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The Comparison of Hematological Factors between Employees of S.G.P.C Gas Company and a General Population of Employees

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ABSTRACT

Introduction: The aim of our study was to compare complete blood count (CBC) parameters between two populations to determine if there is a need for intervention to improve the health status of workers in the work place .

Methods: This study utilized a comparative cross-sectional studydesign. A total of 654 male workers aged 20-69 years at the Shahid Hasheminejad Gas Processing Company (S.G.P.C) were included. Additionally, a control group of employees in Mashhad city (N=681), matched for age and sex, were enrolled in the study. Fasting blood samples were collected from both groups and blood parameters for all participants were analyzed.

Results: Employees exposed to gas in S.G.P.C had higher white blood cell (WBC) and red blood cell (RBC) counts compared to the control group (P-value<0.05). Furthermore, mean corpuscular hemoglobin concentration (MCHC) and mean corpuscular hemoglobin (MCH) were significantly higher in the control group (P-value<0.01). However, there was no significant difference in hemoglobin (Hb) levels between the two groups (P-value>0. 05) .

Conclusion: Occupational status and working environment may contribute to higher RBC and WBC counts in exposed workers.

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Introduction

Life style is an important aspect of life, consistently affecting human health. Jobs and occupations, as parts of life style have considerable effects on health in various ways. The working environment plays a very influential role, especially for individuals living away from their families in specific dormitories or other separated places with certain nourishing programs (1). An association between several syndromes and particulate matter exposure has been suggested (2). Economic concerns, being away from family and hometown, or just the conditions of workmay cause occupational stress, which is a source of many psycho/neuro/digestive diseases. Additionally, depending on the nature of work, workers are faced with a variety of exposures such as radiations, gas, chemicals and even over exposure to sunlight. Work or occupational activity may lead to persistent illnesses. Anemia and leukemia are two examples that can be regarded as disorders related to occupational diseases (3).

A complete blood count (CBC) is a set of blood markers that is usually ordered for health checks prior to recruitment. Monitoring overall health and screening for certain medical conditions are among the advantageous applications of CBC (4). Recent evidence suggests that CBC may be a helpful test for monitoring the health of employeeswho have been exposed to benzene (5).

Lifestyle factors such as hours of work can affect an individual's white blood cell (WBC) count. Exposure to polycyclic aromatic hydrocarbons (PAH) is associated with higher levels of WBC count among petrochemical workers (6). A previous study on a population of Iranian adult workers who had exposure to H2S, found that the mean methemoglobin and sulfhemoglobin levels were significantly higher than the normal population (7). Other studies suggest that exposure to benzene can depress bone marrow and lead to a decrease in hemoglobin (Hb), hematocrit (Hct) and eosinophil counts (8). Another study reported that among Iranian subjects, the inflammatory marker, high-sensitivity C-reactive protein (hs-CRP) is strongly and positively associated with a marker of oxidative stress and several traditional risk factors of cardiovascular disease (CVD) (9). It is likely that connections exist between psychological and physical aspects of the workplace and certain CBC indices such as WBC, neutrophils, and lymphocytes.

The aim of this study was to compare CBC parameters between these two populations of employees to identify any potential health issues related to occupational situations and determine if any health interventions (such as changes in food, environment, health care, physical activity, or sleep habits) are required to improve personal health and job efficacy .

Methods

1. Study Population

This study utilized a comparative cross-sectional design. The survey was conducted on 654 men aged 30-65 years old who were employees of Shahid Hasheminejad Gas Processing Company (S.G.P.C) in Sarakhs, and 681 males from Mashhad, who had no working involvement with occupational exposure to gas or other chemicals, served as the control group (9). The majority of gas company employees work away from their families and cities. S.G.P.C provided similar facilities for all its employees. All demographic and socioeconomic data, including age, gender, residential information, educational and marital status, occupational history, and smoking habits, were collected using an interviewer-administered questionnaire. Participants were included in the study based on having no significant medical history and not being on any medication within the previous 3 months. Subjects with poorly controlled diabetes (glycated hemoglobin, HbA1c >7%) (10), severe hypertension (11), and overt signs/symptoms of CVD, endocrine abnormalities, or those who chose not to participate were excluded from the study.

Anthropometric and Other Measurements

All patients wore light clothing and fasted overnight when their height and weight were measured. Height was measured with a standard scale to an accuracy of ±0.1 cm, and body weight (BW) to an accuracy of ±0.1 kg.

Body mass index (BMI) and body fat mass were measured using a body composition analyzer BC-418 (Tanita, Tokyo, Japan) following a standard protocol. BMI was calculated as weight (kg) divided by height squared (m2). Hip circumference (HC) was measured at the levels of the major trochanters through the pubic symphysis, and waist circumference was measured mid-way between the lateral lower rib margin and the iliac crest with a scale to the nearest ±0.1 cm. The demi-span was measured with an accuracy of 0.1 cm (12).

Dietary intake was assessed using a 24-hour dietary recall based on Iranian foods (13). Additionally, a self-rating scale was used to detect depression and anxiety in all participants (14,15).

Blood sampling

After a 12-hour fasting period, blood samples were collected from each subject. CBC was measured using the Sysmex auto analyzer system KX-21 N in whole blood. Blood samples were collected into "Vacutainer®" tubes, centrifuged at 5000 g for 15 minutes at 48ºC, and aliquots of serum were frozen at -80 degrees Celsius for future analysis. A lipid profile, including total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), was determined for each fully fasted subject. Serum lipid, fasting blood glucose (FBG) and uric acid concentrations were measured using commercial kits and the BT-3000 auto-analyzer machine (Biotechnica, Rome, Italy). Hs-CRP was measured using a polyethylene glycol (PEG)-enhanced immunoturbidimetry method with an "Alcyon" analyzer (Abbott, Chicago, IL, USA).

Statistical analysis

Data analysis was performed using SPSS 16.0 software (SPSS Inc., Chicago, IL, USA). The normality of distribution was assessed using the Kolmogorov–Smirnov test. Descriptive statistics including mean, frequency, and standard deviation (SD) were calculated for all variables. Normally distributed variables were expressed as mean ± SD, while not normally distributed variables, were expressed as median and interquartile range (IQR). The Student t-test was used for normally distributed variables and the Mann-Whitney U test was used for not normally distributed variables. A P-value < 0.05 was considered significant.

Ethics

Participants were informed about the study verbally and through written information sheets. All patients provided written consent to participate in the study, which was approved by the Mashhad University of Medical Science Ethics Committee.

Results

Sample Characteristics

Table 1 highlights the essential characteristics of workers from S.G.P.C and matched samples from Mashhad. The average age of patients was 45.08±6.28 and 45.02±7.48 in Mashhad and Sarakhs, respectively. Employees in S.G.P.C had Significantly higher BMI, weight, waist circumference, hip circumference, waist/hip ratio, and mid-upper circumference (P-value<0.05), while no significant differences were found for height between groups (P-value>0.05). Additionally, there were no Significant differences in cholesterol, uric acid, and triglyceride (TG) levels (P-value>0.05), but significantly differences were observed in serum levels of LDL-C, HDL-C, and FBG (P-value<0.001). Table 2 also indicates notable differences in depression score, calorie intake, diastolic blood pressure, and systolic blood pressure in these populations.

CBC Indices Among Populations

We analyzed hematological factors including WBC and red blood cell (RBC) counts, Hb, Hct, mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), and red blood cell distribution width (RDW) for all patients. Table 2 summarizes the statistics for these markers. S.G.P.C workers had higher of WBC and RBC counts compared to Mashhad samples (P-value<0.05).

Table 1. The baseline characteristics of employees among two study groups.

Parameter \ Place	Mashhad (n=681)	Sarakhs (n=654)	P-value
BMI(kg/m2)	26.47 ±3.90	27.33±3.78	<0.001
Age(yrs)	45.08 ±6.28	45.02 ±7.48	0.24*
Weight(kg)	76.37 ±12.02	79.46±12.03	<0.001
Height(cm)	169.86 ± 6.74	170.51 ± 6.63	0.077
Waist Circumference(cm)	93.03 ± 9.93	95.79 ± 9.58	<0.001
Hip Circumference(cm)	101.4 ±7.15	103.27±9.04	<0.001
Waist/Hip ratio	0.91 ±0.06	0.93±0.15	0.011
Mid Upper Circumference(cm)	30.36 ±4.04	32.11 ± 7.34	<0.001
Demispan(cm)	82.14 ± 4.27	88.71 ± 7.81	<0.001
FBG(mg/dl)	87.69 ± 33.48	102.25 ±31.05	<0.001
Cholesterol(mg/dl)	186.14 ± 35.76	184.76 ± 35.66	0.477
TG(mg/dl)	128 (84 -182)	134(94.7- 190)	0.052
Uric acid(mg/dl)	5.43 ±1.34	5.30 ±1.87	0.162
LDL-C(mg/dl)	108.98 ± 35.17	128.97 ± 33.99	<0.001
HDL-C(mg/dl)	40.18 ±9.73	40.56 ±11.47	0.0153
Depression Score	9.64 ±7.52	6.05±6.59	<0.001
Anxiety Score	8.18 ±8.17	6.81 ±7.34	0.001
hs-CRP(mg/l)	1.31 (0.83-2.61)	1.83(1.13- 3.32)	<0.001
Calorie Intake	2128 ±706	2438 ± 595	<0.001
Protein Intake	83.6 ±40.5	96 ±32.2	<0.001
CHO Intake	278.9 ±102.9	321.5 ±102	<0.001
Fat Intake	82.9 ± 40.1	94.9 ± 26.8	<0.001
Systolic BP(mmHg)	119.63 ± 15.92	115.75 ± 14.75	<0.001
Diastolic BP(mmHg)	79.49 ±10.72	77.18 ± 9.89	<0.001

-Values are expressed as a mean±SD or median and IQR for normally or non-normally distributed variables, respectively.

–**Abbreviations; BMI:** Body Mass Index, **FBG:** Fasting Blood Sugar, **TG:** triglyceride, **LDL:** Low-density Lipoprotein, **HDL:** High-density Lipoprotein, **Hs-CRP:** High Sensitivity C reactive Protein, **CHO:** Carbohydrate, **BP:** Blood Pressure.

-The Student t-test was used for all variables except for age.

* Mann-Whitney U test was used.

Table 2. Comparison of CBC indices among two study groups.

Parameter \ Place	Mashhad (n=681)	Sarakhs (n=654)	P-value
WBC (103/µ)	6.07 ± 1.81	6.67 ± 1.72	<0.001
RBC (103/µ)	5.16 ± 0.48	5.22 ± 0.48	0.015
Hb(g/dl)	14.81 ± 1.29	14.8 ±1.12	0.872
Hct%	43.80 ± 3.59	45.16 ± 2.80	<0.001
MCV(fL)	84.82 ± 5.84	86.39 ± 6.41	<0.001
MCH(Pg)	28.74 ± 2.04	28.40 ±2.27	0.004
MCHC(103/µ)	33.72 ± 1.73	32.73 ± 1.26	<0.001
RDW (%)	40.76 ± 2.82	42.26 ± 2.82	<0.001
PDW (%)	12.85 ± 1.98	12.97 ±1.92	0.264
MPV(fL)	10.25 ± 4.60	10.11± 0.96	0.457

- Values are expressed as a mean±SD

- **Abbreviations; WBC:** White Blood Cell, **RBC:** Red Blood Cell, **Hb:** Hemoglobin, **Hct:** Hematocrit, **MCV:** Mean Corpuscular Volume, **MCH:** Mean Corpuscular Hemoglobin, **MCHC:** Mean Corpuscular Hemoglobin Concentration, **RDW:** Red blood cell Distribution Width, **PDW:** Platelet Distribution Width, **MPV:** Mean Platelet Volume.

- The Student t-test was used for all variables except for age.

Additionally, MCHC and MCH were significantly higher in Mashhad samples (P-value<0.004), although the differences in Hb were not statistically significant (P-value>0.05). The Hb concentration was greater in the Mashhad population compared to the Sarakhs population. The results in table1 show that Hct is differs among these groups, with the total Hct in Sarakhs employees being higher than in Mashhad samples (P-value<0.001). RDW also showed significant differences (P-value<0.001), while there were no significant differences in Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) (P-value>0.05). Further analysis revealed that the neutrophil count is higher in S.G.P.C workers compared to the Mashhad population, while the lymphocyte percentage is higher in the Mashhad population with no significant differences as expected.

Discussion

In this study we found out, by means of CBC indices (RDW, MCHC, Hct, Hb, hs-CRP), that the working life style and the workplace can affect health status (1). Comparing our two populations in order to find out probable health issues related to occupational situation, led us to possible relations between blood indices and occupational diseases. In the subjects from Sarakhs, higher WBC count, Hct, MCV, MCHC and RDW compared with the Mashhad individuals was detected (P<0.001). A remarkable difference was also seen in CBC indices like RBC and MCH (P<0.05). It would be necessary to consider that this changes in the level of blood factors may reflect blood disorders as an example, the worldwide health challenge, anemia (16).

Increased RDW is the most sensitive feature for folate, iron, and B12 deficiencies (all causes of anemia). Also MCV and MCH are used for detection of early iron, folate, and B12 deficiencies (17). These deficiencies may be nutritional; so it shall be a relationship between the higher levels of CBC markers in the Sarakhs population and their shared nutritional program.

In addition to blood related disorders, other markers were also studied. Hs-CRP, as a biochemical marker of inflammation, is associated with atherosclerosis and cardiovascular disease. This marker is higher in patients with hypertension, hyperlipidaemia, obesity, diabetes, and metabolic syndrome (MetS). Hs-CRP is shown to be related with DM and MetS. As this factor is firmly associated with lifestyle-related diseases and a number of risk factors, results of studies suggest that it might be beneficial to measure hc-CRP for risk management in clinical practice (18). It would be agreeable to discuss Hct as a considerably related with environmental factors. Hct is highly affected by both environment and life style; slightly lower in older age groups, and appears slightly lower in the rural area in comparison with the urban (19). A higher Hct level is associated with cigarette smoking, higher relative weight, higher blood pressure, and higher serum cholesterol. The factor of sex influences Hct in different ways; Hct is decreased with advancing age in men, but not in women. The average value for Hct is significantly lower in women than in men. The levels are related with other variables such as serum total cholesterol, serum total protein, and prevalence of hypertension in both sexes (19). An elevated Hct level is associated with an increased risk of myocardial infarction (MI), coronary insufficiency or CHD death in the urban area (20). High hematocrit values are also associated with a higher risk of cerebral infarction (19). As it is both mentioned and proved, the factors measured and their changes in level in this study are each representing various illnesses, so further studies on each factor in different working environments would be highly recommended. Although the observed differences between the study populations may be due to life style related factors, the most influential risk factor in this study, Chemical exposures should also be considered.

Prior studies that have noted the importance of lifestyle in hematological factors, and the result of them showed that exposure to high levels of benzene as a workplace factor of lifestyle can end in decrease of blood cell count (5, 21-24). Another study discussed, particularly, determined hematological factors (RBC, WBC, and platelet) have been lowered significantly in human population exposed to relatively high levels of benzene (3). Unlike

these results, in our study the amounts of WBC and RBC counts are higher in non-exposed population. Hb is also a novel risk marker for the MetS in men (25). A number of studies investigated that all hematological parameters, including RBCs, WBCs, platelets, and lymphocyte were significantly decreased among exposed workers in contrast to control population (24). It has been shown that nutritional factors, including differences in dietary iron or vitamin B12 intake, might further contribute to variations in hematologic indices (26). It is somewhat surprising that the absolute lymphocyte count was identified as the most sensitive markers of benzene associated hem toxicity (21). Likewise, lymphocyte counts were lower in S.G.P.C workers who were exposed to benzene compared to Mashhad population.

Study Strengths and limitations

The advantage of this study is the large sample size which results in a more accurate conclusion; in addition, it is the first study which has been undertaken in Sarakhs population. It is important to bear in mind the possible bias in these responses, however, we didn't' separate white collar workers from blue collars, so the results can be affected by this factor. Also the gender risk factor was not considered, and all the samples in both groups were males. As a matter of fact, gender influences Hb and Hct factors differently, so it can affect the results. Furthermore, information on smoking habits, alcohol consumption, or chronic minor illnesses that could have strengthened the study was not examined.

Clinical Implications

This research has shown that involving with occupational exposure to gas or other chemicals may lead to leucocytosis and erythrocytosis. Our results might provide one explanation for the association between job and the health status of employees. The results may help authorities to make further efforts in enhancement of working conditions and environment.

Furthermore, these findings highlight the importance of monitoring strategies among gas industry employees. Regular medical check-ups including CBC and inflammatory markers, smoking cessation programs, nutritional consult and ensuring proper hydration- particularly for physically active workers- are recommended. Improving air quality and ventilation in processing facilities may also reduce systemic inflammatory burden and promote overall worker health.

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Conflict of Interests

The authors declare no conflict of interests.

References

1. Nakanishi N, Suzuki K, Tatara K. Association between lifestyle and white blood cell count: a study of Japanese male office workers. Occupational Medicine. 2003 Mar 1;53(2):135-7.
2.Thompson JE. Airborne particulate matter: human exposure and health effects. Journal of occupational and environmental medicine. 2018 May 1;60(5):392-423.
3. Qu Q, Shore R, Li G, Jin X, Chi Chen L, Cohen B, et al. Hematological changes among Chinese workers with a broad range of benzene exposures. American journal of industrial medicine. 2002 Oct;42(4):275-85.
4. Verso ML. The evolution of blood-counting techniques. Medical history. 1964 Apr;8(2):149-58.
5. Khuder SA, Youngdale MC, Bisesi MS, Schaub EA. Assessment of complete blood count variations among workers exposed to low levels of benzene. Journal of occupational and environmental medicine. 1999 Sep 1;41(9):821-6.
6. Kamal A, Cincinelli A, Martellini T, Palchetti I, Bettazzi F, Malik RN. Health and carcinogenic risk evaluation for cohorts exposed to PAHs in petrochemical workplaces in Rawalpindi city (Pakistan). International journal of environmental health research. 2016 Jan 2;26(1):37-57.
7. Saeedi A, Najibi A, Mohammadi-Bardbori A. Effects of long-term exposure to hydrogen sulfide on human red blood cells. The International Journal of Occupational and Environmental Medicine. 2015 Jan 1;6(1):20.

8. Tunsaringkarn T, Soogarun S, Palasuwan A. Occupational exposure to benzene and changes in hematological parameters and urinary trans, trans-muconic acid. The international journal of occupational and environmental medicine. 2012;4(1 January):182-45-9.
9. Sheikh-Andalibi MS, Akhavan-Rezayat A, Mohaddes-Ardabili H, Baghshini MR, Gayour-Mobarhan M, Parizadeh MR, et al. Comparison of cardiovascular risk factors and mood disorders in Shahid Hasheminejad Gas Processing Company (SGPC) with healthy subjects. Clinical Biochemistry. 2011 Sep 1;44(13):S235-6.
10. Dizdarevic-Bostandzic A, Begovic E, Burekovic A, Velija-Asimi Z, Godinjak A, Karlovic V. Cardiovascular risk factors in patients with poorly controlled diabetes mellitus. Medical Archives. 2018 Feb;72(1):13.
11. Huguet N, Larson A, Angier H, Marino M, Green BB, Moreno L, et al. Rates of undiagnosed hypertension and diagnosed hypertension without anti-hypertensive medication following the affordable care act. American journal of hypertension. 2021 Sep 1;34(9):989-98.
12. Tan MP, Bansal SK. The arm span to height relationship and its health implications. InHandbook of anthropometry: physical measures of human form in health and disease 2012 Jan 12 (pp. 741-754). New York, NY: Springer New York.
13. Azar M, Sarkisian E. Food composition table of Iran. Tehran: National Nutrition and Food Research Institute, Shaheed Beheshti University; 1980.
14. James WP, Schofield EC. Human energy requirements. A manual for planners and nutritionists. 1990 Dec 29.
15. Sekita A, Arima H, Ninomiya T, Ohara T, Doi Y, Hirakawa Y, et al. Elevated depressive symptoms in metabolic syndrome in a general population of Japanese men: a cross-sectional study. BMC public health. 2013 Sep 18;13(1):862.
16. Sultan AH. Anemia among female college students attending the University of Sharjah, UAE: prevalence and classification. The Journal of the Egyptian Public Health Association. 2007 Jan 1;82(3-4):261-71.
17. Fialon P, Leaute AG, Sassier P, Vallot C, Wone C. Use of red blood cell indices (MCV, MCH, RDW) in monitoring chronic hemodialysis patients treated with recombinant erythropoietin. Pathologie-biologie. 1993 Dec 1;41(10):931-5.
18. Yoshikane H, Yamamoto T, Ozaki M, Matsuzaki M. Clinical significance of high-sensitivity C-reactive protein in lifestyle-related disease and metabolic syndrome. Journal of Cardiology. 2007 Sep 1;50(3):175-82.
19. Kiyohara YU, Ueda KA, Hasuo YU, Fujii I, Yanai T, Wada J, et al. Hematocrit as a risk factor of cerebral infarction: long-term prospective population survey in a Japanese rural community. Stroke. 1986 Jul;17(4):687-92.
20. Sorlie PD, Garcia-Palmieri MR, Costas Jr R, Havlik RJ. Hematocrit and risk of coronary heart disease: the Puerto Rico Heart Health Program. American heart journal. 1981 Apr 1;101(4):456-61.
21. Aksoy M, Dinçol K, Akgün T, Erdem Ş, Dinçol G. Haematological effects of chronic benzene poisoning in 217 workers. Occupational and Environmental Medicine. 1971 Jul 1;28(3):296-302.
22. Goldstein BD. Benzene toxicity: a critical evaluation: hematotoxicity in humans. Journal of toxicology and environmental health. Supplement. 1977 Jan 1;2:69-105.
23. Kipen HM, Cody RP, Goldstein BD. Use of longitudinal analysis of peripheral blood counts to validate historical reconstructions of benzene exposure. Environmental Health Perspectives. 1989 Jul;82:199-206.
24. Rothman N, Li GL, Dosemeci M, Bechtold WE, Marti GE, Wang YZ, et al. Hematotoxocity among Chinese workers heavily exposed to benzene. American journal of industrial medicine. 1996 Mar;29(3):236-46.
25. Hashimoto Y, Tanaka M, Kimura T, Kitagawa N, Hamaguchi M, Asano M, et al. Hemoglobin concentration and incident metabolic syndrome: a population-based large-scale cohort study. Endocrine. 2015 Nov;50(2):390-6.
26. Azimi S, Faramarzi E, Sarbakhsh P, Ostadrahimi A, Somi MH, Ghayour M. Folate and vitamin B12 status and their relation to hematological indices in healthy adults of Iranians: Azar cohort study. Nutrition and Health. 2019 Mar;25(1):29-36.