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Neurological disorders among car painters in Zagazig City, Sharkia Governorate.

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ABSTRACT

Background: Occupational exposure to organic solvents in car painting represents a serious risk for workers' health that cause damage to the central nervous system. Aim of this work: to study the neurological effects associated with chemical exposure among workers in car painting. Patient and Method: A cross-sectional study was conducted at car painting shops of industrial area in Zagazig City during the period from February 2011 to July 2011. The study included two groups, the exposed group included 60 car painters and control group included 80 sellers. All participants were subjected to pre-constructed questionnaire and neuropsychological assessments. Results: A significant percentage of exposed car painters in this study had mild (25.0%) and moderate (15.0%) dementia (P<0.01). Coordination abnormalities among car painters were highly significant compared to their controls (P<0.001), where about half (50.0%) of car painters developed first degree coordination dysfunction, while 6.7% of them developed second degree coordination dysfunction compared to 25.0% and 0.0% respectively among non-exposed workers. Also, sensorimotor peripheral neuropathy was detected in 33.3% of car painters which were significantly higher (P<0.05) compared to 10% among their controls. This study showed significant relations with some risk factors as longer duration of work (≥ 10 years), age of the workers (≥ 30 years) and working in indoor ventilation. Conclusion: This study has shown a risk of excess neurological and neuropsycho-logical abnormalities among car painters exposed to chemical compounds (mainly organic solvents) compared to the non-exposed controls.

Key words: Organic Solvents, Car painters, Dementia, chronic encephalopathy, Peripheral neuropathy.

Introduction

Car painting job is defined as the process of mixing spraying paints, and cleaning of the spraying equipment. It is considered one of the processes with highest exposure to chemical compounds (Braveit *et al*, 2004).

Most of the chemicals used in car-painting fall into two primary categories, volatile organic solvents for many painting mediums and fixatives for dry drawing mediums (Spandarfer, 2001)

Organic solvents are required in car painting because they can dissolve oils, fats, resins, rubber and plastic and in the production of a wide variety of products including paints, varnishes and other coatings, paint removers, glues and dyes (Rutchik, 2007 and Mazhar, 2001).

Occupational exposure to chemicals especially organic solvents in car painting represents a serious risk for workers' health (Andrews and Snyder, 1992). The risk of injury depends on the concentration of the substance in the respirable air and whether it is present alone or in a mixture, beside duration of exposure which play a role in inducing systemic effects (Jones and Kennedy, 1998 and Rutchik, 2012).

Organic solvents have the ability to evaporate and dissolve fats causing damage to hematopoietic tissue, the reproductive system, the nervous system, skin and all parenchimatous organs rich in fats, which lead to poisoning for exposed workers if inhaled (Stefanovic *et al*., 2007 and Gargouri I *et al*., 2011)

At low or moderate concentration in air, organic solvents may cause transient symptoms such as euphoria, headache and vertigo (Wang and Chen, 1993), while higher levels may lead to anesthesia, cardiovascular and respiratory diseases and even death (Moen and Hollund, 2000). Long – term exposure to organic solvents may cause damage to the central nervous system (CNS) causing cognitive and emotional deficits in particular, solvent related chronic encephalopathy (SRCE) has been described in several studies (Triebig 2001, Bratveit *et al*., 2004, and Matteo *et al*., 2005). Many car painting working stations show

environmental measurements exceed MAC and TLV values for the used chemicals (Susan *et al*., 2008), despite the fact that simple control measures are relatively inexpensive and can be applied in even small business settings to protect against work shop exposure and subsequent health hazards (Paul *et al*, 2005).

Car painting job represents unnegligible part of the small scale jobs in Egypt that is result in hidden health problems including CNS affection which needs follow up and occupational safety efforts.

So the aim of this work is to study the neurological effects associated with chemical exposure among workers in car painting and to identify the occupational and personal risk factors that may be associated with these health effects.

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Materials And Methods

Study design and setting:

A cross-sectional study was conducted at car painting shops of industrial area in Zagazig City during the period from February 2012 to July 2012.

Target population:

It includes two groups:

A) The exposed group:

included 60 car painters working in car painting shops and are exposed to a variety of different chemicals.

B) The control group:

includes 80 randomly selected sellers working in shops in Zagazic City and never exposed to any chemicals and considered as unexposed group. They were matched with the exposed group regarding age, sex, residence, educational level and smoking habit.

Sample Technique:

Sample selection:

The sample was selected randomly. Some car painting shops were selected randomly. All workers in these shops were taken until fulfill the number of sample size.

Sample size:

The sample size was calculated through Epi-info (epidemiological information package) software version 6.1, the total population of car painters in Zagazig Industrial City was 230 , the prevalence of weakness of the muscles of whole body in previous study was 53.6% (Mezni and Jemaa, 2011), the degree of precision was 80% and the confidence interval was 95% . The estimated sample size was calculated to be 60 car painters.

Exclusion criteria:

1- Exposure to toxic chemicals in a previous or current second job.
2- Those with past history of diabetes mellitus, addiction, depression, heridofamilial neuropathy, vit. Deficiency and metabolic disorders (uraemia , hypothyroidism)
3- History of head injury that resulted in loss of consciousness of any duration.

Ethical considerations:

An informed verbal consent was obtained from all participants in this study after informing them about the aims and steps of this work.

П. Data collection (Methods):

Information on health status and exposure are collected through:-

A) Questionnaire:

All the participants in this study were interviewed personally and filled a pre-constructed questionnaire which includes:

1- Personal and socio-demographic data:

Includes age, educational level, and personal habits like smoking.

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2- Occupational history:

It includes questions about current job and nature of work, previous or another job where there was exposure to chemicals. Types of chemicals used at work, duration of work in the current job in year, hours of work / day, and use of personal protective equipment.

3- Health complaints:

include questions about:

a)Neuropsychological complaints

as headache, difficulty in concentration and short term memory loss & tingling and numbness, hypoesthesia, hyperesthesia and muscle weakness.

Also standardized questionnaire 22 (**Q22)** was used for early detection of neuropsychological symptoms (Chen *et al*, 1999). It includes:-

- Questions from 1-16 summarize the psychological symptoms.
- Questions from 15-22 summarize the neurological symptoms.
- Q15 and Q16 are common to both.

We used a cutoff point of "**7** yes or more question answers" to identify subjects with psycho-organic syndromes. According to the answers, three degrees of neuropsychological symptoms were identified according to Chen *et al*, 1999 as follow:

- No neuropsychological symptoms when the worker "answers yes to less than 7questions from Q 22".
- First degree neuropsy-chological symptoms when the worker "answers yes to 7-14 questions from Q 22".
- Second degree neuropsy-chological symptoms when the worker "answers yes to 15-22 questions from Q22".

4- Past medical history:

of chronic diseases as diabetes mellitus, hypertension, addiction, depression, relevant drug therapy and hospital admission.

N.B.:

For exclusion of acute exposure effects at work, this questionnaire was conducted in the morning before beginning of the work.

B) Exposure assessment:

Beside occupational information taken from the questionnaire, a walkthrough survey was done to assess some predictors of work-related health hazards as ventilation system, accessibility of washing, availability of safety measures and equipment. Workers were observed for using protective equipment.

C) Health assessment:

Beside the information obtained from the questionnaire on various health complaints, all workers were subjected to:

Neurological examination:

The neurological examination stressed upon examination of subject's mental state, motor system, sensory system.

a. Mental state:

Mini-Mental State Examination (MMSE) tests according to Folstwein *et al*, 1975 were used to assess the mental state in the studied workers. It is composed of items about orientation, registration, attention & calculation, recall and language. It has a total score of 30 marks for literate people, but this score is reduced by 3 marks for illiterate ones.

According to Pullicino *et al*, 1996, this examination discovers different degrees of dementia, where a cut off value of 24 score is taken, below it the diagnosis of dementia begins, as follow:

- Subjects with performance from 1.0-1.5 marks below cut off value 24 had mild dementia.
- Those whose performance from >1.5-3 marks below cut off value 24 had moderate dementia.
- Those whose performance more than 3 marks below cut off value 24 had severe dementia.

b. Tests of coordination:

The following coordination tests were performed:

Finger to nose test, finger to finger test, heal to knee test, diadochokinesia (hand supination /pronation) and Romberg's test and gait (line walking).

Grading of coordination abnormalities was done by recording the number of abnormal coordination tests for each subject:

- No coordination abnormality (considered to be free): if the subject had less than two abnormal tests.
- First grade coordination abnormality: if the subject had 2-3 abnormal tests.
- Second grade coordination abnormality: if the subject had more than 3 abnormal tests (Mikkelesen et. al, 1988).

c. Motor function tests:

Inspection, tone, power and reflexes for both upper and lower limbs were tested and the results were recorded for each subject.

d. Sensory system tests:

Tests of superficial sensations (pain, touch and temperature) and deep sensations (vibration sense, joint and position sense, muscle sense and nerve sense) were done and results were recorded for each subject.

III. Statistical analysis:

Results were analyzed using SPSS programme version 10 and suitable statistical tests were applied:

- Chi-square test (χ^2) was used to test the association between a factor and an outcome, while Fisher exact test was used when expected cell value was less than 5.
- Correlations between quantitative data were evaluated using Pearson's linear correlation coefficient (r).
- The test result was considered significant when P-value <0.05
- Scoring was used for some neurological function screening tests.

Results:

Personal and occupational characteristics of the studied groups:

Table (1) shows that, there are no significant differences between exposed and control groups as regard age, education level, smoking habit. Also this table shows that, the majority of exposed group is working in outdoor ventilation (81.7%), more than 10 years (65.0%), without using personal protective equipment (90.0 %), but have available washing facilities in their workshops (78.3%).

Neuropsychological symptoms among the studied groups according to standardized Q22:

According to the results of standardized Q22, table (2) shows that, the percentage of the car painters who have first (68.4%) or second degree neuropsychological symptoms (13.3%) is higher when compared to the control group (6.25% & 1.25% respectively) and the difference between them is statistically highly significant (P<0.001).

Distribution of neuropsycho-logical signs:

According to MMSE, table (3) shows that the prevalence of mild and moderate dementia is higher among the car painters (25.0% & 15.0% respectively) when compared to the control group (15.0% & 2.5% respectively) and this difference is statistically significant (P<0.01), while no severe dementia cases are detected between the two groups.

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According to the results of coordination tests, this table shows that 50% of the exposed group have first degree coordination abnormality, while 6.7% of them have second degree coordination abnormality, compared to 25% and 0.0% respectively among the control group and this difference between the two groups is statistically highly significant ($p<0.001$). the prevalence of superficial peripheral neuropathy (diminished sense of pain) is significantly ($P<0.05$) higher among the exposed workers (18.3%) compared to their controls (6.25%), while no significant difference is detected between the two comparative groups as regards deep peripheral neuropathy (detected by sense of vibration, movement and position & $P>0.05$). 15.0% of the exposed group have motor function deficits in the form of distal muscle weakness when compared to their controls (3.75%) and this difference is statistically significant ($P<0.05$), while there is no difference between the two groups as regards knee reflex ($P> 0.05$).

Role of duration of work in the prevalence of neurological symptoms and signs among the exposed group:

Table (4) shows that, exposed workers with longer duration of work (≥10 years), have a significant high risk to develop neuropsychological symptoms (first and second degrees & $P<0.01$), dementia grades (mild and moderate & $P<0.05$), coordination abnormalities (first and second degrees & $P<0.01$), superficial peripheral neuropathy ($P<0.01$) and distal weakness ($P<0.05$), when compared to those working for < 10 years.

Role of workers' age in the prevalence of neurological symptoms and signs among the exposed group:

Table (5) shows that, older exposed workers (≥ 30 years), have a significant high risk to develop, neuropsychological symptoms (first and second degrees & $P<0.01$), dementia grades (mild and moderate & $P<0.01$), coordination abnormalities (first and second degrees & $P<0.05$), superficial peripheral neuropathy ($P<0.01$) and distal weakness ($P<0.01$), compared to younger workers < 30 years old.

Role of ventilation type at the work place in the prevalence of neurological symptoms and signs among the exposed group:

Table (6) shows that, exposed group working in indoor ventilation have a significant high risk to develop, neuropsychological symptoms (first and second degrees) ($P<0.05$), dementia grades (mild and moderate & $P<0.05$), coordination abnormalities (first and second degrees & $P<0.05$), superficial peripheral neuropathy & $P<0.01$) and distal weakness ($P<0.05$) when compared to those working in outdoor ventilation.

The most influential risk factor for all the neurological disfunctions detected by logistic analysis as shown by table (7) was duration of work ≥ 10 years followed by working in indoor ventilation , except for dementia where age ≥ 30 years was the third important one after working in indoor ventilation and duration of work ≥ 10 years.

Table 1: Some personal and occupational characteristics of the studied groups

Socio-demographic characteristics	Car painters n=60		Control group n=80		χ^2	P-value
Age in years:	N	%	N	%		
< 20	12	20.0	16	20.00		
20-	18	30.0	24	30.00	0.08	o.994
30-	19	31.7	24	30.00		
≥ 40	11	18.3	16	20.00		
Educational level:						
- Illiterate	8	13.3	9	11.25		
- Read and write	31	51.7	46	57.50	0.48	0.786
- School education	21	35.0	25	31.25		
Smoking habit:						
- Smokers	42	70.0	56	70.0	0.63	0.730
- Non-smokers	18	30.0	24	30.00		
Duration of work in years:						
< 10	21	35.0				
≥ 10	39	65.0				
Ventilation in the work place:						
-Indoor	11	18.3				
-Outdoor	49	81.7				
Using protective equipment	6	10.0				
Available washing facilities	47	78.3				

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Table 2: Neuropsychological symptoms among the studied groups according to standardized Q22.

Neuropsychological symptoms	Car painters n=60		Control group n=80		χ^2	P-value
	N	%	N	%		
- No neuropsychological symptoms (yes answers to less than 7 questions)	11	18.3	74	92.50		
- First degree neuropsychological symptoms (yes answers to 7-15 questions)	41	68.4	5	6.25	79.07	0.000
- Second degree neuropsychological symptoms (yes answers to >15 questions)	8	13.3	1	1.25		

Table 3: Distribution of neuropsychological signs in car painters and their controls.

Neuropsychological signs	Car painters n=60		Control group N=80		χ^2	P-value
Dementia grades (MMSE score):	N	%	N	%		
No dementia	36	60.0	66	82.50		
Mild dementia	15	25.0	12	15.00	10.98	0.01
Moderate dementia	9	15.0	2	2.50		
Coordination abnormalities:						
- None	26	43.3	60	75.0		
- First degree (1-3 abnormal coordination tests)	30	50.0	20	25.0		
- Second degree (≥ 4 abnormal coordination tests)	4	6.7	0	0.0	16.93	0.000
Hyposensibility:						
- Pain	11	18.3	5	6.25	4.95	0.026
- Vibration	4	6.7	2	2.5	F.exa	0.432
- Movement & position	9	15.0	5	6.25	2.92	0.078
Motor function deficits:						
- Diminished or lost ankle jerk	2	3.3	0	0.0	F.exa	0.363
- Distal muscle weakness(s)	9	15.0	3	3.75	5.54	0.018

Table 4: Role of duration of work in the prevalence of neurological symptoms and signs among the exposed group.

Neurological symptoms and signs	Duration of work				χ^2	P-value
	$\geq$ 10(y) (n=39)		< 10(y) (n=21)			
	N	%	N	%		
Neuropsychological symptoms: (Standardized Q22 results)						
- No neuropsychological symptoms	3	7.70	8	38.1		
- First degree neuropsychological symptoms	30	76.9	11	52.4	8.44	0.014
- Second degree neuropsychological symptoms	6	15.4	2	9.5		
Neuropsychological signs:						
a- Dementia grades:						
- No dementia	20	51.3	16	76.2		
- Mild dementia	10	25.6	5	23.8	6.28	0.043
- Moderate dementia	9	23.1	0	0.0		
b- Coordination abnormalities:						
- No abnormalities						
- First degree abnormalities	12	30.8	14	66.7		
- Second degree abnormalities	25	64.1	5	23.8	8.89	0.011
c- Hyposensibility	2	5.1	2	9.5		
- Pain	11	28.2	0	0.0	Fisher exact	0.005
d- Distal muscle weakness	9	23.1	0	0.0	Fisher exact	0.020

Table 5: Role of workers' age in the prevalence of neurological symptoms and signs among the exposed group.

Neurological symptoms and signs	Age of workers				χ^2	P-value
	$\geq$ 30(yrs) (n=30)		< 30(yrs) (n=30)			
	N	%	N	%		
Neuropsychological symptoms: (Standardized Q22 results)						
- No neuropsychological symptoms	1	3.3	10	33.3		
- First degree neuropsychological symptoms	24	80	17	56.7	9.06	0.01
- Second degree neuropsychological symptoms	5	16.7	3	10		
Neuropsychological signs:						
a- Dementia grades:						
- No dementia	12	40.0	24	80.0		
- Mild dementia	10	33.3	5	16.7	11.11	0.003
- Moderate dementia	8	26.7	1	3.3		
b- Coordination abnormalities:						
-No abnormalities	8	26.7	18	60		
-First degree abnormalities	20	66.6	10	33.3	7.18	0.027
-Second degree abnormalities	2	6.7	2	6.7		

c- Hyposensibility:						
- Pain	9	30	2	6.7	5.45	0.019
d- Distal muscle weakness	8	26.7	1	3.3	6.41	0.011

Table 6: Role of ventilation type at the work place in the prevalence of neurological symptoms and signs among the exposed group.

Neurological symptoms and signs	Type of ventilation at the work place				χ^2	P-value
	Indoor (n=11)		outdoor (n=49)			
	N	%	N	%		
Neuropsychological symptoms: (Standardized Q22 results)						
- No neuropsychological dysfunction	1	9.1	10	20.4		
- First degree neuropsychological dysfunction	6	54.5	35	71.4	6.36	0.041
- Second degree neuropsychological dysfunction	4	36.4	4	10.2		
Neuropsychological signs:						
a- Dementia grades:						
- No dementia	3	27.3	33	67.3		
- Mild dementia	6	54.5	9	18.4	7.20	0.027
- Moderate dementia	2	18.2	7	14.3		
b- Coordination abnormalities:						
-No abnormalities	1	9.1	25	51.0		
-First degree abnormal coordination	8	72.7	22	44.9	7.72	0.021
-Second degree abnormal coordination	2	18.2	2	4.1		
c- Hyposensibility:						
- Pain	5	45.5	6	12.2	6.62	0.01
d- Distal weakness	4	36.4	5	10.2	4.82	0.028

Table 7: Logistic regression of the significant risk factors affecting neurological abnormalities.

Variables	B	SE	Wald	P-value
Neurological abnormalities Dementia:				
Indoor ventilation	2.33	0.83	7.82	0.005
Duration of work≥ 10 years	1.75	0.81	4.71	0.030
Age ≥ 30 years	1.7	0.8	4.4	0.040
Coordination abnormalities:				
Duration of work≥ 10 years	1.5	0.54	7.7	0.005
Indoor ventilation	2.6	1.3	4.1	0.040
Peripheral neuropathy:				
Duration of work≥ 10 years	2.4	0.7	10.5	0.001
Indoor ventilation	2.1	0.7	8.6	0.003
Distal weakness:				
Duration of work≥ 10 years	4.4	0.9	23.0	0.000
Indoor ventilation	3.6	1.0	13.6	0.000

Discussion:

Worker's exposure during car painting activities includes organic solvents compounds (Bratveit *et al.,* 2004), isocyanates in polyurethane paints (Jones and Kennedy, 1998) and a wide variety of chemicals that may reach around 40 chemicals in a single paint product (Gardner, 1987). Those chemicals may endanger several internal organs of the body resulting in damage to the central nervous system causing cognitive and emotional deficits (Matteo *et al.,* 2005).

This study has shown a risk of excess neurological and neuropsychological symptoms & signs among car painters exposed to chemical compounds (mainly organic solvents) compared to the non exposed. This risk as shown in table (1) is not related to workers age, educational level, smoking habit or duration of work as both the exposed and non exposed groups were comparable.

Also most of car painters of this study were painting cars outdoor (81.7%) private workshops prepared with washing facilities (78.3%).

Using of personal protective equipments among the exposed group was rare, only 10% of them utilizing personal protective equipment (simple mask and gloves) which means a collective outcome of unprotected exposure to dermal and inhalable contaminants at the work place.

Nervous system assessment:

Neurological dysfunction impact of car painting job was assessed by evaluating the neurological symptoms and signs among workers.

A- Neuropsychological symptoms:

Organic solvent syndrome is the mildest form of the chronic effect marked by symptoms of irritability, fatigue and reversible difficulty to concentrate. Workers exposed to solvents may exhibit numerous syndromes,

ranging from a mild decrease in nerve conduction velocity to neuro- and encephalopathy. Epidemiological studies have frequently shown a decrease in response time, dexterity, speed and memory and abnormalities in peripheral nervous function in workers with prolonged solvent exposure (Baker, 1994 and Adolfo *et al.,* 1998).

Lundberg *et al.* (1997) and Chen *et al.* (1999) reported that early neuropsychological symptoms must be discovered using a modified questionnaire 22 as an efficient tool for diagnosis and early detection. Car painters of our study were found to have significantly first or second degree neuropsycho-logical symptoms by using a modified questionnaire 22. This finding is supported by previous studies carried out among car painters and organic solvents-exposed workers (Hassan *et al.,* 2001, and Yucel *et al.,* 2008).

B- Neurological signs:

Neurological symptoms and signs detected in this study were in accordance with neurobehavioral profile changes documented in many studies among car painters (Lee *et al.,* 2005 and Zaidi *et al.,* 2006). This could be explained by the fact that solvent induced alternation of brain metabolism in the frontotemporal area or through interaction with certain chemicals (Haut *et al.,* 2000 and Triebig, 2001).

These neurological signs include:

1- Dementia:

Where a significant percentage of exposed car painters in this study were found to have mild (25.0%) and moderate (15.0%) dementia ($P<0.01$), which is consistence with Triebig (2001) and Palmer *et al.* (1998) who commented that solvent exposed workers have 2-3 relative risk of developing dementia than unexposed workers. As well as, Faust (2012) reported that occupational organic solvents are known to be neurotoxic and are risk factors for cognitive impairment affecting central nervous system (CNS) functions including attention processing speed and motor performance.

On the other hand, other studies involving workers with varying levels and durations of exposure to organic solvents have reported no cognitive correlations (Tang *et al.,* 2011).

2- Coordination abnormalities:

this study found a highly significant increase in coordination abnormalities among car painters compared to their controls ($P<0.001$), where about half (50.0%) of car painters developed first degree coordination dysfunction, while 6.7% of them developed second degree coordination dysfunction compared to 25.0% and 0.0% respectively among non exposed workers. In the literature the clinical neurological signs of dyscoordination have been studied only in few studies. In a Swedish study among car and industrial painters, the exposed workers performed significantly bad as regard Romberg's test, finger-nose test, finger–finger test and finger tremors when compared to non-exposed group (Elofsson *et al*., 1980).

A global team of scientists are studying the relation between exposure to an industrial solvent and Parkinson‹s disease. A team of scientists from the U.S., Germany and Argentina found that individuals who had been exposed in the work place to Trichloroethylene (TCE) were six times more likely to develop Parkinson‹s (Bond ,2013)

3- Peripheral neuropathy and motor power defects:

Peripharal neuropathy manifested by hyporeflexia, hyposensitivity and decrease in vibration sense is believed to be one of the manifestations of peripheral system effects of the solvent exposure on car painters (Triebirg, 2001 and Elofsson *et al.,* 1980). In the present study, sensorimotor peripheral neuropathy was detected clinically by pain hyposensitivity in 18.3% and distal weakness in 15.0% of car painters which were significantly higher among car painters ($P<0.05$) compared to 6.25 and 3.75% respectively among their controls. These results are consistent with (Dick ,2006) who reported sensory polyneuropathy with impaired vibration perception in the feet has been described in painters.

Also, Stefanovic *et al.*,2007 found that longer exposure to organic solvents at workplaces leads to a proportional and statistically significant reduction in conduction velocity. Two basic forms of damage to peripheral nerves have been identified as responsible for the peripheral neuropathies associated with occupational exposure to organic solvents; (segmental demyelization and axonal degeneration (Thomas, 1971 and Triebig *et al.,* 1983).

Solvents can act even in small doses on the central and peripheral nervous system, initially due to their high liposolubulity and then intervene by various mechanisms such as increases in membrane fluidity that change the flow not only intra-and extracellular nutrient but also other toxic. Some solvents may also be metabolized in the nerve cells and cause structural and biochemical changes such us cellular destruction. Others act after hepatic

metabolism and the passage of metabolites beyond the blood-nerve (Lawrys *et al.,* 2007)

In this study there were no detected cases of sever dementia, severe coordination abnormal-lities, deep polyneuropathy or disabling motor power defects between the exposed group in this study, which can be explained most probably by exposure to lower solvent concentrations due to outdoor ventilation working in most workers, short term exposure in some cases or the healthy worker's effect. On the other side**,** few researchers disagree about organic solvents-induced neuropsychological abnormalities (Heoisma *et al.,* 1993 and Hakkola, 1994).

Neurological dysfunction risk factors among car painters:

Most of neuropsycological dysfunctions in this study showed significant relations with some risk factors as longer duration of work (≥ 10 years), age of the workers (≥ 30 years) and working in indoor ventilation. These relations were discovered in other studies (Triebig *et al.,* 1992; El-Laithy *et al.,* 2002 and Jovanovic *et al.,* 2004 and Stefanovic, *et al.,* 2007) who reported that the degree of nerve conduction affection is a matter of duration and intensity of exposure.

Age was primarily an effective risk factor over all neuropsychological dysfunctions in this study which was detected also in other studies (Chen *et al.,* 1999, King, 2000 and Lee *et al.,* 2005). The most influential risk factor for all the neurological dysfunctions as detected by logistic analysis was duration of work ≥ 10 years followed by working in indoor ventilation, except for dementia where age ≥ 30 years was the third important risk factor after working in indoor ventilation and duration of work ≥ 10 years. These results were in accordance with many studies emphasized the cumulative solvent body burden over time in work (Nilson *et al.,* 2002 and Lee *et al.,* 2005) with decreased neurobehavioral performance with age (Chen *et al.,* 1999; King, 2000 and Lee *et al.,* 2005). But in case of dementia, the aging process of neurological cells was a contributing factor enhancing solvent induced neurological dysfunction making an overall progression of dementia (Santibanez *et al.,* 2007), while Kukull *et al.* (1995) differentiate between solvent induced dementia and aging dementia (Alzheimer disease) by its characteristic static nature and partial improvement on stopping exposure.

Conclusion:

This study has shown a risk of excess neurological and neuropsycho-logical abnormalities among car painters exposed to chemicals (mainly organic solvents) compared to the non exposed controls.

Recommendations:

Prevention of occupationally induced neurological disorders detected in car painters can be accomplished through workplace medical and environmental control programs. The goal of environmental control is to reduce concentrations of organic solvents in the working environment. Medical strategies designed to reduce neurological morbidity include pre-employment or pre-placement evaluation and periodic medical monitoring. The goal of pre-employment or pre-placement evaluation pertaining to neurological disorders is to avoid the placement of individuals with preexisting disease at jobs with exposure that might exacerbate these conditions.

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