Carbon Monoxide Poisoning due to Spray Painting of Cars and Automobiles And Reflection on Some Blood Constituents

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Abstract

Many workshops engaging spray painting of cars were distributed in the city of Mosul/Iraq. These workshops used the traditional process of spray painting for coating and preventing car rust. Accordingly CO was emitted and inhaled by workers (painters) through their period of exposure leading to many complications. The results of this study confirmed the formation of Carboxyhaemoglobin(COHb) in levels exceeding those recommended by authorities guidelines. Fortunately these levels were relatively low and thus causing minor disturbances among painters. The estimated COHb levels ranged from (1.96-2.23) % , (1.88-2.20)% and (1.94-2.24)% for painters of exposure period of 2-7, 7-12 and more than 12 years respectively. Spray painting of cars could be considered to lie within light-heavy category of works. The Effects of COHb appeared to be significant along all periods of exposure for level of ($p<0.01$). This compound also affected some blood constituents. A significant negative correlations were found among this variable and hemoglobin(Hb), packed cell volume (PCV), iron building capacity and transferrin saturation.

Keywords: carbon monoxide, carboxyhaemoglobin, spray paint, car paint

Introduction and Review of Literatures

Carbon monoxide (CO) is the most common and serious by-product of incomplete combustion of carbon-containing fuel. It is also produced within living organisms by natural degradation of hemoproteins, i.e. hemoglobin, myoglobin, cytochromes [1 and 2]

Carbon monoxide is colorless, odorless, tasteless, and non-irritating gas. The exposed person is usually unaware of its effects until serious disorders occur. The poisoning by CO has become very common and may lead to significant complications.

During daily activities, human receives low concentration doses of carbon monoxide (CO) proportional to different working environment. Besides, the occupational and non-occupational exposure may add to an increase of CO concentration in blood. Studies revealed that some works bear high risks for CO exposure particularly vehicle drivers, those working at garages and maintenance, traffic police men and workers at kitchens as well as car spray painting [3].

Carbon monoxide gas enters the blood system during normal breathing. Inhaled CO combines with hemoglobin to form carboxyhemoglobin (COHb) [4]. Once this conversion occurs, the hemoglobin is no longer available for transporting oxygen to other parts of the body. As the amount of CO increases in the bloodstream, the tissues become hypoxic [5].

Further, COHb occurs In humans naturally at low concentration as an endogenous pigment derived from the breakdown of red cells[6].The rate at which carboxyhemoglobin accumulates in the body is a factor of the concentration of gas being inhaled (parts per million or percent) and duration of exposure. Aggravating the effects of exposure is the long half-life of carboxyhemoglobin in the bloodstream.

Carbon monoxide can also occur in the presence of other toxins, complicating both diagnosis and treatment. It is a major contributor in the thousands of smoke-inhalation deaths that occur each year. People who work with spray paint, a paint stripper, can be poisoned because the fumes are readily absorbed and converted to CO in the liver. In such cases, peak carboxyhemoglobin (COHb) levels may be delayed and prolonged because of ongoing production.

In Mosul city/IRAQ, many workshops of car spray paint are distributed along the two banks of the city. These workshops employ many workers (painters). The latter may subjected to CO fume emissions that inhaled and lead to some health disturbances. Paint is applied to car parts and bodies on assembly lines in several coatings, for protection against rust and to provide the required color finish [7]. In developed countries robots with multiple nozzles apply the initial coats followed by hand spraying. In Iraq the whole work is manually done.

This paper focuses on the risks that may occur during working at car painting workshops where exposure to CO may continue for long years. The effects of such work on the increases of COHb levels and reflection on blood constituents such as hemoglobin HC, packed cell volume PCV, total iron binding capacity in the serum, and transferrin saturation are to be determined.

Researches concerning spray paint of cars in Iraq and its relation to COHb formation is very rare. The same thing is valid in other countries. Accordingly a sought for CO studies and its relation to COHb formation is made.

Carbon Monoxide is considerably formed as a results of paint burning and paint stripper processes.[8 and 9]. As a result, those who work in such places as car workshops may inhale this gas and the possibility of COHb formation is very likely.

Carbon monoxide might be the cause of more than one-half of the fatal poisonings reported in many countries [10 and 11]. The oldest reference to the toxic effects of CO may be from Aristotle (384-322 B.C).He described how coal fumes led to heavy

headache and death. In ancient times coal fumes were used for execution [12].

Sources of CO might include(Hatlestad 2009: Gas water heaters , Kerosene space heaters, Charcoal and hibachi grills , Propane stoves , Cigarette smoke , Propane-fueled forklifts , Gas-powered concrete saws, Indoor tractor pulls , swimming behind a motorboat or under a houseboat , spray paint, solvents, degreasers and paint removers.

Ambient concentration of COHb had been reported in various studies. These concentrations were influenced largely by environmental factors and practices associated with incomplete combust of carbonaceous fuels constituting CO among others. The majority of the population were invariably exposed to varied ambient background CO levels.

Carboxyhemoglobin decreases blood oxygen content and hinders the release of oxygen from hemoglobin to tissues. Carbon monoxide quickly binds with hemoglobin with an affinity 200-250 times greater than that of oxygen to form COHb [13 and 14]. The resulting decrease in arterial oxygen content and shift of the carboxy- hemoglobin dissociation curve to the left explains the acute hypoxic symptoms (primarily neurological and cardiac) seen in patients with CO poisoning; however, the toxic effects of CO cannot be explained by this process alone.

COHb levels do not correlate well with symptoms or outcome, and this process cannot account for the phenomenon of delayed neurological squeal. In patients with severe poisoning, carboxyhemoglobin compromises delivery of oxygen to tissue and leads to tissue hypoxia and its immediate functional implications, especially for organs with high oxygen demands, such as the brain and heart.

Materials and Methods

Around 40 workers (painters) engaged in the spray painting were chosen for the purpose of this paper. These painters were distributed among 3 categories concerning intervals of operation. The intervals of operation comprised an interval of 2-7 years, 7-12 years and more than 12 years.

Blood samples were collected by venepunctive from both the subjects under study and the controls. 5 ml of blood was collected into a lithium heparin anti-coagulated bottles and immediately tightly covered to prevent interference of atmospheric oxygen with the carboxyhemoglobin to be estimated. The samples were estimated for carboxyhemoglobin within two hours of sample collection.

The chemical compounds and facilities included:

1. Bottles containing CO gas produces at FLUKA Company(Germany)
2. sodium acetate solution $CH_3COONa.3H_2O$, concentration 40.8 gm/100ml of distilled water
3. acetic acid concentration 28 mg/100 ml of distilled water
4. normal saline solution 0.09%
5. bench centrifuge
6. water bath and
7. spectrophotometer

For estimation of COHb % in blood, the Whitehead and Worthington procedure [cited in Al-Fhadi,2002] was adopted .The procedure is simply explained hereunder:

1 ml of blood was diluted by 9 ml of normal saline solution in a test tube. The latter was placed into centrifuge running at 3000 cycle per minute for 5 minutes. The residue was removed and the precipitate was washed by adding 9 ml of normal saline and put into centrifuge.

The filtrate was neglected and the suspension(blood cells) were treated by adding 5 ml of distilled water and thoroughly mixed.

1 ml of the recent solution was placed in a test tube while the remaining were put into glass flask and connected to CO source. The bubbles were pushed for 1 minute with continuation of agitation

1 ml of CO- treated blood (control) was placed into test tube similar to the first one . To each test tube 3 ml of sodium acetate (40.8 gm/100ml) was added and thoroughly mixed . Then 0.75 ml of ice acetate acid (28 gm/100 ml) was added to each test tube. The tubes were then placed into a water bath 57-57.5 C for 8 minutes. Later these were cooled and filtrated through Watman filter paper. The absorption intensity was estimated at wave length 555nanometer.

To estimate COHb% , the following formula was adopted [3]:

COHb%={(Reading of unknown x dilution factor)/ reading of percent control x10}x 100

For determination of total hemoglobin the following procedure was followed:

(5) ml of Drabkin reagent was placed in a test tube and mixed with 0.02 ml of blood sample. The mix was left for 10 minutes. The amount of hemoglobin was estimated through hemoglobin meter at a wave length of 450 nm. The result was expressed in gm/dl.

For estimating the packed cell volume PCV or the percentage of packed corpuscles , the capillary method was adopted. The latter could simply include putting small amount of blood sample in a capillary tube (sealed from one end) and put at Microhaematocrit centrifuge of 5000 cycle/min for (5) minutes. The capillary tube was read at reading ruler which represented the value of packed percentage.

In order to determine the iron in the serum, a (2) ml of buffer solution(Acetate buffer dimethyl sulphoxide surfactant) with 0.1 ml of reducing solution (Ascorbic acid) and (0.5) ml lf blood serum were put in a test tube. Later, (2) ml of buffer solution was placed in a 2^{nd} test tube with (1)ml of reducing solution and (0.5) ml of standard solution.

Another 3^{rd} test tube containing (0.1) ml of reducing solution and (0.5) ml of distilled water free from iron was used. All the tubes were thoroughly mixed and the absorption intensity at wave length of 595 nanometer.

For determination of total iron building capacity in the serum, the following procedure was followed:
A (0.5) ml of blood serum was placed in iron solution and thoroughly mixed at temperature of (20-25) ^{o}C for 30 minutes. 180 mg of $MgCO_3$ is added and the mix was left for 30-60 minutes at the above temperature. the mix was then put into a centrifuge of 3000cycle per minute. A (0.5) ml of filtrate was taken adding to it (0.1) ml of reducing solution and (2) ml of buffer solution. To the the whole mix a (0.1) ml of Chromogen was added and then incubated for 5 minutes at 20 C temperature. the absorption at wave length 600 nanometer was recorded.

Results and Discussion

The survey of 6 –months study revealed the results listed in (tables 1-3).
The results had shown a constant percentage of blood binding CO for all studied groups of painters with minor differences among periods of exposure.

Table (1) Percentage of COHb of employees for exposure period of (2-7) years

No.	A	B	C	No	A	B	C	No.	A	B	C
١	1.97	1.88	2.02	٦	2.09	2.00	1.96	١١	2.12	1.99	2.09
٢	1.99	2.10	1.94	٧	2.02	2.06	1.99	١٢	2.11	2.08	2.05
٣	1.96	2.06	1.99	٨	1.99	2.02	2.00	١٣	2.15	2.06	1.99
٤	1.97	2.02	1.96	٩	2.23	2.09	2.06				
٥	1.97	1.99	2.04	١٠	2.13	2.12	2.09				

Table (2) Percentage of COHb of employees for exposure period of (7-12)years

No.	A	B	C	No.	A	B	C	No.	A	B	C
١	2.03	2.07	2.00	٦	2.05	2.00	1.94	١١	2.11	2.03	2.00
٢	2.07	2.02	1.99	٧	2.10	2.04	2.00	١٢	2.17	2.20	2.11
٣	2.00	2.05	2.01	٨	2.17	2.09	2.13	١٣	2.21	2.05	2.12
٤	2.03	1.99	2.08	٩	2.09	2.00	2.03				
٥	1.89	1.96	2.00	١٠	2.08	2.19	2.04				

Table (3) Percentage of COHb of employees for exposure period of (>12) years

No.	A	B	C	No.	A	B	C	No.	A	B	C
١	2.00	1.96	2.12	٦	2.11	2.00	2.21	١١	2.16	2.10	2.09
٢	2.05	1.99	2.00	٧	2.09	2.00	2.07	١٢	2.13	2.19	2.15
٣	2.04	2.10	2.07	٨	2.13	2.12	2.09	١٣	2.19	2.11	2.24
٤	1.92	1.99	2.02	٩	2.09	2.00	2.11				
٥	1.97	1.99	2.05	١٠	2.20	2.17	2.12				

A= 1st measurement , B= 2nd measurement after 3 months, C=3rd measurement after 6 months,
No. =individuals employed in painting i.e. painters

The variation of above measurements might be due to different exposure periods, overall health conditions, intensity of work,…etc.
Figure (1) showed the distribution of COHb percentages according to the period of exposure with the mean interval and 95% confidence interval in painters and controls. The figure depicted the increase in COHb percentage in painters clearly.
Generally speaking the COHb percentages of most concerned painters increased with exposure time period with few exceptions. Such exceptions might be attributed to decreased work .
The recorded range value amounted for the studied group intervals were (1.96-2.23) % , (1.88-2.20)% and (1.94-2.24)% for groups A,B and C respectively
The average COHb levels in the general population were around 1.2-1.5 % [13 and 14] or recommended values of control as 0.3-0.7 % [1]. The obtained results exceeded the above values which indicated the effects of spray paint on painters.

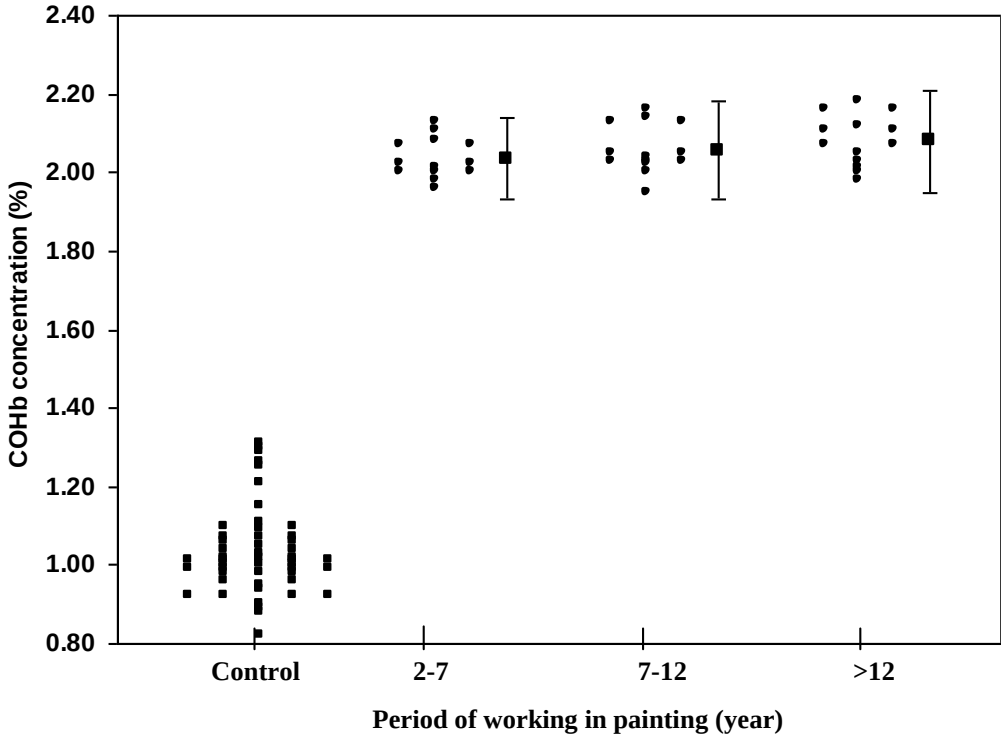


Figure (1) Distribution of COHb of the study sample according to period of working in the painting. Bars represents Mean ± 2SD.

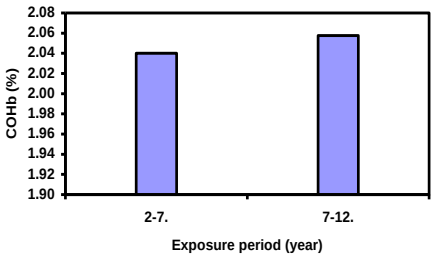
On the other hand, table (4) showed the COHb levels expected for a variety of works [14]. This suggested that spray paint might be considered as a light-heavy work.

Table (4) the expected levels of COHb in the blood at different concentrations of CO

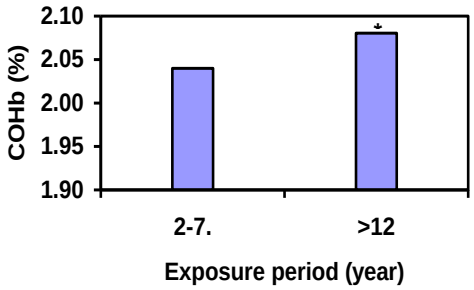
CO concentration		Exposure time	Predicted COHb level% for indicated works		
ppm	mg/m^3		sedentary	Light	Heavy
100	115	15 minutes	1.2	2.0	2.8
50	57	30 minutes	1.1	1.9	2.6
25	29	1 hour	1.1	1.7	2.2
10	11.5	8 hours	1.5	1.7	1.7

The obtained levels of COHb could lead to aggravation of symptoms in angina pectoris patients which was a major public health concern. Besides, most painters complaining from headache , dizziness and due to their work in spray painting,

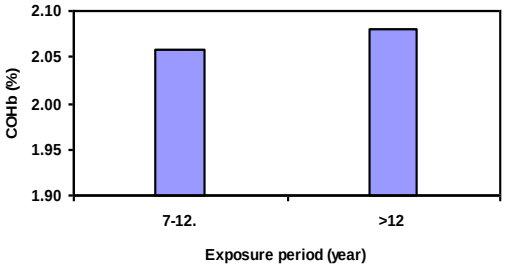
For the effect of period of exposure of painting on COHb percentage, figure (2) showed a non-significant increase in those exposed for a period of 2-7 years compared with those of 7-12 years. On the other hand, a significant increase in COHb percentage was recorded in those of more than 12 years exposure in comparison with 2-7 years exposure at $p<0.01$ as shown in figure (3). Additionally, figure (4) showed a non-significant increase in COHb percentage between the groups 7-12 and more than 12 years exposure to paint. This meant that painters would exhibit a significant increase in COHb percentage at 12 years exposure.



No significant difference ($p>0.05$) according to paired t-test Figure (2) Comparison of COHb concentration in car painter between those of exposure period of 2-7 and 7-12 years.



**** Significant difference at p<0.01 according to paired t-test Figure (3) Comparison of COHb concentration in car painter between those of exposure period of 2-7 and more than 12 years.**



No significant difference (p>0.05) according to paired t-test Figure (4) Comparison of COHb concentration in car painter between those of exposure period of 7-12 and more than 12 years.

Figure (5) showed a significant negative correlation between COHb percentage and iron concentration. AS COHb percentage increased in painters iron concentration decreased.

The figures (6-9) also showed a significant decrease in iron binding capacity, transference saturation, Hb and PCV with the increase in COHb percentage in painters respectively.

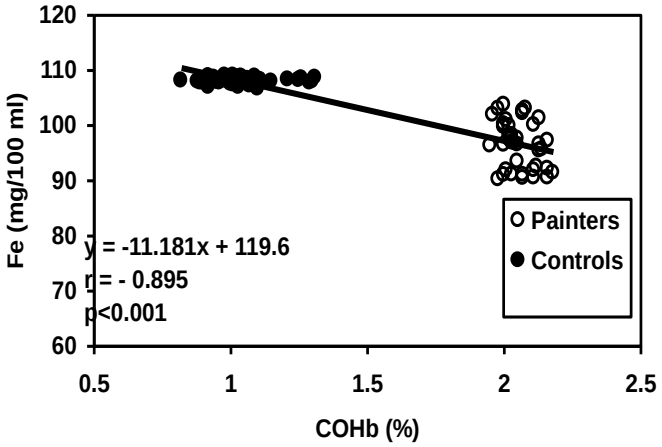


Figure 5. Effect of COHb concentration on Fe.

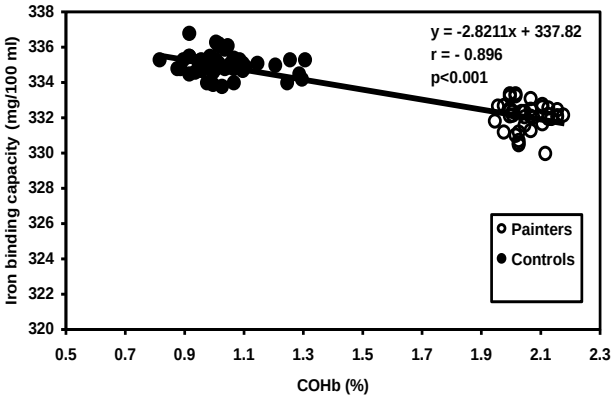


Figure 6. Effect of COHb concentration on iron binding capacity.

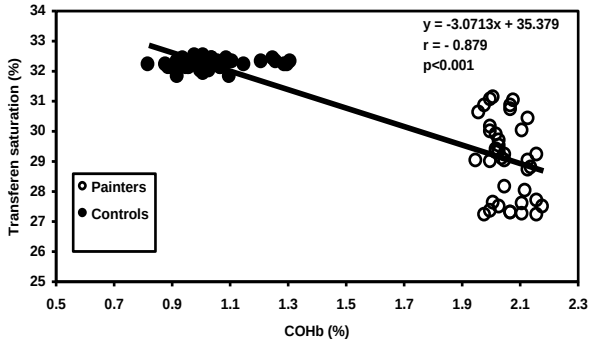


Figure 7. Effect of COHb concentration on transferrin saturation.

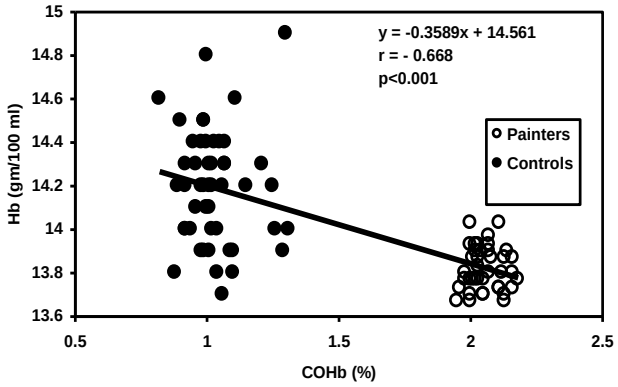


Figure 8. Effect of COHb concentration on Hb.

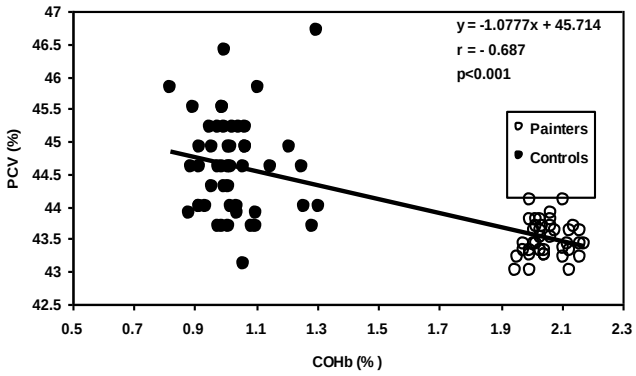


Figure 9. Effect of COHb concentration on PCV.

Conclusions

This study concluded with the following:

1. Spray painting of cars and automobiles may lead to COHb formation in low levels as a result of inhalation of emitted CO.
2. Formed COHb range from (1.96-2.23) % , (1.88-2.20)% and (1.94-2.24)% for workers of exposure period of 2-7,7-12 and more than 12 years respectively.
3. (Painters) or workers engaged in spray painting suffer from headache, dizziness and other health disturbances.
4. Spray paint can be regarded to lie within light-heavy work category according to guidelines.
5. Painters were significantly affected by COHb at level($p<0.01$).
6. COHb could bear a significant negative correlation to some blood constituents such as HC, PCV, iron saturation, and iron building capacity.

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التسمم بمركب كربوكسي هيموغلوبين جراء صباغة السيارات والمركبات وانعكاس ذلك على بعض مكونات الدم

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الملخص

يوجد العديد من الورش الصناعية التي تعمل بصبغ السيارات في الموصل. وهذه الورش تستخدم الطريقة التقليدية بالصبغ بالرذاذ لطلاء ومنع الصدأ للسيارات. على هذا الأساس ينبعث غاز أول اوكسيد الكربون ويتم استنشاقه خلال فترة التعرض له من قبل العمال/ الصباغين في هذا المجال مما قد يؤدي الى حدوث مضاعفات عديدة. اكدت نتائج هذه الدراسة تكوّن مركب الكربوكسي هيموغلوبين بمستويات تجاوزت المحددات المقرة. ولحسن الحظ فان هذه المستويات كانت واطئة مما قد يترتب عليه ان يكون اضرر ضعيفاً على العمال /الصباغين . تراوحت نسب هذا المركب لدى العاملين في هذا المجال بين (١,٩٦– ٢,٢٣)% ، (١,٨٨– ٢,٢)% ، و(١,٩٤– ٢,٢٤)% لفترات تعرض بلغت ٢–٧ ، ٧–١٢ ، وأكثر من ١٢ سنة على التوالي . وهذه النسب تشير الى ان مجال صباغة السيارات يندرج ضمن فئة الأعمال الخفيف– العالية الشدة. ظهر من التحليل الإحصائي ان هذه النسب المتحققة معنوية لكل فترات التعرض ضمن المدى . يعمل هذا المركب أيضا على التأثير على بعض مكونات الدم حيث أظهر التحليل الاحصائي وجود تأثير معنوي سالب يحكم العلاقات بين هذا المتغير والهيموغلوبين وحجم الخلايا المضغوطة وسعة الارتباط الكلي للحديد ونسبة اشباع الترانسفيرين.