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Lactate Dehydrogenase Level, Oxygen Saturation and Hematological Parameters among Workers Exposed to Dust of Construction Materials in Sana'a

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Abstract

Respirable dust and crystalline silica remain an important risk factor for respiratory disease amongst construction workers. The aim of this study was to evaluate the Serum Lactate dehydrogenase (LDH) level, oxygen saturation level (SpO₂) and hematological parameters of workers exposed to construction materials dust and to compare them with the healthy control group in Sana'a city. Blood samples were collected from 70 non-smoker adult male, 20-60 years old, divided into two groups; 35 construction workers and 35 unexposed individuals as control, during the period from May to December 2016, in Sana'a. The results showed that mean serum LDH level of the construction workers (432.25±139.25 IU) was significantly higher than the control group (265.66±98.26 IU) (P<0.0001). The SpO₂ percentage showed a significant decrease (P<0.0001) in values of 84.09±13.95 in construction workers as compared to control 96.09±7.15. The hematological parameters revealed a significant increase in red cell distribution width (RDW), mean corpuscular hemoglobin (MCH), eosinophils and neutrophils (P<0.05). However, a significant decrease in hemoglobin (Hb) content, WBCs count and basophils was found among construction workers when compared with control group (P<0.05). The elevations of serum LDH level and other parameters are highly indicative of pathological conditions among construction workers, suggesting the use of protective masks to prevent inhalation of respirable particulates.

Keywords: LDH, oxygen saturation, SpO₂, hematology, construction workers, Sana'a.



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INTRODUCTION

Sana'a is located in an upland basin at an altitude of 2300 meters within a mountainous and semi-arid region of Yemen (Basti *et al.*, 2009). It's one of the oldest cities in the world, which has different forms of buildings that have been built with different types of materials. In the Yemeni mountainous regions, the stone is the most predominant material for buildings. All Yemeni buildings exhibit superb craftsmanship in a tradition of mud and stone masonry that has been maintained for centuries (Al_Kahtani and Al-Darzi, 2007; Jeffery, 1989). The stones and concrete block are used as a main material used in building in the local Sana'a area. The buildings of Sana'a city are known with its obtainability of many types of stones as a construction material that includes granite, basalt, marble, limestone and travertine, sedimentary, tuff and other sedimentary and volcanic rock. In addition, the using of new building material such as concrete block appears to be the best choice available for the low-income people in Yemen (Al_Kahtani and Al-Darzi, 2007). Tuff is the general term for rock formed of pyroclastic material. Ignimbrite is identical to tuff in formation but is specifically rock formed by widespread deposition and consolidation of volcanic ash flows. The principal chemical composition of Tuff and Ignimbrite in Yemen is SiO₂, which comprises 60-70 percent of the stone. Basaltic rocks are basic volcanic rocks of fine crystallization similar to gabbros in mineral composition (Pugachevsky *et al.*, 2009). The effect of particle deposition in the lungs and its toxicity by means of the inflammatory effect calls for biometric monitoring in order to determine its impact on human health (Ophir *et al.*, 2016).

Enzymes improve the consistency of feed that helps in maintenance of gut health and digestion process (Imran *et al.*, 2016). Many cellular enzymes occur in body fluids and in particular, the properties of serum enzymes have been widely studied. Lactate dehydrogenase (LDH) is a cytoplasmic enzyme that is widely expressed in tissues. The enzyme converts pyruvate, which is the final product of glycolysis, to lactate when oxygen is in short supply, and it is detectable in the serum (Feron, 2009). It is especially concentrated in the heart, liver, red blood cells, kidneys, muscles, brain, and lungs. Increased serum LDH activity is considered as a marker of cellular necrosis, and serum LDH levels have been used as a biochemical marker in the diagnosis in various cancers such as Lymphomas (Shamoon and Polus, 2010), oral premalignant lesions and oral squamous cells carcinoma (Pereira *et al.*, 2015), colorectal cancer (Koukourakis *et al.*, 2005), acute hepatocellular injury (Cassidy and Reynolds, 1994), abnormal liver function, heart failure (Van Deursen *et al.*, 2010), cardiovascular disorders (Buchner *et al.*, 2016). The results of the previous studies showed that LDH activity is significantly increased in a coal-dust exposure and in the

blood plasma among agate workers (Cobben *et al.*, 1997; Aggarwal, 2014) and pulmonary alveolar proteinosis (PAP) (Deleanu *et al.*, 2016).

Pulse oximetry is an essential monitoring technology. Clinical decisions are often made based on pulse oximetry oxygen saturation (SpO₂) measurements (McMorrow and Mythen, 2006). It's widely used for patients who require continuous monitoring of oxygen saturation in various locations such as inpatient units, outpatient pulmonary function testing, emergency care, intensive care, home care and surgical centers. Its main purpose is the early detection of hypoxemia in diverse situations and the monitoring of perfusion and circulation (Hinkelbein *et al.*, 2007; Wilson *et al.*, 2010).

Construction materials have become good job opportunities for thousands of citizens. However, workers are at risk of health problems due to physicals injury and exposure to dust particles during work activities. No information was available on the job history, except a general description of the present occupation.

The aim of the current study was to evaluate the Serum Lactate dehydrogenase level, oxygen saturation level and hematological parameters of Workers exposed to construction materials dust and to compare them with healthy controls group in Sana'a.

MATERIALS AND METHODS

Subjects

The samples of the current study were collected during the period from May to December 2016 from 70 nonsmoking male volunteers, age range (20- 60), from the city of Sana'a, Yemen. The subjects of the study consist of two groups:

Group 1: 35 male volunteer workers from construction-related industries such as stone carving/polishing, stonemasonry, concrete blocks, brick and tile, in Thahban factory and some factories and plants in Al-Nassr St., and Marib St., from the city of Sana'a. who had been exposed to construction dust up to the last 7 years.

Group 2: 35 healthy volunteers, none of them exposed to construction dust as control group with no history of systematic illness.

Blood samples

The blood samples were taken from the construction workers and control group. 8 ml of venous blood was taken from the ante cubit in 3 ml of blood sample was put into a tube that contains EDTA as an anticoagulant to hematological studies. Other 2 mL of blood sample was put into a deposited tube without anticoagulant. Then the tubes were centrifuged at 3000 rpm for 5 mints. The serum samples were separated and stored at (-20 °C) until the time of the enzyme analysis. All blood samples were analyzed in the laboratories of Al Kuwait University Hospital in Sana'a, Yemen.

Enzyme level measurement

Total Lactate dehydrogenase (LDH) level was measured in the blood serum of construction workers and control subjects using the kit of Roche Company, according to the methods described by Pagani et al. (2003).

Hematological Analysis

Blood cell count testing was performed by the automated hematology analyzer, (CELL-DYN 3700 System, USA). The hematological parameters which were studied in this study included the red blood cells (RBCs) count, hemoglobin concentration (Hb content), hematocrit value (Hct), cell volume (MCV), corpuscular hemoglobin (MCH), corpuscular hemoglobin concentration MCHC, red cell distribution width (RDW), the total white blood cells (WBCs) count and leukocytes differential count (monocytes, lymphocytes, basophils, eosinophils, and neutrophils following Iqbal et al. (2014).

Oxygen Saturation

Percutaneous arterial oxygen saturation (SpO₂) was measured the oxygen saturation in order to assess respiratory and circulatory effects. Furthermore, Level (SPO₂) was obtained from construction workers and control group using a digital finger pulse oximeter (USA).

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics v.20 software. The results were expressed as mean ± SD. Differences between I stone crushing workers and control groups were assessed using the t- test. P values less than 0.05 were considered statistically significant.

RESULTS AND DISCUSSION

As shown in Table 1, the statistical analysis showed that there was significant increase in the mean values of serum LDH levels (P<0.0001) in the construction workers. In details, it can be observed that the mean value of serum LDH levels in the construction workers was (432.25 ± 139.25 IU/liter), whereas the mean values of serum LDH levels in control group was (265.66± 98.26IU/liter).

Furthermore, as shown in Table 2, the results showed a significant decrease in the oxygen saturation level (SpO₂) of construction workers (P<0.0001). The mean value in construction workers was 84.09±13.95 (%), whereas the mean value in control group was (96.09±7.15 (%).

Table 1. Serum LDH level of construction workers and control.

Groups	Unit	N	Serum LDH Mean ±SD	P- value
Workers	(U/l)	35	432.25±139.25	<0.0001
Control	(U/l)	35	265.66±98.26	

Table 2. Comparison of mean values of oxygen saturation in construction workers and control.

Groups	Unit	N	SpO ₂ Mean ± SD	P- value
Workers	(%)	35	84.09±13.95	<0.0001
Control	(%)	35	96.09±7.15	

Moreover, the hematological parameters revealed a significant increase at (P<0.05) in the mean red cell distribution width (RDW). The value in construction workers was 13.674± 1.409 higher than the value in control group 13.400± 0.948. In addition, the mean corpuscle hemoglobin (MCH) was 33.732 ± 4.686 in construction workers and 29.609 ± 3.449 in control group. Also the results showed a significant decrease at (P<0.05) of hemoglobin concentration (Hb content). The mean value in construction workers was 15.380 ± 1.829, whereas the mean in control group was 16.729 ± 1.197. However no significant difference was observed for the mean of red blood cells (RBCs) count, the mean hematocrit value (HCT), the mean cell volume (MCV), and mean corpuscular hemoglobin concentration (MCHC), (P>0.05) in both groups (Table 3).

As shown in Table 4, the results of the study proved that there was a significant difference at (P<0.05) in total and differential leucocyte counts for construction workers compared to the control group. The results revealed significant increase at (P<0.0001) in eosinophil (%) the mean in construction workers was 7.364± 4.848 and the mean in control group was 3.234 ± 2.125. The mean neutrophil in construction workers was 36.574 ± 11.655 and in control group was 35.859 ± 17.386. Moreover, the results also showed a significant decrease (P<0.0001) of the mean of white blood cells (WBCs) count with 5.180± 1.210 in construction workers and 5.638±2.153 in control group and the mean basophile value was 1.522± 0.459 in construction workers and 1.818± 1.1549 in control group. However, there was no significant difference (P>0.05) in the percentage of monocytes and lymphocytes.

Table 3. Total and red blood corpuscle indices among construction workers and control group

Parameters	Unit	Construction Workers N=35 Mean ± SD	Control N=35 Mean ± SD	P-value
RBC	($10^{12} \cdot \text{ml}^{-1}$)	5.375± 1.233	5.726± 0.524	>0.146
Hb	(g/dl)	15.380± 1.829	16.729± 1.197	<0.002
HCT	(%)	45.886± 4.14	46.044± 10.960	>0.919
MCV	(fL)	85.661± 10.609	82.845± 19.605	>0.093
MCH	(Pg)	33.732± 4.686	29.609± 3.449	<0.042
MCHC	(g/dl)	37.783± 5.252	33.129± 3.520	>0.127
RDW	(%)	13.674± 1.409	13.400± 0.948	<0.025

Table 4. Total and differential leucocytes count among construction workers and control groups

Parameters	Unit	Construction Workers N=35 Mean ± SD	Control N=35 Mean ± SD	P-value
WBC	($10^9 \cdot \text{ml}^{-1}$)	5.180± 1.210	5.638± 2.153	<0.0001
Monocytes	(%)	10.711 ± 3.052	11.098 ± 5.782	>0.194
Lymphocytes	(%)	43.821 ± 13.273	43.864 ± 13.396	>0.380
Basophils	(%)	1.522± 0.459	1.818± 1.1549	<0.0001
Eosinophils	(%)	7.364± 4.848	3.234 ± 2.125	<0.000
Neutrophils	(%)	36.574 ± 11.655	35.859 ± 17.386	<0.004

DISCUSSION

LDH is considered as one of the true intracellular enzymes which are found in the blood of normal individuals at levels up to hundred-fold lower than in tissues. The presence of LDH in plasma at a level elevated above normal value suggested an increased rate of tissues destruction. Lung related disorders as possible sources of serum LDH abnormalities have been underreported as rarely measured. In the current study, the mean serum LDH level was significantly higher in construction workers than to control group ($P < 0.0001$). These findings are consistent with the observations of Drent et al. (1996) that showed that marked elevations of serum LDH level are highly indicative of pathological conditions in the lungs, such as cell damage or inflammation. Also, the results of the current study are similar to those obtained by Larivee et al. (1990); Cobben et al. (1997); Al-Salhen, (2014) and Pavan et al. (2016), who found increase in serum LDH activity.

Furthermore, some studies have been reported about selected human cells (Akhtar et al. 2010), animal models of evolution (Naimabadia et al., 2016), and the cytotoxic effect of quartz on lung cells in vitro (Morrison et al., 2016). Those studies also showed an increase in LDH activity. On the contrary, our results are not similar to those obtained by Yildrimi et al. (2016). The lactate dehydrogenase (LDH) among marble workers was normal. Crystalline silica increases BAL LDH and the protein levels in later stages of silicosis. Silicosis starts with lung inflammation (Alveolitis

and tissue destruction) as a consequence of SL-induced macrophage activation and the release of inflammatory mediators (Fujimura, 2000; Weill et al., 1994). Cellular damage or death from inflammation is associated with the increased release of protein and LDH (Langley et al., 2004).

The extracellular appearance of LDH is used to detect cell damage or cell death. It is released into the peripheral blood after cell death caused by, e.g. ischemia, excess heat or cold, starvation, dehydration, injury, exposure to bacterial toxins, after ingestion of certain drugs, and from chemical poisonings (Hong et al., 2010; Drent et al., 1996).

The current study revealed that the oxygen saturation level (SpO_2) was significantly decreased in construction workers more than the controls. The results of the current study are similar to previous studies' results that showed a decrease in oxygen saturation level (SpO_2) in Japanese workplace (Jp et al., 2017). Mamo (2016) found the mean value of % SpO_2 was reduced significantly ($P = 0.03$) in exposed cobblestone workers groups compared to non-exposed groups. Cecunjanin et al. (2016) showed that the worker's group average values of O_2 saturation in children with acute bronchiolitis before treatment were significantly lower than the values measured after the administration of therapy. Exposure to air pollutants has been linked to pneumonia, reduced birth weight, acute respiratory infection (ARI) (Bruce et al., 2000). Oxygen binding to hemoglobin is determined by the partial pressure of oxygen (SpO_2), PH and hemoglobin concentration and is also

affected by the same. Oxygen tension, temperature and organic phosphate also affect it (Lemon *et al.*, 1987).

The hematological parameters revealed significant increase at ($P < 0.05$) in the mean of RDW and the mean of MCH. However, a significant decrease ($P < 0.05$) was observed of Hb content in the construction workers when compared with the control group. In a recent research, Wang *et al.* (2016) found that the RDW increase in patients with pulmonary embolism. Cecunjanin *et al.* (2016) also found that in the peripheral blood, there were lower values of erythrocytes, hemoglobin, and hematocrit. Wildman *et al.* (1976) suggested that the low hemoglobin production is because of exposure to flour dust-induced disturbance of heme-biosynthesis. Moreover, Isselbacher *et al.* (1992) reported a drop in the mean of corpuscular hemoglobin concentration (MCHC). The same study explained that such drop might be due to reducing of biosynthesis of heme in bone marrow.

Our results showed a significant increase at ($P < 0.0001$) in eosinophils and the mean neutrophil in the construction workers when compared to the control group. Similar findings were recorded by Ophir *et al.* (2016); they found that eosinophilic counts in induced sputum samples could differentiate between asthma, COPD and asthma-COPD overlap syndrome. Al-Katib and Al-Hakkak (2016) also showed that the significant increase in eosinophil in flour mill workers might be attributed to increase of activation of allergic response.

The neutrophil counts in induced sputa were shown to correlate to exposure duration and disease severity in artificial stone, welders, dental technicians (Ophir *et al.*, 2016; Fireman *et al.*, 2008; Stark *et al.*, 2014). The utility of neutrophil counts in induced sputum samples was demonstrated in other pulmonary disorders as well. For example, sputum neutrophil counts were associated with more severe asthma phenotypes using cluster analysis (Moore *et al.*, 2014). Ijadunola *et al.* (2005) found that the inhalation of grain dust was associated with the development of airflow obstruction, neutrophils recruitment to the lung, and an increase in the concentration of neutrophils in the blood.

However, the current study showed a significant decrease ($P < 0.0001$) in the mean of WBCs count and the mean of basophile value in construction workers when compared to control. Wang *et al.* (2016) showed that the WBCs count decrease in patients with pulmonary embolism. Cecunjanin *et al.* (2016) found the average value of the number of leukocytes in children with bronchiolitis before treatment was significantly higher compared to the values measured after administration of therapy. The focal accumulations of epithelioid macrophages and lymphocytes within alveolar septate might represent the sites for granuloma formations. The

observation that early cell accumulations are not in the alveolar lumen explains their inability to appear in the BALF (Langley *et al.*, 2004).

CONCLUSION

The current study revealed that the serum LDH levels, eosinophils, and neutrophils percentage were higher and SpO_2 , Hb content, and WBCs count were lower in construction workers than in the healthy control group. Artificial construction materials were not handled at the facility. No data was provided about the dust density or silica contents since there was no occupational health and safety specialist available at the facility. During working with dust, workers should wear protective masks to prevent inhalation of respirable particles. Unfortunately, in terms of occupational health, safety in our country is still not sufficient.

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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