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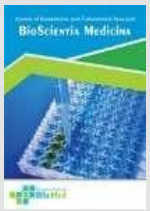

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Advantages of Using an Air Purifier for the Control of Atopic Dermatitis

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A B S T R A C T

Numerous studies have been carried out to ascertain the detrimental impact of air pollution on allergy conditions such as asthma, allergic rhinitis, and atopic dermatitis. Substandard indoor air quality exacerbates atopic dermatitis, which can be attributed to several reasons. Proper air circulation is crucial in households, especially in areas with high foot activity, since it can lead to elevated amounts of air contaminants entering the space. Indoor air pollutants, such as house dust mites, volatile chemical compounds, particle matter, and indoor mold, can aggravate atopic dermatitis. An air purifier effectively enhances the quality of indoor air. This gadget offers significant advantages for those with atopic dermatitis by effectively mitigating the frequency and intensity of disease relapses.

1. Introduction

AD is a persistent and recurring inflammatory condition that causes eczematous lesions of varying appearance accompanied by itching.[1] The prevalence of AD has more than tripled, making it a significant global health concern. Epidemiological research indicates that the global incidence of AD varies between 1% and 20%. The incidence rate for children varies from 0.2% to 24.6%. However, there is limited information available for adult AD, with an estimated prevalence rate of roughly 1% to 3%.[2,3] The Children's Dermatology Study Group (KSDAI) in Indonesia has found that atopic dermatitis (AD) is steadily increasing each year. Among the top 10 kids skin illnesses, atopic dermatitis remains the most prevalent, accounting for 23.67% of cases in five major Indonesian cities.[4,5]

Atopic dermatitis arises from an intricate interplay of hereditary and environmental variables. Researchers have devised various therapeutic strategies for atopic dermatitis (AD), including moisturizing the skin with emollients, avoiding allergens or triggers, and using antihistamines or corticosteroids during the worsening phase. It is crucial to identify the specific trigger variables for each individual in order to effectively manage individuals with AD.[6,7] Researchers have conducted numerous studies to determine how air pollution negatively affects allergy conditions like asthma, allergic rhinitis,

and atopic dermatitis (AD). Exposure to air pollution can trigger individuals who are sensitive. Several prior studies have examined the magnitude of the impact of air pollution on DA. Observations have identified air pollutants, such as nitrogen oxides (NOx), particulate matter (PM), volatile organic compounds (VOCs), and butyl benzyl phthalate (BBzP), as risk factors in AD.[8-10]

Indoor air pollution is a significant issue. Approximately 90% of contemporary everyday activities occur in indoor environments. Particulate matter (PM) is a kind of air contaminant that is frequently associated with human health issues. Particulate matter (PM) refers to a combination of solid and liquid particles present in the atmosphere. Certain particles, such as dust, dirt, soot, or smoke, possess a size or color that allows them to be visible without the use of optical instruments. Only an electron microscope can identify extremely minute materials. PM2.5 is a shortened form of inhalable tiny particles that typically have a diameter lower than 2.5 micrometers. PM 10 refers to particulate matter in the atmosphere that consists of minuscule particles with a diameter less than 10 micrometers. Elevated levels of PM2.5 and PM10 substantially enhance the likelihood of experiencing symptoms related to AD. Traffic conditions and outside emissions from motor vehicles affect indoor levels of PM2.5 and PM10, resulting in elevated particle concentrations in regions with heavy traffic.[10-14]

Air purifiers, equipped with high-efficiency particulate air (HEPA) filters, effectively eliminate airborne pollutants within an enclosed space. Studies have established that air purifiers equipped with high-efficiency particulate air (HEPA) filters effectively diminish indoor air pollution and manage allergy disorders. Multiple studies have demonstrated the beneficial effects of air purifiers on individuals suffering from allergic rhinitis (RA), atopic dermatitis (AD), and asthma. In addition, air purifiers have the capability to eliminate various allergens, including pollen, mold spores, and house dust mite allergies. Eleven to fourteen Air purifiers demonstrate an efficacy of 75-78% for PM2.5, 72-84% for PM10, 48-64% for airborne bacteria, and 48-64% for mold in eliminating them. Therefore, using air purifiers can improve indoor air quality and reduce the frequency and intensity of AD.[13-14]

Atopic dermatitis (AD)

Itchy eczematous lesions that come and go in phases of worsening and improvement mark atopic dermatitis, a long-lasting, inflammatory skin condition. AD is typically linked to other atopic disorders, such as asthma, allergic rhinitis, or allergic conjunctivitis.[15,16] This condition is characterized by the appearance of itchy eczematous lesions that may subsequently develop excoriation or lichenification. Atopic dermatitis is more frequent on the face or extensor portions of the limbs in babies and children and on the flexor areas in adults.[17]

Atopic dermatitis is a significant global public health issue, affecting around 10–20% of children in America, Northern and Western Europe, metropolitan areas of Africa, Japan, Australia, and other industrialized nations. The incidence of AD in adults is significantly lower, varying between 1-3%. During the initial two months and first year of life, around 60% of patients receive a diagnosis for the condition. An additional 30% of patients receive their first diagnosis at the age of 5 years, while only 10% of cases with AD are identified between the ages of 6 and 20 years. Adult-onset atopic dermatitis is uncommon.[17,18] Researchers conducting 2013 epidemiological research in the USA using data from the National Health Interview Survey found that the occurrence rate of adult AD within a one-year period was 10.2%.[19-23]

Pruritus, or itching, can be extremely intense to the point of causing sleep disturbances and is a common and prominent symptom of atopic dermatitis (AD). Pruritus may manifest sporadically throughout the day, although it is often most severe during the morning and evening. Causing the development of skin lesions characterized by scratching, prurigo papules, lichenification, and eczema. The lesion will exhibit severe itching, raised bumps accompanied by scratching, redness of the skin surrounding the blisters, and discharge.[24] The presence of redness, skin abrasions, and raised, dry patches distinguishes

subacute atopic dermatitis. Thicker plaques on the skin, clear skin (lichenification), and fibrotic papules (prurigo nodularis) distinguish chronic AD.

Individuals with AD typically exhibit xerosis and cutaneous atrophy.[24] The incidence of skin response patterns varies based on the patient's age and the level of disease activity. In infancy, atopic dermatitis (AD) typically manifests more abruptly and mostly affects the facial area (cheeks), scalp, wrists, and the outside surfaces of the limbs. During infancy, individuals often experience the persistent kind of atopic dermatitis characterized by thickening and hardening of the skin, with the rash primarily appearing in the creases of the arms and legs (specifically, the inner elbow and back of the knee). In early childhood, food allergies serve as a significant catalyst; however, as children transition into adolescence, other variables such as climate and psychological strain become more prominent.[24,25]

The management of AD necessitates a methodical and comprehensive strategy that involves ensuring proper hydration and restoration of the skin barrier, using topical anti-inflammatory agents, controlling infections, and eliminating factors that might trigger the condition, such as allergens, irritants, and emotional stress. Additionally, pharmaceutical therapy and education are also crucial components of the treatment plan.[26] The Asia-Pacific Guidelines of 2013 outline five fundamental objectives for AD treatment, both in the immediate and extended periods.[27] Provide education to patients and medical workers regarding atopic dermatitis; implement strategies to prevent and modify variables in the surrounding environment that might trigger the condition; establish and sustain an ideal skin barrier function; address and manage existing inflammatory skin disorders; and regulate and eliminate the cycle of itching and scratching.

When treating individuals with AD, it is important to not only prioritize current disease therapy but also to consider enhancing the patient's overall quality of life.[27] The management of AD necessitates an individualized strategy for each patient, according to the specific stage of AD and its severity. The initial stage involves moisturizing the skin to enhance its barrier function, thereby preventing excessive trans-epidermal water loss (TEWL) and the development of dry skin. Moisturizers, available in both cream and ointment formulations, are the primary treatment option for moderate AD. The second stage of managing moderate AD involves the use of topical anti-inflammatory medications to address skin irritation. For moderate-to-severe AD, experts recommend using creams high in ceramide or FLG in combination with topical steroids or calcineurin inhibitors. For maintenance therapy, use corticosteroids with weak potency or calcineurin inhibitors. In situations of moderate-to-severe symptoms or exacerbations, healthcare providers may temporarily administer corticosteroids with medium or high potency. Studies have shown that calcineurin inhibitors and topical steroids with moderate potency used on a regular basis can help keep atopic dermatitis from coming back.[24,26]

An additional crucial long-term approach in the therapy of AD is identifying triggering variables such as diet, aeroallergens, stress, and infection. Antibiotics are effective in combating illnesses. Antipruritic therapy is necessary due to the persistent and debilitating nature of the itching, which progressively hampers disease management as scratching leads to skin sores. Physicians commonly use sedative H1 antihistamines, such as hydroxyzine, dyphenhydramine, or doxepin HCL, to alleviate sleep difficulties caused by itching. Once therapy is stopped, oral administration of steroids can relieve symptoms but may also cause a significant worsening of symptoms. Therefore, doctors can still prescribe steroids to treat acute atopic dermatitis, but only for brief durations. In cases with atopic dermatitis (AD) that does not respond to standard treatment (uncontrolled severe eczema), the next course of action is systemic therapy. This involves the use of medications such as cyclosporine, methotrexate, azathioprine, and immunotherapy.[26,27]

Air purifiers

An air purifier, sometimes referred to as an air cleaner, enhances indoor air quality by eliminating air contaminants and pollutants, including dust and

pollen.[28] This device significantly contributes to the maintenance of clean indoor air by effectively filtering air pollutants, hence enhancing the comfort of those with asthma and other allergic conditions.[29] Commercial air purifiers come in two forms: compact standalone units or larger units that can be integrated into air handler units (AHU) or heating, ventilation, and air conditioning (HVAC) systems commonly found in hospitals, factories, and industrial industries. Air purifiers in industrial settings commonly remove contaminants from the air before processing.[28-30] Air purifiers include many air filtration technologies. Air purifiers typically consist of five main steps.[28-30]

Initial filtration stage

The pre-filter serves as the initial phase of air filtration within the air purifier. A pre-filter is essentially a fibrous mesh with a comparatively larger pore size. The primary function of this pre-filter is to remove larger particles from the air, preventing them from obstructing the HEPA filter.[36] The pre-filter captures particles such as hair and dust.[29]

HEPA filter

HEPA filters, composed of fiberglass, effectively remove airborne pollutants. HEPA filters have the ability to eliminate a minimum of 99.97% of airborne particles that are as small as 0.3 micrometers (μm) in diameter. The HEPA filtration system must be fully sealed for optimal functioning. The maintenance expenses associated with this HEPA filter are comparatively greater in comparison to other filters. However, proper use and upkeep of the prefilter can extend the lifespan of the HEPA filter by about 25%. HEPA filters function through interception, impaction, and diffusion modes. Within the interception mechanism, particles adhere to the fiberglass as they trace the trajectory of incoming air currents along flow lines. The impaction process propels bigger particles with the incoming air flow, compelling them to combine with each other in the filter. During the diffusion process, particles having a size of ≤0.1 μm will undergo collisions with one another within the airflow. The fiber in the fiberglass will trap these minuscule particles upon entering, either through interception or impaction processes.[4] HEPA filters often remove particles such as fine dust, flower pollen, pet dander, and dust mites.[28]

Activated carbon filter

Carbon filters are the predominant filters utilized for the elimination of gas, smoke, or smells. The carbon filter possesses resilient, minute pores that effectively interact with certain particles, causing them to adhere to the carbon surface. The chemical media of the active carbon layer reacts with gas pollutants, smoke, or pungent odors, forming compounds that are then retained within the filter.[28] Carbon filters purify gases by passing them through a layer of activated carbon (also known as activated charcoal). These filters commonly remove various chemicals from gases. Household goods emit volatile organic compounds (VOCs). Frequently employed, this filter captures malodorous pollutants present in the area, such as the scent of tobacco smoke, culinary fragrances, and the body odor of dogs and humans, to eliminate airborne scents. Carbon filters are ineffective at eliminating small particles like mold, dust, or pollen from the air.[21]

Ultra-violet germicidal irradiation (UVGI)

UV light in air purifiers utilizes UV radiation to release ultraviolet (UV) radiation into the surrounding environment. Microorganisms, including bacteria, fungus, and viruses, are of such minuscule size that they can occasionally penetrate the HEPA filter. The UV filter primarily eliminates microorganisms and pathogens from air that has not undergone effective filtration.[28] The majority of germicidal UV lights available on the market are low-pressure mercury lamps that produce radiation at a specific UVC wavelength of 253.7 nm. UVGI rays function by impairing the DNA structure of these microbes, rendering them incapable of reproducing and, hence, non-infectious.[16]

Electric ion generator

Artificial ion generators function by changing the ion composition of the surrounding air through the emission of ions into the atmosphere. Manufacturers

have created and sold ion generators as household air purifiers designed to eliminate indoor dust and smoke. The ions emitted by the ion generator adhere to airborne pollution particles. These particles will exhibit repulsion and move towards interior surfaces, such as walls or floors. As a result, this equipment expels polluting particles from the air in the room.[28]

The significance of air purifiers in the treatment of atopic dermatitis

Genetics, environmental factors, or the interplay between the two contribute to the incidence of AD. Several sources link the recent rise in the occurrence of AD to heightened exposure to different environmental stimuli rather than heredity. Turning off genes that make the cornified envelope (keratin, filaggrin, and loricrin), dropping ceramide levels, increasing activity of natural proteolytic enzymes, and causing increased water loss through the skin lower the skin's protective barrier function. These alterations in the outer layer of the skin are linked to atopic dermatitis. These alterations in the outer layer of the skin contribute to an enhanced uptake of allergens and the establishment of microbial colonies. Allergen-induced sensitization of the epidermis leads to the activation of an allergic immunological response in the skin.[2]

Several studies have also concentrated on the influence of environmental variables on intensifying symptoms in people with AD. Aeroallergens, such as house dust mites (HDM), animal dander, and pollen, can exacerbate pruritus and eczema. Environmental factors can worsen AD by either damaging the skin barrier or triggering an immunological response. Researchers recognize indoor and outdoor air pollution as risk factors that contribute to the development of DA exacerbations.[25]

Particles emitted from both indoor and outdoor sources of combustion can potentially make a contribution. Indoor air pollution originates from wood-burning stoves, gas appliances, fireplaces, vehicular exhaust gases, and cigarette smoke. An enclosed parking facility within a building can account for up to 30% of the indoor air quality in a residential dwelling and can serve as a potential source of contaminants.[20] Exposure to indoor air pollution has significant health effects on children and neonates, since they spend around 80–90% of their day indoors throughout their first year of life.[30] While it is crucial to identify and manage environmental risk factors for the effective treatment or prevention of AD, studying the impact of air pollution on AD patients is still a difficult task.[19]

House dust mites (HDM)

House dust mites (HDM) are mites belonging to the *Pyroglyphidae* family that inhabit household dust. HDM contains feces that can trigger allergy conditions such as allergic rhinitis and atopic dermatitis. HDM allergens absorbed via the skin induce T-cell-mediated responses in sensitive individuals with atopic dermatitis. Particular Fc IgE receptors on Langerhans cells collect HDM allergens that infiltrate the skin. Langerhans cells subsequently expose the allergen to T lymphocytes, resulting in the expansion of particular T cells and the exacerbation of eczema.[2] Multiple investigations have documented that the residences of individuals with AD harbor substantial quantities of house dust mites (HDM) and their antigens, particularly on garments and bedding.[16,20]

Volatile organic compounds (VOCs)

Volatile organic compounds (VOC) are organic compounds that readily evaporate at ambient temperature due to their high vapor pressure. The compound's elevated vapor pressure arises from its lower boiling point. Volatile organic compounds encompass a range of substances, including benzene, toluene, and formaldehyde, which can have detrimental health consequences both in the short-term and long-term. A wide range of common items, including paint, wood, fabric, cleaning agents, air fresheners, cosmetics, furniture, and floor and wall coverings, emit volatile organic compounds (VOCs) through evaporation at ambient temperatures.[13]

Multiple studies suggest a correlation between VOC gas and atopic dermatitis throughout early development.[21,22] Volatile organic compound (VOC) gas causes chemical irritation that impacts the

immune system's functioning. However, scientific sources have conducted very limited research on the effects of VOCs. Exposure to volatile organic compounds (VOCs) can harm the outermost layer of the skin and intensify the impact of home dust mites in individuals with atopic dermatitis (AD).

Prior research found that individuals in the high VOC exposure group had a prevalence of atopic dermatitis three times higher than those in the low VOC exposure group.[12] Children that had more exposure to volatile organic compounds (VOCs) during the first 6 months of their lives had a notably increased incidence of atopic dermatitis. Children exposed to high levels of VOCs for around 3 years exhibited elevated levels of intoxication in comparison to those exposed to low levels of VOCs. The high and low TVOC exposure groups did not show any notable disparities in blood indicators for allergic inflammation, such as eosinophil count, total IgE, and IL-10. By the time they were 36 months old, infants exposed to new household furnishings at 6 months of age had a higher risk of developing atopic dermatitis. New furniture is known to release significant amounts of formaldehyde-volatile organic compound (VOC) gas. Additional studies indicate a strong correlation between the utilization of synthetic air fresheners and elevated levels of volatile organic compounds (VOCs) such as benzene, toluene, and ethylbenzene.[14]

Indoor fine particulate matter

Particulate matter (PM) refers to a combination of solid and liquid particles that are present in the atmosphere. Certain particles, such as dust, dirt, soot, or smoke, possess a size or color that allows them to be visible without the use of optical instruments.[10-12] Factories, power plants, waste incinerators, automobiles, construction activities, fires, and windblown natural dust are among the primary contributors to particulate matter. Particulate matter is a kind of air pollution that poses a significant risk to human health. The size of the particles mostly influences the health impacts of PM. Particulate matter with a diameter less than 2.5 μm (PM2.5) causes as many as 4.2 million premature deaths per year, accounting for 7.6% of all global deaths.[7,8] Heavy traffic is a major contributor to particulate matter (PM) emissions, resulting in elevated PM concentrations in metropolitan regions. Researchers found that living near high-traffic regions correlated with an increased frequency of asthma-related medical care visits and a higher occurrence of respiratory symptoms in children, compared to those residing near areas with lower traffic levels.[19]

Indoor particulate matter (PM) heightens susceptibility to allergy conditions such as asthma and atopic dermatitis (AD). Elevated exposure to PM2.5 substantially augments the likelihood of experiencing symptoms associated with AD.[23] There is a strong correlation between the occurrence of eczema and prolonged exposure to particles measuring 10 μm (PM10) and PM2.5 in size. Additionally, several studies have discovered that brief exposure to particulate matter (PM) exacerbates the symptoms experienced by individuals with AD. According to previous study, there is a direct correlation between symptoms of AD and levels of particulate matter (PM), particularly indoor PM.[5] Systematic reviews and meta-analyses indicate that there is a correlation between PM2.5 and the deterioration of AD symptoms in early life.[12,15]

Another study found that higher levels of indoor PM2.5 during specific seasons, such as spring and winter, strongly correlated with greater AD symptom ratings. Additionally, residences without air purifiers showed a similar association.[8] The precise mechanism by which PM might exacerbate AD symptoms remains incompletely understood. PM exposure directly damages the skin barrier. When the amount of PM2.5 in the air is high, it can create reactive oxygen species (ROS) and damage proteins in keratinocytes. This breaks down the skin barrier and makes atopic dermatitis (AD) symptoms worse.

Previous study also demonstrated that exposure to particulate matter (PM) in mice increased the generation of reactive oxygen species (ROS) within cells. The antioxidant N-acetylcysteine, on the other hand, stopped IL-8 and matrix metalloprotease-1 from activating, which reversed this effect.[3] Exposure to PM2.5 increases the production of tumor necrosis factor-α (TNF-α), which in turn decreases filaggrin production in human keratinocytes through the aryl

hydrocarbon receptor (AhR) pathway. This eventually leads to a malfunction of the epidermal barrier.[4] It is important to take into account the management of indoor PM2.5 in order to control AD symptoms, particularly in children with severe symptoms. Appropriate air circulation and the utilization of air purifiers can effectively reduce the impact of indoor PM2.5 on respiratory health.[7]

Indoor mold

The presence of mold on house walls is not only an aesthetic concern but also a significant health risk that demands attention. Contaminated air transports wall fungus, which originates from fungal spores in the surrounding environment, into the room and causes it to adhere to the walls of the home. Mold infiltrates the crevices of the home and subsequently thrives in areas with high moisture. There is a strong correlation between the presence of mold on walls and the levels of indoor PM10 particles.[9] The adhering molds often originate from the genera Cladosporium, Alternaria, basidiospores, and ascospores. This fungus possesses the capacity to generate many types of particles that have the ability to disperse in the air, including fungal spores, metabolites, and fungal fragments.[6]

Prior research found a strong correlation between the presence of indoor mold and a high chance ratio for the occurrence of AD.[7] Mold exposure can trigger an immunological response through T-helper 2 (Th2) and lead to an elevation in IgE levels, but the precise mechanism remains unidentified.[9] Another study found a strong correlation between the presence of visible mold on walls and elevated indoor PM10 concentrations.[5] The size of mold spores can vary significantly, often falling within the range of 4–20 μm.

The role of air purifiers in minimizing the recurrence of atopic dermatitis

Many types of contaminants and particles present in the atmosphere can impact the frequency and intensity of atopic dermatitis. An air purifier may effectively mitigate the presence of these pollutants and particles. Air purifiers equipped with a High-Efficiency Particulate Air (HEPA) filter effectively reduce indoor air pollution and manage allergy conditions. Several studies indicate that air purifiers provide advantages for those suffering from allergic rhinitis (RA), atopic dermatitis (AD), and pediatric asthma.[6]

The effectiveness and efficiency of an air purifier in removing these particles are contingent upon its construction and the filter technology it utilizes.[6] A study investigated the efficacy of air purifiers in removing certain particles in different child care environments.[7] The study determined that the effectiveness of decreasing particles and bio-aerosols was found to be 75-78% for PM2.5, 72-84% for PM10, 48-64% for airborne bacteria, and 48-64% for fungal. Multiple sources have conducted studies on the efficacy of air purifiers in diminishing different allergens that provoke allergy illnesses, including pollen, mold spores, house dust mite (HDM) allergens, and dog allergens.[6,7]

Another research investigated the efficacy of utilizing an air purifier to improve air quality in relation to the severity of AD.[4] The study concluded that using an air purifier significantly reduced PM (particulate matter) and VOC (volatile organic compound) levels. Subsequently, there was a considerable reduction in SCORAD (scoring atopic dermatitis) and TEWL (trans-epidermal water loss) among individuals with atopic dermatitis (AD). These findings suggest that air purifiers have the potential to mitigate the severity of AD by decreasing the presence of air pollutants, such as PM and VOC.[14,18] This research provides a foundation for contemplating the utilization of an air purifier as a preventive measure against the deterioration of clinical conditions in individuals with AD.

2. Conclusion

Atopic dermatitis can arise from several sources, and one particular element that might exacerbate AD is substandard indoor air quality. Proper air circulation is crucial throughout the house, especially in areas with high foot activity, since it can lead to elevated amounts of air pollutants entering the space. Indoor air contaminants that exacerbate

respiratory conditions such as AD include home dust mites, volatile organic compounds (VOCs), particulate matter (PM), and indoor mold. An air purifier can enhance the quality of indoor air. This technology offers significant advantages for those with AD by diminishing the frequency and intensity of the condition.

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