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Air Pollution and Its Impact on Physical Fitness Level in Relation with Nutritional Status

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Abstract: The present study was carried out with an objective to find out relationship between nutritional status and physical fitness level of junior sportspersons, age ranging between 14 and 16 years, in two different ambient air pollutant zones in West Bengal, India. The sample consisted of 50 sprinters (trained boys) (25 from Kolkata and 25 from Sonarpur) and 80 untrained boys (40 from Kolkata and 40 from Sonarpur) of West Bengal. Ambient air quality of two zones was monitored. Air pollutants' levels were higher in Kolkata than Sonarpur. The physical fitness parameters included agility, leg muscle power, speed and handgrip strength. Nutritional status was measured by oral questionnaire method and nutritive values (energy, carbohydrate, protein, fat, vitamin C, β-carotene, vitamin B_1) were calculated. Result revealed that physical fitness parameters were significantly higher in both sprinters and untrained boys of Sonarpur than Kolkata. No significant difference was observed in energy, carbohydrate, protein and fat intake between the groups. But vitamin C, β-carotene and vitamin B_1 intake showed significant higher values in both sprinters and untrained boys of Sonarpur. It was concluded that environmental air pollutants have adverse effect on physical fitness components and higher intake of vitamins helped both sprinters and untrained boys of Sonarpur to improve the performance level against the impact of air pollution.

Key words: Air pollution, physical fitness, nutritional status, boys.

Introduction

Air pollution is one of the major problems of today's world. Epidemiological data have identified individual components of air pollution or pollution collectively, as parameters of cardiovascular and respiratory diseases (Pope et al., 2004). These air pollutants can impact on athletic performance by inducing oxidative stress and inflammation in the lung (Florida-James et al., 2004). Good physical fitness is very much associated with good sports performance. Many factors contribute to good physical fitness including heredity, maturation, environment, nutrition etc. The interaction of physical fitness components under different conditions like genetic inheritance, morphology, environment, personal interest, habitual physical activity etc. play 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. An increased intake of food naturally occurs to accommodate the day-to-day nutrient needs of young athletes, and unlike non-athlete, young competitors typically come closer to meeting their requirements for micronutrients (Petrie et al., 2004). A study conducted

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on junior sportspersons of West Bengal revealed that they were affected by poor nutritional status (Das et al., 2007a).

Supplementation of vitamin C and other antioxidants could be proposed in subjects with additional oxidative stress challenge, such as exposure to high levels of air pollution. Subjects with impaired immune response could also benefit from vitamin A (Romieu, 2005).

The present investigation was taken up with following objectives: (1) to study the impact of air pollution on physical fitness level of both sportspersons and untrained boys and (2) to assess the nutritional status of those boys and investigate whether any difference of nutritional status can affect the performance of athletes against the pollutants.

Materials and Methods

Selection of Place

Two zones namely, Kolkata and Sonarpur in West Bengal, India were selected for the present study. The air quality of these two zones were monitored through the months of November and December, 2005 and January, 2006 for the parameters suspended particulate matter (SPM), respirable particulate matter (RPM), sulphur dioxide (SO_2), oxides of nitrogen as nitrogen dioxide (NO_2).

Selection of Subjects

A total of 130 Bengalee boys, age ranging 14-16 years volunteered. Among them 25 sprinters and 40 untrained boys were from Kolkata. Remaining 25 sprinters and 40 untrained boys were from another zone, Sonarpur. Sprinters of the study were trained boys as they had minimum three years training background and they were under regular practice and training. But untrained boys did neither follow regular practice and training nor any regular physical activity programme. All subjects from both the regions were from same socioeconomic status.

Physical Measurements

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

Assessment of Physical Fitness Level

Physical fitness is made up of different components. Among them four physical fitness components were assessed in all subjects. These were agility, leg muscle power, speed, hand grip strength. All the experiments had been done under temperature range 28-32°C and humidity range was 65-70%.

Brief description of all the tests follows:

Shuttle Run Test (Johnson and Nelson, 1982): To assess the agility of the subject, shuttle run test was administered. The score for each subject is the length of time required to complete the course. Out of three trials the best trial was recorded as the score.

Vertical Jump Test (Sargent, 1924): To assess leg muscle power subjects were allowed to perform this test. The number of centimetre between the reach and jump marks was measured as the score.

50-yard Dash (Johnson and Nelson, 1982): To assess speed quality subject was allowed to run for a distance of 50 yards. The elapsed time from the starting signal until the runner crossed the finish line was measured in seconds.

Hand Muscle Power: To assess the hand muscle strength subjects were allowed to perform Hand grip strength (Phillips and Hornak, 1979). The best of three trials was recorded as the score for hand grip strength with 30 sec. rest between trials. The dynamometer scale was read in kg.

Assessment of Dietary Intake by Recall Method

Dietary intake of subject was recorded using recall method (Seth and Singh, 1993), which is a commonly used dietary survey method. This method elicited information from the respondents on the kinds and amounts of foods eaten during a previous period of usually 48 hours. Menu and amounts of food eaten in household measures were written. These amounts were converted into the raw weight of foods. Energy, carbohydrate, protein, fat, vitamin C, β-carotene, vitamin B_1 content of the one day's diet were calculated.

Statistical Analysis

All the values are expressed as Mean ± Standard Deviations (SD). To find out the significant difference of those parameters between the two groups independent samples T test was used. To find out relation of training, air pollutants and micronutrients with physical fitness components of athletes, general linear model (GLM) univariate procedure was done. Statistical Package for social sciences (SPSS) MS Windows Release 6.1 was used for statistical analysis.

Results and Discussion

Mean values of ambient air quality data of three months is given in Table 1. Difference in physical parameters and physical fitness components between sprinters and untrained boys of two zones are given in Table 2. Table 3

shows the difference in physical parameters and physical fitness components of sprinters and untrained boys between two zones. Table 4 shows the difference in nutritional parameters between sprinters and untrained boys of two zones. Table 5 shows difference in nutritional parameters of sprinters and untrained boys between two zones. Relation of training, air pollutants and micronutrients with physical fitness components of sprinters has been shown in Table 6.

From Table 1, it was seen that SPM, RPM, SO_2, NO_2 levels were higher in Kolkata than Sonarpur in those three months. Kolkata was highly polluted zone whereas Sonarpur was less polluted zone.

Table 2 revealed that physical fitness components of sprinters of both zones were significantly higher than untrained boys.

From Table 3, it was seen that there was no significant difference in height and weight of boys between the two regions. All the physical fitness components i.e. agility, leg muscle power, speed, and handgrip strength were significantly higher in both sprinters and untrained boys of Sonarpur than Kolkata.

Table 1: Ambient air quality data of Kolkata and Sonarpur areas

Pollutants	*Kolkata*			*Sonarpur*		
	November 2005	*December 2005*	*January 2006*	*November 2005*	*December 2005*	*January 2006*
SPM ($\mu g/m^3$)	206.33	287.38	316.33	77.10	92.18	76.62
RPM ($\mu g/m^3$)	101.22	187.37	192.44	28.89	41.08	30.74
SO_2 ($\mu g/m^3$)	7.44	14.25	13.22	BDL	BDL	BDL
NO_X ($\mu g/m^3$)	69.11	99.13	93.44	8.81	12.45	9.11

BDL= Below detected level

Table 2: Level of significance of difference in physical parameters and physical fitness components between sprinters (trained boys) and untrained boys of the two regions

Parameters	*Kolkata*			*Sonarpur*		
	Sprinters (n=25) (Mean ±SD)	*Untrained boys (n=40) (Mean ±SD)*	*Significance level*	*Sprinters (n=25) (Mean ±SD)*	*Untrained boys (n=40) (Mean ±SD)*	*Significance level*
Age (year)	15.05±0.71	15.05±0.87	NS	15.13±1.08	15.28±0.58	NS
Height (cm)	157.26±6.21	156.44±7.92	NS	159.44±6.00	158.52±5.65	NS
Weight (kg)	43.42±5.68	45.39±10.69	NS	44.24±5.32	46.40±7.14	NS
Agility (sec)	9.70±0.41	10.44±0.75	$p<0.05$	9.33±0.34	9.97±0.48	$p<0.05$
Leg muscle power (cm)	36.80±6.14	33.26±6.31	$p<0.05$	41.72±6.63	37.08±5.32	$P<0.05$
Speed (sec)	6.72± 0.37	7.78±0.66	$p<0.05$	6.47±0.3	7.27±0.53	$P<0.05$
Hand grip strength (kg)	33.00±9.39	26.93±6.79	$p<0.05$	39.64±5.44	36.68±6.35	$P<0.05$

Table 3: Level of significance of difference in physical parameters and physical fitness components of sprinters (trained boys) and untrained boys between two zones

Parameters	*Sprinters*			*Untrained boys*		
	Kolkata (n=25)	*Sonarpur (n=25)*	*Significance level*	*Kolkata (n=40)*	*Sonarpur (n=40)*	*Significance level*
Age (Year)	15.05±0.71	15.13±1.08	NS	15.05±0.87	15.28±0.58	NS
Height (cm)	157.26±6.21	159.44±6.00	NS	156.44±7.92	158.52±5.65	NS
Weight (kg)	43.42±5.68	44.24±5.32	NS	45.39±10.69	46.40±7.14	NS
Agility (sec)	9.70±0.41	9.33±0.34	$p<0.05$	10.44±0.75	9.97±0.48	$p<0.05$
Leg muscle power (cm)	36.80±6.14	41.72±6.63	$P<0.05$	33.26±6.31	37.08±5.32	$p<0.05$
Speed (sec)	6.72±0.37	6.47±0.3	$P<0.05$	7.78±0.66	7.27±0.53	$p<0.05$
Hand grip strength (kg)	33.00±9.39	39.64±5.44	$P<0.05$	26.93±6.79	36.68±6.35	$p<0.05$

Table 4: Level of significance of difference in nutrients intake between sprinters (trained boys) and untrained boys of the two regions

Nutrients	*Kolkata*			*Sonarpur*		
	Sprinters (n=25) (Mean ±SD)	*Untrained boys (n=40) (Mean ±SD)*	*Significance level*	*Sprinters (n=25) (Mean ±SD)*	*Untrained boys (n=40) (Mean ±SD)*	*Significance level*
Energy (kcal)	2035.65±356.25	1646.66±317.14	$p<0.05$	2089.52±373.45	1625.75±287.19	$p<0.05$
Carbohydrate (g.)	365.48±73.29	291.53±68.89	$P<0.05$	393.43±69.98	286.90±70.63	$p<0.05$
Protein (g.)	70.14±13.78	55.33±12.74	$p<0.05$	62.49±12.61	52.55±13.74	$p<0.05$
Fat (g.)	33.91±9.62	28.38±6.62	$p<0.05$	38.37±10.57	30.39±8.24	$p<0.05$
Vitamin C (mg.)	63.68±26.23	40.75±19.30	$p<0.05$	95.92±54.33	95.86±67.27	NS
β-carotene (µg.)	750.33±395.74	568.77±384.40	NS	1029.97±350.13	1223.14±943.20	NS
Vitamin B_1 (mg.)	1.26±0.31	1.04±0.27	$p<0.05$	1.50±0.45	1.10±0.24	$p<0.05$

Table 5: Level of significance of difference in nutrients intake of sprinters (trained boys) and untrained boys between two zones.

Nutrients	*Sprinters*			*Untrained boys*		
	Kolkata (n=25)	*Sonarpur (n=25)*	*Significance level*	*Kolkata (n=40)*	*Sonarpur (n=40)*	*Significance level*
Energy (kcal)	2035.65±356.25	2089.52±373.45	NS	1646.66±317.14	1625.75±287.19	NS
Carbohydrate (g)	365.48±73.29	393.43±69.98	NS	291.53±68.89	286.90±70.63	NS
Protein (g)	70.14±13.78	62.49±12.61	NS	55.33±12.74	52.55±13.74	NS
Fat (g)	33.91±9.62	38.37±10.57	NS	28.38±6.62	30.39±8.24	NS
Vitamin C (mg)	63.68±26.23	95.92±54.33	$p<0.05$	40.75±19.30	95.86±67.27	$p<0.05$
β-carotene (µg)	750.33±395.74	1029.97±350.13	$p<0.05$	568.77±384.40	1223.14±943.20	$p<0.05$
Vitamin B_1 (mg)	1.26±0.31	1.50±0.45	$p<0.05$	1.04±0.27	1.10±0.24	$p<0.05$

Table 6: Relation of training, air pollutants and micronutrients with physical fitness components of sprinters using GLM Univariate procedure

Dependent variables	*Independent variables*							
	Training (year)	*SPM (µg/m³)*	*RPM (µg/m³)*	*SO_2 (µg/m³)*	*NO_2 (µg/m³)*	*Vitamin C (mg.)*	*β-carotene (µg.)*	*Vitamin B_1 (mg.)*
VO_2 max (ml/kg/min)	NS	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
Agility (sec)	NS	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
Leg muscle power (cm)	NS	$p<0.01$	$p<0.01$	$p<0.01$	$p<0.01$	$p<0.05$	$p<0.05$	$p<0.05$
Hand grip strength (kg)	NS	$p<0.01$	$p<0.01$	$p<0.01$	$p<0.01$	$p<0.05$	$p<0.05$	$p<0.05$

All macronutrients intake were significantly higher in trained boys of both regions than untrained boys (Table 4). From Table 5, it was shown that no significant difference was observed in energy, protein, carbohydrate and fat intake of sprinters and untrained boys between two zones. But vitamin C, β-carotene and vitamin B_1 intake showed significant higher values in both sprinters and untrained boys of Sonarpur. From Table 6, it was revealed that there was no significant relation of training with physical fitness parameters whereas air pollutants and micronutrients showed significant relation with those parameters.

From the results it was seen that in this study there was no significant difference in age, height and weight between the groups. Actually physical fitness components depend upon various factors. Elbel et al. (1958) found a significant correlation between physical fitness score and body weight and height. As there was no significant difference in age, height and weight between the groups, higher physical fitness components values of trained boys

of two regions were due to their regular participation in physical training programme. It was noted that most of the macronutrients intake were significantly higher in sportspersons than untrained boys. Another study in Italy also showed that dietary intake or nutrition knowledge in athletes were quite better than non-athletes, suggesting a favourable role of sports practice on dietary habits and nutrition knowledge (Cupisti et al., 2002). According to Johnson-Down et al. (1997) children who did more physical activity had significantly higher intakes of energy, calcium, iron, zinc and fibre but were not heavier.

All the physical fitness components were significantly higher in sprinters of Sonarpur. In this study the sprinters 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 high air pollutant zone (Kolkata) whereas other from Sonarpur – the less air pollutant zone. Results showed that there were no significant differences in their age, height, weight and also in macronutrients like energy, carbohydrate, protein and fat intake. In spite of that agility, leg muscle power, speed and handgrip strength were lower in case of sprinters of Kolkata. Hence, it seems that it was only environmental factor which might be the major determining factor for the difference in those fitness components. Das et al. (2005) also showed that agility power of footballers in less pollutant zone i.e Hooghly was significantly higher from footballers of Kolkata. Another study also showed the impact of air pollutants on physical fitness components of sportspersons in West Bengal, India (Das et al., 2007b). The health effects in growing children of long term exposure to a polluted atmosphere are of deep concern (Das et al., 2007b). Some study also reported that athletes are at special risk of inhaling pollutants (Shephard, 1984). In case of untrained boys same scenario has been revealed. Actually the diffusion of pollutant gases increases with exercise as pulmonary diffusion capacity has been shown to increase with exercise (Daigle et al., 2003; Fisher and Cerny, 1982).

It is to be noted that vitamin C, β-carotene and vitamin B_1 intake were higher in Sonarpur boys. Due to belonging in the rural-urban fringe area, boys of Sonarpur had a tendency to take leafy vegetables and green fruits. For that reason vitamin C, β-carotene and vitamin B_1 intake was significantly higher in Sonarpur boys. Ahmed et al. (1998) reported that leafy vegetables and fruits were the main sources of carotenes. Harmful effects on the body from pollutants are multifactorial, with acute or chronic exposures increasing the cellular processes associated with anthrogenesis, impairing pulmonary function, provoking local and systemic inflammation, disrupting cardiac autonomic control and including vascular dysfunction (Sharman, 2005). Numerous studies have linked atmospheric pollutants to many types of health problems of many body systems including the respiratory, cardiovascular, immunological, hematological, neurological and reproductive developmental systems. Some studies have found increases in respiratory and cardiovascular problems at outdoor pollutant levels well below standards set by such agencies as the US EPA and WHO (Curtis et al., 2006). Deleterious health effects may result from exposure to pollutants at concentrations that are lower than recommended standards. Indeed, research to date has failed to determine a "threshold" limit for which there is no adverse health effect (Kunzli, 2002). According to Shephard and Shek (1998) vitamins are important to immune function because of their antioxidant role. Kelly (2004) 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. Vitamin C is more effective in preventing oxidation by NO_2 (Menzel, 1992). Romieu (2005) suggested that high intake of fresh fruit and some vegetables appears to have a beneficial effect on lung health and their consumption should be recommended on a daily basis and supplementation of vitamin C and other antioxidants could be prescribed in subjects with additional oxidative stress challenge, such as exposure to high levels of air pollution. In less pollutant zone vitamin C, carotene and vitamin B_1 intake were higher which had an impact on improving their performance level against the possibility of the effect of pollutants if effects were present.

Conclusions

From the present study it was concluded that environmental air pollutants have adverse effect on physical fitness components irrespective of the fact whether the boys were under regular physical training or not and higher intake of vitamin C, β-carotene and vitamin B_1 in Sonarpur boys influenced to improve physical fitness components against the impact of air pollution existing over there.

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