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A Comparative Study on Physical Fitness Components of Trained and Sedentary Boys of Two Different Air Pollutant Zones of Kolkata with Special Emphasis on Nutritional Status

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Abstract

Exercising in polluted environment has become a matter of great concern in today's world. Study was carried out to analyze association between air pollutants levels with physical fitness components of trained and sedentary boys living in two different air pollutant zones of Kolkata and to investigate whether any difference of nutritional status may affect the health status and performance of athletes against pollutants. Ambient air quality data of two monitoring stations at Rabindrabharati (Zone I) and Victoria Memorial (Zone II) was collected from West Bengal Pollution Control Board. Study was conducted on 280 boys, age range 14 to 16 years, living within 3 km radius of two monitoring stations. Sample consisted of 120 footballers and 160 sedentary boys subdivided into two groups from two areas. Selected physical fitness components and nutritional status were measured. Nutritive values (energy, carbohydrate, protein, fat, vitamin C, β-carotene, vitamin B_1) were calculated. Air pollutant's levels were higher at Zone I than Zone II. Physical fitness components were significantly lower ($p<0.01$) both in footballers and sedentary boys of Zone I than Zone II when nutritional status of subjects were comparable. On the other hand, no significant differences in physical fitness components were observed between two zones when vitamins intake of the subjects of Zone I was significantly higher. Exercising in higher air pollutant zone might have an adverse effect on physical fitness level. However, higher intake of vitamins might have contributed to combat the impact of air pollution and thereby leading to improvement of performance level in both trained and untrained boys.

Keywords: ***Air pollution; Physical fitness; Footballers; Vitamins***

Introduction

Sports have become a part of human life and living. To take part in sports and games is one of the very common traits of human character and it starts developing from early childhood. But with the development of age, very few people dedicate themselves to become true sports persons by serious practice and training on regular basis, whereas some people take it as their recreational activities or participate in amateur sports. Physical fitness may be defined as the ability of the human organism to function effectively as well as efficiently. The different components of physical fitness have specific contribution to total quality of life and healthy existence. These components of physical fitness including muscular strength and endurance, cardio-respiratory endurance, speed, agility, balance, flexibility, power etc. constitutes the characteristic feature of an athlete and determinant factor of athletic performance. The interaction of these physical fitness components under a wide range of conditions plays an important role in sports performance.

With exercise and sports competition, acute need for nutrients will change. Energy needs also increase because of the elevated energy expenditure with physical activity. A study conducted in Kolkata revealed that motor performance of football players and sprinters was affected by nutritional status of them [1]. In a study on junior sports persons [2] recommended the subjects of the age group of 14 to 15 years suffering from macronutrient deficiencies to take carbohydrate and protein rich food for meeting their caloric demand as well as to improve their sports performance. Genetic and environmental influence on physical and motor fitness measurements has also been established [3].

Now-a-days the world is facing with several environmental challenges, air pollution being the most serious. There is growing concern regarding the problems in connection with exercising in polluted air. Regular exercise helps to maintain a better health and usually prescribed by the physicians. However, people who exercise in urban areas are particularly in contact with air pollution including particles and gases suspected to cause cardio respiratory disease and cancer. Athletic performance and the health of the athletes as a whole are severely affected by the air pollution. Many investigators have investigated the effect of living environment on physical fitness components [4,5]. The relationship between the levels of air pollutants and respiratory function/physical efficiency of adolescents living in the Upper Silesian Industrial Region was analyzed by Zebrowska and Mankowski [6]. However, even fewer studies are available which dealt with the assessment of physical fitness components in different environmental air pollutant zones. Das et al. studied the motor fitness components of school going boys in two different air pollutant zones [7].

So, the present study was undertaken with the followings objectives:

- To study and compare the physical fitness components of footballers practicing in two different air pollutant zones of Kolkata.
- To study and compare the physical fitness components of sedentary boys living in those two air pollutant zones.
- To study the nutritional status of those footballers and sedentary boys.
- To investigate whether any difference of nutritional status can affect the performance of athletes against the pollutants.

Materials and Methods

Selection of place

Study areas were chosen from Kolkata, West Bengal. The air pollution data of the period from January 2012 to March 2012 was collected from West Bengal Pollution Control Board, Kolkata [8] which included the pollutant levels at the two ambient air quality monitoring stations located at Rabindrabharati (North Kolkata – Zone I) and Victoria Memorial (Central Kolkata – Zone II). The major air pollutants monitored at these stations were particulate matter (PM10), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO).

Subjects

Study was conducted on 280 (two hundred eighty) boys of the age range 14 to 16 years. Among them 60 footballers and 80 untrained boys were from Zone I. The remaining 60 footballers and 80 untrained boys were from another zone, Zone II. Boys selected for the study were living within 3 km radius of that two monitoring stations. All the participants (subjects) were residents in those two zones for a minimum period of three years. Subjects with acute or chronic respiratory illness, past or present history of smoking, systemic illness and on chronic medication were excluded from the study. All the boys were from the same economic status following the categorization as set up by the West Bengal Housing Board [9]. The footballers in the study were trained boys as they had minimum three years training and they were undergoing regular practice and training. But the untrained boys did neither regular practice and training nor any regular physical activity program. All institutional policies concerning the human subjects in research were followed. Ethical approval was taken from the competent authority.

Data collection

The data collected included anthropometric parameters, measurement of physical fitness components and nutrients intake.

Anthropometric parameters

Standing height in cm was measured with shoes removed, feet together. Weight in kg was measured with shoes and Jackets removed.

Physical fitness components include

- Maximum oxygen uptake (VO_{2max}) by 20-m MST [10,11].
- Flexibility by Wells Sit and Reach Test [12].
- Agility by Shuttle Run Test [13].
- Leg Muscle Power by Sargent Vertical Jump Test [14].

Assessment of dietary intake by recall method

Dietary intake of subject was recorded using recall method, which is a commonly used dietary survey method. This method elicited information from the respondent on the kinds and amounts of foods eaten during a previous period of usually 48 h. Menu and amounts of food eaten in house hold measures were written. These amounts were converted into the raw weight of foods following the proforma of Seth and Singh. Energy, carbohydrate, protein, fat, vitamin C, β-carotene, vitamin B_1 content of the one day's diet were calculated [15].

Statistical analysis

All the values are expressed as Mean ± Standard Deviations (SD). To find out nutritional differences, subjects of each category of each zone are subdivided according to the recommended dietary allowances (RDA) values of ICMR (Indian Council of Medical research) regarding the vitamins intake. To find out the significant difference of those parameters between the two groups, independent samples T test was used. Statistical Package for Social Sciences (SPSS) MS Windows Release 20 was used for statistical analysis.

Results

The ambient air quality data (Mean ± SD) as reported by WBPCB in the two areas of Kolkata along with National Ambient Air Quality Standard are shown in TABLE 1. Values of PM10 of both regions were much more than the national ambient air quality standards, while SO_2 and CO were within the standards. On the other hand, NO_2 of Zone I showed higher values than standard but was lower in other zone. Comparison of the two ambient air quality data revealed that PM10 and SO_2 were significantly higher ($p<0.01$) in Zone I than Zone II whereas no significant difference was obtained in NO_2 and CO, although values were higher in Zone I.

TABLE 1. **Level of significance of difference in air pollutant concentration between two zones of Kolkata.**

Air Pollutant	National Ambient Air Quality Standard	Zone I	Zone II	'T' - test
PM10 ($\mu g/m^3$)	100 (24 h)	184.03 ± 53.76	125.27 ± 63.59	p<0.01
SO_2 ($\mu g/m^3$)	80 (24 h)	28.34 ± 16.27	7.15 ± 4.20	p<0.01
NO_2 ($\mu g/m^3$)	80 (24 h)	81.60 ± 49.16	75.02 ± 43.15	NS
CO (mg/m^3)	04 (1 h)	1.59 ± 1.76	1.43 ± 0.78	NS

NS=Not Significant

TABLE 2 shows the mean ± SD of nutrients intake by sports persons and untrained boys and subject division according to the vitamins intake in comparison with recommended dietary allowances (RDA) values of ICMR i.e., subjects were again subdivided into groups as per the vitamins intake below and above the RDA values.

TABLE 2. **Nutrients intake (Mean ± SD) of school-going boys and division of subject according to the vitamins intake in comparison with recommended dietary allowances (RDA) values of ICMR.**

Nutrients intake	Zone I				Zone II				RDA of nutrients & Hb Standard
	Foot Ballers (RF1) (n=30)	Foot Ballers (RF2) (n=30)	Untrained Boys (RUB1) (n=40)	Untrained Boys (RUB2) (n=40)	Foot Ballers (VF1) (n=30)	Foot Ballers (VF2) (n=30)	Untrained Boys (VUB1) (n=40)	Untrained Boys (VUB2) (n=40)	
Energy (Kcal/d)	1971.56 ± 327.50	2029.29 ± 372.75	1930.81 ± 334.35	1990.88 ± 343.60	1907.84 ± 254.32	2043.34 ± 384.04	1923.12 ± 388.14	1918.62 ± 304.68	2450
Carbohydrate (g/d)	346.20 ± 93.50	384.43 ± 72.74	287.74 ± 50.58	299.96 ± 70.31	345.35 ± 51.72	388.12 ± 71.83	285.88 ± 71.87	294.583 ± 68.35	398
Protein (g/d)	63.73 ± 14.83	62.50 ± 13.60	55.01 ± 18.21	54.73 ± 12.49	62.97 ± 10.24	61.09 ± 12.30	52.39 ± 15.69	52.12 ± 13.05	70
Fat (g/d) (Visible+Invisible)	33.01 ± 10.02	34.43 ± 9.79	52.42 ± 16.60	48.71 ± 6.65	32.68 ± 8.2	35.36 ± 9.98	50.98 ± 18.75	49.62 ± 10.62	63
Vitamin C (mg/d)	38.91 ± 21.65	64.61± 26.29	38.95 ± 24.84	67.21 ± 30.02	39.48 ± 48.77	55.79 ± 50.78	39.25 ± 50.10	60.20 ± 33.84	40
β-carotene (μg/d)	543.90 ± 336.53	2836.16 ± 444.95	757.76 ± 319.17	2968.14 ± 368.17	548.69 ± 478.51	2486.72 ± 254.48	757.59 ± 277.11	2407.85 ± 892.64	2400
Vitamin B_1 (mg/d)	1.17 ± 0.29	1.45 ± 0.30	1.16 ± 1.50	1.55 ± 0.28	1.14 ± 1.36	1.32 ± 0.40	1.14 ± 0.38	1.32 ± 0.27	1.2

RF1=Footballers of Zone I (Rabindrabharati) with vitamins intake below RDA; RF2=Footballers of Zone I (Rabindrabharati) with vitamins intake above RDA; RUB1=Sedentary boys of Zone I (Rabindrabharati) with vitamins intake below RDA; RUB2=Sedentary boys of Zone I (Rabindrabharati) with vitamins intake above RDA; VF1=Footballers of Zone II (Victoria memorial) with vitamins intake below RDA; VF2=Footballers of Zone II (Victoria memorial) with vitamins intake above RDA; VUB1=Sedentary boys of Zone II (Victoria memorial) with vitamins intake below RDA; VUB2=Sedentary boys of Zone II (Victoria memorial) with vitamins intake above RDA.

The anthropometric parameters and physical fitness components of the school going boys residing in the two zones of Kolkata are shown in TABLES 3-5 indicate the level of significant of differences in nutrient's intake, anthropometric and physical fitness parameters between the groups. No statistical difference was observed between the groups in anthropometric parameters.

Physical fitness components were significantly lower (p<0.01) both in footballers and sedentary boys of Zone I than Zone II when nutritional status of subjects were comparable. On the other hand, no significant differences in physical fitness components were observed between two zones when vitamins intake of the subjects of zone I was significantly higher.

TABLE 3. **Measurements of anthropometric parameters and physical fitness components of school going boys (Mean ± SD).**

Parameters	Zone I				Zone II			
	Foot Ballers (RF1) (n=30)	Foot Ballers (RF2) (n=30)	Untrained Boys (RUB1) (n=40)	Untrained Boys (RUB2) (n=40)	Foot Ballers (VF1) (n=30)	Foot Ballers (VF2) (n=30)	Untrained Boys (VUB1) (n=40)	Untrained Boys (VUB2) (n=40)
Height (cm)	158.82 ± 4.66	157.19 ± 5.89	160.32 ± 9.54	158.61 ± 9.23	157.40 ± 8.32	156.03 ± 7.08	159.75 ± 4.12	159.83 ± 6.0
Weight (kg)	42.18 ± 3.95	41.5 ± 5.35	43.90 ± 10.68	43.21 ± 11.73	43.33 ± 6.42	42.95 ± 6.01	43.18 ± 4.79	42.72 ± 8.41
VO_{2max} (ml/kg/min)	51.07 ± 5.83	56.94 ± 3.02	44.47 ± 5.01	49.60 ± 4.68	55.07 ± 3.52	56.63 ± 4.13	47.49 ± 3.18	48.97 ± 5.05
Flexibility (cm)	9.37 ± 6.37	11.98 ± 5.83	6.78 ± 7.69	7.82 ± 6.35	10.97 ± 3.59	11.35 ± 5.31	8.13 ± 4.11	7.94 ± 5.97
Agility (sec)	10.05 ± 0.54	9.10 ± 0.42	10.88 ± 0.71	10.06 ± 0.68	9.29 ± 0.16	9.03 ± 0.34	10.16 ± 0.39	10.03 ± 0.60
Leg muscle power (cm)	33.54 ± 5.36	36.72 ± 5.91	29.91 ± 6.45	32.88 ± 6.44	37.37 ± 5.61	36.33 ± 6.58	32 ± 11.50	32.23 ± 6.03

TABLE 4. **Level of significance of difference in nutrient's intake of boys of different groups.**

Nutrient's intake	RF1 Vs VF1	RF2 Vs VF2	RUB1 Vs VUB1	RUB2 Vs VUB2
Energy (Kcal/d)	NS	NS	NS	NS
Carbohydrate (g/d)	NS	NS	NS	NS
Protein (g/d)	NS	NS	NS	NS
Fat (g/d) (Visible+Invisible)	NS	NS	NS	NS
Vitamin C (mg/d)	NS	P<0.05	NS	P<0.05
β-carotene (µg/d)	NS	P<0.05	NS	P<0.05
Vitamin B_1 (mg/d)	NS	P<0.05	NS	P<0.05

NS=Not significant

Discussion

A standard nutritional status is a prerequisite for a healthy life, productivity and efficiency. Diet plays an immense important role for growth, development and active life and a proper diet should be maintained from the very childhood. Greatest nutrients need for boys are between 12 to 15 years. With the profound growth of adolescence there are increased demands for energy, protein, minerals and vitamins [16].

The human organism is continuously exposed to different toxic xenobiotics including pesticides, drug, environmental contaminants, food additives, etc. These highly reactive chemicals are metabolized to pharmacologically inert compounds and eliminated from the body. This deactivation process is dependent on nutritional status. As a perspective of the purpose of this study, subjects were divided finally according to RDA values of vitamins [17].

TABLE 5. **Level of significance of difference in anthropometric parameters and physical fitness components of boys of different groups.**

Parameters	RF1 Vs VF1	RF2 Vs VF2	RUB1 Vs VUB1	RUB2 Vs VUB2
Height (cm)	NS	NS	NS	NS
Weight (Kg)	NS	NS	NS	NS
VO_{2max} (ml/kg/min)	P<0.01	NS	P<0.01	NS
Flexibility (cm)	P<0.01	NS	P<0.01	NS
Agility (Sec)	P<0.01	NS	P<0.01	NS
Leg muscle power (cm)	P<0.01	NS	P<0.01	NS

NS=Not significant

Several studies have shown that physical fitness measurements depend upon sex, age, height, weight, body size, occupational habit [18]. In this study the footballers from two regions were from same socio-economic background, under three years of regular training and practice, except their environmental conditions. One group came from Zone I where the air pollutant level was high and other from Zone II where the pollutant level was low. Results showed when vitamins intake of subjects were comparable, VO_{2max}, flexibility, agility, leg muscle power were significantly lower in case of both footballers and sedentary boys of Zone I. But there were no significant differences in their age, height, weight and macronutrients specially energy, carbohydrate, protein intake. Hence, it seems that it was only environmental factor which might be the major determining factor for the difference in those fitness components. Yu et al. [19] showed that air pollution adversely affected the maximum oxygen uptake capacity (VO_{2max}) of 8 to 12-year-old children in Hong Kong. Das et al. [7] also showed that agility power of footballers in less pollutant zone i.e., Hooghly was significantly higher from footballers of Kolkata. Several studies have also revealed the impact of air pollution on physical fitness components of sportsperson and untrained boys [20,21].

On the other hand, there were no significant differences in physical fitness components of both trained and untrained boys between two zones when vitamins intake of the subjects of zone I was significantly higher. Several studies have reported association of atmospheric pollutants with health disorders of different body systems including the cardiovascular, hematological, respiratory, immunological, reproductive and neurological systems. Few such studies have found increases in respiratory and cardiovascular problems at outdoor pollutant levels well below standards set by such agencies as the US EPA (United States Environmental Protection Agency) and WHO [22]. It is reported that deleterious health effects may be due to exposure to pollutants at concentrations that are lower than recommended standards. Indeed, research has not been successful yet to determine a "threshold" limit for which there is no adverse health effect [23]. According to Shephard and Shek [24] vitamins are important to immune functions because of their antioxidant role. Antioxidant supplementation such as β-carotene, vitamin C may provide some protection against oxidative stress [25]. Kelly [26] observed that prolonged periods of supplementation of vitamins are associated with protection against average O_3 backgrounds of 67.3 $\mu g/m^3$ and 38.5 $\mu g/m^3$ respectively. In a study by Menzel [27], it has been reported that vitamin C is more effective in preventing oxidation by NO_2. As suggested by Romieu [28], high intake of some vegetables and fresh fruit might have a beneficial effect on lung health and daily consumption of these food staffs is highly recommended. In subjects facing with challenges of additional oxidative stress including exposure to high levels of air pollution, supplementation of vitamin C and other antioxidants may be beneficial and should be prescribed. In high pollutant zone i.e., Zone I, vitamins intake was higher which had an impact on improving their performance level against the possibility of the effect of air pollutants.

Conclusion

From the study it was revealed that exercising in higher air pollutant zone might have an adverse effect on physical fitness level. It was also revealed that in case of sedentary subjects, the boys residing in lower air pollutant zones had a better physical fitness status. However, higher intake of vitamins might have contributed to combat the impact of air pollution and improve performance level both in trained and untrained boys.

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