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The influence of light on the occurrence and treatment of seasonal affective disorders

Magdalena Wasielewska
Nicolaus Copernicus University in Toruń Collegium Medicum in Bydgoszcz,ul. Jagiellońska 13-15, 85-067 Bydgoszcz, Major Pharmacy

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ABSTRACT
Light is a factor influencing the regulation of the secretion of transmitters in the human body. Light regulates the secretion of melatonin and serotonin in the pineal gland through various routes from the eye to the brain. Disturbed homeostasis of these two mediators directly influences the emergence of seasonal depression, which occurs most often in the autumn and winter period in Poland. The symptoms of seasonal depression are similar to regular depression, but unlike depression, it is characterized by increased appetite and periodicity. It may be caused by the problem of light transmittance through the retina of the eye, and disturbances in circadian rhythms. In 2001, new receptors in the eye were discovered - ipRGC. They contain the pigment melanopsin, which absorbs light falling on the retina of the eye, and then transmits the signal directly to the suprachiasmatic nucleus in the hypothalamus, from where the impulse travels to individual tissues and organs, causing a reaction. The color of the light determines the effect that this electromagnetic wave has on the human body. This fact was used in the treatment of seasonal depression. Recently, one of the most modern methods of treatment is phototherapy,based on the emission of photons by standardized lamps with a power of 2,500-10,000 lux on the retina of the eye, thanks to which there is an increase in the activity of the serotonin system in the brain and the regulation of biological rhythms.It does not cause side effects, is safe for children and the elderly and does not require large financial outlays.

Keywords: light; melatonin; suprachiasmatic nucleus; seasonal depression; phototherapy

I. INTRODUCTION

Light - a factor of the environment that accompanies man from the moment of birth to the end of his life. It is the benchmark by which we perform all activities. When it is bright, life goes on, we work, we act, we have the strength and energy to take on new challenges. When dusk falls in the evening and it gets dark, we become tired, sleepy, reflective, and at night we fall asleep, which is the time of regeneration of our body. It is no accident that the human circadian rhythm lasts approximately 24 hours. Among other things, body temperature, endocrine gland activity and blood pressure are regulated daily. In the last century, access to artificial lighting has become commonplace. Man began to be active at times when it was not possible in the past. Along with the enormous changes in man's lifestyle, the consequences had to come. People are overworked, sleepy and overloaded. They spend very little time outside, soaking up the sun's rays. [1] The worst situation is when, during autumn or winter, we spend most of the day indoors and the light intensity is too low. [2] It seems that in a certain group of people, most likely genetically predisposed, proper regulation of the biological clock requires greater intensity of lighting than is possible under natural conditions, in winter, indoors. [3,4] when during autumn or winter we spend most of the day indoors and the light intensity is too low. [2] It seems that in a certain group of people, most likely genetically predisposed, proper regulation of the biological clock requires greater intensity of lighting than is possible under natural conditions, in winter, indoors. [3,4] when during autumn or winter we spend most of the day indoors and the light intensity is too low. [2] It seems that in a certain group of people, most likely genetically predisposed, proper regulation of the biological clock requires greater intensity of lighting than is possible under natural conditions, in winter, indoors. [3,4]

Visible light

It is electromagnetic radiation with a wavelength in the range 380 - 780 nm. Waves in this range of lengths evoke visual impressions in the eye, hence the often used name - visible radiation. It carries a certain energy, which is supported by the theory of its wave-particle nature. [5] This energy reaches the body and affects its functioning both positively and negatively. One of

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the components of visible light is red light, which is largely present, for example, in a burning fire. Blue light also falls within the scope of visible light and many artificial light sources, e.g. computer or smartphone screens. The influence of visible radiation on humans is most often considered in the context of vision, but its impact on the human body is much wider,

Light-dependent hormone secretion

The participation of visible radiation in the stimulation and regulation of a number of physiological processes in the human body takes place, among others, on the hormonal path. Especially the pineal gland shows considerable sensitivity to light stimuli. The way to create the visual impression leads through the eye and the retina to the optic nerve,then through the optic junction to the optic tract and other brain structures, eventually reaching the visual cortex of the occipital lobe. However, some axons leave the optic junction to reach the suprachiasmatic nucleus in the hypothalamus, where there are junctions with the pineal gland.[6]

Non-visual information from the suprachiasmatic nucleus reaches the pineal gland, which secretes two hormones - melatonin and serotonin. [7, 8] Excessive melatonin secretion caused by long winter nights may in some people induce a constant feeling of drowsiness and fatigue. During the day, under the influence of ultraviolet radiation, the pineal gland secretes the melatonin prohormone - serotonin, which is a neurotransmitter that affects mood, sleep, sexual needs, impulsive behavior and appetite. [9] Arising from the amino acid provided with food - tryptophan, which is activated only under the influence of sunlight, its level largely depends on the length of the organism's exposure to light. Homeostasis of both neurotransmitters is essential for the proper functioning of the biological clock. [10]

Neurotransmitters such as norepinephrine, serotonin and dopamine, and hormones, including melatonin, are secreted according to the circadian rhythms. The suprachiasmatic nuclei modulate the daily noradrenergic activity of the bluish site, which is indirectly dependent on light. [11] In contrast, the serotonergic activity of the raphe nuclei, which is related to exercise, sleep, mealtimes and other social factors, provides light-independent stimulation of the suprachiasmatic nuclei. [12] Indirect action on these transmitters is part of the treatment of many mental disorders.

Seasonal Affective Disorder (SAD)

It is a disease very similar to major depression. It is characterized by the recurrence of depressive disorders, usually in autumn and winter, and their remission in spring and summer. Seasonally, there may appear unipolar disorders, i.e. recurrent depressive states, and bipolar disorders, i.e. recurrent depressions, usually in late autumn or winter, and manic periods - in spring and summer.

The phenomenon of winter depression was first described in the 20th century, because never before had such a large number of people (approx. 90%) stayed indoors most of the time. The fact indirectly confirming this hypothesis is the observation that in the group of people with winter depression there is a clear over-representation of people with higher education. [13]

Seasonal depression usually lasts from a few weeks to several months. The severity of symptoms is usually mild to moderate, less often severe. [14] The first episode of the disease usually occurs between the ages of 20 and 30. After the third decade of life, 30-40% of people develop a non-seasonal pattern of depression. The rest experience only mild symptoms or the disease recovers completely. Atypical symptoms of depression present in the early course of the disease are the best predictor of recurrence of seasonal symptoms. [15]

The etiopathogenesis of seasonal depression focuses on a number of hypotheses. One of them is the insufficient amount of sunlight reaching the retina of the eye, decreased sensitivity of the retina to light, and disturbed circadian rhythms. In the autumn and winter period, the lack of sunlight in the morning hours may disrupt the rhythm of hormone secretion and diversify the activity of neurotransmitters. Altering the concentration of chemicals in the brain, in turn, is the direct cause of the depressed mood that is typical of depression. Sunlight also regulates the so-called biological rhythms. circadian. It can speed up or slow down periods of rest and wakefulness depending on the duration of exposure. Insufficient light during winter disrupts the natural sleep-wake cycle. In the dark during the night, the pineal gland releases the melatonin hormone which, apart from light, is involved in regulating the circadian rhythm. In the autumn and winter season, a shorter day, a reduced amount of light increases the production of this hormone. The increased amount of melatonin in the body causes the symptoms of seasonal depression.

Seasonal depression symptoms

Characteristic for this disease entity are vegetative symptoms closely related to the autumn

and winter season. There is excessive drowsiness, fatigue, and decreased motivation. [16, 17, 18] An atypical symptom that distinguishes winter depression from the standard one is increased appetite and weight gain. [19] The patient feels an irresistible craving for sweets or other high-calorie foods, especially in the evening or at night. Increasing the concentration of carbohydrates in the blood increases the secretion of serotonin, which the body tries to mitigate the negative effects of excess melatonin. Therefore, the disease picture often shows a significant increase in body weight in the winter. [20] The most common types of depression are loss of appetite and weight loss. [21]

Seasonal depression therapy

Patients diagnosed with seasonal depression rarely require hospitalization. The risk of developing symptoms of psychosis or suicidal thoughts is also small.[15] Nevertheless, the disease is serious. It causes difficulties in fulfilling the current social functions, professional functioning, problems in relations with others. There are many psychological, psychotherapeutic and psychiatric therapies available. [22] However, seasonal affective disorders are resistant to treatment with common antidepressants and have many serious side effects and drug interactions. Therefore, it would be worth focusing on a more natural solution to this problem. One of the causes of winter depression is the lack of sufficient light exposure.

The influence of the color of light on the human body

The sun changes the spectrum of its radiation during the day. Shortly before sunset, the greatest amount of red light is, which regenerates the thyroid gland, soothes inflammation and lowers cortisol levels, keeping us relaxed. Blue light, on the other hand, works the other way around - it signals the mobilization of the body and increases the level of cortisoland inhibits the secretion of melatonin, preparing the body for action.

Positive aspects of the influence of blue light on the body

In 2001, a new receptor was discovered in the human eye - ipRGC - the intrinsically photosensitive retinal ganglion cell.[23] This discovery changed the approach to the topic of inhibition of melatonin secretion and its influence on biological rhythm. [24] These cells have direct neuronal connections to the areas of the brain related to the regulation of the level of arousal. The pigment - melanopsin - is the most sensitive to the waves of the 480 nm light spectrum. [25] It absorbs light falling on the retina of the eye, and then transmits a signal to the suprachiasmatic nucleus in the hypothalamus, from where the impulse travels to individual tissues and organs, triggering a reaction. [26] Thus, blue light has a stimulating effect, increases vitality, the ability to concentrate and the body's efficiency, allows for deeper sleep and better well-being, fights acne and prevents skin inflammation, and counteracts depressive moods, especially seasonal ones. However, when such light reaches the eye when it should be dark, it acts as a stressor on the body and can cause multi-system problems. So the idea was born to use radiation as a form of biological treatment in psychiatry.

Phototherapy

The term "phototherapy" in the treatment of SAD was first described by NE Rosenthal in 1984 [27]. Sunlight has an intensity of 100,000 lux. An average lamp in a room has an intensity of 500 lux. The effectiveness of light treatment depends on the duration of exposure to light and its intensity. This means that the higher the light intensity is used, the shorter the sessions can be. It is believed that the minimum light intensity should be at least 2,500 lux directly into the eyes of the patient to obtain the antidepressant effect. [28] Such sessions usually last 2 hours.

Phototherapy is a modern form of treatment based on the emission of photons by standardized lamps with a power of 2,500-10,000 lux on the retina of the eye, thanks to which the activity of the serotonin system in the brain is increased and biological rhythms are regulated. [29]

A report from the literature showed that phototherapy, as the method of choice used in seasonal affective disorder, is more effective in younger people. Elderly depressed people may have limited light transmittance to the eye due to age-related changes.

A better effect of morning sessions than evening sessions was shown. [30] Treatment usually lasts for 5 to 14 days. [31] This method is also safe for children and the elderly. [32] Due to the low cost of the treatment, easy application and relative safety, phototherapy was quickly applied in the treatment of depressive disorders.

In the controlled therapies carried out at the Institute of Psychiatry and Neurology in Warsaw in 2015, a lamp generating light with an intensity of 10,000 lux was used. The exposure time was 30 minutes. The irradiation procedure was performed daily in the morning for the next 14 days. Twelve patients with seasonal depression

were treated, whose depression intensity before phototherapy was 17.3 ± 4.9 on the Hamilton scale. After a two-week cycle of morning irradiation, the intensity of depression decreased to 5.1 ± 5.9 on the Hamilton scale. [33]

II. SUMMARY

Exposure to both sunlight and artificial light of appropriate intensity plays a key role in the proper secretion of neurotransmitters and hormones. Their inadequate level or timing of secretion lead to mental disorders, for example, seasonal depression. To avoid exposure to this type of disease, everyone should spend more time outdoors, exposing their body to sunlight, and use lighting during the day, not at night, when our body secretes melatonin and is getting ready for sleep. It is especially important to ensure good lighting conditions in the autumn and winter season, when there is less sunlight. In the case of people suffering from seasonal affective disorders, phototherapy is a good method of treatment, which gives beneficial effects and is safe for the patient,

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