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THE EFFECT OF ULTRAVIOLET RADIATION ON SEROTONIN LEVELS: A META-ANALYSIS

ЗНАЧЕННЯ УЛЬТРАФІОЛЕТОВОГО ВИПРОМІНЮВАННЯ НА РІВЕНЬ СЕРОТОНІНУ: МЕТААНАЛІЗ

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Abstract. *Relevant studies have demonstrated a link between depression and ultraviolet B, but a direct link between them has yet to be investigated.*

Objective: To analyze the available studies on the effect of ultraviolet radiation on serotonin levels in the human body and identify general patterns, dependencies and potential clinical implications.

Methodology: bibliographic analysis, meta-analysis

Results: Several dozen available studies indicate that the existing effect of ultraviolet radiation on serotonin synthesis, in some subgroups of studied and cultured human keratinocytes and melanocytes, in the latter UV inhibited the synthesis of dopamine, which is an inhibitor of serotonin synthesis. And in experiments on mice and humans, an antidepressant effect was shown. This is explained by the fact that UV can cause non-enzymatic transformation of tryptophan into hydroxytryptophan, a serotonin mediator.

UV rays cause electrical, chemical and biological signals to be sent to the brain, endocrine and immune systems, as well as other central organs, which together regulate the body's homeostasis.

Conclusion: The available studies do not allow us to say unequivocally that UV increases serotonin synthesis in humans, but does not unequivocally affect mood deterioration, more information is needed in the future, namely randomized controlled trials and specifically the determination of DOPA decarboxylase, to clarify the role of dopamine in the process of serotonin regulation during the action of ultraviolet radiation.

Keywords: *serotonin, ultraviolet radiation, meta-analysis.*

Introduction.

Depression is a common mental disorder affecting over 264 million people worldwide. Anxiety, diabetes, Alzheimer’s disease, myocardial infarction, and cancer, among other conditions, are known to increase the risk of depression. Exposure to ultraviolet B (UVB) radiation can increase a person’s serotonin levels. The vitamin D pathway is one mechanism by which ultraviolet light absorbed by the skin can affect mood; however, UVB exposure is known to increase the risk of cancer. Studies have shown a link between depression and UVB, but a direct link between the two remains

to be investigated. [1].

The traditional view that has dominated neuroscience for decades has been that serotonin plays a key role in mood regulation and that its imbalance is a major cause of depressive disorders. However, a review published in Nature (2022) [2] has questioned this association, showing, through metabolite profiling, genotype analysis and comparison, that serotonin levels have no effect on the development of depression or negative mood. A comprehensive review of the main lines of research on serotonin shows that there is no convincing evidence that depression is associated with or caused by low serotonin concentrations or activity. High-quality, powerful genetic studies have effectively ruled out an association between genotypes associated with the serotonin system and depression, including a putative interaction with stress. Weak evidence from some studies of serotonin 5-HT1A receptors and serotonin levels suggests a possible association between increased serotonin activity and depression. However, these results are likely to have been influenced by prior use of antidepressants and their effects on the serotonin system. The effects of tryptophan deficiency in some cross-sectional studies of depressed individuals may also be mediated by antidepressants, although this has not always been found. This fact has led us to reconsider the role of serotonin, particularly its interaction with other biological and environmental factors.

A divergent validity analysis showed that cultural values and allele frequency of the serotonin transporter gene predict the global prevalence of anxiety and mood disorders, but not impulse control and substance abuse. If current cross-national estimates of the prevalence of mental health disorders were subject to obvious response errors, it is likely that they would influence cross-national estimates of the prevalence of all disorders, not just anxiety and mood disorders [3].

Since serotonin levels vary with season and geography, the question arises whether UV radiation may be a factor in regulating serotonin processes, even if its effect on mood is mediated or indirect.

The study of the effects of UV radiation on serotonin is relevant not only for a deeper understanding of its biological role, but also for the development of new approaches in the treatment of conditions associated with seasonal disorders or

physiological disorders.

Objective: To analyze the available studies on the effect of ultraviolet radiation on serotonin levels in the human body and identify general patterns, dependencies and potential clinical implications.

Methodology: bibliographic analysis, meta-analysis

Results: Several dozen available studies indicate that the existing effect of ultraviolet radiation on serotonin synthesis, in some subgroups [4] of studied and cultured human keratinocytes and melanocytes, in the latter UV inhibited the synthesis of dopamine, which is an inhibitor of serotonin synthesis [5]. And in experiments on mice [6] and humans [7] an antidepressant effect was shown. This is explained by the fact that UV can cause non-enzymatic transformation of tryptophan into hydroxytryptophan, a serotonin mediator [8].

However, it is important to note that despite the inhibition of dopamine synthesis [5], the production of dioxyphenylalanine [9], which is a precursor not only of melanin, but also of dopamine itself, increased due to decarboxylation. This makes the claim about the reduction of the serotonin inhibitor in the form of dopamine questionable.

No less significant is the methodology of the available studies, more precisely, studies conducted on animals and cell cultures are very rarely reproduced, sometimes < 1% [10], and those with humans [7] have a small sample of 20 people, without specifying the selection principles, weak statistical processing and lack of control.

If we talk about mood, then if we take the hypothesis of serotonin synthesis in the skin under the influence of UV as true, then there will be no effect, because 95% of serotonin is synthesized in the intestines. Thus, understanding the effects of 5-HT on inflammation and other neurotransmitters could potentially be useful for modulating gastrointestinal motor and sensory functions, especially in critically ill patients. This is particularly interesting given that in these patients the gut microbiome as well as the crosstalk between the gut and brain microbiome is significantly affected (e.g., by antibiotics, vasopressors, and parenteral nutrition) [11]. This may indicate a minor contribution of the cutaneous serotonin synthesis system; more importantly, the blood–brain barrier does not allow serotonin from the outside into the brain, so we effectively

have two different serotonin pools. With the exception of the requirement for ultraviolet B (UVB) for vitamin D3 production, the positive role of UV radiation in modulating homeostasis is underappreciated. Skin exposure to UV radiation induces local secondary responses by inducing chemical, hormonal, immune, and neural signals, which are determined by chromophores and the degree of UV radiation penetration into the skin compartments. These responses are not random and are coordinated by the cutaneous neuro-immune-endocrine system, which counteracts the action of external stressors and adapts local homeostasis to the changing environment. UV radiation causes the sending of electrical, chemical, and biological signals to the brain, endocrine, and immune systems, as well as other central organs, which together regulate the body's homeostasis [12].

Conclusion:

The available studies do not allow us to unequivocally say that UV increases serotonin synthesis in humans, but does not clearly affect mood deterioration. More information is needed in the future, namely randomized controlled trials and specifically the determination of DOPA decarboxylase, to clarify the role of dopamine in the process of serotonin regulation during exposure to ultraviolet radiation.

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Аннотація. *Вступ. Відповідні дослідження продемонстрували зв'язок між депресією та ультрафіолетом Б, але прямий зв'язок між ними ще належить дослідити.*

Мета: Проаналізувати наявні дослідження щодо впливу ультрафіолетового випромінювання на рівень серотоніну в організмі людини та виявити загальні закономірності, залежності та потенційні клінічні імплікації.

Методологія: бібліографічний аналіз, метааналіз

Результати: декілька десятків наявних досліджень, вказують , що наявний вплив ультрафіолетового випромінювання на синтез серотоніну, в деяких підгрупах досліджуваних та культивованих людських кератиноцитах і меланоцитах, в останньому УФ інгібував синтез дофаміну, який є інгібітором синтезу серотоніну. А в дослідах на мишах та людях показана антидепресивна дія. Це пояснюється тим, що УФ може викликати неферментативну трансформацію триптофану в гідрокситриптофан, посередник серотоніну.

УФ-промені викликають надсилання електричних, хімічних і біологічних сигналів до мозку, ендокринної та імунної систем, а також інших центральних органів, які разом регулюють гомеостаз організму.

Висновок: Наявні дослідження не дозволяють однозначно сказати, що УФ підвищує синтез серотоніну у людей, але однозначно не впливає на погіршення настрою, в подальшому необхідно більше інформації, а саме рандомізовані контрольовані дослідження та конкретно визначення ДОФА-декарбоксилази, для вияснення ролі дофаміну в процесі регулювання серотоніну під час дії ульрафіолетового випромінювання.

Ключові слова: *серотонін, ультрафіолетове опромінення, метааналіз.*

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