Effect of quarry dust on hematological variations among stone quarry workers

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Abstract:
Stone quarries are an unregulated sector that generate harmful substances into the environment. Exposure to these inhalable substances poses to have a deleterious impact on the health of the workers. India has the highest occupation related mortality in the world. The present study is a step towards finding out the association of stone quarrying and its harmful effect on the hematological parameters, to ascertain the changes due to dust inhalation. This study was performed on exposed group consisting of 75 individuals who belonged to different exposure levels to quarry dust (<5years, 5-10 years and >10 years) and the control group consisted of 45 selected individuals without any firsthand exposure. Significant difference was observed between the hematological profile of the groups by unpaired 't' test and univariate analysis using SPSS version 21.0. The results showed that the values of white blood cell (WBC), lymphocytes (LYM), monocytes (MID), mean corpuscular hemoglobin (MCH), and platelets (PLT) were significantly increased in exposed workers ($p \leq 0.05$*) whereas red blood cell (RBC) hematocrit (HCT), and Hemoglobin (Hb%) were significantly lower ($p \leq 0.00$**). This study emphasizes the importance of regular assessment of the environmental pollution, periodic health screening and necessitates the usage of personal protective equipment to protect them from occupational hazard.

Keywords: Quarry dust, occupational exposure, health impact, hematological parameters

Introduction

Occupation or a job is an activity that one engages in the society for their existence or luxury that provides a social status in the community**,** based on the educational qualification or skills. in spite of the benefits, every occupation holds certain risks either caused accidently or a disease caused on exposure to certain hazardous substances. Hence, Occupational hazard is a major threat to the wellbeing of every worker. Stone quarry workers are not an exception to such hazards faced during work. Stone quarry is a inevitable sector that provides raw materials for construction [1].

Development in the form of industrialization and urbanization in the country has brought about environmental degradation causing pollution and threat to human lives. Occupations such as, stone quarrying, drilling, tunnelling and sandstone industry are closely associated with hazardous exposure to silica [2]. Epidemiologic data indicates that approximately 83% of stone quarry workers including sandblasters and miners are posed to the respirable crystalline silica particles resulting in irreversible occupational diseases [3]. Quarries in India are predominantly private owned by small business men with less government assistance. Though there are advancements in the field of stone quarry industry from usage of manual to semiautomated methods in India, yet there is negligence in the usage of safety precautions. Hence Workers of under developed countries face serious health consequences, when compared to developed countries where safety precautions are practiced with at most care and workers are made to undergo regular interventions and screening programs to protect them from the hazards of exposure [4]. Quarries generates dust particles of various heavy metals, organic solvents and silica ranging between 1to 100microns in size. The dust particles, emitted through quarrying activities, have direct impact on one's health causing conditions like asthma, chronic bronchitis, pulmonary tuberculosis, lung fibrosis, obstructive pulmonary disease, cardiovascular disease, cancer of lungs and stomach [5,6]. The disease conditions not only depend on the extent of exposure to quarry dust but also to the size, type and chemical nature of the dust particles to which one is exposed. (Suspended, inhalable, respirable, and particulate matter) [7,8].

The World health organization (2018), has hence reported air pollution to be the prime factor for non-communicable diseases that approximately 7 million people yield to complications on chronic exposure apart from disturbing the systems of the body, these dust particles are hazardous enough to affect the hematological parameters which helps understand the mechanism of the disease [9].

Hence routine hematological analysis should be employed to assess the health of quarry workers exposed to dust. Blood is a window to general health condition of an individual The Complete Blood Count (CBC) gives details on red blood cell, white blood cells, platelets count among other parameters. The increase or decrease in these parameters beyond the normal range usually indicates an underlying medical issue which might require further evaluation based on the conditions of the individual (10). This present study was carried out to analyze the effect of quarry dust on the hematological parameters in quarry workers with relevant to the unexposed subjects.

2. Materials and Methods

2.1. Sampling

2.1.1. Specifications of participants for exposed group participants

The study was conducted at stone quarries from Yelaanjeri village, Vempakkam vattam which is located at Thiruvannamalai district, 120 Km away from Chennai. It is a small village having numerous stone quarries being flanged on all sides of the roads and almost the entire population depends on quarry industries for their living. The worker were selected for this study age between 20-55 years and

were all male participants and having not less than 2 years of work exposure.

2.1.2. Specifications of participants for control group participants

A 45 healthy volunteers, not exposed to quarry dust, matched in terms of age, sex, gender and socio-economic status with that of exposed participant were included as control group participants. They are residing in an area, free of air pollutions due quarry or any other form of industries or factories. The control group subjects were area called Allikuzhi village, Thiruvallur District, Tamilnadu where no quarries are present in and around 20 km and have no exposure to quarries.

2.1.3. Inclusion Criteria for Control Group participants

Age 20 to 55 years, not exposed to quarry or any other form of industrial air pollution, and is willing to participant in this study were recruited as control participants.

2.1.4. Exclusion Criteria for Control Group Participants

The control subjects who had no history of respiratory dysfunction, or signs of liver, heart, generic, hematological and bone diseases were excluded from the study.

2.1.5 Ethical clearance

Ethical clearance was dully obtained from Institutional Human ethical committee NO: 19 January/ 2021 and verbal informed consents were taken from both the groups.

2.2. Sample Collection:

The study was conducted during the months of February 2022 to July 2022. Prior consent and self-designed questionaries was administered to all the subjects by reading and explaining the purpose of the work. The blood samples were collected from the quarry site during midmorning to noon (10.00 am to 12.00 pm) for both the subjects and likewise in the controls. 5ml of blood sample was collected by vein puncture under aseptic conditions into a dry, clean heparinized tubes for hematological assays. Other blood samples were left to coagulate and was centrifuged at 3,500 rpm for 5 minutes. After centrifuging, the serum was separated and dispensed into dry clean serum container, after which the samples were analyzed for biochemical assays immediately by transfer with proper ice-cold storage container to stored at -20°C.

Analysis of hematological indices:

The hematological indices of Hemoglobin (Hb %), Hematocrit, Leukocytes, lymphocytes, Monocytes, and Platelets, mean corpuscular hemoglobin (MCH), Mean corpuscular volume (MCV), white blood cell (WBC), Packed cell volume (PCV) Red blood cell (RBC) determination was done using Hematology Auto Analyzer (Beckman Coulter, model no. ACTDIFF-02) at Hi-tech Diagnostic center, Kanchipuram.

2.3. Statistical Analysis

The values are expressed as Mean± SD. The statistical analysis carried out for comparative analysis include independent t-Test and univariate analysis by SPSS 21.0. The statistical significance was calculated $p < 0.05^*$ and $p<0.001$ respectively.

2.4. Results

About 120 were participated in this study among this 75 were quarry workers and 45 non exposed. **Table 1** shows the general comparison of mean and standard deviation (±SD) of hematological parameters (RBC, Hb% , Total WBC and

DC, MCH, MCV, RDW, Hematocrit and Platelet count) of quarry workers exposed to quarry dust which is compared with control subjects.

Table.1: General comparison of hematological parameters for the study group and control group.

	Study Group (n=75)			Control Group (n=45)	
Parameters	**Mean**	**±Std. Deviation (95% CI)**		**Mean**	**±Std. Deviation (95% CI)**
RBC Count	4.88	±0.54 (4.76, 5.01)		5.06	±0.3 (4.97, 5.15)
Total WBC	8244.13	±1753.31 (7840.73, 8647.53)		7708.67	±785.49 (7472.68, 7944.65)
Differential Count					
Neutrophils	56.29	±8.38 (54.36, 58.22)		52.1	±3.89 (50.93, 53.27)
Lymphocytes	32.03	±6.72 (30.49, 33.58)		29.37	±5.07 (27.85, 30.90)
Esonophils	7.56	±6.77 (6.00, 9.12)		2.94	±0.63 (2.75, 3.13)
Monocytes	4.05	±1.31 (3.74, 4.35)		3.6	±0.87 (3.34, 3.86)
Basophils	0.89	±0.51 (0.77, 1.01)		0.63	±0.28 (0.55, 0.72)
Haemoglobin	13.60	±1.77 (13.60, 14.01)		14.18	±1.09 (13.85, 14.51)
MCH	29.14	±2.34 (28.61, 29.68)		28.48	±3.3 (27.49, 29.47)
MCV	87.97	±9.01 (85.89, 90.04)		82.59	±14.13 (78.35, 86.84)
RDW	13.71	±1.44 (13.37, 14.04)		13.01	±0.91 (12.73, 13.28)
Platelets count	3.21	±0.58 (3.03, 3.38)		2.55	±0.71 (2.39, 2.71)
Hematocrit	38.71	±5.10 (37.53, 39.88)		40.56	±4.96 (39.07, 42.05)

In the **Table 2** significant decrease in mean standard deviation (±SD) of RBC (4.88±0.54 and 5.06±0.31), Hb% (13.60±1.77 and 14.18±1.07) and Hematocrit (38.71±5.10 and 40.56±4.96) in quarry workers compared to control subjects which shows statistically significant (p≤0.05*). Whereas in the levels of Total WBC, Neutrophils, Lymphocytes, Eosinophil, Monocytes and Basophils, MCH, MCV, RDW and Platelet counts shows significantly increased due to the dust exposure in quarry workers compare to control participants (p≤0.05*).

Table. 2: Independent Test -Differences in biochemical parameters of hematology between study group and control group.

Parameters	Group	n	Mean	Std. Deviation	T	df	P-value
RBC Count	Study Group	75	4.88	0.544	-2.04	118	.04*
	Control Group	45	5.06	0.30			
Total WBC	Study Group	75	8244.13	1753.31	1.93	118	.06
	Control Group	45	7708.67	785.49			
Differential Count							
Neutrophils	Study Group	75	56.29	8.38	3.15	118	.00**

	Control Group	45	52.10	3.89			
Lymphocytes	Study Group	75	32.03	6.72	2.29	118	.02*
	Control Group	45	29.37	5.07			
Eosinophils	Study Group	75	7.56	6.77	4.55	118	.00**
	Control Group	45	2.94	0.63			
Monocytes	Study Group	75	4.05	1.31	2.02	118	.04*
	Control Group	45	3.60	0.87			
Basophils	Study Group	75	0.89	0.51	3.13	118	.00**
	Control Group	45	0.63	0.28			
Hemoglobin	Study Group	75	13.60	1.77	-1.99	118	.04*
	Control Group	45	14.18	1.09			
MCH	Study Group	75	29.15	2.34	1.29	118	.20
	Control Group	45	28.48	3.30			
MCV	Study Group	75	87.97	9.01	2.55	118	.01*
	Control Group	45	82.59	14.13			
RDW	Study Group	75	13.71	1.44	2.92	118	.00**
	Control Group	45	13.01	0.91			
Platelets count	Study Group	75	3.21	0.58	-4.37	118	.00**
	Control Group	45	2.55	0.71			
Hematocrit	Study Group	75	38.71	5.10	-1.95	118	.05*
	Control Group	45	40.56	4.96			
Note: *.P<0.05, **.P<0.01							

The independent‘t’ test data are represented as mean ±SD for hematological parameters between exposed and control group. Statistically Significant level indicates (P<0.05*), and (P<0.001**).

The **Table 3** indicates the differences in hematological parameters on duration of exposure to quarry dust within the study group. The Univariate analysis shows mean±SD of RBC count, Total WBC, neutrophil, eosinophil, monocyte and lymphocytes was significantly lowered as years of exposure increased (less than 5 years, 5-10 years and above 10 years) p≤0.05* and p≤0.00**.

Table.3: Univariate ANOVA Test - Differences in Biochemical parameters of hematology by year of exposure to quarry (n=75)

Parameters	**Mean (Std. Deviation) for year exposure to quarry (n=75)**						
	≤ 5 years (n=36)		**5-10 years (n=29)**		**≥ 10 years (n=10)**		**P-value**
RBC Count	4.99	(0.45)	4.73	(0.63)	4.31	(0.48)	0.04*
Total WBC	8156.11	(1845.09)	8108.00	(1697.85)	7819.00	(1620.38)	0.00**
Neutrophil	57.26	(9.05)	55.39	(7.94)	53.42	(6.81)	0.01*
Lymphocytes	30.05	(6.66)	34.50	(5.77)	32.03	(7.73)	0.03*

Eosinophils	7.87	(6.94)	7.54	(5.88)	7.18	(7.04)	0.00**
Monocytes	4.10	(1.20)	4.06	(1.58)	3.81	(0.80)	0.02*
Basophils	0.79	(0.45)	1.00	(0.59)	0.94	(0.49)	0.25

The Univariate analysis for years of exposure in quarry worker data are represented as mean ±SD of hematological parameters. Statistically Significant level indicates (P<0.05*), and (P<0.001**) years of exposure among (≤5years, 5-10 years and ≥10 years) the quarry workers.

The Univariate analysis of Hb%, MCV, MCH, RDW, Platelet count and Hematocrit shows significant differences in hematological parameters in the study group based on the years of exposure to quarry dust is provided in the **Table 4**. This indicates that workers who had worked for less than 5 year shows mild decrease were as years increased 5-10 years and above 10 years of work exposure showed significant increases in MCV, MCH, RDW and Platelet count (p≤0.05*). Hb% and Hematocrit shows significant decrease in the level (p≤0.00**).

Table.4: Univariate ANOVA Test - Differences in Biochemical parameters of Hematology by year of exposure to quarry (n=75)

Parameters	**Mean (Std. Deviation) for year exposure to quarry (n=75)**						
	≤ 5 years (n=36)		**5-10 years (n=29)**		**≥ 10 years (n=10)**		**P-value**
Hemoglobin	14.18	(1.64)	13.18	(1.74)	12.74	(1.76)	0.02*
MCV	87.27	(8.70)	88.19	(9.58)	89.82	(9.03)	0.01*
MCH	28.93	(2.79)	29.36	(2.00)	29.87	(1.02)	0.04*
RDW	12.84	(1.65)	13.56	(0.94)	13.92	(0.90)	0.00*
Platelets Count	2.43	(0.61)	2.51	(0.65)	2.60	(0.77)	0.02*
Hematocrit	39.78	(5.03)	38.42	(5.13)	37.48	(4.09)	0.00**

The Univariate analysis for years of exposure in quarry worker data are represented as mean ±SD of hematological parameters. Statistically Significant level indicates (P<0.05*), and (P<0.001**) years of exposure among (≤5years, 5-10 years and ≥10 years) the quarry workers.

2.5. Discussion:

The present study was carried out to assess the hematological variations due to chronic inhalation of quarry dust. The study evidenced an increase in leucocyte and platelet count with decrease in the red blood cells, hemoglobin and hematocrit in quarry workers than the control subjects. The decline in the RBC count is suggested to be an impact of silica dust on the walls of the RBCs causing hemolysis and as a result of stress response to the toxic inhalation. Quarry dust consists of 71% of silica. Inhalation of silica attributes a deleterious effect on the entire body including blood. Quarry dust has the potential to reduce G6PD an enzyme that protects RBCs from oxidative damage causing hemolysis [11].

Decrease in red blood cells reduces hematocrit. Hematocrit is a key factor in identifying anemia. Thus, reduced hemoglobin reported in this study is suggested to be the consequence of anemia caused by hemolysis due to inhalation of quarry dust, which is supported by Calistus *et al*., (2002) [12]. Other studies on cement dust workers report that Decrease in RBC and hemoglobin to be an effect of inhalation of hazardous material not of the nutritional status, as both groups involved were socioeconomically matched [13].

On the other hand the values of MCV, MCH and RDW in quarry workers were relatively elevated. Increase in the MCV level in this study indicates that, the RBCs are larger in size. Which could be due to stimulation of erythropoiesis following haemolysis. Increase in MCH is indicative of anaemia due to low levels of Vitamin B12, folate or liver disease or infection associated complications. Higher value of RDW indicates higher variation in the size of RBCs, noticed in macrocytic anaemia. Thus, it is evident that the increase in the levels of MCV, MCH and RDW is considered to be due to haemolysis of the RBCs on exposure to quarry dust [14] or could be due to the impact of inhalation of quarry dust on the Lungs, causing pneumonia or chronic lung disease [15].

Increase in platelets observed in this study is in acquiesce with Mojiminiyi *et al* (2008), which reported the effect of quarry dust on bone marrow to increases the platelet count [16]. The High leukocytes observed in this study is suggestive of infection, inflammation and oxidative stress reaction that the quarry workers are subjected to, due to prolonged inhalation of quarry dust . This is evident, that the immune system is working effectively to combat the effect of the toxic substances inhaled. This is in accord with a similar report that says the aggravated inflammatory response as an early induced non adaptive response of the body's immune system [17]. A drastic increase in the eosinophils is a key to understand the allergic inflammatory reactions occurring in the quarry workers due to irritants in the air. Conroy and Williams, reported that the elevated eosinophils in quarry dust exposed groups is a consequence of exotoxin induced oxidative stress which is also suggestive of this study [18]. Lymphocytes increase in this study is well evident to be an immune response to the inhaled toxins present in the quarry dust also supported by another study [19]. It is reported that quarry dust induces inflammatory mediated DNA damage that causes lymphocytosis [20,21,22]. Therefore, on chronic exposure to quarry dust induces inflammatory response that progress into fibrosis. If the particulate matter inhaled escapes the reticuloendothelial system, it gets phagocytized by the alveolar macrophages triggers the release inflammatory agents like cytokines [23,24]. And also, IL6 and Granulocyte Macrophage Colony Stimulating factor (GMCSF) as a response to inhaled pollutants [25].

From this study it is observed that chronic exposure to dust induces changes in the hematological parameters as a response, disturbing the hematopoietic system of the exposed workers, since the mammalian hematopoietic system has the tendency to be affected by the environmental toxicants [12]. It is also noticed that the effect of dust on the quarry workers further aggravates with respect to duration of exposure.

This present study concludes that exposure to stone quarry dust does significantly affect the hematological parameters causing enhanced immunological reaction

among exposed subjects and vital role in enhancing inflammation. Thus, from this study it is evident that quarry dust could alter the blood cell parameters affecting the cell walls of the blood cells.

2.6. Conclusion:

Inhalation of hazardous materials from the quarry site leads to magnitude of health effects on the workers. Routine examinations and symptom-based health assessment should be made mandatory to mitigate disease burden. Workers should be provided with proper safety effects to reduce exposure levels.

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Conflicts of Interest: The authors declare there are no conflicts of interest**.**

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