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## Review Article

# Relationship Between Anxiety and Dandruff: A PsychoneuroDermatological Perspective

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### ABSTRACT

Dandruff is a frequent chronic condition of the scalp that is marked by flaking, itching, irritation and frequent scaling of the scalp whereas anxiety is a frequent mental disorder that is characterized by excessive worry, responsiveness to stress and neuroendocrine imbalance. There is an emerging evidence base that these two conditions are interrelated, psychodermatologically, with the brain-skin axis. The hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system are activated by anxiety, leading to the release of more cortisol, catecholamines and inflammatory mediators, which may change the activity of the sebaceous glands, damage the integrity of the scalp barrier, and disrupt immune regulation. These alterations can facilitate overproduction of sebum, oxidative stress, neuroinflammation, and proliferation of Malassezia species, which are major pathogenic factors of dandruff. On the other hand, conspicuous scaly dermatitis, persistent itch, and cosmetic embarrassment can have adverse impacts on self-esteem and social confidence, thus heightening anxiety and emotional discomfort. This two-way process forms a vicious cycle where psychological stress enhances dandruff and where unremitting dandruff exacerbates psychological health. Clinical observations also show that stress sensitive individuals usually have recurrent or treatment refractive episodes of dandruff. As such, the management ought to go beyond topical antifungal therapy and also incorporate stress management, psychological assistance, lifestyle management, nutritional management, and whole scalp management. The following areas of research in the future include biomarkers, microbiome modulation, and personalized psychodermatological interventions. This review suggests the necessity of multidisciplinary methods of improved understanding and management of the correlation between anxiety and dandruff.

### INTRODUCTION

Dandruff is a highly prevalent chronic scalp disorder which afflicts a significant percentage of

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the general population in the world. Clinically, it is an overexcretion of dead epidermal cells on the scalp that is accompanied by itching, irritation, dryness, erythema, and white or yellow flakes that are visible. Despite the fact that dandruff is usually regarded as a minor cosmetic issue, its chronic symptoms may severely affect individual comfort, social comfort, and the quality of life. On more serious occasions, the dandruff is overlapped by seborrheic dermatitis, which is an inflammatory skin disease that is characterized by the erythematous plaques and greasy scales in the sebum rich regions of the body. Dandruff etiopathogenesis is multifactorial and includes the activity of sebaceous glands, the presence of the *Malassezia* species, dysfunction of the epidermal barrier, genetic predisposition, and inflammation.



**Figure 1: Dandruff Scalp Clinical Image**

Anxiety is a common mental disorder that is manifested by an overabundance of worry, nerves, fear, autonomic nervousness, and increased stress sensitivity. Chronic anxiety has effects on various physiological systems such as the nervous system, endocrine system, and immune system. Prolonged psychological stress may lead to the activation of the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system, which leads to higher secretion of cortisol, catecholamines, and pro-inflammatory mediators. It is known that these neuroendocrine changes can modify immune

surveillance, barrier, microbial balance and inflammatory signaling pathways and thus, skin homeostasis.

Recent developments in psychodermatology have emphasized on the concept of the brain-skin axis that explains the two-way communication between the psychological states and the dermatological health. The physiological connection between the nervous system and the skin has a common embryological origin of the ectoderm. The disruption of scalp disorders by emotional disturbances like anxiety can be enhanced by sebum homeostasis, oxidative stress, cytokines release, neurogenic inflammation, and compulsive scratching. On the other hand, itchy scalp, visible scalp flaking and embarrassment due to dandruff can further exacerbate anxiety, decrease self-esteem, and create a vicious cycle.

Although both anxiety and dandruff are very prevalent, little is known about the mechanistic relationship between the two conditions. This association is significant in understanding how to formulate integrated treatment approaches that take into consideration both the dermatological symptoms and the psychological triggers. Hence, the current review will focus on the psychoneuroimmunological processes between anxiety and dandruff, a summary of the existing clinical evidence, and an overview of the existing and emerging multidisciplinary therapeutic interventions.

### **1.1. Overview of Anxiety and Dandruff as Common Health Conditions**

Anxiety and dandruff are two very common health problems that afflict millions of people all over the world and have considerable impacts on physical, psychological and social health. Though these disorders fall under separate fields of medicine, with anxiety being more of a psychological and

dandruff a dermatological one, they often occur together and can even have similar biological and behavioral pathways. Their prevalence among age groups and populations is significant as they are important public health issues and should be addressed multidisciplinary.

Anxiety is a normal emotion feeling as a result of stress or a perceived threat; however, when it is too much, persistent, and not in proportion to the circumstances, it can evolve into a clinically significant disorder. Anxiety disorders are the most prevalent mental health disorder in the world and they encompass; the generalized anxiety disorder, panic disorder, social anxiety disorder and specific phobia. Excessive worrying, restlessness, irritability, sleep disturbances, muscle tension, fatigue, palpitations, and lack of concentration are some of the symptoms experienced by individuals with anxiety. Persistent anxiety may affect the work performance, education, social interaction and general life quality. Moreover, chronic anxiety is linked to the disruption of hormone balance, immune, autonomic nervous systems, and inflammatory pathways, which can negatively influence various organ systems such as the skin.

Dandruff is a typical chronic scaly skin condition that is associated with the shedding of observable scales of the head and in most cases, comes with itchiness, irritation, dryness or slight inflammation. It is believed to be the least severe type of seborrheic dermatitis and is often linked to the hyper-growth of lipophilic *Malassezia* genus yeasts, hyperactivity of the sebaceous glands, epidermal barrier malfunction and personal predisposition. Dandruff often develops after puberty because of the production of more sebum, and is more commonly seen in adolescents and young adults, but can happen at any age. The condition can be worsened by environmental

factors like humidity, pollution, harsh hair products, poor scalp hygiene, dietary imbalance and stress.

Although it is not a life-threatening condition, dandruff may have significant psychosocial impacts. Constant clothing flaking, evident scalp flaking, and chronic itching can cause embarrassment, loss of confidence, social withdrawal, and emotional distress. On the same note, anxiety may exacerbate personal grooming habits, sleep quality, and stress, hence indirectly affecting scalp health. Due to the prevalence of the two conditions, their repetition and the capacity to adversely impact the quality of life and self-image, it is clinically essential to know their overlap. The increased awareness of mind and body connections implies that anxiety and dandruff cannot always be treated as separate disorders, but as the two related conditions that must be evaluated and treated as a unit.

## **1.2.Rationale for Exploring the Psychoneuro Dermatological Connection**

The connection between psychological well-being and skin diseases has received more and more scientific interest over the last few years and resulted in the interdisciplinary discipline of psychodermatology. This is a medical field that acknowledges the fact that emotional state, stress reaction, and mental health can greatly impact the development, course, and the intensity of dermatological diseases. The psychoneuro dermatological relationship between anxiety and dandruff is of special interest due to the high prevalence and the occurrence rate of both disorders and their ability to significantly deteriorate the quality of life. Although these disorders are common, biological and behavioral relationships between the disorders are not fully understood.



The skin is not a mere outer protective layer but rather an active neuroimmunoendocrine organ which is in constant communication with the central nervous system. The embryonic ectoderm gives rise to the skin and brain, and that is why they are closely structurally and functionally related. Psychological stress and anxiety can also affect skin physiology, through neural signaling, hormone variations and immune modulation via the brain-skin axis. The response of hypothalamic-pituitary-adrenal (HPA) axis to anxiety results in the release of cortisol and catecholamines, which can disrupt epidermal barrier integrity, modify sebaceous gland functions, weaken the immune defense, and stimulate inflammation. Such alterations provide a favourable condition to scalp irritation and worsening of dandruff.

Dandruff in itself is growing to be seen as more than a cosmetic concern. It is linked to microbial imbalance, in particular, *Malassezia* overgrowth, excessive sebum, oxidative stress, and low grade scalp inflammation. As anxiety is also capable of modulating most of these same pathways, the question of their interaction might help to identify common mechanisms that can explain why certain individuals have persistent or stress sensitive dandruff. In addition, anxiety-induced behavioral effects, including sleep disturbances, inconsistent grooming patterns, unhealthy eating, obsessive scratching, and lack of self-care can also worsen symptoms on the scalp.

The other notable reason is the two-way nature of the condition. Obvious flaking, itching, and scalp irritation can have a negative impact on self-esteem, social self-confidence and emotional stability, in particular, in adolescents and young adults. This may make the situation more worrisome and may create a vicious cycle where psychological distress exacerbates dandruff and vice versa.

The clinical implications of understanding this relationship are huge. Traditional dandruff management usually targets antifungal shampoos or topical agents, but does not address psychological factors that may trigger dandruff. Discovering the psychoneuro dermatological nature of dandruff, healthcare providers can consider more integrated approaches to managing dandruff, incorporating dermatological with stress management, counseling, and lifestyle modifications. Thus, studies on the anxiety-dandruff correlation are needed to enhance the effect of treatment, avoiding a relapse and improving the overall well-being of the patient.

## 2. Psychoneuroimmunological Basis of Skin Disorders

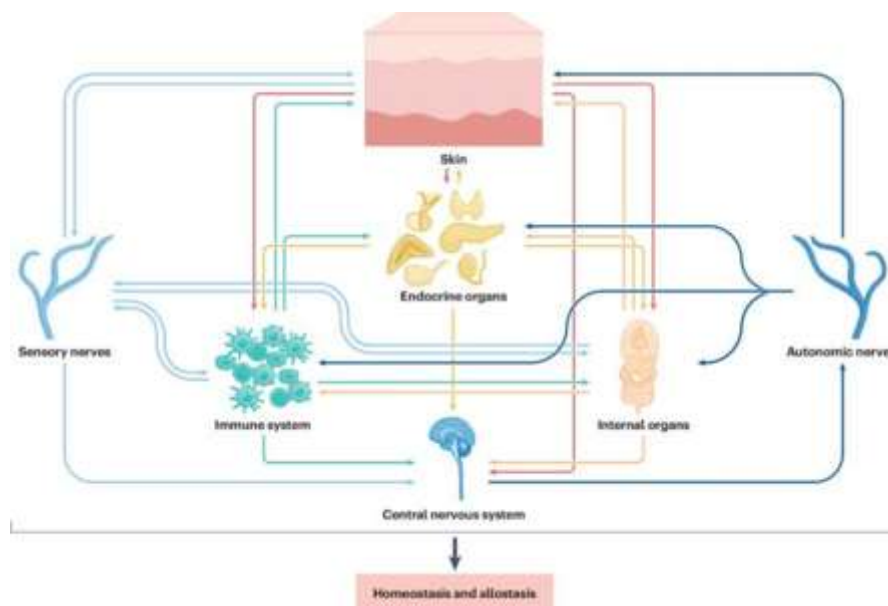
Psychoneuroimmunology is an interdisciplinary science which studies dynamic and bi-directional relationship between psychological system (mind and emotions), nervous system, endocrine system, and immune system. It describes the effects of emotional states like stress, anxiety, fear, depression and trauma on the functioning of the body at a biological, immune, hormonal and inflammatory level. In recent decades, psychoneuroimmunology has gained more and more significance in medical science since it has shown that mental and emotional conditions are not independent of physical health, but rather directly influence the disease process, course, and recovery.

Psychoneuroimmunology is particularly important in the sphere of dermatology since the skin is among the most sensitive organs to internal emotional conditions. The skin is not simply an outer protective layer, it is a very active immunological, sense organ and endocrine, able to respond to psychological stress. It hosts nerve endings, immune cells, hormone receptors, sebaceous glands, sweat glands and inflammatory



mediators that are in constant communication with the central nervous system. This renders the skin very sensitive to emotional upsets and

physiological responses to stress. Consequently, a broad scope of dermatological disorders can be activated or aggravated by psychological factors.



**Figure 2: Brain–Skin Axis Communication Model**

The basis of this close relationship is the fact that both the skin and the nervous system are formed out of the embryonic ectoderm during the fetal stage of development. Due to this common developmental basis, the brain and the skin are biologically related at all ages. Brain signals have the potential to rapidly influence skin activities including blood flow, temperature, immune keep watch, itching, sebum, wound healing and barrier properties. Similarly, acute inflammatory skin conditions may provide stress feedback to the brain, impacting mood, self-esteem and emotional health. This two-way interaction is what psychodermatology is based on.

The immune system balance can be disrupted by psychological factors like anxiety, chronic stress, depression, social fear, and emotional trauma. Stress triggers the activation of hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system, which results in the secretion of cortisol, adrenaline, noradrenaline, and inflammatory cytokines. These responses to stress

can cause impairment of skin barrier, slow tissue repair, disrupt microbial balance, enhance sensitivity and make skin susceptible to inflammatory reactions when they are chronic in nature. As a result, stress is known as a contributing factor to most prevalent skin diseases.

A number of dermatological conditions have exhibited close links with psychoneuroimmunological processes. An example is that, psoriasis tends to intensify under emotional stress because of the release of inflammatory immune responses. The flare of acnes vulgaris can be caused by anxiety due to the hormonal disharmony and enhanced secretion of sebum. Itching and mast cell activation in atopic dermatitis and urticaria are highly dependent on stress. Autoimmune dysregulation due to emotional stimuli has been associated with alopecia areata. Equally, the inflammation, changes in scalp immunity, and increased secretion of oils could worsen seborrheic dermatitis and dandruff when someone is anxious.

The role of neuropeptides and neurotransmitters is another significant fact of psychoneuroimmunology in dermatology. Substance P, serotonin, calcitonin gene-related peptide (CGRP), and neuropeptide Y are some of the molecules that are released by nerve fibers in the skin during stress. These mediators provoke vasodilation, itch, mast cell degranulation, cytokine release, and local inflammation. These neurogenic inflammatory reactions make sense of why most patients develop the sudden itch, redness, burning or flare-ups in stressful situations.

The psychoneuroimmunological model has greatly revolutionized contemporary dermatological knowledge. Conventional methods commonly only used topical creams, shampoos, antifungals, corticosteroids, or systemic drugs to treat skin diseases. Nevertheless, the existing body of evidence upholds a more holistic approach where emotional well-being, sleep, lifestyle, coping style, and coping with stress are also regarded as important elements of treatment. Counseling, relaxation therapy, mindfulness, yoga, behavioral therapy, and psychological support are usually useful to patients with chronic skin disorders in addition to traditional dermatology.

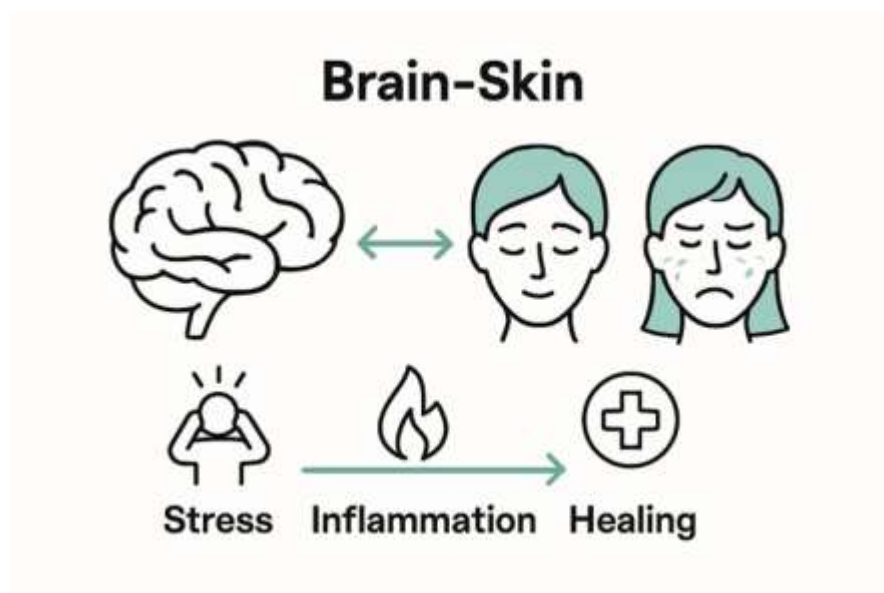
Finally, psychoneuroimmunology gives a scientific rationale as to the close relationship between the mind and the skin. It highlights that skin illnesses do not necessarily arise as local diseases, but can be indicators of more systemic disruptions in physiology of stress, immune imbalance and emotional well-being. This concept is important to understand to enhance the quality of life and treatment outcomes and to improve

diagnosis in dermatological patients in the long run.

## **2.2. The Brain–Skin Axis and Bidirectional Communication**

The brain-skin axis is a scientifically known concept that explains two-way communication system between the skin and central nervous system, which is two-way and dynamic. This model describes the close interactions of emotional states, neurological activity, hormonal reactions, and immune reactions with the skin physiology. The brain and the skin are intertwined in a complex set of signaling processes which involve nerves, hormones, cytokines, neuropeptides and immune cells rather than functioning as distinct systems. Due to such a strong connection, psychological stress may cause or aggravate skin disorders, and chronic skin conditions may have a profound impact on emotional conditions and mental health.

One of the key biological grounds to this connection is in embryology. The skin and nervous system derive their origins in the ectoderm, which is one of the three main germ layers developed in fetal development. The skin and nervous system have a number of structural and biochemical similarities in life due to this common developmental origin. The skin is rich with sensory nerve endings, neurotransmitter receptors, immune cells and hormone sensitive structures which enable it to receive and transmit messages of stress and emotion. This renders the skin as an active neuroimmunological organ as opposed to a passive protective barrier.



**Figure 3: Brain Skin**

The brain leads to effects on skin in a number of ways. Activation of the hypothalamic-pituitary-adrenal (HPA) axis during stress is one of the most crucial processes. Upon the experience of anxiety, fear, or emotional tension, the brain causes the release of corticotropin-releasing hormone (CRH) that prompts secretion of adrenocorticotropic hormone (ACTH) and cortisol. High cortisol levels may negatively affect skin barrier recovery, modify keratinocyte turnover, suppress immune control and predispose to inflammation. Meanwhile, the stimulation of sympathetic nervous system causes the release of adrenaline and noradrenaline, which can impact blood circulation, sweating, the functioning of sebaceous glands, and inflammation.

Neural signals that are associated with stress can directly modify a couple of key functions in the skin. They are high levels of sebum that leaves the scalp greasy and more susceptible to microbial imbalance; decreased epidermal barrier integrity, resulting in dryness and inflammation; altered vascular tone, resulting in redness or sensitivity; weakened immune defence, which promotes infections or inflammation flare-up; and enhanced sensory sensitivity, which may enhance itch or

burning. These physiological alterations are the reason why a lot of skin conditions are aggravated during times of mental suffering.

The message is not two-way. Also, the skin is capable of sending feedback to the brain and affecting the emotional and neurological condition. Persistent flaking, redness, or discomfort, chronic itching, and visible lesions may stimulate stress circuits in the brain and adversely impact mood. Combination of low self-confidence, anxiety, and depression are typical among individuals with observable skin conditions, which lowers their social life. This back signaling shows that skin disease is not just a physical burden, but it is also a psychological burden.

Such a concept as bidirectional communication is particularly applicable to chronic dermatological diseases. Psoriasis, acne vulgaris, eczema, urticaria, alopecia areata, and seborrheic dermatitis are often aggravated by the circumstances of stressful events in life. At the same time, the cosmetic and symptomatic burden of these disorders has the potential to generate

continuous emotional distress, which generates a vicious cycle of stress and inflammation.

The brain-skin axis provides a valuable explanation of the recurrence and severity of the symptoms in the case of dandruff. Psychological stress can cause scalp inflammation, overproduction of oil and changes in the immune response, thus promoting the overgrowth of *Malassezia* species and scaling. Scratching behaviour can also be further aggravated by anxiety which will further harm the scalp barrier. Conversely, apparent flakes on clothing, itchiness when interacting with others, and anxiety about physical attractiveness can enhance self-consciousness and social phobia. Repeat episodes have the ability to maintain scalp symptoms and emotional stress.

The significance of this brain-skin relationship is becoming more and more accepted in modern dermatology. The management of recurrent scalp disorders might also involve more than just the topical use of antifungal or anti-inflammatory medications and involves focusing on stress management, sleep quality, emotional strength, and behavioral wellbeing. In that way, brain-skin axis can be a valuable tool to explain the close relationship between mental and cutaneous health.

### **3. MECHANISTIC LINK BETWEEN ANXIETY AND DANDRUFF**

The interplay between dandruff and anxiety is a number of interconnected processes. The hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system is activated by anxiety, leading to the production of cortisol, adrenaline, and sebum, which form an oily environment on the scalp that nourishes the *Malassezia* species linked to dandruff. Repeated stress is also a stimulator of inflammatory cytokines, oxidative stress and poor scalp barrier

functioning resulting in itch, irritation and excessive flaking. Moreover, behaviors associated with anxiety, including bad hygiene, insomnia, and scratching, may also exacerbate symptoms of the scalp. On the other hand, obvious dandruff and ongoing itchiness can decrease self-esteem and elevate social anxiety, and a vicious cycle of psychological distress and head problem emerges.

#### **3.1 Stress-Induced Sebaceous Gland Hyperactivity and Excess Sebum Production**

The hyperactivity of the sebaceous glands, caused by stress, and the subsequent rise of the sebum level is one of the most significant mechanisms connecting anxiety and dandruff. Sebaceous glands are microscopic glands that produce oil, which are present around hair follicles and secrete the sebum, a lipid rich substance which lubricates the scalp, keeps it moist and shields the skin barrier. In normal physiological conditions, sebum has a positive effect in maintaining the health of the scalp. Nevertheless, it may lead to an oily environment when it is produced in large quantities, which causes a number of scalp diseases, such as dandruff and seborrheic dermatitis.

Anxiety stimulates stress-response pathways in the body, especially the hypothalamic-pituitary-adrenal (HPA) axis, as well as the sympathetic nervous system. In times of emotional stress, the hypothalamus secreted corticotropin-releasing hormone (CRH) that activates a cascade that leads to more cortisol secretion of adrenal glands. Concomitantly, sympathetic stimulation enhances the secretion of catecholamines like adrenaline and noradrenaline. The effects of these stress mediators determine both direct and indirect effects on the functioning of sebaceous glands by modulating hormonal signaling and inflammatory pathways.



The sebocytes, which are the cells that make sebaceous glands, have been shown to be stimulated by corticotropin-releasing hormone resulting in greater lipid production and more sebum secretion. High cortisol levels can also alter androgen metabolism, which also encourages sebaceous gland activity. Consequently, people who are chronically anxious or who have recurrent stress tend to develop an oily scalp with an accumulation of excess oil surrounding the hair follicles.

This hyper sebum secretion is clinically important as it predisposes the development of dandruff. Dust, pollutants, and dead keratinized cells are trapped in oil on the scalp and lead to scaling and lack of scalp hygiene. More importantly, sebum is a nutrient source of lipophilic yeasts of the *Malassezia* genus, microorganisms highly correlated with dandruff. These fungi break down sebum triglycerides to produce free fatty acids and other irritating acids which break down the scalp barrier, cause inflammation and promote epidermal cell turnover. This results in flaking, itching, redness, and frequent dandruff symptoms.

Moreover, an oily scalp can also reduce normal desquamation with dead cells clustering together as larger flakes instead of shedding unseen. A large number of people with anxiety thus observe the effect of dandruff aggravating during stressful times, exams, work pressure, emotional conflict or sleep deprivation. This shows the potential of psychological stress to be converted into quantifiable physiological alterations in scalp biology.

Hence, hyperactivity of the sebaceous gland in response to stress is a significant mechanistic connection between anxiety and dandruff. Relaxation, sleep, healthy lifestyle habits, and psychological support could be used to control emotional stress and, therefore, sebum production

and decrease the dandruff recurrence rates together with traditional scalp treatments.

### **3.2 Microbiome Imbalance and Overgrowth of *Malassezia* Species**

The scalp microbiome is a complex and dynamic microbial ecosystem that exists on the human scalp and is composed of bacteria, fungi, yeasts and other microorganisms that live in a balanced state. In normal conditions, these microbes are protective in that they ensure ecological stability, assistance in barriers, and inhibition of colonization by pathogenic organisms. Sebum levels, pH, hygiene practices, genetics, climate, and immune functionality are some of the factors that determine the composition of the scalp microbiome. Loss of this fine balance can result in the growth of microbes and inflammation which can cause scalp diseases like dandruff and seborrheic dermatitis.

Lipophilic yeasts of *Malassezia* genus are the most significant organisms related to dandruff, among the microorganisms on the scalp. The *Malassezia* species are naturally occurring commensal fungi, which need lipids to survive as they cannot synthesize some fatty acids on their own. When in moderate quantity, they can be present harmlessly in the scalp. But, under favorable conditions their uncontrolled multiplication may cause irritation, inflammation, and abnormal scaling. The *malassezia globosa* and *malassezia restricta* are common species associated with dandruff.

The scalp microbiome can be greatly affected by anxiety and chronic psychological stress via multiple indirect mechanisms. Stress triggers the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system resulting in a rise in cortisol and catecholamine. Such stress mediators can undermine immune surveillance mechanisms, change local antimicrobial defenses, and decrease



the ability of the skin to effectively maintain microbial populations. Simultaneously, anxiety could lead to an augmentation of sebum, alteration of sebum composition, and disruption of the pH of the scalp, all of which can result in a more conducive environment to the proliferation of *Malassezia*.

Microbial imbalance can also be enhanced by alteration of scalp barrier integrity due to stress. Epidermal renewal, transepidermal water loss, and the protective barrier of the scalp could be weakened due to psychological stress. After the barrier has been damaged, the scalp is more vulnerable to fungal metabolites, pollutants, and inflammatory stimuli. *Malassezia* species break down triglycerides that are present in the scalp to produce free fatty acid like oleic acid, which may enter the compromised barrier and irritate susceptible people. The result is redness, itch, inflammation and increased shedding of the keratinized scales of the scalp in the form of observable flakes.

Behavioral aspects of stress can also contribute to an exacerbation of the microbiome imbalance. People with anxiety can clean their hair inconsistently, apply rough cosmetic products, scratch the head often, or sleep poorly and improperly balance their diet. These can further disturb the microbial environment and are the contributing factors to the recurrence of chronic dandruff.

Thus, *Malassezia* species overgrowth and balance disruption of microbiomes is a key mechanistic pathway between anxiety and dandruff. Psychological stress is not directly responsible in the fungal infection, but it may establish physiological and environmental factors that promote microbial dysbiosis and inflammatory reactions in the scalp. The study of this relationship shows that the combination of

antifungal therapy with stress management, scalp care, and lifestyle change is the key to dandruff management.

### **3.3 Neuroinflammatory Signaling and Cytokine Activation**

Chronic anxiety is becoming more and more accepted as a psychological disorder, and as a systemic pro-inflammatory state that can affect various organs, including the skin. The stimulation of the hypothalamic-pituitary-adrenal (HPA) axis and sympathetic nervous system through the chronic stimulation of stress-response pathways in the brain and body is triggered by persistent psychological stress. Despite the fact that such systems are meant to aid the body in responding to short-term stress, the immune regulation can be disrupted by long-lasting activation and contribute to the development of chronic low-grade inflammation. This inflammatory scenario can also play a big role in the occurrence and exacerbation of scalp disorders including dandruff.

The production of inflammatory cytokines increases is one of the major mechanisms involved. Cytokines are small signaling proteins produced by immune cells that control inflammation, tissue repair and host defense. Pro-inflammatory mediators (interleukin-1 beta ( IL-1 ) interleukin-6 ( IL-6 ), tumor necrosis factor-alpha ( TNF- ) and occasionally interferon-gamma ( IFN- )) have been elevated in people with chronic anxiety. These cytokines may circulate throughout the body and could even be generated locally in the tissues of the skin and scalp. In excess they disrupt normal epidermal homeostasis and destabilise the balance between cell production and shedding.

Inflammatory cytokines in the scalp are able to induce faster growth of the keratinocytes and alter the normal maturation of the epidermal cell. Rather than invisibly shedding in a managed



process, the scalp cells become piled up and peel off swiftly in obvious flakes. This is an abnormal turnover that is characteristic of dandruff. Symptoms can be more apparent and persistent, and cytokine-mediated inflammation can contribute to sensitivity of the scalp, redness, burning sensation, and irritation.

Neurogenic inflammation is another significant pathway and is the one that connects the nervous system to immune responses on the skin. Sensory nerve endings, especially substance P, calcitonin gene-related peptide (CGRP), and neuropeptide Y, are released during anxiety or emotional stress, and substance P is especially important, as it activates mast cells and triggers the release of histamine and cytokines, as well as other inflammatory mediators. The process results in vasodilation, itch, edema, and local inflammation. The enhanced activity of substance P in individuals with dandruff can exacerbate pruritus and cause repetitive scratching, which further impairs the scalp barrier.

Other mechanisms related to dandruff, like overproduction of sebum, and *Malassezia* overgrowth, may also interact with stress-induced inflammation. Reduced and inflamed scalp barrier is more prone to irritation by fungal metabolites and environmental irritants. The symptoms of dandruff, therefore, tend to increase in case of emotionally stressful moments like academic stress, stress at the workplace, sleep deprivation, or during personal conflict.

Consequently, neuroinflammatory cues and cytokine mobilization are significant biological correlates between anxiety and dandruff. Long-term emotional stress may enhance the inflammation of the scalp via immune and neural mechanisms causing more flakiness, itching, and pain. The acknowledgment of this mechanism justifies the necessity of combined management

strategies that would deal with inflammatory scalp pathology and underlying psychological stress.

### 3.4 Oxidative Stress and NF- $\kappa$ B Pathway Activation

Constant anxiety may cause considerable biochemical alterations in the body, and the overproduction of reactive oxygen species (ROS) and result in oxidative stress are among the most crucial. Reactive oxygen species are unstable molecules that occur naturally in the normal metabolic processes of the cell, but when they are produced in large quantities, they may damage tissues and disrupt normal physiological processes. Prolonged psychological stress and anxiety elevate the activity of the sympathetic nervous system, secretion of cortisol, and stress in mitochondria, which can boost the production of ROS. The oxidative stress occurs when the antioxidant defense mechanisms in the body are not adequate to counteract these free radicals.

Oxidative stress may cause damage to various cellular components in the skin and scalp such as lipids, proteins and DNA. Lipid peroxidation destroys the protective fatty layers of the scalp barrier, decreasing the ability to retain moisture and making it more sensitive to irritants. The oxidation of proteins can lead to impairment of structural proteins like keratin and damage to DNA can alter normal cell repair and renewal mechanisms. This makes the scalp susceptible to dryness, inflammation, itching, and epidermal cell overgrowth. These alterations are especially pertinent in the case of dandruff, where the dysfunction of their barriers and excessive flaking are the main characteristics.

Oxidative stress can directly contribute to the promotion of inflammation by activating intracellular signaling pathways, particularly the nuclear factor-kappa B (NF- $\kappa$ B) pathway. NF- $\kappa$ B



is one of the most important transcription factors that control genes related to immune responses, production of inflammatory cytokines, cell survival, and adaptation to stress. NF- $\kappa$ B is activated under oxidative conditions by ROS, and it enters the cell nucleus, promoting the production of pro-inflammatory cytokines such as interleukin-1 beta (IL-1), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF- $\alpha$ ), and chemokines. This inflammatory cascade increases the irritation, redness, and the immune reactivity of the scalp.

Repeatedly activated, the NF- $\kappa$ B pathway can be the source of chronic or recurrent scalp inflammation. Constant inflammatory cues may hasten the process of keratinocyte turnover, resulting in the scaling cells shedding faster and adding up to form flakes visible to the naked eye. It can also boost erythema, pruritus, and discomfort, frequent complaints in people with dandruff and seborrheic dermatitis. Moreover, an oxidatively damaged scalp barrier will be more vulnerable to malassezia metabolites, pollutants, harsh shampoos, and climatic stressors, which exacerbate the symptoms.

Other related lifestyle factors that could augment anxiety-related oxidative stress include poor sleep, smoking, alcohol consumption, nutritional deficiency, and unhealthy dieting which diminish the antioxidant capacity. Vitamin A, C, E, zinc and selenium deficiencies can disrupt the natural defense mechanism of the body against the ROS and predispose the scalp to vulnerability.

Thus, the oxidative stress and the activation of NF- $\kappa$ B pathway is a significant biochemical intermediary between anxiety and chronic recurrence of dandruff. The result of psychological distress may be a molecular damage and inflammatory response of the scalp that results in lasting scaling and irritation. This knowledge advances the possible effectiveness of antioxidant-

enriched diet, stress decrease, and anti-inflammatory treatments as adjuvant treatments in the management of dandruff.

#### 4. CLINICAL EVIDENCE AND PSYCHODERMATOLOGICAL CORRELATIONS

There is growing clinical and epidemiological data indicating that there is a significant correlation between psychological factors and the dandruff-related scalp conditions. Even though the dandruff has been long explained by microbial colonization, sebaceous and epidermal dysfunction, numerous clinical observations show that emotional stress, anxiety, depression and psychosocial burden have a strong impact on the severity of the symptoms, recurrence and responsiveness of the treatment. This has resulted in an increased appreciation of dandruff as a condition that has significant psychodermatological aspects.

A number of observational studies and surveys of patients have found that the symptoms of dandruff usually increase during times of emotional stress, examination pressure, occupational strain, sleep deprivation, and personal conflict. When stressed in life, patients often report increased itchiness, irritation, observable flaking, and discomfort at the scalp. These results align with the biology of stress on inflammatory signaling, sebaceous glands, immune-modulation, and the breakdown of scalp barrier. Recurrent dandruff is usually linked to lifestyle stressors in clinical practice, and therefore, psychological status is regarded as an aggravating, but not exclusive cause.

The issue of anxiety has been specifically relevant to scalp disorders in that it may enhance the perception of symptoms and behavioral reactions. Patients with high anxiety levels can be hypersensitive to slight itchiness, flakes or aesthetic flaws leading to disproportionate suffering.



Anxiety can also stimulate compulsive scalp touching, scratching, and over grooming which further leads to damage of the scalp barrier and increased inflammation. In anticipatory anxiety of the appearance in social or professional life, it may develop into a symptom exacerbation in certain patients, which strengthens the cycle of stress and dandruff.

Persistent dermatological complaints are also often associated with depression and chronic stress. Patients with depressive symptoms can also lack in scalp care, have poor sleep patterns, have poor diets, or be less compliant with medication. Such habits may lead to persistent dandruff reoccurrence. Sustained cortisol imbalance and low-grade inflammation, which are linked to chronic stress, regardless of the absence of a formal psychiatric illness, may over time aggravate the conditions of the scalp.

Psychosocial effects of the observable flaking of the scalp cannot be underestimated. Dandruff can have an implication on self-image, particularly in adolescents, young adults and in social interactive careers. Obvious spots on dark clothes, chronic itching in the genitals and worries about cleanliness or beauty may cause embarrassment, loss of confidence, shunning of socializing, and emotional distress. Others complain of anxiety even at work places, classes, during interviews, or even in personal relationship because of negative judgment. This psycho-emotional load may turn into a clinical one even with mild physical symptoms.

One of the psychodermatological ideas that are important here is the vicious cycle model. Neuroendocrine and inflammatory mechanisms by which anxiety and emotional stress exacerbate dandruff and deteriorate the dandruff aggravate embarrassment and psychological distress. This two-way loop could be the reason behind the

occurrence of chronic relapse in some patients despite the right topical treatment. Symptom control may not be complete unless the emotional triggers are identified and addressed.

There is also clinical experience that reassurance, counseling, stress management and lifestyle advice are commonly used with chronically affected patients with scalp disorders in conjunction with medicated shampoos or topical treatments. Psychological screening can be an important part of dermatology practice to determine patients with symptoms that are highly sensitive to stress.

In general, the existing clinical data confirm the opinion that dandruff is not a superficial cosmetic disease but can indicate significant relations between scalp biology and psychological well-being. These psychodermatological correlations are crucial to understand in order to diagnose more comprehensively, increase adherence, decrease recurrence, and enhance quality of life.

## **5. THERAPEUTIC AND PREVENTIVE APPROACHES**

Treatment of anxiety-related dandruff needs a combination approach that includes treatment of the symptoms on the scalp and the psychological causes. Traditional dandruff treatments like shampoos with ketoconazole, zinc pyrithione, selenium sulfide or salicylic acid can control fungus overgrowth, inflammation, itchiness, and excessive flaking. Nonetheless, chronic management is commonly based on stress-management programs such as mindfulness, yoga, relaxation, and Cognitive Behavioral Therapy (CBT) that eliminate anxiety and stress-related outbursts. A well-balanced diet with vitamins, minerals, omega-3 fatty acids, and antioxidants can provide nutritional support that can help improve the strength of the scalp and decrease



inflammation. The use of proper scalp hygiene, frequent washing of hair, sufficient sleep, exercise, plenty of water and avoiding harsh hair products are other key preventive steps. The intensity of anxiety and dandruff vary in different individuals,

and therefore, holistic and personal approach to the treatment process involving dermatological, psychological, and lifestyle change is the best approach to decreasing the recurrence and enhancing the quality of life.



Figure 4: Dandruff Demystified

### 1. Conventional Dandruff Therapies

The main method of managing the symptoms of dandruff is conventional medical treatment. Shampoos with fungi-fighting properties typically include ketoconazole, zinc pyrithione, selenium sulfide, ciclopirox, coal tar, or salicylic acid to reduce the growth and spread of fungi, inflammation and itching of the scalp, and excessive flaking. These products are necessary to manage the symptoms and prevent their recurrence, and their regular and proper use is crucial.

### 2. Stress-Management and Psychological Interventions

Since anxiety is an important aggravating factor, stress-management strategies are highly beneficial. Mindfulness meditation, yoga, breathing exercises, relaxation therapy, and Cognitive Behavioral Therapy (CBT) are

techniques to reduce stress hormones and enhance emotional balance. Psychological counseling can also be used to help persons who feel embarrassed, lack confidence or have a long-term anxiety regarding dandruff.

### 3. Nutritional and Antioxidant Support

The balanced diet and healthy food help to maintain the scalp and minimize inflammation. Eating fruits, vegetables, whole grains, nuts, seeds and omega-3 fatty acids are essential sources of nutrients which aid in repair of the skin, and boosting the immune system. Zinc, selenium, vitamin D, and B-complex vitamins could help reduce the predisposition to dandruff, and antioxidants could minimise the oxidative stress related to anxiety.

### 4. Proper Scalp Hygiene and Lifestyle Modification

Scalp hygiene should be regular to prevent the dandruff flare-ups. Regular shampooing with the appropriate shampoos assists in eliminating any surplus oil, dirt or dead skin cells. Sleeping well, physical activity, water intake, quitting smoking, and decreased eye-related stress enhance hormonal levels, immunity, and mental health, and thus maintain scalp health.

## 5. Holistic and Personalized Care

The most efficient method of management is a combination of dermatological treatment and mental health and lifestyle improvement. Anxiety and dandruff are different in different people, thus the treatment should be tailored to the severity of the symptoms, type of the scalp, level of stress, and frequency. A holistic care model has the potential to offer enhanced long-term management, lesser recurrence and enhanced quality of life.

## 6. FUTURE PERSPECTIVES AND RESEARCH DIRECTIONS

Future directions and studies in the relationship between anxiety and dandruff ought to be directed towards the complex interactions between psychological stress, immune response, the scalp microbiome, and inflammatory pathways. Clinical trials on very large scales are required to provide a clear causal relationship, and to determine biomarkers, including cortisol, cytokines, and microbial profile, to diagnose and treat people in a more personalized manner. Newer possibilities like the gut–brain–skin axis, probiotic therapy, and digital health monitoring could provide additional management options. The new models of care should incorporate dermatological treatment and stress management, nutrition, and psychological interventions to enhance the quality of life and long-term outcomes.

## 1. Large-Scale Clinical and Longitudinal Studies

The cause and effect relationship between anxiety and dandruff should be clearly determined in future researches that should be conducted in large scale and long term studies. Such studies can assist in answering such questions: Is anxiety a risk factor of dandruff? Is chronic dandruff a cause of psychological distress?

## 2. Exploration of the Gut–Brain–Skin Axis

The gut–brain–skin axis requires further research to determine how the gut microbiota, diet, probiotics, and immune balance affect anxiety-related dandruff. New preventive and therapeutic opportunities may be offered in this field.

## 3. Biomarker Identification and Personalized Medicine

The research in the future ought to concentrate on biomarkers like cortisol, inflammatory cytokines, the markers of oxidative stress, and the profiles of scalp microbiomes. They can be used to anticipate the severity of diseases, their recurrence, and response to treatment, resulting in a personalized treatment.

## 4. Advanced Scalp Microbiome and Therapeutic Research

*Malassezia* species and the ecology of the scalp microbiosis require detailed studies to comprehend the stress-related alterations in the microbiome. This could help to create the new generation of antifungal and microbiome-restoring medicines.

## 5. Integrative and Multidisciplinary Care Models



The future management is to integrate dermatological therapy with psychological counseling, nutritional management, stress management and lifestyle managing interventions. Multidisciplinary approach could enhance the long term quality of life and symptom control.

## 7. CONCLUSION

The correlation between dandruff and anxiety is a noteworthy illustration of the strong interdependence between mental wellbeing and skin health. The effects of anxiety on dandruff include activation of stress pathways, elevated sebum levels, release of inflammatory cytokines, oxidative stress, disruption of the scalp barrier, and an imbalance of microbes. Meanwhile, chronic dandruff can cause embarrassment, low self-esteem and social anxiety, which feeds into the vicious cycle of its own. The results of the study suggest that dandruff can no longer be considered a cosmetic scalp disease, but a psychoneuroimmunological disorder. Management should therefore be based on a combination of the traditional dandruff treatments with stress management, psychological therapy, proper feeding and lifestyle changes. Further studies of biomarkers, the dynamics of the scalp microbiome, and individualized treatment options can enhance long-term outcomes. To improve the condition of the scalp and the quality of life in general, it is necessary to use a multidisciplinary psychodermatological model.

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