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# Comparative Study of Aerobic Power in North and South Indians

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**Abstract:**
Aerobic power is dependent on the ability of the respiratory and circulatory systems to transport oxygen from the air to the respiring tissues, and the ability of the tissues to use the oxygen to break down metabolic fuels. Much information are not available on the extent of changes observed in different systems of body and Aerobic power in untrained north and south Indian subjects during exercise. The present study has therefore been undertaken to investigate the cardiovascular and respiratory responses to submaximal exercise. and aerobic power or $VO_{2max}$ in young healthy untrained South and North Indians .50 North Indians and 50 South Indians, normal healthy normotensive male subjects in the age group of 18-25 years were selected to establish normal standards of cardiorespiratory responses to submaximal exercise on a bicycle ergograph. Parameters like heart rate, blood pressure and respiratory rate were recorded at rest and peak exercise. $Vo_{2max}$ or aerobic power was calculated indirectly from Astrand – Ryhming nomogram after determining the work rate in kilopond meter per minute.Heart rate, systolic blood pressure and respiratory rate rose with exercise, while diastolic blood pressure recorded a fall. Mean arterial pressure was found to change very little. Aerobic power was found to be 2.73 ± 0.21 L/min or 51.21 ml/kg/min in North Indians and 2.67 ± 0.22 L/min or 49.19 ml/kg/min in South Indians. In the present study the aerobic power is statistically increased in north Indians compared to the south Indian which may be due regional variation of morphological characteristics ,socioeconomic, climatic and genetical variations.

**Keywords**: *Aerobic power, $Vo_{2max}$*

## Introduction:

Aerobic power is the maximum capacity of an individual's body to transport and utilize oxygen during incremental exercise, which reflects the physical fitness of the individual [1]. Aerobic power depends on the ability of tissues to use oxygen to breakdown metabolic fuels and the combined abilities of various systems (pulmonary, cardiac, vascular, and cellular) to transport oxygen from the air to mitochondria [2]. Maximal oxygen uptake ($VO_2$max) is widely accepted as the single best measure of cardiovascular fitness and maximal aerobic power. Accurately measuring $VO_2$ max involves a physical effort sufficient in duration and intensity to fully tax the aerobic energy system[3]. In general clinical and athletic testing, this usually involves a graded exercise test (either on a treadmill or on a cycle ergometer) in which exercise intensity is progressively increased while measuring ventilation and oxygen and carbon dioxide concentration of the inhaled and exhaled air [4].

India is a vast country with unique cultural, social, geographical, ethnic and climatic differences. The morphological characteristics of Indian vary according to regional variations of this country. The regional variation of morphological characteristics of Indian occur due to socioeconomic, climatic and genetical variations [2]. Swaminathan et al have worked on aerobic power and cardiopulmonary response of exercise in healthy South Indian children and concluded that nutritional and socio-cultural factors may play an important role in determining peak $VO_2$ of children from different populations rather than ethnic differences alone[2].

Scientists of different countries investigated on their athletes and non athletes, young untrained individuals and some information are available on Indian population also in this regard. But most of the studies are done on subjects from same states. There is also suggested evidence of important ethnic differences in physiological responses to exercise but this aspects has not been adequately investigated in India. So in this present study the aerobic power or $VO_{2max}$ in young healthy untrained south and north Indians were studied.

**Materials and methods:**

The present study was conducted in the Department of Physiology, J.J.M. Medical College, Davangere. 50 North Indians and 50 South Indians, normal healthy normotensive male subjects in the age group of 18-25 years were selected. Criteria for inclusion in the study were, subjects should be non athletic ,but who should occasionally participate in recreational activities, ability to perform a exercise, no prior history of cardiovascular, peripheral vascular, respiratory diseases, malignancy, orthopedic or musculoskeletal lesion. Subjects should be non-smokers, non-alcoholic, not taking any medication and non diabetics. All subjects gave an informed consent after detailed procedure of the non-invasive technique was explained to them. Anthropometric measurements were taken. A pretested structural proforma was used to collect the relevant information. The subjects were instructed not to take tea or coffee for at least 2 hours before the test. All the recording was done in the morning session between 11 AM to 1 PM. Vital parameters like pulse rate, blood pressure and respiratory rate were recorded. A detailed clinical examination of respiratory system, cardiovascular system and central nervous system was done. Subjects performed exercise on a mechanically braked bicycle ergograph. The age predicted maximum heart rate was determined as $HR_{max}$=208-(0.7 × age).Subjects were called to the department and the maximal load at which they would cycle on bicycle on bicycle was determined, Maximal load was found to be 4.5 Kg with the heart rate of 195 beats/min. The submaximal load should be within 85-90% of the maximal heart rate at maximal load i.e in between 164-178 beats / min was found to be 3.5 kg after repetitive testing.

The subjects performed submaximal bexercise lasting for 6 minutes on a mechanically braked bicycle ergograph (INCO). During the exercise the subjects pedaled the bicycle at the rate of 60 revolutions per minute. The rate was kept constant with the help of metronome. At this rate, there is lowest $O_2$ uptake and greater mechanical efficiency. This rate was kept fixed throughout the exercise sessions.

The parameters recorded were pulse rate by 12 lead ECG, blood pressure with a mercury sphygmomanometer and respiratory rate visually. The pulse rate, blood pressure and respiratory rate were recorded just after the $5^{th}$ minute when steady state is reached .Similar recordings were done just before the start of the of exercise. Aerobic Capacity or $Vo_{2max}$ was found out indirectly after calculating the work rate in Kpm/min and then using Astrands nomogram, because $Vo_{2max}$ is the indicator of aerobic fitness [4,6,7].

**Statistical analysis:**

The results are presented as Mean ± SD. Unpaired 't' test was used for group wise comparisons. p-value of 0.05 or less was considered for statistical significance.

**Results:**

The anthropometric data of the subjects were given in Table 1. In the present study it was observed that all the subjects have normal body mass index which reflects healthy status of subjects. The mean heart rate at rest in north and south Indians were 74.27 ± 6.60 and 74.73±6.3 respectively which increased to 162.09 ± 11.92 and 162.2±12.53 during exercise [Table.2]. The mean systolic blood pressure at rest in north and south Indians were 110.72 ± 6.18 and108.33 ± 8.79 respectively which increased to 145.21 ± 5.82 and 143.6±6.12 during peak exercise [Table.2,Fig 1] and the increase was statistically significant on both groups. The mean diastolic blood pressure at rest in north and south Indians were 73.15 ± 5.2and 70.26±5.67

**Table 1:** Physical characteristics

| Parameters | North Indians | South Indians |
|---|---|---|
| Height (m) | 1.64±0.11 | 1.62± 0.09 |
| Weight (kg) | 54.81 ± 6.98 | 53.2 ± 6.49 |
| Body Mass Index (BMI)-kg/m$^2$ | 23.26 ± 2.26 | 18.72± 2.81 |
| Body Surface Area (BSA)-m$^2$ | 1.54 ± 0.06 | 1.53 ± 0.07 |

**Table 2:** Cardiorespiratory parameters at rest and during peak exercise

| Parameters | Sessions | North Indians | P value | South Indians | P value |
|---|---|---|---|---|---|
| | | Mean ± SD | | Mean ± SD | |
| Heart rate (beats / min) | Rest | 74.27 ± 6.60 | <0.001 HS | 74.73±6.3 | <0.001 HS |
| | Peak Exercise | 162.09 ± 11.92 | | 162.2±12.53 | |
| S.B.P. (mm of Hg) | Rest | 110.72 ± 6.18 | <0.001 HS | 108.33 ± 8.79 | <0.001 HS |
| | Peak Exercise | 145.21 ± 5.82 | | 143.6±6.12 | |
| D.B.P. (mm of Hg) | Rest | 73.15 ± 5.2 | <0.001 HS | 70.26±5.67 | <0.001 HS |
| | Peak Exercise | 66.72 ± 6.76 | | 64.86±7.21 | |
| PP (mm of Hg) | Rest | 37.81 ± 4.83 | <0.001 HS | 38.06±4.82 | <0.001 HS |
| | Peak Exercise | 69.69 ± 3.74 | | 64.86±7.21 | |
| M.A.P. (mm Hg) | Rest | 85.72 ± 5.11 | <0. 01 S | 82.91±6.46 | <0. 01 S |
| | Peak Exercise | 91.11 ± 13.41 | | 88.52±13.22 | |
| RR/ min | Rest | 13.9 ± 1.08 | <0.001 HS | 13.43±1.07 | <0.001 HS |
| | Peak Exercise | 29.69 ± 3.74 | | 31.33±2.7 | |

All values expressed as mean ± SD (range). Analysis for all parameters done by un paired't' test. HS → Highly significant, S → Significant and NS → not significant. S.B.P- Systolic Blood Pressure, D.B.P- Diastolic Blood Pressure. M.A.P - Mean Arterial Pressure, P.P - Pulse Pressure, R.R- Respiratory Rate.

respectively which decreased to 66.72 ± 6.76 and 64.86±7.21during peak exercise and the increase was statistically significant on both groups.[Table.2,Fig 1].Change in the diastolic blood pressure was minimal (10-15 mm of Hg) as compared to the change in systolic blood pressure (30-40 mm of Hg).The mean blood pressure and pulse pressure also showed a statistically significant increase during exercise.[Table.2,Fig 1].

**$VO_{2max}$ :**

$VO_{2max}$ was found out by using Astrand nomogram. $VO_{2max}$ was evaluated on the group basis. In the North Indians the $Vo_{2max}$ was 2.73 ± 0.21 (L / min) or 51.21 ± 7.20 (ml / kg / min). In the South Indians group the $Vo_{2max}$ was 2.67 ± 0.22 (L/min) or 49.19 ± 7.86 (ml / kg / min). It was found to be statistically insignificant [Table3, Fig.2].

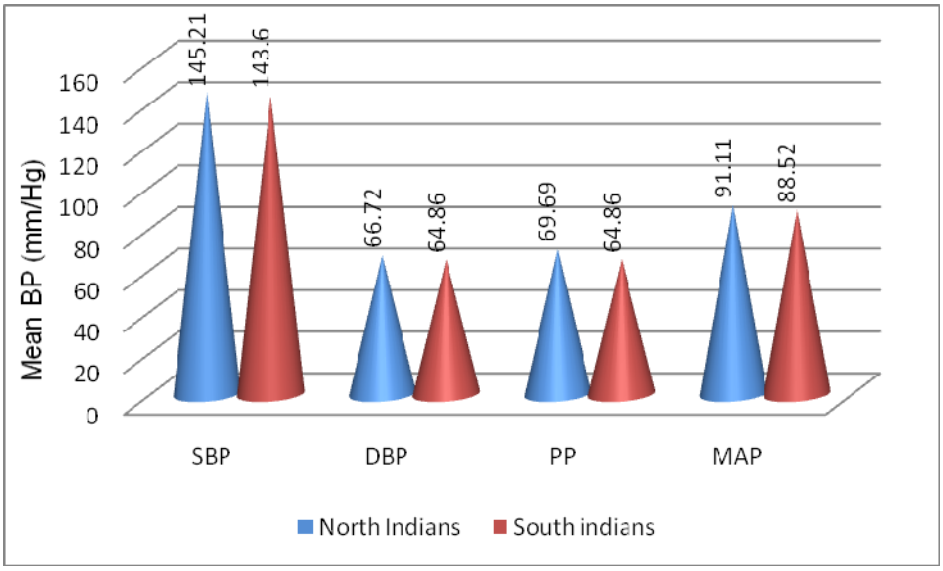


**Fig 1:** Comparison of blood pressure changes during peak exercise in north and south Indians

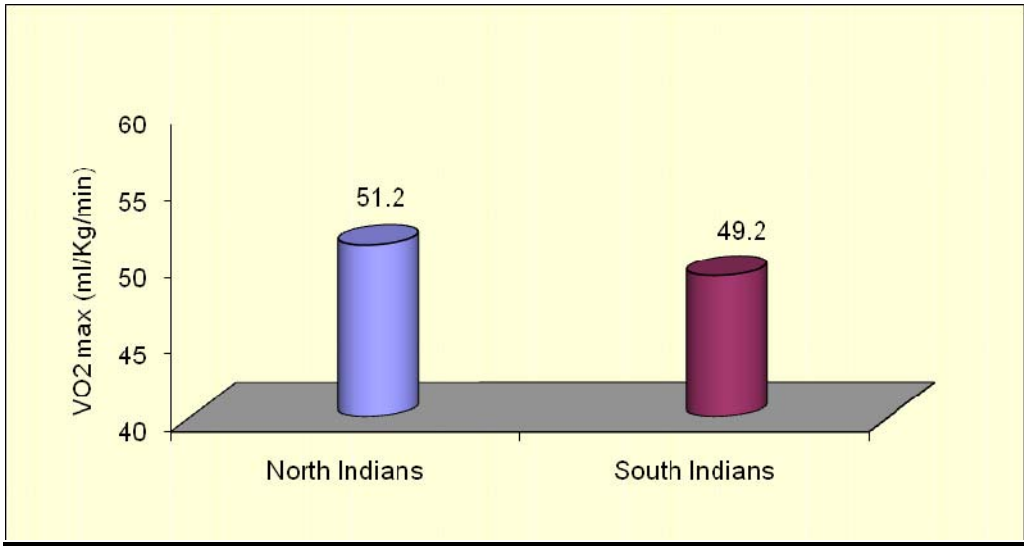


**Fig 2:** Comparison of $vo_{2max}$ or aerobic power in south and north Indians

**Discussion:**

During exercise the heart rate progressively increases owing to an increase in intensity of sympathetic nervous system, increased venous return and withdrawal of parasympathetic inhibition [8]. Systolic blood pressure rose with exercise and it is statistically significant. Exercise induced significant rise in systolic blood pressure reflects the normal sympathetic drive on cardiovascular system which enables the heart to pump more blood to the active tissues in the body, as physical conditioning of person greatly influences the heart rate, blood pressure and rate of blood flow of the individual[9].

**Table 3:** Comparison of $vo_{2max}$ in south and north Indians

| | $Vo_{2max}$ (L/min) | | P value | $Vo_{2max}$ (ml/kg/min) | | P value |
|---|---|---|---|---|---|---|
| | **Range** | **Mean ± SD** | | **Range** | **Mean ± SD** | |
| North Indians | 2.6 – 3.5 | 2.73 ± 0.21 | < 0.02 S (t = 2.32) | 38.81 – 70.0 | 51.21 ± 7.20 | < 0.001 HS (t = 9.4) |
| South Indians | 2.5 – 3.5 | 2.67 ± 0.22 | | 30.95 – 68.0 | 49.19 ± 7.86 | |

**Table 4:** Comparison of maximal oxygen uptake of untrained young men of different countries

| **Ethnic group** | **Age (years)** | **No of Subjects** | **$VO_{2max}$ (L/min)** | **References** |
|---|---|---|---|---|
| Norwegian | 18-28 | 12 | 3.20 | Lars Hermansen et al [1] |
| Sweden | 19-27 | 10 | 3.10 | Ekblom et al [18] |
| Canadian | 18-20 | 24 | 3.92 | Ross et al [19] |
| British | 18-28 | 23 | 3.40 | Cotes JE et al [14] |
| Americian | 18-25 | 50 | 4.05 | SlonimNB etal [15] |
| Japanese | 18-23 | 17 | 3.95 | Miyamura MH etal[16] |
| Chinese | 20-30 | 10 | 2.45 | Duncan et al [17] |
| Malaysian | 20-30 | 10 | 2.31 | Duncan et al[17] |
| Malaysian Indians | 20-30 | 10 | 2.31 | Duncan et al[17] |
| SouthIndians | 18-25 | 50 | 2.67 | Present study |
| NorthIndians | 18-25 | 50 | 2.73 | Present study |

All values expressed as mean ± SD (range); Analysis for all parameters done by un paired 't' test. HS → Highly significant, S → Significant and NS → not significant.

In our study, there was a decrease in diastolic blood pressure with exercise. This decrease is thought to be due to decrease in systemic vascular resistance which occurs during exercise. Change in the diastolic blood pressure was minimal (10-15 mm of Hg) as compared to the change in systolic blood pressure (30-40 mm of Hg). In the present study, mean arterial pressure was found to change very little since changes in systolic and diastolic blood pressure are opposite in direction[10]. In this study, respiratory rate increased in both the sessions of exercise. This result could be due to a rapid neurogenic component and a slower humoral component according to the neurohumoral theory of exercise hyperpnoea[11].

In our findings both in south and north Indians the heart rate ,systolic blood

pressure, respiratory rate increase with exercise and diastolic blood pressure recorded a fall.

$Vo_{2max}$ is the maximum volume of oxygen consumed by the body each minute during exercise, since the amount of oxygen we consume is directly related to the amount of energy we are burning [12]. The physical limitations that restrict the rate at which energy can be released aerobically depend upon the chemical ability of the muscular tissue system to use $O_2$ in breaking down fuels and the combined ability of cardiovascular and pulmonary systems to transport the oxygen to the muscular tissue system. Therefore measurement of $O_2$ consumption is actually a measure of aerobic fitness [13]. The direct determination of $Vo_{2max}$ needs well established laboratory setup, skilled personnel and medical supervision in order to avoid risk factors involved in exhaustive work. As a result, number of studies have been undertaken to obtain $Vo_{2max}$ by indirect estimation. One among them is Astrand-Ryhming nomogram employing heart rate response to submaximal work to estimate $Vo_{2max}$ and this produce a good estimation of $Vo_{2max}$ in a population unaccustomed to cycling.[4] The mean error of the predicted value was only 5 percent when the Astrand-Ryhming nomogram was used[6,].

The Astrand-Ryhming nomogram appears to produce a good estimation of maximal oxygen uptake and it was concluded by many workers, that Astrand-Ryhming nomogram is suitable for using as an indirect method of estimation of $Vo_{2max}$ in Indian subjects and that it may be a practical test for establishing that an individual meets a minimum standard[7].

The determination of aerobic power or $Vo_{2max}$ gives an idea of the capacity and regulation of $O_2$ transporting and also sets a norm in assessing physical fitness. In the present study aerobic power was found to be 51.21ml/kg/m in North Indians and 49.19 ml/kg/m in south Indians by using Astrand – Ryhming nomogram and the difference was statistically significant. The sedentary $Vo_{2max}$ values are also genetically determined. The genetic factor probably plays a major role in a person's performance capacity, at least for those persons aspiring to the levels required for the attainment of Olympic medals. The individual's response to training is also associated with an endowed genotype. Thus it appears that up to 70% of an individual's maximum force, power or capacity is a matter of genetic factor [2]. The reason for this observation is not clearly understood. In our study the body mass index is more in North Indians compared to South Indians. Some studies showed that there is a positive correlation between BMI and aerobic power up to the normal value of BMI 25 $kg/m^2$. This could be also a reason for increase aerobic power in North Indians. We concluded that nutritional and socio-cultural factors may play an important role in determining peak $VO_2$ of people from different populations rather than ethnic differences alone. However the activity level and nutritional status of the subjects which are not taken into account in the present study, may be the possible causes of such results. Further study is required in this direction.

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