AN EXPLORATIVE STUDY TO ASSESS THE CARDIO PULMONARY RESPONSES TO UPPERLIMB AND LOWER LIMB FREE EXERCISES IN ATHELETES

ULTRA TRUST

REGISTER NO : 27091201

A DISSERTATION SUBMITTED TO THE
TAMIL NADU DR.M.G.R. MEDICAL UNIVERSITY
CHEENAI-600032, TN, INDIA
IN PARTIAL FULFILLMENT FOR THE REQUIREMENT OF THE DEGREE OF MASTER OF PHYSIOTHERAPY

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HEAD OF THE INSTITUTION: ______________________________

PRINCIPAL : ______________________________

Prof: Dr. R.SHANKER, MPT., (O & G)
TMMF. MADURAI

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GUIDE : ____________________________________

Dr. B.RAMKUMAR M.P.T (Cardio)
VICE PRINCIPAL TMMF. MADURAI

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EXAMINER ______________________________

____

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<u>CERTIFICATE</u>

This is to certify that the project work entitled "**An Explorative Study to Assess the Cardio Pulmonary Responses to Upperlimb and Lower Limb Free Exercises In Atheletes"** was done by **P. Balamurugan** a bonafide student of **Master or Physiotherapy under the Tamil Nadu Dr. M.G.R. Medical University, Chennai.**

Principal

Prof. Dr. R. SHANKER MPT., (O & G)
TMMF. MADURAI

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AN EXPLORATIVE STUDY TO ASSESS THE CARDIO PULMONARY RESPONSES TO UPPER LIMB AND LOWER LIMB FREE EXERCISES IN ATHELETS

Abstract

The purpose of this study is to enhance the idea towards prescribing a standard exercise programme to the cardio Pulmonary risk patients. By understanding the difference in physiologic response between upper and lower extremity free exercises, the professionals can formulate a standard exercise programme.

About 15 athletes were selected randomly and conducted the study in **BAMA HOSPITAL & BAMA SPORTS CLUB, Vadakkampatti.** To these individuals, the resting Blood pressure, Heart Rate were monitored and pressure product is calculated. Then the prescribed free exercises, given to the subject were done to upper extremity. Then the Heart rate, Blood pressure was monitored and Rate pressure product is calculated.

On the consecutive day, the and post test values were calculated while doing lower extremity free exercise.

Then the difference in hemodynamic changes were calculated by using “t” test.

From the results we can conclude that hemodynamic changes while doing upper extremity free exercise is more than lower extremity free exercise.

This study aids in prescriping a standard exercise programme for cardio-pulmonary patients.

AN EXPLORATIVE STUDY TO ASSESS THE CARDIO PULMONARY RESPONSES TO UPPER LIMB AND LOWER LIMB FREE EXERCISES IN ATHELETS

INTRODUCTION

Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure. Physical activities are of two types, static activity and dynamic activity. A static activity is defined as sustained muscle contraction against a fixed load resistance with no change in length of the involved muscle or joint motion. A dynamic activity is the physical exertion characterized by rhythmic repetitive movements of large muscle groups.

Cardiac Rehabilitation, including exercise training, patient and family education and counseling, and risk factor modification has become and accepted component of the care plan for patients with cardiac disease. Exercise training, an important element of a rehabilition program, affords important benefits for most cardiac patients.

The reason often given for exercise training in cardiac rehabilitation is that of improved psychological well being.

A detailed analysis of cardio-pulmonary reference to the heart rate blood pressure, may indicate the amount of stress that may impact on the individual.

The study ascertains a safer prescription of dynamic exercise to the individuals with cardio-pulmonary disorder.

Need for the study

As the aim of cardiac Rehabilitation programme is to achieve an optimal health status and maintenance of the status in each patient.

As the aim of Cardiac Rehabilitation programme is to achieve an optimal health status and maintenance of the status in each patient.

Lack of secondary prevention has become the major cause of occurrence or recurrence of cardiac problems.

So a knowledge of cardio-Pulmonary response dynamic exercises helps the clinicians to determine the level of cardio pulmonary stress which can be implicated to patients.

This put forward the need for the study.

AIM

The purpose of the study was to compare the cardio pulmonary vascular response while doing repetitive free exercises for upper and lower limb.

HYPOTHESIS

The cardio Pulmonary response is more while repetitive free exercises for upper limb than lower limb.

NULL HYPOTHESIS

The cardio- pulmonary response is not more while doing repetitive free exercises for upper limb than rower limb.

KEY WORDS

Cardio- Pulmonary response :

In this study refers to,

Heart ,Rate	:	H.R
Blood pressure	:	B.P
Systolic blood pressure	:	S.B.P
Diastolic blood pressure	:	D.B.P
Rate pressure product :	:	R.P.P

LIMITATIONS:

The study is limited to,

- Healthy athletic are only male subject were included.
- Only to age group of 18-23 yrs were included.
- Generalizations is not possible because the sample size is small.
- Only normal individuals are included.

OPERATIONAL DEFINITION

HEART RATE

The number of beats per minute (b/m) is calculated as heart rate "It is an extremely useful indicator of response to activity "It is measured by counting the pulse (in healthy individuals) or read from ECG readings.)

Normal values:

Adult male : 72 Beats per minute (ranges from 70 -90 beats per/min)

BLOOD PRESSURE

Arterial blood pressure Pressure exerted defined as the of blood on the Hydrostatic wall of the arteries.

Systolic pressure

This is the maximum pressure exerted on the arterial wall during the systole of the heart.

Diastolic pressure

This is the maximum pressure exerted on the arterial wall during the diastolic of the hearts

It is measured with a device called **Sphygmomanometer.**

Normal values:

Systolic pressure	-	120 mm of Hg
Range	-	110-140 mm of Hg
Diastolic pressure	-	80mm of Fig
Range	-	60-90 mm of Hg

RATE PRESSURE PRODUCT

The rate pressure product is the reliable index of myocardial oxygen consumption in patients as well as in Normal people it is obtained by the formula,

$$\text{Rate pressure product pressure} = \frac{\text{heart rate X systolic blood pressure}}{100}$$

FREE EXERCISES

It is any form of active exercise in which a dynamic muscle contraction is obtained by no external force except gravity.

LITERATURE REVIEW

- KERBER, MILLAR and , NAJGAR in showed that dynamic exercise is more likely to produce ischemic changes than isometric contractions.
- TONER et al in 1983 , demonstrated that there are higher hemodynamic changes during combined static and dynamic exercises.
- BHAMBHAN, BHURNHAM , SINGH.M. GOMES .P, 1989, demonstrated that energy expenditure increases in a liner fashion with increased muscle work" And hemodynamic responses can he obtained by systolic blood pressure and rate pressure product.
- GOBEL tt971), NORSTORM (\978), METNER (1983), HOSSAC (1987) investigated hemodynamic responses during various types of exercises with the above parameters this is the reason for utilizing these parameters in this study"
- Energy expenditure was monitored through heart rate which was considered as a valid tool for measuring energy expenditure .This was shown by CAPANII "F , CONSOLI .A , DEL PONTE . A ,GUAGNANO.T, LEZZI.M, SENSI.S. So monitoring of heart rate

was included in this study"

- Measurement of myocardial oxygen demand involves invasive procedure which is reactive clinical examination is not feasible. Simple non-invasive measure of, cardio-vascular response however can be obtained with systolic blood pressure , heart rate Rate pressure product , which was utilized as an important parameters in this study of NORSTROM (1978), GHLOBAL.H, WEINER (1983), HOSSACK (1987), that is why parameters were included in this study.
- ANTONIOPETTA (1998) had worked on ventilator and cardiovascular response and the rating of exertion to three types of upper limb exercises and discussed that there was a significant change in the cardio-respiratory system and suggested that it is typical of exercises used by the physiotherapists in post operative cases,
- HOSSACK (1987) CHENEAU and numerous investigators reported the marked increase of cardio-respiratory (HRSPP,RPP,RR) response to dynamic exercises.
- Mc-ARDLE et al (1996) reported the stable or slight increase or decrease in Diastolic Blood Pressure.

- changes during exercises depends on types of exercises and muscles involved.
- FRANKLIN (1985) reported that the differences in cardio-vascular responses to arm versus leg exercise at identical work loads may be due to several factor

METHODOLOGY

RESEARCH DESIGNS

The research design for this study was experimental design with pre-test and post-test"

STUDY SETTING

The study was conducted in the out-patient department of BAMA HOSPITAL & BAMA SPORTS CLUB, VADAKKAMPATTI, Madurai, Tamil Nadu.

CRTTERIA FOR SELECTIOIN

INCLUSION CRITERIA

,

- Healthy male Athletics were selected
- Age group of 18-23 years was selected"
- Body mass index 25-27 were selected.

EXCLUSION CRITER.IA

- Students with any cardiac problems were excluded.
- Deformed upper or lower extremities were excluded
- Smokers were excluded
- History of illness for the past 1 year was excluded.

EQUIPMENT USED

BLOOD PRESSURE AND PULSE RATE MONITOR

Automatic blood pressure monitor with heart rate sensor was used to record blood pressure and pulse rate [refer appendix for company instructions] The validity and reliability was cross checked with manual sphygmomanometer.

HEIGHT MEASURING SCALE

WEGHITING MACHINE

RESERCH TOOLS

- Heart Rate
- Blood Pressure
- Rate Pressure Product

TEST PROTOCOL

Subjects went to 2 test conditions, upper extremity free exercise (which Includes shoulder flexion and abduction)

Lower limb exercise (which includes knee Flexion and extension AND ankle dorsi and plantar flexion) Practice sessions and test were done on consecutive days.

For preparations to testing procedures, refer (APPENDIX)

DATA COLLECTIOIN PROCEDURE

The subject is made to sit comfortably and relaxed on a chair. Then the subject's name age sex height and weight were recorded and the body mass index is calculated.

The subjects were instructed with demonstration the practice of, free exercises and made to become familiar with the performance of the exercises.

The subject is asked to do the upper extremity exercises . After the completion of exercises, the blood pressure and heart rate were calculated at once after assuming the reference position and the rate pressure product were calculated

On the next day. the same steps were followed and the resting blood pressure and heart rate calculated. Then the subject is asked to do the lower limb exercise . The Blood pressure and heart rate were monitored at once after the completion of exercises after assuming the reference position. The rate pressure product was calculated.

Note:

All the exercise prograrnme are carried out at the room temperature.

EXPLORATION OF DATA,

DATA ANALYSIS

In this chapter we deal with the analysis interpretation and discussion of the collected data.

STATISTICAL PROCEDURE

Paired T-test is used to find out any significant difference between the pre and post-test scores of heart rate. Blood pressure and rate pressure product"

While doing upper limb and lower limb free exercises.

FORMULA

For paired t test,

MEAN

$$\overline{X} = \frac{\sum X_n}{n}$$

Standard deviation

S: $(d - \overline{d})^2$ n-1

S.E:S/√n

Paired t- test

T=$\overline{d}$/S/√n=$\overline{d}$/s.E

TABLE 1

DISTRIBUTION OF SUBJECT ACCORDING TO AGE

S.No	Age In Years	No of Subjects	%
1	18-20	11	55
2	21-23	9	45
	Total	20	100

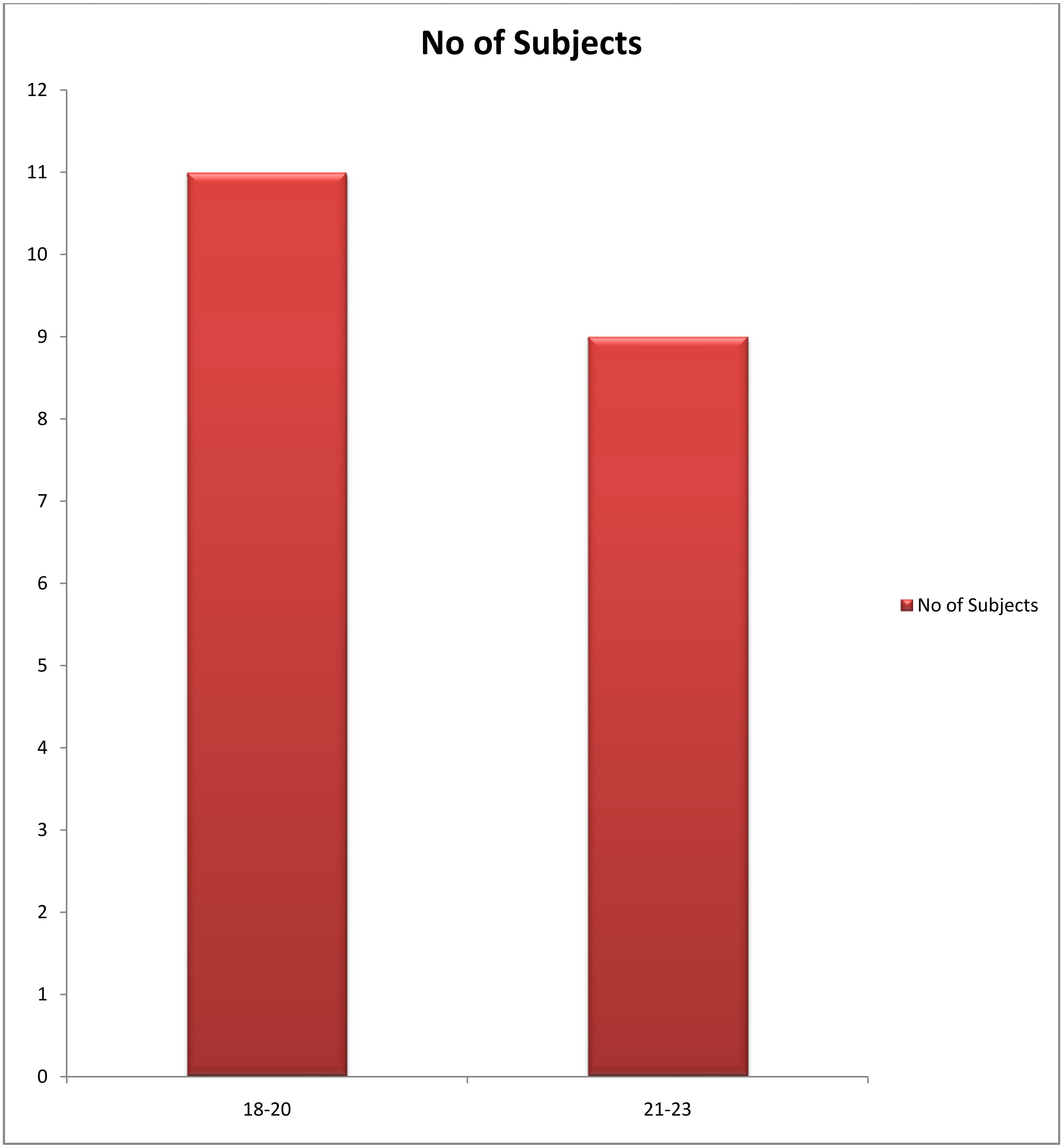

No of Subjects
12
11
10
9
8
7
6
5
4
3
2
1
0
18-20
21-23
No of Subjects

TABLE 2

MEAN AND STATEMENT DEVIATION OF AGE, WEIGHT, HEIGHT & BMI

S.No	Variables	Mean	S.D
1	AGE	20.4	1.8
2	WEIGHT	59.88	6.99
3	HEIGHT	170	3.45
4	BMI	20.70	2.79

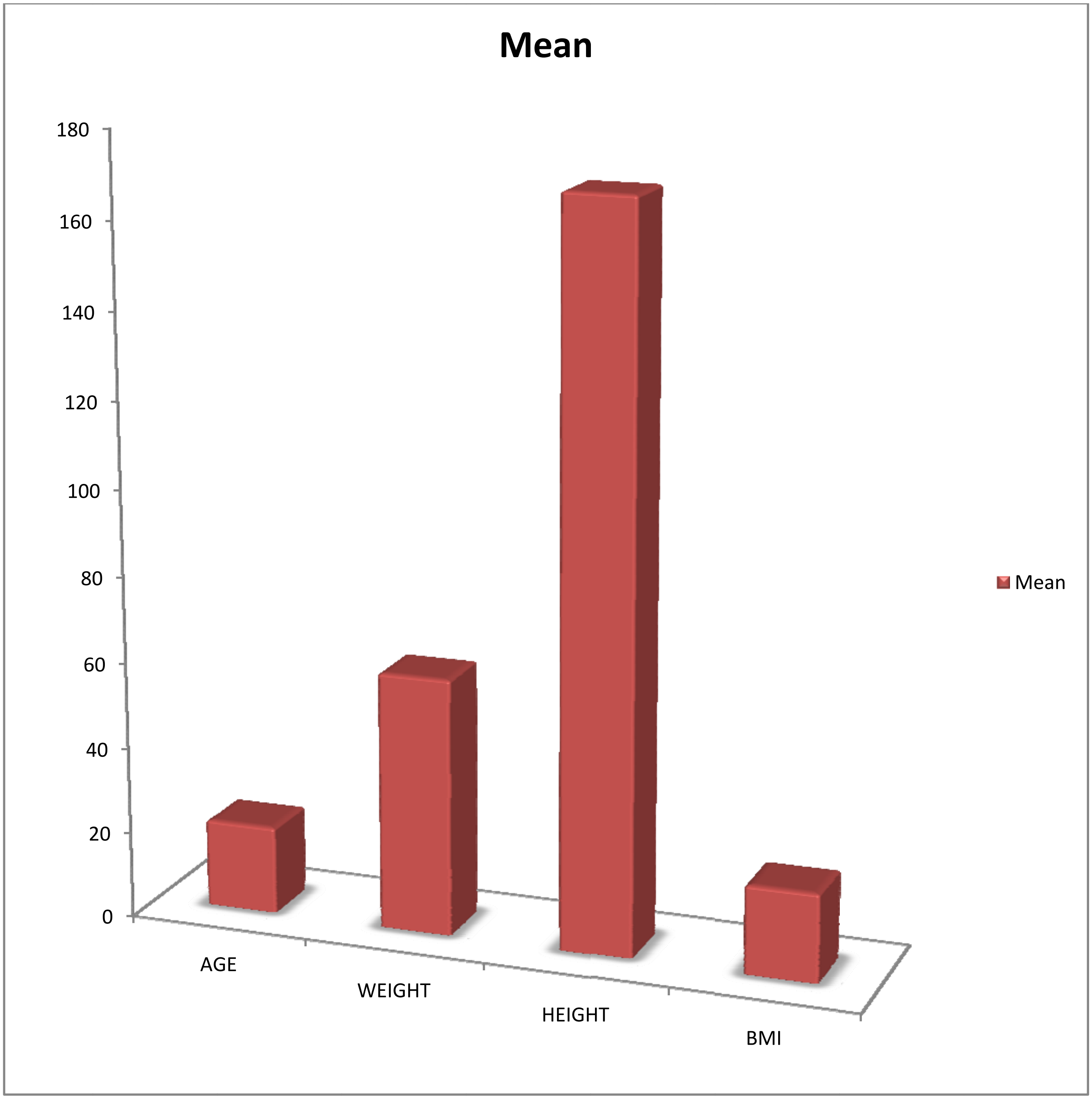

Mean
180
160
140
120
100
80
60
40
20
0
AGE
WEIGHT
HEIGHT
BMI
Mean

TABLE 3

MEAN AND STANDARD DEVIATIONOF PRE AND POST SCORE OF HEART RATE

S.No	Extremity	Heart Rate				
		Pre test		Post test		% of increase in heart rate
		Mean	S.D	Mean	S.D	
1	Upper limb	71.95	1.56	76.4	1.24	6.2
2	Lower limb	70.9	2.07	73.7	1.1	3.96

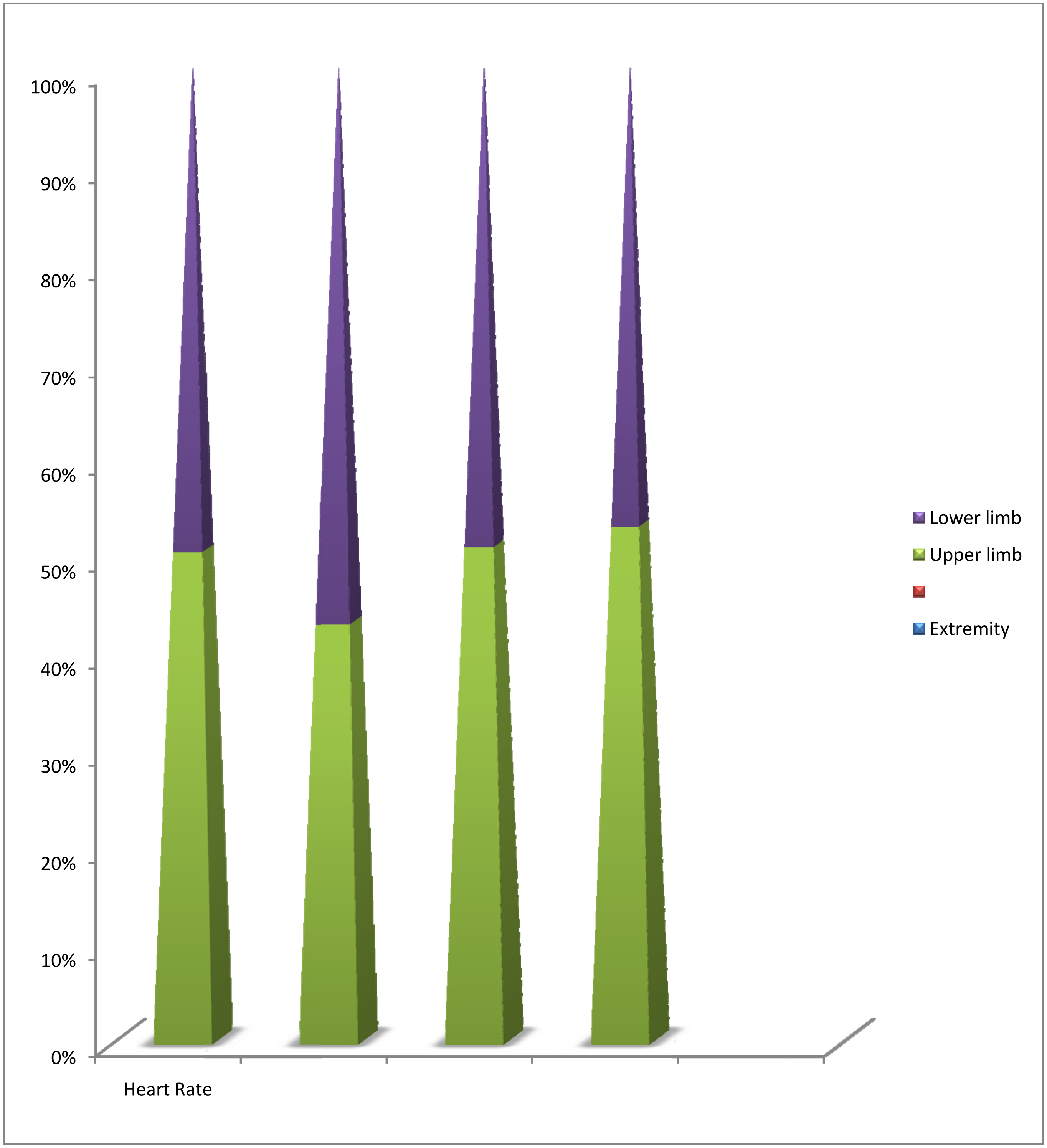
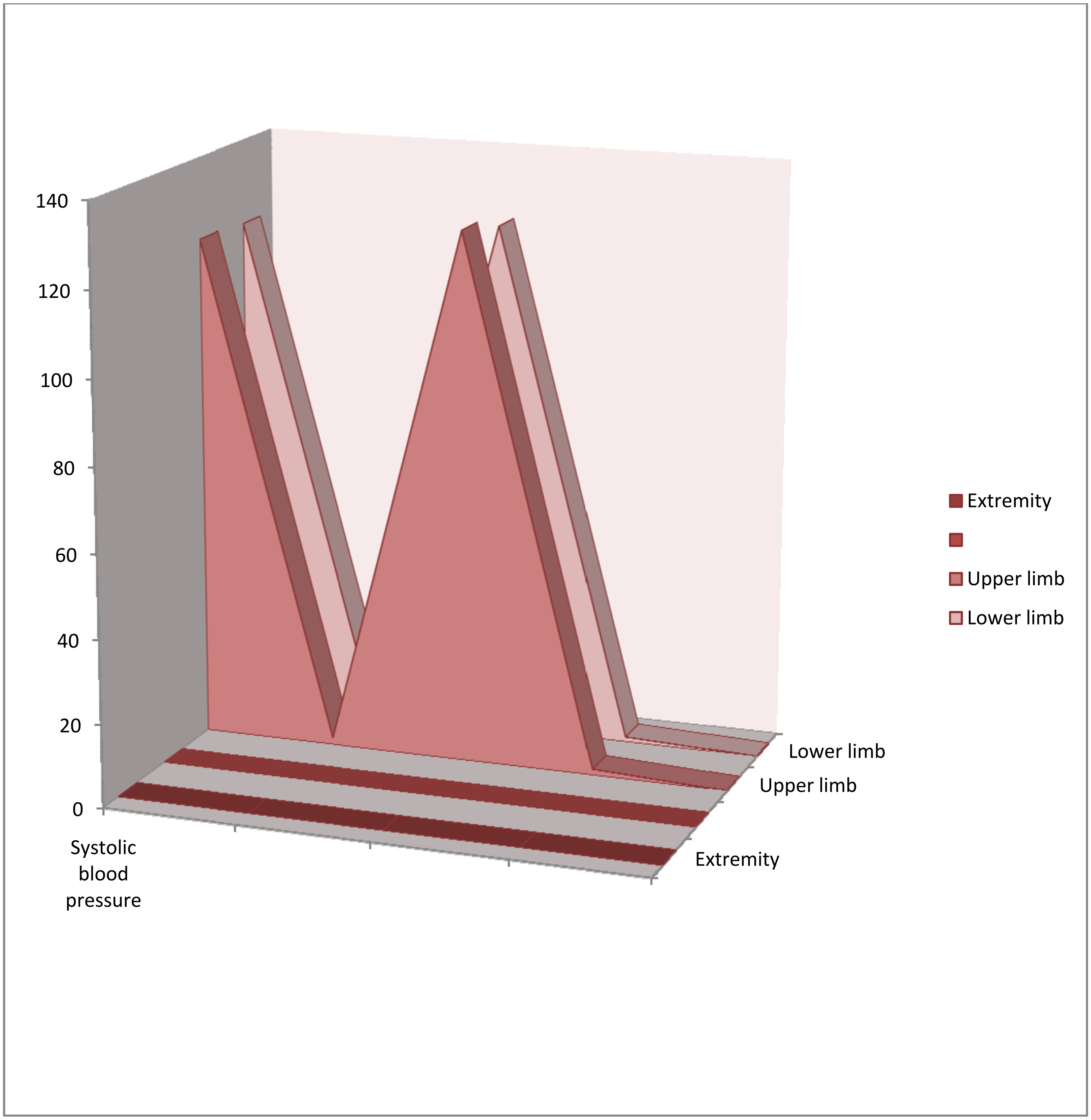

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Heart Rate
Lower limb
Upper limb
Extremity

TABLE 4

MEAN AND STANDARD DEVIATION OF PRE AND POST SCORE OF SYSTOLIC BLOOD PRESSURE

S.No	Extremity	Systolic blood pressure				
		Pre test		Post test		% of increase in heart rate
		Mean	S.D	Mean	S.D	
1	Upper limb	120.65	1.652	126.95	1.47	5.22
2	Lower limb	119.7	1.6	123.35	1.19	3.04



140
120
100
80
60
40
20
0
Systolic blood pressure
Lower limb
Upper limb
Extremity
Extremity
Upper limb
Lower limb

TABLE 5

MEAN AND STANDARD DEVIATION OF PRE AND POST SCOREOF DIASTOLIC BLOOD PRESSURE

S.No	Extremity	Diastolic blood pressure				
		Pre test		Post test		% of increase in heart rate
		Mean	S.D	Mean	S.D	
1	Upper limb	80.35	1.352	83.15	1.24	3.5
2	Lower limb	79.45	1.32	82.55	1.24	3.9

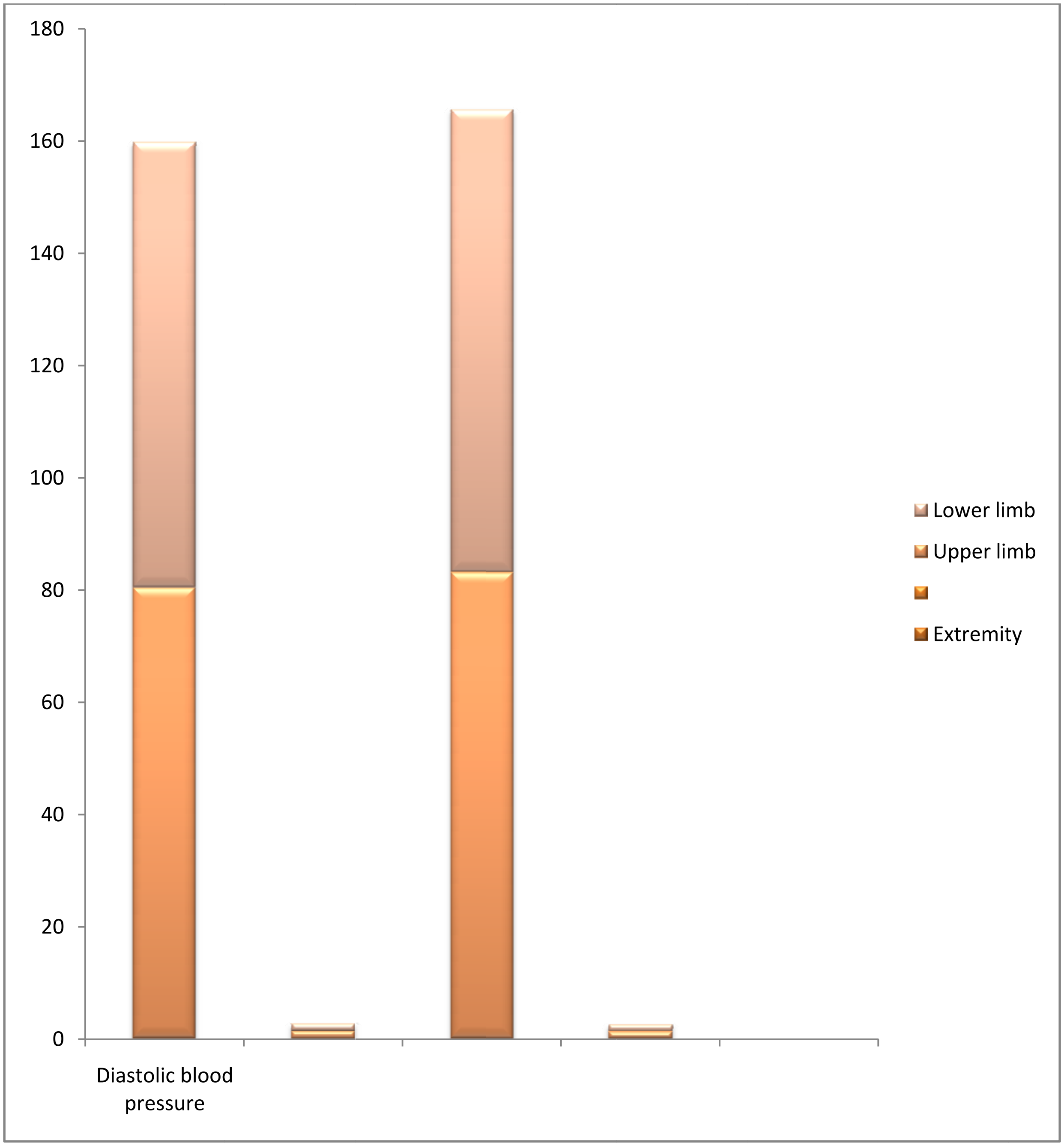

180
160
140
120
100
80
60
40
20
0
Diastolic blood pressure
Lower limb
Upper limb
Extremity

TABLE 6

MEAN AND STANDARD DEVIATION OF PRE AND POST SCORES OF RATE PRESSURE PRODUCT

S.No	Extremity	Rate pressure Product				
		Pre test		Post test		% of increase in heart rate
		Mean	S.D	Mean	S.D	
1	Upper limb	86.83	2.963	97.00	2.55	11.7
2	Lower limb	84.85	2.7	90.91	1.81	7.1

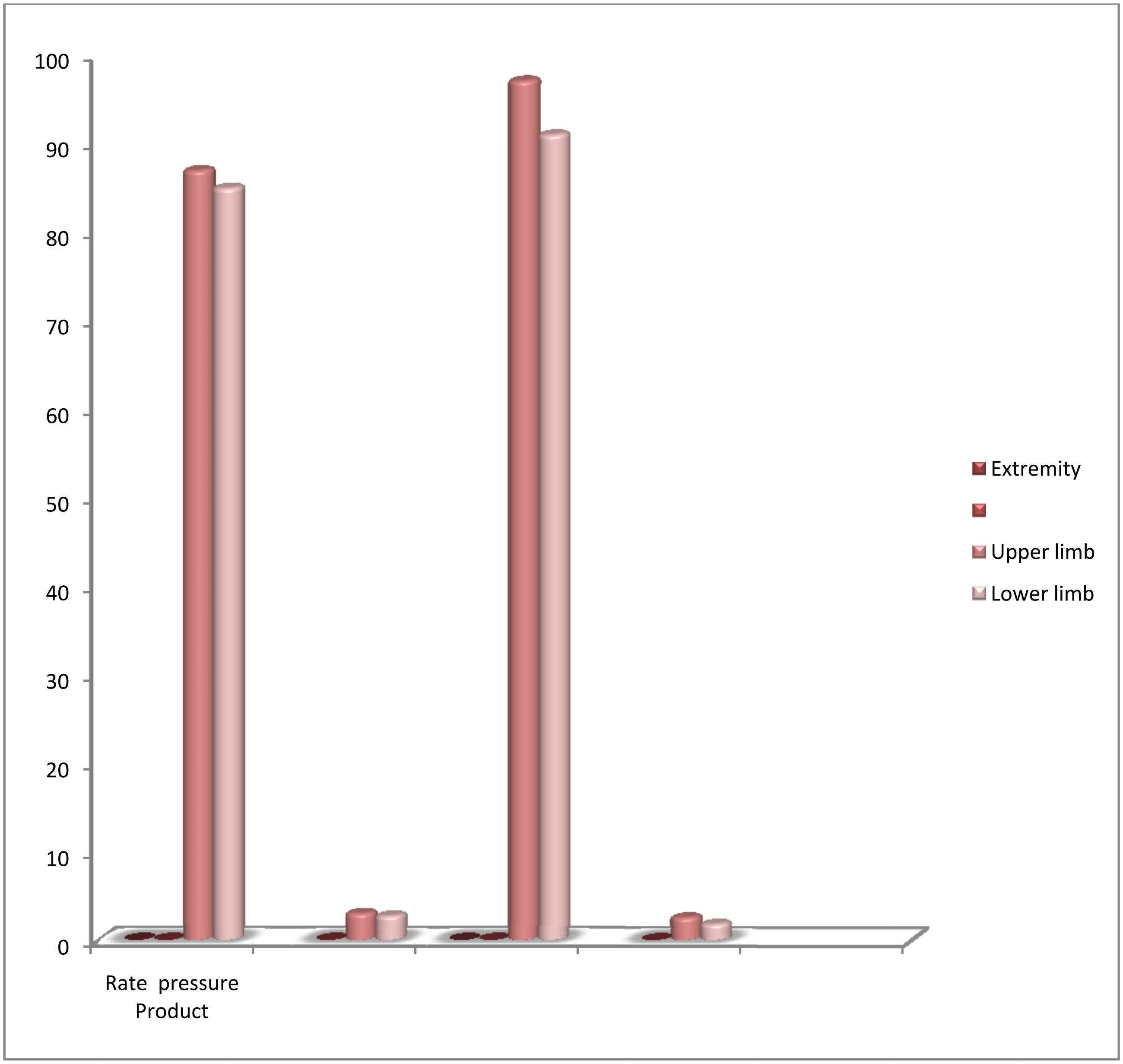

100
90
80
70
60
50
40
30
20
10
0
Rate pressure Product
Extremity
Upper limb
Lower limb

TABLE 7

PAIRED " t" TEST ANALYSIS OF UPPER LIMB AND LOWER LIMB

S.No	Variables	Upper limb		Lower limb	
		t-value	Results	t-value	Results
1	Heart rate	38.76	Significant	20.29	Significant
2	Systolic blood pressure	32.642	Significant	15.00	Significant
3	Diastolic blood pressure	9.259	Significant	49.93	Significant
4	Rate pressure product	44.65	Significant	33.67	Significant

*** Significant at∞= 0.0001 level.**

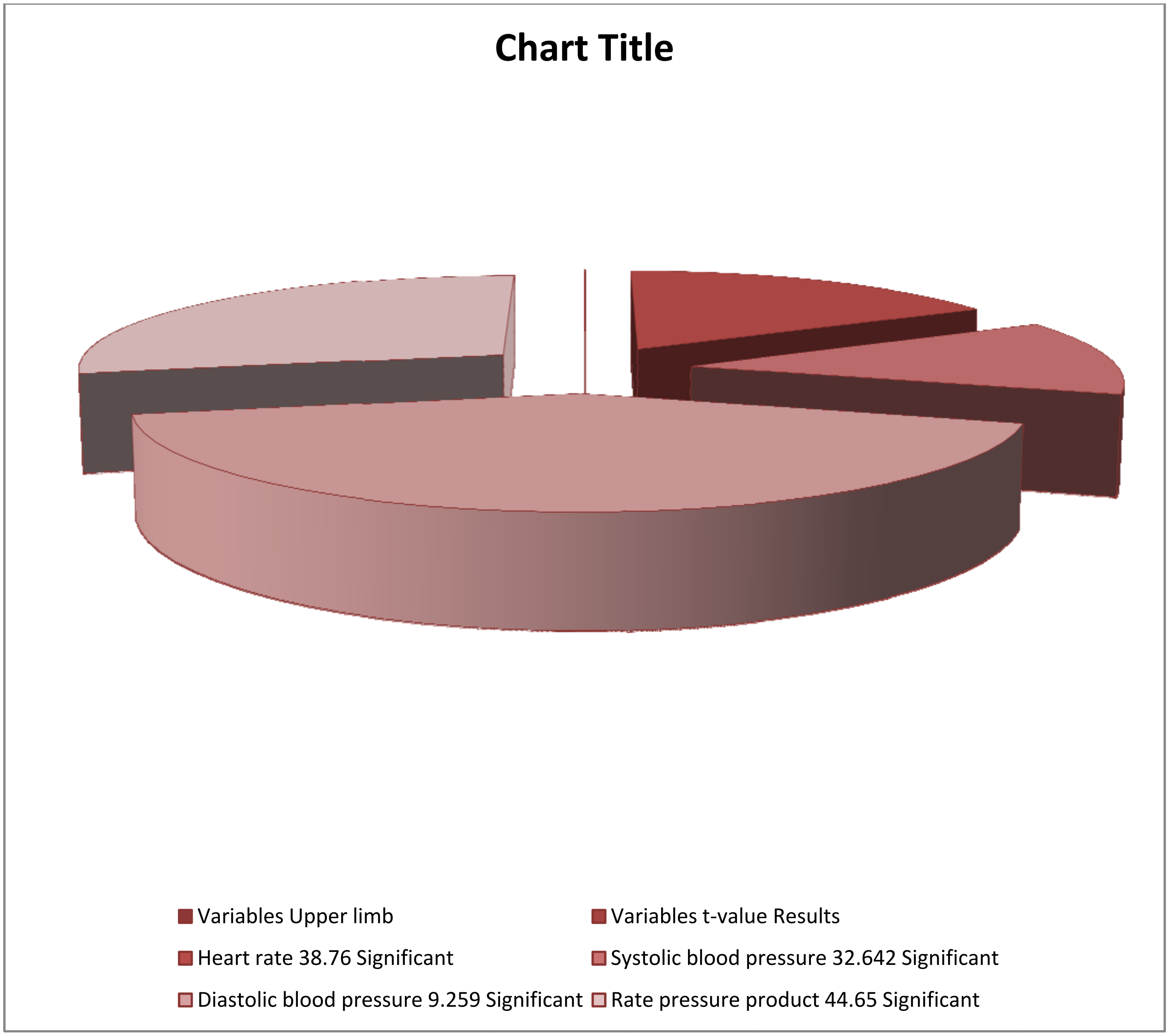
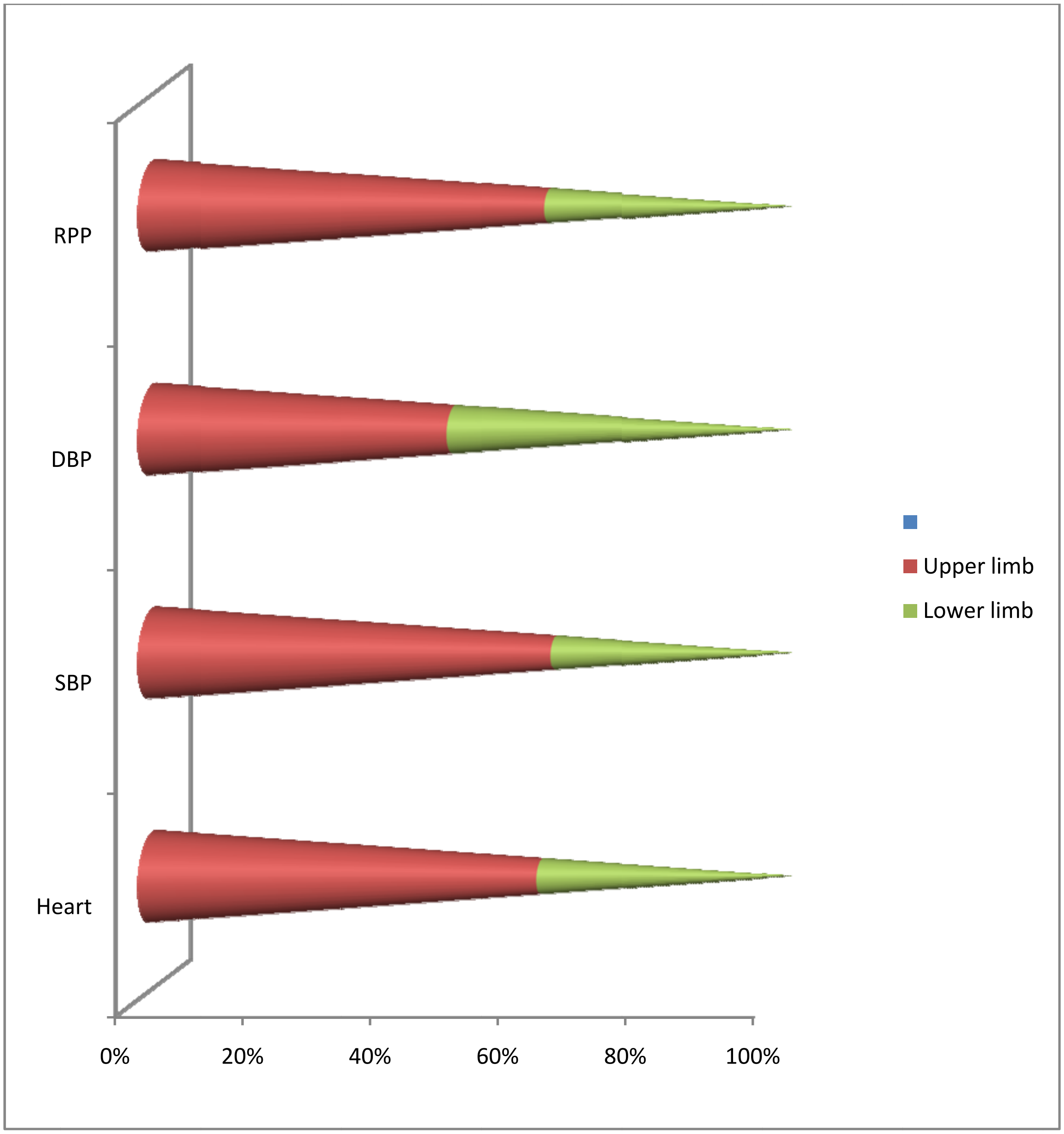


Chart Title
Variables Upper limb
Variables t-value Results
Heart rate 38.76 Significant
Systolic blood pressure 32.642 Significant
Diastolic blood pressure 9.259 Significant
Rate pressure product 44.65 Significant

TABLE 8

Percentage of increase in mean scores of heart rate, Systolic Blood pressure, Diastolic Blood pressure, Rate pressure product

S.No	Limb	Heart Rate	SBP	DBP	RPP
1	Upper limb	6.2	5.22	3.5	11.7
2	Lower limb	3.96	3.04	3.9	7.1


RPP
DBP
SBP
Heart
0%
20%
40%
60%
80%
100%
Upper limb
Lower limb

RESULTS

The demographic information includes,

Mean Age	:	20.4 [sd = 1.8]
Mean Height	:	170 [sd = 3.45]
Mean Weight	:	59.88 [sd = 6.99]
Mean Body mass index (Kg/lm2)	:	20.70 [sd = 2.79]

From the following results , we could find that is no significant difference observed among the demographic data and also shows, the subjects are homogenous.

The following results were attained after Statistical analysis using paired 't' test.

Heart rate showed a significant difference between pre and post test values at 0.0001 level of significance.

Systolic blood pressure showed a significant difference between pre and post test values at 0.0001 level of significance.

Diastolic blood pressure showed a significant difference between pre and post test values at 0.0001 level of significance.

Rate pressure product showed a significant difference between pre and post test values at 0.0001 level of significance.

By the above analysis we find the heart rate, systolic blood pressure, diastolic blood pressure and rate pressure product showed a significant increase while doing upper limb free exercise than lower limb free extremity there by supporting experimental hypothesis.

DISCUSSION

The study which includes the athletes was given upper extremity and lower extremity free extremity on consecutive days. Their pre and post-test value of heart rate, systolic blood pressure, diastolic blood pressure and rate pressure product were calculated and analyzed.

When comparing the mean scores of, pre and post-test values of upper extremity free exercises, we find a marked increase in mean values of these parameters.

When comparing the pre and post-test values of lower extremity free exercises, we find a marked increase in mean values of these parameters.

When comparing the mean scores of pre and post-test values of upper limb and lower limb free exercises, we find that there is a significant increase in those parameters in upper extremity free exercises than lower extremity free exercises [under 0.0001 level of significance]

This shows that cardio- pulmonary responses are more while doing upper extremity free exercises than lower extremity free exercises. So we reject the null hypothesis and accept the hypothesis.

CLINICAL IMPLICATION

As the study results indicate the absolute increase of cardio-pulmonary response may be in consequential in a person with out cardio-pulmonary pathology. How ever it may constitute a marked haemodynamic strain in an individual with such pathology. This is true for persons with risk factors and who have asymptomatic cardio-vascular pathology therefore, the standard exercise evaluation should include cardio pulmonary risk factors and the patients should be warned not to exceed the prescribed repetitions for a home program.

By understanding the difference in physiologic responses between upper and lower extremity exercises, the professionals can formulate exercises programme for specific diagnosis and training.

CONCLUSION

The results indicate that the absolute increase of cardio- Pulmonary , responses may be in consequential in a Athletes without cardio -pulmonary pathology.

Monitoring the haemodynamic responses while doing free exercises to upper and lower extremity provides a index of, the work Cardio -pulmonary System.

This provides defensible guidelines and prevents carrying on the side of caution in these persons who are at risk of Cardio-pulmonary conditions.

It is concluded that the cardio-pulmonary system responses are more while doing upper limb free exercises than lower limb free exercises.

RECOMMENDATIONS

The test can be done with ,

- Cardio- Pulmonary patients
- Large sample size
- Female subjects
- Effects of respiratory system can also be included

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APPENDIX-l

BODY MASS INDEX (390- ACSM)

BODY MASS INDEX is a ratio of weight to height in adults that indicate body composition. BMI can be used to determinate the degree of adiposity without accounting for the body frame size. It is calculated by the quetelet equation,

$$BMI = weight\ (kg) / [height\ (m)]^2$$

The BMI correlates the least with the body height and the most independent measures of body fatness in adults, including of the elderly. ABMI score of 20-25 is associate with the lowest risk for excessive or deficient adipose tissue.

Obesity is divided into three grades

Grade I 25 -29.9

Grade II 30 -40

Grade I above 40

A BMI of atleast 27 indicates obesity and increased health risk" BMI increases with age, therefore age-specific guidelines for interpreting the BMI in the elderly have been recommended.

APPENDIX -2

GENERAL GUIDELIENS FOR INDIVIDUAL EXERCISE PROGRAMING

1. Exercise only when feeling physically well. wait until symptoms and signs of, a "cold or the flu" (including fever) have been absent 2 days before resuming activity.
2. Do not exercise vigorously soon after eating. wait at least 2 hours. Eating increases the blood flow requirements of the intestinal tract. During rigorous exercise. the demand of the muscles for blood may exceed the ability of the circulation to supply, both the –bowel and the muscles. depriving organs of blood, resulting in cramps, nausea, or faintness.
3. Drink fluids. water is generally- the replacement fluid of, choice for most individuals. specific recommendations regarding the amount of fluid needed to replace that lost in sweat through exercise are difficult to provide, because this will vary depending on the training intensity and duration. Environmental conditions, and health status of the individual. In general, water should be taken before, during, and after any moderate-to-vigorous intensity exercise >30 minutes in duration. Disease and medications may increase susceptibilit5, to heat illness and fluid loss. Elderly persons. obese individuals, and those taking diuretics and other antihypertensive

medications are particularly prone to heat illness. Alcohol consumption can precipitate heat stress due to its effects on vasomotor tone and volume status.

4. Adjust exercise to the weather" Exercise should be adjusted to environmental conditions. Special precautions are necessary when exercising in hot weather. It is difficult to define when it is too hot to exercise because air temperature is greatly influenced by humidity and air movement (wind), which are not easy to measure. The following guidelines are recommended for a noncompetitive workout: if air temperature is >70^{o}F, slow the pace, be alert for signs of heat injury, and drink adequate fluids to maintain hydration" A good rule to follow is to exercise at the usual workout pace (rating of perceived exertion, 12 to 16), which may be a slower pace or lower work intensity because of environmental conditions. Acclimatization to moderate levels of heat is gradual and may require 12 to 14 days. Accommodation to extreme heat never occurs. Symptoms or signs of heat injury may be varied at the onset; hence, any symptom should be regarded as evidence of heat overload. The following indications of heat stress are particularly likely to occur: headache, dizziness, faintness, nausea, coolness, cramps, and palpitations. If any of these symptoms are present, stop exercising immediately and go to a cooler environment. If the air temperature is >80"F, exercise in the early morning or late afternoon to

avoid the heat. Air-conditioned shopping malls are popular for walking. Exercise is better tolerated if humidity is low and a breeze is present. Exercise in the heat causes excessive fluid loss; therefore, adequate fluid intake is important before, during, and after each session.

5. Slow down for hills. when ascending hills, decrease speed to avoid overexertion. Again, a useful guide is to maintain the same rating of perceived exertion as in a usual workout.
6. Wear proper clothing and shoes. Dress in loose-fitting, comfortable clothes made of porous material appropriate for the weather. Use sweat suits only for warmth. Never use exercise clothing made of rubberized, nonporous material. In direct sunlight, weather sunlight, Wear light -colored clothing and a cap. Wear shoes designed for exercise (eg. walking or jogging shoes).
7. Understand personal limitations. Everyone should have periodic medical evaluations. When under a physician's care, ask if there are limitations.
8. Select appropriate exercises Endurance exercises should be a major component of, activities. It is recommended that any individual >40 years should take special care to avoid high-impact activities. If such activities are chosen, then- should the initiated at low. Levels and increased slowly. A day of rest between exercise periods permits the body to gradual adapt to stressed s and strains. More attention should also be given to warm-

up and cool- down periods with stretching, low-level calisthenics, and low-level endurance exercises. In general, fast walking is a well-tolerated, low-impact exercise that provides excellent results. Swarming, stair climbing, rowing, and stationary caviling may also be appropriate.

9. Be alert for symptoms" If the following symptoms occur, obtain medical consultation before continuing exercise. Although any septum should be clarified, these are particularly;' important:

   a. Discomfort in the upper body- including the chest, arm, neck, or jaw during exercise . The discomfort nary be of any intensity and may be present as an aching, burning, tightness, or sensation of fullness"

   b. Faintness accompanying the exercise. Sometimes brief light_ headedness may occur after an unusually vigorous bout of exercise or a limited cool-down period. This condition generally does not indicate heart disease and may be managed by exercising at a lower intensity with a gradual cool-down at the end of the session. If fainting or a feeling of faintness occurs during exercise, discontinue the activity until after medical evaluation.

   c. Shortness of breath during exercise. During exercise, the rate and depth of breathing should increase but should not be uncomfortable. A useful guideline is that an ordinary conversation should not be an effort, wheezing should not develop, or not more than 5 minutes should be required for recovery.

d. Discomfort ill bones and joints either during or after exercise. There may be slight muscle soreness when beginning exercise, but if back or joint pain develops, discontinue exercise until after medical evaluation.

10.Watch for the following signs of over exercising:

a. Inability to finish. Training sessions should be completed with reserve.

b. Inability to converse during the activity" Breathing increases during exercise but should not be uncomfortable. When a conversation cannot be conducted during exercise because of difficulty breathing, the conditioning activity is too intense.

c. Faintness or nausea after exercise. A feeling of faintness after intense or has been stopped too abruptly. In any event, decrease of the intensity of the workout and prolong the cool -down period.

d. Chronic fatigue. During the remainder of the day or evening after exercise, an individual should feel stimulated, not tired. If fatigue persists during the day, intensity and/or duration of the workout should be decreased.

e. Sleeplessness. If unable to sleep well despite feelings of fatigue, the amount of activity should be decreased until symptoms subside. Insomnia may occur during distance training. A proper training program should make it easier, not more difficult, to have adequate sleep.

f. Aches and pains in the joints. Although there may be some muscle discomfort joints should not hurt or feel stiff. Check exercise procedures, particularly stretching and warm-up exercises, to ensure that the proper technique is being used. Muscle vamping and back discomfort may also indicate poor technique. If symptoms persist, check with a physician before continuing.

11.Start slowly and progress gradually. Allow time to adapt.

APPENDIX.3

Testing Procedures

Subject Preparation

Preparations for exercise testing include the following.

- The subject should be instructed not to eat or smoke for 3 hours before the test. water may be taken as needed at any time. Subjects should dress appropriately for exercise, especially with regard to footwear. No unusual physical efforts should be performed for at least 12 hours before testing.
- when exercise testing is performed for diagnostic purposes, withdrawal of medications may be considered because some drugs (especially β-blockers) attenuate the exercise responses and limit the test interpretation. There are no formal guidelines for tapering medications, but rebound phenomena may-occur with abrupt discontinuation of β-blockers in patients with a recent acute coronary syndrome. However, most subjects are tested while taking their usual medications. Specific questioning is important to determine which drugs have been taken so that the physician can be aware of possible electrolyte abnormalities and hemodynamic effects of cardioactive drugs.
- A brief history and physical examination should be performed to rule out contraindications to testing or to detect important clinical signs such as a cardiac murmur, gallop sounds, pulmonary "wheezing"" or rales. Subjects

with a history of worsening unstable angina or decompensated heart failure should not undergo exercise testing until their condition stabilizes. A cardiac physical examination should indicate which subjects have valvular or congenital heart disease. Because hemodynamic responses to exercise may be abnormal in such subjects" such subjects always warrant careful monitoring and, at times, may require early termination of testing. Special considerations should be made for those with elevated blood pressure and aortic stenosis.

- If the indication for the testing is not clear, the subject should be the questioned and the referring physician contacted.
- A resting standard 12-lead electrocardiogram (ECG) should be obtained because it may differ from the resting pre-exercise ECG. The "torso" ECG distorts the standard ECG by shifting the axis to the right, increasing voltage in the inferior lead group. This may cause a disappearance of Q waves in a patient with a documented previous Q-wave inferior myocardial infarction (MI).
- Standing ECG and blood pressure should be recorded (in the sitting position with cycle ergometry) to determine vasoregulatory abnormalities and positional changes, especially ST-segment depression.

- A detailed explanation of the testing procedure should be given that outlines risks and possible complications. The subject should be instructed on how to perform the test, and these instructions should include a demonstration" If musculoskeletal or certain orthopedic limitations are a concern, the testing protocol should be modified"

Myocardial Oxygen Uptake

Myocardial oxygen uppake is primarily determined by intramyocardial wall stress (ie, the product of left ventricular [LV] pressure and volume, divided by LV wall thickness), contractility, and heart rate. Other, less important factors include external work performed by the heart, the energy necessary for activation, and the basal metabolism of the myocardium.

Accurate measurement of myocardial oxygen uptake requires cardiac catheterization to obtain coronary arterial and venous oxygen content. Myocardial oxygen uptake can be estimated during clinical exercise testing by the product of heart rate and systolic blood pressure, which is called the double product or rate-pressure product. There is a linear relation between myocardial oxygen uptake and coronary blood flow. During exercise, coronary blood flow increases as much as 5-fold above the resting value. A subject with obstructive coronary artery disease (CAD) often cannot maintain adequate coronary blood flow to the affected region and supply the metabolic demands of the myocardium during exercise;

consequently, myocardial ischemia occurs. Myocardial is chemia usually occurs at the same rate-pressure product rather than at the same external workload (eg, exercise test stage),

Heart Rate Response

The immediate response of the cardio pulmonary system to exercise is an increase in heart rate due to a decrease in vagal tone. This increase is followed by an increase in sympathetic outflow to the heart and systemic blood vessels. During dynamic exercise, heart rate increases linearly with workload and O_2. Heart rate will reach a steady state within minutes during low levels of exercise and at a constant work rate. As workload increases, the time necessary for the heart rate to stabilize will progressively lengthen.

The heart rate response to exercise is influenced by several factors. There is a decline in mean maximum heart rate with age that seems to be related to neural influences. Dynamic exercise increases heart rate more than isometric or resistance exercise. An accelerated heart rate response to standardized workloads is observed after prolonged bed rest, indicating a deconditioning response. Other factors that influence heart rate include body position, type of dynamic exercise, certain physical conditions, state of health, blood volume, sinus node function, medications, and environment.

Arterial Blood Pressure Response

Systolic blood pressure rises with increasing dynamic work as a result of increasing cardiac output, whereas diastolic pressure usually remains about the same or moderately tower, and it may be heard to zero in some normal subjects. Normal values of maximum systolic blood pressure for men have been defined and are directly related to age.

After maximum exercise, there is usually a decline in systolic blood pressure, which normally reaches resting levels within 6 minutes and often remains lower than pre-exercise levels for several hours. When exercise is terminated abruptly, some healthy persons have precipitous drops in systolic blood pressure due to venous pooling and a delayed immediate postexercise increase in systemic vascular resistance to match the reduction in cardiac output. Show the physiological response to submaximal and maximum treadmill exercise on the basis of tests of >700 apparently healthy men aged 25 to 54 years. Maximum rate-pressure product (heart ratexsystolic blood pressure) ranges from a tenth percentile value of 25 000 to a 90th percentile value of 40 000.

Hemodynamic Responses

Blood Pressure During Exercise

Blood pressure is dependent on cardiac output and peripheral resistance. An inadequate rise or a fall in systolic blood pressure during exercise can occur. An inadequate rise in systolic blood pressure (<20 to 30 mm Hg) or a drop can result from aortic outflow obstruction, severe LV dysfunction, myocardial ischemia, and certain types of drug therapy (ie, β- blockers). In some subjects with CAD higher level of systolic brood pressure exceeding peak exercise values have been observed during the recovery phase. In most studies, exercise-induced hypotension in association with other measures of ischemia predicts a poor prognosis, with a positive predictive value of 50% for left main or triple-vessel disease. Exercise-induced hypotension is also associated with cardiac complications during exercise testing (for example. serious arrhythmias), seems to be alleviated by coronary artery bypass grafting (CABG), and can occur in subjects with CAD, valvular heart disease, or cardiomyopathy. Occasionally, subjects without clinically significant heart disease will exhibit exercise-induced hypotension during exercise related to, dehydration, antihypertensive therapy, or prolonged strenuous exercise.

Heart Rate During Exercise

Relatively rapid heart rate during submaximal exercise or recovery could be due to deconditioning prolonged bed rest, anemia, metabolic disorder, or any other condition that decreases vascular volume or peripheral resistance. This finding is relatively frequent soon after MI and CABG. Relatively low heart rate at any point during submaximal exercise could be due to exercise training, enhanced stroke volume, or drugs. The common use of β-blockers. which lower heart rate, limits the interpretation of the heart rate response to exercise. Conditions that affect the sinus node can attenuate the normal response of heart rate during exercise testing. Chronotropic incompetence, which is defined as either failure to achieve 85% of the age-predicted maximal heart rate or a low chronotropic index (heart rate adjusted to MET level). is associated with an increased mortality risk in patients with known cardiovascular disease.

Central Hemodynamic Changes

Although a greater maximal cardiac output can be achieved after training, submaximal values are usually unchanged. Subrnaximai heart rate is reduced after training, with a concomitant increase in stroke volume. The mechanism of these changes is not known, although exercise training has resulted in an increase in myocardial contractility in animals. Depicts relations of heart rate and stroke volume before and after training.

PROFORMA

Name :

Age : Sex :

Height : Weight :

B.M.I : Occupation :

Address

Dependent variables/ Parameters	Upper Limb		Lower Limb	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
Heart- rate				
Systolic blood pressure				
Diastolic blood pressure				
Rate pressure product				

Signature of the Subject **Signature of the Therapist**