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RESEARCH PAPER

**ASSESSMENT OF PERCEPTION AND KNOWLEDGE OF
OCCUPATIONAL CHEMICAL HARZARDS, IN THE KUMASI
METROPOLITAN SPRAY PAINTING INDUSTRY, GHANA**

E. Adei¹, D. Adei², and S. Osei-Bonsu¹

¹*Department of Chemistry, College of Science, KNUST Kumasi, Ghana*

²*Department of Planning, College of Architecture and Planning, KNUST, Kumasi, Ghana*

ABSTRACT

The hazardous particulates or vapours found in informal small scale auto body and furniture manufacturing industries come from the solvent, lacquer, paint and hardener systems used in the spray painting processes. The health implications of workers' exposure in this industry are well established. The purpose of the study was to assess the occupational chemical hazards perceptions, safety practices and their enforcement in the Kumasi Metropolitan automobile, furniture and coffin spray painting industry. One hundred and fifty (150) randomly sampled paint sprayers at eighty-three (83) spraying workshops in nine (9) suburbs in Kumasi Metropolitan Area were selected for the study. A combination of questionnaires and purposive interviews were used to collect data for analysis. There was high level of self-reported exposure to spraying fumes, because only 0.7 percent of respondents reported always using the appropriate Personal Protective Equipment (PPE), during the spray painting process. Virtually all the workers were aware of the manifest health hazards; coughing, throat irritation, headache and breathing problem but did not know the extent to which these hazards could be dangerous to their health. Respondents rated Law enforcement concerning safety practices as low; EPA and DFI officials attributed this to lack of adequate logistics and personnel to carry out the task effectively. Lack of Chemical education and enforcement of safety practices in the metropolis are major contributing factors of the occupational chemical hazard exposure in the paint spraying industry. Mandatory training for initial certification to work and operate a paint spraying workshop and refresher training every two years by the government is therefore recommended.

Keywords: *Chemical hazards, Spray Painting, Personal Protective Equipment, occupational health and safety*

INTRODUCTION

It is widely recognized that chemicals play an important and productive role in many areas of

urban and rural activity. Thousands of toxic chemicals pose serious health hazards potentially causing cancer, respiratory and skin dis-

eases as well as adverse effects on reproductive function; and around 350 chemical substances have been identified as occupational carcinogens (WHO/OMS, 2000).

According to the ILO, each year there are hundreds of thousands of cases of mishaps related to chemical use in the workplace resulting in injury and death. The toll on workers, production, property and the natural environment has now reached staggering proportions (ILO, 1994). It is difficult to say how many of the annual accidents reported by the ILO happened at the micro/informal level; no means exist to understand the extent of the problem. Given that many of the workers in the micro-enterprise sector are poor, unorganized and often unformed regarding the risks, there is a strong basis to believe that health and the environmental impacts of hazardous substances are much more severe than known (Matachaba-Hove, 1996). In Ghana, most of the spray painters who work in the micro-enterprise sector are not only found in the auto body repair shops but also in the coffin and furniture manufacturing workshops.

The auto body workers' exposure to hazardous particulates or vapours from grinding, cutting, welding, car preparation, and spray painting processes in the auto body shops is well established (Jayjock and Levin, 1984; Rongo *et al.*, 2004). Occupations in which high exposure to organic solvent have been described are the car spray painting (Kalliokoski, 1986) and spraying in furniture manufacturing (Hooiveld *et al.*, 2006). Recent analyses of indoor air at an auto painting facility (Daniel *et al.*, 1992) identified up to 100 different organic compounds, 90 percent of these being acetone, xylene, toluene, methyl ethyl ketone, methyl isobutyl ketone and hexane. Various combinations of these solvents are used along with other additives (retarders, accelerators, and levelers) to reduce the viscosity of the material to a spray-able consistency and accommodate climatic conditions. These solvents are particularly hazardous and inhalation is the primary means of painter

exposures to them (Selikoff, 1975). Outcomes associated with exposure to these organic compounds in oil based paints and coatings by construction and maintenance painters include increased rates of lung, throat and larynx cancer, leukemia, impaired nervous system function, kidney and liver disease, diseases of the blood or blood forming organs; and birth defects among offspring (IARC, WHO 1989).

Some toxicologically important constituents of auto body/furniture paint and hardener systems include ethyl acrylate, ethylbenzene, benzene, cumene, various acetates, isocyanates, glycols, ethers, epoxy resin and amines (DETIR, 2000; Hooiveld, 2006). Polyurethane-based paints are readily used in car body repair shops owing to their outstanding technical features such as durability, colour stability and resistance to abrasion, chemicals and weather extremes (Boutin *et al.*, 2006). Thermal degradation of these paints during cutting, grinding and orbital sanding operations releases isocyanates (Tinnerberg *et al.*, 1997; Karlsson *et al.*, 2002; Pronk *et al.*, 2006) which on exposure may cause bronchial asthma, bronchitis, rhinitis, conjunctivitis and dermatitis (Raulf-Heimsoth and Baur, 1998).

It is against this background that the researchers set out to assess the perception and knowledge of paint sprayers with respect to; chemicals used in the spray paint industry; the use of personal protective equipment; workers compliance to basic safety rules in the spraying industry, health implications of the use of these chemicals, and to make recommendation to inform policy.

MATERIAL AND METHODS

The research approach was cross sectional and specifically case study design was used to allow an in-depth assessment and analysis of an existing contemporary situation. The study relied on primary and secondary data source, and adopted a procedure involving collecting data and information on types of chemicals used in the spray paint industries, awareness and per-

ception of risks at the workplace, provision and use of Personal Protective Equipment (PPE), extent of compliance of chemical safety guide lines and perceived effect of chemical hazards on workers health. Secondary data were obtained from published and unpublished sources including journals, periodicals, internet among others. The survey covered a sample size of 150 paint sprayers (masters, employees and apprentices) located at 83 spraying workshops (furniture, coffin and auto body) in 9 suburbs in Kumasi; Suame magazine, Asafo, Anloga, Asokwa, Adum, Oforikrom, Tafo, Fanti New Town and Amakom (where about 80 percent of the small scale paint spraying workshops are located) in Kumasi, Ghana between October 2005 and May 2006.

A total number of 150 masters, employees and apprentices (sample size) were administered with questionnaires based on the sample frame (i.e. total number of master spray painters who worked in the various suburbs). Since a sampling frame was not readily available a recognition survey was conducted to estimate the number of masters (115) who worked in the various Suburbs. Sample size (n) was determined using Slovin's sampling formula (Guilford and Fruchter, 1973) $n = N/[1+N(\alpha)^2]$ (where n = sample size; N = sample frame; α = confidence level). Using a confidence level of 95 % (sample size $n = 115/1+115(0.05)^2 = 89$). Despite the reassurance that the study had no legal, political or economic undertones, the response rate was 93 percent.

Simple random sampling was used to pick the number of masters for the administration of questionnaires. The selected masters (and the employees and apprentices where applicable) were administered with questionnaires at their own convenience to reduce non response rate. The questionnaires were prepared in English, but local language, Twi was used to translate and communicate the content of the questionnaire where necessary since 70 percent of the respondents were more comfortable with the local language. Since the mother tongue of the

researcher who administered the questionnaires is Twi, the questionnaire could easily be interpreted. Workshops where questionnaires were pre-tested and administered included garages and carpentry shops located in permanent wooden structures (13 percent), open air (54 percent) and spraying ovens (33 percent). By observation and interaction with sprayers, while carrying out their work, the perceptions, attitude, knowledge and safety practices in the industry were ascertained.

Purposive sampling was also used to interview heads of institutions such as, Department of Factorate Inspectorate (DFI), Kumasi Metropolitan Assembly (KMA) and Environmental Protection Agency (EPA) in relation to various legislative instruments and extent of its implementation/enforcement. The data were analyzed using the Statistical Package for Social Science (SPSS) software (SPSS- PC for windows, version 11.0). Descriptive analysis was used for the observation and interviews conducted.

RESULTS AND DISCUSSION

The survey revealed that the sprayers in the age group between 16 and 40 years constituted about 79 percent (Table 1) who are the strong and energetic group that the country needs to build the nation. More than 70 percent of male sprayers were between 26-40 years. The spraying industry was in the past considered job for men and not for females. However, 12 percent of the respondents were females and majority of them (83 percent) were within 21-25 years of age.

Table 2 shows that 13.3 percent of the respondents had no formal education 60 percent had MSLC and JSS, 26.7 percent had SSS/GCE "O" level, and Technical/Vocational education. Only 6.6 percent of respondents read instruction on the products, this group from the survey do not even read the instructions often. This leaves a large percentage of 93.3 who do not read the instruction on the product but depended largely on their job experience to use

the paints and solvents. Consequently, these sprayers will not benefit from information concerning safety and new techniques on the paint/lacquer spraying materials. The sprayers who read the labels were mainly SSS/ "O" level holders.

done in enclosed shops there was no separation between the ventilation system of the spraying area and the general ventilation in the garage.

Certification of workshops before operation perhaps would ensure that workplaces and wo-

Table 1: Age and sex distribution of workers

Age	Sex					
	Males		Females		Totals	
	No.	%	No.	%	No.	%
16 -20	5	3.8	1	5.6	6	4.0
21 - 25	2	1.5	15	83.3	17	11.3
26 - 30	33	25.0	1	5.6	34	22.7
31 - 35	40	30.3	1	5.6	41	27.3
36 - 40	21	15.9			21	14.0
41 - 45	7	5.3			7	4.7
46 - 50	8	6.1			8	5.3
51 - 55	15	11.4			15	10.0
Above 60	1	0.8			1	0.7
Total	132	100	18	100	150	100

About 54 percent (Table 3) of the sprayers, practiced their work in the open air but stored their solvents and equipment in small wooden structures, 13.3 percent of sprayers practiced in a wooden structure which served as their workshop, and also storage place for their solvents and equipment. According to Rossol (1995) since most hazardous exposure to paints and solvents will occur when they are sprayed, or otherwise made air borne, these processes require local exhaust ventilation. About 32.7 percent of the sprayers send their jobs to places where plastic spray ovens (booths) are available for a fee. These spray ovens were equipped with general ventilation systems that in principle allowed constant exchanges of air; with fresh air from outside replacing the contaminated air in the booths. Clean air in the booth certainly will be ensured only by well maintained filters that efficiently removes overspray articles and mist from exhaust air. Where spraying was

rk activities are designed with health and safety in mind to ensure that risks can be minimized from the beginning. This is because the enclosed plastic ovens it tends out were used by some car paint sprayers not because of safety consideration but were used when high finishing work was required. The plastic ovens prevented accidental body part touching of the wet paint surfaces, and also provided a dust free environment which other wise produced a gritty car surfaces. Most of the open air furniture and coffin lacquer spraying occurred in residential areas where these operators were located, posing serious health concerns to residents.

All respondents claimed there was adequate ventilation in working premises, however there was strong solvent odour on walk in inspections in the workshops and its immediate environment putting bystander workers at risk of health hazards associated with paint spraying.

Wang and Chen (1993) in their studies of paint workers exposure to organic solvents in Taiwan found that there was a relationship between the frequency of acute symptoms (skin irritation, eye irritation and headache) and high exposure levels of workers who painted in poorly ventilated painting booths.

Spraying solvents commonly used by respondents included; thinners, lacquer, hardener and automobile paints. These solvents and paints contain hazardous chemicals such as Toluene, Xylene, hexane and methanol; these are all volatile and therefore pose a considerable risk of exposure via inhalation and skin contact during the mixing, filling and spraying. Similar observations have been reported in the workplace health and safety hazard survey (Ministry of Health, Occupational Health Unit, 1998).

,Azar, Corel, B-mark and Leylac. Among the spraying product manufacturing companies, Sikkens and Azar dominate the market with 21 percent while B-mark had the least (0.7 percent) market share. The use of Material Safety Data Sheet (MSDS) and product labels are very important since it informs on product composition, its usage, warnings on hazards and first aid interventions before its application (Rossol, 1995). The respondents reported the proper labeling of these products, however, product labels were generally not read; perhaps because of lack of knowledge of the health and safety implications of the hazards associated with the use of these products.

Based on the experience on the job, 99 percent of the respondents knew that the solvent used in their work were volatile and flammable and

Table 2: Level of educational attainment in percentage

Description	No.	%
No formal education	20	13.3
Middle school (MSLC)	33	22
JSS	57	38
O' Level/S.S.S	38	25.3
Technical	2	1.4
Total	150	100

Positive associations between paternal and maternal occupational exposure to organic solvents and congenital malformations in offspring have been reported by Hooiveld *et al*, (2006) and Wolford *et al* (1997), respectively. Kurnczuk and Clarke (2001) in their study of leatherwork and male fertility also found out that workers who work with solvents were at an increased risk of presenting with infertility. Consequently paint sprayers need adequate protection; particularly pregnant women involved in this occupation must take extra care of protecting themselves and the unborn baby.

Figure 1 shows respondents use of paints and solvents from companies such as Gazo, Sikkens

therefore were cautious of fire near the workshop. Twenty two percent of respondents understood the warnings on the container, 4.7 percent did not understand the warnings, and 72.3 percent understood the common warnings such as the goggles and nose mask signs. Seventy seven percent of respondents said they obeyed the hazard warnings, but their practices on walk in visits indicated otherwise.

Working time was not standardized but varied according to the workload, but generally they had a six day working week. Thirteen percent of the sprayers have been actively involved in car, coffin and furniture spraying for more than 20 years, while 78.7 percent had been invol-

ved for 13 years and below. This prolonged sprayers' exposure and poor handling of these chemicals and solvents vapour is likely to lead to serious disabilities in their old ages. Those with more than twenty years of practice invariably were found to be masters and were usually not involved in paint related work. However, because they had once been active sprayers, their presence as bystanders during spraying on the work premises as supervisors make them also vulnerable to long term effect of solvents/paints exposure.

The legislative bodies responsible for health and safety in the country need to educate enforce safety rules and practices to avoid long term social and economic cost to families and government, however, since about 71 percent of workshops had not formally registered, inspections and monitoring of their activities by legislative bodies may be difficult.

Safety booklets, posters and leaflet on safety were almost nonexistent, as only 2 percent (Table 3) of the workshops had such materials, however only 1.3 percent did put the posters at visible places. The survey revealed that 63.3

percent of the respondents do wash their hands after each work to get their hands cleaned from solvents and paints; however 36.7 percent indicated that they wash their hands but not all the time. Some sprayers were found eating or drinking close to spraying areas, while spraying was in progress suggesting lack of understanding of the effect associated with paint spraying exposure. Generally inhalation of solvents and the possible ingestion of some chemicals may cause fever, headache gastrointestinal and respiratory tract irritation (Correction Enterprises, 2007). Wolford et al (1997) in a study conducted under a cooperative agreement between the Center to Protect Workers' Rights (CPWR) and the National Institute for Occupational Safety and Health (NIOSH) on a comparison of Safety-and –Health Training of Painters in Alaska, Oregon, and Washington concluded that ; safety and health training improves painters' self-protective behaviours, such as respirator and fan use. Trained workers appear to better protect themselves from exposures to toxic substances, thus reducing the risks to themselves and their offspring of serious and costly long-term work-related health effects. A paint sprayer is supposed to equip himself with all

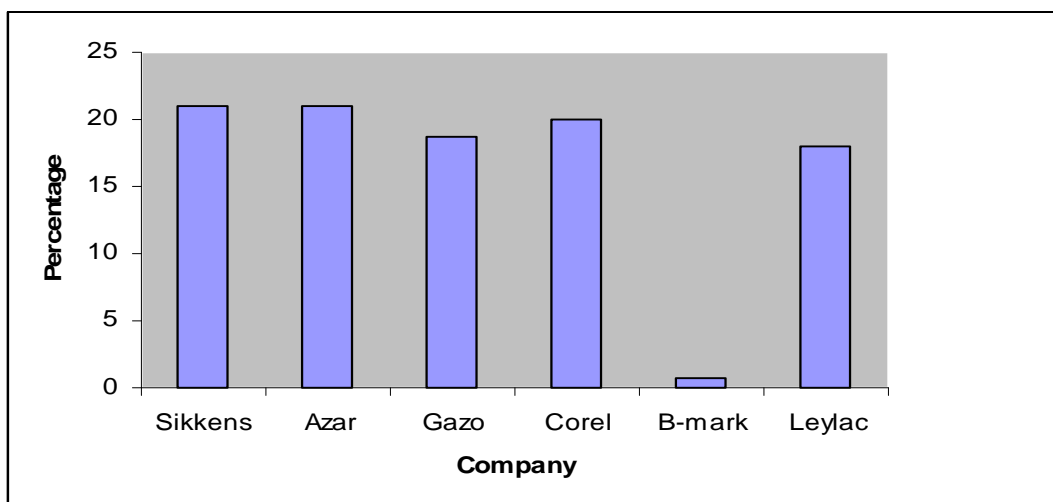


Fig 1: Brands of paint or solvents used by sprayers

the necessary PPE such as special overalls, nose mask, glasses, boots, gloves and hat to prevent inhaling toxic vapours and mist, swallowing paints and absorbing irritants through the skin and eyes (Rongo, 2004). In this study only 0.7 percent of respondents always used the appropriate PPE, 21.3 percent sometimes put on protective clothing whilst 78 percent do not wear PPE (Table 3). Consequently the workers in this study were not fully protected from the paint itself and from the fumes generated in painting.

Some of the workers did not put on gloves since they claimed them to be uncomfortable to use and also adversely affected the beauty of the spraying objects. Others also did not feel comfortable wearing PPE, especially in the dry and hot weather. Nose masks, workshop apron, goggles and safety boots (Table 3) were the common safety gadgets which some of the workers used. In most of the spraying shops, the provision of the protective clothing and equipment was found to be the responsibility of the individuals but not the managers or proprietors of the workshop. Although most of the workers recognized the importance of wearing the appropriate PPE, they claimed these were not used because of financial constraint. In a study of 600 workers in Dar es Salaam, Rongo (2004) observed that most of the workers operated in the open and did not use PPE, he therefore recommended the use of PPEs as the appropriate measure for hazards protection in small scale industries since their open air operations did not make engineering interventions appropriate. Wolford et. al., (1997), Moen, and Hollund (2000); have reported that most workers always used gloves, overalls and respiratory protective equipment during car painting, with consequent low organic solvent exposure because of strict legislative enforcement.

In this study there was a general belief by the workers in the efficacy of the use of soda water and/or milk as a body detoxifying agent, after a considerable exposure to chemicals and solvents vapour, which needs to be investigated.

There was considerable use of solvents in cleaning paints from the skin of workers after spraying even with protective clothing and the researchers in this work also came across the PPE complimenting practice of shea butter application in the nostrils to minimize solvent and paint inhalation. Shea butter was also applied on the skin (conceivably to serve as a protective layer) to facilitate cleaning of lacquer and paints from the skin after spraying. The efficacies of this practice need to be investigated and fine-tuned for extensive practice, because Bello et al., (2008) have demonstrated that skin exposure to aliphatic polyisocyanates during painting, mixing, and paint-related tasks in auto body repair and refining workers is common and also commonly detected under routine PPE (gloves, cartridge respirators and protective clothing), questioning the efficacy of PPE commonly used in these auto body shops.

None of the spraying shops had eye washers, fire detector alarm or safety shower to wash off solvent from the body in case of spillage. Ninety four percent of the respondent indicated that, in case of accident, the victims were sent to the hospital. However 2.7 percent who had first aid kits claimed administering first aid before sending the victim to the hospital. Only 6.7 percent (Table 3) of the establishment provided first aid training for master sprayers and senior apprentice. Only 1 percent of the workers had the National Health Insurance coverage.

About 7 percent of the workshops possessed fire extinguishers. It was however, observed that some of the fire extinguishers were found to be empty making these workshops susceptible to fire hazards and property loss in case of fire outbreak. None of the establishment had accident-record book, which could contain log of common accidents for future effective intervention. There was no written or unwritten health and safety policy in all the workshops visited. This is not surprising because there was no education and /or enforcement of the health and safety regulations by government legislative institutions.

Table 3: Workers compliance to basic safety rules in percentage

Safety	Yes
Spraying in open air	54.0
Spraying in wooden structure	13.3
Spraying in plastic oven	32.7
Reading of instructions on products	6.6
Understanding of warning signs on products	
All	22.0
Some	72.3
None	4.7
Use of safety booklets, posters and leaflets	2.0
Knowledge of flammable nature of solvent	99.0
Existence of fire extinguisher	6.7
Availability of eye washers, fire detector alarm or safety shower	0.0
Washing of hands after each work	63.3
Use of Personal Protective Equipment during Paint Spraying	
Never	78.0
Sometimes	21.3
Always	0.7
Nose mask	27.0
Workshop apron	46.0
Safety boots	27.0
Goggles	1.0
First aid kit	2.7
Existence of safety policy	0
Periodic job training	10.0
First aid training	6.7
Existence of accident-record book	0

Ten percent of the respondent indicated that, they received annual job training from Sikkens a paint manufacturing company, however there were others who were motivated to attend Sikkens training programmes periodically because of the problems they were confronted with in their practice. Periodic education on safety that helped to upgrade knowledge of potential hazards of materials used in the car, furniture and coffin spraying industry were minimal (6.7 percent). Ninety three percent of the spraying workshops did not have someone responsible for safety; however 5.3 percent and 3 percent had their masters and senior apprentice responsible respectively. Wolford et. al., (1997), Moen, and Hollund, (2000) have reported effective compliance of health and safety regulations by spray painters as a result of mandatory training for initial certification and refresher training every two years, reaches a wide range of painters, regardless of previous training, union status, or company size, rather than voluntary training through workers associations in improving self-protective behaviours.

The survey revealed that about 79 percent of health complaints by paint sprayers were mainly respiratory related (Figure 2). In a situational analysis of small scale industry workers in Dar es Salaam, Tanzania, painters self-reported chest/throat pains and headaches of 60.4 and 62.8 respectively (Rongo *et al.*, 2004). Eifan *et al.*, (2005) in their study of occupational asthma in 72 apprentice adolescent car painters, concluded that an average of three years of working duration in an unfavourable/unhealthy condition is sufficient for developing occupational asthma. Nakashima *et al* (2001) recommended the wearing of masks in the workplace as a form of protection of healthy workers, in preventing sensitization to Isocyanates and consequent development of occupational hypersensitivity Pneumonitis. In this study virtually all the workers were aware of the manifest health hazards of their work but did not consider the hazards dangerous to their health. The conditions that the sprayers work put them and their neighbouring residents at

risk of respiratory, eye and skin diseases; however no records of ill health or disease were kept.

Although there is a general association for garages at Kumasi magazine (Ghana National Association of Garages) which, oversees the activities of all garages (which include; automobile electricians, mechanical engineers, automobile body straighter, automobile paint sprayers etc) its main objectives are land administration and the general welfare of its members without emphasis on health and safety.

The survey revealed that apart from KMA officials' visits to collect revenue, none of the government bodies responsible for health and safety paid visits to the paint spraying workshops. Moen and Hollund (2000) in their study of car painters in Bergen, Norway found that as a result of enforcement of official regulations on exposure to organic solvents, workers exposure to organic solvents were low producing a minimum of acute symptoms among car painters. In this study respondents' rated Law enforcement concerning safety practices as low; officials of the Department of Factorate Inspectorate (DFI) and Environmental Protection Agency (EPA) were fully aware of the hazards of the paint spraying trade but attributed the lack of visits to educate and enforce laws to inadequate logistics and personnel to carry out this task effectively. Since the micro-enterprise sector workers in developing countries are characterized by workers who are poor, unorganized and often unformed regarding workplace risks (Matachaba-Hove, 1996) strict enforcement of Ghana Factories Offices and Shop Act (ACT 328) and other legislative instrument without prior planned education and training would mean the closure of most of these spraying shops.

CONCLUSION AND RECOMMENDATION

Most of the spray painters are young, have little education and worked over seven (61 percent)

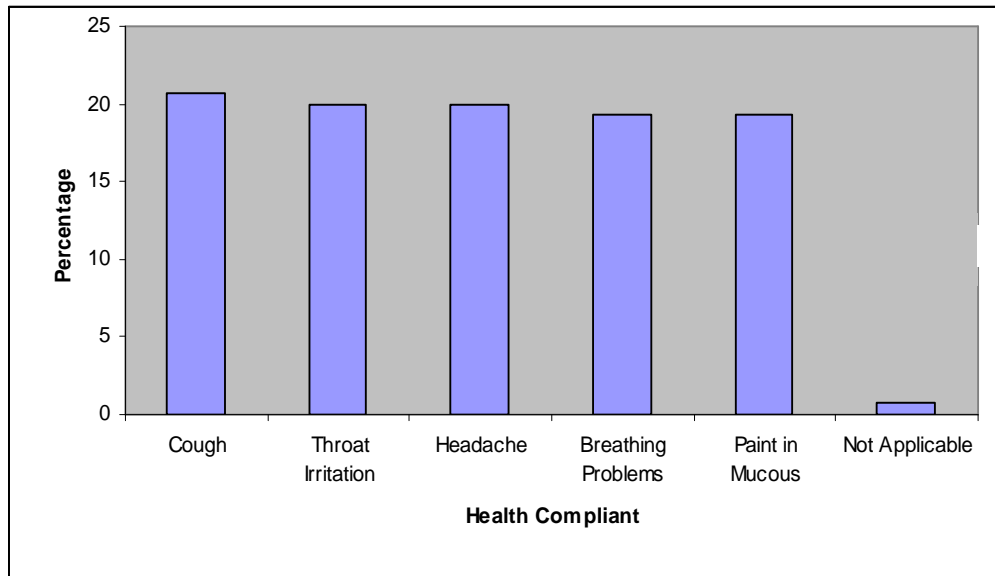


Fig. 2: Common health complaint by workers

years. There was high (>90 percent) self reported occupational health problems, particularly respiratory related problems. In this study only 0.7 percent of respondent always used the appropriate PPE, such as workshop apron, nose mask, goggles, and safety boots to prevent inhaling toxic vapours and mist, swallowing paints and absorbing irritants through the skin and eyes during paint spraying. Since most workshops (54 percent) are in open air and appropriate engineering methods could not be used the enforcement of training in the use of appropriate PPEs as a measure for hazards protection in the paint spraying industry is paramount. The efficacies of the practice of the use of shea butter applied to the nostrils and the skin to minimize paint and solvent inhalation and to facilitate cleaning of lacquer and paints from the skin after spraying respectively, need to be investigated and fine-tuned for extensive practice. Respondents rated Law enforcement concerning safety practices as low; DFI personnel attributed this to lack of adequate logistics and personnel to carry out the task effectively.

Lack of Chemical education and enforcement of safety practices in the metropolis is a major contributing factor of the occupational hazard exposure. There is the need for law enforcement and education on occupational chemical hazard exposure in the paint spraying industry to improve occupational health and safety provision. Mandatory training for initial certification and refresher training every two years by the government may be a more effective strategy in reaching a wide range of spray painters, regardless of previous training, union status, or company size, rather than voluntary training through workers associations in improving self-protective behaviours. To be certified, sprayers may have to pass knowledge test on health hazards of painting, reading and understanding MSDS and use of PPE. This will ensure effective health and safety rules compliance and a healthy workforce and environment. The government should also provide adequate financial and logistical support to all enforcement agencies of OSH legislation to enable them effectively carry out their duties.

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