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Original Research Article

Comparison of Heart Rate, Heart Rate Reserve and Oxygen Uptake (VO_2) in Different Exercise

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Conflict of interest: Nil

Abstract:

Background: Infertility is defined as condition of male or female reproductive system with failure of pregnancy after 12 months or more of regular unprotected sexual intercourse. The thyroid hormones are vital for regular activities due to their significant role body's basal metabolic rate, growth, development, differentiation of cells or organs. Many factors can influence female infertility, and one of the most important is undiagnosed and untreated thyroid disease. In condition of primary hypothyroidism, the levels of thyrotropin-releasing hormone (TRH) are more to rise thyroid-stimulating hormone (TSH) levels, causing hyperprolactinemia, oligomenorrhea and anovulation. Hypothyroidism may result in miscarriage, premature birth, and neuro-developmental deformities. Thyrotoxicosis also associated with spontaneous abortions, risk of congenital anomalies and aplasia cutis. Studies have shown association of infertility with stress, luteal phase defects, structural and functional reproductive disturbances. Many infertile women with thyroid dysfunction had hyperprolactinemia, increased TSH in ovulatory dysfunction. The present study is primarily focused on study of thyroid hormones in female infertility.

Materials & Methods: The present cross-sectional study was carried out at the outpatient department, Arundhati Institute of Medical Sciences, Hyderabad. Subjects attending infertility clinic, Obstetrics & Gynecology Department were selected. A total of 183 women have given their consent for participating in the present study. Out of these, 142 women were eligible after consideration of the inclusion exclusion criteria. The Thyroid assay was performed and determined. Hyperthyroidism was confirmed if serum TSH was < 0.3 mIU/L and hypothyroidism, if serum TSH was >4.0 mIU/ L. The total cases in the study were categorized into 7 types, based on the thyroid profile – Euthyroid, Primary hypothyroid, Primary hyperthyroid, Secondary hypothyroid, Secondary hyperthyroid, Subclinical hypothyroid, Subclinical hyperthyroid.

Results: After careful obtaining of the data, the data is entered into tables under relevant heading using MS Excel software. Mean age of the study subjects in our study was 25.2±1.7 years. In our study, significance was not observed with relation to age and thyroid status in different groups. Mean age of the study subjects in our study was 25.2±1.7 years. In our study, significance was not observed with relation to age and thyroid status in different groups ($p > 0.05$).

Conclusions: Thyroid dysfunction and female infertility are usually correlated. With our study, we can propose thyroid supplementation in subclinical hypothyroidism for treating infertile women. Simultaneously, females with marginal levels of TSH shall not be ignored in infertile women, which may lead to asymptomatic subclinical hypothyroidism. It can be concluded that thyroid dysfunction is related to primary infertility in females. Hence, primary infertility may be better studied with large sample size and long term follow up to further confirm our findings.

Keywords: Thyroid hormones, Hypothyroid, Hyperthyroid, Female infertility, TSH, T3, T4.

Introduction

As per World Health Organization (WHO), health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity [1]. Staying healthy is a must for every individual in the present situation particularly for being successful in life. Healthy individual can withstand the stress and accept the challenges in achieving the success in own life. Physical fitness can be achieved by performing regular exercise. Understanding the exercise, the effects of the exercise is a must for getting the maximum benefit. Exercises are of four types – Endurance, Strength, Balance and Flexibility. Endurance exercises, also aerobic exercises result in increased respiratory and heart rates. They will keep healthy, improve fitness and improve performance. Simultaneously, they also have beneficial effects on heart, lungs, and circulatory system. Diseases such as diabetes, cancers, heart diseases can be prevented with these exercises. Different activities concerned with endurance include: brisk walking or jogging, yard work, dancing, swimming, biking, climbing stairs or hills and playing games such as tennis or basketball [2].

The effect of endurance exercises has a positive correlation on heart rate. As the severity of the exercise is increased, so is the heart rate and oxygen uptake (VO_2). The energy demand can be estimated by assessing the oxygen uptake. Modern technology can be used to assess oxygen uptake [3,4]. For well over a century, researchers and clinicians have been studying the effects of endurance exercise training on the heart. This review assesses the current state of knowledge in two areas of research where clinical decision making may be complicated: the impact of chronic endurance exercise training on cardiac structure, function, and electrical activity to the point where the athletic heart phenotype may be similar to the expression of some cardiac pathologies and the impact of acute bouts of prolonged exercise on cardiac structure, function, and electrical activity. In the final section, the combination of acute endurance exercise stress on the heart and prolonged periods of training are considered together [5].

Physical activity on a regular basis lowers the risk of cardiovascular disease, type II diabetes, obesity, certain cancers, and overall mortality. Nonetheless, there is mounting evidence that excessive exercise may be harmful to human health. This review compiles decades of research on the physiology and pathophysiology of ultramarathon running, with a focus on the cardiorespiratory implications. The prevalence and clinical significance of postrace decreases in lung function and diffusing capacity, respiratory muscle fatigue, pulmonary emphysema, biomarkers of cardiac injury, left- or right-ventricular dysfunction, and chronic myocardial remodelling [6].

The present study is done to assess and compare the heart rate, heart rate reserve and oxygen uptake in different exercises.

Methods

The present cross-sectional study was carried out at Government Medical College, Mancherial, Telangana. The Institutional Ethics Committee has approved the study. Written informed consent in the language understandable to the subjects has been obtained from all the participants of the study. The study includes a range of procedures, including interviews, observation, and observational data collection, to obtain new information from the subject. To achieve our research objectives. This study was duration based true experimental study (pre-test, post-test design) carried out for a period of one year on athletes at Government Medical College, Mancherial, Telangana. A total of 105 subjects are recruited and divided the group into three batches (35 for walking exercise, 35 for running and 30 for cycling exercise). Random sampling is predicated on the premise that each sample has an equal chance of being chosen. A random sample is intended to be a representative sample of the entire population.

The inclusion criteria were adult subjects of age between 18 to 35 years. Subjects given consent to participate after informed consent were included in the study. Subjects with known history of any chronic illness, having habit of taking any performance enhancing drugs, ay chronic cardiac or respiratory diseases were excluded. The subjects not willing to participate at any stage of study were also excluded. The study included collection of Socio-demographic data including name, age, gender, height, weight etc. Study included calculation of BMI, VO_2 estimation, Heart rate monitoring and Blood pressure monitoring. All the examination findings were noted in the predesigned questionnaire and report sheet. All participants were made familiar with the procedures of the study. 105 participants (35 for walking exercise, 35 for running and 30 for cycling exercise). The test was conduct in 12 hours, 24 hours and 48 hours protocols.

Pretest was done at 6 AM, which included VO_2, Heart Rate (HR) and systolic and diastolic blood pressure (SBP, DBP) for all participants.

12-hour exercise (laboratory setting) began at 7 AM and consisted of almost continuous exercise at controlled intensity VO_2, HR and systolic and diastolic blood pressure conducted for all participants. The subjects were allowed a total of 50 min (5 x 10 min) of break for food intake and change of equipment in the course of the entire 12-hour exercise study. Intake of food and water was allowed ad libitum.

24-hour exercise (laboratory setting) was made up of almost continuous mixed exercise in a controlled setting. The study designs in both protocols in a laboratory setting allowed for repeated sampling and strictly controlled diet and work intensity. The subjects after three days of standardized food intake, performed the disciplines in the stated order. VO_2, HR and systolic and diastolic blood pressure estimation done for all participants. The subjects were allowed a total of 100 min (5 x 20 min) of break for rest, food intake and change of equipment in the course of the entire 24-hour exercise study. Intake of food and water was allowed ad libitum.

48-hour exercise (laboratory setting) The 48 hr protocol was made up of almost continuous mixed exercise in a controlled setting. The study designs in both protocols in a laboratory setting allowed for repeated sampling and strictly controlled diet and work intensity. The subjects after three days of standardized food intake, performed the disciplines in the stated order. VO_2, HR and systolic and diastolic blood pressure estimated for all participants. The subjects were allowed a total of 200 min (5 x 40 min) of break for rest, food intake and change of equipment in the course of the entire 48-hour exercise study. Intake of food and water was allowed ad libitum.

Post test conducted one day after completion of all the protocols, the parameters of participants like VO_2, HR and systolic and diastolic blood pressure conducted for all participants

The data was arranged in suitable tables for analysis under the relevant headings. The results were averaged as (mean ± standard deviation) for each parameter subgroups separately. Each variable was assessed by sample *t* test. Statistical analysis was done using IBM SPSS Statistics 20 package. p-value of <0.05 is considered as statistically significant and p-value of <0.005 is considered as statistically highly significant.

Results

After careful obtaining of the data, the data is entered into tables under relevant heading using MS Excel software & analyzed using descriptive, inferential statistics and conventional content analyze as per objectives of the study.

On analysis of the data, the age group wise distribution of the subjects is shown in Table-1.

Table 1: Demographic variables of subjects included in the study

Age group	Number	Percentage
≤ 20 years	48	48%
21 – 25 years	37	37%
26 – 30 years	11	11%
> 30 years	04	04%
Total	100	100%

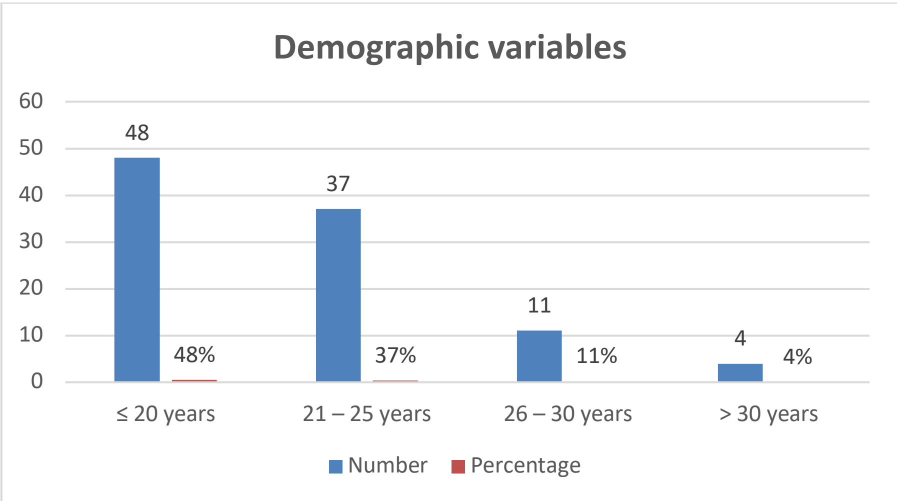

Figure 1: Demographic variables of subjects included in the study

Table-1 explains the distribution of age pattern of the included cases, it is observed that most of the subjects were from the age group of upto 20 years. Most of the subjects i.e., 85% are upto age group of 25 years.

Table 2: Gender wise variables of subjects

Gender	Number	Percentage
Male	56	56%
Female	44	44%
Transgender	00	00%
> 30 years	04	04%
Total	100	100%

Mean age of the study subjects in our study was 25±4.17 years. In our study, significance was not observed with relation to age and thyroid status in different groups (p > 0.05).

Table 3: Height of subjects

Height (cms)	No. of Subjects	Percentage
< 160	20	20
160 – 170	50	50
170 – 180	26	26
> 180	04	04
Total	100	100

Table -3 depicts that, majority of the subjects (50%) were have height between 160-170 cms and only 4% were of more than 180cms.

Table 4: Weight of subjects

Weight (Kgs)	No. of Subjects	Percentage
< 50	10	10
50 – 70	60	60
70 – 90	20	20
> 90	10	10
Total	100	100

Table -4 depicts that; majority of the subjects (60%) were having weight between 50-70kgs and only 10% were have more than 90 kgs weight in participants.

Table 5: BMI of subjects

BMI	No. of Subjects	Percentage
<25	38	38
25 – 30	62	62
> 30	0	0

38% subjects in our study were having BMI less than 25 whereas none were in the group of BMI more than 30. Most of the subjects were in the BMI range of 25 to 30.

Table 6: Mean heart rate test results of subjects

Exercise	0 hour	12 hours	24 hours	48 hours	P value
Walking	70±6.3	110±18.18	82±8.1	72±6.2	P<000.1
Running	72±7.1	112±21.76	76±8.5	70±12.09	P<000.1
Cycling	76±7.2	114±22.66	78±7.9	72±9.63	P<000.1

The heart rate mean results show that during the 24-hour protocol, the heart rate (HR) at the standard work rate in cycling was increased 24 hours with compared to 0 h, but after that, there was a decrease towards the initial values throughout the exercise. This was true regardless of the intensity of the exercise. After a period of rest for twenty-four hours, HR was completely restored. The first peak, followed by the subsequent decline, was comparable across all exercise modalities. This kinetics of the drift was corroborated in the 12-hour study, where there was an increase in HR when compared to 0 hr, but afterwards it drifted back towards original values, despite the fact that it was still high at 24 hr when compared to 0 hr. At both the Middle and Post testing stages of the 24-hour procedure, HR had dropped to a level that was lower than Pretest.

Table 7: Oxygen uptake (VO_2)Test Results of subjects

Exercise	0 hour	12 hours	24 hours	48 hours	P value
Walking	38.3±4.1	45.03±8.43	50.71±7.1	55.09±7.4	P<000.1
Running	36.8±6.2	42.98±10.16	48.31±7.7	52.81±11.43	P<000.1
Cycling	35.9±3.9	41.12±12.09	49.01±5.8	53.61±6.12	P<000.1

When compared to Pre, there were increases in VO_2 at standardized work rate across the board in every protocol, regardless of the site of measurement. During the 12-hour protocol, VO_2 rose when walking (45.03±8.43), running (42.98±10.16), and cycling (41.12±12.09), and it continued to climb throughout the rest of the workout.

Table 8: Comparison between Heart Rate and VO_2 of subjects

	Walking	Running	Cycling
Mean HR	82±8.1	76±8.5	78±7.9
Mean VO_2	45.03±8.43	42.98±10.16	41.12±12.09
P value	0.0001	0.0001	0.0001

The table-8 reveals that comparison between heart rate and VO_2 of athletes. This circulatory adaptation was verified in all exercise events and shows that VO_2/HR was increased all exercise event and different time zone.

Table 9: Systolic Blood (mmHg) Pressure Results of subjects

Exercise	0 hour	12 hours	24 hours	48 hours	P value
Walking	120 ±3.1	170±8.33	150 ±8.3	122 ±7.6	P<000.1
Running	122±7.0	180±15.17	148 ±9.1	124±10.23	P<000.1
Cycling	126±5.1	186±14.01	152 ±7.9	120±7.09	P<000.1

When compared to Pre, there were increases in Systolic Blood Pressure at standardized work rate across the board in every protocol, regardless of the site of measurement. During the 12-hour protocol, Systolic Blood Pressure rose when walking (170±8.33), running (180±15.17), and cycling (186±14.01), and it continued to settled down in throughout the rest of the workout.

Table 10: Diastolic Blood (mmHg) Pressure Results of subjects

Exercise	0 hour	12 hours	24 hours	48 hours	P value
Walking	78 ±2.45	90±7.13	92 ±7.4	76 ±8.6	P<000.1
Running	82±6.12	98±10.43	94 ±7.2	74±13.25	P<000.1
Cycling	80±7.12	96±12.61	88 ±9.01	82±7.19	P<000.1

When compared to Pre, there were increases in Diastolic Blood Pressure at standardized work rate across the board in every protocol, regardless of the site of measurement. During the 12-hour protocol, Diastolic Blood Pressure rose when walking (90±7.13), running (98±10.43), and cycling (96±12.61), and it continued to settled down in throughout the rest of the workout.

Discussion

Results revealed that regarding age group of majorities of the Athletes were 48% of ≤20 years, only 4% of >30yrs. In the case of gender, male athletes constituted higher percentage than females. Regarding BMI, majority of the Athletes (62%) were had BMI between 25-30 and only 38% were have less than 25 BMI in Athletes and none of them were more than 30. Majority of the Athletes (50%) were having height between 160-170-cm and only 4% were have more than 180cm. Regarding weight majority of the Athletes (60%) were have weight between 50-70kg and only 10% were have more than 90 kg weight in Athletes. The findings were concordant with Eime, R.M. et al [7] in which, study made on the type, frequency, and duration of leisure-time physical activity for Australians aged 15 and above.

Mean Heart rate Test Results of Athletes

The test results show that during the 24-hour protocol, the heart rate (HR) at the standard work rate in cycling was increased 24 hours with compared to 0 h, but after that, there was a decrease towards the initial values throughout the exercise. This was true regardless of the intensity of the exercise. After a period of rest for twenty-four hours, HR was completely restored. The first peak, followed by the subsequent decline, was comparable across all exercise modalities. This kinetics of the drift was corroborated in the 12-hour study, where there was an increase in HR when compared to 0 hr, but afterwards it drifted back towards original values, despite the fact that it was still high at 24 hr when compared to 0 hr. At both the Middle and Post testing stages of the 24-hour procedure, HR had dropped to a level that was lower than Pre. The findings were concordant with Reimers AK et al [8] in which the resting heart rate (RHR) is associated to mortality. RHR is reduced by regular exercise. There were 21 yoga classes, 5 tai chi classes, 3 qigong classes, and 2 undefined sports. All sorts of sports reduced RHR. Only endurance exercise and yoga, on the other hand, substantially reduced RHR in both sexes. Exercise-induced RHR reductions were associated favourably to pre-interventional RHR and adversely to the participants' average age. We may deduce from this that exercise, particularly endurance training and yoga, reduces RHR.

Oxygen uptake (VO2)

When compared to Pre, there were increases in VO2 at standardized work rate across the board in every protocol, regardless of the site of measurement. During the 12-hour protocol, VO2 rose when walking (45.03±8.43), running (42.98±10.16), and cycling (41.12±12.09), and it continued to climb throughout the rest of the workout. The findings are concordant with Hebisz P et al [9] in which, the study compared peak oxygen uptake (VO2 peak) measured with the incremental graded test (GXT) (VO2 peak) to two tests to verify maximum oxygen uptake, performed 15 minutes after the incremental test (VO2peak1) and on a separate day (VO2peak2) (VO2peak2). For repeated measurements, the analysis of variance revealed no statistically significant changes ($F = 2.28$, $p = 0.118$, $2 = 0.12$). The Bland-Altman analysis indicated a modest bias in the VO2peak1 findings when compared to the VO2peak (0.4 mlmin-1kg-1) and VO2peak2 results when compared to the VO2peak (0.76 mlmin-1kg-1). It was discovered that VO2peak1 and VO2peak2 differed by more than 5% from VO2peak in isolated cases.

Comparison between Heart Rate and VO2

This circulatory adaptation was verified in all exercise events and shows that VO2/HR was increased all exercise event and different time zone. The findings are concordant with Pakkala Aet al [10] which was to evaluate the maximum associated oxygen transport during exercise, namely maximum heart rate (max HR), dyspnoeic index (DI), oxygen pulse (O2 pulse), and recovery heart rate in an athletic and a non-athletic group. Athletes had significantly higher values in the following metrics when compared to non-athletes: VO2 max, V(E) max, delta heart rate, and max O2 pulse were lower in athletes, however resting heart rate, DI at VO2 max, and recovery heart rate were not significantly different in either group. The findings indicate an overall higher adaptability of the cardiovascular system and a relative refractoriness of the respiratory system to the effects of training, with maximum oxygen consumption in both groups showing similar values to those found in other parts of the country, whereas MW, V(E) max, BR at VO2, and DI at VO2 max differ.

Systolic Blood (mmHg) and Diastolic Blood (mmHg) Pressure When compared to Pre, there were increases in Systolic Blood Pressure at standardised work rate across the board in every protocol, regardless of the site of measurement. During the 12-hour protocol, Systolic Blood Pressure rose when walking (170±8.33), running (180±15.17), and cycling (186±14.01), and it continued to settled down in throughout the rest of the workout. When compared to Pre, there were increases in Diastolic Blood Pressure at standardised work rate across the board in every protocol, regardless of the site of measurement. During the 12-hour protocol, Diastolic Blood Pressure rose when walking (90±7.13), running (98±10.43), and cycling (96±12.61), and it continued to settled down in throughout the rest of the workout.

The findings are concordant with Schweiger V et al [11] which shown an inverse association between physical exercise and blood pressure. As a result, physical activity is advised to prevent, control, and treat hypertension. The prevalence of hypertension, on the other hand, may vary by sport and, in certain situations, may be greater among athletes participating in specific disciplines than in the general population.

Conclusion

The study concluded that the LV sizes of all of our ultra-endurance athletes were within normal ranges. In response to ultra-endurance exercise, the central circulation undergoes various modifications. Most of the observed metrics drift with time. HR with constant submaximal work rate increases only during the first 12 hours of exercise, then progressively declines to baseline levels. VO2 is raised at each time point in comparison to beginning values. The rise may be attributable to peripheral adaptations, as seen by a strong relationship between VO2 change and a-v O2 diff change. After the first 12 hours of exercise, there was an increase in oxygen pulse (VO2/HR) and the computed quantity of oxygen drawn from each heart beat rose by around 10%. (indicating a more efficient energy distribution). After 48 hours of exercise, late cardiovascular drift may be noticed, which is characterised by increased VO2/HR, reduced peripheral resistance, increased stroke volume, and decreased heart work. We view the alterations as physiologically adequate responses to ultra-endurance exercise since cardiac output is maintained.

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