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RESEARCH ARTICLE

PHYSIOLOGICAL STUDIES ON THE EFFECTS OF OBESITY ON CARDIOVASCULAR PARAMETERS IN YOUNG ADULT FEMALES

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ABSTRACT

The present study assessed the effect of obesity on the cardiovascular physiological parameters in young adult females' age group of 18-25 years. The study group consisted of 60 obese adult female with BMI>30 kg/mt^2 and the control group consisted of 60 non-obese adult female with BMI 18.5-25 kg/mt^2. Physical parameters studied were a) Body mass index (BMI) and b) Waist-hip ratio. The cardiovascular parameters measured were a) Heart Rate b) Blood Pressure c) PR interval and d) QTc interval in both the groups. The data obtained was analyzed by student 'z' test and $p<0.05$ was considered as level of significance in all parameters. Results show that obese adult female's BMI and wait hip ratio was found significantly high as compared to non-obese adult females. In cardiovascular parameters increase in heart rate and diastolic blood pressure was found insignificant in study group as compared non-obese adult females ($p>0.05$) while systolic blood pressure was significantly elevated in study group ($p<0.001$). ECG findings reveal that obese adult females have significantly increased both PR and QTc interval ($p< 0.001$) as compared to controls group. These results are suggestive of the cardiovascular risk to the obese adult females.

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INTRODUCTION

Obesity is a condition in which there is an excess of body fat. Obesity today has now become a pandemic and is affecting almost all subsections of human population globally, particularly in developing countries like India. This has led to an increase in obesity-related morbidity which has imposed a heavy burden on health care systems and lowered the quality of life of obese people. One of the greatest public health challenges in the first half of the 21st century is preventing the epidemic of obesity. With increased obesity prevalence of metabolic disease increased. The need therefore to prevent and treat obesity becomes obvious to reduce its incidence and costly associated metabolic disease. Obesity can be genetic, metabolic, behavioral and environmental. Obesity can be hereditary. Government statistics also show that children are more likely to have a weight problem if one parent is overweight, and this risk is increased if both parents are overweight or obese. The consequences of industrialization and urbanization, which lead to decrease in the physical activity, together with substantial dietary changes and overall pattern of the lifestyle, promote weight gain. Many of the diseases like polycystic ovary disease and thyroid disease are also responsible for weight gain. Some medicines such as antidepressants, corticosteroids and oral contraceptives can also cause weight gain. Obesity possesses the serious risk for the development of the following: High blood pressure & stroke, breast cancer (after menopause), womb, kidney and colon cancer and diabetes. Coronary heart disease is twice as common in obese men under the age of 45. Osteoarthritis is more painful and less easily treatable if the person is obese. Severe obesity may cause reproductive problems, metabolic syndromes, obesity hypoventilation syndrome and Obstructive sleep apnea (George and Bray, 1998).

Many studies have been done on many parameters in relation to obesity. Many of the studies have been done in obese individuals suffering from diseases like Diabetes, Hypertension etc. So, there is a need to do such types of studies on obese for normal individuals to assess the hidden or potential cases in the society. Taken together, in view of the lacuna of the previous studies, the present study was designed to observe and understand the effect of obesity on the cardiovascular physiological parameters in young adult females.

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MATERIALS AND METHODS

The study was conducted in the Department of Physiology at Moti Lal Nehru Medical Collage, Allahabad (UP) between years 2010 to 2011. 60 controls and 60 study groups were included in the study after applying inclusion and exclusion criteria. The study was approved by the Institutional human ethics committee (IHEC).

INCLUSION CRITERIA

Control Group:

- Normal young healthy females having age group of 18-25 yrs
- Having BMI between 18.5 and 25.0.
- All subjects were taken from either social class 2 or 3.

Study Group:

- Obese young females having age group of 18-25 yrs
- Having BMI more than 30.0.
- All subjects were taken from either social class 2 or 3.

EXCLUSION CRITERIA

The following types of individuals were not included in the study:

- Non compliant subjects
- Subjects who have ever been smoker
- Subjects with history suggestive of disorders of following systems:-
  1. Respiratory disease
  2. Cardiovascular disease
  3. Hepatobiliary disease
  4. Endocrinal e.g. Thyroid, diabetes mellitus etc
- Family history of significant medical disorder with reference to :-
  1. Diabetes mellitus
  2. Hypertension
  3. Ischemic heart disease
  4. Obstructive and restrictive lung disease
- Any history of long term treatment or drug intake
- History of Menstrual disorder
- History of Hirsutism
- History of Galactorrhea (milk secretion from breast)

EVALUATION

Informed written consent was taken from all the subjects. Detailed history including age, name, sex, relevant past history was taken. Attention was also given to any variable which may affect. After detailed history, the following parameters: height, weight and body circumference were measured for the calculation of BMI of all subjects.

Measurement of Height and Weight

Height and Weight of the subjects were measured using a standardized height and weight machine known as Seca-Vogel and Helke Hamburg balance. For this, the subjects were lightly clothed but without shoes. Standing height was measured to the nearest 0.5 cm. The subject stood against a standard meter scale, ears and the infra-orbital margins lay in one horizontal plane. Body weight was recorded in kilograms on an empty bladder and before lunch on a standardized weighing scale. The weight measurement was recorded to the nearest 0.1 kg.

Measurement of body circumferences

The body circumferences were taken by the measuring tape over a light gown or loose clothing. The measurements were recorded to the nearest 0.5 cm. Following body circumferences were taken:-

Waist circumference:

Waist circumference measurement was done with minimal, adequate clothing (light cloths) with feet 25–30 cm apart and weight equally balanced with a tailor's measuring tape in a plane perpendicular to the long body axis at the level of umbilicus between the inferior margin of the last rib and the crest of the ilium without compression of the skin with nearest to 0.5 cm (WC >/=90 cm in men and >/=80 cm in women) were defined as abdominal obesity using WHO Asia Pacific prospective guidelines.

Hip circumference:

Hip circumference measurement was done with minimal, adequate clothing (light cloths) across the greater trochanter with legs and feet together by a measuring tape without compressing the skin fold at the maximum extension of buttocks.

After taking body circumference and height and body weight, the following parameters were calculated:-

1. Waist hip ratio: It is the measure of central pattern of fat distribution.

WHR= waist circumference/hip circumference

2. Body mass index (Quetelet's index): - BMI= Weight (kg)/ Height (m^2)

The subjects are divided into control and study groups (BMI 18.5-25kg/m^2 and >30kg/m^2 respectively) according to WHO's recently classified

Measurement of cardiovascular parameters

Heart rate (PULSE)

The arterial pulse can be examined at many sites in the body where an artery is felt against a bone e.g. radial pulse at the wrist, brachial pulse at the elbow, carotid pulse at the neck etc. In our study, we calculated pulse rate by observing the radial pulse at the wrist.

Measurement of the blood pressure

A mercury sphygmomanometer was used for recording the blood pressure. The subject was made to sit comfortably for

5minutes. She was also not allowed to drink coffee or tea 30 minutes prior to the recording of BP.

Electrocardiographic Recording

An electrocardiogram (EKG or ECG) is a test which measures cardiac activity and provides a snapshot look at the electrical activity of the heart. EKGs are obtained by placing electrodes and leads on a subject's chest, which send electrical signals to the EKG machine. The electrocardiographic recording was done using Vega 3 channel ECG machine. Before recording leads, ECG machine was tested and adjusted as 1 mV should be equal to 10 small square or 1 cm. The speed of ECG paper was 25 mm/sec. The EKG was recorded in lying posture. A resting ECG was recorded after duly assuring them the noninvasive nature of the procedure and by demonstrating on volunteer to allay any apprehension.

In ECG recording, PR interval & QTc interval were measured by automated method. $$QTc = \frac{QT}{\sqrt{RR}},$$

Where **QTc** is the QT interval corrected for heart rate, and RR is the interval from the onset of one QRS complex to the onset of the next QRS complex, measured in seconds.

Statistics: Data obtained was analysed by 'z' test and represented as mean+_SD, $p<0.05$ was considered as significant.

RESULTS

The present study was conducted to study the effect of obesity on cardiovascular physiological parameters in young adult females. In the control group of 60 subjects, the mean age was 21.42 ± 2.22 years. In study group of 60 subjects, the mean age was 21.5 ± 2.18 years. There was insignificant difference in both the groups (P>0.05). In the control group, the mean height was 157.58 ± 5.77 cm. In study group, the mean height was 157.47 ± 5.49 cm. There was insignificant difference in both the groups (P>0.05). In the control group, the mean weight was 51.88 ± 5.33 kg. In study group, the mean weight was 79.97 ± 5.23 kg (Table 1). The increase in the obese group was highly significant (P<0.001). In the control group, the mean body mass index (BMI) was 20.88 ± 1.34. In study group, the mean B.M.I. was 32.27 ± 1.51. The increase in the obese group was highly significant (P<0.001). In the control group, the mean waist hip ratio (WHR) was 0.81 ± 0 .03. In study group, the mean WHR was 0.85 ± 0.04. The increase in the obese group was highly significant (P<0.001). In the control group, the mean socioeconomic status was 2.18±0.39. In study group, the mean socioeconomic status was 2.1 ± 0.30.The difference between both the groups was insignificant (P>0.05). Results are shown in Table 1.

Cardiovascular parameters:

The various cardiovascular parameters which were recorded are shown in following Tables (2).

Heart rate

In the control group of subjects, the mean heart rate was 75.2 ± 4.23 beats per min. In the study group of subjects, the mean heart rate was 75.6 ± 4.41 beats per min. The increase in the heart rate in the obese group was insignificant (p>0.05). Results are shown in Table 1.

Table 1. Showing mean of different parameters in control and study group with their standard deviation and significance

Parameters	Control Group (Mean ± SD)	Study Group (Mean ± SD)	Significance
Age (yrs)	21.42 ± 2.22	21.5 ± 2.18	P>0.05
Height (cms)	157.5 ± 5.77	157.47 ± 5.49	P>0.05
Wt.(kgs)	51.88 ± 5.33	79.97 ± 5.23	P<0.001
BMI (kg/m^2)	20.88 ±1.34	32.27 ± 1.51	P<0.001
S/E Status	2.18 ± 0.39	2.1 ± 0.30	P>0.05
WHR	0.81 ± 0 .03	0.85 ± 0.04	P<0.001

Blood pressure

In the control group of subjects, the mean systolic blood pressure (SBP) was 112.97 ± 5.23 mmHg. In the study group of subjects, the mean SBP was 117.82 ± 6.22 mmHg. The increase in the SBP in the obese group was found to be highly significant (P<0.001).

In the control group of subjects, the mean diastolic blood pressure (DBP) was 75.13 ± 5.35 mmHg. In the study group of subjects, the mean DBP was 75.78 ± 4.75 mmHg. The increase in the DBP in the obese group was found to be insignificant (P>0.05). Results are shown in Table 2.

Table 2. Showing mean of cardiovascular Parmeters in both groups with their standard deviation and significance

Parameters	Control Group (Mean ± SD)	Study Group (Mean ± SD)	Significance
Heart Rate (beats/min)	75.2 ± 4.23	75.6 ± 4.41	p>0.05
SBP (mmHg)	112.9 ± 5.23	117.8 ± 6.22	p<0.001
DBP (mmHg)	75.1 ± 5.35	75.7 ± 4.75	p>0.05

Electrocardiogram

In the control group of subjects, the mean PR interval was 139.58 ± 11.73 msec and the mean QTc interval was 396.23 ± 33.12 msec. In the study group of subjects, the mean PR interval was 150.1 ± 18.79 msec and the mean QTc interval was 413.75 ± 26.83 msec. Thus, there was a highly significant increase in PR interval and QTc interval in the study group as compared to control group (P<0.001). Results are shown in Table 3.

Table 3. Showing mean PR interval and QTc interval in both groups with their standard deviation and significance

Parameters	Control Group (Mean ± SD)	Study Group (Mean ± SD)	Significance
PR Interval (msec)	139.58 ±11.73	150.1 ± 18.79	p<0.001
QTc Interval (msec)	396.23 ± 33.12	413.75 ± 26.83	p<0.05

DISCUSSION

Obesity today has become a pandemic and is affecting almost all subsections of human population globally, particularly in developing countries like India. The age-adjusted prevalence

of obesity was found to be 30.5% in 1999-2000 compared with 22.9% in accordance with NHANES III (1988-1994; $P < 0.001$).

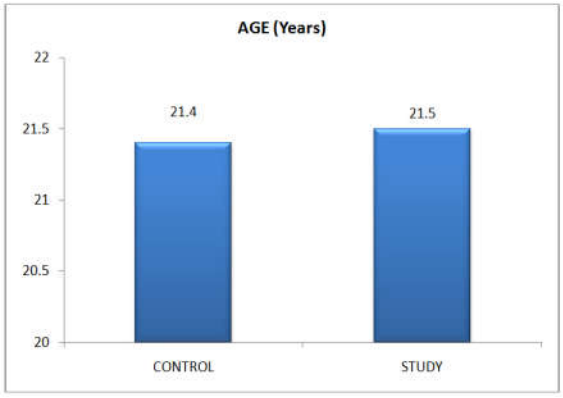

Fig.1. Age distribution in control and study group

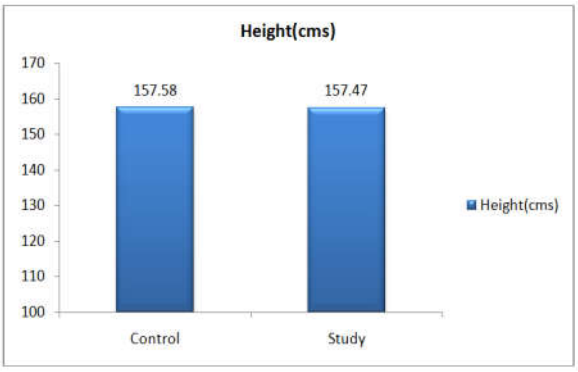

Fig. 2. Height distribution in control and study group

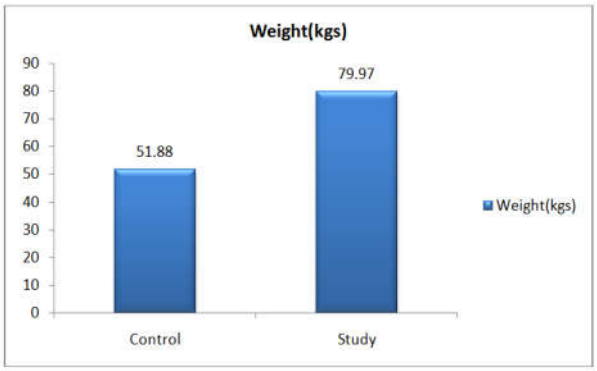

Fig. 3. Weight distribution in control and study group

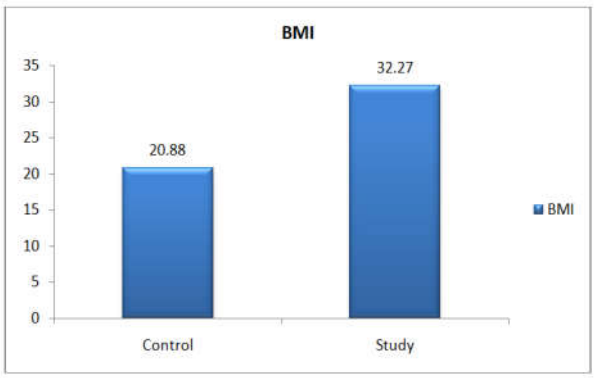

Fig. 4. BMI distribution in control and study group

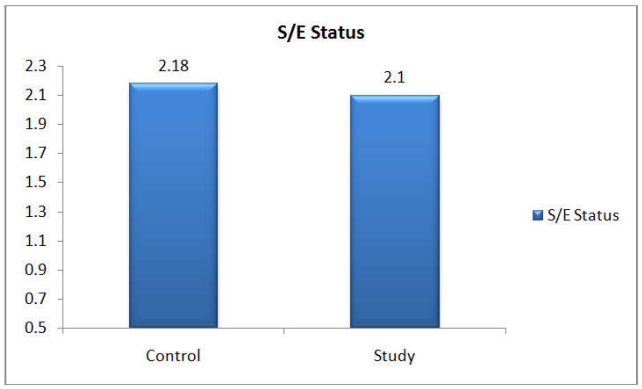

Fig. 5. S/E Status distribution in control and study group

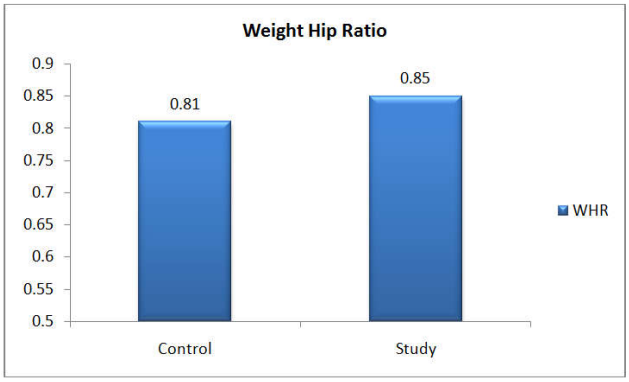

Fig. 6. WHR distribution in control and study group

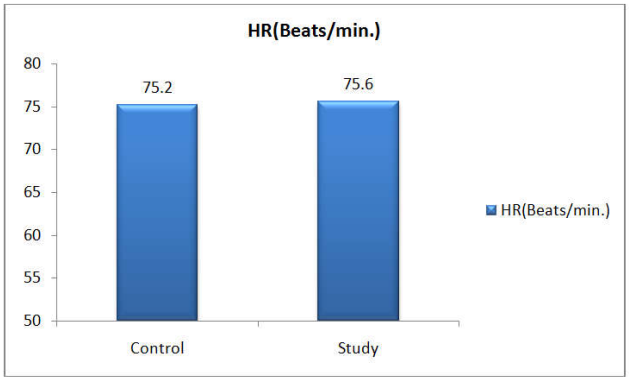

Fig.7. Heart Rate distribution in control and study group

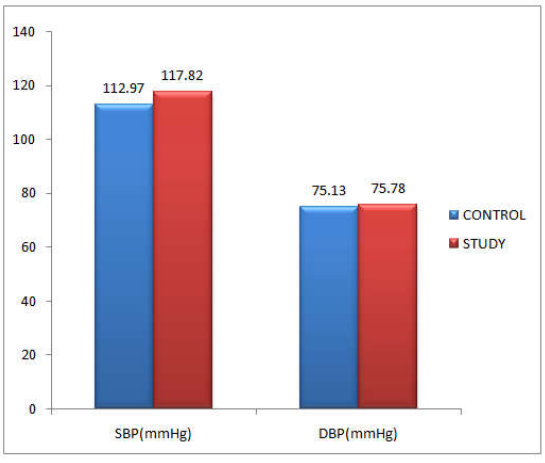

Fig. 8. Blood pressure (SBP/DBP) distribution in control and study group

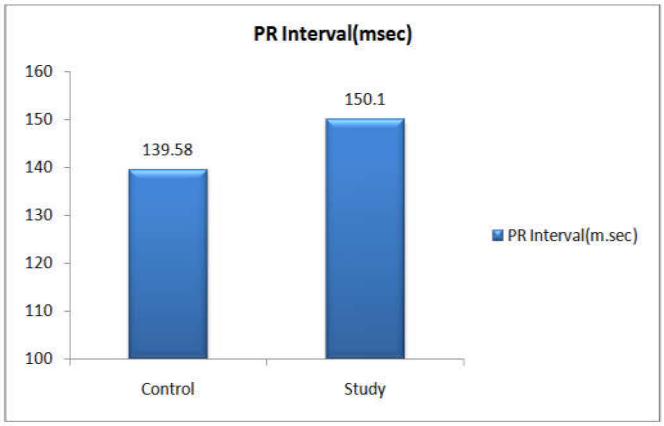

Fig. 9. Distribution of PR interval in control and study group

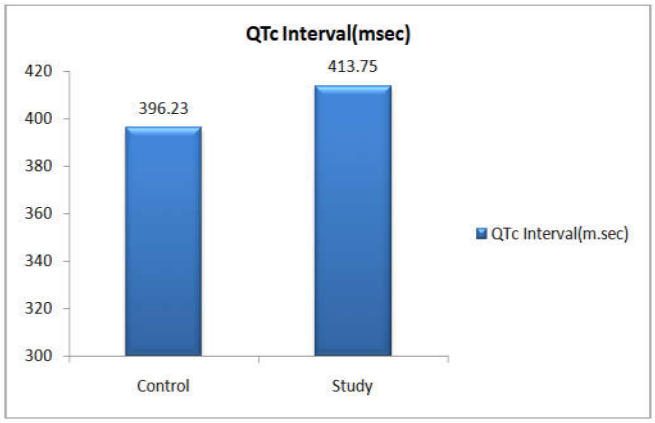

Fig. 10. Distribution of QTc interval in control and study group

This has led to an increase in obesity-related morbidity which has imposed a heavy burden on health care systems and lowered the quality of life of obese people. One of the greatest public health challenges in the first half of the 21st century is preventing the epidemic of obesity. It affects the different systems of our body like cardiovascular system, reproductive system, hormones, skeletal system etc. It has been found as a significant causative factor for various cancers.

In the study, the 120 subjects were divided into two groups after applying inclusion & exclusion criteria: control group of 60 non-obese adult female and study group of 60 obese females.

Physical characteristics (age, height, weight) of all the subjects were taken & then age, height of both the groups was properly matched because these characteristics can affect the cardiovascular physiological parameters. The mean of both the groups are: Control group: - The control group consists of 60 comparable non-obese adult female medical students. In this group, the mean body mass index (B.M.I.) was 20.88 ± 1.34. The mean age was 21.42 ± 2.22 year. The mean height was 157.58 ± 5.77 cm & the mean weight was 51.88 ± 5.33 kg. Study group: - The study group consists of 60 obese adult female medical students. In the study group, the mean B.M.I. was 32.27 ± 1.51. The mean age was 21.5 ± 2.18 years & the mean height was 157.47 ± 5.49 cm. The mean weight was 79.97 ± 5.23 kg.

The mean waist hip ratio of both the groups was also compared because obesity occur due to excessive deposition of fat and relatively more increase in waist circumference than the hip circumference. In study group, the mean WHR was 0.85 ± 0.04 as compared to 0.81 ± 0 .03 of the control group. The values of weight, B.M.I. and waist hip ratio were significantly ($p<0.001$) higher for study group because of obesity.

The cardiovascular parameters studied were Heart Rate, Blood Pressure, Electrocardiogram mainly PR & QTc interval. The present study showed that the mean heart rate in the study group of subjects was 75.6 ± 4.41 beats per min as compared to 75.2 ± 4.23 beats per min observed in the control group. The increase in the heart rate in the obese group was insignificant ($p>0.05$). According to Reisin *et al.* (1981), heart rate, mean rate of left ventricular ejection and regional hemodynamics are not significantly influenced by obesity, although total peripheral vascular resistance is slightly less in obese than in lean subjects, presumably on the basis of the greater cardiac output. Various earlier studies like those of, Zavorsky (2009) and Ofuya *et al*. (2005) have also shown the increase in the heart rate in obese individual but most of the studies found that the significant increase in the heart rate occurs only when there is morbid obesity.

In our study, the mean systolic blood pressure (SBP) in case of control group was 112.9 mmHg while that of obese group was 117.8 mmHg. This increase of systolic blood pressure in obese female was found to be significantly higher ($p<0.001$) as compared to the control group. This finding is supported by some of the previous studies as well. The increase in diastolic blood pressure was not statistically significant ($P>0.05$). Although the exact mechanism of increased blood pressure in obese individuals is not known. It is believed that increased blood pressure in obese individuals is due to the extra amount of fatty tissues in the obese subjects. To supply oxygen to this extra fatty tissue, the heart must pump additional blood than compared to non-obese subjects. These two factors i.e. increased blood volume and stroke volume in obese subjects lead to increased workload on the heart which further leads to increased heart rate and blood pressure (Alexander *et al.*, 1959; Whyte 1965). According to Haynes and Morgan *et al.* (1998), Obesity is associated with increased activity of sympathetic nervous system.

The increased waist-hip ratio of obese females in our study also indicates towards their upper body obesity. This increased waist-hip ratio of obese females in our study may be also a cause for the significantly increased systolic blood pressure in the study group females. Penedope (1971), in his study attributed upper body obesity as a cause of raised blood pressure. Studies which show the increase in systolic blood pressure due to overweight or obesity are those of Alexander *et al*. (1959), Whyte (1965), Reeder *et al*. (1997), and Chen *et al*. (1998). On the other hand studies which show just hypertension with increase in B.M.I. above normal are those of Brown *et al.* (2000), Rexrode *et al*. (1996). We found that the mean PR interval in obese females was 150.1ms as compared to 139.58 ms in control group females i.e. highly significant ($p<0.001$). Our study also exhibit that mean QTc interval of obese group females (413.7ms) was significantly higher than of

the control group females (396.2 ms) with $p<0.001$. These findings are in agreed with the earlier studies of Frank *et al*. (1986) who found the increase in QTc interval along with the increased PR interval in obese individuals. This difference in ECG findings is also supported by the previous studies of Koehler *et al*. (1989), Lalani *et al*. (2000), Esposito *et al*. (2002), Park *et al*. (2005) and Seyfeli *et al*. (2006).

The increased PR and QTc interval in our study can be explained by the slowed conduction in the cardiac muscle due to increased amount of fatty tissue in the cardiac musculature. According to Frank *et al*. (1986) as body weight increases, cardiac conduction of impulse is slowed and their QRS vector shifts towards the left. The increased waist-hip ratio of obese females in our study also indicates towards their upper body obesity. This increased waist-hip ratio of obese females in our study may be one of the causes for significantly increased QTc interval. According to Park and Swan *et al*. (1997), upper body obesity has longest QTc interval as compared to lower body obesity and non-obese even at same level of body fat in moderately obese woman.

There are, however several studies which show the retrospective aspect of the above findings. They show that in overweight and obese individuals, the QTc interval decrease when they lose weight. The studies which support this are those of Carella *et al*. (1996), Pietrobelli *et al*. (1997), Pidilich *et al* (1997) and Grazia Corbi *et al*. (2002).

Thus, we conclude that cardio-vascular physiological parameters of the obese adult females are compromised when compared to the non-obese adult females. Therefore obese young females may be more prone to develop many disorders particularly cardiovascular diseases.

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