

Dry cleaning industry in the City of Colombo, Sri Lanka: A preliminary study of chemicals used and possible health effects

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Abstract

Introduction

This study was conducted to assess the occupational health and safety of workers of dry cleaning industry in Colombo.

Method

A descriptive cross-sectional study was conducted in 24 dry-cleaners from 15 randomly selected dry cleaning establishments in Colombo Municipal area. A group of 24 shop workers from the same area comparable with respect to age, marital status, educational level and duration of service, served as a comparison group. A structured observational schedule and an interviewer administered questionnaire were used to collect data.

Results

Fourteen (93.3%) establishments used Perchloroethylene (PERC). Material Safety Data Sheets (MSDS) were not available in 80% and storage was unsatisfactory in 60%. Fire safety (100%), lighting (100%) and ventilation (73.3%) were satisfactory in a majority while thermal environment (73.3%) and noise levels (100%) were unsatisfactory. Except for clothing (53.5%), welfare facilities were satisfactory in a majority (86.7%) of establishments. Among the workers, irritation of skin ($p=0.000$), eyes including tearing ($p=0.004$) and sneezing ($p=0.032$) were significantly higher than controls. Personal Protective Equipment (PPE) were provided for 14 (58.33%) workers and only 5 (35.71%) used them.

Conclusion

Acute symptoms related to chemical exposure were significantly higher among workers in dry cleaning industry. Overall work environment in these establishments was unsatisfactory.

Introduction

Laundering and dry cleaning have become a formal industry in Sri Lanka providing a professional service to individuals as well as to the corporate sector. Most star grade hotels have its own laundry and dry cleaning facility. With the boom in the hospitality industry there is a huge potential for expansion of this industry in Sri Lanka. Dry cleaning has also developed into small business enterprises seen in residential areas within Colombo. Dry cleaning is a cleaning process for clothing and textiles using a chemical solvent other than water to remove soil and stains from fabric[1].

The process begins with sorting of clothes by type of fabric, color, or stain. It's then pre-treated and placed in a large washing machine that uses solvents instead of water. The washed garments are then pressed and packed [2]. Chemicals can be grouped into five broad categories, as dry cleaning solvents, other chemicals used in the dry cleaning machines, pre-cleaning/spotting agents, garment treatment chemicals and chemicals used in solvent and equipment maintenance.



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The type of solvent used has been changing from petroleum based highly flammable ones to less flammable chlorinated solvents such as Perchloroethylene (PERC) also known as

tetrachloroethylene, (C_2Cl_4 or $Cl_2C=CCl_2$) which is the dominant chemical used in dry cleaning at present and has long been recognized as an effective dry cleaning solvent. The use of PERC was increased due to its superior cleaning ability [2] and the dry cleaning industry is known to be a work environment which is exposed to high levels of PERC [3].

In 2008, Environmental Protection Agency (EPA) suggested that PERC be classified as a "likely human carcinogen" (2). Moreover, the EPA found that PERC's most dangerous non-cancer toxicity is brain and nervous system damage. The World Health Organization, states that PERC is a "probable human carcinogen." Symptoms on exposure to high levels of PERC include dizziness, fatigue, headaches, confusion, nausea, and skin, lung, eye and mucous membrane irritation. Repeated exposure to high levels can also irritate the skin, eyes, nose and mouth, and can cause liver damage and respiratory failure. PERC might cause effects at lower levels as well [4].

Stoddard solvent is a petroleum-based dry cleaning solvent. It's a mixture of aliphatic and alicyclic C7 to C12 hydrocarbons. Dipropylene glycol tertiary butyl ether (DPTB) is another solvent being used. There are several other solvents namely, carbon tetrachloride, high flashpoint hydrocarbons DF-2000, Modified hydrocarbons blends (Pure Dry) etc. [2, 5]. In the pretreatment where stains are removed, solvents are used in removing dry stains due to grease or oil. Exposure to solvents may occur from inhalation of vapours, skin absorption or eye contact. Exposure to vapors and chemicals can cause short and long-term breathing problems, neurotoxicity [6] and malignancies [7].

No studies have been done on the dry cleaning trade in this country and therefore the hazards faced by these workers remain largely unidentified. The objectives of this study were to identify the most commonly used dry cleaning solvents, to observe the working conditions and facilities provided to employees by conducting a walk through survey, to assess the extent of exposure to chemicals used and their health effects, observe other hazards and risks in the work environment and to determine the protective measures provided and its adherence by workers.

Methodology

Study design, setting and sample

From a list of registered dry cleaning and laundry establishments situated in the city of Colombo, a sample of fifteen (15) were randomly selected for the study. Of them eight were housed in 'star grade' hotels in Colombo; balance seven individual shops situated in the city. Locating the establishments, gaining admittance and obtaining permission to conduct the study was carried out by the Public Health Inspector (PHI) attached to the Colombo Municipal Council (CMC). The research assistant with the PHI entered the establishments and conducted the study.

It was a descriptive cross-sectional study with a comparison group, confined only to the dry cleaning facility of the selected establishments where only one or two workers are engaged. Hence, 24 workers who satisfied inclusion criteria by having worked in the trade for a minimum of three years were recruited. Subjects with any form of congenital lung conditions, having undergone a chest injury or those having respiratory diseases diagnosed prior to starting work in this industry were excluded. For the comparison group, 24 subjects with a minimum of 3 years of service were selected from employments where there was no exposure to any form of dusts, fumes, gases, vapors or mists which would bring about a respiratory condition.

Study instruments and data collection

Two study instruments were used for data collection.

1. A survey form to assess the workplace which extracted information on location, name of occupier, Business Regulation number, number of persons employed, process and machinery used, whether moving parts are guarded, several aspects with regards to storage of raw materials, chemicals used, availability and accessibility to Material Safety Data Sheets (MSDS), type of energy used, reportable accidents during the past 6 months, maintenance of the General Register, provision of welfare facilities as per Factories Ordinance, such as, facilities for washing, meal room, sanitary conveniences, drinking water, accommodation for clothing, provision and use of protective gear, such as, eye protection and other personal protective equipment [8]. A subjective assessment of how the investigator perceived the work environmental with respect to thermal environment, illumination, ventilation and noise were also included. Availability of correct type of fire extinguishers, risk of workers being electrocuted, availability of first-aid box, presence of a trained first-aider, and discharge and disposal of waste products were also included.
2. An interviewer-administered questionnaire was

used to collect socio-demographic characteristics and employment history of workers, any condition of ill health that occurred during the past 6 months, a list of conditions that may occur due to exposure to dry cleaning solvent, provision of personal protective equipment, if provided whether they are being used and if not reasons for same and information with respect to any accidents they experienced while at work. Similar information was collected from the control group as well.

Data collection was done during May to July 2015.

Data entry and statistical analysis

Data collected were entered to SPSS and analysed using standard descriptive methods and statistical tests.

Ethical issues

Ethics approval was obtained from Ethics Review Committee, Faculty of Medicine, Colombo. Permission was obtained from the owners of the establishments to conduct the study by the area PHI. Verbal informed consent was obtained from the participants who satisfied the inclusion/exclusion criteria after adequately informing them of the objective of the study, any risks/benefits involved and their involvement in the study. Anonymity was maintained and the participants were assured of confidentiality of information they provided. Participants were interviewed with minimal interference to their work.

Results

Part I – Assessment of the work place

A walk through survey in all selected work places was done and observations and information was gathered by talking to the management and workers.

Description of the chemicals used, provision of MSDS, storage of chemicals, waste generated and provision and use of protective gear

PERC was the only chemical used for dry cleaning by 14 out of the 15 (93.3%) establishments. The other facility, housed in a leading hotel in Colombo used D-2000. Besides the dry cleaning agents, thinner, stain remover, spotting agent, and softener were also used. MSDS were not available on the dry cleaning solvent and other chemicals used in 80% work places, however, 9 out of the 12 had informed the employees about the hazardous nature of the chemicals. MSDS were available for all or at least for some chemicals in only 3 out of the 15 workplaces. Any form of protective gear was not provided to workers in two workplaces. These two workplaces did not have MSDS for PERC. As for

the storage of chemicals, a separate area was available in only 5 (33.3%) workplaces. Storage was maintained according to standards, the bottles had labels intact and the employees knew how to open the bottle and pour out the chemical with least exposure. Nine workplaces did not have separate storage facilities for chemicals. The other workplace in a leading hotel purchased the dry cleaning solvent and filled the container inside the machine only when required.

In the process of dry cleaning, clothes are pre-tested individually with PERC and separated out according to colour, texture of the material and placed in the machine. Automatically PERC is pumped into the machine containing the clothes and the cleaning process begins under steam. Solid and liquid wastes were generated by all workplaces which is collected and disposed with the municipal waste.

Fire and electrical safety and availability of first aid facilities

Fire extinguishers were available in all 15 establishments. A first aid box was also available in all 15. However, a trained first aider was present in only 7 (46.7%) establishments.

Investigators perception about the work environment

Summary of the thermal environment, light intensity, ventilation and noise as perceived by the investigator are given by Table 1, below.

Table 1: Summary of the investigator's perception about the work environment in the dry cleaning facilities under study (N=15)

Work environment	Level of Satisfaction No. (%)	
	Satisfactory	Not Satisfactory
Thermal	4 (26.7)	11 (73.3)
Light	15 (100)	0 (0)
Ventilation	11 (73.3)	4 (26.7)
Noise	0 (0)	15 (100)

The investigator perceived the work environment being not satisfactory with respect to the thermal comfort (73.3%) and noise (100%). Illumination was perceived as satisfactory in 100% and ventilation being satisfactory in 73.3%. The types of energy used were electricity and steam. The steam released through leaks from the machinery and delivery tubes would have contributed to the hot environment.

Machinery safety, accidents and ill health

Except in one establishment, moving parts of machinery were seen to be guarded in all the other (93%) establishments. There were no incidents of reportable accidents (i.e. where the worker could not

earn full wages for three days or more) during the past 6 months.

Maintenance of the General Register

about the General Register. Only 4 (26.7%) maintained the General Register and they were housed in star grade hotels. The other 2 establishments maintained the information in a record book.

Provisions of welfare facilities

Provision of satisfactory welfare facilities as perceived by the investigator are given in Table 2 below.

Table 2: Summary on the provision and quality of welfare facilities as perceived by the investigator on inspection of the dry cleaning facilities under study (N=15)

Welfare facilities	Provided No. (%)	Level of Satisfaction No. (%)	
		Satisfactory	Not Satisfactory
Washing facilities	15 (100)	13 (86.7)	2 (13.3)
Meal room	15 (100)	13 (86.7)	2 (13.3)
Sanitary conveniences	15 (100)	13 (86.7)	2 (13.3)
Drinking water	15 (100)	13 (86.7)	2 (13.3)
Accommodation for clothing	15 (100)	08 (53.3)	7 (46.7)

All the establishments under study provided welfare facilities to their employees. Except for accommodation for clothing (53.3%), facilities for washing, meal room, sanitary conveniences and drinking water were satisfactory in majority (86.7%).

Risk of exposure to chemicals

Risk of skin and eye contact and inhalation of chemicals used were observed in all 15 work places. When rubbing a cloth wet with PERC on the garment to be tested, there is a risk of inhalation of PERC vapours and these vapours can come in contact with the eyes. Skin contact is also possible during pre-testing of clothes. Exposure is also possible when

Part -II-Socio-demographic characteristics, employment history, health effects and personal protection of workers

Laundering is merely washing clothes using water while dry cleaning is machine washing using a solvent. A dry cleaning facility may not be provided in every laundry. Dry cleaning operation is less labour intensive and is handled by only one or two workers. Hence, this study is on a group of 24 workers from 15 establishments. All workers employed were males. A group of 24 subjects drawn

Nine (60%) establishments did not maintain the General Register and one of them had not even heard

from shops and sales outlets close to the dry cleaning establishments, employed as sales assistants formed the control group.

The table 3 below gives the socio-demographic characteristics of the subjects in the study and control groups.

Table 3: Socio-demographic characteristics of study (N=24) and control groups (N=24)

Socio-demographic characteristics	Study Group No. (%)	Control Group No. (%)	Significance
Age (years)			
< 30	5(20.8)	11 (45.8)	
30-39	9(37.5)	7(29.2)	
40-49	6 (25)	3(12.5)	
50-59	3(12.5)	3(12.5)	
60 or more	1(4.17)	0	
Mean (SD)	39.08 (9.58)	35.04 (9.72)	t=1.45, df=46
Range	38	33	p>0.05
Marital status			
Single	8 (33.33)	10(41.67)	SND= 0.63
Married	16(66.66)	14(58.33)	p>0.05
Educational level			
Grade 5-9	1 (4.2)	0	first 2 rows
GCE O/L	21 (87.5)	22 (91.7)	amalgamated –
GCE A/L	2 (8.3)	2 (8.3)	No difference
Duration of employment (years)			
Mean (SD)	18.5 (8.9)	15.2 (5.8)	t = 1.52, df = 46 p>0.05

The subjects in the study and control groups were comparable respect to age, marital status, educational status and duration of employment (p>0.05).

Table 4: Distribution of the study population by duration of service in laundry & dry cleaning trade and no. working hours/day and no. days/week

Employment characteristics	No. (%)
Duration of service (years)	
3 – 9	6 (25.0)
10 – 19	9 (37.5)
20 – 29	8 (33.3)
30 – 39	1(4.2)
No. of working hours per day	
8	20(83.3)
9	4 (16.7)
No. of working days per week	
4	2(8.3)
5	8 (33.3)
5.5	4 (16.7)
6	10(41.7)

Table 4, shows the employment history of the study

population. Total duration of service considered here is the duration of employment in the dry cleaning trade in the current and previous occupations. In the case of 4 (16.67) employees, they had worked abroad in this trade during their previous occupation. Majority were employed for 10-19 years, worked for 8 hours per day and worked 5.5 days per week. All

workers were handling chemicals and all of them said they knew the type of chemicals they were handling. The subjects in the control group were not exposed to any chemical in their current or previous occupations and worked as sales assistants for 8 hours a day and 6 days per week.

Table 5: Distribution of the study and control groups by conditions of ill health they suffered from during the past 6 months and symptoms related to chemical exposure

Whether suffered any form of ill health	Study group No. (%)	Control group No. (%)	
No	20 (83.33)	19 (79.17)	
Yes	4 (16.67)	5 (20.83)	
Total	Condition of ill health Lower resp. tract infection-2 Cold and fever-1 Cough- 1 24(100.00)	Condition of ill health Lower resp. tract infection-1 Viral fever-1 Knee pain- 1 Back pain-2 24(100.00)	
Prevalence of chemical-related symptoms among study and control groups			
	Study group	Control group.	Level of Significance*
None	6 (25.0)	0	p<0.05
Dizziness	-	-	
Fatigue	-	-	
Headache	-	-	
Confusion	-	-	
Nausea	-	-	
Skin irritation	12 (50.0)	0	p<0.05
Respiratory problems	4 (16.67)	0	p>0.05
Eye irritation and tearing	8 (33.33)	0	p<0.05
Nasal irritation and discharge	5 (20.83)	0	p=0.05
Sneezing	6 (25.0)	0	p<0.05
Mouth irritation	-	-	-

*Fisher's Exact test

Majority (83.33%) in the study group did not complain of any illness over past 6 months. Of the 4 (16.67%) who complained, 2 complained of lower respiratory infection, 1 had had a cold and fever while the other complained of cough which he attributed due to exposure to chemicals. In the control group majority (79.17%) did not complain of any illness. Of the 5 (20.83) who complained, one had been ill with a respiratory tract infection, another with a common cold and 3 others with back and knee pain.

In response to the question on whether they experienced symptoms related to chemical used listed in Table 5 above, 25% of the study population responded that they have not experienced any of the above conditions. Eleven (45.83%) had at least 2 or more conditions. Skin irritation (n=12) was the commonest condition, followed by irritation of the eye and tearing (33.33%, sneezing (25%), nasal irritation and discharge (20.83%), and respiratory

problems (16.67%). These conditions were reported to occur when they are exposed to the chemical while pre-testing the garments with PERC, particularly skin irritation as the chemical comes in contact with the skin and irritation of the eye and nose due to the chemical vapour. Breathing difficulties were also

reported when workers were near the machine for long hours. The control group had none of the conditions listed in Table 5. Compared to the control group the prevalence of skin irritation, eye irritation and sneezing were significantly higher among the dry cleaning workers (p<0.05).

As for the provision of personal protective equipment, 14 (58.33%) said that they were provided with one or more protective equipment while 10 (41.67%) said that they were not provided with any kind of protective equipment. Masks, gloves and goggles were the equipment provided to them and masks being the most common. However, only five said that they wear the protective

equipment while working, two stated that they wear them only when cleaning the machine and seven said that they do not wear any of them. The reasons for not wearing being, used to working without them and one worker complained that the rubber gloves melt when come in contact with PERC. However, in contrast to the above facts the investigator did not observe any worker wearing any protective equipment during the walk-through survey. In response to the question as to whether they had experienced any kind of accident while at work, all responded in the negative.

Discussion

Of the 15 dry cleaning facilities that were studied, 53.3% were housed in star grade hotels. Except in one facility which used DF-2000, all others used PERC as the dry cleaning solvent. PERC has long been recognized as an effective dry cleaning solvent and it's the most commonly used solvent in dry cleaning shops in the City of Colombo.

PERC is an excellent cleaning power and is stable, non-flammable and gentle to most garments [9]. However, it is currently considered as a potential carcinogen by the Environmental Protection Agency [2] and the National Institute for Occupational Safety and Health [9]. Occupational Safety and Health Administration (OSHA) has set mandatory Permissible Exposure Limits (PELs) of 100 ppm for PERC [10]. Other OSHA standards that may apply when workers are exposed to PERC include hazard communication and general requirements for PPE and respiratory protection [10]. In addition, the dry cleaning facility must comply with EPA regulations that control the release of PERC to the environment as dry cleaning wastes are potentially hazardous and must be handled as a hazardous waste [11]. This regulation is violated by all the dry cleaning shops as the solid and liquid wastes generated were collected and disposed with the municipal waste by all the establishments. As for DF-2000, used by only one facility, is a synthetic hydrocarbon fluid, effective and environmentally friendly alternative to perchloroethylene [2]. MSDS for the chemicals were available only in 20% of dry cleaning shops and they were housed in hotels. In the facilities which did not have MSDS, the workers were aware about the nature of chemicals they used. Majority (60%) of dry cleaning shops did not have separate storage area for chemicals. Only 4 out of 15 (26.7%) maintained the General Register, a requirement of the Factories Ordinance [8] and two other facilities maintained the same information in a record book.

Dry cleaning technology has evolved substantially over decades. The newer machine designs greatly reduce the amount of PERC vapour released into the

air inside the shop as well as outdoors resulting in cost saving, providing a safer working condition and cleaner environment. Adequate ventilation is essential in controlling PERC levels within the shop. Replacing old with modern equipment and routine machine maintenance combined with detection and timely repair of identified leaks can be extremely effective in controlling airborne levels of PERC vapor [10]. Investigator's perception on ventilation was not satisfactory for 4 (26.7%) facilities. The environment was perceived to be 'hot' in these four and in seven others. Except in one dry cleaning facility, in all others, moving parts of machinery were guarded. There were no incidents of reportable accidents within the past 6 months. Fire safety was satisfactory and so were the welfare facilities provided to workers.

The fact that these workers generally have been in this industry for a long period intensifies their vulnerability to adverse effects of chemical exposure. This is further accentuated by the fact that a majority of them work 5½ or 6 days a week. In contrast to the expectation, only a few complained of ill health during the past 6 months.

When considering the acute symptoms that may arise due to exposure to PERC, 75% complained of at least one or more symptoms, 46% having had more than 2 complaints: skin irritation, irritation of the eye and tearing, sneezing, nasal irritation and discharge and respiratory problems. Skin irritation being the most common complain (50%), followed by irritation of the eye and tearing by 33%. Since none of the subjects in the control group had any of these symptoms, these were significant occurrences in the study group. These could be due to workers not conforming to good work practices and not wearing personal protective equipment. In the walk through survey the investigator did not observe workers wearing any form of protective gear. Even though PPE were provided to the workers, its use by the workers during work was limited.

Conclusions and recommendations

Even though MSDS are not available in majority of the dry cleaning shops, workers seem to be aware of the nature of chemicals they handle. Conditions and facilities provided to workers in the dry cleaning facility housed in hotels were better than those provided in other setting. Use of protective equipment except was limited. Work environment was perceived as hot and noisy but adequately ventilated and well illuminated. There were no significant incidents of reportable accidents or illnesses during the past 6 months. Skin irritation, irritation of the eye and tearing, sneezing, nasal

irritation and discharge and respiratory problems were present among workers.

MSDS should be made available and accessible to workers. General Register should be maintained by all dry cleaning shops. Use of PPE should be made mandatory at all times during work. Respirators equipped with filters or cartridges specifically designed for organic vapors should be available to be used when elevated PERC exposures are anticipated. Waste should be collected and disposed

References

1. Future prospects of laundry industry, [online] Available at: <<http://archives.dailynews.lk/2012/08/21/bus27.asp>> (2013/08/15)
2. Dry cleaning, [online] Available at: <<http://en.wikipedia.org/wiki/Drycleaning/>>(2013/09/09)
3. Hellweg S, Demou E, Scheringer M, et al. Confronting workplace exposure to chemicals with LCA: examples of trichloroethylene and perchloroethylene in metal degreasing and dry cleaning. *Environ Sci Technol* 2005;39(19):7741-8.
4. Dry cleaning chemicals likely to cause cancer, [online] Available at: <<http://www.webmd.com/cancer/news/20100209/dry-cleaning-chemical-likely-causes-cancer/>> (2013/10/05)
5. Ceballos DM, Whittaker SG, Lee EG, et al. Occupational exposures to new dry cleaning solvents: High-flashpoint hydrocarbons and butylal. *J Occup Environ Hyg*. 2016;13(10):759-769. doi:10.1080/15459624.2016.1177648.
6. Jiménez Barbosa IA, Boon MY, Khuu SK. Exposure to organic solvents used in dry cleaning reduces low and high level visual function. *PLoS One* 2015;10(5):e0121422. doi: 10.1371/journal.pone.0121422. eCollection 2015.
7. Vlaanderen J, Straif K, Ruder A, et al. Tetrachloroethylene exposure and bladder cancer risk: a meta-analysis of dry-cleaning-worker studies. *Environ Health Perspect* 2014;122(7):661-6. doi: 10.1289/ehp.1307055. Epub 2014 Mar 21.
8. Factories Ordinance, [online] Available at: <<http://www.labourdept.gov.lk/images/PDFupload/chapter04/1factoriesordinancei.pdf>> (2015/01/22)
9. Control of Exposure to Perchloroethylene in Commercial Dry cleaning. U.S. Department of Health and Human Services. Public Health Service Centers for Disease Control and Prevention National Institute for Occupational Safety and Health. October 1997 DHHS (NIOSH) Publication No. 97-154. stacks.cdc.gov/view/cdc/13414/cdc13414DS1.pdf (2013/10/05)
10. Guidance and information for reducing worker exposure to Perchloroethylene (PERC) in dry cleaning. Occupational Safety and Health Administration Directorate of Standards and Guidance, [online] Available at: <<https://www.osha.gov/dsg/guidance/perc.html>> (2014/03/02) Perchloroethylene, [online] Available at: <<http://www.nodryclean.com/epaperfaq.htm/>>(201

in accordance with the regulations for hazardous waste disposal.

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