

Solvent Exposure, Related Work Practice and Self- Reported Health
Problems Among Car Painters in Workshops at Hebron City-Palestine

“A Study from Hebron City- Palestine”

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Dedication

“To the spirit of my father praying to God to bless him, to my merciful mother, to my darling wife, to my dear brother and sisters and their husbands, nieces, and nephews and to all car painters and workers in Palestine, I dedicate this unassuming work”

*Researcher: Ayman Khaleel Al-Frookh
Oslo, June-2002*

Abstract

Solvent Exposure, Related Work Practice and Self- Reported Health Problems Among Car Painters in Workshops at Hebron City-Palestine

In order to gain more knowledge about the working environment and on the occurrence of solvent-exposure symptoms among workers of car painting workshops, we conducted a cross-sectional occupational survey (descriptive study) among workers in Hebron-Palestine. Sixty-two workers from thirty-one workshops were interviewed using a structured questionnaire on work environment and self-reported adverse health effects. The present study showed that all owners and workers in Hebron City were at risk to be exposed to organic solvents directly or indirectly. The workshops lacked standard criteria of safety such as ventilation systems. The workers lacked knowledge about the adverse health effects of organic solvents and safe use. The majority of the workers painted the cars without precaution, and they did not use protective measures (e.g., non of them used filter gas, 71% filter masks, 17% gloves, 22% goggles, 7% working clothes, 8% special shoes, 7% head cover). They reported general health complaints (68% headache, 42% painful tingling, 40% red or sore eyes, and 52% difficulties in breath) which could be due to exposure to organic solvents used in car paints. We concluded that the workers are exposed to high concentrations of organic solvents for short times during painting process. During this period, they were not adequately protected.

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List of abbreviations

ACGIH: American Conference of Governmental Industrial Hygienists.
CEC: Commission of the European Communities.
EPA: -Environmental protection agency (USA).
HDI: Hexamethylene diisocyanate.
IARC: International agency for research on cancer.
NIOSH: National institute for occupational safety and health (USA).
OEL: Occupational exposure limit.
OSHA: Occupational safety and health administration (OSHA).
PCBS: Palestinian Central Bureau of statistics.
PEL: Permissible exposure limits.
PGFTU: Palestinian General Federation of Trade Union.
PPE: Personal protective equipment.
STEL: Short-term exposure limits.
TDI: Toluene diisocyanate.
TLV: Threshold limit value.
TWA: Time-weighted average.
VOC: Volatile organic compounds.
WHO: World Health Organisation.]

Chapter One

*Introduction
and
study objectives*

1-1: Definitions of organic solvents

Organic solvents are a group of volatile compounds or mixture that are relatively stable chemically and that exist in the liquid state at temperatures of approximately 0° to 250 °C (32° to 482°F) (NIOSH 1987).

1-2: Uses of organic solvents

More than 750,000 chemicals are known to be in our environment and between 1000 and 2000 new ones enter the market each year (WHO 1993). The U.S. environmental protection agency (EPA) estimated that up to 286,000 tons of volatile organic compounds (VOC) are released annually from car painting operations (Enander et al. 1998).

Organic solvents have a variety of uses. Solvents are used in cleaning to dissolve stains, dirt or grease, which are removed when the solvent is washed away. The dirt on a wool suit is removed when it dissolves in perchloroethylene used by dry cleaners. Grease on metal parts is often removed with mineral spirits ("varsol"). Many solvents are ingredients in coatings (paints, enamels, varnishes, shellacs, and lacquers), pesticides and resins. Examples of other applications include disinfectants (isopropyl alcohol to kill germs) and as anti-freeze agents (ethylene glycol),
(<http://www.mflohc.mb.ca/factSheets/organicSolvents.html>).

Organic solvents are also used for extracting, dissolving, or suspending materials such as fats, waxes, and resins that are not soluble in water. The removal of the solvents from a solution permits the recovery of the solute intact with its original properties (Considine 1976).

1-3: Classes of organic solvents

Organic solvents are a broad class of chemical compounds used extensively in industrial process and in consumer products, commonly in the form of mixtures (Daniell et al. 1993). Common organic solvents are classified as aliphatic hydrocarbons, cyclic hydrocarbons, aromatic hydrocarbons, halogenated hydrocarbons, ketones, amines, esters, alcohols, aldehydes and ethers (NIOSH 1987). Many common solvents often exist as mixture or blends of chemical compounds (e.g. Stoddard solvents and thinners) (WHO 1985).

1-4: Exposure to chemicals

Exposure to organic solvent mixtures is widespread in both industrialized and developing countries (Triebig et al. 1988). Workers in occupations such as house painting, dry-cleans, machine degreasing, printing, and in non-occupational settings by homeowners encounter organic solvents (Paul et al. 1987).

Exposure to organic solvents can occur through vapor inhalation, skin contact with the liquid, or ingestion. Since many organic solvents have relatively high vapor pressure and readily evaporate, inhalation of vapors is considered a primary route of occupational exposure (OSHA 1996). Workers may also absorb organic solvents either through the respiratory tract or the skin. Their uptakes are influenced by level and duration of exposure, workload, and specific physicochemical features of each solvent (Baker et al. 1985). Solvents are chiefly eliminated through the lungs and kidney (Ghittori et al. 1987).

Harmful exposure to many organic solvents can cause irritation, central nervous system depression, headache, nausea, and potential effects on the liver, kidney, or other organs. Many industrial solvents are primary irritants, and can cause defecting of the skin and dermatitis. Solvents are among the leading causative of occupational skin disease. Biological effects of exposure can range from practically non-toxic (e.g., some freons) to highly toxic (e.g., carbon tetrachloride) or carcinogenic (e.g., benzene). The ability to detect the presence of a solvent by the sense of smell will vary widely depending on the specific substance, and individual sensitivity. Substances are considered to have good warning properties if an average person with normal sensory perception can detect the presence of the chemical at a level well below the recommended exposure limit. Table 1 summarizes the main health effects associated with these solvents (OSHA 1996).

Table 1: the most common solvents used in industry with the respective health effects due to exposure (OSHA 1996).

Chemical	Principle Health Effects
Ethyl acetate	Central nervous system depression, dizziness, eye irritation
Methyl-ethyl ketone (2-butanone)	Headache, dizziness, numbness of extremities, dermal and eye irritation
Toluene	Eye/respiratory irritation, fatigue, headache, narcotic effects
Xylene	eye/respiratory irritation, narcosis, headache, dermal effects
Acetone	Eye irritation, nausea, headache, central nervous system depression
N-butyl acetate	Eye/respiratory irritation, narcosis
Styrene	Dizziness, drowsiness, headache, nausea. Weakness, redness, Pain. Abdominal pain (OSHA 1978).

Workers in car painting workshops are potentially exposed to different kinds of chemical compounds and to solvents that are used for cleaning of equipments. The main components of the paints are listed in table 2.

Table 2: the main components of car paints (Husman 1980).

1.	Aromatic hydrocarbons e.g., toluene and xylene
2.	Aliphatic hydrocarbons e.g., white spirit.
3.	Alcohols e.g., ethanol, butanol; isopropanol.
4.	Esters e.g., ethyl acetate, thyl glycol.
5.	Ketones e.g., met hyle ethyle ketone, methyl isobutyl ketone.
6.	Pigments and fillers e.g., organic dyes, inorganic dyes, zinc, chromates, titanium dioxide and talk.
7.	Catalysts e.g., phosphoric acid, plastisizers.

Toluene is the most popular solvent in many applications (Yasugi et al.1998). It is also the most common solvent used in painting and surface-coating work. Xylenes as well as acetates are also frequently used. Xylenes commonly found in painting work as toluene (Ukai et al. 1997).

Isocyanate compounds are a group of highly reactive, plastic monomers, the most common of which are toluene diisocyanate (TDI) and hexamethylene diisocyanate (HDI). They are widely used, especially in the manufacture of paints. HDI is the most common isocyanate in car paints. Available exposure data has shown high level of airborne HDI polyisocyanates during spray application (Liu et al. 2000).

1-5: Exposure limits

The Occupational Safety and Health Administration (OSHA) has promulgated permissible exposure limits (PEL) or occupational exposure limits (OEL) for occupational exposure to some of the chemicals and mixtures that are used as organic solvents. Each PEL is determined as an 8-hr time-weighted average (TWA) concentration, and it is based on threshold limit value (TLV) of the American Conference of Governmental Industrial Hygienists (ACGIH) for a specific organic solvent (NIOSH 1996).

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some have recommended short-term exposure limits (STEL) or ceiling values, which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term (OSHA 1996).

1-6: Effects of organic solvents on health

Relatively few epidemiological studies on adverse effects of organic solvents have been carried out in developing countries including Palestine (Nijem et al. 2000).

Because organic solvents are lipophilic and volatile, they are generally toxic to the central nervous system after exposure via inhalation at high doses (Yasugi et al. 1998).

International Agency for Research on Cancer (IARC) concluded that there is sufficient evidence for the carcinogenicity of occupational exposure for painting workers.

Therefore, painters frequently reported allergic and non-allergic contact dermatitis, chronic bronchitis, asthma, and adverse central nervous system effect (Enander et al.

1998). Prevalences of self-reported health complaints i.e. headache, tingling of limbs, and mucous membrane irritation was high among the workers in the shoe workshop workers in Hebron City-Palestine as a result of exposed to cleaning substances such as acetone. These compounds could cause mucous membrane irritation and induce neurotoxic effects (Nijem et al 2000). Once they enter the body they can lead to a variety of neurological, immunological, endocrinological, genitourinary, and hematopietic problems (Crinnion 2000).

1-6-1: Effect of organic solvents on central nervous system

Paint components pose health hazards to the workers. Some paints contain toxic metals such as lead, and chromium (Heitbrink et al. 1995).

The most common symptoms reported in studies of workers chronically exposed to different organic solvents are unusual tiredness, concentration difficulties, impaired memory, and dizziness (Husman 1980). The results of a cross-sectional study conducted by Kaj Husman 1980, showed that car painters had more symptoms of fatigue, concentration difficulties, and disturbances in the vigilance than unexposed references. Also, he found that irritation and pre-narcotic symptoms were present in the exposed group. Nausea, drunken feeling, dizziness, and absentmindedness were common complaints among the car painters. Also, shortness of breath was more common among car painters (Husman 1980).

A cross-sectional study of construction painters exposed to mixed organic solvents indicated a positive association between most measures of exposure and the occurrence of neurotoxic symptoms, dizziness, fatigue, and nausea (Fidler et al. 1987). In a study of

subjects who received disability pensions on account of presenile dementia painters were over-represented (Gregersen et al. 1984). Paint workers exposed to a mixture of organic solvents reported acute symptoms of headache, chest tightness and chronic symptoms of dizziness, easy fatigability, depressed mood, and palpitation (Wang and Chen 1993).

Chronic exposure to organic solvents had been reported to produce an increased frequency of neurological signs and symptoms including, toxic encephalopathy and polyneuropathy (Backer et al. 1985, Carapella 1977).

Reports from Scandinavia had suggested behavioral impairment among workers long term exposed to solvents below regularly standards (Maizlish et al. 1985). It was suggested that long-term exposure to mixture of organic solvents below the current occupational exposure limit (OEL) could cause central nervous system affection with consequent neuropsychiatric signs and symptoms (Struwe and Wennberg 1983).

Early neurotoxic effects were found among paint workers after long-term exposure to organic solvents (Colvin et al. 1993).

Short-term exposure to organic solvent vapors may result in prenarctic states of CNS-depression, and often characterized by behavioral dysfunction (Winneke 1982).

Heightened exposure to organic solvents was significantly related to depression, sever headache, light-headedness, appetite difficulties, weakness/fatigue, and abdominal pain (Parkinson et al. 1990).

1-6-2: Effects of paint chemicals on respiratory system

It is estimated that about 5-20% of exposed workers to Isocyanate compounds develops asthma. Expanded use of polyurethane paints, plastics, foams, and coatings diisocyanates

have emerged as the most commonly identified cause of occupation asthma in developed countries (Liu et al. 2000).

Workers exposed to organic solvents have complained of chronic cough, dyspnea (difficulties in breath), wheezing (Paggiaro et al. 1985) and bronchial hyperreactivity (Jones and Brautbar 1997). In two studies among house painters, the performance capacity of the painters group was inferior to that of reference group.

Volatile organic compounds in concentrations found in both the work and the home environments may influence lung function and are probably of importance as bronchial irritation (Harving et al. 1991). It was also found that solvents have been demonstrated to cause mucosal irritation of the eyes and upper airways (Schenker and Jacobs 1996).

1-7: Painting industry

Approximately 200 000 workers worldwide are employed in paint manufacture. The total number of painters is probably several millions, a major group being construction painters. Other industries in which large numbers of painters are employed include manufacture of transportation equipment and metal products, automotive and other refinishing operations and furniture manufacture, (<http://193.51.164.11/htdocs/monographs/Vol47/47-13.htm>).

Painters use hardeners and white spirit in paints and filler during the paint mixing process as dryer to fasten the paints drying. In Western Europe about 60% of the total white spirit consumption is used in paints, lacquers and varnishes; white spirit is most widely used solvent in the paint industry (IPCS 1996).

1-7-1: Industry in Palestine

1-7-1-1: Area and demographics of Palestine

The area of Palestine, before the Israeli occupation in 1948, comprised about 26323.00 km². After the occupation, the total Palestinian territory was reduced to about 6249.00 km², and divided into two parts, the West Bank (5884.00km²) and the Gaza Strip (365km²) (Ministry of planning and international relations 1997). The total Palestinian population in West Bank and Gaza strip including those living in east Jerusalem amounted to 3.929 million people (PCBS 1997).

Hebron City is one of the largest cities in the Palestinian Authority. It is an agricultural marketing and trade center with glass and leather manufacturing. Many industrial activities started to develop during the last ten years, including stone and aggregate quarrying, tanning industry, food industry, plastic industry, chemical industry, and leather industry (Hebron Chamber of Commerce and Industry 1999). In addition to these industries there are several car-painting garages and auto-body repair in Hebron City (table 3).

Some of these garages are both car painting and auto-body repair at the same time. There is no data available about the total number of workers which are specific for painting in each city (PCBS 2000). Approximately 140 car-painting workshops are located in Hebron (PGFTU personal communication).

Many car-painting workshops in Hebron are located in areas under Israeli control and all of these workshops are closed due to the political situation (PCFTU, 2001).

Table 3: table illustrates the number of auto-body workshops scattered among the Palestinian cities and their districts (PCPS 2000).

City	Number of Auto-body workshops
Jenin	329
Tubas	24
Tulkarm	362
Qalqiliya	105
Salfit	60
Nablus	593
Ram Allah & Al-bireh	285
Jericho	27
Jerusalem	248
Bethlehem	195
Hebron	637

Source: Palestinian central bureau of statistics, population housing and establishment census 1997, last updated 31-12-2000.

1-7-1-2: Car painting process in Hebron City

Car painting industry (workshops) is considered to be an important industrial sector in the West Bank and Gaza strip. However, little is known about the prevalences of general adverse health effects as a result of exposure to organic solvents in this sector. However, based on information from personal visits to car-painting workshops, we believed that there is a large number of workers reporting adverse health effects, due to heavy use of organic solvents and lack of personal protective equipment (PPE).

1-8: Research questions and objectives

This study was planned with the following research questions:

- How is the work situation of car painters in workshops in Hebron city-Palestine, with respect to work environment (exposure to organic solvents, protective measures; ventilation system; and barriers between different working tasks).

- What are the health effects reported by workers in car painting industry in Hebron City – Palestine, which could be related to exposure to organic solvents.

In order to give answers to the research questions, the following objectives were achieved:

1. To describe the working environment (like ventilation system, use of protective equipments, and barriers between tasks).
2. To estimate the prevalence of selected self-reported adverse health complaints associated with the working environment.
3. To describe the association between exposure to solvents (number of hours per day or number of months in car painting industry) and health effects.

Chapter Two

*Study population and
methods*

In this chapter it is a description of the selected population and the research methods that have been applied in order to achieve the research objectives and thereby to give answers to the research questions. It is a description of the following items: study design; population at study, and sampling procedure; research instruments which were used for data collection; data collection procedure, data analyses procedure, definition of the main variables and ethical issues.

2-1: Research design

The study design is a cross-sectional occupational exposure survey.

Through this design it is possible to collect data presenting a description of the current situation in a population exposed through a specific occupation.

This design belongs to descriptive studies, which concern primarily on determining the existing situation or phenomenon, and is quantitative in its nature. According to Varkevisser et al. 1995, a descriptive study involves a systematic collection and presentation of data to give a clear picture of a particular situation.

2-2: The population

This study was conducted in Hebron City, which is one of the largest cities in the West Bank with a total population of 200,000 inhabitants. Hebron City is located in the southern part of the West Bank, 40 km south of Jerusalem. Hebron is a trade center manufacturing glass and leather. Over the past 10 years, many industrial activities started to develop (Nijem 2000).

No official register exists for workers in Palestine. However, there are registers of factories and workshops (PCBS 2000). There are 140 car-painting workshops in Hebron City (PGFTU, personal communication). All workshops located in the area under the Israeli control are closed due to the political situation. Twenty-six car-painting workshops are found in the areas under the Palestinian Authority. The 26 workshops employ normally 40-120 workers and owners, but many of them left the work due to the difficult economical situation in Palestine. Therefore, in some workshops, the owner is working alone.

2-2-1: Sample under study

Owners and workers of all 26 workshops in Hebron City in the area under Palestinian control were invited to participate in the study. The total number of owners who were a regular worker was 24 and the total number of workers was 29. Two owners and two workers refused to participate. The final number of workers and owners included in the present study from Hebron City was 53 painters.

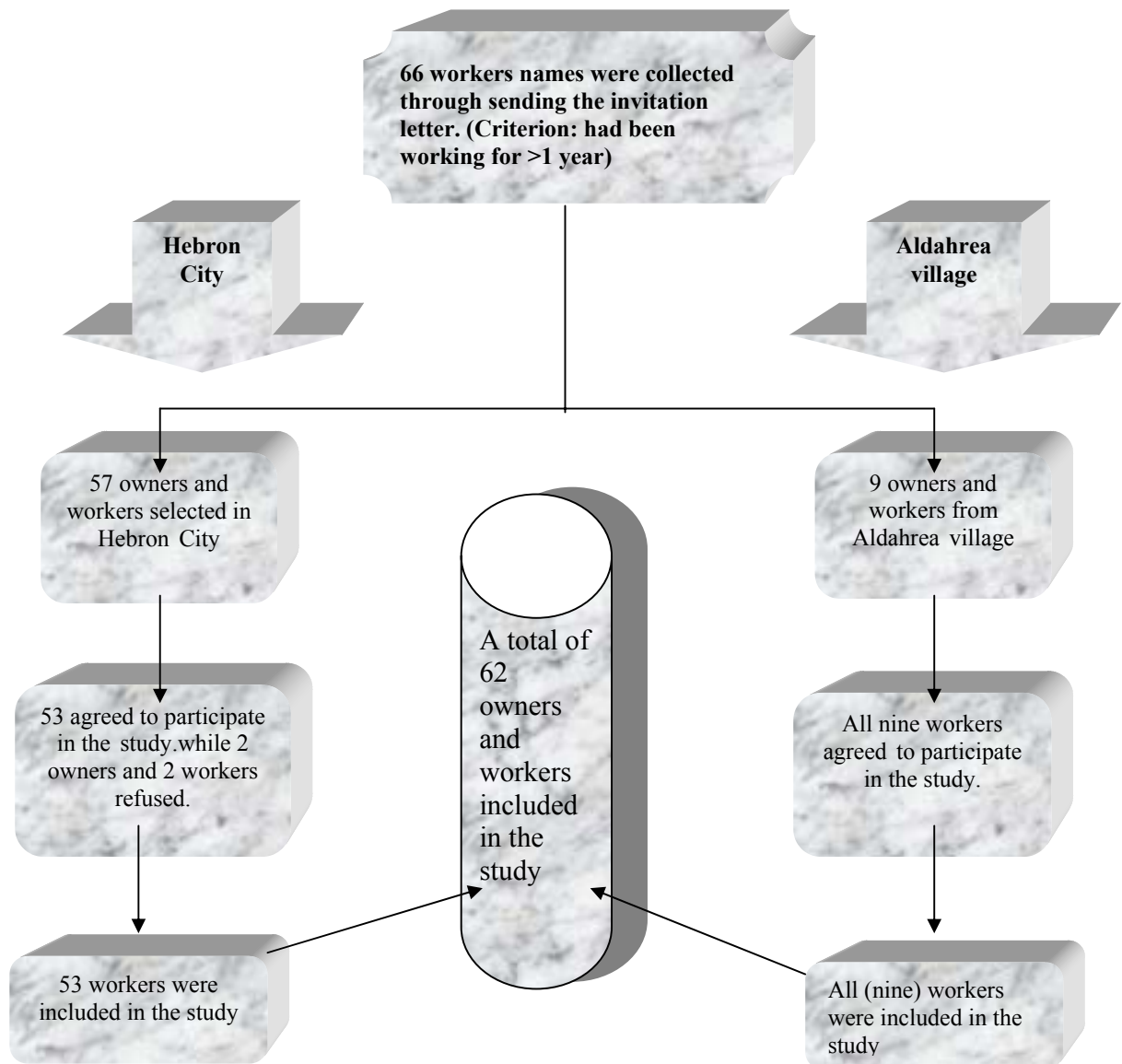
In order to increase the sample size, seven workshops from Aldahrea village (in Hebron district) were also invited to participate in the study. The number of workers in these workshops was nine workers. All nine workers and owners of these workshops accepted to participate in the study.

Thus the final sample size was 62 workers from 33 workshops including the two owners who were not regular worker who gave information about the workshop only (the owner's questionnaire), this information is included in the present study. The inclusion of

workers was based on the following criterion: the workers should have been working for at least one year in car painting at workshops.

Sixty workers answered the worker's part of the questionnaire (appendix 1) and two answered the owner's part of the questionnaire (appendix 2). The sampling procedure can be summarized in figure 1 as follow.

Figure 1: Selection of study sample.



2-3: Research instruments

- *Structured interview of workers and owners.*

All the workshop owners except two participated in the car painting work. Those two owners were therefore included in owner's interview only (appendix 2). The other owners took both part in the owners and workers interview (appendix 1).

Data was collected by using a modified version of a questionnaire used in a study of exposure to organic solvents and plastic compounds among shoe workers, (Nijem et al.2000). It measures self-reported health complaints among the workers, and it is based on a validated Swedish neuropsychiatric symptom questionnaire (Q16) (Hane et al 1980) with a slight revision. The questionnaire included questions related to symptoms associated with the airways passages (e.g., chest tightness, difficulties in breathing and wheezing in the chest), the central nervous system (headache, mental irritability), the peripheral nervous system (painful tingling of limbs), and other mucous membrane irritation (sore eyes). For each health complaint we asked if the workers considered it to be work related.

The occupational history of each painter was assessed with a standardized questionnaire on items such as type of paints and lacquers used, duration of exposure application techniques, and work-place conditions. Other questions included, age, socio-demographic characteristics (marital status and education), smoking, and the use of personal protective equipment (respiratory protective equipment, gloves, goggles, head cover, special shoes, and working clothes).

All the interviews were face to face, which enabled the researcher to obtain more information and opinions from the interviewees.

- *Inspection of the workshops.*

The researcher inspected the workshops in order to register ventilation system, availability of protective equipment, types of chemicals, and other factors related to the working environment.

2-4: Data collection procedure

2-4-1: Preparation for data collection

We selected questions from the questionnaire used by Nijem et al. (2000), added new selected questions, constructed a questionnaire part to the owners (appendix 2), and a questionnaire part to the workers and owners together (appendix 1).

The second step was to get the necessary permission from the relevant governmental departments (health ministries) concerned with the topics under study. In order to facilitate getting this permission, a clearance letter was sent from Hebron University, which explained the study objectives and importance of the study being conducted in the Palestinian society. Permission (appendix 3) from the Ministry of health in Hebron was finally given. The process of getting permission took around one week.

The third step was to look for an assistant who would assist the researcher with interviews of the painters. The assistant was asking the questions and the researcher was writing down the answers.

The purpose and importance of the study was explained for the assistant during one meeting. He was already trained in interviewing as he had done a study about effects of pesticides on fertility in Palestine (Issa et al. 2000). In the present study he was trained in the meaning for each specific question, its purpose, and how to ask correctly in order to

avoid misunderstanding. He was trained in how to avoid asking leading questions, (e.g., training to be a good interviewer).

The fourth step was to ensure the appointments with the owners and workers, which was done by telephone.

2-4-2: Types of data that have been collected

Quantitative data were mainly collected through this study and few qualitative data (field notices) were collected. These data were collected from the painters (owners and workers) by personal interviews (face-to-face) in their workshops by using a structured questionnaire. The worker's interview took about one hour while the owner's interview took 1 and half an hour.

The workers part of the questionnaire included background information, knowledge about health effects of organic solvents in car paints, general adverse health effects due to use of car paints, and use of personal protective equipments. The owner's part included the average production of painted cars, the quantity average of used solvents, number of workers as a full-time & part-time work, the existence of personal protective equipment, and the name of the chemical products that used by the painter.

2-5: Data analysis procedures

For the main individual questionnaire all collected data were computerized into the SPSS programme (statistical package for social science, windows version release 9.0). The SPSS programme was used to calculate the percentages of self-reported health complaints (e.g., short memory, sore eye, headache, tingling of limbs, mental irritability,

and breathing difficulties). In order to give a description of the collected information, only the frequency part and cross-tabulation of the SPSS programme was used. For the main qualitative data (field notices), the analysis was as the summary of what the workers talked about. And these qualitative results were incorporated with the results that were collected from the qualitative part of the questionnaire.

2-6: Definition of main variables

Data on age, education level, socio-economic status, number of working years, place of the workshops, smoking (number/day, number of smoking years) and number of people in house hold were included. Based on the educational system in Palestine, the basic education stage ranges from 1 to 10 grade or years; the secondary stage ranges from 11 to 12 years; and the higher education stage more than 12 years.

The general health complaints included: nervous system (headache, tingling, short memory, and concentrating problem), eczema (any skin symptoms), breathing difficulties (wheezing, irritating cough, chest tightness), and red or sore eyes.

The use of personal protective equipments (PPE) included masks, gloves, goggles, special shoes, special clothes, head cover, and specification whether the workers used them during the work. PPE in the workshop were also included in the study to measure the availability of these equipments.

Exposure variables included: type of paint, time of exposure (Hours work per day, total number of months), methods of painting, quantity of paints, methods of mixing the paints, storage methods (in the workshop, outside the workshop), and disposed of empty paints containers (burning, throwing, reuse).

2-7: Ethical issues

The proposal was submitted to the Norwegian Research Ethics Committee. The researcher explained the concept of the project and the participants understood that their participation was optional and they could quit at any time during the interview. The researcher asked for signatures or names from the participants. If they refused to sign but accepted to participate, the researcher's signature was regarded as an indicator for accepting to participate in the study.

2-8: Project organizers

The study was organized with Prof. Espen Bjertness (University of Oslo) as a project leader and main supervisor, Dr. Awni Khatib and PhD. khaldoun Nijem (Hebron University) are co-supervisors. Master student Ayman Alfrookh is the researcher.

Chapter Three

Results of the study

This chapter focuses on the main findings, investigated through interviewing car painters by using structured questionnaire.

This chapter includes socio-demographic data, the main types of organic solvents that were used in car paints, the work condition of the workshops, usage and availability of protective measurements, car painting process, main self-reported health problems, and self-reported health problems by number of months working in car painting industry.

3-1: The general characteristics of the study population

Sixty workers were included in the study. The age of the workers ranged from 18-50 years, with a mean of 29 years (Table 4). They have taken basic education with a mean of 8.8 years (Table 4). The majority of painters (55%) were paid between 301-500 USD per month. Almost half of the workers were non-smokers. Two thirds were married.

Table 4: - Socio-demographic characteristics of workers. Figures given as total numbers and percentage in brackets.

Characteristics	Painters No.(%)
# Age in years 18-24 25-32 33-50 Mean (Sd.)	21(35) 20(33) 19(32) 29.03(7.03)
# Painters who smoke no yes	26(43) 34(57)
# Years of education 1-10 years (basic education) 11-12 years (secondary education) > 12 years (higher education) Mean (Sd.)	45(75) 13(22) 2(3) 8.77(2.29)
# Marital status Single Married	21(35) 39(65)
# Monthly income (USD) ≤ 300 301-500 501-1000 ≥1001	22(37) 33(55) 3(5) 2(3)
No. Years working in car paints 1-8 9-10 >10 Mean (Sd.)	21(35) 20(33) 19(32) 12.27(7.53)

3-2: Description of the work environment

3-2-1: Location of the workshops

According to the researcher observations, the majority (53%) of the workers are working in workshops located in popular zones, and 38% of the workers are working in workshops separated from the houses (Table 5). Only two workers were working in workshops located in industrial zone and 3 workers were working in workshops as stores under the building houses.

Among these workshops, two included down draft spray booths (a special technical room supplied with safety standard criteria, to prevent inhaling the mists of the paints by the workers during painting process). All workshops except those two with down draft spray booths are in the form of spray booth and they are small and mostly closed rooms (no openings in the walls).

Table 5: - Location of car painting workshops in Hebron City.

Location of the workshop	Number of workers and percentage, N=60 (%)
1. Store under the house	3 (5%)
2. Separated from the house	23 (38%)
3. In industrial zone	2 (3%)
4. In popular zone	32 (53%)

3-2-2: The process of painting in Hebron City.

Workers involved in auto-body repair can potentially be exposed to a multitude of air contaminants. During structural repair, activities such as sanding, grinding, and welding generate aerosols, which are released into the worker's breathing zone. If the surface of

the car being repaired contains toxic metals such as lead, cadmium, or chromium, exposure to these metals is possible. Workers who paint cars can be exposed to organic solvents, hardeners, isocyanate resins, and pigments, which may contain toxic components (Heitbrink et al. 1992). In Hebron City, most of the painters' use the same process of painting, which is described below.



Figure 2: An owner without wearing respiratory mask during painting process

1. The first step is stripping the car. Old paint is removed and all moldings, trim etc. are removed. Most of the painters use sanders and grit papers. They sand until they see the metal. Then a razor blade may be used to remove the top layer.
2. After they have stripped the car, they start with metal work. Some cars have small dents. So, they use a hummer and dolly or a semi pointed probe worked across the metal on the backside. For large dents, they use fillers.
3. Fixing the rust. For fixing the rust they cut it out and remove it and weld in new metal. They completely remove all rust metal from the car. They use pieces of gauge metal for covering the rusted areas. Rusty areas are often painted by fiberglass.

4. After they finish the surface preparation, they begin to apply fillers, by filling the whole body. They fill the first layer to the whole car and sand it, and then a second layer is a fine fill polyester glazing filler to fill small imperfections and spots left from sanding or hail damage. The painters often use different kinds of fillers each of which has its own function on the body car, and normally each one of filler mix with special hardener to enable the filler to dry. After applying filler, they sand it in 12 to 15 minutes and totally hard after about 2 hours. The painter applies the sanding several times to get it smooth. Most painters apply another coat to cover the entire area and they sand it again to get it smoother.
5. After filling all areas they will start painting. First they cover up the bare metal to protect it. They mask all areas and openings off with masking tape. After masking, the car will be ready to paint. The painter apply lacquer primer (base) as first coat, and then they sand it by grit paper with different inches to get it smooth, and normally this primer is sprayed by pumped spray gun.
6. The last step is painting the car with a color that matches the original color of the car. Then they leave the car for about 15 hours to dry then they remove the masking papers from on the car.

3-2-3: The main types of chemical compounds used in car paints in Hebron City.

Different types of organic solvents and metals (Table 6) are found in car paints used by the painters. Many solvents (e.g., styrene, toluene, xylene), and as well as isocyanates compounds were used as ingredients in most cans of the paints. Toluene is the most popular solvent in almost all types of work areas (Yasugi et al. 1998). It is also the most common solvent that used in painting and surface-coating work. Xylenes as well as

acetates were also frequently used (Ukai et. al. 1997). During the interview, all workers were asked about their knowledge about the adverse health effects of the substances that used in car paints, and all of them do believe that they may create health problems.

Table 6: List of chemical compounds used in car paints in Hebron City.

Chemical compounds used in car paint's
1. Toluene
2. Xylene
3. Benzoyl peroxide
4. Calcium carbonate
5. Cyclohexanone peroxide
6. Methylene chloride
7. Dibenzoyl peroxide
8. polyisocyanate aliphatic
9. polyester resin (styrene)
10. Titanium dioxide
11. Talc
12. Lead chromate
13. Sulfochromate
14. 1,2,2,6,6-pentamethylpiperid- inedeviate
15. Isocyanate
16. Hexane, 1,6-diisocyanate
17. HDI-polymer
18. 1,2,4-trimethylbenzene
19. Solvent naphtha
20. 2-hydroxyethyl acrylate

According to the interviews with the owners, most of the workshops use the same type of paints. A few workshops used more high quality paints.

The majority of the owners reported that they purchase the paints cans from Israel. The paints were produced in Germany, Turkey, Jordan, and Israel. After the establishment of the Palestinian Authority (1994), it is possible to import from Israel and other countries. The availability is more or less the same before and after 1994.

3-2-4: The use of protective measures

No workers used filter gas masks, because they stated that during painting process, the breathing will be difficult, instead, they preferred to wear filter paper, and the majority of them (71.7%) used filter paper during painting process (Table 7).

Table 7: Number and percentage of car painters who using protective measures during the painting process.

Types of protective gear	No. Of workers (N=60) (%)
Masks:	
Filter paper	43 (71.7%)
Filter gas	0 (0%)
Gloves	10 (16.7%)
Goggles	13 (21.7%)
Working clothes	4 (6.7%)
Special shoes	5 (8.3%)
Head cover	4 (6.7%)

Few painters used gloves, goggles, working clothes, specials shoe, and head covers (Table 7).

3-2-5: Availability of protective measures.

Thirty-one owners were interviewed for the purpose of checking whether they had protective measurements in the workshops. The interviewer did also observe the availability of the protective gears in the workshops. The majority of the workshops in Hebron City did not have filter gas, and few workshops had other protective measures than filter paper mask (Table 8). No workshops had available positive pressure breathing apparatus (air pipe brings the air from outside the workshop).

Table 8: The availability of protective measures in the car painting workshops reported by the owners.

<u>Number of workshop owners,(N=31) (%)</u>	
Mask:	
Filter paper	26 (84%)
Filter gas	2 (6%)
Gloves	13 (42%)
Working clothes	6 (19%)
Special shoes	4 (13%)
Head cover	2 (6%)

3-2-6: The availability of data sheet, mechanical ventilation, and labeling of cans.

According to the interviews with the owners, about two thirds of the workshops purchased paint cans without data sheets (Table 9), accordingly, cans labeled instructions and cautions, and safety methods for the workers about how to deal with the paints during mixing the paints and painting process was lacking. Only one owner reported that he got data sheet in Arabic language when he bought the paints (Table 9). So, most of data sheets come with paints in foreign languages. This will be difficult to the workers to read, because about half (45%) of them only had basic education.

Table 9: -Table showing the availability of data sheet that comes with paints cans.

<u>Number of workshop owners,(N=31) (%)</u>	
No	20 (64%)
Yes	11 (36%)
<u>If yes, is it in Arabic</u>	<u>1 (3%)</u>

About one third (12 workshops) receive the paint cans without label (Table 10), and only five workshops get Arabic label when they buy the paints.

Table 10 – Labelling of paint cans used among the workshops in Hebron City.

<u>Number of workshop owners,(N=31) (%)</u>	
No	12 (39%)
Yes	19 (61%)
If yes, is it in Arabic	5 (16%)

According to the interview with owners, around half of the workshops (Table 11) had no mechanical ventilation and the rest of the workshops (52%) had working mechanical ventilation. But according to the interviewer observations, only two workshops were supplied with full safety mechanical ventilation. The remaining stated that they had mechanical ventilations, but in fact these ventilations were vacuum fans fixed on the top of the wall of the workshops, probably not sufficient to remove paints mists during the painting process.



Figure 3:A worker in workshop without ventilation equipment during car painting preparation

Table 11 - The availability of mechanical ventilation in car painting workshops in Hebron City.

<u>Number of workshop owners,(N=31) (%)</u>	
No	15 (48%)
Yes	16 (52%)
If yes, do they work	16 (52%)

3-3: General self-reported health complaints among car painters in Hebron City.

3-3-1: Self-reported symptoms.

Many workers reported health complains such as headache (68%), dizziness (40%), painful tingling (42%), heart palpitation (33%), concentration problems (27%), loss of consciousness (8%), shortness of memory (38%), mental depression (47%), and mental irritation (62%) (Table12). Some of these symptoms (headache, and dizziness) occur to the workers during the painting process.

Table 12: Number of workers and percentage of general self-reported health outcomes among car painters in Hebron City.

<u>N=60 (%)</u>	
Headache	41 (68)
Dizziness	24 (40)
Painful tingling of limbs	25 (42)
Heart palpitation	20 (33)
Concentration problems	16 (27)
Loss of consciousness	5 (8)
Shortness of memory	23 (38)
Mental depression	28 (47)
Mental irritation	37 (62)

3-3-2: Self reported health complaints related to mucous membrane symptoms.

Several workers reported red or sore eyes (40%) especially during painting process, and (13%) reported dermatitis / Eczema (Table 13).

Table 13: Number of workers and percentage of eczema and mucous membrane irritation among car painters in Hebron City.

N=60 (%)	
Red or sore eyes	24 (40)
Dermatitis /eczema	8 (13)

3-3-3: Self-reported health complaints related to airway passages symptoms.

About half of the workers (47%) reported irritating cough, wheezing in the chest (50%), and difficulties in breath (52%), and 40% of the workers reported chest tightness, all during painting process (Table 14).

Table 14: Number of workers and percentage of general self-reported health outcomes (Airway passages) among car painters in Hebron City.

N=60 (%)	
Irritating cough	28 (47)
Wheezing in the chest	30 (50)
Difficulties in breath	31 (52)
Chest tightness	24 (40)

3-3-4: Health outcomes in relation to the exposure time (months) to organic solvents.

All 60 workers were grouped into quartiles according to duration of work distribution (12-61, 62-98, 99-163, and ≥ 164 months). Symptoms were divided into neuropsychiatric, airways, and mucous membrane symptoms (Table 15).

Several of symptoms (headache, dizziness, breathing difficulties, chest tightness) showed a trend towards more workers with symptoms with a larger exposure time (Table 15).

Table 15: - Self-reported health outcomes among car painters by exposure time (months) to organic solvents in Hebron city.

	Number of months working in car painting industry (N=60)			
	12-61 (N=15)	62-98 (N=15)	99-163 (N=15)	≥164 (N=15)
<i>Neuropsychiatric symptoms</i>				
Headache	7	11	10	13
Dizziness	3	5	8	8
Painful tingling of limbs	3	8	7	7
Heart palpitation	3	4	7	6
Concentration problems	2	7	5	2
Shortness of memory	4	6	7	6
Mental depression	7	7	8	6
Mental irritation	9	11	10	7
<i>Airways symptoms</i>				
Irritating cough	7	7	6	8
Wheezing in the chest	7	7	6	10
Difficulties in breath	4	8	8	11
Chest tightness	4	6	6	8
<i>Mucous membrane symptoms</i>				
Red or sore eyes	5	3	7	9
Dermatitis/eczema	1	3	1	3

3-3-5: Relation between symptoms and socio-demographic factors.

As shown in table 16, painful tingling, heart palpitation, concentration problems, and mental depression showed no correlation to the age of workers. Shortness of memory and dizziness were more often reported for older workers as compared with the youngest.

The oldest workers as compared with the youngest (Table 16) more often reported the airway symptoms (irritating cough, difficulties in breath, and chest tightness).

The mucous membrane symptoms (red or sore eyes and dermatitis/eczema) followed the same pattern.

As shown in table 16 in relation to years of education, all workers who had highest education (≥ 10 years) reported fewer symptoms than the lowest educated.

Table 16: - Number of self-reported health outcomes among car painters exposed to organic solvents by socio-demographic factors in Hebron city, West Bank 2001.

	<i>Age of workers (years)</i> (N=60)			<i>Marital status</i> (N=60)		<i>Years of education (years)</i> (N=60)			<i>Smoking</i> (N=60)	
	18-24 (N=21)	25-32 (N=20)	33-50 (N=19)	Single (N=21)(%)	Married (N=39)(%)	0-7 (N=19)	8-9 (N=20)	>10 (N=21)	Yes (N=34)(%)	No (N=26)(%)
<i>Neuropsychiatric symptoms</i>										
Headache	11	15	15	11(52%)	30(77%)	15	12	14	24(70%)	17(65%)
Dizziness	4	15	9	5(24%)	19(49%)	8	11	5	18(53%)	6(23%)
Painful tingling of limbs	8	9	8	8(38%)	17(43%)	8	10	7	16(47%)	9(35%)
Heart palpitation	7	5	8	7(33%)	13(33%)	6	8	6	14(41%)	6(23%)
Concentration problem	6	6	4	5(24%)	11(28%)	7	7	2	8(23%)	8(31%)
Loss of consciousness	2	0	3	1(5%)	4(10%)	2	2	1	3(9%)	2(8%)
Shortness of memory	3	10	10	3(14%)	20(51%)	10	7	6	13(38%)	10(38%)
Mental depression	10	9	9	10(48%)	18(46%)	13	6	9	20(59%)	8(31%)
Mental irritation	14	14	9	14(67%)	23(59%)	14	9	14	23(68%)	14(54%)
<i>Airways symptoms</i>										
Irritating cough	7	11	10	8(38%)	20(51%)	10	11	7	19(56%)	9(35%)
Wheezing in the chest	9	9	12	8(38%)	22(56%)	12	9	9	18(53%)	12(46%)
Difficulties in breath	6	13	12	6(28%)	25(64%)	9	13	9	20(59%)	11(42%)
Chest tightness	6	10	8	5(24%)	19(49%)	8	8	8	15(44%)	9(35%)
<i>Mucous membrane symptoms</i>										
Red or sore eyes	5	10	9	5(24%)	19(49%)	10	9	5	14(41%)	10(38%)
Dermatitis/Eczema	1	3	4	2(9%)	6(15%)	1	4	3	5(15%)	3(11%)

Chapter Four

Discussion and Conclusions

4-1: Discussion

The aim of this study to examine the usage and the occupational knowledge of health and hygiene in Palestine, with regard to organic solvents used in car painting work. This study collects information from the workers in car painting workshops who are exposed to such solvents .We describe the work environment and self reported adverse health effects, which could be related to exposure to organic solvents.

The work environment lacks even the minimum requirement, such as, mechanical air ventilation, and the workers rarely used personal protective equipment, which makes the workers vulnerable for exposure to organic solvents.

A cross-sectional survey (descriptive study) was chosen. A cross-sectional design is commonly used to study work related health complaints that are relatively frequent and have long duration such as neuropsychiatric symptoms. A follow-up study would have been more appropriate, but this design has disadvantages of being expensive and time consuming. A cohort of painters is difficult to establish due to the fact that they mostly work in small firms where they are difficult to follow up (Nasterlack et al. 1999).

The target population for the present study was owners and workers of car painting workshops. Due to the political situation, many workers left their job; therefore, we included all workers available at the time for data collection in Hebron City. Thus the sample was not selected randomly, out of all car painting in Hebron, but we believe that the sample is sufficient size in order to give full description of the work environment and the main adverse health effects for the workers.

In the present study, we gained have knowledge about the work environment in the workshops in Hebron City. This work environment might be similar to that of other cities

in Palestine. Thus reports from the present study may be valid for workers in car painting workshops in Palestine.

Accordingly, we have gained knowledge of importance for reducing exposure by providing the workers with useful information and precautions.

Interviews (face to face) using self-reported questionnaires were the main tool for data collection, which were used, in the present study.

Interviews and questionnaires are common methods for gathering information from subjects. Questionnaires can be applied as screening instruments in a population at risk. Symptom questionnaires are easy and economically applicable tools for occupational physicians or researchers to screen exposed workers (Nasterlack et al. 1999). The advantages of the interview method are low rejection rates, and the possibility of elucidating more detailed responses when needed. The disadvantages are the costs in personnel time.

Furthermore, responses are more susceptible to interviewer bias (Ebrahim 1995).

In the present study, self-reported interview (face-to-face) was used and some field notices were taken in order to obtain additional information. The advantage of this method is in addition to the direct observation is that more facts about the work situation that might enable the researcher to experience the real situation.

In the present study, we faced several problems, especially during data collection. An important problem was the political situation in Palestine, especially in Hebron City, where there is a Jewish settlement in the center of the city, which made data collection very difficult, even impossible in some days due to closure and clashes between the settlers and the Palestinians. This reflected itself in making the working days for the

workers and for the researcher unpredictable. The traveling to reach the workplace is far from certain.

We also had problems in convincing the workshop owners to participate in the study, because many of them believed that the researcher is a tax collector. Therefore, some of them refused to provide the researcher with names and some of them gave wrong name and address. But refusals rate was low (two owners and two workers only refused to take part in the study). We corrected this problem, giving wrong names and addresses by workers, by making list of names of the workshops and their location.

There are many problems that we expected in the present study, e.g., bias from interviewing data. Recall bias is a potential problem in our study, because workers could have difficulties in recalling the time they spent in car painting and/or time of exposure to car paints. Our study was based on a self-reported interview and not on medical examinations or diagnosis tests which would have been a better tool to assess health outcomes among workers, in order to avoid bias due to misclassification of health outcomes.

The cross-sectional study design in a currently active workforce is prone to several sources of error. One shortcoming is the “healthy worker effect”. Only the work healthy workers, those who have leave effect of exposures, will continue in their job, the other will quit. Probably, the only the most healthy workers will start working as a car painter. However, since it is difficult to get a job in Palestine, we believe that this potential bias is low. Thus the present study will report stronger effects of exposure on the workers health. In other settings, this could have led to an underestimation of the occurrence of the outcome of interest and a weak exposure-outcome association (Nasterlack et al. 1999).

However, the aim of our study was not analytical, but primarily descriptive, i.e., to describe the work environment and the health outcomes among the workers. The main aim was to give information concerning work environment in Palestine workshops and to increase the knowledge about the current situation in the workshops.

4-1-1: Working environment

The present study found that most of the workers workshops in Hebron City are located in popular zone where the general population lives. These workshops were not designed for car painting, but for private storing or parking. The reason for using these workshops (stores) might be due to the lack of industrial zones in Hebron City. In addition, these workshops are small, with few openings in the walls except doors and no barriers between the working tasks. This could result in accumulation of different raw materials such as fillers, hardeners, and paints. Also, in accordance with Daniell 1993, small workplaces are more likely than larger ones to have worse occupational hygiene and potentially greater risk for health problems (Daniell 1993).

It is also found that about half of the workshops lack mechanical ventilation. The major routes of ventilation were doors. The workshops that had mechanical ventilation were lacking standard criteria for safety, as they mostly had vacuum fans only. Two workshops only had high quality mechanical ventilation (down draft spray booths). However, we noticed also that most of the workers who were working in these two workshops did not use personal protective equipment such as respiratory masks, gloves, and special shoes and clothes during painting process. This is in accordance with a study on shoe workers in Palestine (Nijem et al. 2000).

Paint cans were usually without label, data sheets if available were found in foreign languages, which were not understood by the workers. Labels of Some types of paints were found in Arabic language because the paint companies started to translate some after the establishment of the Palestinian authority in Palestine. Data sheets were not translated into Arabic language before, possibly due to the absence of work regulation and labor inspection especially during the Israeli occupation.

It was also found that none of the workers were wearing filter masks or positive pressure masks. Very few of them were using gloves, goggles, working clothes, special shoes, and head covers because they said, “when we use them, we can not move freely during painting process, and they do not help too much for our health”. Also they did not believe that it is important to use filter gas during painting process. All of them stated “after we finish painting the car, we used to drink cold milk to get the formed mucous in the lungs out of our body”. Also some of them used rags instead of respirator masks and this could be due to the lack of knowledge among these workers about the safety instruction and about the importance of using personal protective equipment (PPE).

Our sample size was small, because it was strictly conducted in Hebron city and not in other Palestinian cities. This was due to the limited resources (i.e., money), the political situation.

During the data collection, we noticed that in some workshops, the owners do the whole work (most of the workshops performed body repair work and painting at the same time).

4-1-2: Overall symptoms

Based on our study and in accordance with other studies (Daniell 1993, Schenker and Jacobs 1996), we found evidence that there might be a solvent associated effect on the nervous systems, and respiratory passages of workers exposed to organic solvents.

In accordance with a study of Nijem et al. (2000) on shoe workers, the prevalence of some symptoms in our study (e.g., headache, dizziness, painful tingling, heart palpitation, red or sore eyes, wheezing in the chest, and difficulties in breath) were high. The explanation could be, due to high exposure to organic solvents and diisocyanates used in car paints for long time. The absence of use of personal protective equipment such as respiratory masks, goggles, working clothes, and gloves as well as depending on doors and windows for the purpose of ventilation could have increased the effects of organic solvents on the workers health. Another explanation of the reported high symptoms could be socio-economical, and closure of the territories during the Intifada. Mental depression and irritation were found to be very high among the owners and the workers. The explanation could be for two reasons; the first reason is due to long-term exposure to organic solvents, and the second reason, could be related to the political situation which have been one of the worst in the history of Palestine until now.

From the labels and in accordance with Wang and Chen study (1993), we found that isocyanates compounds, xylene and toluene are the major compounds in painting industry.

Symptoms in relation to the age of workers and the years of education showed, some effect on the central nervous system, airways passages, and mucous membrane, which is not in accordance with Bolle et al (1996), and could be explained with that the workers

who got the disease in early stages, continue working because of the difficult job-market in Palestine.

Results of our study showed some symptoms related with an increase of exposure to organic solvents, but according to Wang and Chen study (1993), these symptoms did not necessarily indicate that the symptoms are caused by solvent exposure or isocyanate exposure. They may partly have been due to the difficult living situation in Palestine.

4-2: General conclusion and recommendation

Based on the results of our study, we conclude that, the work environment in Hebron car paint workshops, lack basic safety standard criteria such as ventilation equipment, and personal protective equipment (e g, respiratory masks, gloves, and special clothes). There is a lack of knowledge among workers about the adverse health effects of the chemical compounds, which are used in car paints. Therefore, it is of importance to develop a programme aimed at giving information to the workers and owners about steps that can be done in order to avoid or reduce the exposure.

The programme should be supported by the ministries of labor and health and focus on increasing the knowledge among the workers and owners for a safe use of car paints, and also to find alternative car paints, which contain less organic solvents.

We conclude that our study is a start point for making such programmes.

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