Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublisher.com/sjams/

OPEN ACCESS

Paediatrics

Respiratory Correlates of Work Capacity

Dr. D.L.Vidya[1], Dr. K. Siva Kumar[2], Dr.A.Lavanya[3], Dr. M. Prakash Kumar[4*]

[1]Associate professor, department of pediatrics, government general hospital, Kakinada, India
[2,3]Junior resident, department of pediatrics, government general hospital, Kakinada, India
[4]Assistant professor, department of pediatrics, government general hospital, Kakinada, India

***Corresponding author:** Dr. M. Prakash Kumar
| **Received:** 12.05.2019 | **Accepted:** 20.05.2019 | **Published:** 30.05.2019
DOI: 10.21276/sjams.2019.7.5.46

Abstract **Review Article**

The relationship between work capacity and respiratory parameters were studied in GGH KAKINADA. In this observation work capacities of 50 medical students of both sexes were determined by exercise testing on bicycle ergometer. There was no correlation between vital capacity and work capacity in both groups but the relationship of work capacity and Breathing reserve is varied, bearing significant correlation in males and less in females. The rise in blood lactate levels and pulse rates in exercise which correspond to the severity of stress, is found to be greater in female subjects than males and the nature of blood lactate response to exercise may be a limiting factor of exercise.
Keywords: Vital capacity, Breathing reserve, Respiratory minute volume, Maximum voluntary ventilation.

INTRODUCTION

A multiplicity of factors either alone or in combination impose limitation on exercise capabilities of individuals who therefore differ in this respect.

It is the endeavor of this study to quantitate the work capacity in terms of certain respiratory parameters as will be detailed later.

Many methods are available to measure the exertional levels of Individuals. Ergometers may be used, which register the amounts of mechanical work per unit time. The bicycle ergometer which is utilized the present study provides the expression of work in watts or kg. Meters per minute.

In this study it is aimed to probe the quantitative relationship between vital capacity, Maximum voluntary ventilation and breathing reserve on work capacity as well as the blood lactate and heart rate responses taken as indices of bodily stress.

MATERIALS & METHODS

Materials

1. Bicycle ergograph
2. Loads
3. Materials required for Lactic acid estimation sodium fluoride ,EDTA crystals;10%trichloroaceticacid;20%copper sulphate; 4%copper sulphate; calcium hydroxide ;concentrated sulphuric acid;P-hydroxy diphenyl 1.5% in 0.5% sodium hydroxide; lactic acid standard solution
4. Spirometer

The present study is carried out in a group of 50 healthy, 1st year medical students of both sexes who are not regular athletes. The subjects being medical students presented an added advantage of belonging to matching age groups of between 17-19 years, of comparable physical standards and also medically screened at the time of admission.

Nevertheless, brief medical histories of all the subjects were enquired into, including previous health, smoking, leisure and exercise habits if any. None of the students was reported to be engaged in regular exercise or strenuous physical activities of any kind, Brief clinical examination revealed no disease or disability in any of the participants.

The subjects were all well informed about the experimental purpose and protocol and oral consent obtained. Heights and weights of all the subjects were recorded and data compiled separately for both sexes, designated henceforth as Group A for MALES and Group B for FEMALES, each group comprising 25 students. Before undertaking the exercise regimen, lactate level, vital capacity (V.C), respiratory minute volume (RMV), maximum voluntary ventilation (MVV) and Pulse rate were determined in all the subjects. Then each subject exercised on a bicycle ergometer with incremental loads until the maximum is reached at exhaustion. Work output attained is c

Vital Capacity (V.C)

Vital capacity is determined for each individual subject directly by the use of wet spirometer. The subject is asked to inspire maximally and then expire completely into the spirometer. Since the vital capacity is known to vary from time to time even in the same individual by as much as +/- 200 ml from the mean value, the vital capacity values for each individual were obtained on 3 occasions at intervals and the average of the two that are close to consistency are taken into account. To avoid the effects of postural variation on vital capacities, these are recorded uniformly in all subjects in the upright position i.e. sitting position and the result expressed in liters.

Respiratory Minute Volume (RMV)

Respiratory minute volume also known as pulmonary ventilation per minute(PV) is amount of air inspired or expired per minute.It is determined by collecting expired air into a Douglas bag while the subject breathes under restful conditions for one minute. The volume so collected is measured by displacing the air in the spirometer and the result expressed in liters per minute.

Maximum Voluntary Ventilation (M.V.V)

Maximum voluntary ventilation (MVV) formerly known as maximum breathing capacity (M.B.C) is the maximal volume of gas that can be breathed per minute by voluntary effort. It was recorded by asking the subject to breath as rapidly and as deeply as he can for a 15 second interval. The volume of air moved out is collected in a Douglas bag and then measured by displacing it into spirometer. From the 15 second volume, M.V.V for one minute is calculated and expressed as liters per minute. Breathing reserve in liters is obtained by subtracting the R.M.V from M.V.V.

Determination blood lactate

Blood lactate levels are determined by the following method of Barker & Summerson. 1 ml samples of blood were drawn from the subjects, using sterile syringe and needle from a suitable peripheral vein, prior to the exercise under resting conditions. The collected samples were kept after deproteination, for estimation of blood lactate. At the end of exercise, again blood samples were collected as above and blood lactate concentrations estimated in the same manner. The difference between the 2 values gives an estimate of magnitude of rise induced by exercise.

Preparation of the standard — calcium lactate

This is prepared from calcium lactate which is anhydrous. For the stock standard, 0.342 g of pure dry calcium lactate is dissolved in a 1 liter volumetric flask. 1 ml of concentrated sulphuric acid is added to it. The preparation is diluted up to the mark with water and mixed. This solution contains 1 mg of lactic acid in 5 ml and is stable indefinitely if kept in refrigerator. To prepare the working standard, 5 ml of stock solution is diluted to 100 ml with water in a glass stoppered volumetric flask and mixed. This solution contains 0.01 mg of lactic acid per ml and it is best prepared fresh daily.

Technique

1 ml of blood is drawn from vein and added to a bottle containing the anticoagulant and mixed. 1 ml is transferred in to 4 ml of cold trichloroacetic acid. This solution is centrifused and 1 ml of the supernatant fluid is taken for lactic acid estimation.

To 1 ml of the supernatant fluid, 1 ml of 20% copper sulphate solution is added and made upto 10 ml by adding distilled water 1 gram of powdered calcium hydroxide is added and shaken vigorously. It is left at room temperature for at least an hour, shaking occasionally and then centrifused.

1 ml of supernatant fluid is taken in to a test tube taking care not to include any solid material which may be present in the surface film. About 0.05 ml of 4% copper sulphate solution is added and exactly 6 ml of concentrated sulphuric

CALCULATION

Since the 1 ml portion of copper-lime supernatant used for colour development contains 0.005 mg of lactic acid in the case of the standard and as this represents 0.02 ml of original blood in the unknown (i.e. a dilution of 50) the calculation in this case is as follows:

$$= \frac{\text{Absorbance of unknown - absorbance of blank}}{\text{Absorbance of standard - absorbance of blank}} \times 0.005 \times 100/0.02 \text{ mg/100 ml}$$

$$= \frac{\text{Absorbance of unknown - absorbance of blank}}{\text{Absorbance of standard - absorbance of blank}} \times 25 \text{ mg/100 ml}$$

The result is expressed as mg/100ml

Bicycle Ergometry

Work capacity of subjects was determined by using bicycle ergometer with incremental loads. Work done is determined by multiplying the distance travelled in unit time with load in kgs. Distance moved is a function of number of wheel revolutions (given by a counter) times' wheel circumference.

In order to ensure properly standardized conditions and familiarize the subjects, ergometer and test procedure, all the subjects were allowed a 4 minute unloaded pedaling atleast on two occasions. Then they participated in progressive incremental, ergometric testing.

The incremental exercise test consisted of a 2 minute unloaded pedaling and thereafter against resistance. Each subject exercised on the Bicycle Ergometer in the sitting position with an initial load of 2 kgs in males and 1 kg in females, pedaling at their own rate. The load was increased stepwise every succeeding minute until the maximum exercise tolerance was reached and physical exhaustion was reported or apparent

Work output or exercise capacity was calculated for each individual using the formula.

$$W = Fs$$

Where work is given by the product of force which is equivalent, to load and the distance through which it is moved. The distance moved at any load is given by the product of wheel circumference which is 176.6 cms(0.1766m) and the number of revolutions of the flywheel

As the loads were increased stepwise every succeeding minute, the work output is calculated accordingly for each load in the formula shown below and added to derive the total work output in kg. Meters for the entire exercise period. This value divided by the time duration of exercise gives the work output per minute.

Work output in Kg.m/min = Wheel circumference in meters x no. of Revolutions/ min x load

Work output expressed in watts

The data obtained was tabulated and analyzed using SPSS software

Table-1: Stastical data of group-A

Statistical data	Height (in cms)	Weight (in kgs)	Vital Capacity (V.C)	Max. Vol. Vent .(M.V.V)	Resp. Min. Vol (R.M.V)	Breathing Reserve (B.R)	Work capacity in watts	Resti-ng	Post exercise	Rise	Resting	Post exercise	Rise
Mean	170.7	60.6	3.5	69.9	5.39	64.66	114.32	74.6	151	76	12.96	48.4	35.44
±S.D	±7.9	±6	±1.29 ±	±9.85	±2.51	±11.83	±19.18	±4.8	±9	±6	±2.8	±6.74	±6.44
S.E	1.6	1.2	0.29	1.97	0.50	2.36	3.83	0.96	1.8	1.2	0.56	1.35	1.29

Table-2: Stastical data of group-b

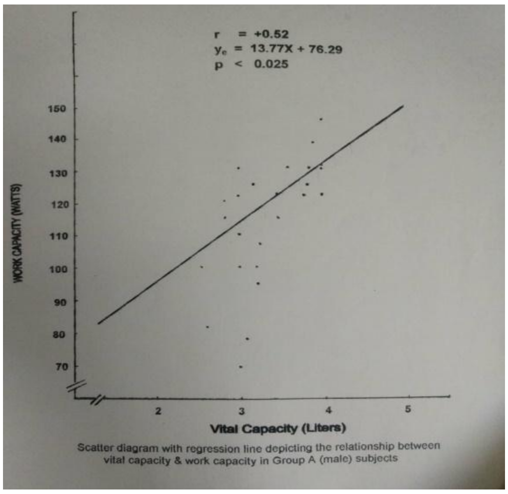
Statistical data	Height (in cms)	Weight (in kgs)	Vital Capacity (V.C)	Max. Vol. Vent .(M.V.V)	Resp. Min. Vol (R.M.V)	Breathing Reserve (B.R)	Work capacity in watts	Resti-ng	Post exercise	Rise	Resting	Post exercise	Rise
Mean	160.6	51.36	2.5	55.38	2.99	52.3	87.24	76.44	158.36	81.92	12.48	54.72	41.56
±S.D	±6.78	±8.58	±0.44	±6.42	±6.62	±3.92	±7.81	±4.46	±9.4	±4.91	±2.35	±7.44	±5.91
S.E	1.36	1.72	0.69	1.28	0.12	0.19	1.56	0.9	1.89	0.98	0.47	1.49	1.18

Table-3: Overall degree of correlation of vital capacity and Breathing reserve with work capacity as well as levels of significance in groups A & B

S.I No	Parameter	Sex	Correlation Coeffecient[r]	Coefficient of determination r2%	t	p
1	Vital capacity	M	+0.52	25	2.8	<0.025
	Vital capacity	F	+0.4	16	2.09	<0.05
2.	Breathing reserve	M	+0.75	56	5.34	<0.001
		F	0.5	26	2.83	<0.01

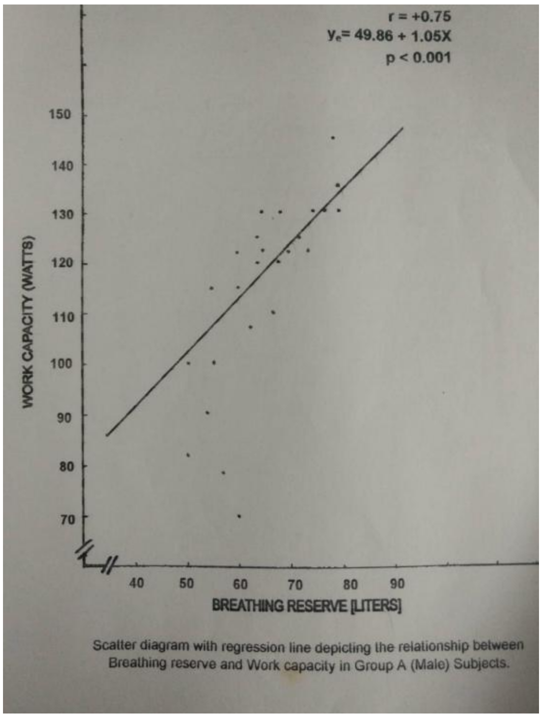
Table-4: Comparative analysis of parameters against performance ranges in both Groups A & B

SI No.	PARAMETERS	WORK CAPACITY IN WATTS					<120W	
		<100 W			100-120 W			
		M	F		M	F	M	F
		N=4 [16%]	<80 w N=8[32%]	80-100 w N=12[48%]	N=8[32%]	N=5[20%]	N=13[52%]	N=0
1	Work capacity[in watts]	80±8.33 SE=4.16	64.75±7.69 SE=2.74	94.25±5.13 SE=1.48	108.37±8.12 SE=3.07	106.4±3.64 SE=1.62	128.53±5.10 SE=1.41	
2	Height(in cms)	167±5.65 SE1.41	160.88±5.88 SE=2.08	160.33±6.45 SE=1.87	167.5±11.29 SE=4.00	159.6±6.9 SE=3.09	172.84±5.84 SE=1.62	
3	Weight(in kgs)	59.5±1.92 SE=0.96	45±4.68 SE=1.65	53.58±7.2 SE=2.08	56.75±6.2 SE=2.2	57.4±10.71 SE=4.78	63.23±11.27 SE=3.13	
4	Vital capacity(in litres)	3.1±0.19 SE=0.09	2.4±0.5 SE=0.17	2.4±3.74 SE=1.08	3±0.26 SE=0.09	2.86±0.38 SE=0.17	3.64±0.36 SE=0.1	
5	Breathing reserve(B.R)	56±2.83 SE=1.41	48.81±3.31 SE=1.18	51.25±4.74 SE=1.36	60±15.6 SE=5.53	60.64±3.38 SE=1.51	71.61±7 SE=1.94	
6	Pulse rate rise[beats/min]	83.5±1.3 SE=1.55	85±5.12 SE=1.82	81.58±7.04 SE=2.03	78.37±5.5 SE=1.95	77.8±5.49 SE=2.45	72.46±4.31 SE=1.19	
7	Blood Lactate rise[mg/dl]	43±5.47 SE=2.73	47±4.45 SE=1.58	39.58±7.5 SE=2.16	35.37±6.69 SE=2.37	37.4±4.56 SE=2.03	33.15±4.99 SE=1.38	



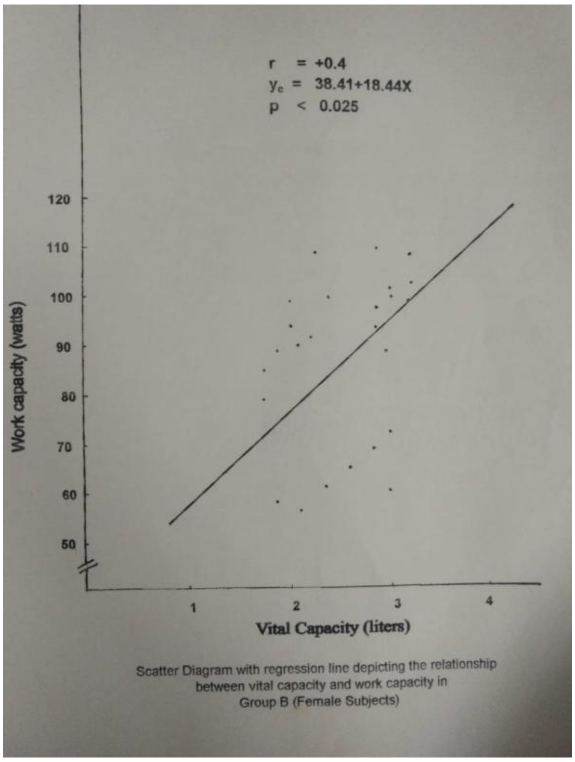
Scatter diagram with regression line depicting the relationship between vital capacity & work capacity in Group A (male) subjects

GRAPH -1

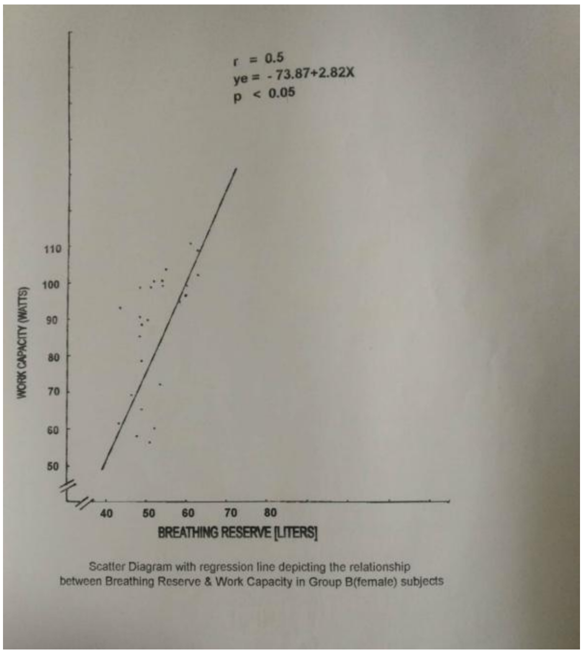


Scatter diagram with regression line depicting the relationship between Breathing reserve and Work capacity in Group A (Male) Subjects.

GRAPH -2



GRAPH-3



GRAPH-4

RESULTS

All the observations were recorded in both group A (male) and groupB (females) subjects and their arthimetical mean values, values of standard deviation and standard error for all the variables are presented separately as in 1 to 4 tables and graphs 1 to 4.

Table 4 segregates individuals into 3 braod categories on the basis of work levels attained in ranges of 20 Watts.In the first category ,subjects whose work output was less than 100 Watt were grouped. The second subgroup consists of individuals who attained a work output in the range of 100-120W and the third, those with work capacities above 120W.The number of individuals (n) falling under each sub group is also represented in actual numbers and also as percentage of total with in a group A or B. Roughly this subdivision equivalent to low, moderate and high work capacities, although these terms are not used in tables.

Among male subjects tested only a small proportion (16%)belonged to low work output category of less than 100W, 32% TO 100-120W range and 52%to a higher range of above 120W.Mean values, S.Ds&S.Es of work capacity and all other variables are presented in tables for each of the above categories or sub groups to facilitate comparative analysis.

None of the female subjects tested could attain a work capacity excedding 120W and hence this colum is left blank.80% of them could achieve levels of work output of only less than 100W and 20% between 100-120W.Further look at the <100 category,reveals the proportion performing low at <80W and at 80-100W range.

The individuals relationship between vital capacity,breathing reserve and work capacity are shown graphically by means of scatter diagrams relating the variables in question with work capacity.

In graph 1 ,vital capacity and work capacity are correlated.Although there is positive correlation with a correlation coefficient of +0.52,it is not very high .The P values being <0.025 donot point to a high level of significance.

Graph 2 presents correlation between breathing reserve and work capacity in the same group A subjects.In this group of subjects the correlation of coefficient of + 0.75 and p value of <0.001.

Graph 3 relates the vital capacity (V.C.) in female subjects with work levels. In this instance, the correlation although positive is of too low significance. The correlation coefficient being only+0.4 and the p value of <0.05.

Graph 4 presents the relationship between breathing reserve (B.R) and exercise capacity in the same group B subjects. The correlation is low with correlation coefficient at +0.5 and the significance level (p)at <0.001.

DISCUSSION

Individuals differ widely in their exertional abilities which are determined by a large number of variables such as nutritional status, age, hemo-dynamic f& respiratory capacities, muscular strength, environmental factors, skill, motivation etc. In the light of these complexities, what can be accomplished is to interpret work capacities against some chosen variables while freezing others to the barest minimum possible.

As can be seen from statistical data derived from Table 1, the male subjects had a mean height of 170.7+7.9 cms mean weight of 60.6+6 Kgs. The mean height for female subjects was 160.36cms+6.78 and mean weight was 51.36+8.58 Kgs., as shown in the table of statistical data derived from Table II.

Exercise testing on bicycle ergometer is employed and the type of test used had been progressive incremental exercise testing.

Group A (male) subjects so tested on bicycle ergometer had a mean work capacity of 114.32 W ±19.18 while Group B (female) subjects reached a mean work level of 87.24 W+7.81 as can be seen from statistical data under Table I & II respectively. Thus a distinct sex difference in work capacities is obvious with females having lower work capacities than their male counterparts in the same age group. Other factors also influence and limit 02 consumption by the muscles. Which are

- Exercise R.Q (Respiratory Quotient)
- The degree of dissociation of oxy Hb in the tissues
- The volume output of the heart.
- The rate of blood flowing through the muscles and
- Pulmonary ventilation.

No single factor can be said to be dominating factor, since during severe work, it is possible that each has its effect. During extremely heavy work states, the co-efficient of oxygen utilization may increase to over 75%. An increase in muscle blood flow and an increase in muscle 02 consumption to well over 15 times the resting state is to be expected. In superbly conditioned individuals, i.e. in individuals possessing excellent cardiovascular and pulmonary response, the muscle O2 uptake may be increased up to 24 times that of resting state. It is therefore logical that the total body 02 consumption (V02) at peak dynamic exercise is a good correlate of work capacity. An increase in V02 may result from an increased Cardiac output (central) or from an increased oxygen extraction (peripheral) or both.

The role of Ventilatory capacities- as limiting factors to exercise is more controversial. Opinion is divided in this regard. It is well known that adequate pulmonary ventilation is an elementary prerequisite in the 02 up take process. Perhaps no other exercise form is so subtly or extensively practiced as respiratory gymnastics. Breath holding is urged upon swimmers and track athletes specializing in the sprint events. The physiological basis of breath-holding, is related to chemical-neural control of respiration. The pendulum has swung from deep breathing exercises to breath-holding to voluntary over breathing. Many individuals especially athletes practice the technique of voluntary hyperventilation.

During these maneuvers, a substantial amount of CO2 will be eliminated and an improvement in blood oxygenation will result. As reported Haldane breath-holding ability is improved by hyperventilation.

Against this backdrop, an attempt is made to study the relationship between certain ventilatory capacities and work output. Since vital capacity is believed to bear an important relationship to physical fitness, this parameter is recorded in all the test subjects to see if a correlation exists with work capacity. It is evident that male subjects under Group A showed a mean vital capacity value of 3.34+/-1.29L, while the females under Group B had mean value of 2.5+/-0.44L. These values are at variance to the normal values quoted in western literature for males as 4.81 and 3.21 for females on the average. The relationship between vital capacity (V.C) in liters and the work capacity' is depicted in Graphs I and 3 for males and females respectively. In both cases the scatter of the dots is far from the regression line suggesting a doubtful relation. In the case of male subjects the correlation coefficient was found to be +0.52 and a p value of <0.025. In females the correlation was even less with\ a coefficient of +0.4 and a 'p' value of <0.05. These comparisons are summarized in table III. In accordance to the values presented, the co-efficient of determination reflects the position; it being 25% in males and far less at 16% in females. From these results it can be assumed that vital capacity bears a weak correlation to work capacity of the individuals, atleast in this study. These results are in agreement with those of Wahlund who holds the view that vital capacity is not important in this assessment of work capacity [1].

Others such as Benjamin Ricci regard vital capacity is important in defining physical fitness [2]. A reduced vital capacity from whatever cause is reflected in a reduced response of pulmonary function to elevated work states, hence to reduce capacity of physical performance. They suggest vital capacity perse is not so significant but must be related to body weight & body surface area to be more meaningful. Many studies establish a close relationship between V.C to height and body surface area and to athletic performance. Mathematical formulas were derived to predict maximal working capacity (Wmax) from vital capacity such as W max=335(V.C)-439kgm/min. As with W V.0 was closely correlated to V02 max. (maximal 02 up take) [3]Kannel and workers (1983), in a large prospective Framinghan study -arrived at the conclusion that V.C can be used as a predictor of V02 max (r+0.86). Again mathematicaI computations can be used to arrive at VO2 max values from V.C values by the use of formulas such as VO2Max =0.74 (V.0)-1.04 1/min. While these studies reckon VAC as a reliable predictor of Maximal working capacity (W max) and also V02 mqx, there is much divergence of opinion.

It is probable that respiratory superiority of the trained athlets lies not so much on larger vital capacity but on greater ability to maximize breathing. They may achieve greater respiratory minute volumes during strenuous exertion. Pulmonary ventilation is remarkably adjusted in relation to 02 requirements. These observations have led to investigations of whether pulmonary ventilation can be used as an index of energy expenditure. Respiratory Minute Volumes (R.M.V) and also Maximum voluntary ventilation (M.V.V) are determined in the test subjects to examine their role as limiting factors of exercise.

To allow some estimation of the dynamic respiratory reserve [4] Hermannsen introduced the concept of Maximum Breathing Capacity (MBC) also known as M.V.V. Principally M.V.V depends on the muscular forces one can summon to attain it. The involvement of accessory muscles of inhalation contributes to greatest increase in ventilation during exercise. The musculature surrounding the chest wall especially those muscles which aid in forced inhalation become fatigued and may limit exercise. This forms the rationale of determining M.V.V. The mean values of R.M.V and M.V.V recorded in the present study are 5.39+/- 2.511 and 69.09+/-9.851 respectively in males and 2.99+/-0.62 1 & 55.38+/-6.42 I respectively \in females.

The difference between M.V.V and R.M.V is the Breathing Reserve (B.R). As the name implies one can draw upon this reserve capacity under conditions of stress such as muscular exercise. The termination of exercise at the perception of dyspnoea and the use of percentage of B.R as an objective index for dyspnoea justify the attempt relating it to exercise capacity. Since B.R varies as a function of both R.M.V and M.V.V, and for the reasons explained above, only this variable is correlated with work capacity in the present study. On account of low M.V.V values, the B.R recorded in males averaged 64.66+/-11.83Liters and 52.3+/-3.92 Liters in females. The correlation co-efficient(r) in the former is +0.75 and p value <0.001 as can be seen from Graph III, suggesting a strong relationship.

Because of these inconsistencies, no definite conclusions can be drawn on the role of B.R as, a determinant of work capacity. Available literature testifies this fact. Perhaps the best index may be a consideration of pulmonary ventilation required for 1 liter of oxygen. Presently V02 max is found to be a better correlate of maximal exercise capacity.

The onset of fatigue in heavy exercise is often associated with increase in blood lactate concentration. When exercise load is increased progressively, energy supply from aerobic metabolism (oxydative phosphorylation) may not be adequate and therefore anaerobic metabolism (anaerobic glycolysis) must be utilized to supplement the energy supply. As a result blood lactate concentration begins to increase and eventually intercellular acidification takes place. The mechanism by which lactic acid contributes to fatigue is primarily by lowering PH. At low pH the affinity of ca++ ions for tropinion is reduced. Further fall in pH inhibits some key glycolytic enzymes, ex. Glycogen phosphorylase and phospho-fructokinase. Thus lactic acid may affect both the contractile mechanism and energy supply adversely. Thus rise in blood lactate concentration which heralds the transition from aerobic to anaerobic muscle metabolism and triggers fatigue is a valuable indicator of severity of exertion

Although accumulation of lactate is a consequence of exercise it is also an important limiting factor as well. The magnitude of rise in blood lactate levels at different work levels is analysed in this study and presented in and table IV.

Finally the various parameters recorded are analysed in terms of work output ranges and presented in table IV for inter group as well as intra group comparison. All the subjects in the study group are arbotrarily divided into low, moderate and high work capacity groups at ranges of 20 w so as to compare the characteristics of the parameters among these groups and trace the differences. Male subjects performing low under 100 w categories had a mean work capacity of 80+/-8.33w, those in the moderate range of 100-120 w, had a mean work capacity of 108.37+/-8.12 w and those in the higher range had a mean work capacity of 128.53+/-5.10w. Classification of this nature in literature is based on higher values for work capacity, characteristic of Western population. Differences in heights weights and V.Cs between these groups are not significant, but Breathing Reserve Volumes are higher at higher levels of work capacity. The magnitude of rise in pulse rate and blood lactate levels was higher in low performers, successively decreased in groups turning out greater work outputs.Thus,the rise in pulse rate and lactate seem to correlate with Breathing reserve rather with absolute level of work capacity.

None of the female subjects attained a work capacity of over 120w. This group (B) is assigned categorization into 3 sub-groups, 2 of which fall under 100w category (80%) i.e.1) <80 w and 2) between 80-100w, and the third group between 100-120w (20%). The mean work capacities and the parameters for these 3 groups are presented in table IV for comparative analysis.

There are no significant differences in heights & V.Cs between the groups. Differences in B.Rs are obvious, being greater in individuals turning out greater work output,while the rise in pulse rate and lactate showed an inverse relation. The results of [5] lvy *et al*. and [6]Weltman and Katch suggest the possibility that individuals with high endurance could exercise at higher sub maximal exercise loads without increasing their blood lactate as compared with individuals with low endurance ([7]. Ekbblom *et al*. [8] Saltin *et al.* [9]. In other words those with high endurance could theoreticaly delay the onset of lactic acidosis by the shift of anaerobic threshold (AT). It seems reasonable to believe that individuals with high AT would be at a decided advantage in delaying the onset of anaerobic glycolysis and thereby postponing this buildup of lactic acid which has been shown to limit intermediate carbohydrates metabolism and hence work capacity.

SUMMARY & CONCLUSIONS

Work capacities of a group of 50 medical students of both sexes, closely matched in age and physical stature are determined by progressive incremental exercise testing on bicycle ergometer and correlations are sought to be established with selected respiratory endowments such as vital capacity (V.C) R.M.V ,M.V.V and Breathing Reserve. There was no correlation between vital capacity and work capacity in both groups but the relationship of work capacity with B.R is varied, bearing a significant correlation in males and far less in females. But opinion is divided as regards the predictive value of ventilatory capacities on work capacity, some in the affirmative while others negating, based on their own observations. The rise in blood lactate levels and pulse rates in exercise which correspond to the severity of stress, is found to be greater in female subjects than males and. The nature of blood lactate response to exercise may also be a limiting factor of exercise. These observatiohs are in agreement with the reports in available literature.

REFERENCES

1. Wahlund H. Determination of the Physical Working Capacity. A Physiological and Clinical Study with special reference to Standardization of Cardio-Pulmonary Functional Tests. Acta medica scandinavica. 1948;132(Suppl. 215).
2. Ricci B. Physiological basis of human performance. Lea & Febiger; 1967.
3. Kannel WB, Hubert A. Vital capacity is a predictor of cardiovascular disease; the Framingham studies AMER HEART J. 2:311-5, 1983.
4. Hermansen L, Ekblom B, Saltin B. Cardiac output during submaximal and maximal treadmill and bicycle exercise. Journal of Applied Physiology. 1970 Jul 1;29(1):82-6.
5. Ivy JL, Withers RT, Van Handel PJ, Elger DH, Costill DL. Muscle respiratory capacity and fiber type as determinants of the lactate threshold. Journal of Applied Physiology. 1980 Mar 1;48(3):523-7.
6. Weltman A. Relationship between the onset of metabolic acidosis (anaerobic threshold) and

maximal oxygen uptake. J. Sports. Med.1979;19:135-42.

7. Ekbblomastrand PO, Saltin Betal. Effect of training in circulatory response to exercise J.APPL. Physiol.1968; 24:518-528.
8. De Angelis M, Vinciguerra G, Gasbarri A, Pacitti C. Oxygen uptake, heart rate and blood lactate concentration during a normal training session of an aerobic dance class. European journal of applied physiology and occupational physiology. 1998 Jun 1;78(2):121-7.
9. Saltin B, Karlsson J. Muscle ATP, CP, and lactate during exercise after physical conditioning. InMuscle metabolism during exercise. Springer, Boston, MA. 1971; 395-399.