

Effectiveness of Indoor Plants Using Home Design Ergonomics in Improving Indoor Air Quality and Human Health: A Systematic Review

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ABSTRACT

Indoor or houseplants are pretty good for health and several studies have shown and confirmed that indoor plants improve the concentration and productivity of the residents. Their presence decreases the stress levels and significantly eliminate common air pollutants. In a limited space, the home garden is an integrated system that produces a variety of foods and agricultural products, including staple crops, vegetables, fruits, medicinal plants and more. The importance of the backyard garden as a source of biological diversity is recognized in this context. When it comes to home gardens, whether in rural or urban regions, the structure and multi-functionality allow for the supply of multiple advantages for both ecosystems and humans. Home gardens conserve a significant amount of genetic variation in plants, both between and within species. Gardening at home is a significant part of social and cultural life, as well as a way for families to earn more money and improve their lives. This review has described the importance of plants in the home and role of home garden prevailing in Saudi Arabia. Biocultural and biological relevance of home gardens are addressed, along with future research challenges and opportunities that could help define and promote the role of house gardens in agricultural biodiversity conservation and cultural legacy preservation.

KEY WORDS: INDOOR PLANTS, CARBON DIOXIDE, HOME DESIGN AND SAUDI ARABIA.

INTRODUCTION

Plants are living organisms, which is present in various colors, sizes, and shapes. Plants requires water, nutrients, air and sunlight for their survival. Planets are majorly covered by plants through every blade of grass, flower, bush, fern and tree. Plants can be found in a variety of sizes and shapes on land and sea, ranging from forests to deserts, and they can be found almost anywhere. Plants are so crucial to human existence that we would not be able to survive without them. In addition to being the primary source of energy for the sun, plants are the building blocks of practically every food chain on the planet. The vast majority of plants are utilized for medical purposes and to treat human diseases. As with animals, the use of therapeutic herbs began instinctively. Because of the lack of information at the time on the causes of illnesses or the plants that could be used to treat them, everything was dependent on personal experience. For a long time, the use of medicinal plants was based solely on empiricism, but this changed throughout time as scientist

began to understand the causes behind the plants' efficacy. Before 16th century iatrochemistry, plants were used to treat and prevent sickness. Although synthetic drug efficacy is falling and there are increasing contraindications to their use, natural medicine is once again becoming a hot topic (Petrovska, 2012).

The concentration of air pollutants can reach lethal levels in current energy-saving airtight structures, posing a major risk to human health. Although the stomatal and non-stomatal processes driving phytoremediation are poorly understood and not yet well characterized, plants can effectively remove contaminants and improve indoor air quality. Most indoor plants are chosen for their aesthetic qualities, rather than their physiological needs, which reflect their ability to eliminate contaminants from the air they breathe. Human health is gravely endangered by indoor pollution, which can be improved by using plants, however this is a cost-effective and environmentally friendly option that is being underutilized. There is, however, a lack of consideration for the physiological processes and mechanisms involved in phytoremediation when selecting plants for indoor use (Brilli et al., 2018). Some researchers have found that rooms with plants have less dust and mold than rooms without

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any foliage. Leaves and other parts of the plants act as natural filters to catch allergens and other airborne particles. Common low-light houseplants like Chinese evergreen or the peace lily can do the job, Der Sarkissian, (2021).

Indoor plants can purify air through a variety of methods: absorption, dilution and precipitation. Indoor plants are regarded to be natural air filters. Photosynthesis is a well-known plant activity that cleans the air by absorbing carbon dioxide (CO₂) and exchanging it for oxygen. Plants also absorb oxygen and exhale CO₂ during the process of respiration. The stomata, which are the primary plant device for absorbing and removing water and nutrients, are responsible for the movement of air in and out of the plant. There are many ways in which plants might help restore the ecological balance in our atmosphere. Besides removing pollutants like CO₂ and volatile organic compounds, carbonyl, particulate matter, organic compounds, calcium, ozone, and carbonate, plants may also remove these pollutants from the air. As a low-cost alternative to reducing indoor pollution and minimizing human exposure to hazardous substances, indoor plants can be considered (El-Tanbouly, Hassan, & El-Messeiry, 2021).

Indoor plants have been shown to have a positive impact on office workers' productivity and well-being, as per confirmed studies. Psychophysiological stress responses, task performance, emotional states, and room assessments are some of the outcomes that can be measured during the experiment. Limited documented studies on the effects of indoor plants on health and discomfort symptoms associated with sick building syndrome, including attitudes toward plants in the workplace. Only limited studies have observed at how plants in the home can affect people's mental health, and those have all been done in a controlled environment. Using laboratory tests to support statements about causation has significant advantages. Environmental control, self-selection control for varied experimental circumstances, and precision measurement of performance on standardized tasks are a few examples of these methods are in usage. To the point where they can lead to unrepresentative conduct in the workplace because of their artificiality and short duration. The outcomes of laboratory or simulated studies may not be applicable to real-world workplaces (Bringslimark, Hartig, & Patil, 2007).

Plants are frequently used to brighten up a room, whether it be a home or a workplace. Indoor plants have been shown in investigations over the last three decades to greatly lower the majority of urban air pollution. It's also important to look for ways to improve indoor air quality and microclimate conditions without using any additional energy, as these processes utilize a lot of it. 10–20% of ventilation and air conditioning energy costs can be saved by using indoor plant designs. Between 80-90% of humans spend most of their time inside the house. As a result, air quality and comfort within the home are critical considerations.

Sick building syndrome, characterized by headache, eye, nose, and throat irritation, weariness, dizziness, and nausea, can occur if indoor air quality is poor. Sick building syndrome affects an estimated 27 million office workers

in the United States and 30% of new buildings worldwide. People are living in increasingly restricted places due to the energy crisis, which increases the concentration of pollutants in the air. The levels of indoor air pollution are normally two to five times higher than those of outside pollution, but they can reach a 100-fold increase. Ventilation is the simplest way to reduce the amount of air pollution in a structure. In the winter, even a brief period of ventilation results in a significant loss of heat, which leads to insufficient ventilation inside the home. As a result, mechanical ventilation uses a great deal of electricity (Han & Ruan, 2020). A staggering 47% (~2.9 billion people) of humanity resided in cities in the year 2000.

There is a wide range of estimates on how many people would live in cities in the 2030s: between 60-90%. More than two-thirds of the people in European countries live in cities. In addition, those who live in urban areas spend at least 80% of their time indoors. There can be no doubt about the importance of indoor air quality to human health and productivity are directly impacted by a reduction in indoor air quality. CO₂ is one of the gases whose concentration can rapidly fluctuate as a result of human metabolic activity in the home. Inhaled air, which contains 21% oxygen and 0.033% CO₂, degrades to 16-17% oxygen and 4% CO₂ upon exiting the lungs. CO₂ levels are expected to rise dramatically in places where people congregate, such as public schools, shopping malls, and hospitals. When the concentration of CO₂ in the air rises, it can cause exhaustion, a loss of awareness, and sleepiness inducing a condition called carbon dioxide narcosis, (Drechsler and Morris, 2022).

It's also common for greater CO₂ concentrations to create a number of complaints that result in a decrease in performance that can't be pinpointed. Over 1,000 ppm of CO₂ causes headaches, dizziness, weariness, and a general feeling of drowsiness; 1,500 ppm or more of CO₂ causes throat irritation, nose irritation, nasal discharge, coughing, and discharge from the eyes and eyes, as well as irritation of the respiratory system (Cetin & Sevik, 2016).

Public health is influenced by the quality of the air we breathe. In the same way that poor outdoor air quality can create health issues, poor interior air quality can do the same. It is possible to have symptoms such as rashes and itchy eyes when exposed to indoor air pollution. Chronic obstructive pulmonary disease (COPD) and lung cancer are just two of the most serious long-term health effects that can result from long-term exposure. Most people spend 80–90% of their time indoors, including at home, school, work, the gym, and on public transits, such as buses and trains. Indoor contaminants are 100 times more concentrated than outdoor pollutants, according to the US Environmental Protection Agency (EPA). Indoor air quality must fulfill specified requirements in order to prevent a wide range of diseases, both short and long term, from developing. It is fairly uncommon for countries to have vastly varying criteria for indoor air quality.

World Health Organization (WHO) 2021 has recently released global indoor air quality guideline and recommendations

aimed at preventing dangerous contaminants and reducing exposure to them in space. Guidelines for indoor air sanitation issued by the Ministry of Health of the Republic of Indonesia are the basis for Indonesia's indoor air quality standards. The accumulation of pollutant levels in a room has been studied in a variety of locations and with a variety of different contaminants. According to most studies, the room's pollutant levels are greater than they should be. Household activities such as cooking, cleanliness, candle burning, and cigarette smoking contribute to a higher concentration of particulate matter in the inside environment than outside. PM_{2.5} from inside a room was found to be more effective at lowering lung function than PM from outside the room, a study showed Building factors such as the year of construction, the year of restoration, and the heating method utilized all affect pollution levels. Infections of the lungs and airways might be facilitated by high levels of air pollution in the room.

There is an association between the usage of domestic fuels including kerosene, coal, and firewood and the frequency of lung illnesses. Other studies claim that the 96 emits indoor pollutants. The use of coal and firewood to improve indoor air quality may raise the risk of tuberculosis infection. Asthma and COPD have also been linked to higher amounts of pollutants in a room, according to certain studies. 150 preschool-aged children in the US were part of a longitudinal cohort research that found a link between elevated PM levels and an increase in asthma symptoms. As a result of exposure to indoor PM_{2.5} particles and the absence of inhaled corticosteroids, school-age children's lung function declines. Indoor NO₂ exposure was found to be linked to an increase in asthma episodes when the concentration of NO₂ in the air went up. After repeated exposure to NO₂, an asthma patient's asthma reaction to pollen increased. Though a systematic study did not find a substantial link between VOC exposure and asthma, it is possible that it causes inflammation of the airways in those who are exposed to it. According to numerous meta-analyses, exposure to indoor pollutants, particularly those arising from the use of solid fuels such as coal and firewood, can cause COPD and lung cancer (Susanto, Winardi, Hidayat, & Wirawan, 2021).

Plants in the home are a natural component of the environment, but the impact they have on the indoor environment and on people has not been studied. An indirect psychological effect on task performance, health, and stress levels has also been found through the use of plants in the home or work environment. Indoor plants may purify the air in your home, and they have been extensively studied in this regard. Sensory, solar, acoustic, and human health and comfort are just a few of the possible uses for indoor plants. Utilizing all of a plant's properties is beneficial to human health and well-being. Engaging in physical and mental activities in the great outdoors has been shown to have numerous health advantages. This shows that bringing nature indoors can be an effective means of enhancing people's choices connection to the natural world. There has been a long tradition of cultivating plants indoors. Having living things around made people feel more secure and

relaxed, but there is a lack of knowledge about how these psychological impacts work (Deng & Deng, 2018).

Bio-filtration and phytoremediation have been studied in laboratory trials as passive ways for eliminating indoor pollutants from the water, soil, and air. A lack of comprehensive study and meta-analysis of phytoremediation systems' indoor contaminant efficiency, chamber specifications, plant leaf areas, airflow rates, light intensities and duration despite decades of research output in the field. Bio-filtration, botanical filters, and potted plants will be evaluated in this article by comparing the removal efficiency of their air chamber volumes and other building envelope design-related factors (Parhizkar & Elzeyadi, 2020).

Saudi Arabia is a prime region, located in the southwest corner of Asia at the crossroads of Europe, Asia, and Africa. Eastern and western coasts each have the important industrial cities of Jubail and Yanbu. Oil and petroleum-related industries and businesses are encouraged and promoted by the Royal Commission (RC), which administers the two cities. These include the production of organic chemicals and fertilizers, plastics and synthetic materials. Sulfur dioxide, ozone, nitrogen oxides, and hydrogen sulfide are among the characteristics being monitored by air quality monitors and meteorology network stations around Saudi Arabia as a result of the construction of industrial cities like Jubail and Yanbu.

As a result, Saudi Arabia's cities have the region's cleanest air. It was shown that isolating the sulfate reducing-oxidizing and nitrogen fixation bacteria helped the bacterial rhizosphere breakdown nitrogen and sulfate compounds that build up in soil. Sulfur elemental and other higher oxidation states are frequently produced in nature by microbial oxidation of more reduced sulfur forms. There are chemoautotrophs, chemoheterotrophs, and photoautotrophs that can carry out these functions. It is likely that the modest numbers of species involved in nitrification and symbiotic nitrogen fixation make these processes especially vulnerable to pollution disruptions. Bacteria which can break down sulfur and nitrogen compounds were utilized as an indicator of soil pollution by oil refineries and other petrochemical facilities. In comparison to the total bacterial count in the control area, sulfate and nitrogen bacteria were found to be significantly more numerous (Khiyami, 2008).

Customer service representatives in Saudi Arabia's eastern telecommunications providers were the subjects of an Alayis et al study to see how Indoor Environmental Quality affected their level of creativity. On the other hand, there is no statistical evidence that the quality of the air, the sound, the noise, the interior design, or the scenery affects the level of creativity. In addition, while age, experience, and education level are not statistically significant differences, there are statistically significant disparities owing to gender. The findings of this study are critical for business leaders and policymakers, as well as customer service representatives, who are tasked with fostering innovative work cultures (Alayis, Amin, & Abdelmajeed, 2020).

Environmental health issues are typically linked to air pollution, both indoor and outdoor. Biological and non-biological dust particles, poisonous gases, and unpleasant scents pollute the air in slaughterhouses. In contrast, little attention was paid to the quality of the air inside slaughterhouses. In Salama & Berekaa (2016) studies, the levels of particulate matter, hazardous gases, and bio-aerosols in the slaughterhouse indoor environment were assessed. The results of Salama et al studies show that industrial sources and traffic above the slaughtering area have a greater impact on air quality than the regulation allows for. The proximity of the slaughterhouse to Dammam in Saudi Arabia second-largest industrial city, has a considerable impact on the quality of the air both within and outside the building. Bioaerosol production and bacterial contamination should be managed in slaughterhouses by the use of an effective ventilation system and strict adherence to hygiene guidelines (Salama & Berekaa, 2016).

Many studies have been carried out in the Saudi Arabia among indoor plants and home design (Al-Jeelani, 2009; Al-Mazam & Mohamed, 2001; Khiyami, 2008 a). In conclusion, Indoor plants plays a major role in impacts on occupational health. Home gardens' biocultural and biological importance are discussed, as well as prospective research challenges and opportunities that could assist define and promote the role of house gardens in agricultural biodiversity conservation and cultural legacy preservation. This review concludes as indoor plants plays a human impact in the house as well as towards the health and the role of the home garden in Saudi Arabia.

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