Assessment of Hepatotoxicity in Textile Industry Workers Exposed to Occupational Hazards

Vasudev Sankhla[1], Don Mathew[2*], Seema Jawalekar[3], Shrikant Sharma[4], Suraj Pal Singh[4], Disha Sahi[5], Prasad khodke[4], Aman Deep[6]

[1]Ph.D. Research Scholar, Department of Biochemistry, Faculty of Medicine, Pacific Medical College and Hospital, Pacific Medical University (PMU) Udaipur, Rajasthan, IND

[2] Assistant Professor, Department of Biochemistry, Faculty of Medicine, Pacific Medical College and Hospital, Pacific Medical University (PMU) Udaipur, Rajasthan, IND

[3] Senior Professor & Head, Department of Biochemistry, Government Medical College, Pali, Rajasthan, IND

[4]Ph.D. Research Scholar, Department of Biochemistry, Faculty of Medicine, Pacific Medical College and Hospital, Pacific Medical University (PMU) Udaipur, Rajasthan, IND

[5] Intern, Department of Biochemistry, Faculty of Medicine, Pacific Medical College and Hospital, Pacific Medical University (PMU) Udaipur, Udaipur, Rajasthan, IND

[6] Technical Assistant (Statistics) ICMR-National Institute of Cancer Prevention and Research, Noida

**Corresponding Author: Don Mathew, mathewdon2@gmail.com*

ABSTRACT:

INTRODUCTION: Textile processing and dyeing industry worker are occupationally exposed to various toxic chemicals, dyes and pollutants for long term which causes hazardous effects on vital organs like lung, liver and kidney. There is scarce data which explains the long term effects of dye and chemicals on these organs. **OBJECTIVES:** We wanted to evaluate the hepatotoxic effects of occupational dye exposure in textile factory workers. **METHODS:** For the current study we recruited 100 occupationally exposed (cases) and 100 non exposed subjects (controls) of either sex. The study was approved by institutional ethics committee Pacific Medical University, Udaipur, Rajasthan. 3 ml peripheral venous blood was collected from both groups and serum was utilized for Liver function tests and Serum GGT analysis ERBA company reagent using fully automated clinical chemistry Analyzer EM 360 - Transasia Bio medicals Pvt. Ltd., India. The statistical analysis was performed by using SPSS version 23. **RESULTS:** Serum bilirubin (OR 3.067, P value 0.0069*), SGOT (OR 3553.276, P value 0.0083*), SGPT (OR 3.330, P value <0.001*), Alkaline Phosphatase (OR 3.235, P value 0.0091*), and GGT (OR-9796.633, P value 0.0087*) levels were found to be significantly increased in occupationally exposed cases as compared to controls. There was no significant change in serum proteins and serum globulin levels but significant increase was seen in serum albumin (OR 3.106, P value <0.001*) levels as compared to control. **CONCLUSIONS:** Result obtained show that the serum bilirubin, SGOT, SGPT, Albumin levels were found to be significant increased in prolonged occupationally exposed in progressive manner as compare to non-exposed people. Serum protein and globulin levels were found to be non-significant in group 1, 2, 3 as compare to controls. We observed increased risk of liver dysfunction in occupationally exposed textile industry workers. This study reveals that exposure to textile dyes have deteriorating effect on liver function.

KEYWORDS: Pali, Occupational health hazard, hepatotoxicity, textile dye, occupationally exposed, textile industry worker.

Categories: Public Health, Occupational Health

INTRODUCTION

The textile sector in India plays an important role in the country's economy, providing employment to a significant population in rural and urban areas. The state of Rajasthan in India is one of the biggest textile sectors with an estimated investment of US$ 224 million across various textile projects [1]. Pali is the largest erstwhile hand processing clusters, now gradually moving towords power processing machines. The area constituting Pali district has been known for a number of industries, best known for dyeing and synthetic fabric. In Pali district itself there are approximately 250 -300 textile dyeing industries employing approximately thirteen thousand to fifteen thousand workers. Many unskilled laborers from rural location work in this sector [2]. The common jobs handled by them are spinning, weaving, dyeing, printing, finishing and a number of other processes that are required to convert fiber into a finished fabric or garment. Working for a long period of time without rest, absence of personal protective equipment and inadequate provision of ergonomic facilities at workplace leads to major health-related issues among the workers. These include chemical exposure used for the processing and dyeing of materials and exposures of various solvents [3-4].

Processing and dyeing is one of the critical procedure in textile industry in which the workers get exposed to a number of hazardous chemicals like caustics, bleaching agents, chromophores and organic solvents like formaldehyde, benzene and different chemical dyes.

These chemicals gain entry into the human body through inhalation or skin contact. Systemic effect may occur beyond the site of contact if the hazardous chemicals and dye is absorbed into blood stream and distributed throughout the body. The textile industries use different kinds of dyes including the most commonly used azo dyes which are aromatic hydrocarbon derivatives of benzene, toluene, naphthalene, phenol and aniline. The solvents used by the workers in different sections licit carcinogenic effect on direct contact with these workers [5].

Many of the dyes and chemicals used by textile industries are known carcinogens which are Acetic acid, ammonium sulphate, Caustic Soda, Soap, Hydrochloric acid, Solvent 1425,Hydrogen Peroxide, Formic Acid,P V Acetate, Oxalic Acid, Sulphuric Acid, Disperse Dyes (Polyester), Vat Dyes, Sulphur Dyes, Reactive Dyes. The International Agency for Research on cancer (IARC) has classified various dyes like benzidine as being associated with cancer in humans. Two benzidine dyes, Direct Blue 6 and Direct Black 38, have been reported to be such potent carcinogens [6]. Prolonged exposure to various processing chemicals, dye and different pollutants causes hazardous effects on various vital organs

particularly lung, liver and kidney. Very less data is available which explain the effects of these chemicals on body [7-10].

Liver is the main organ responsible for biotransformation and detoxification process of these chemicals and solvents used in textile processing industries. As a result, it becomes the prime target organ for the chemical induced tissue injury [11]. Exposure to organic solvents may induce liver toxicity because most of the chemicals are metabolized in the liver and toxic metabolites generated through the metabolism are main cause of liver damage [12]. Gamma Glutamyltransferase or GGT is a liver enzyme that has traditionally been measured to detect liver health and function and directly correlates with hepatic injury caused due to excessive alcohol consumption. GGT is a very sensitive measure than can change very quickly compared to other biochemical markers. Various chemicals are used in dying process, which have hazardous effects on liver which further resonates with serum GGT levels in these workers involved in this process [13]. Assessment of all the above mentioned health problems was help in early diagnosis, treatment and prevention of health hazards. There by reducing long term morbidity and mortality among workers. Very few studies have been done on health hazards of textile industrial workers. Thus, we aim to evaluate overall health hazards of textile workers by developing a comprehensive strategy for their early detection and prevention of epidemiological liver Dysfunction in textile industry workers.

MATERIALS AND METHODS

Methodology

We wanted to evaluate the hepatotoxic effects of occupational dye exposure in textile factory workers. The present study was conducted in the Department of Biochemistry, Pacific Medical University and its associated group of hospitals, Udaipur, Rajasthan. The study was approved by institutional research ethical committee of Pacific Medical University (approval letter no. Ref. No. PMU/PMCH/IEC/2023/15). Sample size was calculated on basis of this formula n = 4pq/e2 and the analytical cross sectional study was carried out among textile industrial workers residing in industrial area and age and sex matched non-textile workers (Comparison group) residing approximately 15-20 km away from Industrial area of Pali city of Rajasthan. The study period was around 1.5 year during 2023-2024. Written informed consent was taken from workers who were enrolled in the study.

Inclusion Criteria

Ø Healthy individuals aged 25-60 years were recruited and separated into 2 groups-

Group 1: 100 Non Exposed patients of either sex.

Group 2: 100 Occupationally exposed patients of either sex.

Ø Occupationally exposed group was sub grouped into 3 sub groups-

1) 60 occupationally exposed <10yrs patients of either sex.
2) 34 occupationally exposed 10-20 yrs patients of either sex.
3) 6 occupationally exposed 20-30 yrs patients of either sex.

Exclusion Criteria

Ø Individuals with significant comorbidities was excluded from study.

Ø Factory workers with tobacco smoking, alcohol intake, drug abuse and family history of liver disease of all individuals were excluded from the study.

Technique

Blood specimen was obtained from both patients and control groups. Serum was separated from the whole blood sample by incubating the vials containing blood sample for 10 minutes in water bath and then centrifugation at 3000 rpm for 5 minutes. The serum samples was brought to Pacific Medical University Udaipur in the Department of Biochemistry in thermocol box with ice box after maintaining strict universal safety precautions. All the biochemical parameters was analyzed in the Central Biochemistry, Department of Biochemistry, Pacific Medical University Udaipur. The separated serum sample was used for further biochemical analysis ERBA company reagent using fully automated clinical chemistry Analyzer EM 360- Transasia Bio medicals Pvt. Ltd., India. Serum Total Protein was measured by Biuret method. Serum Albumin was measured by Bromocresol Green method. Serum Total Bilirubin was measured by Diazo method. Serum Alanine Transaminase, Aspartate Transaminase and Alkaline Phosphatase were measured by (IFFC) International Federation of Clinical Chemistry. Serum Gamma Glutamyl Transpeptidase was measured by (GLUPA-C) L- γ -Glutamyl-3-carboxy-p-nitroanilide method.

Statistical Analysis

The statistical analysis was performed by using SPSS version 23. After analysis of data distribution patterns appropriate statistical tests was utilized for analysing measures of central tendency, dispersion and odds ratio.

RESULTS

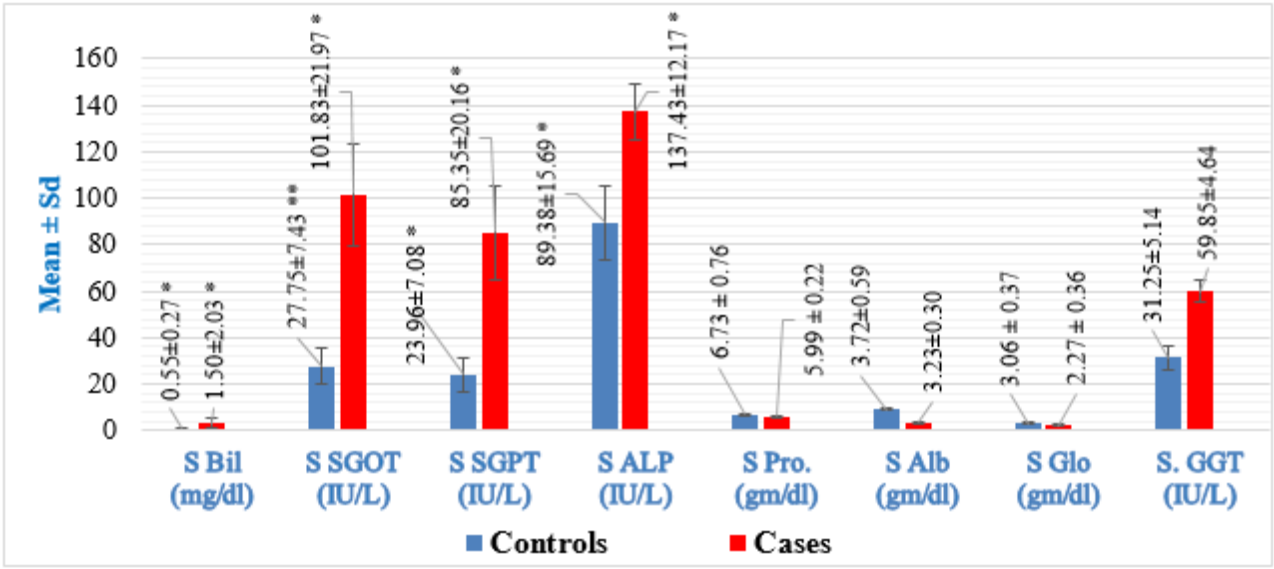
100 Healthy non-exposed participants were recruited and categorized as Group 1 and were considered as controls. 100 Occupationally dye and chemical exposed factory workers were recruited and categorized as Group 2. These participants were considered as cases and further categorized as <10 years (case group 1), 10-20 years (case group 2), 20-30 years (case group 3) occupational dye exposure in textile factory. Of the total participants included in the study 60% were <10 years, 34% had 10-20 years, and only 6% had 20-30 years exposed to occupational Dye and majority were male workers i.e. 68% while only 32% were female workers [Table 1].

TABLE 1: Duration of Occupational dyes and chemical exposure among Group 2 cases

S.NO.	Exposure time	Male workers		Female workers		Total workers	
		No.	%	No.	%	No.	%
1	<10 years (Case group 1)	43	63%	17	53%	60	60%
2	10-20 years (Case group 2)	21	30%	13	40%	34	34%
3	20-30 years (Case group 3)	4	7%	2	7%	6	6%
	Total Cases	68	100%	32	100%	100	100

Peripheral blood was used to perform Liver function tests on all recruited participants. Serum bilirubin (3.067, P value 0.0069*), SGOT (OR 3553.276, P value 0.0083*), SGPT (OR 3.330, P value <0.001*), alkaline phosphatase (OR 3.235, P value-0.0091*), and GGT (OR 9796.633, P value 0.0087) levels were found to be significantly increased in occupationally exposed cases as compared to controls [Figure 1].

FIGURE 1: Liver function test values among cases and controls.



* Statistically significant (P value <0.05)

There was no significant change in serum proteins (OR 3.3210, P value 0.0001) and serum globulin (OR 3.234, P value 0.0001) levels but significant increase was seen in serum albumin (OR 3.106, P value <0.001) levels as compared to control [Table 2].

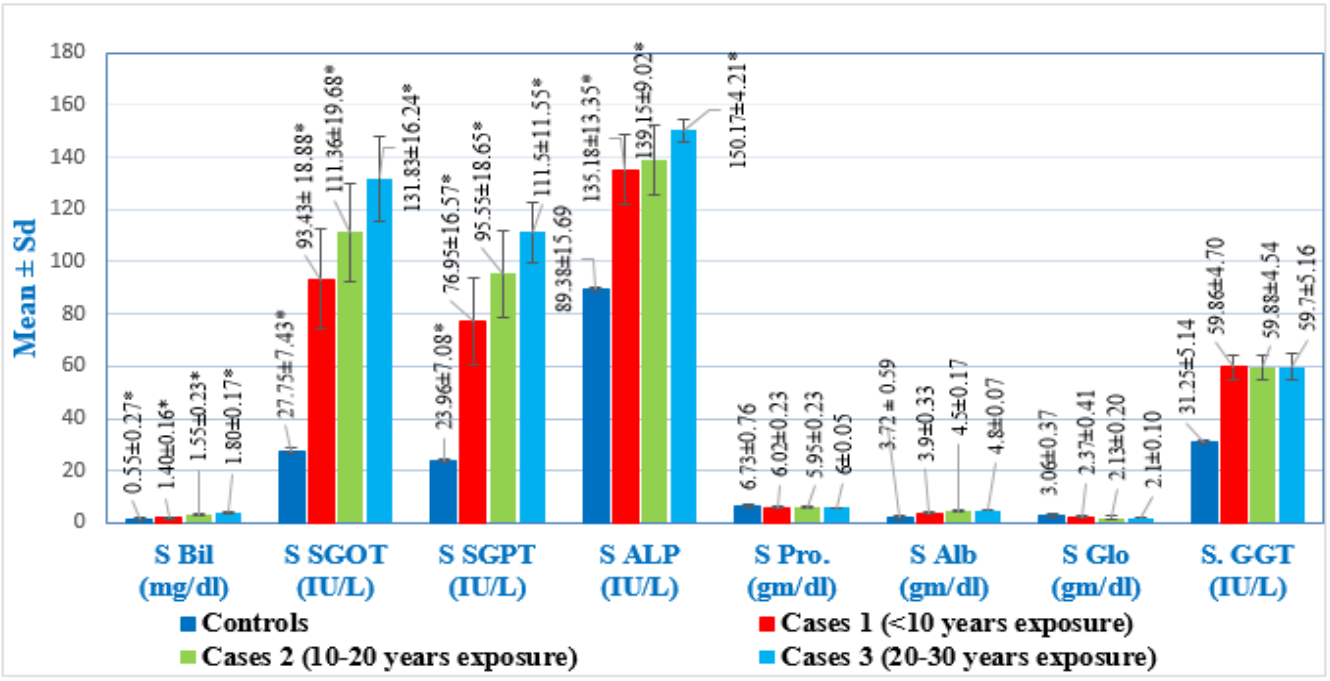
TABLE 2: Liver Function tests values among cases and controls

S. No.	Parameters	Mean ± SD Control (100)	Mean ± SD Case (100)	OR	P value
1	S.Bilirubin (mg/dl)	.55±0.27	1.50±0.23	3.067	0.0069(*)
2	SGOT (IU/L)	27.75±7.43	101.83±21.97	3553.27	0.0083(*)
3	SGPT (IU/L)	23.96±7.08	85.35±20.16	3.330	<0.001(*)
4	Alkaline Phosphatase (IU/L)	89.38±15.69	137.43±12.17	3.235	0.0091(*)
6	S. Protein (gm/dl)	6.73 ± 0.76	5.99 ± 0.22	3.3210	0.0001
7	S. Albumin (gm/dl)	3.72±0.59	3.23±0.30	3.106	<0.0001
8	S. Globulin (gm/dl)	3.06 ± 0.37	2.27 ± 0.36	3.234	0.0001
5	S. GGT (IU/L)	31.25±5.14	59.85±4.64	9796.633	0.0087

* = Significant, P value <0.05 Considered significant

GGT, Serum Albumin, Serum Protein and Serum Globulin levels were found to be non-significant in the occupationally exposed group 1, 2, 3 as compared to control group [Figure 2]

FIGURE 2: LFT values among controls and exposed case groups.



* Statistically significant (P value <0.05)

Case Group 3 had most deranged Serum bilirubin (OR 2109120.18, P value 0.007), SGOT (OR 5179.44, P value 0.009), SGPT (OR 8.450, P value 0.009) and alkaline phosphatase (OR 3.009, P value 0.009) levels and were found to be significantly increased in progressive manner in the 20-30 years occupationally exposed cases group 3 as compared to case group 2 and 1. There for we can say that cases group3 which was for maximum exposure time duration had the highest LFT derangement as compared to control and case group 1 and 2 [Table 3].

TABLE 3: LFT values comparison of prolonged exposed cases groups and controls

S.No.	Parameters	Mean ± SD Control (100)	Cases (Group160, Group2-34, Group3-6)	Mean ± SD Cases	OR	P value
1	S.Bilirubin (mg/dl)	0.55±0.27	Group 1	1.40 ± 0.16	3053.152	0.000013*
			Group 2	1.55 ± 0.23	48682.610	0.000224*
			Group 3	1.80± 0.17	2109120.18	0.007*
2	SGOT (IU/L)	27.75±7.43	Group 1	93.43 ± 18.88	1.723	0.00969*
			Group 2	111.36± 19.68	3.552	0.00991*
			Group 3	131.83± 16.24	5179.443	0.00996*
3	SGPT (IU/L)	23.96±7.08	Group 1	76.95 ± 16.57	1.326	0.000267*
			Group 2	95.55 ± 18.65	1.899	0.00989*
			Group 3	111.50± 11.55	8.450	0.00995*
4	Alkaline Phosphatase (IU/L)	89.38±15.69	Group 1	135.18± 13.35	1.240	<0.0001*
			Group 2	139.15 ± 9.02	1.302	0.00292*
			Group 3	150.17 ± 4.21	3.009	0.00993*
5	S. Protein (gm/dl)	6.73 ± 0.76	Group 1	6.02 ± 0.23	0.047	0.073
			Group 2	5.95 ± 0.23	0.042	0.981
			Group 3	6.0 ± 0.05	0.146	0.427
6	S. Albumin (gm/dl)	3.72±0.59	Group 1	3.9 ± 0.33	0.209	0.096
			Group 2	4.5 ± 0.17	0.074	0.544
			Group 3	4.8 ± 0.07	0.167	0.605
7	S. Globulin	3.06 ± 0.37	Group 1	2.37 ± 0.41	0.026	0.7401
			Group 2	2.13 ± 0.20	0.002	0.841

	(gm/dl)		Group 3	2.1 ± 0.10	0.000127	0.233
8	S. GGT (IU/L)	31.25±5.14	Group 1	59.86 ± 4.7	12170.230	0.982
			Group 2	59.88 ± 4.54	25.072	0.992
			Group 3	59.70 ± 5.16	13.224	0.994

* = Significant, P<0.05 Considered significant.

DISCUSSION

Textile is one of the leading industries in the world. The textile industry workers are exposed to a number of chemicals including dyes, solvents, optical brighteners, finishing agents and numerous types of natural and synthetic fiber dusts which affect their health. Various dyes and solvents used by the textile industry have been found to have mutagenic and carcinogenic properties. The textile industries use different kinds of dyes including the most commonly used azo dyes which are aromatic hydrocarbon derivatives of benzene, toluene, naphthalene, phenol and aniline. The solvents used by the workers in different sections result in a major carcinogenic effect by direct contact with the subjects [14].

A significant increase was observed in the serum Bilirubin levels of occupationally exposed subjects when result were compared with non-exposed subjects [Table 2]. Our observation are similar with a previous study by Keith, et al. which reported that, statistically significant difference in mean levels of serum bilirubin in occupationally exposed groups ($P < 0.001$) were seen as compared to non exposed group. The findings of study highlight that an exposure of solvent, dye and pollutant may be toxic, which in the case of the liver, can be alter it's functions. As such, there is a need to draw the attention of exposure of harmful chemicals, dust and different pollutant to the hazardous effects and subsequent health implications of textile processing and dyeing industry workers [12]. The workers should improve their working methods, or they should use proper protection equipment for decreasing the magnitude of their exposure to the chemicals being used [12]. Our observation were also similar with previous study by Karen, et al. which reported that, lead content of dye used in textile industry have hepatotoxic effect [13]. The elevation of serum bilirubin value after swallowing of lead acetate may induce activation of heme oxygenase. Bilirubin is conjugated with glucuronide in the smooth endoplasmic reticulum of liver, but under the effects of lead toxicity, the conjugation of bilirubin with glucouronoid may become inactive [13].

A significant increase was observed in the serum SGOT and SGPT levels of occupationally exposed subjects when results were compared with non-exposed subjects [Table 2]. Our observation are similar with previous study by Letasiova, et al. which reported increased levels of SGOT and SGPT in industry workers. SGOT and SGPT are the most frequently used indicators of hepatic cell necrosis. In this study, the elevation in the concentration of hepatic enzymes SGOT and SGPT suggest hepatic damage which may develop due to cytotoxicity against hepatocytes with the passage of enzymes into blood stream. Further this leads to necrosis of hepatocytes under influence of xenobiotics [15]. Our observation are similar with previous study which reported that, aspartate

aminotransferase (AST) was higher in textile industry workers. The changes observed in the blood component did not correlate with the age and job duration. A significant ($P \leq 0.05$) depletion in ALT was recorded in most of the age groups along with alterations in AP, LDH, AST and globulin. On the other hand significant decrease in AP, ALP, LDH and increase in AST was observed in workers involved in the dying processes for 6-10 years [16]. There was no significant change in serum protein of occupationally exposed subject when result were compared with non- exposed subject [Table 2]. Our observation are similar with previous study which reported that, the significant decreases in plasma proteins may not become apparent except in severe or long standing hepatic disease. The relatively long half-life of these proteins is also a factor [11]. There was no significant change in serum albumin of occupationally exposed subject when result were compared with non-exposed subject [Table 2]. There was no significant change in serum globulin of occupationally exposed subject when result were compared with non-exposed subject. [Table 2]. Our observation are similar with previous study which reported that, there was no significant change in mean difference of serum total proteins and serum globulin ($P > 0.05$) but highly significant change seen in serum albumin ($P < 0.001$), as compared to controls [17].

There was significant change in serum ALP of occupationally exposed subject when result were compared with non-exposed subject [Table 2].Our observation are similar with previous study which reported that, serum alkaline phosphatase level (ALP) was found to be significantly increased in the study subjects as compared to controls. Exposure of organic solvents and hazardous synthetic dyes in textile industry may leads to hepatocellular damage which indicated by vacuolation, swelling and necrosis of the liver cells, which usually results in disturbed or imbalanced intermediary metabolism, as a result of cellular damage, enzyme like alkaline phosphatase reach out into the serum and hence their level indicates the type and extent of damage inflicted [18-19]. There was significant change in

serum GGT of occupationally exposed subject when result were compared with non-exposed subject [Table 3]. Our observation are similar with previous study of many researchers of different countries [20-22].

Serum bilirubin, SGOT, SGPT and alkaline phosphatase levels were found to be significantly increased in progressive manner in the >20years occupationally exposed cases 3 as compared to Case group 1 and 2 group. Serum Protein, Globulin, levels were found to be non-significant in the occupationally exposed group 1, 2, 3 as compared to control group. However no significant change in GGT was found by some authors [23]. Significantly increased serum ALP and GGT level in these group of workers having occupational exposure to fabric dyeing is most likely due to hepatocellular and canalicular membrane damage. The damage is caused by injurious intermediate metabolites

(epoxides, carbonium, notrenium etc.) produced during biotransformation of the dyes and associated chemicals in liver. These injurious intermediate metabolites bind with liver CYP 450 enzyme and activate them, resulting further production of the intermediate metabolites. All these intermediates bind with cellular proteins, DNA & RNA and damage them [24-26]. Our observation are similar with previous study which reported that, reported that liver dysfunction among workers handling 5-nitro-o-toludine, a raw material for azodyes [27]. Our observation are similar with previous study which reported that, hepatic malfunction in workers occupationally exposed to benzanthrone, an important dye intermediate used in the manufacture of vat dyes [28].

CONCLUSIONS

We observed increased risk of liver dysfunction in occupationally exposed textile industry workers. Increased awareness and early diagnosis of these deteriorative exposures to toxic substance in textile processing and dyeing industries is essential for performing prompt management, improving clinical outcomes.

Additional Information

Disclosures

Human subjects: Consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional ethics committee, Pacific Medical College and Hospital, Udaipur, Rajasthan issued approval PMU/PMCH/IEC/2023/15. Ethical approval for the project

approved by Institutional ethics committee, Pacific Medical College and Hospital, Udaipur, Rajasthan via letter reference number PMU/PMCH/IEC/2023/15 on 01/04/2023. Informed written patient consent form for treatment and publication in open access journal has been obtained from each study participant prior to enrollment in study and sample collection. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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Vasudev Sankhla (vasudevsankhla1@gmail.com) and Don Mathew contributed equally to the work and should be considered co-first authors. Data are available on reasonable request. The data are stored as de-identified participant data which are available on request to Dr. Don Mathew (mathewdon2@gmail.com).

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