# Influence of colored radiation on indicators of heart rate variability

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Along with therapy with pharmacological drugs, non-drug methods of treatment are increasingly used in medical practice, which are based on bioresonance interactions with natural or man-made factors, including light. Since the life processes of the human body obey general physical and chemical laws, are oscillatory - periodic - in nature, the frequency range of electromagnetic radiation is an important component in the regulation of physiological processes.

Heart rate variability (HRV) is one of the quantitative indicators of autonomic activity associated with the cardiovascular system. A relatively simple modification of the method popularized its application. With the advent of more and more devices that provide automatic measurement of HRV, a doctor has a fairly simple tool for solving both research and clinical problems [1, 3].

This report is based on the results of work in which, under the control of HRV indicators, the effect of blue and red colors on a person was studied.

## Materials and methods

We used a portable LED device for colored radiation with the following specifications: blue radiation wavelength 430 ± 30 nm, blue radiation power density not less than 0.7 and not more than 3.0 mW / cm2; red radiation wavelength 660 ± 15 nm, red radiation power density not less than 2.0 and not more than 8.0 mW / cm2. The frequency of repeated radiation pulses is 9 Hz. The irradiation area with a beam of the same color is not less than 1 cm2. HRV was recorded using the hardware-software complex "ORTO-EXPERT", Russia. The work presents the dynamics of the following indicators with reliable results:

HR - average heart rate;
IN - index of tension of regulatory systems (Si - stress index);
LF / HF - coefficient of vagosympathetic interaction or balance;
Mode - the initial value of the range of the most frequent RR intervals; AMo - amplitude of the mode - the number of values corresponding to the mode, expressed as a percentage;

SDNN - standard deviation of cardiointervals and its analogue indicator RMSSD;

X - variation range - the difference between the largest and the smallest duration of cardiointervals;

1K - reflects the influence of the central contour on the autonomous one;

PARS - an integral indicator of the activity of regulatory systems, reflecting the adaptive reserves of the subjects;

Evaluation of the parameters of the transient process - the transient process of the change in the heart rate during the transition from the horizontal position to the vertical position and the change in the spectrum of the cardiac rhythmogram are analyzed.

The study involved 27 people (men and women) aged 20 to 70 years, who consider themselves to be practically healthy. Using a portable color LED device, the light was directed to the antecubital fossa of the patient's right hand. Each recording of HRV indices was carried out for 2 minutes according to the scheme: 1 - reaching a state of rest, 2 - recording against the background of exposure to light, and 3 - recording after exposure to light. The reliability of data differences by Student's test, analysis of variance of repeated measurements and the correlation between the indicators were calculated using the BIOSTAT software package. Differences between the two mean values were considered significant at P 0.05. The deviation of the value of all measured HRV indices from

background data and between recording steps. The work presents the dynamics of indicators with reliable results.

Research results and discussion

The dynamics of indicators of heart rate variability under the influence of red is presented in table. one.

Table 1

Influence of red light (660 ± 15 nm) on HRV indices in the general group

| Indicators | Background | Action of light | After action colors |
|---|---|---|---|
| AMo-ort | 76.57 ± 5.09 | 69.57 ± 5.18<br>P = 0.178 | 66.36 ± 5.53<br>P = 0.010 |
| IN-ort | 748.5 ± 188.2 | 564.7 ± 148.8<br>P = 0.296 | 541.9 ± 153.1<br>P = 0.043 |
| Parameter estimation transition process | 2.643 ± 0.3867 | 2.571 ± 0.4156<br>P = 0.856 | 3.5 ± 0.3101<br>P = 0.028 |

In studies, a decrease in AMo-ort was noted, which indicates an increase in the activity of the parasympathetic nervous system after the action of the red color and a relatively weak centralization of heart rate control. The decrease in the stress index during the orthostatic test after exposure to the red color revealed in the study reflected a decrease in the tone of the sympathetic nervous system and confirmed the response of the AMo-ort indicator. In addition, in the general group, after the action of the red color, there was a change in the parameters of the transient process from a significantly increased reaction of the cardiovascular system to the orthostatic test (~ 3) to its decrease (~ 4), which corresponds to baroreflex regulation of heart activity (confirmed by analysis of variance of repeated measurements, P = 0.04).

[2]. And since the higher the baroreflex sensitivity, the stronger the reaction from the heart to changes in blood pressure (BP) and the faster the deviations of BP from the homeostatic level are compensated for, the effect of the red color, which reduces the response of the cardiovascular system to the orthostatic test, helps to slow down the return of blood pressure. within the framework of homeostasis. This reaction to red color should be especially considered in persons with hypertension and hypotension.

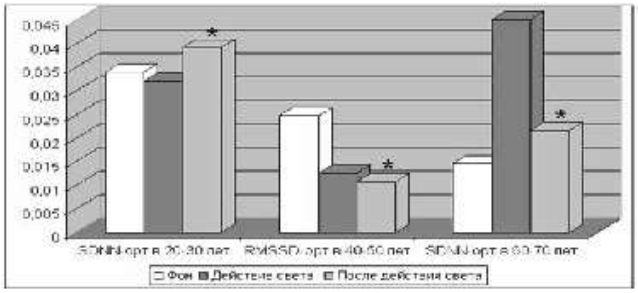
The influence of red in different age groups had its own characteristics in the manifestation of the dynamics of heart rate variability indices.

In the age group from 20 to 30 years after exposure to red light, the level of SDNN-ort increased from 0.034 ± 0.005 in the background data to 0.0392 ± 0.005 after exposure to red light (P = 0.010), which reflected a weakening of the effect on the sinus node of the sympathetic section. autonomic nervous system with orthostatic test. At the same time, the stress index during the orthostatic test (P = 0.023), the reaction of the cardiovascular system to the orthostatic test and the autonomic supply of the body (P = 0.047) decreased, which confirmed the reaction of the SDNN-ort. In addition, the influence of the red color contributed to a decrease in the Mode-rest index (P = 0.004), indicating the predominance of the autonomous circuit of heart rate regulation and an increase in the range of R – R intervals. In other words, after the action of the red color in young people, the influence of the vagus on the regulation of the heart rate was activated, in comparison with the initial state. Sympathetic impulses speed up the heart rate (shorten the cardiointervals), parasympathetic slows down (lengthen the cardiointervals). Therefore, caution should be exercised in prescribing red light to persons with cardiovascular diseases (including bradycardia).

In middle-aged people (40-50 years), there was an increase in the LF / HF index from 3.985 ± 1.54 in the background data to 6.775 ± 1.08 after the action of the red color (P = 0.027), which indicated the activation of the sympathetic nervous system against the background of the direct influence of the red color. In addition, in this group, there was a decrease in X-rest indices (R

= 0.035) and RMSSD-ort (P = 0.035) during the transition from the direct influence of the red color to its aftereffect. Both indicators (X and RMSSD - an analogue of the SDNN indicator) confirmed an increase in the sympathetic effect on the regulation of the heart rate, both at rest and during the orthostatic test. It should be remembered that an increase in the vagosympathetic interaction coefficient (LF / HF) of more than 2.5 and a decrease in the standard deviation (SDNN) of less than 20 ms are independent predictors of the development of cardiovascular complications and should be regarded as equivalent to target organ damage. The use of light can reveal the predictive value of some HRV indicators.

In the group of older people (60-70 years) at the time of the red color effect during the orthostatic test, the initial values of the range of the most frequently occurring R – R intervals decreased with the predominance of the autonomous circuit of the heart rate regulation ( Modort; P = 0.001). After the cessation of the effect of the red color, the variation difference between the largest and the smallest duration of cardiointervals in the orthostatic test in persons aged 60-70 increased. ( X-ort; P = 0.031). An increase in the SDNN-ort index from 0.0146 ± 0.003 in the background data to 0.0216 ± 0.003 after exposure to red color (P = 0.014) was within the framework of increased activity of the sympathetic nervous system in elderly people after exposure to red light. Dynamics of the SDNN-ort indicator in response to the action of red light in persons aged 60-70 years old was the opposite of people aged 20-30 years old (Fig. 1). And in middle-aged people (40-50 years), changes in the same indicator occupied, as it were, an average position between the dynamics of 20-30 and 60-70 years: with a gradual decline and transition to the reaction of older persons... In fig. 1 shows a tendency towards a decrease with age in the SDNN indicator and its analogue RMSSL in the orthostatic test, reflecting the total effect of the influence on the sinus node of the sympathetic and parasympathetic parts of the nervous system, that is, the influence of the central mechanisms of heart rate regulation decreases with age. The greatest suppression of the central control of the heart rate under the influence of red during the orthostatic test was manifested in middle age (40-50 years).




Rice. one.Dynamics of SDNN and RMSSD indicators (SDNN analogue) in response to red color (660 nm) in different age groups

After exposure to red light, individuals with a predominance of sympathetic regulation of the heart rhythm (sympathicotonia) showed a change in the autonomic supply of the body from excessive (2) to reduced (~ 3, P = 0.045). We observed a similar reaction in response to the action of red light in persons aged 20-30 years. In persons with a mixed tone of the autonomic nervous system (eutonia), there was a transition from almost satisfactory adaptation in the background functional state (~ 1) to unsatisfactory adaptation after exposure to the red color (~ 3, P <0.001).

The direct influence of the blue color on the HRV indices in the general group revealed an increase in the activity of the sympathetic division of the autonomic nervous system with the dominance of the central mechanisms of regulation of the heart rate at rest ( Rest mode, P = 0.037) and vagotonia with a predominance of the activity of the autonomous heart rate regulation circuit during the orthostatic test ( Mod-ort, P = 0.004). An increase in the 1K index from 0.7315 ± 0.06 to 0.8023 ± 0.04 (P = 0.035) confirmed the relationship between the circuits of heart rate regulation during the transition from the direct influence of blue to its aftereffect. Taking into account the relationship of the value of Mod with the circulatory system as a whole, it cannot be excluded that the results obtained indicate an improvement in the state of blood circulation in general at rest, but not with

orthostatic test. This state of affairs is not conducive to physical activity against the background of blue light.

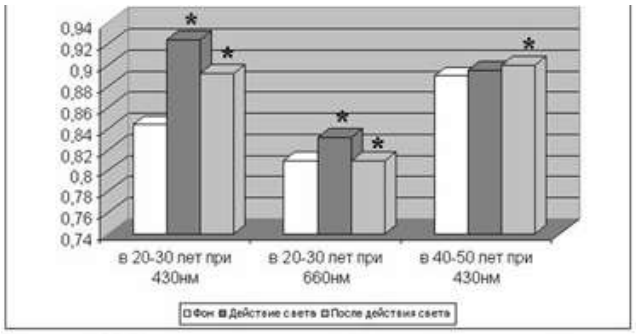
In persons aged 20–30 years, after exposure to blue, there was a decrease in heart rate and stress index at rest, which is observed when the tone of the vagus nerve was restored (Table 2). The dynamics of the RMSSD-rest, SDNN-rest, and Mode-rest indices indicated the dominance of the central mechanisms of heart rate regulation at rest after exposure to blue color.

table 2

Influence of blue color (430 ± 30 nm) on HRV indices in persons aged 20-30 years

| Indicators | Background | Action of light | After the action of the light |
|---|---|---|---|
| Heart rate rest | 70.02 ± 3.09 | 66.12 ± 2.76<br>P = 0.064 | 66.84 ± 3.2<br>P = 0.024 |
| IN-rest | 121.6 ± 12.31 | 103.7 ± 22.51<br>P = 0.253 | 91.2 ± 13.42<br>P = 0.009 |
| SDNN-rest | 0.0448 ± 0.004 | 0.0474 ± 0.005<br>P = 0.614 | 0.0508 ± 0.004<br>P = 0.028 |
| RMSSD-rest | 0.037 ± 0.005 | 0.0494 ± 0.009<br>P = 0.077 | 0.0514 ± 0.009<br>P = 0.033 |
| Peaceful fashion | 0.844 ± 0.04 | 0.924 ± 0.036<br>P = 0.004 | 0.892 ± 0.05<br>P = 0.022 |

In the age group of 40–50 years, during the transition from the direct effect of blue to its aftereffect, a decrease in the AMo-ort index from 71.5 ± 20.5 to 56.5 ± 20.5 (P <0.001) indicated an increase in the activity of the parasympathetic nervous system and the relatively weak centralization of heart rate control in the orthostatic test. At rest, the initial value of the range of the most frequently occurring R – R intervals (Modapokoy) under the direct action of blue increased in 40–50-year-old people, identical to the response at 20–30 years, but to a lesser extent. After the action of blue color in persons aged 40-50 years, the Mod-rest index continued to increase from 0.89 ± 0.02 to 0.9 ± 0.02 (P <0.001), that is, the central mechanisms of heart rate regulation continued to dominate, whereas in young people the range of cardiointervals decreased,




Rice. 2.Dynamics of the modality-rest indicator in response to the action of blue and red colors in different age groups

The dynamics of the PARS indicator indicated a significant tension of the adaptation mechanisms on the part of the cardiovascular system during the orthostatic test (P <0.001). This reaction to blue light is not conducive to physical activity.

In persons aged 60–70 years, against the background of the direct influence of blue color during the orthostatic test, there was a decrease in the Mod-ort indicator from 0.723 ± 0.06 to 0.705 ± 0.058 (P = 0.048), that is, the activity of the autonomous circuit of the heart rate regulation prevailed, as well as under the action of the red color. During the transition from the action of blue light to its aftereffect, the same indicator increased from 0.705 ± 0.058 to 0.7267 ± 0.06 (P = 0.01), which reflected the compensatory dominance of the central mechanisms of heart rate regulation.

After the action of blue in persons with a predominance (sympathicotonia) sympathetic regulation of the heart rate against the background of bradycardia, the following were identified:

one) restoration of the parameters of the transient process from decline reactions cordially vascular system for orthostatic test (4) to normal level (1, P < 0.001);

2) restoration of the PARS indicator from unsatisfactory adaptation to insignificant stress of adaptation mechanisms (according to analysis of variance of repeated measurements, P = 0.038), confirmed by a change in the functional state from unsatisfactory adaptation (~ 3) to practically satisfactory (~ 1, P <0.001).

In persons with a mixed tone of the autonomic nervous system (eutonia), there was a transition from a slight tension of adaptation mechanisms (~ 3) to a moderate and even significant tension of adaptation mechanisms after exposure to blue color (4.25 ± 0.478; P <0.001).

Thus, the obtained data and their analysis allow us to draw the following conclusions:

1. In a number of HRV indicators, an opposite reaction was revealed at 20-30 and at 60-70 years in response on the effect of color, and in persons aged 40–50 years, the dynamics of the same indicators is a transition from the reaction of young people to the response of 60–70 years old. In all age groups, the reaction to both red and blue is not conducive to physical activity.

2. With aging, the influence of the central mechanisms of regulation of the heart rate decreases. Red helped to suppress them, and blue led to their dominance. Both light wavelengths caused a pronounced reaction in persons aged 40–50 years: the greatest suppression by red light and progressive dominance of the central mechanisms of heart rate regulation under the influence of blue, in comparison with other age groups. In persons aged 60–70 years, against the background of the direct influence of both blue and red colors during the orthostatic test, the activity of the autonomous circuit of the heart rate regulation prevailed.

3. In persons with a predominance of sympathetic regulation of the heart rhythm (sympathicotonia) the red color reduced the vegetative supply of the organism. Whereas the blue color, even against the background of bradycardia, led to the restoration of the parameters of the transient process of the reaction of the cardiovascular system to the orthostatic test, the mechanisms of adaptation and the functional state to almost a normal level. The response to sympathicotonia is similar to that in persons aged 20–30 years.

4. In persons with a mixed tone of the autonomic nervous system (eutonia), the action is red and blue colors caused tension of adaptation mechanisms, which is identical to the reaction of persons aged 40–50 years.

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