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Original Article

Pulmonary function & Anthropometric indices analysis in long distance runners of North Bengal

Authors
Dr Deepankshu Shekhar Mandal[1], Dr Prithwish Tantri[2*], Dr Kaushik Samajdar[3]
Dr Somi Dey Sarkar[4]
[1]Associate Professor, Physiology, IPGME & R, Kolkata, WB
[2]Assistant Professor, Physiology, MMC & H, Malda, WB
[3]Professor, Physiology, NBMC& H, Siliguri, WB
[4]CMO (SG), BSF, CAPFs' Hosp', Siliguri, WB
*Corresponding Author
Dr Prithwish Tantri
Assistant Professor, Physiology, MMC & H, Malda, WB, India
Mobile no. 9830696062

Abstract
Correlating specific pattern of lung function indices and anthropometric indices with the performance of long distance runners of Northern Bengal to formularize the ideal anthropometric parameters and pulmonary function parameters for successful endurance training.

Introduction

Long distance running is a very popular sports worldwide.[1] It is said to have started in memory of the historic runs of "Pheidippides" from the battle field of Sparta (Marathon) to Athens, few thousand years back.

Athletes from Kenya and Sub Saharan Africa do extremely well in endurance running, probably due to some Genetic adaptation.[2,3]

There are 4 mode of energy expenditure. 1) adenosine tri phosphate system, 2) creatin/ phosphokinase system, 3) glycogen lactic acid system and the 4) aerobic system.

ATP stored within the working muscle mass gets utilized as soon as the muscle starts working and it gets exhausted usually within about 3 seconds. A well trained sprinter may get a higher storage due to bigger muscle mass. Then muscle starts utilizing creatin phosphate for energy expenditure which stage last for up to 8 to 10 seconds. Phosphocreatin when decomposed produces creatin and phosphate to release a lot of free energy to reconstitute the high-energy bond of ATP. Most muscle cells have two to four times as much phosphocreatine as ATP. A special characteristic of energy transfer from phosphocreatine to ATP is that it occurs within a fraction of a second. These together can provide maximal muscle power for 8 to 10 seconds, almost enough for the 100-meter run,[3,4] Muscle glycogen can be split into glucose and used for energy. The initial stage of this process, glycolysis, occurs without oxygen and, therefore, is anaerobic metabolism.[7] The glycogen-lactic acid system is that it can form ATP molecules about 2.5 times as rapidly as can the oxidative mechanism of the mitochondria. The glycogen-lactic acid system can provide 1.3 to 1.6 minutes of maximal muscle activity.[5]

A runner has to rely on the Aerobic system of metabolism for continuous energy supply as it is continues up till the nutrients are available to endure a race of 1 to 2 hours.

Oxygen consumption is around 4000 milliliters/ minutes in athletically trained average male and 5100 milliliter per minutes in male marathon runner respectively. It has been seen with exercise both the oxygen consumption and pulmonary ventilation increases with positive correlation. It seems to increase up to 20 folds between resting state to minimal exercise in well trained athletes.[3,6]

It is experimentally proven that marathoners have 45% greater genetically determined $Vo_{2\ max}$ than one average person.

Athlete with greater chest size in relation to body size and have stronger respiratory muscles, good circulatory capacity select themselves to become marathoners.[3,7,10]

Analyzing $Vo_{2\ max}$ it seems to resolve into a) respiratory component, b) one circulatory component and c) cellular metabolic component. Maximum oxygen utilization will depend on how the body picks up oxygen from nature, how it is carries towards the working muscle and how active/good is the oxidative cellular metabolic system. With training circulation and cellular metabolism may be increased in many fold but not the respiratory capacities.[8,9]

Regular engagement in sports confers higher lung volume with higher inspiratory or expiratory flow.[11,12] Exercise performance can be predicted by laboratory measurements. Anthropometric measurement such as height, length of the limbs etc. cannot be modified in the subject but Variables like weight and so BMI can alter with specific diet and training.

So, if a specific pattern regarding the variables be identified, that may guide the athletes of future to choose their trade and to perform better. Also the finding that high pulmonary function if associated with better run time may guide a young athlete to choose his running event.

Purpose of this study was to examine whether any specific pattern of lung function indices and anthropometric indices such as height, weight, BMI, chest circumference can be correlated with the performance of long distance runners of the Northern areas of the Indian state of West Bengal. Armed with relevant information (if any obtained) an attempt can be initiated to formularize the ideal anthropometric parameters and pulmonary function parameters for successful endurance training.

Materials and Methods

This cross sectional field study was undertaken mainly in the Department of Physiology North Bengal Medical College, Sushrutanagar, Darjeeling District, WB, India 734 012, where subjects/runners from various areas of Northern Districts of West Bengal, were taken as the study population and were examined prior to track and field events starting from April 2013 and for the subsequent next 2 years, after obtaining written consent for investigation and publication. Data were collected in field studies and tabulated. Those who completed the inclusion criteria were taken into account as there were a lot of recreational runners. Completion time was taken into account. Data was subdivided into two groups of those who could complete (endure) the race and who could not, intergroup and intra group comparison was made using one way ANOVA and Pearson- correlation. The statistical analysis was done using SPSS 20.0 [software pack for social sciences 20.0]. And the results were further tabulated. The Inclusion criteria being 1) voluntarily participation, 2) Habit of regular exercise and track and field training, 3) Male participants who were within age group of 15 to 45 years with 4) No clinically detectable abnormality in cardiovascular, respiratory or the locomotors system. Person chronically abusing tobacco or with history of drug intake or drug abuse were excluded. Subjects were clinically examined thoroughly for any sign of cardiovascular or respiratory illness and then the Parameters recorded were

1. Height of subjects taken using a stadiometer (AVERY).
2. Weight of subjects were taken with bare minimum clothing using a standard electronic weighing machine (ATCO).
3. BMI calculated using weight and height Data accordingly
4. Chest circumference was measured using a fiber soft tape
5. Forced vital capacity (amount of air can be breathed out with maximum effort after a forceful and deep inspiration) was measured using an electronic flow sensing spirometer by Nassan Inc. (Miestro DT Spirometer).[13,14] The printout from the machine was kept along with the form and datasheet for every individual.
6. Forced expiratory volume in 1 second (FEV_1): FEV_1 is defined as amount of air which can be expired during the first second of forceful expiration after taking a maximal inspiration.
7. FEV_1/FVC ratio: It was calculated using the data from the two previous data set.

Results and Analysis

Age: The subjects had a mean age of 22. 9 years with a standard deviation of 5.75. With a range of maximum 40 years to minimum 16 years.

Weight: The subjects had a mean weight of 59.64 kilogram with standard deviation of 9.19. The maximum and minimum weight ranged from 87 kilogram to 47 kilogram.

BMI: The mean BMI of these subjects were 20.81KG/M^2, with standard deviation of 2.59. With a range of 17.19 to 29.88 KG/M^2.

Table 1 BMI distribution of the participants

	Frequency	Percent
Under nutrition	9	22.5
Normal	29	72.5
Overweight	2	5
Total	40	100.0

Chest circumference: Mean chest circumference of the study subjects was 86.15 centimeter with a standard deviation of 6.89. With a range of maximum 107 centimeter to minimum 70 centimeter.

Forced vital capacity: Mean forced vital capacity of the candidates was 3.804 liter with standard deviation of 1.16. With a range of maximum 8.4 liter to minimum 1.44 liter.

FEV_1: Mean FEV_1 of the candidate was 3.03liter with a standard deviation of .99. With a range of maximum 6.5 liter to minimum 1.18 liter.

FEV_1/ FVC ratio: mean ratio of FEV_1: FVC of the subjects 80.45% with standard deviation of 16.524. With a range of maximum 100% to minimum 34.6%.

Pearson's correlation and ANOVA was used to determine the causal relationship of race performance and bodily parameters.

Correlation of all candidates		Performance
Performance	Pearson Correlation	1
	Sig. (2-tailed)	
	N	40
Age	Pearson Correlation	-.112
	Sig. (2-tailed)	.492
	N	40
Height	Pearson Correlation	.202
	Sig. (2-tailed)	.210
	N	40
Weight	Pearson Correlation	.126
	Sig. (2-tailed)	.438
	N	40
BMI	Pearson Correlation	-.005
	Sig. (2-tailed)	.974
	N	40
Chest Circumference	Pearson Correlation	.148
	Sig. (2-tailed)	.361
	N	40
Expanded Chest Circumference	Pearson Correlation	.179
	Sig. (2-tailed)	.270
	N	40
Vitalcapacity	Pearson Correlation	.336*
	Sig. (2-tailed)	.034
	N	40
FEV1	Pearson Correlation	.204
	Sig. (2-tailed)	.206
	N	40
Ratio	Pearson Correlation	-.118
	Sig. (2-tailed)	.469
	N	40

Age: Age is negatively related to the ability of the candidate to endure the race but it is not statistically significant. Increase in age decreases the ability of the candidate to endure the race. Pearson correlation is -.112, significance .492. ANOVA shows F value of .481 and significance .492.

Height: Height is positively correlated with performance, i.e. with increase in height performance gets increased. But this is not statistically significant. Pearson correlation is .202, significance .210. ANOVA shows F value of .1.623 and significance .210.

Weight: weight is positively correlated with performance but it is not statistically significant. Pearson correlation is .126, significance .483. ANOVA shows F value of .613 and significance .438.

BMI: BMI of the runners are very slightly negatively correlated with performance of the candidates i.e. lower BMI candidates better endure the race. But this value was not statistically significant. Pearson correlation is -.005, significance .974. ANOVA shows F value of .001 and significance .974.

Chest circumference: Unexpanded as well as expanded chest circumferences of the candidates were positively correlated with performance, i.e. higher the chest circumference better the performance of the candidates. But this was not statistically significant. Pearson correlation is .148 and .179, significance .361 and .370 respectively. ANOVA shows F value of .855 and significance .361.

Forced vital capacity: The Forced vital capacities of the candidates were positively correlated with the run performance, and it was found to be statistically significant. Pearson correlation is.336 significance .034. ANOVA shows F value of 4.852 and significance .034.

Forced expiratory volume in one second: The candidate's expiratory volume in one second was positively correlated with the run performance. But this was not statistically significant. Pearson correlation is .204 significance .206. ANOVA shows F value of 1.654 and significance .206.

FEV_1/ FVC Percentage: The ratio of candidate's expiratory volume in one second and forced vital capacity was negatively correlated with the run performance, and it was found to be statistically insignificant. Pearson correlation is -.118 significance .469. ANOVA shows F value of .536 and significance .469.

Conclusion

The Pearson's correlation data between the successful (n=10) and unsuccessful (n=30) candidates showed that there are positive correlations between performance (taken as whether they could successfully complete the race) and Height, Weight, Chest Circumference (either expanded or relaxed), Vital capacity and FEV_1. That is with increase in these parameters there is higher possibility of success, whereas AGE, BMI and FEV_1/FVC % ratio has a negative correlation with performance, i.e. lowered age, BMI, FEV_1/FVC ratio increases the chance of success. Possibly with increasing age the subjects lose a little of the respiratory ability as well as the oxidative enzyme activity of the muscle which leads to decrease body's ability to sustain fatigue (64). Also a decreased FEV_1/FVC ratio denotes that those athletes were keeping air for more time in lungs than others, possibly that enables them to have a higher oxygen exchange during that time. But this ratio in all the cases were within physiological limit of health.

Statistical analysis shows that only the vital capacity bears a statistically significant relation with performance time. (Pearson's correlation- .336, Significance [two tailed]- .034).

To be noted that participants with abnormally high FVC susually won the race, following the principle that those people with genetically larger chest size in relation to their body size choose themselves as endurance runners.(1)

Body mass seems to have a marked effect in endurance training. The association of BMI and performance in Kenyan runners are documented.

Black runners tend to be smaller and lighter (26,27) than the white runners (27, 28,29), though the study of Rahamani *et al* could not confirm this.[15] The BMI of Kenyan runners were 19.2 kg/ m^2 whereas 20.6kg/m^2 were for the best of Scandinavian runners. When Senegalese black runners and Italian runners were compared black runners had longer leg length in comparison to the torso (30). It supports that the lower BMI and smaller body size are important for better performance of the black runners. In our study we found a positive correlation of height with race endurance whereas a negative correlation of height with performance time but it was not statistically proven. That is a taller candidate has better chance to survive a race but shorter among those successful candidates has better timing than his longer co-runner.

There are very few studies about long distance runners of India and most of them are only concerned about anthropometric parameters. This study combining both Anthropometric as well as Pulmonary Function parameters might have been enriched with inputs from Genetic study and familial history and examination of relatives to reveal the inheritability of success in endurance sports. No specific anthropometric parameters to guarantee success in in long distance running was revealed but Forced vital capacity was found to be significantly higher in successful long distance runners. So, it may be inferred that an athlete with prior tested high FVC value will do better in endurance sports.

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