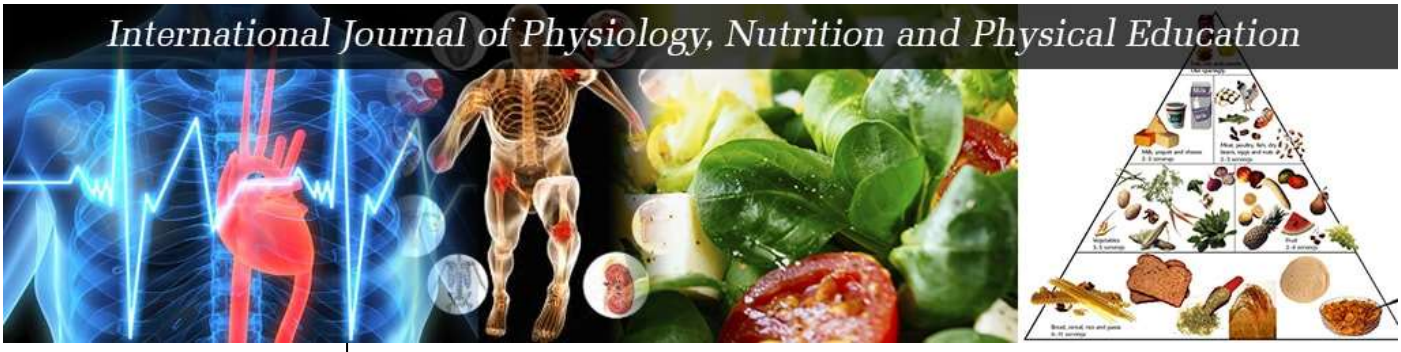

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A comparative study on hematological profile of female athletes of two different air polluted zones of West Bengal

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Abstract
Air pollution has become one of the health hazards of today's world. It is now well known fact the exercises in the form of sports, aerobics or workouts, if performed regularly have a positive impact on various system of the body. But during exercising one should avoid areas with high pollutant concentrations. The study was carried out to observe whether environmental air pollution has any effect on hematological parameters of female athletes of two different polluted zones of west Bengal. Two different zones (Cooch Behar -A B N Seal College, Howrah -Betore) with their respective climate condition of West Bengal, India were selected for the present study. The air quality of these different zones was collected from WBPCB for comparative study of air pollution from January 2017 to February 2017. The total number of 20 female athletes aged 18-25 years undergoing regular training program for a minimum period of 3 years and having participation in national /state/district level sports competitions and residents of that particular area for the past 5 years or more were enrolled as subjects of this study. They were subdivided into two groups according to their residence of particular zone. Selected physical profile, hematological profile and air pollutants were measured. There was no significant difference between female athletes of Cooch Behar and Howrah zones in respect of height, weight and BSA and BMI. Hb concentration, RBC count, PCV%, MCH and MCHC were significantly higher ($p<0.01$) in Cooch Behar female athletes than Howrah female athletes. WBC ($p<0.01$) and platelet count ($p<0.05$) were significantly higher in Howrah female athletes than Cooch Behar female athletes. No significant differences were obtained in MCV although values were higher in Cooch Behar athletes. Values of PM10 of Howrah zone was much more than the national ambient air quality standards. In the case of SO_2 concentration in air, all these zones are below the standard level. Though the NO_2 of Howrah and Cooch Behar zones are below the standard level, the Howrah zone is very near to cross the standard level.

Keywords: Air pollution, hematology, female athletes

1. Introduction
Women are unstoppable in sports, the emancipation of women in sports is as objective a process as the liberation of women from social duties restricted to three K's in the days of Old-Kinder, Kuche, Kirche (Children, Kitchen, Curch). The active participation of women of the East in sporting life after hiding their face under paranja for centuries is the most vivid manifestation of this (Grayevskaya, 1983) [13].

Environmental considerations, at present, are gaining increasing significance due to rapid industrialization and urbanization throughout the world. Different pollutants released due to various industrial as well as other man-made activities including fast expanding vehicular traffic are causing deep concern to all kind of living organisms on the earth, adversely affecting their health.

Numerous studies have reported short term effects of air pollution on increasing the risk of cardiorespiratory mortality and morbidity (Dockery *et al*., 1993; Oliveira *et al*., 2006) [9, 20].

The extent to which an individual is affected by air pollution generally depends on the total exposure to the damaging pollutants, which is usually determined by the duration of exposure and the concentration of the chemicals (Kargarfard *et al*., 2011) [14]. Concern has been increased about problems associated with exercising in polluted air.

Air pollution may affect athlete's health and performance (Pierson, 1989; Rundell, 2012; Shephard, 1984) [21, 25, 27]. Diffusion of pollutant gases increases with exercise as pulmonary diffusion capacity has been shown to increase with exercise (Fisher & Carny, 1982) [11].

The relationship of air pollution with haematological factors remains controversial (Poursafa *et al*., 2011) [23]. Few studies were undertaken to determine impact of air pollution on blood (Nikolic, 2008; Pope *et al*., 1999) [18, 22]. Some studies reported the association of short-term (Riediker, 2007) and long-term (Chen *et al*., 2008) [5] exposure to air pollution with WBC count, while some other studies (Forbes *et al*., 2009; Steinvil *et al*., 2008) [12, 28] did not confirm such association.

According to Nikolic (2008) [18], most air pollutants reach the blood quickly without previous bio-transformation and have been shown to produce harmful effects on the blood, bone marrow, spleen, and lymph nodes. Kristal-Boneh *et al*. (1993) [15] suggested that red blood cell changes may occur in the winter month, when air pollution is higher. Sports have become an integral part of human life and living in today's world. It is an incontestable fact that daily physical activity is beneficial to health and longevity.

However, studies on the effects of air pollution on hematological parameters in adults, particularly female athletes are scanty. So the researcher was interested to measure hematological parameters of female athletes of two different polluted zones of West Bengal and to identify difference between them if any.

1.1 Purpose of the study

The purpose of this study is stated below-

i. To observe whether environmental air pollution has any effect on hematological parameters of female athletes of two different polluted zones of west Bengal.

2. Materials and Methods

2.1 Selection of Place

Two different zones (Cooch Behar -A B N Seal College, Howrah-Betore) with their respective climate condition of West Bengal, India were selected for the present study. The air quality of these different zones was collected from WBPCB for comparative study of air pollution from January 2017 to February 2017. The environmental condition of these zones was more or less same. According to Air Quality Index (AQI) Howrah was marked polluted zone (poor category), and Cooch Behar was Non-polluted zone (satisfactory category) (Air Quality Index, 2020).

2.2 Selection of Subject

The total number of 20 female athletes aged 18-25 years undergoing regular training program for a minimum period of 3 years and having participation in national /state/district level sports competitions and residents of that particular area for the past 5 years or more were enrolled as subjects of this study. They were subdivided into two groups according to their residence of particular zone. The numbers of subjects in two different zones taken for the study have been presented in the table no-1.

Table 1: Represent numbers of subjects from Cooch Behar and Howrah zones

Name of zones	Number of subjects in two different zones	
	Available Population	Selected Athletes (n)
Cooch Behar	23	10
Howrah	22	10
Total	45	20

2.3 Criteria Measured

Physical profile, hematological profile and air pollutants were the criteria for the present study. Under physical profile there were four parameters i.e. height, weight, Body Surface Area (BSA) and Body Mass Index (BMI).

Hematological profile was another criterion related to this present study under which eight parameters assessed viz. Hemoglobin concentration, Red Blood Cell (RBC) count, White Blood Cell (WBC) count, platelets count, PCV, MCV, MCH and MCHC. Air pollutants were included with Particulate matter (PM_{10}), Sulfur dioxide (SO_2) and Nitrogen dioxide (NO_2).

Air pollutants were included with Particulate matter (PM_{10}), Sulfur dioxide (SO_2) and Nitrogen dioxide (NO_2).

2.4 Data collection

The data collected included Physical parameters, hematological parameters and air pollutants.

2.4.1 Physical parameters

Standing height in cm was measured with shoes removed, feet together.

Weight in kg was measured with shoes and Jackets removed.

BSA was calculated by (DuBois and DuBois, 1916) [10]

BMI was calculated by Meltzer's equation (Meltzer's *et al*., 1988) [17]

2.4.2 Hematological parameters

Venous blood samples were collected into plain evacuated tubes by expert pathologist from a forearm vain with a minimal stasis after approximately 10 min of rest in a sitting position between 7 and 8 am, at least 24 hours from last workout of all the participants.

Automatic hematological analyzer used for measuring hematological parameters.

2.4.3 Air pollutants

Particulate Matter (PM10) by (Gravimetric Method) (CPCB, 2013) [6] Sulphur dioxide (SO_2) by (Improved West and Gaeke Method) (CPCB, 2013) [6] Nitrogen dioxide (NO_2) (Modified Jacob and Hochheiser Method) (CPCB, 2013) [6].

2.5 Statistical analysis

The calculated data were analysed using appropriate statistical procedure. Mean was calculated as the measure of central tendency and the standard deviation was calculated as the measure of the variability. Statistical significant of difference, between mean value was analysed by 't'- test -Two Sample Assuming Equal Variance by using MS Excel 2016.

3. Results & Discussion

3.1 Results

The data for different parameter and their statistical analysis have been presented in following section.

Table 2: Personal information of female athletes of two different polluted zones (Mean± S.D)

Zone/Parameters	Cooch Behar	Howrah
Age(years)	19.1±1.10	19.5±1.08
Training age(Years)	5.8±1.03	5.7±1.16

Table 3: Comparison on physical profile of female athletes of two different polluted zones (Mean± S.D)

Zone/Parameters	Cooch Behar	Howrah	't'	Significant
Height(cm)	158.15±2.33	156.04±4.71	1.27	NS
Weight(kg)	49.89±5.62	47.31±4.09	1.17	NS
BSA(m^2)	1.49±0.08	1.44±0.06	1.46	NS
BMI(kg/m^2)	19.97±2.14	19.55±1.88	0.47	NS

*Significant at 0.05 level, ** Significant at 0.01 level, NS =Not Significant, Table value at 0.05 level-2.10, df-18.

Mean and S.D of all the physical parameters of female athletes of two zones are shown in Table no 3. Comparing the mean values, it is observed that there were differences in mean values of female athletes of two zones in respect of height, weight, BSA and BMI. To observe the significant difference between the two groups 't' value was calculated.

No significant differences were obtained in height, weight, BSA and BMI although values were higher in Cooch Behar athletes.

Table 4: Comparison on hematological profile of female athletes of two different polluted zones (Mean± S.D)

Zone/Parameters	Cooch Behar	Howrah	't'	Sig.
Hb Concentration (gm/dl)	13.61±0.57	11.49±0.71	7.34**	0.01 level
RBC count (millions/cu.mm)	4.33±0.27	3.96±0.24	3.22**	0.01 level
WBC count (no. of cells/cu.mm)	8450±533.85	9415±673.32	3.55**	0.01 level
Platelet count (lacs/cu.mm)	2.09±0.10	2.39±0.42	2.22*	0.05 level
PCV (%)	39.8±2.30	36.3±2.00	3.62**	0.01 level
MCV (fl)	91.91±2.12	91.55±1.20	0.46	NS
MCH (pgm)	31.43±0.93	29.02±1.06	5.42**	0.01 level
MCHC (g/dl)	34.18±0.81	31.33±1.31	5.83**	0.01 level

*Significant at 0.05 level, ** Significant at 0.01 level, NS =Not Significant, Table value at 0.05 level-2.10, df-18.

Mean and S.D of all the hematological parameters of female athletes of two zones are shown in Table no 4. Comparing the mean values, it is observed that there were differences in mean values of female athletes of two zones in respect of Hb concentration, RBC count, WBC count, platelets count, PCV, MCV, MCH and MCHC.

To observe the significant difference between the two groups 't' value was calculated.

Hb concentration, RBC count, PCV%, MCH and MCHC were significantly higher ($p<0.01$) in Cooch Behar female athletes than Howrah female athletes.

WBC ($p<0.01$) and platelet count ($p<0.05$) were significantly higher in Howrah female athletes than Cooch Behar female athletes. No significant differences were obtained in MCV although values were higher in Cooch Behar athletes.

Table 5: Mean ± SD of PM_{10}, SO_2 and NO_2 of two differently polluted zones

Parameters/Zone	Particulate Matter (PM_{10}) µg/m^3	Sulphur Dioxide (SO_2) µg/m^3	Nitrogen Dioxide (NO_2) µg/m^3	AQI exclude $PM_{2.5}$	AQI include $PM_{2.5}$
Cooch Behar	80.43±10.14	2.00±0	20.01±1.25	80.24±10.30	NA
Howrah	199.21±40.89	12.26±2.45	77.43±12.42	165.71±28.94	279.24±62.56

NA=Not Available

It is seen from Table no 5 that the means of particulate matter (PM_{10}), sulphur dioxide (SO_2), and that of nitrogen dioxide (NO_2) were not equal of two zones.

According to National Ambient Air Quality Standards (NAAQS) 16th Nov 2019, standard value for particulate matter (PM_{10}) in industrial, residential, rural and other areas for 24 hours is 100 µg/m3 and for sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) is 80 µg/m3 and 80 µg/m3 respectively

Values of PM10 of Howrah zone was much more than the national ambient air quality standards. In the case of SO_2 concentration in air, all these zones are below the standard level. Though the NO_2 of Howrah and Cooch Behar zones are below the standard level, the Howrah zone is very near to cross the standard level.

3.2 Discussion

While comparing to other foreign countries it appears that the athletes of the present study are shorter in height and low in weight than the athletes of the many others country. However, the BMI score with in the normal range with that of foreign female athletes (Nurdi *et al*., 1996) [19].

Therefore, it appears that the physical profile of the female athletes of the present study are within the normal range of with in Indian standard athletes as reported by Indian researchers. On the other hand, foreign athlete's standard in respect of physical profile to some extend higher to subject of the present study. Anyhow, we may consider the subjects of the present study are nearer to Indian standard.

Bandyopadhyay (2008) [3] have found Hb concentration of 11.72 gm/dl among swimmer. Rahman *et al*. (2014) [24] conducted a study on Bangladesh athletes and their findings 9.73 gm/dl was relatively lower than the Indian standard also from the present study.

Plasma and total blood volume increase as much or more than total haemoglobin contain as a result of training. This plasma

and blood volume expansion associate with albumin synthesis and necessity to transport heat and resist dehydration during exercise. A known acute effects of exercise on blood is to cause a release of fluid from the vascular compartment which decreases volume of plasma and blood. This fluid loss from the plasma deceases plasma volume and causes the haematocrit and plasma metabolic concentration to increase which is termed hemo concentration (Brooks *et al*., 2000) [4].

Poursafa *et al*. (2011) [23] found a significant negative relationship between PM_{10} and Hb and RBC respectively. Das and Chatterjee (2015a) [8] found a relatively higher percentage of Hb among the boys of non-polluted zone that of polluted zone. Therefore, findings of the present study in respect of Hb concentration and differences between the zones are in close proximity to other researchers and the differences between the polluted and non-polluted zones are not uncommon. It means more the pollution less is the Hb concentration in a particular zone.

Bandyopadhyay (2008) [3] found RBC count for swimmer 4.11 millions/cu.mm. In a study on Nigerian females Akor-Dewu *et al*. (2012) [2] shown that RBC count varies between 4.23 millions/cu.mm and 4.33 millions/cu.mm in two differently polluted zones.

Kargarfard *et al*. (2011) [14] found a significant decrease in RBC count after exercising in polluted air. Das and Chatterjee (2015b) [7] found significant reduction in RBC count of school going boys in high polluted zone.

Other two blood cells that are WBC and platelets differences between the two zones existed and so far the mean value is concerned just the reverse results observed from that of RBC.

A number of researchers have shown that pollution have a positive effect on WBC and platelets count, i.e. more the pollution in the ambient air, WBC and platelets count are higher in that zone for athletes. Short-term elevation of ambient PM is associated with increased levels of inflammatory markers such as WBC count (Liao *et al*., 2005) [16]. Poursafa *et al*. (2011) [23] found significant positive relationship between PM_{10} and platelet count.

Three hematological parameters i.e. as PCV, MCH and MCHC similar trend of data that of other hematological parameters are observed.

MCHC indicates the amount of haemoglobin in per unit volume and MCHC correlate with the haemoglobin contains with the volume of cell. Das and Chatterjee (2015a) [8] found lower MCHC volume in pollutant zone than boys of the non-polluted zone. The findings of the present study were in close proximity with the findings of the Akor-Dewu *et al*. (2012) [2] and Yasui *et al*. (2015) [29] for PCV, MCH and MCHC.

The data on hematological parameters as obtained from female trained athletes of this study from the two different zones are in all probably associated with the observation, mentioned above. The influence of air pollution on the hematological profile has also been established for the analysis. Howrah being the polluted zone is distinctly different from the Cooch Behar zone and the reason is most probably pollution in the ambient air in this particular zone.

4. Conclusions

On the basis of the discussion the following conclusions has been made.

5. On Physical Profile

1. There was no significant difference between athletes of Cooch Behar and Howrah zone in respect of physical profile.

6. On Hematology Parameters

1. Hb concentration, RBC count, PCV, MCH and MCHC of the Cooch Behar athletes were significantly higher than Howrah athletes.
2. WBC count and platelets count of the Cooch Behar athletes were significantly lower than Howrah athletes.
3. There was no significant difference between athletes of Cooch Behar and Howrah zone in respect of MCV.

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