

A NARRATIVE REVIEW ON HISTOPATHOLOGICAL SIGNIFICANCE OF LIGHT THERAPY

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Abstract:

Light treatment, sometimes known as phototherapy or bright light therapy, is the use of artificial light at specific wavelengths or direct sunshine to treat a range of medical conditions. The most widely utilized forms of phototherapy at the moment are UVA1, PUVA, NB-UVB, and heliotherapy. One can carry out the procedure while being exposed to UVA, UVB, or sunshine radiation. Depending on the suggested indication, different UV radiation dosages and wavelengths are used. It can be used to treat various conditions with fewer side effects in comparison with Pharmacotherapeutics. This review focuses on importance of phototherapy over pharmacotherapy in diseases like Psoriasis, Eczema, Newborn jaundice, Vitiligo, Migraine etc.

Key words: *phototherapy, wavelength, artificial light, fewer side effects, comparison, pharmacotherapeutics.*

1. INTRODUCTION

1.1 PHOTOTHERAPY

A light source and light-sensitive medication are used in light therapy, also referred to as photodynamic therapy (PDT) and bright light therapy, to kill aberrant cells and treat a range of mental health issues. It is primarily used to treat seasonal affective disorder (SAD), commonly referred to as seasonal depression or the winter blues, a common type of depression. In addition, it might be beneficial as therapy for other types of depression, insomnia, or other issues. It can be used to treat specific cancer types as well as a few eye and skin conditions. This makes it possible to treat small, aberrant tissue areas without requiring surgery.^{[1][2]}

1.2 DIFFERENT KINDS OF LED LIGHT THERAPY?

Using different wavelengths that correlate to different visible colors are used in LED light therapy. The depths to which each color penetrates the skin vary.^{[3][4]}

- Blue light has an impact on the epidermis.
- Yellow light has a deeper penetration.
- Red light penetrates the skin deeper.
- Deepest penetration is achieved by near-infrared light.

Using different LED colors have distinct functions. For instance, experts think that:

- Red LED light therapy has the potential to lower inflammation and increase the synthesis of collagen, a protein that gives skin a youthful appearance but depletes with age.
- Blue LED light therapy may eliminate *P. acnes*, the bacteria that causes acne. Skin care professionals may employ a variety of lights during treatment to address particular problems.

1.3. MECHANISM OF PHOTOTHERAPY

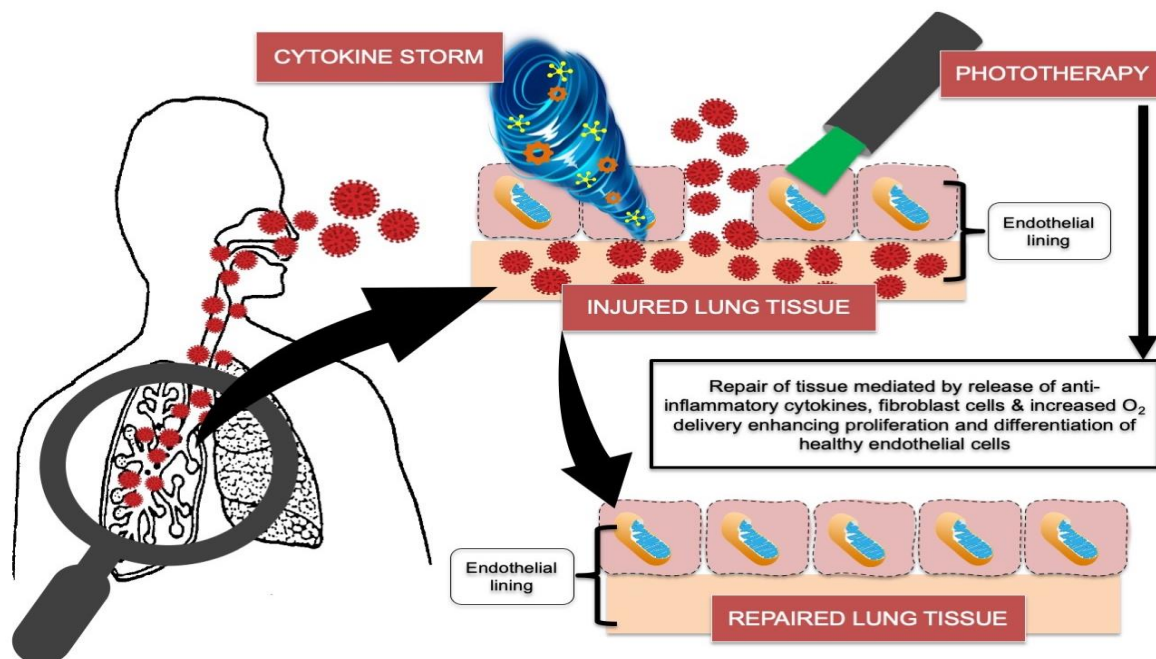


Figure 1 : Action of phototherapy

1.4 HOW IT WORKS

Skin applications for LED light therapy have a well-established history. It was first used by the U.S. Navy SEALs in the 1990s to promote rapid wound healing and the regeneration of damaged muscle tissue. Since then, the treatment has been studied in various aesthetic contexts. It is primarily known for boosting tissues and collagen, which can all help to smooth out your skin and lessen the visibility of damage like wrinkles, age spots, and acne. When treating LED light, various frequencies,

also known as wavelengths, are employed. These include light frequencies that are easily absorbed by the skin, such as red and blue, and do not contain ultraviolet rays.

These lights can penetrate the dermis layers, the deepest layer of skin, with wavelengths of 633 nanometers for red light, 532 nanometers for green light, and 415 nanometers for blue light. When it gets to the layers of the dermis, it boosts the cells and causes the body to respond by using the light. Consequently, enhancing the process of rejuvenation by means of enhanced blood circulation, stimulation of collagen, detoxification, and various other means.^{[5][6][7]}

1.5. TARGETED AREAS

LED light therapy is most frequently used on the face, face is more exposed to the elements than other parts of your body, it can be applied to any area of the body, so skin damage is more likely to occur there. Other areas that are prone to aging signs are the neck and chest, which can also be treated with LED therapy.

1.6. PHOTOBIO-MODULATION

| S.no | Light | Wavelength | Penetrate skin depth | Function |
|------|--------|------------|----------------------|--|
| 1 | Red | 640nm | 1-6nm | Regenerates skin cells, stimulates collagen proteins, reduce fine lines and wrinkles, improves blood circulation, reduce inflammation. |
| 2 | Blue | 432nm | 1nm | Treat acne and sun spots, inhibit sebaceous glands, improves skin texture, diminishes acne scars, improve depression. |
| 3 | Green | 532nm | 0.5-2nm | Decrease melanin production and whitens skin, decrease age spot and freckle, reduces pigmentation, reduces spider veins and rosacea. |
| 4 | Yellow | 583nm | 1-2nm | Stimulates production of RBC, reduces appearance of tiny blood vessels on skin, boost lymphatic flow and increase cellular growth. |

Table1: Types of light and their therapeutic uses ^[9,10]

2. METHODS

2.1 RED LIGHT THERAPY

The term photo biomodulation (RLT) is frequently used. In 1967, Endre Mester at the Semmelweis Medical University in Budapest, Hungary, unintentionally discovered its source (Trusted Source). Rats' hair growth and wound healing were observed to be aided by laser light, according to his observations.

A therapeutic approach, low-level red-light wavelengths are used in red light therapy (RLT), to help treat skin conditions like psoriasis and wrinkles. The treatment appears promising, but more investigation is required.^{[11][12]}

RLT is a type of phototherapy that may help to reduce inflammation or edema; treat skin conditions like psoriasis, scars, and acne; treat skin issues like stretch marks and wrinkles; repair muscle tissues; and encourage healthy aging.^[13]

According to scientific research, there are almost sixty additional names Trusted Source for RLT,^[14] including:

- Biostimulation
- photonic stimulation
- soft laser therapy
- cold laser therapy
- low power laser therapy (LPLT)
- low level light therapy (LLLT)

2.1.1 HOW RED-LIGHT THERAPY WORKS AND ITS BENEFITS

RLT involves exposing skin repeatedly to low doses of red and near-infrared light for a predetermined amount of time. Red light enters the skin between one and two millimeters in wavelength and does not produce heat at these low levels. Body cells may benefit biochemically from this redlight exposure, strengthening the mitochondria where a cell produces its energy. RLT may achieve this by raising your ATP (adenosine triphosphate) levels, oxygen consumption, and electron transit. Cells may be able to rejuvenate and repair themselves, as well as function more effectively, by increasing the energy of the mitochondria.^{[15][16]}

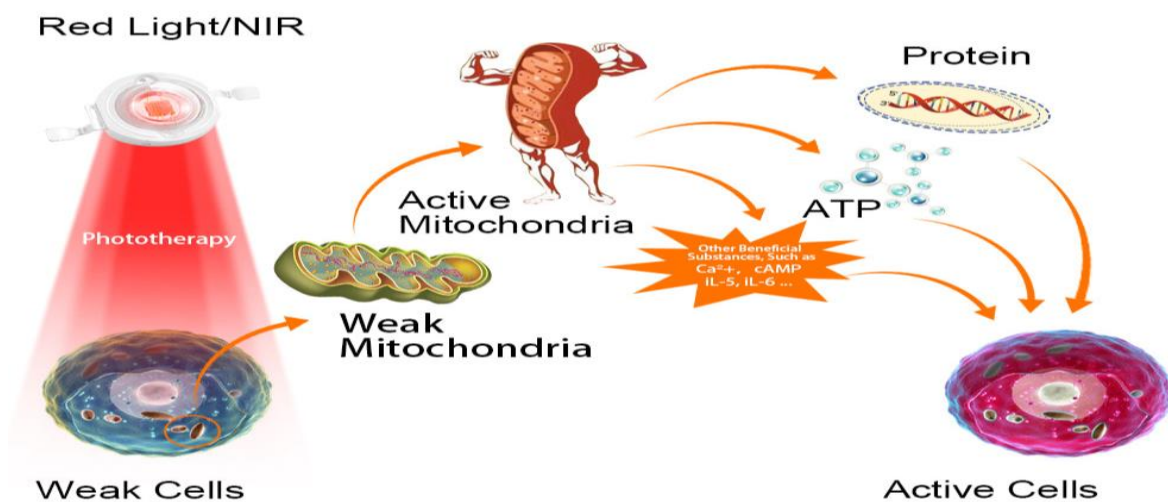


Figure 2: Mechanism of working of red light

2.2. BLUE LIGHT THERAPY

Blue light therapy, sometimes referred to as photodynamic therapy, is a kind of light therapy used to treat skin conditions or damage. It destroys aberrant skin cells while sparing the surrounding tissue by using drugs known as photosensitizing agents in combination with particular blue light wavelengths.^[17]

2.2.1. WHAT HAPPENS DURING A BLUE LIGHT TREATMENT SESSION?

The blue light treatment session is divided into three stages. In the first stage, your dermatologist applies the photosensitizing agent to your skin. This medication increases the susceptibility of precancerous lesions and other types of skin tissue to the absorption of light wavelengths used in their treatment.

The second phase of treatment, known as the incubation period, starts when the dermatologist applies the photosensitizing agent. The photosensitizing drug is absorbed into the skin at this stage. This step can take several hours, depending on the area that needs to be treated.

The compound is exposed to blue light after it has been absorbed. The skin reacts to blue light exposure by destroying the targeted skin tissue. The photosensitizing medication-absorbing tissues are the only ones targeted by the blue light. There may be a brief, slight tingling or burning sensation during blue light exposure.

Dermatologists check skin during follow-up exams to ensure that the intended outcomes have been reached and that the skin is healing properly. We'll talk about whether any more treatments are necessary at this point. Dermatologists advise a yearly checkup if no further treatments are needed to ensure that skin is healthy and to spot any signs of concern that might call for maintenance procedures down the road.^{[18][19]}

2.3. GREEN LIGHT THERAPY

Green light therapy, sometimes referred to as phototherapy, is a non-invasive treatment that "cures" a number of conditions by using a particular color of light, in this case, green. It entails exposing the body and psyche to particular radiation wavelengths for a predetermined period of time, usually between 510 and 560 nm.

By encouraging the body's healing processes, the therapy functions. A sequence of biological reactions is set off when the green light enters the skin and reaches the cells. These include the release of reactive oxygen species, which are essential for immune system and cellular signalling, and adenosine triphosphate, a molecule that gives cells energy.

There are several therapeutic benefits to green light therapy. These effects are seen in mental activity in addition to emotional and physical reactions. Green light has been shown to improve focus, alertness, and concentration. It can ease tension and stress, giving you more energy and motivation to go through the day. Green light therapy has also been shown to aid in the treatment of sleep disorders by encouraging more restful, high-quality sleep.^{[20][21]}

2.4. YELLOW LIGHT THERAPY

Amber light therapy is another name for yellow light therapy. With a shallow penetration level and a spectrum spanning from 570 to 620 nm, it can be useful for redness-related skin conditions like rosacea or spider veins.^[22] Yellow light is absorbed by keratinocytes, melanocytes, Merkel, and Langerhans cells when it reaches the skin's surface (between 0.5 and 2 mm). These cells are essential for preserving the skin's epidermis layer. According to studies, cytochrome c oxidase, a crucial mechanism for changing biological pathways, absorbs yellow light.

The interaction between yellow light at 590 nm and epidermal cells causes mitosis and cell renewal while also hydrating and protecting the epidermis. This yellow wavelength can give the skin a much-needed boost as a stand-alone treatment, increasing dermal blood flow and leaving it looking more radiant and healthier.^[23]

2.5. LED LIGHT THERAPY

3. USE OF LIGHT THERAPY ON VARIOUS DISEASES

3.1 PSORIASIS

Skin cells might multiply up to ten times more quickly than usual when someone has psoriasis. Patchy accumulation of skin results from this. Psoriasis symptoms differ from person to person. It includes dryness, flakiness, peeling, tiny bumps, thickness, or redness, rashes, depression, stiff joints, plaque buildup, or tiny nail dents are also frequent. Psoriasis has a wide range of therapies. While some reduce irritation and dry skin, others limit the formation of new skin cells.^{[24][25][26]} It covers biological therapy, medication therapy, and phototherapy. Pharmacotherapy include use of **Corticosteroids**, **Vitamin D analogues**, calcitriol, **Retinoids**, **Calcineurin inhibitors**, Salicylic acid, Coal tar and Anthralin for long term or short-term use.^{[27][28]} It may take an average of 4 to 6 weeks or 12 to 16 weeks.

Phototherapy for Psoriasis: To impede the proliferation of skin cells, the doctor exposes your skin to UV rays. It can be used either by itself or in conjunction with medicines. Although a person may receive three Trusted Source phototherapy sessions spread over 4 to 12 weeks. Skin will be able to repair in between treatments.



Figure 3 : Phototherapy for Psoriasis

There are some types of phototherapies include

- i) **Goeckerman therapy**- a strategy that incorporates light therapy and coal tar treatment.
- ii) **UVB broadband**- extensive psoriasis, and psoriasis not relieved by topical treatments can be treated.
- iii) **Psoralen plus ultraviolet A (PUVA)**-Combining a psoralen with a particular type of UV light.

Studies indicate that 50-90% of patients experience either a discernible amelioration or total remission when utilizing light treatment for psoriasis.^{[29][30][31]}

3.2 SEASONAL DISORDERS

One kind of depression is called seasonal affective disorder, or SAD. It usually occurs in the fall or winter, but it also appears throughout other seasons of the year. It is believed that shorter days and reduced daylight may cause a chemical shift in the brain that results in depressive feelings. Antidepressants and light therapy are two treatments for SAD. The medication may take up to 4 or 6 weeks to start working fully.^{[32][33][34]}

Phototherapy for SAD: Light therapy is an effective way to significantly elevate SAD sufferers' mood. To do this, you must spend thirty to an hour every morning sitting next to a light box, a type of specialty lamp. A brilliant light is produced by them. During the darker winter months, the light produced by the light box replicates the absence of sunshine. Through promoting the brain to produce more serotonin, a hormone that impacts mood, and less melatonin, a hormone that makes you drowsy, the light may help SAD.^{[35][36]} The phototherapy produces an effectiveness for treatment of SAD is 57%.



Figure 4: Light box and phototherapy for SAD

3.3 VITILIGO

Skin loss of pigmentation or color is a symptom of vitiligo. The skin turns white or seems paler than it normally would. Melanocytes are destroyed by the immune system in your body, which results in the disorder.^[37] It is most usual for vitiligo symptoms to appear on the hands, feet, arms, face, mucous membranes (the insides of your mouth, lips, and nose), and genitalia.

A specific prescription cannot reverse the effects of vitiligo on the skin; however, several medications can assist melanocytes sprout, slow down the rate at which pigmentation is lost, or restore color to the skin.^[38] Treatments for vitiligo may involve corticosteroids, topical Janus kinase inhibitors (ruxolitinib), and blockers of calcineurin.^[39]

Phototherapy for Vitiligo: Skin color can be restored with the use of light therapy. It can require multiple rounds of light therapy like 2 to 3 sessions per week. Depend upon severity of vitiligo the session may vary. Vitiligo in broad patches of skin can be treated with UVA (phototherapy ultraviolet A) combined with oral psoralen medicine. For those with vitiligo on their head, neck, torso, upper arms, and legs, this treatment works well.^{[40][41]} 74% efficiency is produced through 6 months sessions.

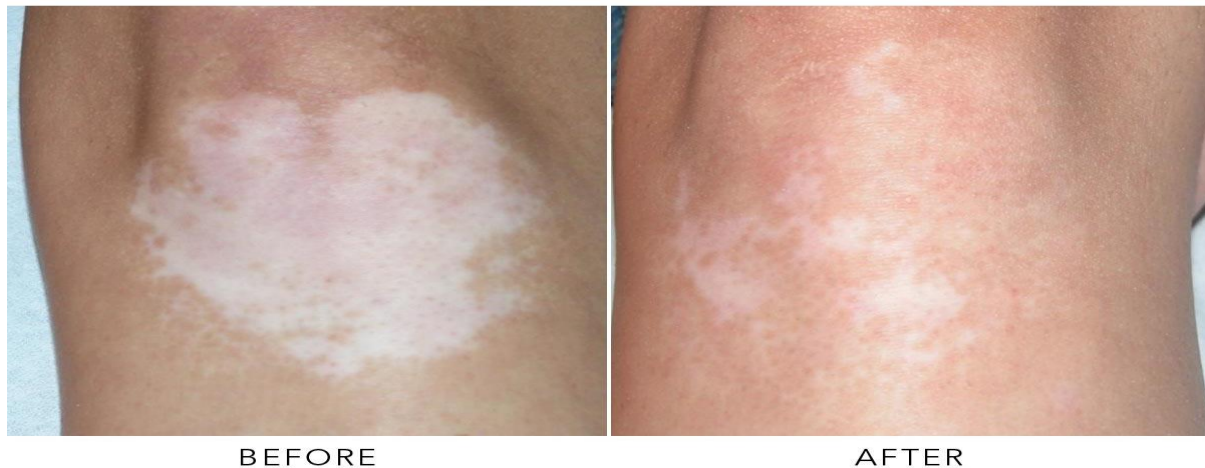


Figure 5 : Phototherapy for Vitiligo

3.4 SKIN CANCER

The development of aberrant cells in the tissues of the skin is the cause of skin cancer. Normally, new skin cells develop to replace aging and dying skin cells. Cells proliferate more quickly when this process isn't functioning properly, such as after being exposed to ultraviolet (UV) light from the sun.^{[42][43]} Chemotherapy courses typically last three to six months, though they can last longer or shorter. Chemotherapy medication will be a part of the treatment.

Phototherapy for Skin cancer: Photodynamic therapy (PDT) uses medications known as photosensitizers to kill cancerous cells as well as other harmful cells. These medications are activated by light, which sets off a chemical reaction that kills the dangerous cells. The pharmacological effectiveness of photodynamic treatment provide 82%. Depending on the kind of phototherapy, the course of treatment will vary.^[44] For example, broad band therapy may need three to five sessions per week. Narrow band therapy calls for two to three sessions every week. About 25 treatments spread over two to three months are typically needed for PUVA treatments.

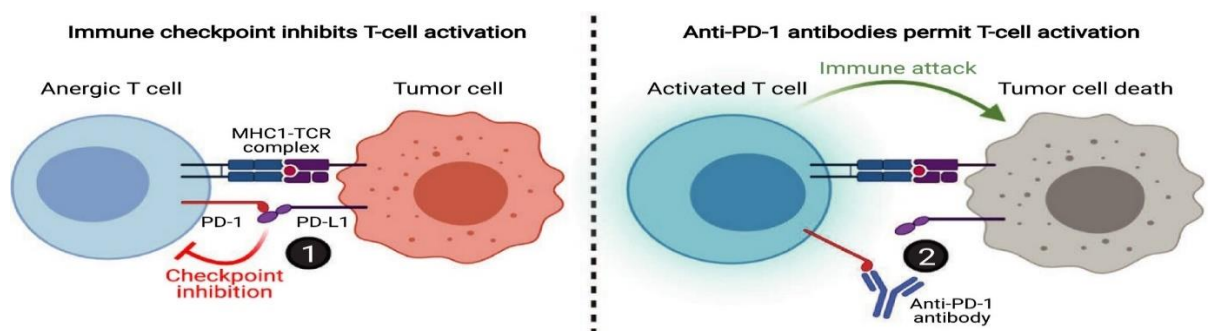


Figure 6 : Phototherapy for Skin Cancer

3.5 NEONATAL JAUNDICE

Usually, the pigment known as unconjugated bilirubin deposits in the skin and mucous membranes, causing jaundice. This condition may manifest at any point during the neonatal period, depending on

the underlying etiology. when the total serum bilirubin level is more than five times the birth weight, to begin phototherapy. [45][46]

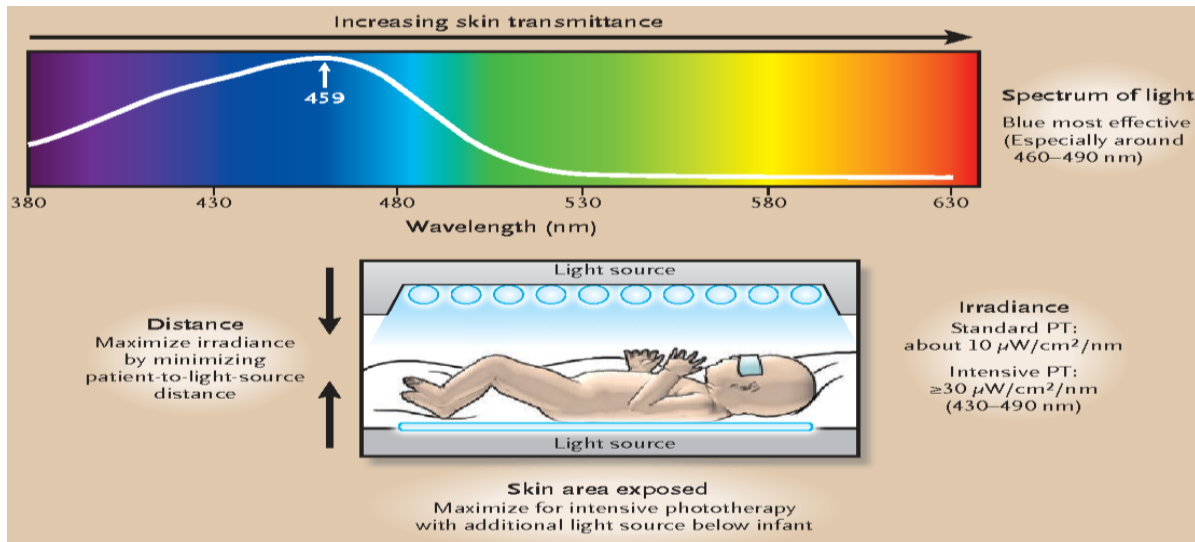


Figure 7 : Phototherapy for Neonatal Jaundice

Phototherapy for Neonatal jaundice: Phototherapy is initiated at a bilirubin level of 5 mg/dL for a 1-kg infant, 10 mg/dL for a 2-kg infant, and so on. Phototherapy may be necessary for a day or less in certain situations, or it may be needed for five to seven days. According to the AAP Guidelines, a baby who has been readmitted due to hyperbilirubinemia and whose level is 18 mg/dL or higher should have a level between 13 and 14 mg/dL before phototherapy is stopped. 99% of severe neonatal hyperbilirubinemia in term neonates is successfully treated with phototherapy, the standard treatment for significant unconjugated neonatal hyperbilirubinemia. It has also been demonstrated to reduce the need for exchange transfusion and enhance neurological outcomes. [47]

3.6 MIGRAINE

Different levels of headache, frequently accompanied by light and sound sensitivity and nausea. Although they rarely pose a threat, migraines significantly impair your quality of life. They also raise your chance of developing potentially fatal illnesses including heart attacks and strokes. [48]

Phototherapy for Migraine: Migraine attacks may become less intense with the use of green light therapy. Exposure to a specific range of green light from a particular lamp is part of this therapy. Green light doesn't seem to cause or heighten light sensitivity because it produces the fewest electrical signals when compared to other colours like red or blue. Green light therapy is said by some to lessen migraine symptoms. Green light may have this impact because it is less unpleasant than other colours or because it raises the amounts of substances in the brain that reduce pain. Research on green light therapy is limited but promising. [49]

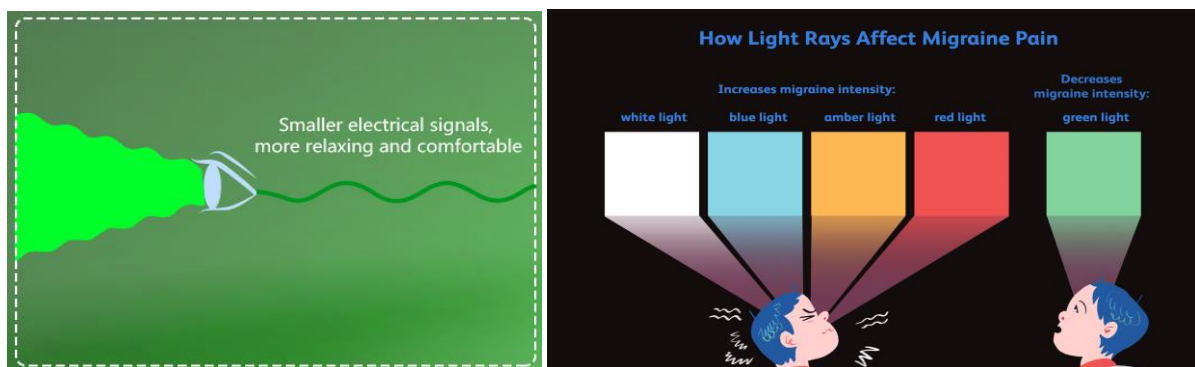


Figure 8 : Phototherapy for Migraine

3.7 ATOPIC DERMATITIS

Dry, itchy, and inflammatory skin are symptoms of atopic dermatitis, often known as eczema. It can happen at any age, although it's more common in young children. Atopic dermatitis is a chronic condition that occasionally flares up. It's not contagious, although it can be annoying.^[50]

Phototherapy for Atopic dermatitis: Eczema is treated by UVA and UVB radiation.^[51] It seems that UV light affects the immune system. It appears to specifically lower the quantity of T-cell lymphocytes in the skin. These cells are known to have a significant role in eczema and are implicated in the inflammatory response. Decreased quantity of these cells leads to decreased inflammation and corresponding amelioration of symptoms.^[52] According to research, light treatment can successfully reduce inflammation and other sensations like itching, allowing the skin to temporarily recover. Long-term relief from eczema is not achievable, though.

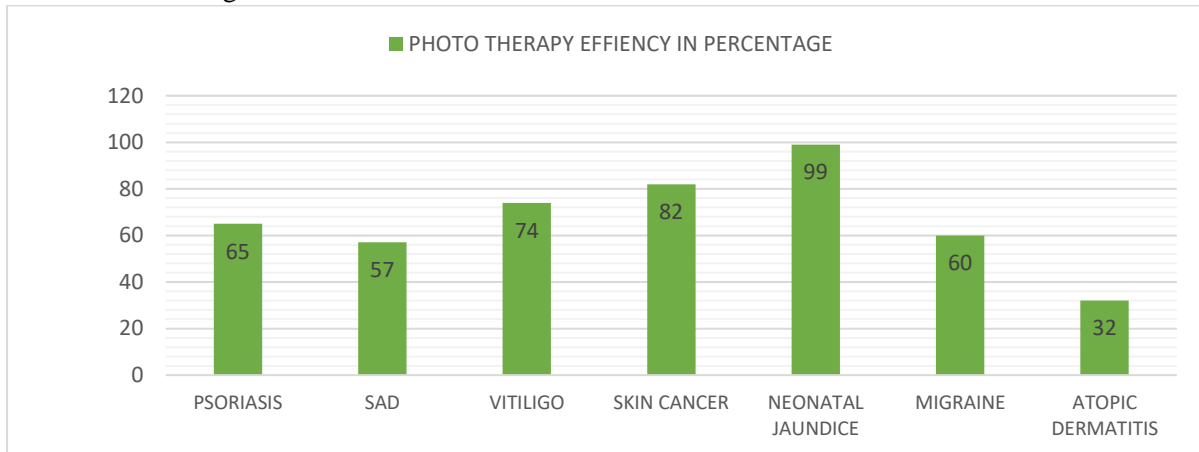
3.8 LIMITATIONS OF PHOTOTHERAPY

| S.NO | CONDITION | LIMITATIONS |
|------|--------------------|---|
| 1 | PSORIASIS | It is not advised for those who have experienced any of the following: Melanoma or other forms of skin cancer |
| 2 | SEASONAL DISORDERS | Those who have bipolar disorder, using the light box too long each time or increasing exposure too quickly may cause manic symptoms. |
| 3 | VITILIGO | Skin stinging or irritation along with a reaction resembling a sunburn. |
| 4 | SKIN CANCER | Sunburn risk increases following PUVA treatment because the psoralen is more sensitive. |
| 5 | NEONATAL JAUNDICE | Alteration of circadian rhythm, Dehydration, Hypocalcemia, Bronze baby syndrome, Hemolysis, Effect of phototherapy on hemodynamics, Patent ductus arteriosus, Retinal injury, Late adverse reactions Phototherapy and allergic diseases. |
| 6 | MIGRAINE | Headaches, Fatigue or tiredness, Insomnia Hyperactivity, Irritability. |
| 7 | ATOPIC DERMATITIS | Skin may redden and itch. ^[53] |

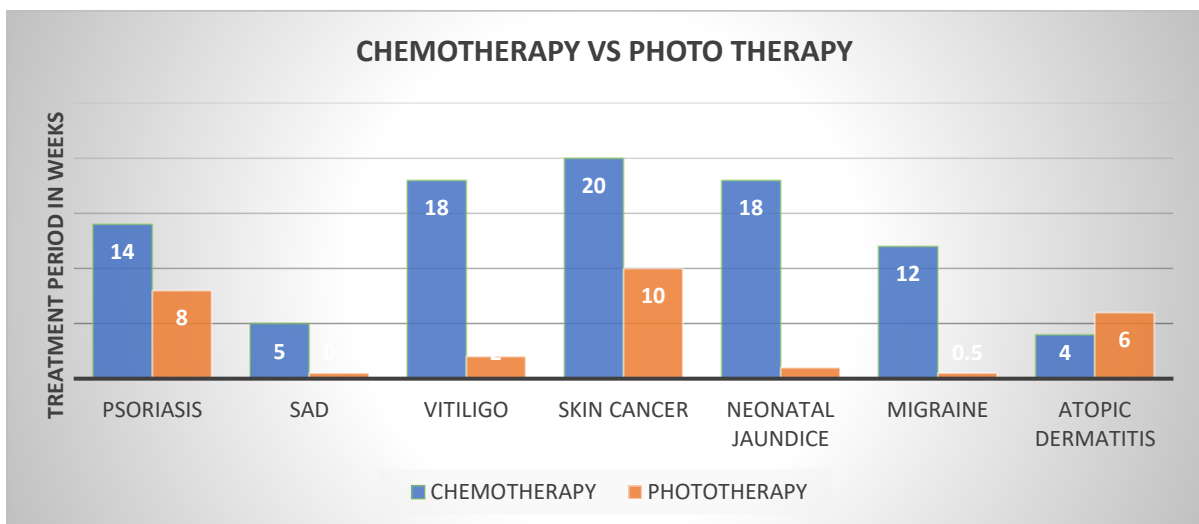
Table 2: Limitation of phototherapy

4. DISCUSSION

Overall, phototherapy is a helpful therapeutic approach that is beginning to be widely accepted for the treatment of many dermatological conditions as well as seasonal disorders. A non-invasive technique called laser/light therapy uses light energy to regenerate and repair damaged skin. According to the examined articles, NB-UVB appears to be the most effective treatment option for vitiligo, lichen planus, annular granuloma, psoriasis vulgaris, neonatal jaundice and skin cancer. Positive outcomes and a reduced risk of side effects are anticipated when the protocols and treatment guidelines are adhered to.



Chemotherapy is treated in two ways: short-term therapy and long-term therapy. Highly dosed formulations that are intended for short-term therapy have been shown to cause more side effects, while long-term therapy can lead to an accumulation of drug metabolites that can cause toxicity. Phototherapy is one alternative for lowering side effects, treatment effectiveness, and frequency of administration. Phototherapy encourages diseased cells to mend themselves and aids in recovery.



Given that the majority of the aforementioned dermatological conditions exhibit a notable rate of remission following a variable number of phototherapy sessions, more consideration should be given to this therapeutic approach.

5. CONCLUSION

Even though more research is needed on some phototherapy treatment options, recent advancements in this field have made it possible to provide more effective and comprehensive care.

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