they were described in a book published by a Polish doctor in 1843. The effectiveness of speleotherapy is associated with the unique cave microclimate; the sodium chloride aerosols represent the main curative factor. The saline aerosols are formed off the salt walls by convective diffusion.[1] Halotherapy is the natural therapy method which boroughs the main curative factor for speleotherapy, meaning the saline aerosol particles dispersed in the salt mine microclimate.[2]The salt room microclimate should have a constant humidity (a relative air humidity of 40-60%) and a temperature of 18-24º Celsius, as these parameters create favourable conditions for patients and they are a stable environment for aerosols.[3-4] The precinct should also ensure a stable environment, bacteria- and allergen-free; studies have shown that the microbial contamination during a halotherapy session is of 130-200 saprophyte microorganisms to 1m^3 of air (the WHO standards regarding air sterility are of › 300 microorganisms/1m^3 air). Thus, a 10-20 minutes break after each session is necessary to purify the air within the chamber.[1]

Keywords: saline aerosols, halotherapy, athletes, performances;

1. Introduction

1.1.The Benefices of Halotherapy

As concerns the breathing system of the person in the precinct of the salt room, there is a permanent high concentration of dry saline aerosols. This concentration is considered therapeutic if it exceeds 1mg/m^3. By inhaling these aerosols, the airways are "cleaned" of focuses of infection (staphylococci and streptococci) – present at adults and especially children –which trigger and maintain many respiratory conditions (in most cases with relapses, becoming chronic) and gradually lead to a decrease in the body immunity. Salt is bactericide by nature, not allowing the microbial cultures to develop, behaving like a disinfectant in most cases. Through the deposition or absorption of salt ions, both for the superior and the inferior airways, mostly in case of small aerosols, conjugated with the hygroscopic property, an effect of dilution of impurity or foreign matter depositions takes place (including microorganisms). These microorganisms lead to breathing disorders or dysfunctions, starting from simple hoarseness, and up to bronchitis and asthma. [1,6-8]

* Stirbu Catalina. Tel.: +40 722 565 969
E-mail address: freeina2004@yahoo.com

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The observations over time regarding the persons with breathing disorders showed that the respiratory tract mucus thickens when losing humidity and salt; the body cannot compensate the lack of necessary fluid and salt (especially Na+ ions). [8]

Through its electro-chemical properties, salt, and mostly saline ions, once deposed on the respiratory tract, not only eliminate bacteria and microorganisms, but also determine the emollition, liquefaction and fluidization of the mucus off the airways, thus extracting the foreign matters among the cilia within the micro-cavities of the respiratory tract, determining the progressive and long-term relief of breathing, the natural and easy expectoration, the elimination of allergen or bacterial matters through the reflex phenomena of coughing, nose secretions, expectorations, etc., characteristic symptoms for the airways' relief. [4-7]

1.2. Main Objective

The study concerns the adapting level of athletes' bodies and developing the effort capacity to natural saline underground factors, insufficiently valorised, or not properly used in sports, and elaborating effective halotherapy technologies

1.3. Hypothesis

We will try to extend the research referring to the effect of exposing athletes to saline aerosols, of adapting the cardiovascular system to effort and of improving the sports performances, as well as to the influence of halotherapy upon certain indices of the breathing system. Concretely, our hypothesis is that saline aerosols are effective in treating respiratory conditions, and we will try to prove that by exposing athletes' bodies to saline aerosols the respiratory and cardiovascular indices will improve, as well as athletes' performances.

Material and Methods

The study was carried on with a sample of 12 middle-distance runners, aged between 14 and 16. The assessment of their cardiovascular and respiratory functions will take place at the Laboratory of functional explorations, testing the effort capacity and evaluating the physical development within the Sports Clinic of Iaşi.

Within the research we will be monitoring the following factors:

- Respiratory indices: vital capacity (VC), maximum expiratory volume per second (MEVS), maximum ventilation (V max), peak expiratory flow (PEF);[5]
- cardiovascular indices: Blood pressure at rest (BP), heart rate at rest (HR);[4]
- cardiovascular indices during effort: the Martinet test (lab test) allows the momentary evaluation, and the evolution in time regarding the functional capacity of the cardiovascular system, being a useful means, often used in carrying on sports training [6-7]. The test proposed by Martinet assesses the cardiovascular response to low-intensity, standard, non-specific, cabinet, short-term effort.

The investigations concerning the respiratory and cardiovascular system took place after 21 days of salt therapy. The halotherapy was carried on in an air-proof chamber, providing a precinct with saline aerosols through domestic SALINE aerosol devices, produced by Biotehnic SA Buzău. The functioning principle of the device is forcing the air to pass through the NaCl recrystallized granules, leading to alterations in the air composition and quality due to salt nanodispersion, as air ions with negative charge. The chamber was clean, well ventilated, with comfortable temperature and humidity.[2]

There was a daily exposition after practices, as recovery period after the training effort. There was a gradual exposition to the saline aerosols – 20 minutes the first day, 25 minutes the second day, up to 60 minutes a day. The last four days the exposition was reduced by 5 minutes, thus avoiding the sudden interruption of the treatment. During the halotherapy session the subjects breathed normally, being relaxed, and the post-effort recovery had a total of 21 sessions per participant.

3. Results and Discussion

- **Respiratory parameters**

Stirbu Catalina. Tel.: +40 722 565 969
E-mail address: freeina2004@yahoo.com

Table 2. Proportion of subjects with alterations of respiratory parameters

Respiratory parameters	Initial test				Final test			
	Increase		Decrease		Increase		Decrease	
	c.a.	%	c.a.	%	c.a.	%	c.a.	%
VC (litres)	6	50	6	50	11	91	1	9
MEVS (l/s)	9	75	3	25	12	100	–	–
V max. (l/min)	9	75	3	25	12	100	–	–
PEF (l/s)	8	67	4	33	11	87.5	1	9

Before halotherapy, half of the subjects had higher values of vital capacity, compared to the normal one, and the other half – lower values. After halotherapy the percentage of those with higher vital capacity increased (Table 2).

The same positive aspect applies to MEVS and V max.: after the treatment all the subjects presented increased values.

Of all the subjects, only one had a decrease in the VC and PEF after the treatment (possibly caused by a momentary indisposition).

Analysing the average values of the four breathing volumes, registered before and after the treatment, we see they increased after the halotherapy session attended by the subjects.

Table 3. Average values of respiratory indices

Respiratory indicators	Subjects	Initial test		Final test		P
		m	σ	m	σ	
VC (litres)	12	481.1	102.09	542.7	99.9	0,1494
MEVS (1/s)	12	425.3	68.4	484.8	74.4	0,0530
PEF (1/s)	12	8.1	1.25	10.3	1.20	0,0002
Vmax (1/min.)	12	1276.1	205.3	1454.6	223.3	0,0002

All subjects had higher values of the four respiratory volumes after halotherapy, with significant differences four three of them (Table 3). For the VC, with no significant differences, we should mention as favourable aspect the increase tendency.

- **Respiratory index**

The respiratory index is calculated with the following formula:

$$\mathbf{R = VC\ (cm) / G\ (kg) \times 1/10}$$

It is very useful to calculate the R, because we can easily orient towards the functional lung potential of the subject, thus being a compulsory functional parameter when determining the general biologic potential. In our case, the subjects scored over 6, meaning that they have a “very good” and “excellent” respiratory index. We should also stress the fact that, after the halotherapy treatment, there was an increase in the percentage of subjects who scored over 8 – the maximum score (Table 4).

Table 4. The subjects’ scores within the respiratory index scale

1 Stirbu Catalina. Tel.: +40 722 565 969
E-mail address: freeina2004@yahoo.com

Score	Initial test		Final test	
	c.a.	%	c.a.	%
Low (0-4)	–	–	–	–
Average (4-5)	–	–	–	–
Good (5-6)	–	–	–	–
Very good (6-8)	8	67	3	25
Excellent (over 8)	4	33	9	75
Total	12	100	12	100

- **Cardiovascular indices**

Table 5. Assessment of the cardiovascular system – initial and final test

	Heart rate at rest	Systolic BP at rest	Diastolic BP at rest
Initial test	71.30	118	67.9
Final test	69.12	116.5	66.6
Reference values	60-90 b/min	100-140 mmHg	60-90 mmHg

The assessment of the cardiovascular system at rest is very important during the medical examination because we can detect problems that would become acute during sports effort. We followed the heart rate at rest, which was within the normal rates approved by WHO. The rest bradycardia was registered at athletes with increased sports value, the average value, towards the inferior limit of heart rate, being the expression of the bio-positive adaptation to effort, which means an economical work of the heart at rest. Bradycardia in case of athletes is secondary to the increase in the systolic volume, allowing a constant, basic heart debit.[8]

WHO admits the following values of blood pressure at rest: BP max. 100-140 mmHg; BP min. 60-90 mmHg; differential BP 40-50 mmHg. and average BP of 90-100 mmHg., for both athletes and non-athletes . Blood pressure at rest, in case of human subjects within our research, registered values within the range approved by WHO.

- **Cardiovascular indices during effort**

Table 6. The Martinet test– initial and final test – average values of heart rate

	Clinostatism	Orthostatism	Effort	Post effort 1 min	Post effort 3 min	Post effort 5 min	Dorgo index
Initial test	64.7	73.4	107.3	89.6	64.6	64.6	-1.66
Final test	60.3	70.5	103.8	84.71	60.3	60.3	-3.43
Reference values	60-90 b/min	+ 10-12 b/min					B (-5-0)

The initial Martinet test indicated normal values of heart rate at rest, between 60 and 90 beats/minute. There were values of 60- 80 beats/minute in clinostatim, and in orthostatism the average values of heart rate indicated an increase by 10-12 beats/minute.[5-9]

The values of post-effort heart rate registered a 40-50%, increase, without exceeding 120 beats/minute. The HR values came back to normal three minutes post-effort in case of all the athletes, which shows a good functional state.

The Dorgo index of recovery was calculated at the end of the test, using the average HR values. The index had values between -2.05 and -0.01, with a -1.66 average; the GOOD qualifier [4-6].

The final Martinet test showed an improvement of heart rate at rest by 5-10 beats/minute, with values between 60 and 75 beats/minute. The average values of post-effort heart rate have also improved – 98-108 beats/minute, without exceeding 120 beats/minute.

The Dorgo index of recovery, calculated for average HR vales during the intermediary tests, was also positively altered, with values between -3.95 and 1.46, with GOOD qualifier.

The cardiovascular regulation tests are indicators of body adaptation to effort, and only indirectly of the effort capacity, allowing to assess the effectiveness of training methods used for a certain amount of time [6]. The

Stirbu Catalina. Tel.: +40 722 565 969
E-mail address: freeina2004@yahoo.com

quality of cardiovascular regulation is the better, the lower the heart rate and blood pressure values on the same effort scale, the sooner values at rest come back to normal, and if the Dorgo values are negative [7].

4. Conclusions

- After the halotherapy treatment, there was an increase in the respiratory volumes (VC, MEVS, V max., PEF) for all subjects investigated. There was also an increase in the percentage of subjects with "excellent" respiratory index
- As concerns the breathing system, there was an improvement in the breathing mechanics, as well as an increase in the oxygen saturation of arterial blood and in the resistance to apnea and hypoxia.
- Due to the recovery, which took place in mediums with saline aerosols, the breathing was more effective, both regarding he gaseous exchanges, and using tissue-level oxygen.
- The assessment of standard cardiovascular system during effort, the Martinet test, indicated better values during the final tests, and the cardiovascular assessment tests are indicators of body adaptation to effort and only indirectly of the effort capacity, allowing to assess the effectiveness of training methods used for a certain amount of time.
- We have also noticed a decrease in the heart rate and breathing rate during the training session effort, which was possible due the cardiovascular adaptation and regulation of athletes' organism.

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1 Stirbu Catalina. Tel.: +40 722 565 969
E-mail address: freeina2004@yahoo.com