

# **Exposure to Paints and Respiratory Health Ailments among Painting Workers in Commercial Sectors**

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## **Abstract**

Background: The chemistry of paints has changed over time and this led to potential health hazards for house painters. Survey and interviews scheduled on work profiles determined the exposure to solvents in commercial painting. Painting work was observed in many work situations at different sites. Aim: This research paper aims to explore the worker's experiences with solvent-based and water-based paints regarding health implications. Methods: The current study is related to research on paint workers' health issues. Subjects for the study were chosen randomly from several places around Uttar Pradesh, India. An interview schedule was developed to collect relevant and maximum information. The study used a sample size of 150 that were not pre-determined. All the responders were from the labour class and worked with paints. A schedule of interviews was developed to gather information about the painters' demographic profile and current health status. The statistical approaches such as Standard Deviation and ANOVA were used for analysis. Results: The study reveals that painters are exposed to paints, so they have to face various health issues. Painters were at high risk and significantly associated with health problems and respiratory issues compared to the average population. Conclusion: Our study highlighted the risk and problems among painters due to paints, including breathing problems, prolonged cough, chest discomfort and almost all lung problems.

## **Keywords**

Carcinogen, Chest Discomfort, Respiratory Health, Lung Cancer

## **1. Introduction**

Painting in the commercial sector involves working with coating materials either by a brush or manually. Painters are exposed to various chemicals throughout their work, including pigments, solvents, fillers, binders, and other additives, which they may inhale (Kim et al., 2013).

Previously, these chemical exposures were expected to have no serious consequences. Recent statistical analyses have revealed that occupational exposure to organic solvents is potentially associated with chronic nerve damage (Gerhardsson et al., 2021). As a result, the paint industry began to produce new paints that included considerably lesser chemical solvents. These new "water-based" paints are emulsified pigments and polymers suspended in water with trace amounts of ingredients such as volatile organic compounds (Amo et al., 2002).

Painters may face increased health risks as a result of this chemical complexity. When using water-based paints, painters have complained of skin sensitivity, excessive urination, and gastrointestinal issues (Wieslander et al., 1994). There seems to be a temporary increase in urine excretion and a decreased urine concentration, a slight increase in average red cell volume, and a reduction in pulmonary function (Wieslander et al., 1994). Another study on painters who used water-based paints reported a possible effect on the kidneys, as measured by increased

albumin excretion in the urine (Lundberg et al., 1994). Field studies were initiated among active house painters to elucidate the health consequences of exposure to water-based paints. The interest is focused on the exposure situation, symptoms, lung and kidney function, and skin allergy (Wieslander et al., 1994). In routine maintenance, mainly alkyd-based paints, liquid paints are still widely used (Ifijen et al., 2022). As a result, painters are more likely to be exposed to solvents during maintenance work than during new-build painting (Riala et al., 2019).

Respiratory problems, infections, and neurotoxic effects are expected among painting workers. It is necessary for the government that all of these workers work in a safe and healthy workplace. Every worker must be aware of their environmental health and safety legislation privileges.

### **1.1 Objectives**

The primary objectives of our study were to investigate how painters felt about working with solvent-based and water-based paints in terms of the general work environment, and various work-related health problems. So the objective is to study the impact of paints on respiratory health of the painters.

## **2. Literature Review**

The concentration of total organic volatile in several of the painting occupations exceeds regulatory standards, and industrial painters are exposed to a variety of solvents, such as malignancies and biological toxin. According to an exposure research, the three main application techniques of rolling, rubbing, and spray coating generate significant air emissions (Qian et al., 2010). Pro iron oxide comprise the majority of the shielding that developed within the painting surface. Silica from sand and silicate powders was added to the covering layer as well (Amo et al., 2002). A research on work - related hazards and safety standards among paint factory workers, among 400 participants, 72.5% of survey participants were conscious of the risks related to their occupations, 30% had proper instruction on risks and protection regulations, 40% did not use personal protective equipment, and 90% of high prevalence signs similar to risks. The maximum concentrations of heavy metals in the urine samples increased in a statistically significant ( $p < 0.05$ ) way (Awodele et al., 2013). According to the findings of some other studies on paint exposure, the indoor epoxy coating primer task had the highest Exposure Index (EI) for painting works, accompanied by the enclosed adhesive task (2.03), the exterior oil-based spray paint task (1.65), the outdoor liquid acrylic task (0.66) and the indoor oil-based paint task (0.15) (park et al., 2015). According to a study on solvent exposure, solvent-based paints, 58% of painters were classed with a multiple exposures category (Wang et al., 2011). Regular liver function tests may vary in individuals who have had previous significant contact to chemicals from liquid paints but have little to no present exposure, suggesting minor chronic effects (Lundberg et al, 1994). An increased risk of developing Multiple Sclerosis may be tangentially linked to the use of organic solvents (Gerhardsson et al., 2020). According to the studies, painters must use personal protective equipment and/or work safety precautions to safeguard themselves from chemical agents when performing painting tasks. In order to identify high-risk tasks and ameliorate hazardous work environments, research must concentrate on the exposure evaluation of various hazards for paint workers.

## **3. Methods**

### **3.1 Sample size determination and participant selection**

A total of 150 consenting respondents were included in this study. This sample size has been found to be adequate for the study. The locations for the study were three district of Uttar Pradesh. These districts were selected on the basis of paint industries. The respondents were selected from each location for making a total of 150 respondents by using purposive random sampling technique. Prior to data collection process, respondents were informed properly about the purpose of the study and associated information. The sample size was 150, divided into four groups based on their age (19-32, 33-46, 47-60, and 61-75 years). The respondents from each location were interviewed based on a pre-tested survey schedule.

### **3.2 Tools and techniques**

An interview schedule was designed to gather complete and valuable information based on the working pattern. A general information sheet was developed included age, education and residence of the respondents. The modified Kuppaswami scale was used to measure the socio-economic condition of the respondents, which includes the education and occupation of the breadwinner along with income per month of the family, categorized into five levels Upper (26-29), Upper middle (16-25), Lower middle (11-15), Upper Lower (5-10) and Lower (<5). The information on the occupational profile, within which years of working, days of work, duration of work, the posture of working, etc., were also included. Respiratory and lungs problems questions were also included to identify the primary

objective of this research study. It consists of 9 items i.e. Shortness of breath/breathlessness, cough, phlegm and blood, chest problems irritation with paints etc.

### 3.3 Statistical analysis and calculation

The data was coded, tabulated and analysed using SPSS 20.0 Software. The problems with different sections were additionally determined with the help of standard deviation and the significance was tested using ANOVA. The association of respiratory health problems and lungs problems with different independent variables was tested using Pearson's correlation.

## 4. Data Collection

The survey was conducted from January- to February 2021. All the respondents were represented throughout the information assortment on their working days. A well-structured standard questionnaire was designed and distributed to the respondents for the purpose of gathering information. For assessing the knowledge and awareness of painters, the interview schedule consisted of items based on the respondents' general perception of Health and Safety Issues.

## 5. Results and Discussion

### 5.1 Numerical Results

Table 1. Demographic characteristics of painters

Demographic characteristics		Frequency (N=150)	Percentage (%)
<b>Age (in years)</b>			
1	19-32	64	42.7
2	33-46	56	37.3
3	47-60	22	14.7
4	61-75	8	5.3
<b>Total</b>		150	100.0
<b>Education</b>			
1	Illiterate	32	21.3
2	Primary	52	34.7
3	Junior	26	17.3
4	High school	24	16.0
5	Intermediate	10	6.7
6	Graduation	6	4.0
<b>Total</b>		150	100.0
<b>Residence</b>			
1	Native	120	80
2	Migrant	30	20
<b>Total</b>		150	100.0

Table 1 represents the demographic data and general information of painters. The table indicates that the dominant part (42.7%) of the painters belonged to the age group of 19-32 years, followed by 33-46 years (37.3%) followed by 47-60 years (14.7%), whereas only 5.3 % of the painters belonging to 61-75 years. It is also evident from the data that the majority of the total respondents (34.7%) had stopped their education at primary level, while 21.3% were illiterate. Out of 150, only 26 respondents were passed followed by high school (16%) and junior levels only 4% of them were graduate.

Table 2. Socio-Economic Profile of the Respondent's Family

Socio-Economic Scale		Frequency (N=150)	Percentage (%)
1	Upper (26-29)	6	4.0
2	Upper Middle (16-25)	8	5.3
3	Lower Middle (11-15)	10	6.7
4	Upper Lower (5-10)	50	33.3
5	Lower (<5)	76	50.7
<b>Total</b>		150	100.0

Table no. 2 indicates the socio-economic condition of the respondent. The majority of the respondents (50.7%) belong to Lower Economic status, followed by Upper lower (33.3%) followed by Lower middle (6.7%) followed by Upper middle, and only 4% of them belong to the Upper class.

Table 3. Occupational profile of painters

Occupational profile		Frequency (N=150)	Percentage (%)
<b>Working Years</b>			
1	0-5 years	24	16.0
2	5-10years	42	28.0
3	10-15years	38	25.3
4	More than 15 years	46	30.7
<b>Total</b>		150	100.0
<b>Working Days of the Respondent</b>			
1	5 days	14	9.3
2	6 days	34	22.7
3	7 days	102	68.0
<b>Total</b>		150	100.0
<b>Working Time of the Respondent</b>			
1	5-7 hours	28	18.7
2	7-9 hours	70	46.7
3	More than 9 hours	52	34.0
<b>Total</b>		150	100.0

Table. 3 represents the occupational profile of the painters, which indicates that the majority of the respondents (30.7%) had spent over 15 years in their current occupation, followed by (28%) who had been doing the work from 5-10 years, whereas only 16% have spent less than 5 years in this occupation. The data (Table 4) also indicates majority (68%) of them were working all the 7 days in a week, followed by 6 days (22.7%), whereas only (9.3%) went to work for 5 days. The majority of the respondents worked for 7-9 hours a day, followed by more than 9 hours (34%), while only 18.7% worked for 5-7 hours.

Table 4. Association of lung problems with the age of the respondents

S. N.	Lung problems	Age of the respondent				F Value	P- Value
		19-32 years	33-46 years	47-60 years	61-75 years		
		mean± S. D	mean± S. D	mean± S. D	mean± S. D		
1.	Shortness of breath/breathlessness	1.69±0.774	2.64±0.773	2.73±0.767	3.50±0.535	26.417	0.000
2.	Cough	1.38± 0.745	1.82± 0.897	2.27±0.767	3.0 ± 1.069	13.578	0.000

3.	Cough produces: Phlegm and Blood	1.19±0.990	0.89±1.021	0.73± 0.767	2.50±1.604	7.023	0.000
4.	Chest sound wheezy or whistling	0.97±0.925	1.18±0.974	0.73±0.883	2.50±1.604	6.988	0.000
5.	Tightness in the chest from cold air	1.38±0.934	2.21±0.780	1.91±0.811	2.50±1.604	10.218	0.000
6.	Irritation when working with paints	2.75±0.563	3.21±0.414	3.09±0.811	3.50±0.535	9.386	0.000
7.	Chest Pain or discomfort when breathing in or out	1.81±0.814	2.29±0.706	2.27±1.077	3.50±0.535	11.833	0.000
8.	The trouble with smelling odors	3.00±0.713	3.39±0.623	3.55±0.510	4.00±0.00	9.457	0.000
9.	Currently taking or receiving any form of medication	1.34±1.439	2.71±1.398	2.09±1.477	2.00±1.528	9.396	0.000

The association between the respiratory problem and the age of the respondent has been examined in Table no. 4. In this study, we found significant difference between respondent's age and respiratory health. This data indicates that respondents who faced high breathlessness ( $\mu = 3.50$ ) belongs to the age group of 61-75 years, followed by 47-60 year ( $\mu = 2.73$ ), 33-46 year ( $\mu = 2.64$ ), and minimum problems observed in the age group of 19-32 years ( $\mu = 1.69$ ), this data shows highly significant differences between age group and the problem occurs with breathlessness in painters. So it indicates that breathlessness increases as the age increases and vice versa. The majority of the respondents have cough problems with increasing age; the respondents who faced severe cough problems ( $\mu = 3.00$ ) belongs to the age group of 61-75 years, followed by 47-60 year ( $\mu = 2.27$ ), 33-46 year ( $\mu = 1.82$ ) and minimum in the age group of 19-32 years ( $\mu = 1.38$ ), this data shows highly significant differences between age group and cough problem. It is evident from the data that Cough produces: phlegm and blood problem was high ( $\mu = 2.50$ ) among 61-75 years age group, whereas least ( $\mu = 0.73$ ) in 47-60 years. Wheezy chest sound or whistling was noted high among 61-75 years ( $\mu = 2.50$ ) of the respondents and least ( $\mu = 0.73$ ) in 47-60 years. The majority of the respondents who felt tightness in the chest from cold air were 61-75 years ( $\mu = 2.50$ ) of the age group and least in 19-32 years ( $\mu = 1.38$ ) of the age group. (Table 4) demonstrates that the more significant part ( $\mu = 3.50$ ) of facing irritation when working with paints occurs in the age group 61-75 years, followed by the other three age groups. It is evident from the data that Chest Pain or discomfort when breathing in or out was expressed significantly ( $\mu = 3.50$ ) in the 61-75 years age groups and least ( $\mu = 1.81$ ) in 19-32 years age groups. The data also (Table 4) demonstrates that the more significant part of the respondents faced trouble with smelling odors in 61-75 years ( $\mu = 4.00$ ), followed by the other three age groups. Table 4 shows that a statistically significant feeling of lung and chest problems increases with increasing age.

Table 5. Association between working patterns and Lungs problems

	Use of mask	Years of working	Working duration in a day	Shortness of breath/breathlessness	Cough	Cough produces: Phlegm and Blood	Chest sound wheezy or whistling	Tightness in the chest from cold air	Irritation when working with paints	Chest Pain or breathing discomfort	The trouble with smelling odors	Currently taking any medication	
Use of mask	1												
Years of working	.189*	1											
No.of working days in a week	.046	284*	1										
Working duration	.051	.447*	.427*	1									
Shortness of breath/breathlessness	-.083	.447*	.394**	.370*	1								
Cough	.232**	.443**	.322**	.018	.577**	1							
Cough produces: Phlegm and Blood	.326**	.126	.219**	.193*	.377**	.562**	1						
Chest sound wheezy or whistling	.379**	.157	.136	-.093	.123	.403**	.403**	1					
Tightness in the chest	.211**	.395**	.302**	.230*	.403**	.424**	.419**	.539**	1				
Irritation when working with paints	-.064	.360**	.218**	.369*	.564**	.175*	.269**	.191*	.433**	1			
Chest Pain or breathing discomfort	-.102	.340**	.195*	.594*	.525**	.189*	.338**	.029	.440**	.571**	1		
The trouble with smelling odors	-.118	.532**	.318**	.455*	.580**	.276**	.261**	.020	.527**	.706**	.589**	1	
Currently taking any form of medication	.257**	.115	.374**	.295*	.403**	.238**	.426**	.169*	.560**	.365**	.502**	.435**	1

(\*\*Statistically significant at >0.01.), (\*statistically significant at >0.05.)

The correlational values of various respiratory conditions and occupational variables such as working year, working days, and working duration are defined in Table 5. There is a perfect positive significant correlation of working year, days, and duration with different lung problems was identified. In the Table 5, we find a perfect positive correlation (.447\*\*) between breathlessness and respondents' working year, indicating that respondents who have worked for longer durations had more breathing problems. The number of working days is correspondingly associated with breathlessness (.394\*\*). Moreover, like the other two variables, the duration of time spent working in a day affects the lungs and leads to breathlessness, which has a positive correlation (.370\*\*).

We also identified a perfect positive association (.443\*\*) between years of work and cough difficulties, indicating that workers who have worked for more prolonged periods were more susceptible to cough. Cough problems were highly associated with painters who worked more days per week. Cough issues were perfectly and significantly associated (.232\*\*) with painters who use masks while working. This reveals that wearing a mask can protect painters from coughing.

According to the statistics, there is a positive and substantial correlation (.577\*\*) between a cough and shortness of breath, implying that painters who had cough also had shortness of breath. Although there was no significant association between working years and phlegm and blood production while coughing, there was a good association across mask-wearing (.326\*\*), working days per week (.219\*\*), and working duration in days (.193\*). There was a strong positive association between mask use and chest sound or whistling, but no association was identified between chest sound and year of work, days, or duration. At the same time, the problems of whistling and coughing have a significant correlation (.401\*\*).

Painter's chest sound is also associated with coughing up phlegm and blood (.403\*\*). As the cough problem worsens, the chest sound or whistling gets more intense. Another problem was chest tightness caused by cold, which has a perfect positive correlation with mask use while working (.211\*\*), working years (.395\*\*), and working days in a week (.302\*\*), and working duration (.230\*\*). This means tightness in the chest increases as years, days, and working hours increase. Tightness in the chest has perfect positive correlation with other lung problems like breathlessness (.403\*\*), cough (.424\*\*), cough that produces phlegm and blood (.419\*\*), and chest sound (.539\*\*). These issues have a deep association with one another.

Irritation while working with paints has a significant and perfect positive association with working years (.360\*\*), working days in a week (.218\*\*), and working duration (.369\*\*). Other issues, such as painters being irritated while working with paints, were found to be perfectly and significantly associated with breathlessness (.564\*\*), cough (.175\*\*), cough producing phlegm and blood (.269\*\*), chest sound (.191\*), and chest tightness (.433\*\*).

Moreover, there was a positive and significant association found between discomfort during breathing and working years (.340\*\*), working days in a week (.195\*), and working duration (.594\*\*). The findings also revealed a positive and highly significant association between breathing problems and other respiratory issues such as breathlessness (.525\*\*), cough (.189\*), cough produces phlegm and blood (.338\*\*), chest sound (.029), chest tightness (.440\*\*), and irritation while painting (.571\*\*). We find a perfect positive association between trouble with smelling odors with working years (.532\*\*), working days in a week (.318\*\*) and working duration (.455\*\*) and also with the other lungs problems like breathlessness (.580\*\*), cough (.276\*), cough produces phlegm and blood (.261\*\*), chest sound (.020), tightness in the chest (.527\*\*), irritation while working with paints (.706\*\*) and chest pain or discomfort when breathing in or out (.589\*\*).

There was a positive and significant correlation was found between painters currently receiving any form of medication and working years (.115\*\*), working days in a week (.374\*\*) and working duration (.295\*\*) and also with the other lungs problems like breathlessness (.403\*\*), cough (.238\*), cough produces phlegm and blood (.426\*\*), chest sound (.169\*), tightness in the chest (.560\*\*), irritation while working with paints (.365\*\*), Chest Pain or discomfort when breathing in or out (.502\*\*) and trouble with smelling odors (.435\*\*).

## 5.2 Graphical Results

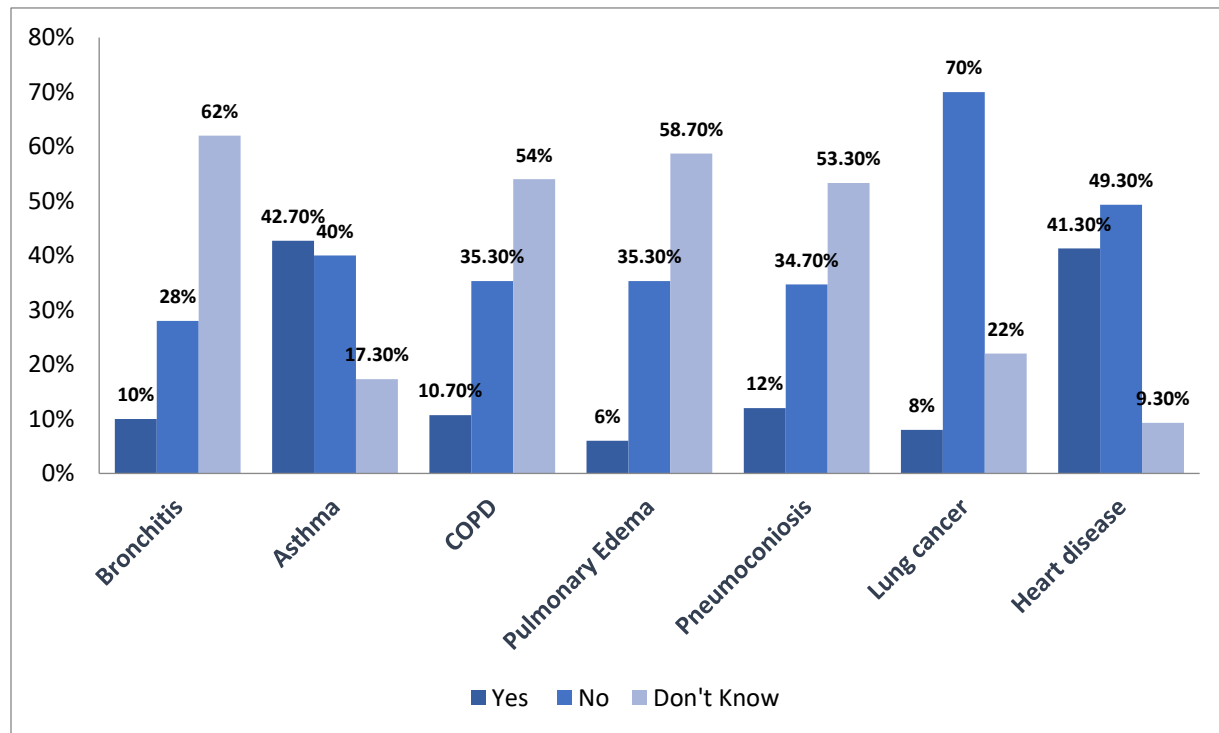


Figure. 1. Occupational health problems among respondents (Data contains multiple responses)

Figure 1 indicates the various health issues among painters working in the commercial sectors. They were asked whether they were aware of their diseases or not, whether they suffer from them, and whether they have or have not any disorders. In total, only 10% of the respondents mentioned that they were familiar with bronchitis and taking medication to recover. In comparison, 28% stated they were aware but did not have the disease, and the majority of the respondents said they did not know whether they had it or not since they were unaware of the disease. Asthma is the other significant problem among painters.

The majority of the respondents (42.70%) stated they were aware of asthma and suffering, whereas 40% were aware but did not suffer. COPD was well-known and well-understood by 10.70% of the respondents who were also suffering from this disease, while 35.30% were not. The majority of the respondents (54%) were unaware of the disease.

Pulmonary oedema was uncommon name for the respondents, so after explaining about the symptoms of it, only 6% of the respondents admit that they have these symptoms whereas 35.30% of the respondents don't have any symptoms like that while most of them (58.70%) unable to identify, whether they have these or not.

Pneumoconiosis is an occupational and restrictive lung disease caused by the inhalation of dust. Out of 150 respondents 12% of them were well known the symptoms and faced this issue, while 34.70% reported no problem like that and 53.30% of the respondents were don't know about this disease. The other disease related to this occupation is lung cancer. Data demonstrates that 8% of the painters were suffering with lung cancer while 70% of them not suffering.

Heart disease has a significant impact on respondents' health (41.30 %), while the remaining 49.30 % said they were aware of the condition but did not have any problem, and about 9.30% of the respondents do not know that they were affected or not. Figure 1 indicates that two problems have a significant impact on the health of painters: asthma and heart disease.



The research revealed various information about painters' general and occupational health. Demographic data and general information about painters were included in Table 1. The age of the respondents is a significant independent variable in determining the severity of the health problems. It might have a significant impact on painters' health. Education is another essential aspect for determining the level of work in the same occupation; it may affect painters' creativity and income.

The survey also found that the socio-economic conditions of painters were poor. The majority of the respondents were from a lower socio-economic category (Table no. 2). The poor socio-economic situation is caused by illiteracy, a lack of skill development, or they all were unaware of government programs for the labor class.

The occupational profiles of the respondents reveal information such as years of experience, working days, and working duration that has a considerable impact on painters' health. In a similar study, workers exposed to silica dust and spray painting had an increased risk of lung cancer as their work experience year increased (Tse et al., 2011). In Table 4, Lung difficulties were associated with age. Different types of lung and respiratory difficulties become more prevalent as respondents age, which was determined to be statistically significant ( $p=0.000$ ). A comparable analysis revealed that construction painters with respiratory symptoms and disorders had a similar outcome (Park et al., 2016). Another study on paint exposure and painters' health showed that all the patients suffered slight airway injury and restrictive ventilation dysfunction. Three out of seven patients had severe lung damage (Song et al., 2009) (Ramanakumar et al., 2011).

This study also found that painters are more involved in their work and have more respiratory problems (Figure 1). Lung problems, heart problems, and asthma were the most commonly mentioned health issues. According to a study, spray painting has been associated with respiratory symptoms and lung function (Hammond et al., 2005). This study reported all respiratory symptoms like allergy, asthma, and cough (Hammond et al., 2005). A similar study identified samples at high risk associated with construction jobs recognized to be more at threat, such as painters, for getting lung cancer (Mattei et al., 2016). According to the data, COPD was not much prevalent problem among painters, but about 10.70% of the respondents suffered from this disease (Fig. 1). In a similar study, painters significantly had more COPD than other groups (Hammond et al., 2005).

Results demonstrate that respondents who have worked for more years, days, and longer durations had more breathlessness, cough, tightness in the chest, irritation with paints, and trouble with smelling odors (Table 5) (Tse et al., 2011). We can find the result from the data (Table 5) that wearing the mask was significantly associated with respiratory problems like cough ( $p= .004$ ), chest tightness ( $p= .009$ ), and whistling sounds from the chest ( $p= .000$ ).

So as per result, we can conclude that wearing a mask is significantly associated with health problems, which may be due to the direct contact with paint fumes, dust, and other hazards while painting. A study reported that the respondents did not use the protective equipment, and most of them reported hazard-related symptoms (Awodele et al., 2014).

## **6. Conclusion**

This paper highlighted the risks and problems of paints among painters, including breathing problems, prolonged cough, chest discomfort, or almost all lung problems. Painting workers are supposed to get exposed to various physical, chemical, and biological carcinogens responsible for health problems. Respiratory and other health risk is often associated with dust and smoke, chemical pollutants, solvents, etc. As reported in the observations and studies, most of these toxic smokes, gases, residue, and other toxic particles can penetrate masks and other safety equipment, endangering painters even though precautionary measures are taken. The study came up with conclusions based on the research objectives in the study area. They were as follows: (a) The population at risk of ill health effects of paint exposure was significantly associated with age. (b) The study confirmed the presence and association between painting and asthmatic symptoms, bronchitis symptoms, lungs issue, heart issues, and other health problems. Therefore, it was concluded that the high proportion of painters suffering from various disease symptoms associated with painting was due to the presence of health hazards associated with the painting occupation. (c) It was observed that painters in the study were less using a mask during work and concluded that this lack of protection increased exposure time, increasing the likelihood of contracting disease symptoms associated with painting.

## **Acknowledgements**

The study was conducted as an educational and research activity of the Babasaheb Bhimrao Ambedkar University, Lucknow, which provided us a favourable environment for the study.

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