

Full length Research Article

# Mean Values, Normal Limits and Sex Differences of Heart Rate, QT Interval, QTc, PR Interval and QRS Duration among Young Adults of Yoruba Ethnicity

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**Summary:** An electrocardiogram (ECG) is important for non-invasive cardiovascular health assessment. This study was carried out to determine the mean values, normal limits, and sex differences of selected electrocardiographic variables in young adults of Yoruba ethnicity. One thousand healthy volunteers (500 males and 500 females) aged 18 to 40 years participated in the study. Ethical approval was obtained from the Institute of Public Health of the University. Standard 12-lead resting ECG of each participant was obtained according to standard protocol. After a period of rest of 5 minutes, the chest and extremities of each participant were exposed for placement of limb and chest electrodes. The ECG printouts were analyzed. Descriptive variables were expressed as means  $\pm$  standard deviation. The lower and upper limits were determined using the 5th and 95th percentiles respectively. The comparison of the mean values of the male and female variables was done using the Student t-test. A p-value less than 0.05 was considered statistically significant. The results showed that the mean heart rate, QT interval, QTc interval, QRS duration, PR interval were  $70.56 \pm 10.99$  bpm,  $0.36 \pm 0.03$  s,  $0.38 \pm 0.03$  s,  $0.07 \pm 0.01$  s and  $0.16 \pm 0.02$  s, respectively. Among young adults of Yoruba ethnicity, sex differences exist concerning heart rate, QTc, and QRS duration and these should be considered in ECG interpretation.

**Keywords:** Electrocardiogram; normal limits; mean values; sex differences; Young adults; Yoruba ethnicity.

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Manuscript received- March 2024; Accepted: August 2024

DOI: <https://doi.org/10.54548/njps.v39i2.4>

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## INTRODUCTION

An electrocardiogram (ECG) is a useful screening and diagnostic non-invasive cardiac test. It has been reported that racial and sex differences exist with regards to ECG variables (Santhanakrishnan *et al.*, 2016; Macfarlane, 2018). Ethnic group-specific mean values and reference limits in the area of ECG are not available in Nigeria. Among the population of the Yoruba ethnic group in the South-West of Nigeria, baseline data for ECG assessment are not available. The aims of the study were to define the mean values, normal limits, and sex differences of heart rate, QT interval, QTc, PR interval, and QRS duration among young adults of Yoruba ethnicity.

The heart rate is the frequency of the heartbeat. QT interval is the total duration for ventricular depolarization and repolarization. It is measured from the onset of QRS complex to the end of T wave. QT interval is corrected for the heart rate and the derived variable is referred to as corrected QT interval (QTc). The PR interval is a measure of duration for atrioventricular conduction. It is measured from the onset of the P wave to the onset of the QRS complex. Changes in the PR interval may reflect physiological delay or signify abnormality in atrioventricular conduction. PR interval abnormality may be classified as prolongation (PR > 0.2 s) or shortening

(PR < 0.12s) (Holmqvist *et al.*, 2015). QRS duration is a measure of ventricular depolarization time and it has been shown to be a prognostic marker of coronary artery disease (Chen *et al.*, 2021).

## MATERIALS AND METHODS

**Study location:** The study was carried out at the Obafemi Awolowo University Health Centre and the Department of Physiological Sciences, Obafemi Awolowo University, Ile-Ife.

**Study design and population:** It was a cross-sectional descriptive study. One thousand participants were grouped into two (500 males and 500 females). Inclusion criteria include; apparently healthy young adults between the ages of 18 and 40 years and Yoruba ethnicity. Exclusion criteria include the presence of systemic illness and other ethnic groups in Nigeria. The target population was the students of Obafemi Awolowo University community, Ile-Ife, Nigeria. The participants were educated about the procedure and informed consent was obtained from them.

**Methodology:** The standard 12-lead ECG of each participant was obtained in the supine position during quiet respiration using an electrocardiograph (Nihon Kohden

CardioFax). The chest and the limb extremities were exposed and 10 ECG electrodes were placed on the body surface of each participant according to internationally approved protocol. The chest lead recordings (V1 –V6) were obtained by the attachment of 6 electrodes to the anterior chest wall; V1 was placed at 4th intercostal space, right sternal edge, V2 was placed at 4th intercostal space left sternal edge, V4 was placed at the left 5th intercostal space along the mid clavicular line, V3 was placed at the midpoint between V2 and V4, V5 was placed at left 5th intercostal space along the anterior axillary line while V6 was placed at the left 5th intercostal space along the mid axillary line. The six limb leads (I, II, III, aVF, aVL, and aVR) were recorded with the aid of four electrodes attached to the distal end of the limbs (one electrode per limb). The PR interval, QT interval, RR interval, and QRS duration of each participant were measured from the ECG. The QT interval was measured using the tangent method and QT corrected (QTc) was calculated using Bazett's formula,  $QTc = QT \text{ measured (ms)} / \sqrt{\text{preceding R-R interval}}$  (Dahlberg *et al.*, 2021). Heart rate was measured using the formula: Heart rate = 60/RR interval. All measurements were taken from lead II.

**Data analysis:** The data were analyzed using IBM SPSS version 20.0 software. The descriptive variables were expressed as means  $\pm$  standard deviation. The lower and upper limits were determined using 5th and 95th percentile respectively. A comparison of the means of the male and female variables was done using the Student t-test. A p-value less than 0.05 was considered statistically significant.

## RESULTS

A total of one thousand students (500 males and 500 females) between the ages of 18 and 40 years old, participated in this study. The mean age, heart rate, QT interval, QTc, QRS duration and PR interval for all participants were  $21.06 \pm 2.82$  years,  $70.56 \pm 10.99$  bpm,

$0.36 \pm 0.03$  s,  $0.38 \pm 0.03$  s,  $0.07 \pm 0.01$  s and  $0.16 \pm 0.02$  s respectively (Table 1).

**Table 1:**

Mean values and normal limit of selected ECG variables for all participants

ECG Variables	Mean $\pm$ SD N=1000	Normal limits (5th-95th percentile)
Heart rate (bpm)	$70.56 \pm 10.99$	55.00-91.00
QT interval (s)	$0.36 \pm 0.03$	0.32-0.40
QTc (s)	$0.38 \pm 0.03$	0.34-0.44
QRS duration (s)	$0.07 \pm 0.01$	0.06-0.10
PR interval (s)	$0.16 \pm 0.02$	0.12-0.20

Normal limits at 5th and 95th percentile

There was a statistically significant difference in the heart rate of males and females with the males having a lower mean heart rate than females ( $t = -12.994$ ,  $p = 0.001$ ). The mean QT interval for females ( $0.35 \pm 0.03$  s) was lower than that for males ( $0.36 \pm 0.03$  s) but it was not significant ( $p = 0.05$ ). The mean QTc interval was significantly higher ( $p = 0.001$ ) in females ( $0.39 \pm 0.03$  s) than in males ( $0.37 \pm 0.02$  s). The mean QRS duration in males ( $0.08 \pm 0.01$  s) was significantly higher ( $p = 0.001$ ) than that of the females ( $0.07 \pm 0.01$  s). The mean PR interval for males and females were the same ( $0.16 \pm 0.02$  s). The normal limits of ECG variables for all participants and each of the subgroups are illustrated in Tables 1-3.

## DISCUSSION

The lower and the upper limits of the normal limits (55-91 bpm) of the heart rate from this study was lower than the lower and upper limits of the normal limits (61-93 bpm) reported among young adults in Nigeria by Ayoka *et al.*, (2014). This might be because the sample size (324) of the previous study was smaller than the one for this present study (1000).

**Table 2:**

Sex differences in selected ECG variables

ECG Variables	Male (n=500) Mean $\pm$ SD	Female (n=500) Mean $\pm$ SD	t- value	p-value
Heart rate (bpm)	$66.38 \pm 9.19$	$74.73 \pm 11.06$	- 12.994	0.001*
QT interval (s)	$0.36 \pm 0.03$	$0.35 \pm 0.03$	1.962	0.050
QTc (s)	$0.37 \pm 0.02$	$0.39 \pm 0.03$	- 11.664	0.001*
QRS duration (s)	$0.08 \pm 0.01$	$0.07 \pm 0.01$	7.419	0.001*
PR interval (s)	$0.16 \pm 0.02$	$0.16 \pm 0.02$	-0.497	0.620

\*: significance at  $p < 0.05$

**Table 3:**

Mean values and normal limits of selected ECG variables for males and females

ECG variables	Male n=500		Female n=500	
	Mean $\pm$ SD	Normal limits	Mean $\pm$ SD	Normal limits
Heart rate (bpm)	$66.38 \pm 9.19$	52.00-84.00	$74.73 \pm 11.06$	59.00-95.00
QT interval (s)	$0.36 \pm 0.03$	0.32-0.40	$0.35 \pm 0.03$	0.32-0.40
QTc (s)	$0.37 \pm 0.02$	0.33-0.41	$0.39 \pm 0.03$	0.34-0.45
QRS duration (s)	$0.08 \pm 0.01$	0.06-0.10	$0.07 \pm 0.01$	0.04-0.08
PR interval	$0.16 \pm 0.02$	0.12-0.20	$0.16 \pm 0.02$	0.12-0.20

Normal limits at 5th and 95th percentile

Moreover, while this present study was carried out among young adults of Yoruba ethnic group, the previous study was

not ethnic group specific. Furthermore, Chime *et al.*, (2020) reported a higher mean heart rate ( $73.46 \pm 10.70$  bpm) from

their study on healthy Nigerians in the Eastern part of the country. This disparity might be due to the fact that their study was on a wider age range (20-54 years). In contrast, Soliman and Rautaharju (2012) reported a lower mean heart rate of  $68 \pm 11$  bpm among the United States White and Black adult population. This could be because they studied an older population (40 years and above), not of Yoruba ethnicity. The variation might be due to difference in environment and ethnicity.

From this present study the females had a significantly higher mean heart rate than males. This is in line with other reports (Ogunlade *et al.*, 2012, Ogedengbe *et al.*, 2023). The lower heart rate in males could be because of their higher vagal tone. Results from this present study could imply that males may be more prone to developing bradyarrhythmia and females may be more prone to developing tachyarrhythmia. The normal limits for QT interval from this study was similar to those reported by Ogunlade *et al.*, (2012) and Ayoka *et al.*, (2014) among the young adults in the Southwestern part of Nigeria. This could be because the participants of these other studies were predominantly of Yoruba ethnicity. The mean QT interval observed from this study was lower than the mean QT value of  $0.41 \pm 0.03$  seconds observed by Soliman and Rautaharju (2012) in a population of black and white Americans. This could be because the other study was carried out on an older population (40 years and above). This is in concordance with a report by Dewhurst *et al.*, (2014) that QT interval increases with increasing age. There was no significant difference between the QT interval of males and females in this study. The mean QTc interval value ( $0.38 \pm 0.03$  s) obtained from this study was lower than the mean QTc of  $0.44 \pm 0.05$  s reported by Tan *et al.*, (2016) among the Southeast Asian population. This might be because the study was among the Southeast Asian population of older age group (mean age of 65.7 years). Females had significantly higher QTc compared with their male counterparts. Several other studies have given similar reports (Funada *et al.*, 2008; Tan *et al.*, 2016, Ogedengbe *et al.*, 2023). It has been proposed that the gender related difference in QTc-interval is most likely the result of changes in sex-specific hormones (Vink *et al.*, 2018).

The normal limit for PR interval in this study was the same as the normal limit of PR interval (0.12 to 0.20 sec) obtained from a study carried out by Edemeka (2004) on adult (15 – 49 years) Nigerians resident in Lagos. The mean PR interval for males and females in this study was the same. On the contrary Tan *et al.*, (2016) reported that males had longer PR interval than females among the Asian population. This could be because the study was carried out on an older population with a mean age of 67.7 years.

With regards to QRS duration, the males showed a significantly higher QRS duration than the females in this study ( $p < 0.001$ ). This is similar to the observations by Ogunlade *et al.*, (2012) and Tan *et al.*, (2016) among the Nigerian and Asian populations respectively. This difference might be due to the greater ventricular muscle mass in males than in females causing depolarization to take longer in males. This could mean that males might be more prone to the development of conduction abnormalities such as left or right bundle branch block. On the contrary Ogedengbe *et al.*, (2023) found no significant difference in QRS duration from their study on Young Africans.

In conclusion, the higher rate of cardiovascular disease incidence in recent times calls for greater specificity in defining normative values for cardiovascular variables. This study has been able to establish the mean values, normal limits of heart rate, QT interval, QTc, QRS duration and PR interval among young adults of Yoruba ethnicity. Furthermore, among young adults of Yoruba ethnicity, sex differences exist with regard to heart rate, QTc and QRS duration and these should be taken into consideration in ECG interpretation.

#### Acknowledgements

We appreciate the entire staff of the Department of Physiological sciences, Obafemi Awolowo University, Ile-Ife. We are also grateful to the Medical Director and to all members of staff of the Electrocardiographic (ECG) Unit, Obafemi Awolowo University Health Centre, Ile-Ife for their support.

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