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Impacts of Oil Industrial Process upon Occupationally Exposed Workers at Al-Dora Refinery

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Abstract

It's well known that raw oil deposits would cause various health impacts particularly upon those occupationally exposed workers ranging from mild to lethal health influences. This study therefore was designed to probability of finding any prior health symptoms that may act as early indicators of such sever health syndromes which can assist in prediction and expectation of such problems well before being occurred. A total of 50 workers from Al-Dora oil refinery and 10 individuals from well away sites to act as control samples were subjected to this study. All samples were interviewed individually using personal questionnaire, and subsequently examined for total blood content vanadium. Further examination, consisting clinical blood test, was carried out. The current study has found that most occupationally exposed workers suffering various physiological syndromes such as digestive, dermal, and respiratory dieses. Furthermore, it was found several health symptoms such as hair fallen, teeth decay, vision impairment and weight fluctuation, in addition to other clinical symptoms relating to blood components such as packed cell volume (PCV), lymphocytes and eosinophile (WBC) since all these variables have been found significantly ($P \geq 0.05$) regarding exposure period, blood vanadium content and the number of health troubles that workers displayed and insignificantly ($P \geq 0.05$) in case of the worker age. Also, it has been found that the most examined workers were suffering from psychological problems such as depression, stress and malaise. The current work may present a steep of needed researches towards finding out of various health signs occurring prior sever and lethal syndromes appearance that may be act as early warring symptoms. Such sings can be accounted for prediction and evaluation of different raw oil pollutants impact upon all those occupationally, environmentally, and even medically exposed cases.

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1. Introduction:

Oil industries may emit several pollutants targeting air, soil and water that significantly affect certain physicochemical properties of such ecosystems and subsequently result in various disorders of public health particularly those occupationally and environmentally exposed workers [1,2].

Intense scientific researches clearly indicate to high emission levels of various pollutants in oil processing refineries [3] and different manufacturing bodies that consume large oil quantities such as electrical power plants, cement & constructing materials, glass & ceramic factories, and others [4].

Oil emitted pollutants consist of polycyclic aromatic hydrocarbons (PAH), various gas oxides such as carbon oxides (COx), nitrogen oxides (NOx), and sulfur oxides (SOx), as well as hydrogen sulfide (H_2S). However, some volatile organic compounds (VOCs) may contribute in forming secondary pollutants like ozone, the most dangerous ambient air pollutant, via photochemical oxidation of benzene particularly in oil refineries [5].

Significant works have examined probable health impacts upon occupationally and environmentally exposed workers in oil industries and other facilities that use raw oil as a fuel such as electricity power plants, cement industry, and glass factories. Various health symptoms of different physiological and psychological diseases were found particularly among those occupationally exposed workers due to the raw oil deposits [6].

Systematic toxic health effects due to hydro carbonic deposits were recorded on all those exposed workers covering most histological parts such as respiratory tract, digestive canal and blood system. Lethal cancer disease was reported to have occurred in lung and other inhaling parts [7,8]; in skin [9] and in blood [10]. However, genotoxic and other DNA effects were also reported [11].

However, several studies have examined possible effects of heavy metals emitted deposits, particularly vanadium; and reported various adverse influences upon workers in all facilities that consume raw oil. Psychological and physiological disorders such as depression [12] and systematic effects in respiration [13], liver [14], blood [15] and immunological defense [16].

Analysis of different works result may help in finding some physical health symptom that may act as early indicators due to oil deposits exposure. Few studies have reported that vanadium and PAH may cause damage in cestine of hair, nail, and teeth [17] and others may alter shape, size and number of leukocytes [13,15], furthermore some psychological symptoms may be displayed as consequence of exposure to certain pollutants such as vanadium [12].

Study samples were located in Al-Dora oil refinery (DOR). Two types of samples (occupationally and environmentally exposed workers) were chosen. Control sample was taken far away from both sites. Total sample size was 60 individuals; 50 workers (40 occupational & 10 environmental) from Al-Dora Oil Refinery and control sample (10 persons) was taken from site well away from the refinery.

Each tested individual was subjected to general survey using a sheet consisting different variables such as age, exposure period, working place and time, health condition, most suffering syndromes and other mild symptoms. Afterwards, 3 cm^3 blood were taken from each individual for clinical (blood picture) and 5 cm^3 for chemical (vanadium content) tests.

2. Material and Methods:

All experimental samples were randomly collected and therefore different variables such as ages, sex, working date, exposure time, and health history were included.

Blood sample was taken from each person and two blood examinations were carried out:

1. Complete Blood Picture (CBP) including hemoglobin (Hb), packed cell volume (PCV), differential count of white blood cells (WBC) and blood group (BG). This test was preceded in privet clinical laboratory.
2. Blood vanadium content (BVC) using wet oxidation chemical test following method used by previous work [8].

For first test, 3 cm^3 blood samples were taken from each individual and sent to privet clinical laboratory for CBP, WBC, BG and full analyzed results were obtained.

In case of the second test, 5 cm^3 blood sample from each worker was chemically tested for vanadium blood content. Each sample was placed in glass test tube and left to dry under lab conditions.

Well cleaned ceramic crucible was used and its weight was recoded (W_o), then received dried blood sample and re-weight for determination blood weight (W_2). Each crucible was placed in an oven at average temperature of 55 C º for 24 h to completely insure blood dryness and then left to cool out under lab conditions and again its weight was recorded (W_1).

Each crucible was placed into glass beaker and received 75 cm ³ of hydrogen peroxide (H_2O_2) prepared at a ratio of 1:1 (similar volume of de-ionized water and hydrogen peroxide), to complete analyzed blood components. The sample was stirred thoroughly until formation of unpleasant smell white foam. The stirring process was continued till the vanishing of foam and disappearance of blood color.

The beaker, containing the crucible and remaining hydrogen peroxide, was covered by glass watch and then placed on a warming plate to get rid of remaining hydrogen peroxide and leaving sample volume about 25 cm ³. The sample was left to cool out at lab temperature.

The prepared sample, again was placed on warming-plate after being received 10 cm ³ of nitric acid (50% m) to insure complete blood components digestion via brown fume formation, then left to cool out and filtered through wattman filter paper (0.42 mm) in volumetric flask and sample volume was enhanced up to 50 cm ³ using de-ionized distil water.

Twenty-five cm ³ from each sample, prepared above, were divided into five sub-samples of 5 cm ³ each. Similar amount (5 cm ³) of concentrated sulfuric acid was added to each sub-sample for acidity justification followed by adding 0.12 cm ³ of hydrogen peroxide and 1 cm ³ phosphoric acid. Vanadium at a chemical form of ammonium vanadite was finally added at five different (0.0, 0.25, 0.5, 1.0, & 2.0 µg/cm³) concentrations; that each concentration was added to each sub-sample.

Vanadium blood content was determined by using ultra-violet spectrophotometer at absorption level of 450 nm.

All obtained data were subjected to statistical analysis using various valid methods.

3. Results:

The data of current work was summarized and presented using various biometrical techniques.

Table 1 shows mean ± standard deviation of all variables for both occupationally and environmentally exposed workers as well as to control sample. Blood vanadium content was found significantly ($p \leq 0.05$) higher, in occupationally exposed workers (9.945 ± 3.6 µg/cm³) than those of both environmentally (5.341 ± 1.75 µg/cm³) and control (4. 42 ± 0.7 µg/cm³) samples (Fig 1).

Exposure period was varied from 3 – 31 years (mean 18.38 ± 9.72 yrs) and from 4 to 37 years (mean 19. 7 ± 13.95 yrs) for occupational and environmental samples respectively. However, occupational working age was found to range from 22 – 45 years (37. 23 ± 5.99 yrs) while in case of environmental sample lied between 26- 46 years (43.3 ± 12.3) Table 1.

Table 1: Mean ± SD of different variables of all tested samples from Al-Dora oil refinery

Variable	Mean ± standard deviation		
	Occup. Sample (n=40)	Environ. Sample (n=10)	Control Sample (n=10)
Blood Vanadium content µg/cm³	9.945 ± 3.6	5.341 ± 1.75	4. 42 ± 0.7
Exposure period yrs	18.38 ± 9.72	19. 7 ± 13.95	-----
Working age yrs	37. 23 ± 5.99	43.3 ± 12.3	-----
Packed cell volume %	39.6 ± 5.74	43.8 ± 2.25	45.7 ± 1.95
Lymphocyte(WBC) %	42.3 ± 0.89	38.8 ± 2.53	36.33 ± 2.31
Esinocyte (WBC) %	2.68 ± 0.71	0.0 ± 0.0	0.0 ± 0.0
No. of syndrome	1.95 ± 0.99	Nil	Nil
No. of physical symptoms	2.13 ± 1.1	Nil	Nil

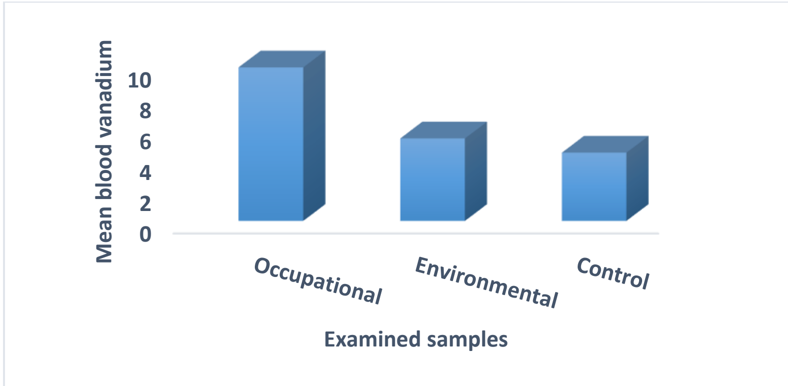

Figure 1. Mean vanadium blood content (µg/cm³) in occupational, environmental and control samples.

Packed cell volume percentage of control sample was found (45.7 ± 1.95 %) significantly greater (t value = 9.17 at $p \leq 0.01$) than those of both occupationally (39.6 ± 5.74 %) and environmentally (43.8 ± 2.25 %) exposed samples (Figure 2). Significant differences were also found between last two samples but at probability of 0.05 (t value = 2.78).

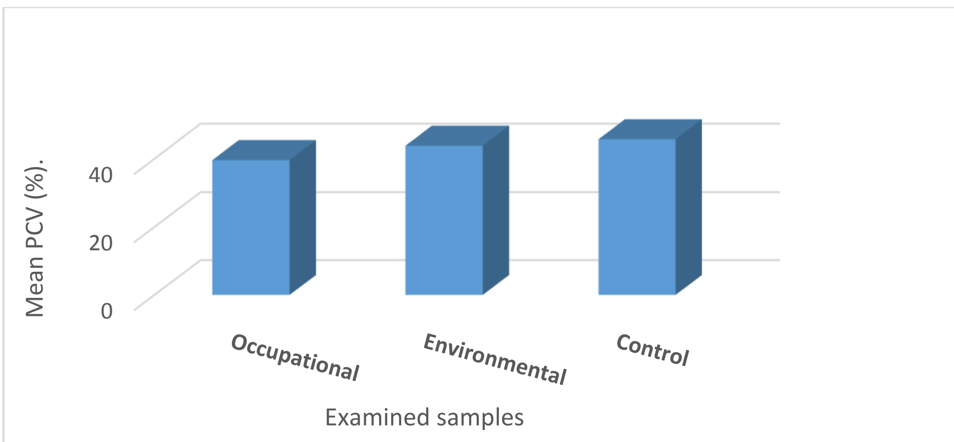

Figure 2. Mean packed cell volume (%) of blood test in all examined samples

However, a significant difference between means of all examined samples has been found in case of lymphocytes (Figure 3). The difference between occupational workers (42.3 ± 0.89 %) and control sample (36.33 ± 2.31 %) was significant ($t = 9.31$; at $p \leq 0.01$, $n = 48$) but less significant ($t = 6.958$; at $p \leq 0.05$, $n = 48$) between occupational and environmental (38.8 ± 2.53 %), however such difference between environmental and control samples was also found ($t = 5.562$; at $p \leq 0.01$, $n = 18$).

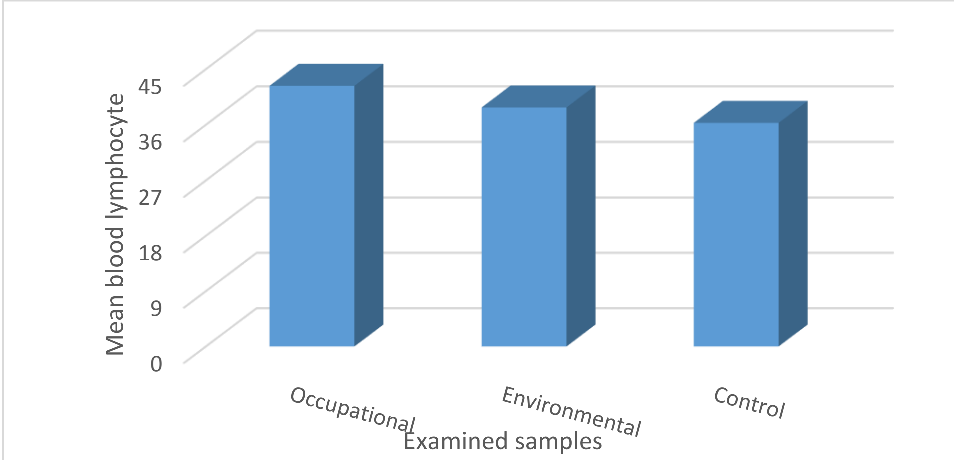

Figure 3. Mean lymphocyte number of blood test in all examined samples

This situation in case of Esinocyte percentage was different, where no values were detected for environmental and control samples and only found in occupational workers (2.68 ± 0.71 %), (Figure 4).

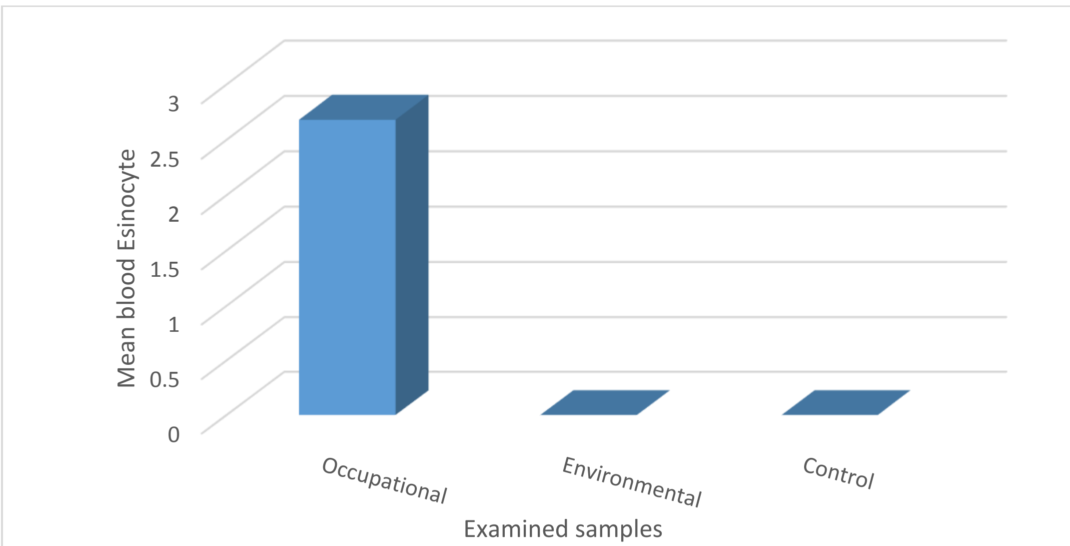

Figure 4. Mean Esinocyte number of blood test in all examined samples

The number of syndromes (mean 1.95 ± 0.99) and other physical health symptoms that used in current work, as early indicators (mean 2.13 ± 1.1) have been occurred in only those occupational workers, but not displayed on those of other environmental and control samples (Figure 5).

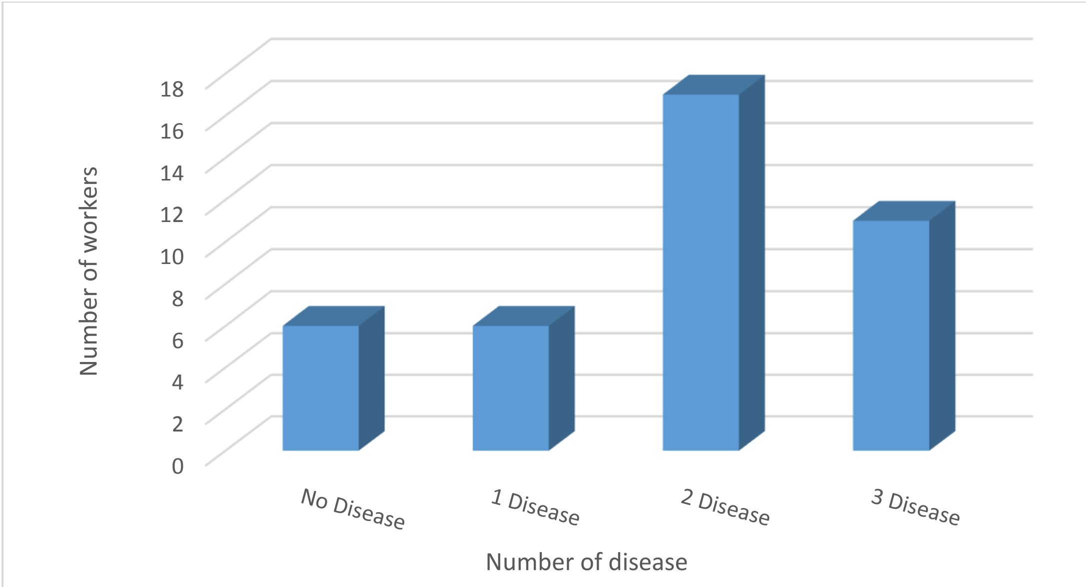

Figure 5. Number of occupational workers exercising number of different diseases

Table 2 shows the relationships between all examined factors. The number of syndromes that workers displayed was significantly related to the exposure period ($r = 0.715$; $P \leq 0.01$, $n = 40$), and total blood vanadium content ($r = 0.63$; $P \leq 0.01$ $n = 40$) but insignificantly related to the worker age ($r = 0.28$; $P > 0.05$, $n = 40$). Also, it was shown to have similar relationships with both Lymphocytes ($r = 0.469$; $P \leq 0.01$ $n = 40$) and Esinocyte ($r = 0.516$; $P \leq 0.01$ $n = 40$) but non significant in case of Monocyte ($r = 0.2$; $P> 0.05$, $n = 40$). However, the relation between syndrome number and the percentage of packed cell volume (PCV) was significantly ($r = - 0.0736$) negative.

Table 2: Correlation analysis between all variables used in study

Correlated variables	r value	Probability
Syndrome no. verses worker age	0.28	$P > 0.05$
Syndrome no. verses exposure period	0.715	$P \leq 0.01$
Syndrome no. verses blood vanadium	0.63	$P \leq 0.01$
Syndrome no. verses PCV	- 0.0736	$P \leq 0.01$
Syndrome no. verses lymphocyte	0.469	$P \leq 0.01$
Syndrome no. verses Monocyte	0.2	$P > 0.05$
Syndrome no. verses Esinocyte	0.516	$P \leq 0.01$
Syndrome no. verses physical symptoms	0.615	$P \leq 0.01$

The number of adverse health signs has significantly ($r = 0.615$; $P \leq 0.01$) correlated to the number of syndromes.

Figure 6 indicates to the common health problems that occurred among examined workers. These were 30.26% related to the respiratory system, 26.32% dermal, 19.74% concerned to digestive canal and finally 23.68% to muscles and skeleton diseases.

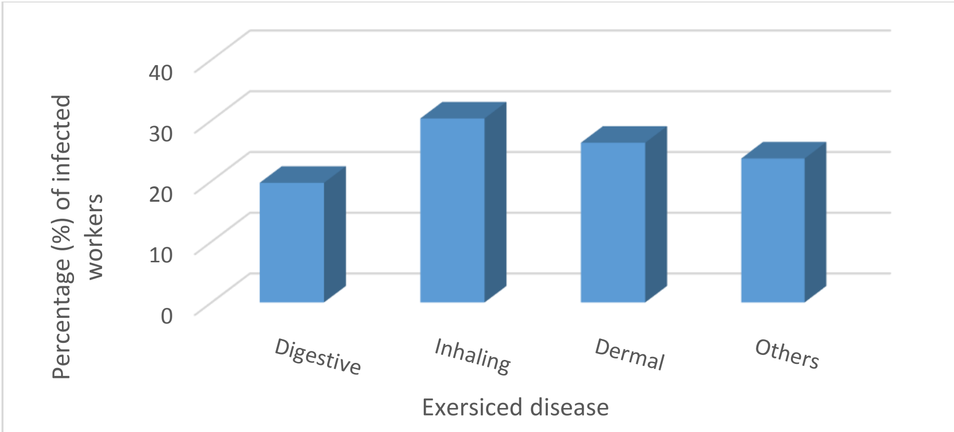

Figure 6: Percentage of common diseases that occupational workers suffering from (DOR)

The number of various diseases that workers displayed. It seems that more than 40 % (17 workers) suffering from three associated syndromes, and more than 30 % (13 employers) exercising four diseases. Meanwhile, only five workers were found to complain from single disease, and similar numbers were found to be disease free.
However, the number of other health physical symptoms that found among workers. About 37% (15 workers) have shown two different physical symptoms, followed by 27% (11 workers had single physical sign, while 22% (9 workers) displayed three physical signs, and only 14% (5 individuals) did not show any physical symptom.

Figure 7 describes those healthy physical signs which were vision impairment (33.87%), teeth decay (25.6%), fallen hair (24.9%), and finally weight fluctuation (16.13%).

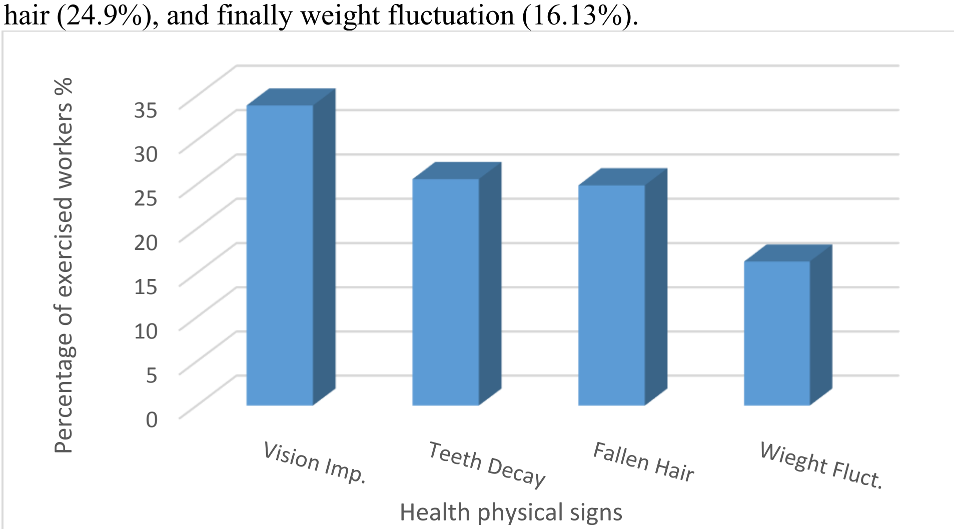

Figure 7: Percentage (%) of physical signs found in occupational workers (DOR).

4. Discussion.

It seems clearly from current study that raw oil emissions have caused several health effects on occupational workers in Al-Dora oil refinery.

I. Blood Vanadium Content:

This work has shown elevated blood vanadium content in all occupational workers tested, which were significantly higher than those of environmental and control samples.

As it has been much known, blood vanadium concentrations may be affected by several factors such as type and level of exposure, work nature, the way raw oil used, emitted deposits behavior, and other characters related to the workers such as age, sex, exposure period, and health condition [13,18].

Previous work [8] has assessed blood vanadium content in occupational workers of Al-Ramadi glass producing factory and reported almost similar findings. He however explained elevated vanadium concentrations being due to released vanadium from raw oil burning process.

II. Blood Clinical Test:

Due to practical difficulties, this test was carried out for only DOR occupational, environmental, and control samples.

This clinical test has involved heamatocrite (Hb), packed cell volume (PCV) and blood white cells (WBC) namely lymphocytes and esinocytes because of their significant immune functions and being used for detecting various health troubles.

The results obtained here showed that the mean percentage of PCV was virtually lower than those of normal values. This blood component however is usually applied in determination of red blood cells (RBC) percentage in plasma which represents almost three times of hemoglobin (Hb) concentration [19].

This finding may be in need of further investigations as certain pollutants targeting blood stream and may cause various damages to different blood components [20] particularly those occupationally exposed workers.

In case of lymphocytes, the study has found significant increase of these cells percentage in occupational workers, comparatively with those of ordinary individuals where normal values range from 20 to 40 % [21]. Environmental and control samples are within this normal range.

It is well known that leukocyte percentage would reflect different clinical infections [22]. Therefore, leukocytes were reported to have been affected by various environmental pollutants such as V_2O_5 [23].

Esinocytes, on the other hand, were seen in blood smears of only those occupational workers giving a mean of 2.68 ± 0.71 %. In general, these cells account for less than 5 % of total leukocytes [28]. National clinical tests assume such value does not exceed 1 % (Personal communication). So the presence of these cells may indicate to several inhaling problems such as bronchial asthma and hay fever in addition to body sever stress [23].

III. Health Adverse Effects:

It has been found that occupational workers were displaying several health problems. They have shown various diseases such as those affecting inhaling, digestive, dermal and others resulting in joint sores, muscle, and bones. These health influences were statistically correlated to the exposure periods and not to the worker ages. These findings, however, are in agreement with the results of available studies [13,15,24]

Interestingly, these health syndromes that displayed upon workers showed similar frequency patterns. The highest percentage was found to be related to respiratory system and the lowest percentage was linked to digestive system, whilst the remaining diseases (dermal & others) had almost similar percentages.

It is well known that the adverse health effects depend upon the pollutant species, concentration, and behavior [13, 16, 25, 26]. For instance, people exposed to emitted vanadium, it was found that more than 80 % of absorbed vanadium quantities via digestive canal would be excreted [17,18] and this may be the cause beyond the lowest percentage of digestive troubles. By contrast, the case is different for PAH, VOC, and various inorganic oxides, where most inhaled concentrations will be held inside human body and only limited quantities are expelled.

In general, any contaminant that enters human body via inhaling process or intravenous injection will be transmitted through blood stream to preferable tissues or organs and would start preceding its influences once effective levels being accumulated.

IV. Early Physical Health Signs:

Most frequent adverse physical health symptoms that this study has detected, upon occupational workers of both experimental cases, were vision impairment, tooth decay, fallen hair and weight fluctuations.

The most common physical sign was vision impairment while weight fluctuation has the least frequency. On the other hand, these physical signs were significantly correlated to exposure periods rather than the age of the workers.

Virtually, any physical symptom originates from biological materials (Biomarker) such as hair, tooth, nail, and others would be more realistic to be applied as early signs (indicators) in monitoring environmental pollutants since these materials are widely used in assessing various chemical influences [27]. So that, it seems reasonable to consider such physical symptoms as early signs that can help in diagnosing pollutant effects prior occurrence of lethal impacts. Nevertheless, such conclusion requires intense medical and clinical works.

5. Conclusion:

It is obviously that various chemicals released from different raw oil industries would have notable health impacts ranging from minor to lethal effects particularly upon those occupationally exposed workers since they are subjected to intake different pollutants via various routes such as inhaling, digesting, contacting, and intravenous injecting [18,26].

Thus it seems very important to assess working exposure to the pollutants using biomarkers [13,26] such as hair, tooth, nail, and other biological fluids and materials. However, any physical damage on these biological specimens would be account for monitoring such contaminants prior occurrence of severs or lethal diseases.

The available data have shown that such physical symptoms displayed on peoples after being exposed to environmental pollutants such as lead, mercury, cadmium, and chromium [27,28].

It seems true that there are sincere scientific attempts in monitoring environmental pollution via different exposure levels and routes. Nevertheless, intense investigations towards finding adverse physical indicators are quiet necessary and urgent.

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