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INDOOR AIR QUALITY FUELLING INDIA'S COVID-19 INFECTION

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Just as the smell gets diluted by ventilation, the dangerous concentration of the virus can also get reduced by ensuring appropriate amount of outdoor air flows in. In closed and stale space droplets and aerosol gets quickly concentrated and greatly increases the risk of transmission of virus in that area. Visit to any nearby shopping malls, newly furnished coaching classes, modern residential buildings, government offices, hotels, restaurants and even hospitals shows that they are nothing but an assortment of closed and unventilated spaces. These closed space acts as Super spreader of the virus. Peak test positive rate of 22.6% per hundred test is observed during the month of May, which is a result of high humidity particulate matter concentration temperature CO_2 concentration.

Keywords: Indoor air pollution; covid-19; particulate matter; humidity; CO_2.

1. INTRODUCTION

The novel severe acute respiratory syndrome (SARS-Cov-2), which causes corona virus disease 2019, was firstly reported in Wuhan China in December 2019. It has impacted the global economy and created a health crisis. The WHO declared covid 19 as a global pandemic on 11th march 2020. Studies shows the role of droplet and aerosol particles in covid transmission, particularly termed as airborne transmission [1,2]. There are reports of aerosol particle transmission in nursing homes and hospitals [3,4,5]. Several on field studies were carried out inside Wuhan hospitals showing the presence of SARS-COV-2 RNA in air sample collected in the hospital [6,7]. The US Centre for disease control and prevention has acknowledged that airborne aerosol particle transmission of SARS-COV-2 can occur under certain specific circumstances, such as in closed places with inadequate ventilation [8]. This might be critical, particularly within hospitals, nursing homes and shopping malls where SARS-COV-2 infection has

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been found to be spreading at a rapid rate despite the use of surgical mask and personal protective equipment [5]. During another experimental study conducted at the hostel facility in Wuhan China, researchers have investigated airborne transmission of SARS-COV-2 and the possible role of aerosol particle in SARS-COV-2 transmission. Covid viral RNA was found in 21% of the aerosol sample (n=38) collected from Wuhan Hospital in early 2020. Modern architecture style which replaces mechanical ventilation (windows) with artificial ventilation (air-conditioner) which increases viral load in the enclosed environment [9,10]. The newly regulated CO_2 energy efficient ventilation system in which indoor air refreshed only when CO_2 concentration exceeded 1000 ppm, if CO_2 concentration is below 1000 ppm the ventilation system recirculate the indoor air without any filtration. In a field study of shopping malls having fluctuating ventilation system that recirculate indoor air without filtration the researchers found covid virus on the dust filter off the air conditioning system which further strengthened the belief of researchers that fluctuating ventilation system increases chances of covid outbreak [5,11]. Evidence from laboratory experiments suggest so far that Covid virus favours dry and cold conditions, particularly out of direct sunlight [12], (Tobias, 2020). Intermediate relative humidity range of 40 to 60% is considered optimal for human respiratory immunity [13]. In addition the virus inactivation rate also increases at this relative humidity range of 40 to 60% [14]. While in tropical countries like India, Bangladesh, Sri Lanka, Indonesia and China tropical and rainy conditions also favours the outbreak [15]. In a recent research at University of Colorado when excess CO_2 level doubles, the risk of transmission also roughly doubles (Colorado, 2020). Emission of formaldehyde from paints toys and electronic gadgets, results in weakening of lungs alveoli which plays a major role in increase mortality rate in urban parts of the country ("Each breath", 2021).

2. MATERIALS AND METHODS

A Field survey was done from May 2021 July 2021 to detect the concentration of following:

1. CO_2:- using DS-CO_2-20 dual channel NDIR sensor.

   This sensor use infrared light at specific wavelength for the detection of CO_2.

2. Relative humidity (RH):-

   Using humidity sensor. This sensor detects humidity Based on robust capicitative technology.

3. Aerosols:- HPM laser-based sensor

   A laser based sensor that uses the light scattering method to detect and count particle in the concentration range of 0 to 1000 emu/meter cube.

Other noted condition includes:-

- Poor housekeeping
- COVID related symptoms/ disease: self-reported
- Damped walls/roof

3. RESULTS AND DISCUSSION

Total 37 building types (Hospitals, Resident buildings, Hotels, Departmental store, Gyms and Malls) has been monitored using DS-CO_2-20 dual channel NDIR sensor shows an increased $C0_2$ concentration in split air conditioned hospitals, gym and malls, which ranges from 800 ppm to 2567 ppm (during peak time in evening).

Table 1. Concentration of CO_2 at different types of buildings

S. No.	Type	Numbers of observations	$C0_2$ value (in ppm)	Mean CO_2 value
1	Hospitals	11	600-2672	1639
2	Residential buildings	10	400-1200	1000
3	Hotels	7	400-1000	900
4	Departmental store	5	600-1275	937.5
5	Gym	3	500-1500	1000
6	Malls	1	600-2100	1350

Table 2. Relative humidity (RH) difference in air-conditioned and non-air-conditioned spaces

S. No.	Type	RH (in %)
1	Air-conditioned space	25%-50%
2	Non Air-conditioned space	65%-85%

Table 3. Comparative analysis of particulate matter in air-conditioned and non-air-conditioned spaces (in micro meter cube)

S. No.	Types of PM	Air-conditioned space	Non Air-conditioned space
1	>.3	4500-6000	6000-8000
2	>1	140-250	250- 700
3	>2.5	10-25	40-125
4	>10	1-5	3-20

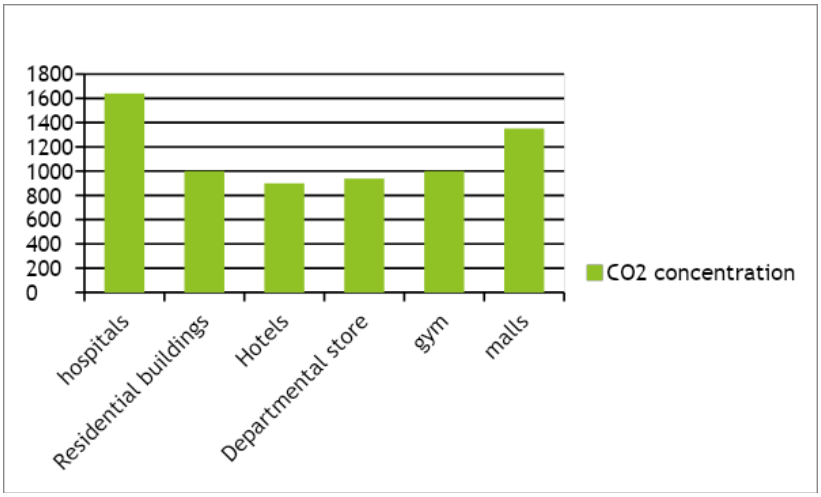

Fig. 1. CO_2 concentration in different building types

As May/June is the season of monsoon in Darbhanga relative humidity is very high in non-air conditioned places (ranges from 50% to 88%) and below optimum range in air-conditioned places . Relative humidity of more than 70% is not good, virus survives under moist condition in the droplet under the physiological concentration of salts. At moderate humidity of 40% - 60% salt gets concentrated due to evaporation which deactivates the virus, and at humidity below 30% salts crystallize out of solution, which may keep the virus active (Yang et al. 2020).

Detection of particulate matter using laser based sensor shows high concentration of particulate matter in almost all the building type. Air quality index which mainly depend upon PM .3, PM 1, PM2.5 and PM 10 shows elevated results. These particulate matter act as an vector for the transmission of SARS-COV-2 virus hence high concentration of these particulate matter results in high chances of outbreak of the infection [16,17]. Though places with air-conditioners having nano filters reduces particulate matter concentration drastically.

4. CONCLUSION

On the basis of above result it is to be concluded that high $C0_2$ concentration specially in hospitals, malls and gyms made them more susceptible to covid infection outbreak. CO_2 monitors should be installed for checking $C0_2$ levels. UV sanatization technique should not be used too often, as it increases ozone concentration in surrounding environment. Use of effective humidifier in air conditioned space helps reducing viral load. Use of nano filters in air conditioners and HEPA filters in non-air conditioned room reduces particulate matter concentration indoors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Meselson M. Droplets and aerosols in the transmission of SARS-CoV-2. N. Engl. J. Med. 2020;382:2063.
2. Van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, Tamin A, Harcourt JL, Thornburg NJ, Gerber

SI, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. N. Engl. J. Med. 2020;382:1564–1567.
3. Arons MM, Hatfield KM, Reddy SC, Kimball A, James A, Jacobs JR, Taylor J, Spicer K, Bardossy AC, Oakley LP, et al. symptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. N. Engl. J. Med. 2020; 382:2081–2090.
4. Santarpia JL, Rivera DN, Herrera V, Morwitzer JM, Creager H, Santarpia GW, Crown KK, Brett-Major D, Schnaubelt E, Broadhurst MJ, et al. Transmission potential of SARS-CoV-2 in viral shedding observed at the university of Nebraska medical centre. Nat. Sci. Rep; 2020.
5. De Man P, Paltansing S, Ongg SYD, Vaessen N, van Nielen G, Koeleman JGM. Outbreak of Coronavirus disease 2019 (COVID-19) in a nursing home associated with aerosol transmission as a result of inadequate ventilation. Clin. Infect. Dis; 2020.
6. Liu Y, Ning Z, Chen Y, Guo M, Liu Y, Gali NK, Sun L, Duan Y, Cai J, Westerdahl D, et al. Aerodynamic characteristics and RNA concentration of SARS-CoV-2 aerosol in Wuhan Hospitals during COVID-19 outbreak. Nature. 2020;582:557–560.
7. Hu J, Lei C, Chen Z, Liu W, Hu X, Pei R, Su Z, Deng F, Huang Y, Sun X, et al. Distribution of Airborne SARS-CoV-2 and possible aerosol transmission in Wuhan hospitals, China. Natl. Sci. Rev. Nwaa. 2020;250.
8. Centres for Disease Control and Prevention; 2020.
9. Ahlawat A, Wiedensohler A, Mishra SK. An Overview on the role of relative humidity in airborne transmission of SARS-CoV-2 in indoor environments. Aerosol Air Qual. Res. 2020;20:1856–1861.
10. Gralton J, Tovey E, McLaws M, Rawlinson W. The role of particle size in aerosolised pathogen transmission: A review. Journal of Infection. 2011;62(1):1-13.
DOI: 10.1016/j.jinf.2010.11.010
11. Dabisch P, Schuit M, Herzog A, Beck K, Wood S, Krause M, Miller D, Weaver W, Freeburger D, Hooper I, et al. The influence of temperature, humidity, and simulated sunlight on the infectivity of SARS-CoV-2 in aerosols. Aerosol Sci. Technol; 2020.
12. Merow C, Urban MC. Seasonality and uncertainty in global COVID-19 growth rates. Proc. Natl. Acad. Sci. USA; 2020.
13. Moriyama M, Hugentobler WJ, Iwasaki A. Seasonality of respiratory viral infections. Ann. Rev. Virol. 2020;7:83–101.
14. Lin K, Marr LC. Humidity-dependent decay of viruses, but not bacteria, in aerosols and droplets follows disinfection kinetics. Environ. Sci. Technol. 2020;54:1024–1032.
15. Sooryanarain H, Elankumaran S. Environmental role in influenza virus outbreaks. Annual Review of Animal Biosciences. 2015;3(1):347-373.
DOI: 10.1146/annurev-animal-022114-111017
16. Palmore TN. Coronavirus Disease 2019 (COVID-19): Infection Control in Health Care and Home Settings; 2020.
17. Riddell R, Goldie S, Hill A, Eagles D, Drew TW. The effects of temperature on persistence of SARS-CoV-2 on common surfaces. Virol. J. 2020;17:145.