

Research Paper

## Psychological and Physiological Impact of Indoor Plants and Their Maintenance

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### ABSTRACT

Majority of indoor or house plants are cultivated for decorative or ornamental purposes and are typically grown within our homes, businesses, and retail spaces. It has been hugely reported that besides aesthetics, they also exhibit several physical and psychological benefits. They bring peace and positive vibes to our residence and workplace and also purify the surroundings by reducing indoor air pollution by absorbing some volatile organic compounds. During the COVID-19 pandemic, people realised the significance of the environment and its resources which eventually made these indoor plants even more popular. The present survey-based study therefore took into account the psychological, physiological and the maintenance aspect, and interconnected and established a correlation amidst the three aspects. The study also helped us find the benefits of indoor plants on people living inside enclosed spaces, especially during the recent pandemic. 86% of the respondents reported that their stress levels decreased in the presence of indoor plants, and 52% agreed that houseplants are better than artificial air purifiers. As a result, these are presently employed to enhance mental health as well as alternatives for beautifying and enhancing the aesthetic value of homes and workplaces.

**Keywords:** *Indoor Plants, Psychological Impact, Covid-19, Air-Purification, Human Health, Maintenance of Plants, Visual Stimulus, Physiological Effect*

The recent COVID-19 pandemic suddenly caused a huge shift in the amount of time we started spending indoors. Stay-at-home orders were issued by the Indian government as well as by the governments of various other countries for a long duration, in fact several months altogether (Gostin & Wiley, 2020). Visiting outdoor green spaces became extremely rare, thus taking a toll on the physical and mental well-being of people, especially the ones who were living solitary. The pandemic caused a havoc stimulating fear in people regarding their health and economic status (Fig. 1). Social interactions were also reduced to bare minimum. This led to an increased amount of stress, anxiety, depression, insomnia (Chaudhury et al., 2020). Large number of suicide cases were

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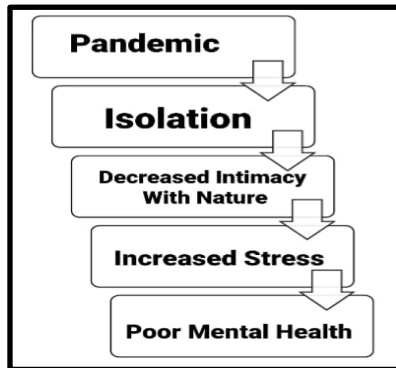
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Received: July 03, 2022; Revision Received: September 18, 2022; Accepted: September 30, 2022

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reported worldwide (Sher, 2020). On the contrary, the coronavirus pandemic also provided relief from the existing pollution crisis, since we saw a reduction in the number of vehicles on the road. The concentration of pollutants such as PM 2.5, PM 10, NO<sub>2</sub> and CO saw a major decline during the initial stage of the lockdown (Saxena & Raj, 2021).

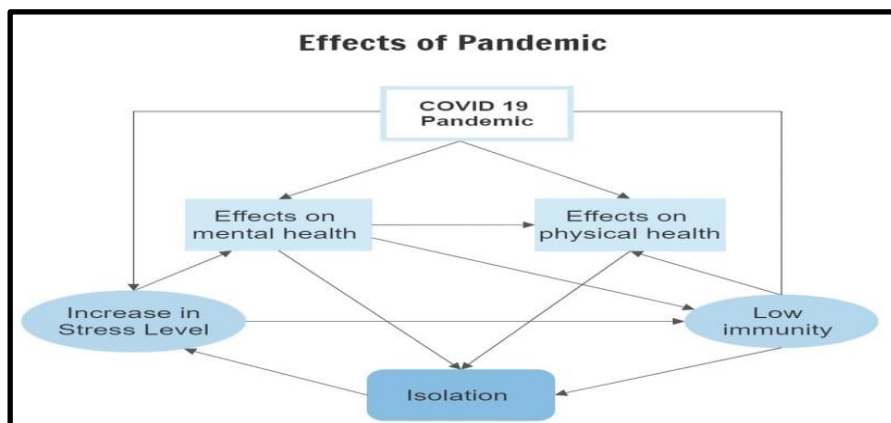
**Figure 1: Flow Chart depicting how pandemic led to poor mental health**



There have been various studies that emphasise the psychological benefits that outdoor surroundings provide to us (Triguero-Mas et al., 2017). The visual and physical exposure to plants has been correlated with reduced mental stress levels and led to relaxation and comfort levels in humans and animals (Grinde & Patil, 2009), (Piotti et al., 2021). It has also been reported that the natural environment provides a better attention span by coping with attention deficit (A. Faber Taylor & Kuo, 2009). These psychological benefits may be related to the Biophilia concept (the innate human instinct to connect with nature) which theoretically expects that plants in the natural setting would have an impact at par with indoor greenery (Grinde & Patil, 2009).

Many people tend to correlate the terms “nature” and “outdoor” which results in people paying less attention to indoor plants (Bringslimark et al., 2009). It is well known that absence of plants in our indoor surroundings can cause irritation and animosity in humans (Lederbogen et al., 2011). This scenario was essentially aggravated during the COVID-19 lockdown with people facing a lot of negative emotions (Brooks et al., 2020). We know that psychological stress weakens the immune system leading to an increase in the chances of morbidity (Dragoş & Tănăsescu, 2010). The pandemic led to a multi-layer effect triggering various aspects of life, psychological and physiological inclusive (Fig. 2).

**Figure 2: Flow chart depicting relation between various effects of pandemic**



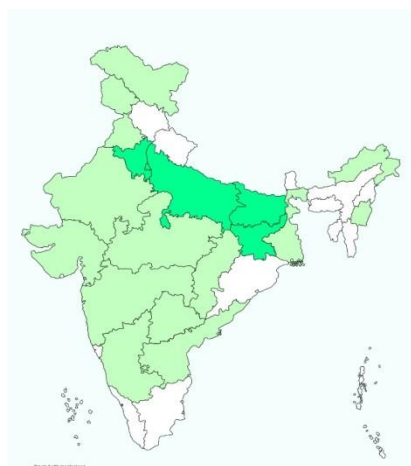
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With the lockdown imposed due to COVID-19, we actually got time to stay indoors and spend time with our houseplants, which helped us decrease our stress and anxiety levels (Dzhambov et al., 2020). Indoor pollution is also a major concern nowadays. Studies have shown that air quality inside the house has been reported to be more harmful than the quality of air outside the house (Mahfooz et al., 2022). Artificial air purifiers used to purify air inside homes come with its own disadvantages, like cost, high energy consumption and regular need for filter replacement; whereas keeping indoor plants is a great method for air purification at an environmental, cost and user-friendly alternative (El-Tanbouly et al., 2021), (Hörmann et al., 2017), (Han et al., 2022), (Grigsby-Toussaint et al., 2015). Plants can purify the air from pollutants such as carbon dioxide, VOC (Volatile Organic Compound), particulate matter and carbonyl (Pegas et al., 2012), (Hong et al., 2017), (Vardoulakis et al., 2020). Maintaining indoor plants during COVID-19 period was not only enjoyable but also proved as an escape from the negativity that accompanied the pandemic (Pérez-Urrestarazu et al., 2020). The aim of the current study was threefold:

- **The psychological aspect:** To study how house plants affect the mental health of living beings which are present around them. Also analysing the various reasons that contribute towards its growing popularity.
- **The maintenance:** To study the various methods deployed to maintain indoor plants in different regions of India and comparing the various aspects of indoor plants with outdoor plants.
- **The physiological aspect:** To study how indoor plants affect the environment around it, how it helps in reducing air pollution and allergens in its vicinity. Also, to examine their influence on the overall ambience and the aesthetic appeal of the place.

### Materials And Methods

We conducted this survey online by using Google Forms. The survey consisted of 19 questions dealing with effects of indoor plants on our mental and physical health, its maintenance and its effect on the surroundings. The respondents were given an option to keep their input anonymous. The survey was conducted from 23<sup>rd</sup> November 2021 to 4<sup>th</sup> January 2022. Total 254 responses were recorded from different regions of India. Majority of the responses were from Uttar Pradesh, followed by New Delhi, Haryana, Jharkhand and Bihar. We also got responses from West Bengal, Karnataka, Andhra Pradesh, Telangana, Maharashtra, Punjab, Jammu, Ladakh, Manipur, Arunachal Pradesh, Madhya Pradesh, Chhattisgarh and Rajasthan (Fig. 3).



Colour	% of people
Light Green	<50%
Dark Green	>=50%
No Colour ~ White	0%

**Figure 3:** Map showing the regions that our survey covered, regions with most respondents are shaded darker than other regions

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The questionnaire was divided into 5 segments. Out of the five segments, the first segment consisted of questions dealing with personal information about the participants like their age, their gender, the region they belong to and their name (optional). The second section focused on the psychological effects of indoor plants. The third segment dealt with questions related to the maintenance of indoor plants. The fourth segment focused on environmental effects of indoor plants, and the last section consisted of some miscellaneous questions about indoor plants. Keeping in mind the convenience of our respondents, we kept most of the questions with multiple choice and in few the participants were allowed to choose on a scale of five (1 being strongly disagree and 5 being strongly agree). Most questions also allowed the respondents to add their own views if they couldn't find the given options accurate leading to a fair survey.

The Google Form comprising the questions for the survey were widely circulated through mails and other social networking sites which helped in the outreach of our survey which led to the increase in efficiency of the survey by generating a wider database of responses. The questions were framed such that we could do a detailed study on various aspects of indoor plants. The multiple-choice questions helped the respondents to fill the survey even if they didn't have any prior technical knowledge about indoor plants and its effect on physiology, psychology and environment and the language was kept very simple so that the people not possessing a scientific background could also fill the survey. Thus, it helped us in maintaining the diversity of the survey.

To analyse the data gathered through this online survey, we used Microsoft Excel to plot the pie charts and bar graphs, for easy and accurate comparison of various responses leading to efficient data analysis. According to the statistics (Table 1), the majority of the respondents were from the age group 18-30 years old (65.7%) followed by the age group 30-60 years (28.3%). And the majority of the survey takers were females (77.6%). There were 21.3% male respondents whereas 0.8% people preferred not to mention their gender.

**Table 1: Characteristics of the respondents**

CATEGORY	Male	Female	Below 18 yrs	18-30 yrs	30-60 yrs	60 yrs and above
No. of respondents (out of 254)	57	197	14	167	72	1
Percentage (%)	22.4	77.6	5.5	65.7	28.3	0.4

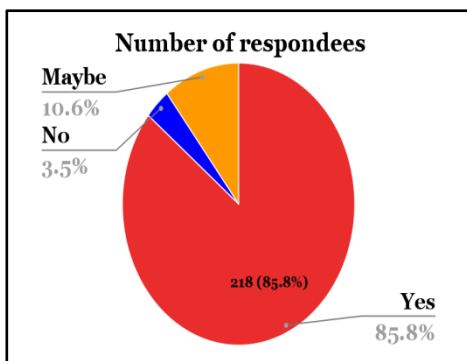
## RESULT AND DISCUSSION

### *Psychological Effect*

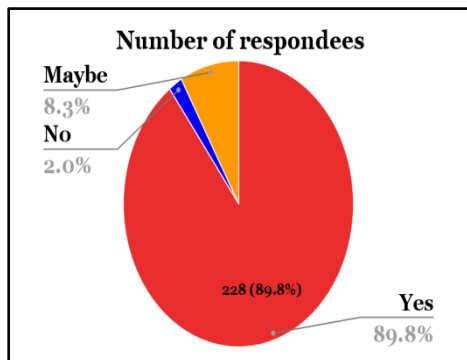
Approximately 90% of the respondents confirmed that the presence of indoor plants in their surroundings increased their intimacy towards nature (Fig. 4.1). It is well reported that indoor plants effectively increase contact time and intimacy with nature, thereby promoting our physiological and psychological health (Deng & Deng, 2018). Integrating plants into our indoor surroundings could definitely effectively increase people's engagement with nature and now after the pandemic when most of us are spending more time indoors, plants in the indoor environment are necessary to maintain our bond with nature.

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86% of people surveyed confirmed that their stress levels reduced when they looked at plants (Fig. 4.2). Lots of studies have shown the effect of the natural environment (outdoor parks, public greens spaces, home gardens) in promoting human psychological well-being and various theories such as “Pro-Nature theory”, “Attention recovery theory” and “Stress relief theory” are also proposed to prove the same (Jo et al., 2019), (Vardoulakis et al., 2020), (Berry et al., 2020), (Grainer et al., 2017). Our research also focused on the visual effect of indoor plants in decreasing the stress level of a person. Some research work is done on the impact of indoor plant’s psychological impact and the results have not reported any obvious negative impacts (Bringslimark et al., 2009). The visual effect of indoor plants is hence proven to be highly effective.



**Figure 4.1:** Pie chart depicting the percentage of respondents agreeing that indoor plants increase their intimacy with nature



**Figure 4.2:** Pie chart depicting the percentage of respondents who felt decrease in their stress level around indoor plants

On an average, 80% of people feel that their work efficiency increased while working around indoor plants (Fig. 4.3). Work environment is highly influenced by indoor plants as they help in improving ventilation in the surroundings and filtering the air effectively, as will be further proved in the survey research. According to research conducted in Chandigarh, it was found that, amongst 660 employees from various offices, the self-perceived productivity increased (Singh, 2018).

It has also been suggested in past research that flowers, specifically a rose, can decrease stress and improve health of office workers (Ikei et al., 2014). 53% of the respondents felt that both fragrant and non-fragrant plants are equally relaxing in nature while 39% were of the opinion that fragrant plants are more relaxing (Fig. 4.4). Past research has discovered that fragrant *Primula forbesii* Franch (baby primrose) led to greater relaxation and attention span than the non-fragrant *Primula malacoides* Franch (fairy primrose); which means in addition to their positive impact of visual simulation, the aromatic simulation is also proving valuable (Jiang et al., 2021). Bringslimark et al., 2009 also suggested in several studies that flowering plants are more effective than foliage plants like elephant ear (*Colocasia*), croton (*Crotons*), coleus (*Coleus*) (Fig. 4.5) in stress reduction.

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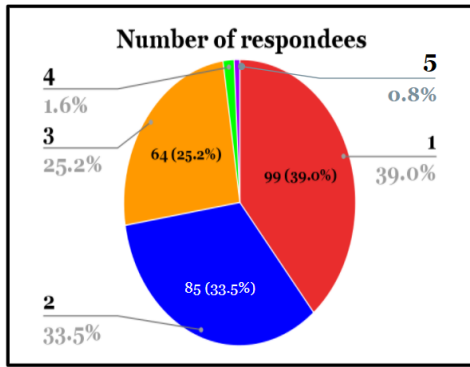


Figure 4.3: Pie chart depicting the percentage of respondents who felt increase in their work efficiency around indoor plants

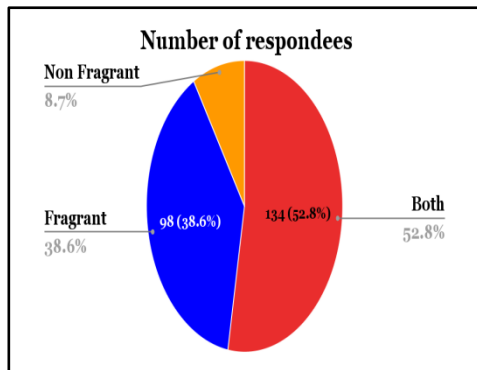


Figure 4.4: Pie chart depicting whether the respondents favoured fragrant or non-fragrant plants



Figure 4.5: *Jasminum auriculatum* (Left) and *Epipremnum aureum* (Right)

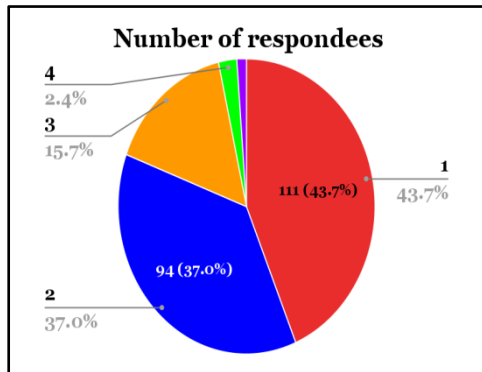
According to our survey, artificial plants provide relaxation to 18% of the people surveyed, rest of the people believe that artificial plants aren't helpful. With the increasing advent of resources, a lot of people tend to buy artificial plants but according to our research they don't really compete with real plants in terms of utility (Fig. 4.6). According to research conducted with pansies on school students, visual stimulation with fresh pansies decreased sympathetic nerve activity and the subjects felt comfortable, relaxed, and natural; the findings indicated that visual stimulation with fresh pansies (*Viola tricolor var. hortnesis*) induced physiological and psychological relaxation effects on high school students (Igarashi et al., 2015). Another research validated that real foliage plants provide more relaxation and improve concentration among elementary school children (Oh et al., 2019).

46% of the surveyees noticed different psychological changes on the positive side, among family members of various age groups, while 42% were doubtful (Fig. 4.7). Within different age groups, we experience different kinds of tasks and accordingly our energy and stress levels change. According to the change in energy and stress levels, the reaction to indoor plants may also vary. Psychological pressure on working adults is the maximum and it is

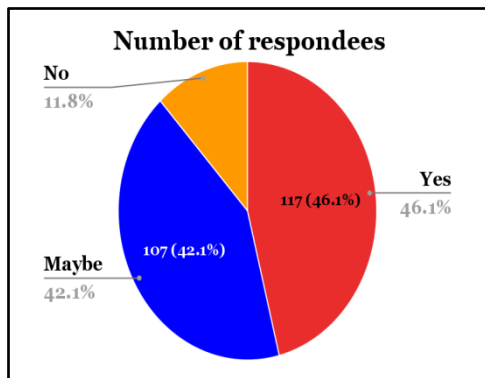


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proven previously that indoor plants help in increasing the work efficiency and decrease stress among office workers. While amongst school children, indoor plants help in improving concentration and providing psychological relaxation. The home garden is considered therapeutic which further boosts mental health (Zhang et al., 2021).



*Figure 4.6: Pie chart depicting the percentage of participants agreeing artificial plants to be as efficient as natural ones*

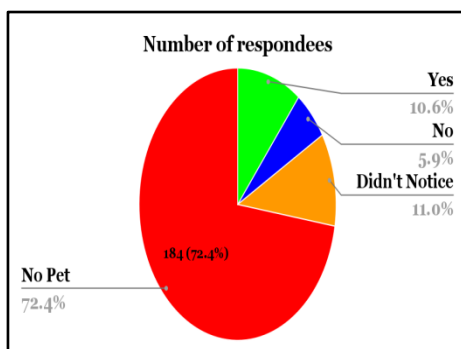


*Figure 4.7: Pie chart depicting the percentage of respondents observing psychological changes in their family members around indoor plants*

Indoor plants not only affect humans but also their pets. According to the survey, people observed different effects of indoor plants on their pets (Fig. 4.8). According to a study, it is found that many animals ingest plant parts which can be toxic to them leading to health issues (Bertero et al., 2020).

Our surveys reports that the pets even tend to show some behavioural changes in certain cases:

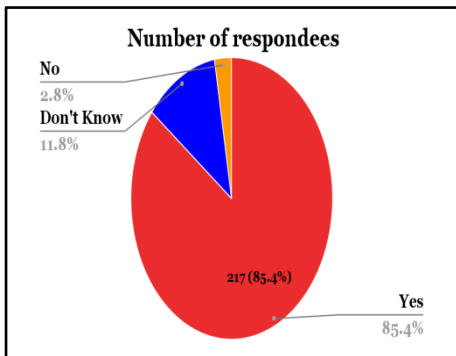
- Feels Irritated: 2 (2.5%)
- Feels Happy: 38 (46.8%)
- Likes to play with plants: 1 (1.3%)
- No difference: 2 (2.5%)
- Likes to be around plants: 1 (1.3%)
- Animals in general like to be around plants: 1 (1.3%)



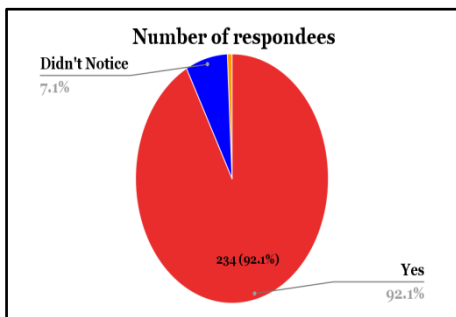
*Figure 4.8: Pie chart depicting the percentage of respondents who observed changes in the behaviour of their pets around indoor plants*

**Maintenance of Indoor Plants**

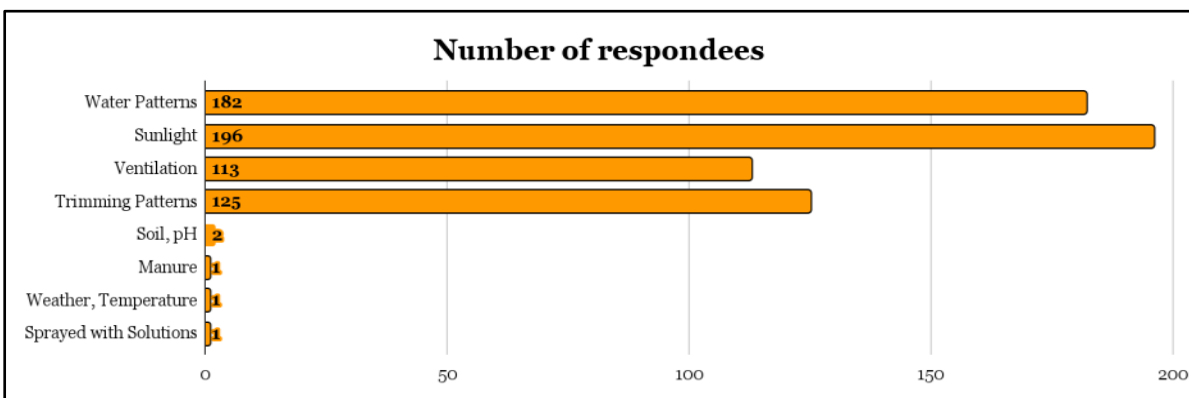
According to our survey, 85.4% agree with the statement that variation in climate leads to change in the method of maintenance, while 2.8% don't agree with the statement. There are also 11.8% who are not sure about this above statement (Fig. 5.1). It can be concluded on the basis of the answers we got, that the outdoor environment greatly affects the maintenance of indoor plants. Thus, one can't deploy the same methods to maintain plants in the tropical area and temperate zones. In case of a humid area, the plants will probably need less water and in a dry region, you will have to water the plants more frequently and almost all the surveyees (92.1%) agree with this statement. While there are 7.1% people who didn't notice and 0.8% who disagree; in totality it can be inferred that different species of plants require different maintenance strategies and one rule can't fit all plants (Fig. 5.2). Many people have different opinions about this. Some think it is the different water and ventilation requirements, while others feel they have different sunlight requirements. Different soils and manure qualities are also required (Fig. 5.3) (Kankaria et al., 2014), (Mariz-Ponte et al., 2021), (Chiang et al., 2020a), (Bunce, 2020), (He & Qin, 2021). Few of the respondents had faced special problems. Their ornamental plants developed insects very often and they had to be sprayed with insecticidal solutions frequently.



*Figure 5.1: Pie chart depicting the percentage of respondents who agreed that with variation in climate the method of maintenance also varied*



*Figure 5.2: Pie chart depicting the percentage of participants who think some special plants need specific method for maintenance*



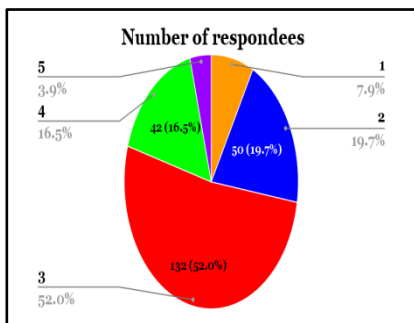
*Figure 5.3: Graph depicting the various kind of maintenance procedures for indoor plants*



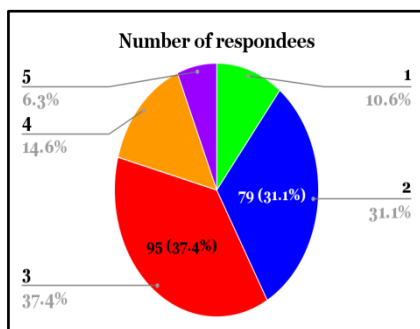
## Psychological and Physiological Impact of Indoor Plants and Their Maintenance

52% of the people surveyed believe that maintenance of indoor plants is neither very difficult nor too easy (Fig. 5.4). 20.4% people reported maintaining houseplants is easy, while 27.6% said it is quite difficult to maintain them. According to questionnaire-based research conducted during COVID pandemic, over 4205 people, “more than half of the participants were willing to host more plants at home and allocate more time for their maintenance during the confinement period” (Pérez-Urrestarazu et al., 2020). Plant maintenance may be considered not only as an enjoyable activity but also as a means of focusing the mind on a specific task, thus diverting attention from the COVID-19 situation and helping in the suppression of negative emotions.

Out of all the respondents, 37.4% maintained a mid-way opinion on the indoor plants being too expensive and, more number of people were disagreeing than those who agreed (Fig. 5.5). We can calculate that on average only 27% of the respondents were of the opinion that indoor plants are expensive in relation to all the benefits that it provides us, as discussed in our previous remarks and study. We can conclude that the amount of benefits that indoor plants provide makes it more cost-effective. It has been confirmed in a study that the Areca palm (*Chrysalidocarpus lutesens*) potted plants provided an efficient, cost-effective, self-regulating, sustainable solution for improving indoor air quality and thereby human well-being and productivity in closed and confined spaces while being not very harsh on the pocket (Bhargava et al., 2021).



**Figure 5.4:** Pie chart depicting the percentage of participants who feel maintaining indoor plants is difficult



**Figure 5.5:** Pie chart depicting the percentage of respondents who agree with indoor plants being expensive

### ***Effect of Indoor Plants on Physiology and Environment***

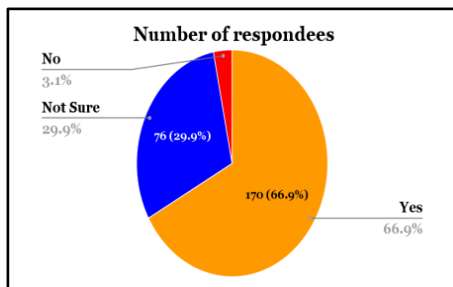
66.9% of participants felt that indoor plants help in the removal of allergens and pollutants from air leading to better overall health (Fig. 6.1) Indoor plants are claimed to have the ability to remove Volatile Organic Compounds (VOC) from the surroundings. According to some studies, it is the soil microorganism present with the potted plant responsible for the removal of VOC (Torpy et al., 2017).

Indoor plants can be a good alternative to artificial air purifiers leading to less energy consumption and benefiting ecologically and financially. People who took our survey also agreed with the fact that indoor plants are better than artificial air purifiers in terms of cost

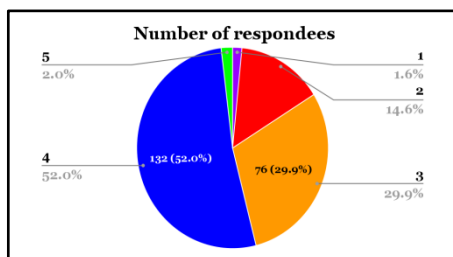
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and energy consumption (Fig. 6.2). Indoor plants can be used as natural air purifiers as they are known to improve the air quality of the surroundings as well as asthmatic patient's health (Kim et al., 2014). Indoor plants can lead to better respiratory health as 50% of our respondents noticed improvement in their respiratory health (Fig. 6.3). Indoor plants have an indirect effect on respiratory health but some small percentage of people can be allergic to pollen grains (Aerts et al., 2020). But the benefits are much more than one demerit of indoor plants. People surveyed also observed some negative effects of indoor plants such as:

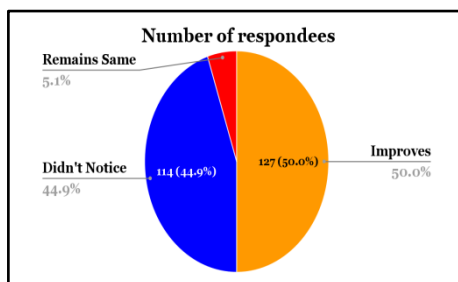
- Pollen allergy is also called allergic rhinitis. But it is majorly due to outdoor plants (D'Amato et al., 1996)
- Toxic if ingested like ivy (*Hedera helix L.*), peace lily (*Spathiphyllum wallisii*)
- Skin problems if touched (Very very rarely)
- Inbreeding of mosquitoes may happen sometimes in the rainy season.
- Needs time and energy
- Harmful for pets as they can unknowingly ingest leaves of certain toxic indoor plants such as ivy (*Hedera helix L.*), peace lily (*Spathiphyllum wallisii*) etc.
- Indoor plants which causes harmful effects like pollen allergies, skin irritation, inbreeding of insects can increase mental stress (Muliol et al., 2008), (Nathan, 2007)
- Creates dirt from sand, fallen leaves etc
- Can be harmful to kids when accidentally ingested by them or touching indoor plants that cause skin irritation like poison ivy (*Toxicodendron radicans*), giant hogweed (*Heracleum mantegazzianum*) (Fig. 6.4)



**Figure 6.1:** Pie chart depicting the percentage of participants who observed the ability of indoor plants to remove allergens and pollutants

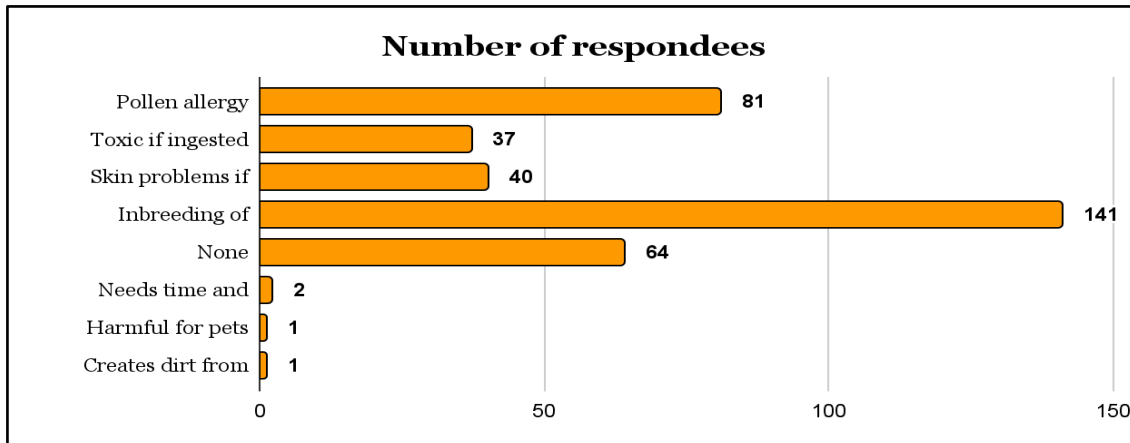


**Figure 6.2:** Pie chart depicting the percentage of respondents who think indoor plants are better air purifiers than artificial air purifiers



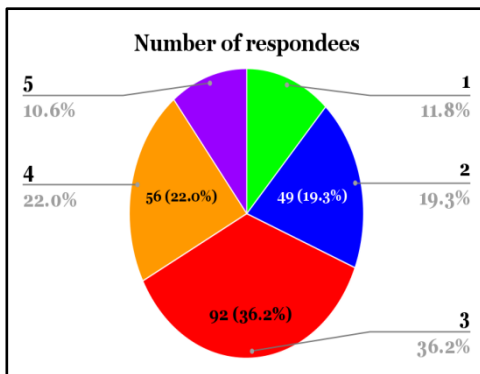
**Figure 6.3:** Pie chart depicting the percentage of participants whose respiratory health improved in the presence of indoor plants

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**Figure 6.4:** Graph showing the negative effects of indoor plants faced by the respondents

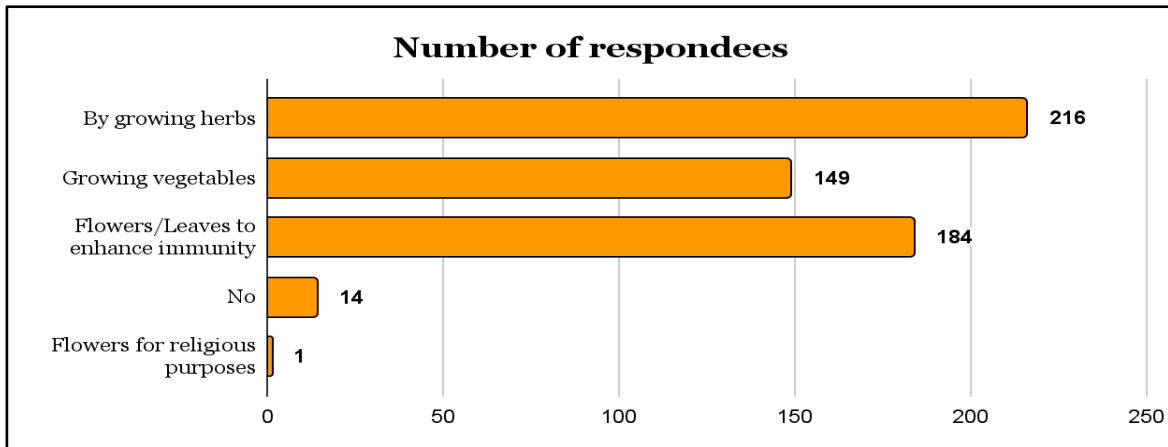
Approximately 36% of the people kept an intermediate opinion as to whether they observed any changes in the sense of touch, sight or smell while around indoor plants. More people (32.6%) agreed to this than those who disagreed (31.1%) (Fig. 6.5). ‘It is well reported that ‘Exposure to real stimuli, such as green plants, flowers, and wooden materials, had positive effects on the prefrontal cortex and autonomic nervous activities compared with the control’ (Jo et al., 2019). ‘Biophilia may be described as a vague preference for having a natural environment as a consequence of our evolutionary history. As such, one would expect that plants are agreeable, and that the absence of greenery is sensed, possibly unconsciously, as a stress factor’ (Grinde & Patil, 2009).



**Figure 6.5:** Pie chart depicting the percentage of respondents who observed changes in their sense of sight, smell and touch around indoor plants

Many indoor plants can provide us major nutritional benefits, with minimum investment. Like by growing herbs, growing vegetables, flowers/leaves whose consumption enhances immunity (Fig. 6.6). Especially during COVID times there was an immense increase in consumption of herbs like Tulsi (*Ocimum sanctum*), Giloy (*Tinospora cordifolia*), Lemon grass (*Cymbopogon citratus*), Spearmint (*Mentha spicata*), Ashwagandha (*Withania somnifera*) for increasing the immunity. India is a believer in Ayurveda and thus people had huge trust in these home-grown herbs (Singh et al., 2022), (Isbill et al., 2020). Various people prefer to consume home-grown organic vegetables as they are free from harmful chemical pesticides and boost the health rather than leading to consumption of pesticide remnants. Thus, indoor plants have uncountable benefits.

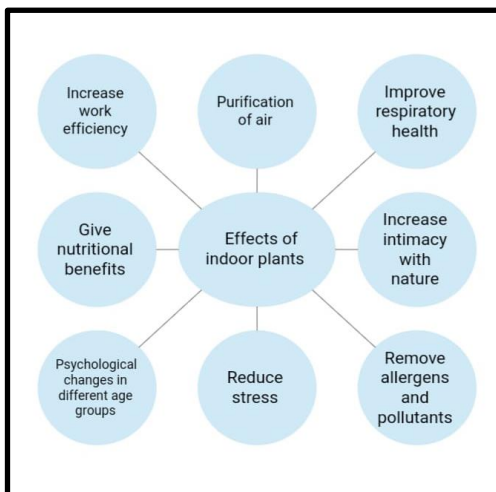
## Psychological and Physiological Impact of Indoor Plants and Their Maintenance



**Figure 6.6:** Graph depicting some nutritional benefits of indoor plants observed by the participants of the survey

### CONCLUSION

COVID-19 has suddenly disrupted the mental stability of billions of people across the world and the restriction to confined spaces only aggravated the problem. In this case, indoor plants hold a significant position in providing a simple cure for mental and physical stresses (Fig. 7). This paper primarily focuses on establishing a relationship between three aspects of indoor plants and to get an idea as to what people think of indoor plants as an aid to various problems associated with COVID-19 and otherwise. The research has successfully established a connection between maintenance, physiological and psychological aspects of indoor plants. This can be explained by the fact that the physiological conditions and the type of maintenance determines the health of the plants which are grown inside which also benefits the mental health of the people surrounded by the plants. Further research is suggested in order to study the specific correlations between the three aspects mentioned.



**Figure 7:** Cluster web representing the effects of indoor plants

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### **Acknowledgement**

The authors acknowledge and extend thanks to all those who supported the study by participating in the questionnaire-based survey and contributed in survey analysis. The authors also thank Gargi College, University of Delhi for all the support during this study.

### **Conflict of Interest**

There is no conflict of interest among the authors.

**How to cite this article:** Chamola, A., Apurva, S., Rao, A. & Ghosh, C. (2022). Psychological and Physiological Impact of Indoor Plants and Their Maintenance. *International Journal of Indian Psychology, 10*(3), 1376-1391. DIP:18.01.147.20221003, DOI:10.25215/1003.147