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Perception of indoor air quality among students in educational institutes

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Abstract
Indoor air quality (IAQ) refers to the air quality inside and around buildings and structures, particularly as it relates to occupant health and comfort. This paper aims to explore the perception of students about indoor air quality in both technological and medical & para medical colleges. An exploratory research method was used to conduct the study in 5 different zones of Hyderabad with 200 students i.e. 100 each from technological and medical & para medical colleges. The results showed that the majority of students in both technological and medical & paramedical colleges perceive the indoor air quality in classrooms and laboratories as good. In the classroom, 39% of students perceive the air quality as good, 31% perceive it as average, 9.5% perceive it as poor, and 3.5% perceive it as very poor. In the laboratory, 54.5% of students perceive the IAQ as good, 15.5% perceive it as very good, 20% perceive it as average, and 3% perceive it as very poor. In the office, 61.5% of students perceive the air quality as good, 23.5% perceive it as very good, 18% perceive it as average, and 4% perceive it as very poor. However, there is a small percentage of students who perceive the air quality as poor or very poor. The correlations between perception of IAQ and various factors such as temperature, feeling suffocated, feeling congested, presence of mouldy odors, and others were generally weak. Further research is needed to understand the underlying causes and develop effective strategies for IAQ improvement. The study findings suggest that it is important to monitor the indoor air quality in classrooms, laboratories and office spaces and to take steps to improve the air quality if it is found to be poor. This can help to protect the health of students and staff and to improve their learning and work environment.

Keywords: Indoor air quality (IAQ), perception, students, temperature, dusty, poor lighting, noisy, humid, dry

Introduction
Indoor air quality (IAQ) is the term used to describe the air quality within and outside of buildings and structures, especially with regard to how it affects occupant health and comfort. IAQ has received significant attention from the international scientific community and environmental governances in the last few decades as a way to improve the comfort, health and wellbeing of building occupants. Numerous scientific studies published recently have shown that people spend the majority of their time indoors, such as at home, in offices, educational institutes, hospitals, kindergartens, sports arenas, libraries, restaurants, bars, theatres and cars. People are more exposed to indoor pollution compared to outdoors.

Due to its impact on human health, indoor air quality has recently taken on a more important role. As a result, IAQ has a substantial impact on overall health and quality of life. Natural pollutants such as allergens, radon, dampness and moulds can also have significant health effects.

Understanding student's perception of IAQ about educational institutes is essential as students spend most of their time in educational institutes and IAQ shows a major impact on student's academic performance, health and their wellbeing. Inadequate ventilation, volatile organic compounds (VOCs) which are released by building materials, paints, furnishings, and detergents poses health risks on students as well as lowers the academic performance of students (Pulimeno, M. *et al.* 2020) [9].

The indoor air quality is significantly impacted by the sealing of building natural openings for energy savings, the adoption of experimental new materials, as well as inadequate air exchange. As a result of this, there will be an increase in concentrations of indoor air pollutants including CO, CO_2, PM_{10}, $PM_{2.5}$, and TVOC. A significant portion of particulates come from outdoor air and enter the indoor environment through physical openings and cracks, ventilation systems and cleaning methods. Poor building conditions, such as structural flaws and inadequate ventilation, led to the poor air quality in schools (Majd *et al*. 2019) [8].

Prolonged exposure to indoor air contaminants like CO, CO_2, PM_{10}, $PM_{2.5}$, and TVOC can seriously harm occupant's health. In order to determine the pollutant levels and implement the essential safety precautions for a superior domain, indoor air quality should be regularly evaluated (Sayed, K. *et al.*, 2018) [11].

Various studies conducted in recent times showed that the occupancy time period and the perception of the occupants about IAQ show a statistically significant correlation. An assumption that occupants who spend a significant amount of time in a constant place are exposed to indoor air pollution for an extended period of time and are easily influenced by concerns about their health and Sick Building Syndrome (Arar, M., & Jung, C. 2022) [1].

Studying the perception of indoor air quality among students in educational institutes is crucial for their health and academic success. Poor air quality can lead to various health issues and hinder cognitive function, affecting learning outcomes. By understanding student's perceptions, educational institutions can identify and address potential air quality issues, creating a comfortable and conducive learning environment. Improved indoor air quality can reduce absenteeism, enhance focus and productivity, and contribute to student's overall well-being.

Objective

To study the perception of students about the indoor air quality and the possible factors that affect the perception about IAQ in educational institutes.

Materials and Methods

An exploratory research method was used to conduct this study using a random sampling technique. The selected sample includes 200 students (100 technological colleges & 100-medical & paramedical colleges) located in 5 different zones (East, West, North, South & Central) of Hyderabad. The variables selected for the study were perception of occupants which is an independent variable and the IAQ which is a dependent variable. The data regarding perception of students about IAQ was recorded under the parameters like time spent in a day, feeling of connectedness, perceived temperature and perceived IAQ. A structured questionnaire was used to collect the data and analysed using descriptive statistics.

Results and Discussion

The results regarding the perception of students about indoor air quality in both the technological and medical & para-medical colleges were discussed below with the distributions and percentages about perception.

Perception of students about Indoor Air Quality

Perception means the ability to become aware of something or the way of interpreting or understanding something through senses. IAQ is the quality of air in an indoor environment. Perception of people regarding something changes from person to person and will never be the same. So it is important to assess the perception of IAQ in educational institutes as there will be more number of occupants.

Table 1: Distribution of Perception of students about indoor air quality in Classroom

(N=200)

Perception about classroom IAQ	Technological colleges		Medical & Para medical colleges		Total	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Very good	24	24.00	10	10.00	34	17.00
Good	31	31.00	47	47.00	78	39.00
Average	27	27.00	35	35.00	62	31.00
Poor	13	13.00	6	06.00	19	09.50
Very poor	5	05.00	2	02.00	7	03.50

Table 1 depicts the information regarding the perception of IAQ in classrooms of technological and medical & para medical colleges. Nearly half of the respondents i.e. 47% in medical & para medical colleges felt that the IAQ was good and 31% of the respondents in technological colleges perceived that the IAQ was good in the class room. 13% of the respondents in technological colleges perceived that the IAQ was poor in laboratory and 6% in the medical & para medical colleges felt the same.

Over-all majority of the respondents (39%) perceived that the IAQ was good in the classroom. 9.5% of the respondents perceived that the IAQ was poor in class room.

Table 2: Distribution of Perception of students about indoor air quality in laboratory

(N=200)

Perception about classroom IAQ	Technological colleges		Medical & Para medical colleges		Total	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Very good	23	23.00	8	08.00	31	15.50
Good	70	70.00	53	53.00	12	61.50
Average	7	07.00	33	33.00	40	20.00
Poor	0	00.00	6	06.00	6	03.00
Very poor	0	00.00	0	00.00	0	00.00

Table 2 consists of information regarding the perception of students about IAQ in laboratory in technological and medical & para medical colleges. Highest number of respondents (70%) in technological colleges felt that the IAQ was good in laboratories and nearly half of the respondents (53%) in medical & para medical colleges perceived the same. None of the respondents in the technological colleges perceived the IAQ as poor, whereas 6% of the respondents felt the IAQ in laboratory was poor in medical & para medical colleges.

Over all, majority of the respondents (61%) from both the type colleges perceived the IAQ was good in laboratories and a very less number of respondents (3%) felt it as poor.

Table 3: Distribution of Perception of students about indoor air quality in Office space (N=200)

Perception about classroom IAQ	Technological colleges		Medical & Para medical colleges		Total	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Very good	25	25.00	22	22.00	47	23.50
Good	56	56.00	53	53.00	109	54.50
Average	13	13.00	23	23.00	36	18.00
Poor	6	06.00	2	02.00	8	04.00
Very poor	0	00.00	0	00.00	0	00.00

Table 3 presents the data regarding the perception of students about IAQ in office space of technological and medical & para medical colleges. From the table it was observed that nearly half of the respondents (56% in technological colleges & 53% in medical & para medical colleges) in both the type of colleges perceived the IAQ in office space was good. However a very less percentage of the respondents (6% technological colleges & 8% in medical & para medical colleges) perceived it as poor.

Over all, perceived IAQ was good in office space according to half of the respondents (54.5%) and very less percentage of respondents (4%) felt it as poor.

Distribution of perception of students about indoor air quality in Classroom, Office room and laboratory

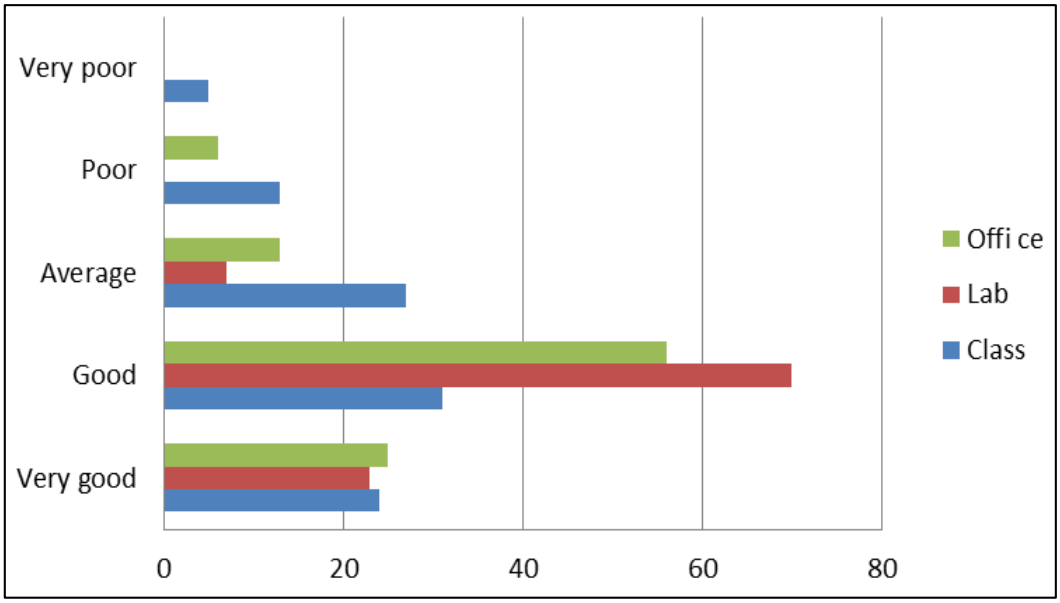

Fig 1: Perception of Indoor air quality in technological colleges

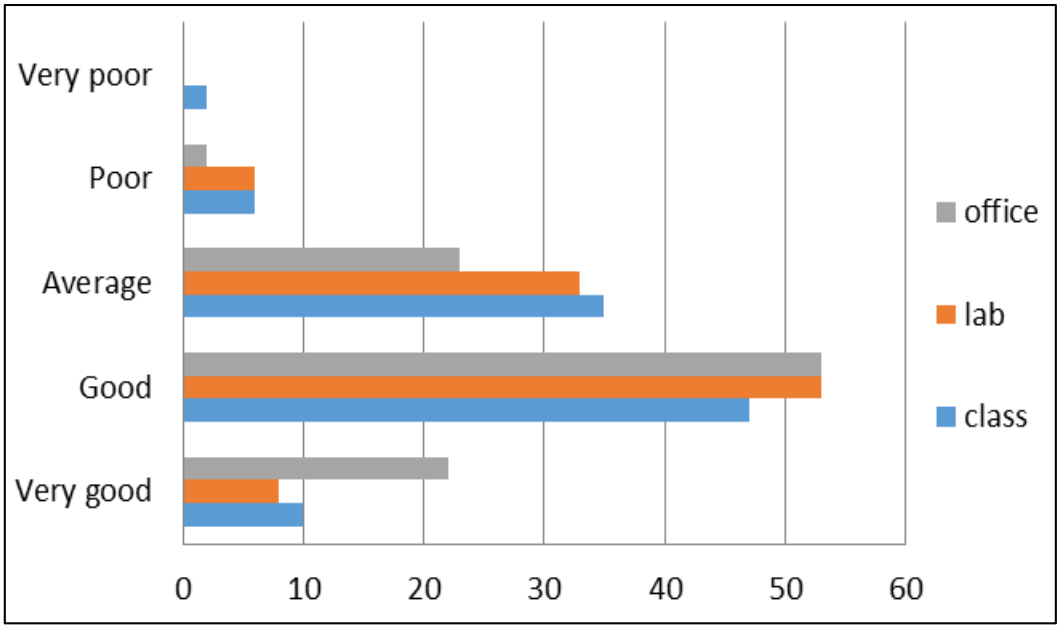

Fig 2: Perception of indoor air quality in medical & para-medical colleges

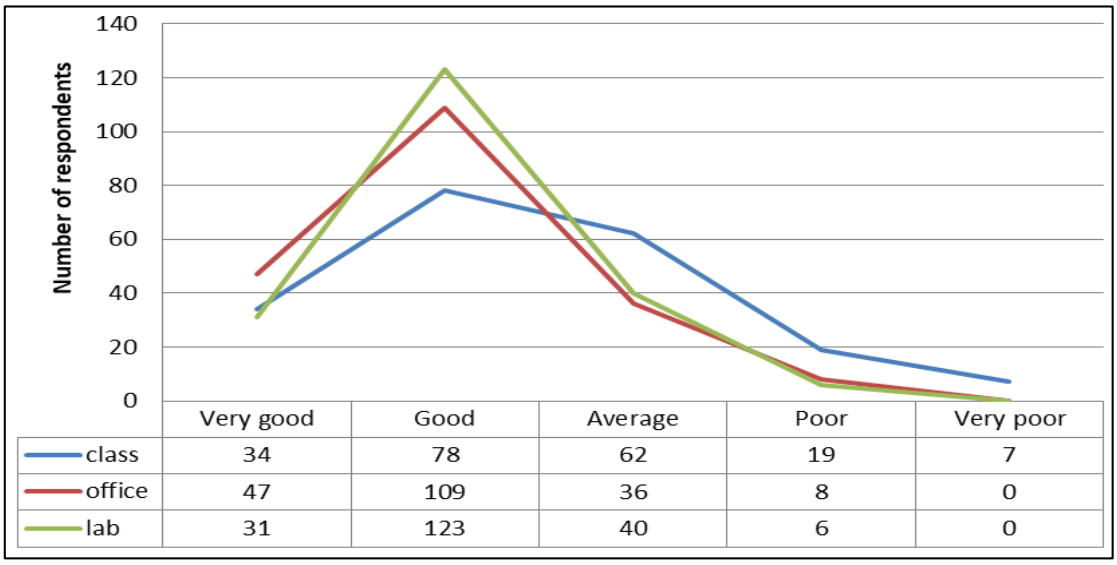

Fig 3: Perception of Indoor air quality in Technological and Medical & Para medical colleges

Figure 1 indicates the distribution of perception of students about indoor air quality in classroom, laboratory and office room of the technological colleges. It shows that majority of the respondents felt that the Indoor Air Quality was good in all the three settings (class, laboratory, office).

Figure 2 indicates the distribution of perception of students about indoor air quality in classroom, laboratory and office room of the medical & para medical colleges it shows that majority of the respondents felt that the Indoor Air Quality was also good in all the three settings (class, laboratory, office) of Medical & Para medical colleges.

Figure 3 indicates the average distribution of perception of students about indoor air quality in classroom, laboratory and office room of the both the type of colleges. It shows that majority of the respondents felt that the Indoor Air Quality was good in both the type of colleges with highest number of respondents.

Table 4: Correlation of perception of students about IAQ with variables

Variable 1	Variable 2	Correlation coefficient (r)		
		Class	Office	Laboratory
Perception of students about Indoor Air Quality (IAQ)	Temperature too cold	0.005285	0.004163	-0.0271
	Temperature too hot	-0.11907	0.073931	-0.03572
	Feeling suffocated	-0.12319	0.010688	0.081885
	Feeling congested	-0.02453	-0.00748	-0.10762
	Feeling stuffy air	0.074233	-0.02558	-0.07761
	Mouldy odours	-0.129582	-0.103534	-0.06548
	Feeling dusty	-0.07888	-0.12095	0.122902
	Feeling noisy	-0.1651	-0.08324	0.050222
	Too dry	0.085263	0.010688	0.014477
	Too humid	0.064523	-0.12877	-0.00724
	Poor lighting	-0.07325	-0.04263	0.011139
	Feeling crowdedness	-0.00206	-0.13731	-0.04217

*- Significance Level at 0.05

1. Perception of IAQ and Variation in Temperature

Temperature too cold: There is a very weak positive correlation (r = 0.005 & r = 0.004) between the perception of students about indoor air quality and feeling that the temperature is too cold in class and office. And a negative correlation was observed in the case of laboratory. However the correlation is practically negligible.

Temperature too hot: There is a weak negative correlation (r = -0.119 & r = -0.035) between the perception of students about indoor air quality and feeling that the temperature is too hot in class and laboratory. As the perception of indoor air quality increases, the feeling of the temperature being too hot tends to decrease.

High temperatures may cause discomfort to building occupants (Yahaya *et al*. 2108) [3]. Either too low or too high temperatures will effect IAQ of the buildings (Kamaruzzaman, S. N and Sabrani, N. A. 2011) [5].

2. Perception of IAQ and Feeling suffocated: There is a weak positive correlation (r = 0.082 & r = 0.01) between the perception of students about indoor air quality and feeling suffocated in office and laboratory and there exists a weak negative correlation (r = -0.123) between perception of students about indoor air quality and feeling suffocated in classroom between but the correlation is not particularly strong.

3. Perception of IAQ and Feeling congested: The correlation results (Table 4) shows that there is a weak negative correlation between the perception of students about indoor air quality and feeling congested in all three settings. As the feeling of congestion tends to decrease, the perception of indoor air quality increases.

4. Perception of IAQ and Feeling stuffy air: There is a weak negative correlation (r = -0.078 & r = -0.026) between the perception of students about indoor air quality and feeling of stuffy air in office and laboratory. The perception of indoor air quality increases, when the feeling of stuffy air tends to decrease. Air tight buildings that were constructed to conserve energy may impact IAQ (Sadrizadeh, S. *et al.* 2022) [10].

5. Perception of IAQ and Mouldy odours: There is a negative correlation (Table 4) between the perception of students about indoor air quality and the presence of mouldy odors in all three settings. As the perception of good indoor air quality increases, the likelihood of detecting mouldy odors tends to decrease.

6. Perception of IAQ and Feeling dusty: The results of the correlations (Table 4) reveal that there exists a negative correlation between the perception of student about indoor air quality and the presence of dust in class and office. This shows that as the presence of dust decreases the perception of good indoor air quality increases.

7. Perception of IAQ and Feeling noisy: There exists a negative correlation (r = -0.165 & r = -0.083) between the perception of students about indoor air quality and feeling noisy in class and office settings. As the feeling of noise tends to decrease the perception of indoor air quality increases slightly. Acoustics had an impact on occupant's satisfaction with the indoor environmental quality (Hall, M. B. *et al*., 2022) [3].

8. Perception of IAQ and too dry: The results suggest that there is a weak positive correlation (Table 4) between the perception of students about indoor air quality and feeling that the air is too dry in all three settings. As the dryness in indoor environment increases the perception of bad air quality increases (Wolkoff, P. 2018) [12].

9. Perception of IAQ and too humid: The negative correlation coefficient suggests that (Table 4) as the feeling of humidity tends to decrease slightly the perception of indoor air quality increases. However, the correlation is practically negligible as the correlation is weak. There is an impact of humidity sensation on air quality satisfaction (De Oliveira, C., *et al.* 2021) [2]

10. Perception of IAQ and Poor lighting: The results of correlation shows that there is a weak negative correlation between the perception of students about indoor air quality and poor lighting in class and office and positive in laboratory. It shows that if there is no sufficient lighting, then the perception of indoor air quality decreases. There is an influence of lighting technologies on IAQ. Poor lighting affects the occupants health (Katabaro, J. M., & Yan, Y. 2019) [6].

11. Perception of IAQ and Feeling crowdedness: The negative correlation coefficients (Table 4) suggest that as the crowdedness decreases, the perception of students about of indoor air quality increases. Reduced occupancy can decrease the amount pollutants which contribute to increase in air quality (Jung, C., & Samanoudy, G. E. 2023) [4].

Conclusion

In conclusion, this paper investigated the perception of students about indoor air quality (IAQ) in technological and medical & paramedical colleges. The findings revealed that the majority of students perceived the IAQ in classrooms, laboratories, and office spaces as good. However, a small percentage of students expressed poor or very poor perceptions of IAQ in these settings (Class, Office and Laboratory).

The correlations between perception of IAQ and various factors such as temperature, feeling suffocated, feeling congested, presence of mouldy odors, and others were generally weak. Further research is needed to understand the underlying causes and develop effective strategies for IAQ improvement.

Overall, it's important to note that most of the correlations observed between the perception of students about indoor air quality and specific factors are relatively weak, suggesting that these factors may not have a strong linear relationship with the overall perception of indoor air quality. Additionally, other factors not included in this analysis may also influence the perception of indoor air quality among students.

Giving attention to indoor air quality in educational institutes is important as students will spend most of their time after home. Monitoring IAQ in educational institutes and taking steps to improve it, if necessary is important because it shows impact on health, comfort and academic performance of the students and there might be potential risks associated with it.

Future studies can be done focusing on the effective IAQ improvement measures, the impact of IAQ on academic performance, and the role of indoor air pollutants in shaping students' perception of IAQ in educational institutes. These findings can contribute to creating healthier and more conducive learning environments for students, enhancing their overall well-being and educational outcomes.

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