THE EFFECT OF IONISED AIR ON WORK CAPACITY AND VITAMIN METABOLISM

By Prof. A.A. Minkh, Corresponding Member of the USSR Academy of Medical Sciences

(Chair of Hygiene at the Central Institute of Physical Culture and Training)

The task of hygiene, apart from sanitation of the conditions of the external medium, is to work out measures of active influence on the organism helping to increase work capacity and speed up rehabilitation processes after work. In this connection, we have conducted observations over the effect of artificially ionised air of a negative charge sign on the physical work capacity of healthy people, students of the Institute of Physical Culture and Training systematically engaging in sports (A.A. Minkh, M.A. Vytchikova, G.I. Nikiforova).

A similar research was earlier carried out by L.M. Lepekhina who studied the effect of ionised air produced with the aid of a radioactive ioniser on the work capacity of sportsmen. The sessions of aeroion inhalation were prescribed immediately before physical exercises, and in each session the sportsmen received 6 to 12 thousand million aeroions of one or another sign of charge. As a result, there was established a stimulating effect of positive ions on the work capacity of sportsmen making strength exercises (weight lifting) and undergoing speed tensions (exercises on stationary cycle with submaximal intensity). In these experimental conditions, negative ions had no favourable effect. N.N. Khavina, studying the effect of ionised air on the muscular activity of man, used an ergograph making the subjects under examination lift with a finger load of 3 to 5 kg. at a rate of one movement per second until complete fatigue immediately after a session where for 10 minutes they inhaled highly ionised air - from 100,000 to 1,000,000 aeroions in 1 cm.3 of air. Consequently, in each of these sessions the examined subjects received a much larger dose of aeroions than in the experiments of L.M. Lepekhina. It was found that in the given high concentrations negative ions produce a positive effect accelerating the formation of the motor dominant. As a rule the duration of work on the ergograph after the inhalation of negative ions increased to a much greater extent than in control experiments. In some subjects under examination there was observed a two-phase effect of aeroions: first, their work capacity decreased, the duration of work became shorter, but soon it grew even higher than the results of the control experiments. An increase in the duration of work had a typical reflection in an electroencephalogram and an electromyogram. The author believes that the employed dose of negative ions facilitates the creation of an optimal level of excitability and lability in the motor centres.

As distinct from the above-mentioned investigations, in our observations the sessions of inhalation of ionised air were not directly connected with the physical work performed; the sessions were held in the morning for 25 days, and their effect was determined by a number of physiological investigations made three times a week before aeroionisation sessions. A
radioactive ioniser producing 1.5 million light negative ions in 1 cm.3 of air was used as the source of the aeroions. The duration of aeroionisation sessions was 15 minutes, and in each session the studied subjects received 200 thousand million negative ions.

In the first series of experiments, observations were carried out on 24 students of great skill in sports gymnastics. Physiological investigations were accompanied by control, that is the same studies were made on a group of subjects who were not subjected to treatment with ionised air, of which fact that they did not know (quasi-aeroionisation). Before starting the study of the effect of ionised air, preliminary investigations were made for a week with the object of receiving initial data on the adopted physiological indices. Then, aeroionisation sessions were started, and their effect on the organism was observed by means of repeated physiological investigations. The experimental data cited below give the physiological changes noted in 9 to 10 days after aeroionisation sessions, and also those changes that were noted in 25 to 26 days. The method of variation statistics was used in processing the data obtained, and the difference of the obtained values proved authentic in all cases.

The results of the studies have shown, above all, that under the effect of daily session of inhalation of highly ionised air of negative polarity, there is considerable improvement in the general tone, cheerfulness, energy, good sleep and appetite. The effect on arterial pressure, the pulse rate and respiration proved to be insignificant and has no practical importance. Slight shifts were also noted in the growth of the muscular strength of hands determined with the aid of an ordinary dynamometer: after 9 to 10 days of aeroionisation sessions the muscular strength of the hands had increased 5.6 per cent on the average and remained at the same level during all the subsequent 16 days of application of negative aeroionisation sessions.

Contrary to this, there was a considerable increase in endurance to static work which was determined with the aid of a modified dynamometer registering the time of keeping the instrument in a compressed state (the pointer of the dynamometer after its compression is fixed on a scale division equal to a half of the instrument's maximal compression). The results of this investigation are shown in Fig. 1 in which it can be seen that during the first 9 days of aeroionisation sessions endurance to static work had practically no change, whereas by the end of the experimental period, that is in 25 days, it grew by 100 seconds which is 46 per cent on the average. The noted increase is endurance to static work should be recognised as considerable, especially against the background of the results obtained in the control group where the given index proved at the end of the experiments lower than in the beginning.

Just as favourable results have been obtained with regard to the effect of aeroionisation sessions on endurance to dynamic work. Used as a test in this case was running on one spot at a speed of 180 steps per minute until complete fatigue. The results of the studies are shown in Fig. 2 from which it follows that after 9 days of aeroionisation sessions endurance to dynamic work increased on the average by 5 minutes 47 seconds, that is by 59.5 per cent, and on the 25th day - by 15 minutes 16 seconds, that is by 87 per cent. In the given observations, the experiments were staged only
after 9 to 25 days of aeroionisation sessions, and no control experiments were made.

With the object of characterising the state of the central nervous system, determination was made of the duration of the latent period of the motor reaction in response to visual irritations. This index is widely used in sporting practice, and it has been established that with the progress in the training trim of the sportsman the motor reaction of the sportsman becomes shorter and more accurate. It was found in our observations that during all the experimental period when all of the girl students had regular spells of sporting gymnastics all of them exhibited by the end of the test period a reduction in the latent period of the motor reaction, but to a greater extent in those who had been subjected to negative aeroionisation. Thus, in the control group the duration of the latent period of the motor reaction shortened by the end of the test period by 11 milliseconds on the average, and in the group subjected to aeroionisation sessions - by 22 milliseconds. The shortening of the latent period of the motor reaction attests to an increased excitability of the motor apparatus and, indirectly, to the mobility of nervous processes.

In the second series of experiments, the effect of negatively ionised air was tested in similar conditions on 18 girl students highly skilled in track and field. The effect of aeroionisation sessions on the general tone and the basic physiological functions proved to be the same as in the previous experiment. The muscular strength of the hands in the first 9 days of application of aeroionisation had practically no change, whereas on the 25th day it grew by 16 per cent; in the control group the strength indices also grew but to a lesser extent - 11 per cent.

Endurance to static work increased in the experimental group during the first 9 days of aeroionisation by 33 per cent on the average, and in the subsequent 16 days - by 192 per cent, and it remained increased on the average by 148 per cent during the traced 10 days after cessation of the aeroionisation sessions; in the control group, endurance did not change in the first period and then increased by 40 and 30 per cent respectively.

Endurance to dynamic work was determined in the present observations by means of exercises on a cycle-ergometer, and it was found that after 9 days of the application of aeroionisation it grew on the average by 86 per cent, and in the following 16 days - by 240 per cent and remained increased during the ten traced days after the end of the test period by 38 per cent on the average. In the control group the increase of endurance was accordingly 8, 24 and 7 per cent.

The duration of the latent period of the motor reaction under the effect of aeroionisation became less in the experimental group; in 9 days - 13 per cent on the average, in 25 days - by 16 per cent, and remained at this level during the traced ten days after completion of the aeroionisation sessions. In the control group, the latent period of the motor reaction, on the contrary, became longer by 0.7 to 1.5 per cent and only in the last 10 days of the test period shortened by 4.5 per cent on the average.

Besides that, this experiment was used to determine the ability to keep equilibrium in positions of varying difficulty and it was established that this ability grows under the effect of aeroionisation sessions: by 370 to
393 per cent on the average after 9 days, by 145 to 333 per cent in the following 16 days and surpasses the initial data by 115 to 295 per cent during the traced 7 days after the end of aeroionisation sessions. In the control group, in position of lesser difficulty, the time of the preservation of balance increased by 58-76, 80-82, and 53-132 respectively; in positions of the greatest difficulty it proved to be less than the initial values.

Thus, the observations conducted show that light negative ions have a positive effect on some indices of physical work capacity. A particularly marked increase is to be seen in endurance to static and dynamic work.

In connection with the problem of increasing the work capacity of sportsmen a study was made in our laboratory of the vitaminogenous effect of negatively ionised air.

In sports exercises vitamin requirements grow sharply, and to ensure them, as well as to prevent fatigue and increase work capacity, one has to resort to an additional taking of large doses of separate vitamins, primarily vitamins C and B1. Unilateral vitaminisation, however, cannot be recognised quite rational, since the optimal quantitative balance between separate vitamins and other food substances may be upset. Therefore, it is of practical interest to find means regulating the expenditure of vitamins and permitting a reduction in the rate of their additional administration. By the data of Japanese authors, Kimura and others, negatively ionised air has an anti-scurvy effect checking the development of scurvy in guinea pigs fed with food deprived of vitamin C and also having a favourable effect on pigeons in experimentally induced avitaminosis B1.

The observations were made on the same two groups of girl students - gymnasts and track and field athletes. The same radio active ioniser was used, and aeroionisation sessions were held daily for 15 minutes during 25 days. The order of the experiments was as follows: in the first 7 days of the test period no aeroionisation was employed, in the following 9 days all the subjects were subjected to aeroionisation treatment, and in the subsequent 16 days one half of the group underwent aeroionisation sessions, and the other half was besides given preparations of vitamin B1 in a daily dose of 10mg., vitamin B2 in a dose of 2mg., vitamin C in a dose of 100mg and vitamin A in a dose of 1mg. The control group received quasi-aeroionisation treatment and sour water passes as a vitamin solution. All the subjects under examination received the same food in sufficient quantity and has the same daily routine. During the entire test period, including the first 7 days before prescription of aeroionisation sessions, in all of the subjects under examination three to four times a week in the morning, before taking food and before aeroionisation sessions, determination was made of the content of vitamins B1, B2 and N1-methylnicotinomide in the urine and of pyrotaaric acid and vitamin C in the urine and blood. The results of the investigations were processed by the variation-statistical method and the difference of the obtained values with one exception (see below) proved authentic.

The investigations conducted have proved that in the subjects examined before aeroionisation sessions there was noted a deficiency of the above mentioned vitamins soluble in water.

The effect of aeroionisation sessions discovered in the first series of
As can be seen in Fig. 3, the vitamin B1 content of the morning portion of urine was on the average 6.2 g per hour during the first week of the test period (before aeroionisation sessions). The excretion of vitamin B1 with urine normally fluctuates in adult people between 5 and 15 g per hour (Kark, Schigel). Thus, the level of vitamin content was somewhat higher than the lower limit of the normal. It increases after aeroionisation sessions as follows: after 9 days up to 8.3 g per hour on the average, and after 25 days - up to 10.8 g per hour. Those who apart from aeroionisation treatment received a vitamin complex had the level of the vitamin B1 content of the urine increased up to 15.2 g per hour.

The content of the pyrotartaric acid permits to ascertain indirectly the vitamin B1 metabolism. During the first (control) week the quantity of pyrotartaric acid in the morning portion of urine was on the average 6.7 mg per hour against the ordinary amount of 0.8 - 1.0 mg per hour observed in practically healthy people not engaging in hard physical work. Consequently, in the subjects we were examining there was observed a considerable accumulation of pyrotartaric acid. In 9 days of aeroionisation sessions its content reduced on the average down to 4.1 mg per hour, and in the following 16 days - down to 3.9 mg per hour. The simultaneous administration of vitamins in the final period of experiments produced an even greater reduction in the concentrations of pyrotartaric acid in the urine -- down to 3.2 mg per hour.

The amount of pyrotartaric acid in the blood prior to aeroionisation sessions was on the average 5.31 mg% with the normal of 0.6-2.0 mg%. The use of aeroionisation caused a slight reduction in the content of pyrotartaric acid in the blood: after 9 days - down to 4.29 mg% on the average, and in the following 16 days - down to 4.31 mg%. The taking of a vitamin complex in the past 16 days of the test period, simultaneously with aeroionisation, decreased the concentration of pyrotartaric acid in the blood on average down to 3.78 mg%.

The data obtained indicate that the daily sessions of negative aeroionisation increase the excretion of vitamin B1 with urine and reduce the content of pyrotartaric acid in the urine and in the blood. Consequently, ionised air has a certain normalising effect on vitamin B1 metabolism in the organism. An additional administration of the vitamin complex, including vitamin B1, increases this effect still further.

The results of determination of other vitamins are given in Fig. 4. It appears that the concentration of vitamin B1 in the urine during the first control week was on the average 11.9 g per hour, that is somewhat lower than the standard indicated by Schigel (14-30 g per hour in the morning portion of urine). Under the effect of aeroionisation sessions the content of vitamin B2 (riboflavin) grew after 9 days up to 14.5 g per hour on the average, and after the following 16 days - up to 23.7 g per hour. The administration of the vitamin complex including vitamin B2 largely intensified the normalising effect of aeroionisation and brought the level of riboflavin content in the urine to 38.8 g per hour on the average. Thus, negatively ionised air produced on vitamin B1 metabolism.
The content of N1-methylnicotinamide in the morning portion of urine before aeroionisation sessions was equal on the average to 0.49mg. per hour which accords with the standard given by Kark (0.4-0.5mg. per hour). Under the effect of aeroionisation sessions the content of N1-methylnicotinamide in the urine increased: in the first 9 days - up to 0.57mg. per hour on the average, and in the following 16 days - up to 0.73mg. per hour. The additional administration of a vitamin complex containing no nicotinic acid increased the concentration of N1-methylnicotinamide in the urine up to 1.0mg. per hour on the average. The cited data indicate that the content of N1-methylnicotinamide in the urine, being within the normal limits, changed very insignificantly under the effect of aeroionisation and an additional taking of vitamins, but still this change was in the direction of an increase in the concentration of the given index.

Determinations of the content of vitamin C in the morning portion of urine have shown that the average values of this vitamin throughout the entire test period, both before the aeroionisation sessions and after them, and even after an additional administration of ascorbic acid, were below the average standard established by Zheleznykova and others in all the subjects under examination (0.8mg. per hour).

thus, before aeroionisation the average vitamin C content of the urine was 0.53mg. per hour, after 9 days of aeroionisation treatment - 0.46mg. per hour, after 16 days of aeroionisation treatment alone - 0.63mg. per hour, and in combination with an additional administration of ascorbic acid - 0.71mg. per hour.

The results of the determination of vitamin C in the blood did not correlate with the just cited data referring to the urine. Thus, the average vitamin content of the blood aeroionisation sessions was 1.41mg%, that is, it corresponded with the normal (0.8 - 1.2mg%). After 9 days of aeroionisation the vitamin C concentration in the blood increased on the average up to 1.33mg% (the difference is not authentic!) and in the following 16 days of aeroionisation - up to 1.87mg%; an additional administration of vitamin C during the above mentioned 16 days of aeroionisation increased the ascorbic acid content of the blood up to 2.55mg% on the average.

The vitamin C content of the blood is a more reliable index of sufficiency of this vitamin in the organism, and therefore, preference should be given to the results of the latter investigation; one should also presume that negatively ionised air has also a favourable effect on vitamin C metabolism. It should be noted at the same time that the independent normalising effect of aeroionisation proved nearly just as effective as in the combined effect with an additional administration of vitamin C in a daily dose of 100mg.

The results of the second series of observations on girl students engaging in track and field corroborate the previous studies. We shall only note that the shifts in the content of vitamins which occurred under the effect of negative aeroionisation sessions were much greater, and this also referred to the results of determination of vitamin C content in the urine and, particularly, in the blood. Thus, the excretion of vitamin B1 with urine after 25 days of aeroionisation sessions increased on the average by 170.8 percent, the vitamin B2 content of the urine grew on the average by 248 per cent, the content of N1 methylnicotinamide in the urine - by 152
per cent, of vitamin C in the urine - 44 per cent, in the blood - by 188 per cent. Besides that, it has been established that after the completion of aeroionisation sessions a trend to a return of the cited indices to the initial values is observed right away; during the traced 8 days, however, the effect of aeroionisation was sufficiently noticeable.

In addition to the conducted series of experiments with light gaseous ions of a negative sign investigation was made of the effect on physical work capacity produced by aeroions obtained by the artificial pulverisation of distilled water (Lenard's effect). In the USSR this method of production of artificially ionised air was introduced in a number of medical institutions and is known under the name of hydroaeroionisation. In our experiments we used a hydroaeroioniser producing 300,000 light negative hydroaeroions in combination with a certain number of positive ions. The study was made on 16 students of the Institute of Physical Culture and Training (all men) specialising in swimming and boxing. The arrangement of the experiments was the same as in the first case.

The following has been established by the conducted study:

All of the subjects under examination, with rare exceptions noted a certain improvement in their general tone but almost as a rule complained about the unpleasant feeling of cold from the water pulverised during the aeroionisation sessions (the apparatus is set at a distance of 20cm from the face). No shifts in the pulse rate, respiration, and blood pressure under the effect of hydroaeroionisation (25 daily sessions of 15 minutes each) were discovered.

In the experiments with students engaging in swimming the muscular strength of the hands reduced under the effect of hydroaeroionisation by 9.5 per cent on the average, endurance to static work increased by 7 per cent, endurance to dynamic work - by 30 per cent, the latent period of the motor reaction shortened on the average by 9.7 per cent. In the control group of swimmers these indices were -9.9, +0.7, +20, -4 per cent respectively.

In the experiments with students going in for boxing, the muscular strength of hands decreased on the average by 16 per cent, endurance to static work grew by 16 per cent, the latent of the motor reaction became shorter by 23 per cent on average.

Comparing the results of these investigations with those obtained earlier in experiments with light gaseous negative ions with a considerably higher concentration of strictly unipolar ions, we can see that hydroaeroionisation in doses usually employed in medical practice has a much smaller stimulating effect on physical work capacity. It is necessary to note that in the latter experiment the participants were sportsmen, and in the former - sportswomen.

Negatively ionised air in doses employed in medical practice at a number of clinical and polyclinical institutions in the USSR can be used for increasing the physical work capacity and improving the general tome of healthy people. Light gaseous ions of a negative sign produce in this process a much more intensive effect compared with hydroaeroions obtained in the artificial pulverisation of distilled water. Negatively ionised air
also has a favourable normalising effect on the metabolism of vitamins B1, B2, PP and C regulating their increased consumption in sports exercises.

LITERATURE