

# Neurobehavioral Effects and Hormones Profile among Spray Painters

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**Abstract:** A cross-sectional study was conducted in 25 spray painters and 35 control subjects to evaluate neurobehavioral function, and thyroid and reproductive hormones profile. This study indicated higher prevalence of psychological and neurological symptoms, and clinical findings among spray painters when compared with controls. Levels of TSH were significantly ( $p < 0.01$ ) elevated in spray painters over the control group ( $3.04 \pm 1.53$  vs  $1.88 \pm 1.07$   $\mu$ IU/ml, mean  $\pm$  SD), respectively. Two of the 25 spray painters acquired sub-clinical hypothyroidism, and one subject was detected with overt hypothyroidism.  $T_4$  levels were significantly ( $p < 0.05$ ) suppressed in spray painters while  $T_3$  was not changed significantly in both the groups. Reproductive hormones (LH, FSH, and testosterone) showed no significant changes in control and spray-painting group. However, two spray painters had abnormally high level of LH (26.43 and 12.22 IU/l; normal range 0.5–10 IU/l). These subjects were also found to have abnormally higher level of FSH (38.63 and 14.11 IU/l; normal range 1.3–11.5 IU/l). An isolated higher level of FSH (39.94 IU/l) was also observed in one spray painter. No abnormality in the level of LH was observed in control group while 3 subjects from this group had abnormally high level of FSH. Testosterone levels were under the normal range (3–12 ng/ml) in both the groups. This study might suggest that spray painters are at risk of developing neurobehavioral, thyroid and reproductive problems.

**Key words:** Spray painters, Solvent exposure, Neurobehavioral changes, Reproductive irregularities, Thyroid and reproductive hormones

## Introduction

Exposure to chemical ingredients present in paints can cause injury and illness through inhalation of toxic vapors and mists, and absorption of irritants through the skin. Industrial workers such as spray painters represent a high-risk population group who are supposed to be heavily exposed to paint ingredients (solvent, resin and pigments) while performing their jobs. The magnitude of hazards becomes more worsen in confined area. Prior to spray-painting, painters are likely to perform many other jobs such as tinting, mixing and pouring paints, grinding and sanding and coating. Thus, a painter may face multiple-exposure. Chemical substances such as lead, aluminium, antimony, and hexavalent

chromium, and organic solvents like toluene, xylene, acetone, carbon tetrachloride, ethyl benzene, and methyl ethyl ketone are some of the common toxic chemicals present in paints. Some of these compounds have been recognized for their mutagenic, carcinogenic and teratogenic potential<sup>1,2</sup>. Many of these compounds are also known for their neurotoxic<sup>3</sup>, reproductive and endocrine disruptive effects<sup>4,5</sup>.

Epidemiological studies as summarized by NIOSH<sup>3</sup> have shown significant increase in neurobehavioral effects in workers chronically exposed to organic solvents. Available information indicates that some heavy metals and other industrial chemicals are endocrine disruptors. They have the ability to mimic or suppress hormone synthesis and regulation and thereby, affect the metabolism and development of animals and humans. As reviewed earlier<sup>6</sup>, damage to male fertility, spontaneous abortions and birth defects and childhood cancer are associated with solvent

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exposure. These studies are limited and belong to certain chemicals only, while a large number of chemicals are yet to be investigated. There have been appeared several reports in the literature, which indicate that over exposure to solvents affects the quality and quantity of sperm in male solvent exposed workers. In one of the study conducted on shipyard painters, exposed to 2-ME (2-methoxy ethanol) and 2-EE (ethoxy ethanol), an increased prevalence of oligozoospermia and an increased odds ratio for a lower total sperm count were found compared to non-exposed workers at the same shipyard<sup>7,8</sup>. Epidemiological studies in human also suggest that some paternal exposures may have adverse effects on offspring<sup>9-11</sup>.

Reproductive abnormalities are believed to be under endocrine control and it is being increasingly clear that male and female reproductive hormones play important role in maintaining the normal reproductive function. Studies on hormonal changes might also be useful as biomarkers for early detection of reproductive dysfunction among workers exposed to solvent and other chemicals. Studies in animals and humans in this regard are very limited and merits for investigations. Therefore, the present study was undertaken to assess neurobehavioral changes and hormones profile among regular spray painters who are exposed to a mixture of metal and solvent fumes.

## Materials and Methods

### *Study population*

Twenty-five spray painters having occupational exposure (2–35 yr) and engaged in different kind of jobs such as dust and rust removal, sanding and pre-coating of surfaces, preparation of surfactant and spraying of paints etc were examined to evaluate health effects due to spray painting and associated processes. Simultaneously, 35 control subjects from the same premises, having similar age, socioeconomic status and life style with no present and past occupational exposure to solvents and/or paints were also studied. Demographic, occupational characteristics and clinical examination with emphasis on CNS system and reproductive function were recorded on pre-designed profroma. Neurobehavioral test were conducted through questionnaire administered to the workers.

### *Location*

The study was conducted in Gujarat State Roadways Transport Corporation (G.S.R.T.C) Ahmedabad, having Paint Workshop with a total strength of regular 25 spray painters performing different type of jobs associated with spray painting. The control subjects of same sex were randomly selected from the same premises and ensured of not having present and past exposure to paint chemicals and other chemicals too.

### *Hormones analysis*

Blood samples (6–8 ml) were drawn in the morning session. Serum was used for the estimation of thyroid (TSH, total T<sub>3</sub> and total T<sub>4</sub>) and reproductive hormones (LH, FSH, and Testosterone) using Radioimmunoassay (RIA) technique. Commercially available diagnostic kits for the above hormones were obtained from Immunotech, Beckman Coulter Company, Czech Republic. Gamma Counter, Wallac 1470 Wizard automatic (Perkin Elmer) with Ria Calc WIZ was used for hormone analysis.

### *Exposure and nature of jobs*

Spray painters were engaged in various jobs processes associated with automobile body repairing and spray painting. Dust and rust removing, grinding, sanding and uniform coating were done by some of the spray painters before primer coating followed by first and final coating with white and blue enamels. Red-oxide containing zinc chromprimer, petroleum hydrocarbon solvent, polycot DRR was used as the primer. The spray was done with high-pressurized spray gun and the paint slurry was prepared in separate paint booth. In spite of repeated instructions given to the workers, the painters except a scarf for covering face and eyes used no respiratory mask and other protective clothing.

### *Statistical analysis*

Student *t*- test was used to see the differences between the control and spray painters for the thyroid and reproductive parameters. In neurobehavioral studies, the results were expressed as the percent of prevalence over the control parameters.

## Results and Discussion

Demographic profile and occupational history of the study subjects are described in Table 1. The mean age of spray painters and control groups were  $42.36 \pm 10.71$  and  $47.64 \pm 10.26$  yr, respectively. The average period of exposure in spray painters was  $13.72 \pm 10.65$ . Neurological complaints, psychological symptoms and clinical signs in spray painters and control group are summarized in Tables 2, 3 and 4, respectively. Results of this study indicated higher prevalence of neurological symptoms (tingling and numbness, 32%; irritation in eye, 32%; fatigue, 28%; asthenia, 24%; and headache, 16%), psychological symptoms (loss of temper, 52%; lack of memory, 32%; worrying and disliking, 28%; trouble by insomnia, 20%); and clinical findings (tremor, 24%; hypertension, 44%; and vision defects; myopia, hypermetropia, presbyopia 20%, 28% and 12%) among some workers in spray painter group. Such symptoms of prevalence were higher in painter group as compared to controls. Subjects in control group showed either low or no symptoms. Table 5 shows the levels of thyroid hormones in spray painters

**Table 1. Demographic and occupational characteristics of the study subjects**

Characteristics	Spray painters N=25	Controls N=14
Age (in years)		
<35	8 (32.0)	3 (21.4)
35–40	3 (12.0)	1 (7.1)
40–45	2 (8.0)	–
≥45	12 (48.0)	10 (71.5)
Mean Age	42.36 ± 10.71	47.64 ± 10.26
Duration of exposure		
<10	11 (44.0)	3 (21.4)
10–15	4 (16.0)	1 (7.1)
15–20	2 (8.0)	–
≥20	8 (32.0)	10 (71.5)
Mean ± SD	13.72 ± 10.65	23.43 ± 11.49

All values represent as the percent of prevalence in control and exposed subjects.

**Table 2. Distribution of neurological complaints in study subjects**

Neurological symptoms	Spray painters	Controls
Tingling and Numbness	8 (32.0)	1 (7.1)
Irritation in eyes	8 (32.0)	–
Fatigue	7 (28.0)	–
Asthenia	6 (24.0)	2 (14.2)
Headache	4 (16.0)	2 (14.2)
Tinnitus	3 (12.0)	–
Deafness	2 (8.0)	–
Vertigo	2 (8.0)	1 (7.1)
Tremors	2 (8.0)	–
Cough	2 (8.0)	–
Itching in skin	2 (8.0)	1 (7.1)

All values represent as the percent of prevalence in control and exposed subjects.

and control subjects. TSH levels were found to be significantly ( $p < 0.01$ ) elevated in spray painters as compared to control group ( $3.04 \pm 1.53$  vs  $1.88 \pm 1.07$   $\mu\text{IU/ml}$ , mean  $\pm$  SD), respectively. This study revealed that 7 out of 25 spray painters were having elevated levels of TSH that ranged from  $4.96$ – $77.27$   $\mu\text{IU/ml}$  against the normal range ( $0.3$ – $3.1$   $\mu\text{IU/ml}$ ) provided by the manufacturer. TSH values, determined for control group by us ranged from  $0.63$ – $5.08$   $\mu\text{IU/ml}$ , and 3 of them were having partially elevated levels of TSH. Higher cases of suspected hypothyroidism (about 28%) were registered in spray painters group against the control group (about 8.5%). One spray painter was detected with hypothyroidism as the TSH level was highly elevated to  $77.27$   $\mu\text{IU/ml}$  against the reported normal range ( $0.3$ – $3.1$

**Table 3. Distribution of psychological symptoms in study subjects**

Psychological symptom	Spray painters	Controls
Lose temper easily and often	13 (52.0)	4 (28.4)
Lack of memory	8 (32.0)	3 (21.3)
Always worrying	7 (28.0)	4 (28.4)
Continually dislike to be with people	7 (28.0)	1 (7.1)
Troubled by regular insomnia	5 (20.0)	2 (14.2)
Continually unhappy	4 (16.0)	2 (14.2)
Afraid without real cause	2 (8.0)	1 (7.1)
Feeling of committing suicide	2 (8.0)	–

All values represent as the percent of prevalence in control and exposed subjects.

**Table 4. Distribution of clinical signs in study subjects**

Clinical signs	Spray painters	Controls
Tremors	6 (24.0)	3 (21.3)
Vision		
a) Myopia	5 (20.0)	1 (7.2)
b) Hypermetropia	7 (28.0)	5 (35.7)
c) Presbyopia	3 (12.0)	3 (21.4)
Normal	10 (40.0)	5 (35.7)
Pallor	7 (28.0)	2 (14.2)
Hypertensive	11 (44.0)	5 (35.5)
Brisk DTR	4 (16.0)	–

All values represent as the percent of prevalence in control and exposed subjects. DTR: deep tendon reflexes.

$\mu\text{IU/ml}$ ). This subject was excluded while taking mean of TSH level.  $T_4$  level in this subject was quite low ( $3.29$   $\mu\text{g/dl}$ ) against the normal range ( $6.5$ – $11.5$   $\mu\text{g/dl}$ ) justifying the status of hypothyroidism in this subject. Other two spray painters seem to have acquired sub-clinical hypothyroidism as TSH level in these subjects was found higher.  $T_3$  level was normal in all spray painters and ranged from  $0.65$ – $1.30$   $\text{ng/ml}$  (normal range  $0.80$ – $2.0$   $\text{ng/ml}$ ). An elevation in the level of thyroid hormones (TSH) have also been reported by us earlier in pesticides formulators<sup>12)</sup> and welders<sup>13)</sup> and these studies substantiate our present findings on the pattern of thyroid levels in spray painters.

Studies on reproductive hormones revealed no significant changes in both the groups (Table 6). However, impairments in the levels of LH and FSH were observed in two individuals. Two of the 24 spray painters were having abnormally high level of LH ( $26.43$   $\text{IU/l}$  and  $12.22$   $\text{IU/l}$  against the normal range  $1.3$ – $11.5$   $\text{IU/l}$ ). High levels of FSH ( $38.63$  and  $14.11$   $\text{IU/l}$ ) were also detected in these subjects. One spray painter had an isolated elevated level of FSH ( $39.94$   $\text{IU/l}$ ) with the normal levels of LH and Testosterone. No abnormality in the level of LH was observed in control group while 3 subjects

**Table 5. Levels of thyroid hormones in control and spray painters**

Parameter	Control (N=35)	Spray painters (N=24)#	p value
TSH μIU/ml	1.88 ± 1.07	3.04 ± 1.53	< 0.01
T <sub>4</sub> μg/dl	9.72 ± 2.514	7.75 ± 1.94	< 0.05
T <sub>3</sub> ng/ml	1.87 ± 0.35	2.06 ± 0.19	NS

# One case of overt hypothyroidism not included in expressing mean value of TSH.

**Table 6. Levels of reproductive hormones in control and spray painters**

Parameter	Control	Spray painters	Normal range described by Manufacturer
LH (IU/l)	3.49 ± 1.237 (N=34)	3.79 ± 1.23 (N=22)	0.5–10
FSH (IU/l)	4.62 ± 1.35 (N=30)	4.13 ± 1.32 (N=20)	1.3–11.5
T ng/ml	6.04 ± 2.94 (N=34)	4.94 ± 2.13 (N=24)	3–12

N=number of subject studied.

were found to have abnormally high level of FSH. All subjects in control group had normal level of Testosterone but it generally decreased with the increase in age. During this study, though the changes in hormonal levels were not significant among the control and spray painter groups, it might indicate an increased risk of sub-fertility<sup>7, 14</sup>. These authors<sup>7, 14</sup> reported odd ratio for a lower total sperm count for 2-ethoxy ethanol workers compared with non-exposed workers with out a concurrent change in serum LH, FSH and testosterone. We have also described the status of semen quality with the level of reproductive hormones in welders<sup>15</sup>. The mechanism for the disruption of thyroid and reproductive is not fully understood. Thus toxic solvents can affect hormone production and spermatogenesis independently<sup>16</sup>.

These hormones (LH, FSH and testosterone) are reported to have fine co-ordination with the cells producing sperm. FSH stimulates primarily the Sertoli cells, which nurture the developing germ cells. In the absence or disruption of sperm production, FSH level increases as a result of lack of inhibin hormone feed back from the Sertoli cells. Higher level of FSH and LH detected in few spray painters and control subjects in our study is an indicative of reproductive abnormalities in them and that needs further investigations. The abnormal levels of these hormones, in general, might be useful as biomarkers for early detection of reproductive

dysfunction in spray painters and other workers exposed to solvent and other chemicals.

During this study it was noticed that some individuals from spray painter group showed slight to moderate alterations in neurobehavioral profile, thyroid and reproductive hormones. Such individual variation in these parameters seems to be associated with a number of factors that may include variable duration of exposure, body immunity and life style etc. Since exposure was of multiple-type with mixture of volatile organic solvents, resin monomers and pigments (heavy metals), all present in spray paints, the cumulative toxicological effects cannot be assigned to single compound. Thus the toxicological implications from these exposures cannot be pinpoint at this stage. Multi-organ toxicity causing death of a male paint worker accidentally exposed to solvent fumes from thinner has recently been described by us<sup>17</sup>.

## Conclusion

This study suggests that spray painters are at risk of developing neurological, thyroid and reproductive problems.

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