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Aparup Konar
Director of Physical Instruction,
Office of the Director of Physical
Instruction, Sports Board,
Jadavpur University, Kolkata-
700032, West Bengal, India.

Samiran Mondal
Head & Professor, Department
of Physical Education, Visva
Bharati University,
Santiniketan- 731235, West
Bengal, India.

Correspondence
Aparup Konar
Director of Physical Instruction,
Office of the Director of Physical
Instruction, Sports Board,
Jadavpur University, Kolkata-
700032, West Bengal, India.

Exercise induced T cell variation in an air polluted area: A case study

Aparup Konar and Samiran Mondal

Abstract

Objectives: The mechanism of regular exercise to the magnitude of the T cell response exposed by air pollution is not completely understood. The purpose of this study was to investigate specific immune response to regular exercise in an air polluted area.

Design: School children randomly selected and participated in this study. Exercise subject regularly took part in their physical education curriculum activities like athletics, football, volleyball, yogasanas etc. and control subject was non regular participant of physical activities.

Methods: A highly air polluted zone of Durgapur, Burdwan, West Bengal, India was selected for this study. Regular habit of exercise subject (ES) [n=01] and control subject (CS) [n = 01] aged 14 years male chosen from the same area. T-lymphocyte subsets enumeration of absolute cell counts: T- lymphocyte (CD3+); T- helper (CD4+); T-cytotoxic / killer (CD8+) and relative or percent cell counts: T- lymphocyte (%CD3+/CD45+); T-helper (%CD3+/CD4+); T-cytotoxic / killer (%CD3+/CD8+) and CD4/CD8 ratio were examined.

Results: Absolute cell counts: T- lymphocyte (CD3+); T-helper (CD4+) & T-cytotoxic / killer (CD8+) of exercise subject was higher than the control subject and the control subject was below the reference range. The mean value of relative or percent cell counts: T- lymphocyte (%CD3+/CD45+); T-helper (%CD3+/CD4+) & T-cytotoxic / killer (%CD3+/CD8+) of regular exercise subject and control subjects were within the reference range and the CD4/CD8 ratio of exercise subject was lower than control subject & below the reference level.

Conclusions: In high ambient air polluted area regular exercise may impress the development of specific immune health which has been suggested as a possible biologic medicinal mechanism to counter the adverse air pollution effect on health.

Keywords: Air Pollution, Immune health, T Cell & Moderate Exercise.

1. Introduction

Long term exposure of air pollution exhibit increased respiratory symptoms, decreased lung function and changes in T-cell deficits which lead to damage human immune response that may impair the health. Regular physical exercise can have positive effect and appears to improve functioning of the specific immunological health. The effect of regular exercise on the T-cell in air polluted area has been received very little evidence to suggest clinical significance and many questions are still reaming. Long term exposure of air pollution observed reduction of T-cells and influence the immune system [1, 8, 23]. Also scientist observed no changes in the T-cells exposure to air pollution [19, 25, 30]. Findings showed that significant negative correlation between air pollutants and the number of T cells [10, 17, 19, 25].

On the other hand, regular exercise results significant increase in number of T-lymphocyte subsets and the percentage of T cells [5, 13, 16, 39]. Though there are evidences that regular physical activity had no significant effect on lymphocyte subsets in response to exercise [2, 11]. Now the question is whether the regular exercise in an air polluted area may elicit positive changes from specific immune cell or not. The aim of this case study was to determine human T- cell responses due to regular exercise in a highly air polluted area.

2. Materials and Methods

Study location was selected an industrial area of Durgapur, Burdwan, West Bengal, India as air polluted area. The city of Durgapur (Latitude 23° 30' North, Longitude 87° 19' East) is among the most air polluted area in India.

This area which was situated within 5 kilometers from many small & large scale factories, industries and includes heavy duty vehicles in Durgapur and it could ideally be identified as an experimental site. The present study restricted only 2 male subjects (1 exerciser & 1 control) aged 14 years and they were collected from a school of Durgapur air polluted zone (Sagarbhanga High School, Durgapur). Exercise and control subjects were chosen through personal interview of the subjects and with the consultation of the concern Physical Education teacher. These two subjects were belongs to families with very similar Background of socioeconomic and sociocultural status. Exercise subject was participated (training age 4 years) in general physical education curriculum activities like athletics, football, volleyball, yogasanas etc. and control subject was non regular participant of physical activities. It is a part report of major research project on air pollution, health and regular exercise.

Before taking the subject's data, the Headmaster of that school and the subjects were informed and gave consent. Blood sample was collected during school hours by an expert of a standard laboratory (SRL Ranbaxy Clinical Reference Laboratories, 113, Street 15, MIDC, Andheri [East], Mumbai-400093). Single platform/direct analysis technology was used for measuring specific immunological health variables. Following T-lymphocyte subsets enumeration were examined such as absolute cell counts: T- lymphocyte (CD3+); T-helper (CD4+); T- cytotoxic / killer (CD8+) and relative or percent cell counts: T- lymphocyte (%CD3+/CD45+); T-helper (%CD3+/CD4+); T-cytotoxic/killer (%CD3+/CD8+) and CD4/CD8 ratio. The following methods were used for measuring specific immunological cell variables. Absolute CD4 and CD8 counts are carried out using single platform technology (12). This technology allows direct measurement of lymphocyte subsets by Flow Cytometric analysis alone. Single platform/direct analysis using four- color reagent (CD45/CD3/CD4/CD8) with flow count fluorospheres for absolute count determination were used for measuring specific immunological health variables. Since the test of all the above specific-immunological variables were conducted in a reputed pathological research laboratory, reliability of data was established automatically. The test procedures were all valid since the methods adopted from standard literature.

Air quality sampling was performed for Nitrogen dioxide (NO₂), Sulphur dioxide (SO₂), Ozone (O₃) and Suspended Particulate Matter (SPM) at the selected location of Durgapur, West Bengal, India with the help of the Department of Environmental Studies, Visva Bharati University, India. High Volume Sampler was used for measuring air pollution [4, 15].

3. Results and Discussion

The level of NO₂, SO₂, O₃ & SPM were alarmingly higher in the air polluted area and above the National Ambient Air Quality Standards (NAAQS) in industrial area.

The results of specific immunological variables were presented in the Table No. 1. The higher average of absolute T lymphocyte counts (CD3+; CD4+ and CD8+) were observed in the exercise subject and within the reference range. But the control subject was found below the reference range. The absolute T lymphocyte count significantly increased after regular exercise.

The relative or percent T lymphocyte count (%CD3+/CD45+) of exercise and control subject was within the reference range, but the control subject showed slightly higher value than the exercise subject. Other results suggested that regular exercise had no significant effect on lymphocyte subsets [2, 11].

The relative T helper cell (%CD3+/CD4+) of exercise and control subjects were also within the reference range, but the cell count of control subject was higher. Result suggested that physical activity level had no significant effect on lymphocyte subsets in response to exercise [2, 11]. Some study has shown moderately but not significantly increase T helper cell during exercise [6, 24] and result in no change [28] and 15 min PE time points before returning to baseline by 30 min PE [26].

The relative T cytotoxic/killer cell (%CD3+/CD8+) was found with higher level of exercise subject than the control subject and both the levels were within the reference range.

Physical exercise indeed increase of WBC and significant changes in the percentage of lymphocyte subsets: CD3+, CD4+, CD8+ & CD4 / CD8 ratio and T – lymphocyte (CD3+) and killer or cytotoxic T (CD8+) lymphocytes cells [9, 24, 27]. The CD4/CD8 Ratio of T Lymphocyte subset was observed in lower level of exercise subject than the control subject and slightly below the reference range. Researchers found exercise resulted in a significantly longer lasting decrease in the CD4+/CD8+ ratio [3, 11, 21].

Post Exercise (PE) increases in total T cells, CD8 T cells and total lymphocytes when expressed as absolute cell counts. However, when expressed as cell percentages, total lymphocytes and CD8 T cells did not increase significantly PE, total T cells and CD4 T cells decreased PE [28]. The method of reporting changes in circulating leukocytes may especially affect lymphocytes since the dominant lymphocyte subset to change is NK cells. Immediately PE NK cells increase in magnitude by a much greater percentage than T cells or B cells often is increasing by over 200% [7, 18, 22, 28]. The magnitude of the NK cell response can mask the relative response of other lymphocytes when expressed as cell percentages. Therefore absolute cell counts should be the preferred method of reporting exercise induced changes in leukocytes. Exercise can have both positive and negative effects on immune function. The number and functional capacity of WBC may be impaired by repeated bout of intense & prolonged exercise. The reason is probably related to increased level of stress hormones during exercise, increased production of reactive oxygen species, excess of free radicals and entry into the circulation of less mature leucocytes from the bone marrow. During exercise, exposure to airborne pathogens is increased due to the higher rate and depth of breathing that can suppress immune function. The ideal specific immune response would be one that minimizes the risk of infection/onset of sickness/illness allowing for peak performance to be uninterrupted by immune compromise. This is especially crucial for athletes who compete and train during a season, a time at which maintenance of performance is crucial. The relationship among the T cell response, regular exercise and air pollution effect on health remains unclear. It would be valuable for future research studies to determine the impact of regular exercise on each T cells variables of leukocyte subsets in the air polluted area that will help to maintain performance and immune health.

3.1 Tables and Figures

Table 1: Specific Immunological Variables

T-lymphocyte Subsets Enumeration	Reference Range	Exercise Subject	Control Subject
Absolute Cell count:			
T lymphocyte (CD3+) [Per μ L]	1000 – 3900 / microL	1568	884↓
T helper (CD4+) [Per μ L]	560 – 2700 / microL	844	525↓
T cytotoxic / killer (CD8+) [Per μ L]	330 – 1400 / microL	510	279↓
Relative / Percent Cell count:			
T lymphocyte (%CD3+/CD45+) [%]	55 – 82%	68.3	69.8
T helper (%CD3+/CD4+) [%]	27 – 57%	36.7	41.4
T cytotoxic / killer (%CD3+/CD8+) [%]	14 – 34%	22.2	22.0
CD4/CD8 Ratio	1.69 – 1.92	1.65	1.88

↓Below reference range

4. Conclusions

It is concluded that air pollution exposure have adverse impact on subjective and respiratory physiological health which is actually manifestation of immunological dysfunction. But participation in regular moderate exercise on immunological system preferentially elevated the T cells, shown higher magnitude of response even in the air polluted area.

4.1. Practical Implication

Engaging in moderate physical activity may enhance immune function. Evidence indicates that, acute exercise stimulates T cell subset activation in vivo and response to mitogen and antigen stimulation. Mechanism underlying the alterations in immunity with acute exercise related to the activation of the sympathetic nervous system which linked to altered activity of the hypothalamic-pituitary-adrenal axis that result restores optimal antibody responses including antigen specific cell mediated delayed type hypersensitivity responses. Human immune health undergoes distinctly adverse effect with air pollution that may be explained by decreased function of regulation in immune system. In this context, as the thymus involutes, T cells, which have a central role in cellular immune function, show the largest alterations in related to regular exercise.

4.2 Conflict of Interest

Further research needs to be done to determine the specific exercise response to specific immune function exposed by air pollution. We hope this study gives a new way and inspires researchers to pursue further work in this important area to understand the relationship among regular exercise, immune system and air pollution exposure.

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