Comparative Study Of Diurnal Variations In Electrocardiographic Intervals Of Non-Athletes And Athletes In Zaria, Nigeria

Yusuf M. Suraj, Muhammad A, Mabrouk, Joseph O. Ayo

Abstract: There is paucity of information on the diurnal variation in electrocardiogram (ECG) parameters of normal individuals, especially those subjected to physical exertion. The aim of the study was to determine changes in patterns of ECG intervals of normal young adults with variations in hours of the day, and to compare the changes between athletes and non-athletes. The study investigated resting ECG values from 30 athletes (20 males and 10 females) and compared with those obtained from 26 non-athletes (16 males and 10 females) in the same laboratory. ECG recordings were performed according to the recommendation of Society for Cardiological Science and Technology, 2006. Recordings were made at 07:00 h, 12:00 h and 17:00 h daily for two days consecutively for all the subjects. Intervals considered included P-wave duration, PR interval, QRS interval, QT interval and the corrected QT interval (QTc). [Data were subjected to statistical analysis using the Student's *t*-test and were expressed as mean±SEM]. The results of the study revealed that values of all the measured parameters for all the subjects were all within normal range, and a significant ($P < 0.05$) diurnal variation. The results also indicated that there was a higher ($P < 0.05$) range of ECG interval variations in males than females, and in athletes compared to non-athletes, In conclusion, the study showed that the ECG intervals exhibited diurnal variation and that exercise exerted effects on diurnal variations of ECG intervals in man.

Index Terms: circadian rhythm, diurnal, electrocardiogram, exercise, heart, parameters, variations

1 INTRODUCTION

Although first described in the suprachiasmatic nucleus (SCN), circadian clocks have been identified in many peripheral tissues, including adipose, heart, kidneys and vasculature. These peripheral clocks are regulated by central circadian clock machinery and circulating serum markers of circadian function [15]. Circadian (diurnal and nocturnal) rhythm is an integral part of the physiology of the body; specifically, sleep, feeding behavior and metabolism are tightly linked to the light-dark cycle dictated by the earth's rotation [4]. In the cardiovascular system, circadian clocks have been characterized within multiple cell types, including cardiomyocytes [25]. The circadian clock within the cardiomyocyte influences cardiovascular function. Hence, this is reflected in different heart parameters, which include heart rate and its variability, cardiac autonomic tone, and ventricular arrhythmias [1]. However, information on the possibility of a circadian rhythm of the electrocardiogram (ECG) is limited. Even though some studies have been carried out by Michael et al., 2007 [21] to show that there is a diurnal variation in ECG parameters of cardiac patients, more research needs to be done to actualize better understanding of the diurnal variation in electrocardiographic parameters of humans, especially in normal young adults.

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The ECG is divided into several parameters made up of amplitudes, segments and intervals, which include the P wave, PR interval, QRS complex, QT interval, ST segment, T wave, and U wave [3]. These parameters show different electrical activities of the heart in different regions at different times. Therefore knowledge of the performance of the heart at a particular time of the day may be of great importance in understanding the appropriate timing of application of necessary external influences on the heart. Such influences include the application of prophylaxis, diagnosis, therapy or even physical exertions like exercise. Physical activities like strenuous exercise of many muscle groups are intended to increase muscle tone and cardiovascular fitness. Athletes usually engage in any of such physical activities. In different sports, physical performance is subject to circadian-type modifications. For example, most world records in sporting events were broken during the evening hours [6]. The general aim of this study was to find out changes in ECG intervals of normal young adults as the hours of the day vary, and to specifically determine as well as compare the changes in ECG intervals with variations in hours of the day in athletes and non-athletes. The hypothesis was that diurnal variations may occur in ECG parameters of normal young adults, and that exercise may affect the variations.

2 MATERIALS AND METHODS

2.1 Materials

Equipment used were: 12-lead ECG (EDAN instruments Incorporated, China, Model SE-3 and Serial Number SE306413452A) which is a 3-channel, battery-powered two-speed (25 and 50 mm/sec) machine, Mercury sphygmomanometer, stethoscope, clinical thermometer, weight scale (China, Mechanical Personal Scale with Model number BR 9011), height scale, dry and wet-bulb thermometer. The study population include 56 young adult humans of ages between 20 and 45 years, divided into two groups; group A consist of 26 non-athletes (16 males and 10 females) and group B was made up of 30 athletes (20 males and 10 females). The study was conducted in Zaria (11º03' N,

7º42' E), a heterogeneous city, occupying a portion of the high plains of Northern Nigeria, 652.6 meters above sea level and some 950 kilometers from the coast. It is located in the Northern Guinea Savannah zone of Nigeria.

2.2 Procedure

The study was conducted at 07:00 h, 12:00 h and 17:00 h daily for two days consecutively for all the subjects. ECG recordings were conducted following the approved methodology by the Society for Cardiological Science and Technology for recording a standard 12-lead electrocardiogram, which was last reviewed in October, 2006 [7]. Measurement of the vital body functions and parameters of all the subjects were also carried out before each ECG recording. These are basically (i) blood pressure (systolic and diastolic), (ii) body temperature (axillary), and also the height and weight of each subject. Meteorological parameters of ambient temperature, atmospheric pressure and relative humidity in the laboratory environment were all recorded concurrently with the physiological parameters, with all the subjects maintained in the same laboratory conditions. The measurement units for all the ECG interval durations were expressed in milliseconds (ms), and parameters focused on were the intervals which included: P-wave interval, PR interval, QRS interval, QT interval, and the corrected QT interval (QTc interval).

2.3 Statistical Analysis

Data were subjected to statistical analysis using the Student's *t*-test, and values were expressed as mean ± SEM. Values of $P < 0.05$ was considered significant.

3 Results

The meteorological data from the study period are shown in Table 1. The ambient temperature ranged between 18.00 ºC and 31.00 ºC with a mean of 22.00 ± 0.41. The relative humidity varied between 72.00 % and 83.00 %, and the mean value was 76.25 ± 2.39.

Table 1: Meteorological data from the study period

Meteorological parameters	Day				
	1	2	3	4	Mean ± SEM
Ambient temperature (ºC)					
Maximum	29.00	31.00	30.00	30.00	30.00 ± 0.41
Minimum	22.00	18.00	19.00	22.00	20.25 ± 1.03
Dry-bulb	27.67	27.67	27.80	28.00	27.79 ± 0.08
Relative humidity (%)	76.00	72.00	74.00	83.00	76.25 ± 2.39
Rainfall (mm)	54.20	96.00	3.70	7.60	40.38 ± 21.80
Wind Speed (km/day)	115.53	93.20	89.98	68.24	91.74 ± 9.68

*Data collated from the meteorological service unit of Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria.

The recordings obtained at different periods, representing the various intervals from the ECG for the subjects are presented in fig. 1 to fig. 4.

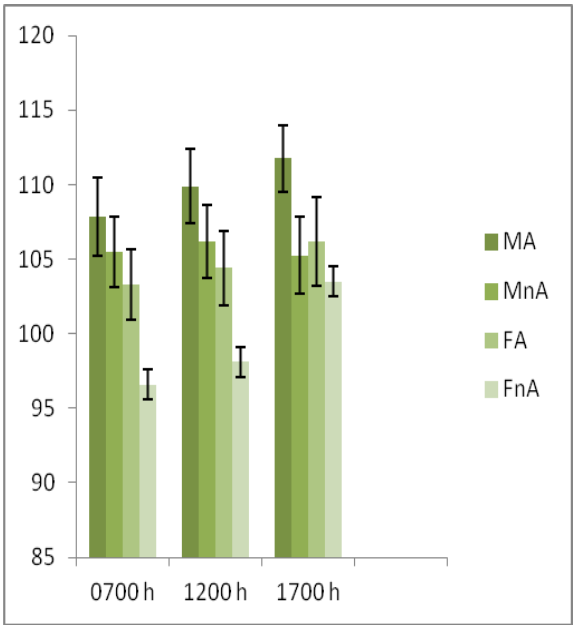

Fig. 1. Diurnal variations in P-wave durations (ms) of male athletes (MA), male non-athletes (MnA), female athletes (FA) and female non-athletes (FnA).

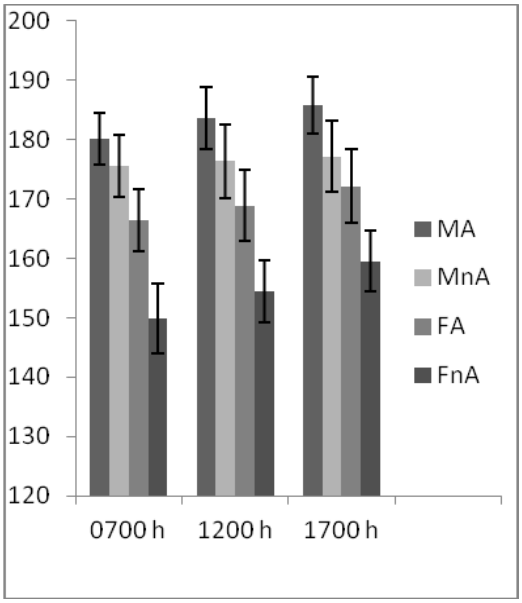

Fig. 2. Diurnal variations in PR-interval durations (ms) of male athletes (MA), male non-athletes (MnA), female athletes (FA) and female non-athletes (FnA).

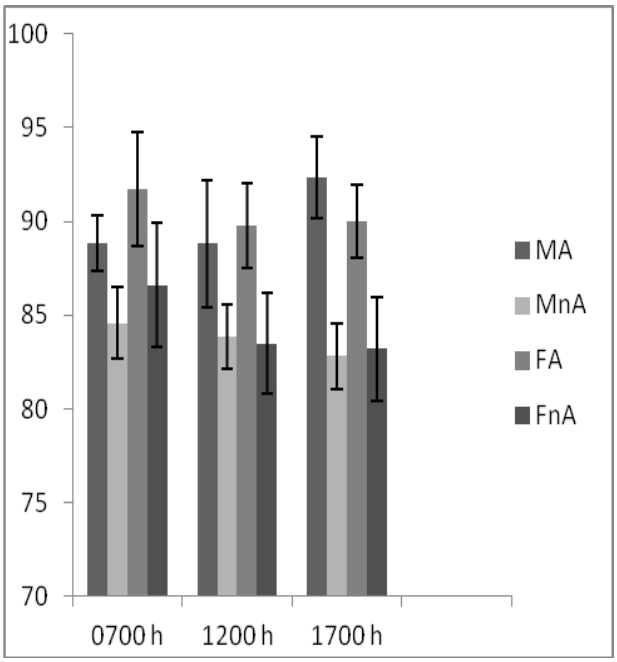

Fig. 3. Diurnal variations in QRS durations (ms) of male athletes (MA), male non-athletes (MnA), female athletes (FA) and female non-athletes (FnA).

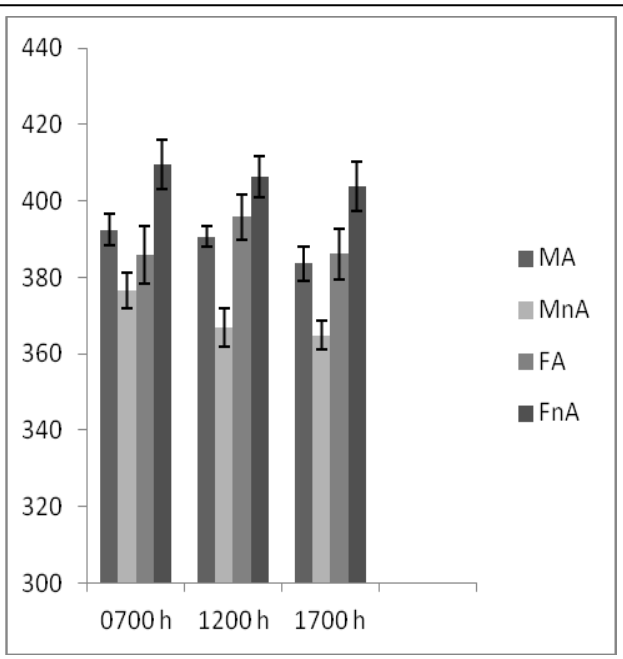

Fig. 4. Diurnal variations in QTc-intervals durations (ms) of male athletes (MA), male non-athletes (MnA), female athletes (FA) and female non-athletes (FnA).

4 Discussion

All the ECG parameters recorded were found to be within the normal ranges in all cases as established in numerous studies, including works of [2], [11], [9], [20], [7], [14] and [19]. The results obtained revealed that there was a remarkable diurnal variation in all the measured ECG parameters, and the findings were in consistence with the results obtained by [8], [23], [16], [10], [12], [13] and [24]. A higher range of ECG intervals variations was observed in athletes. This shows that exercise affects diurnal variation, and that the results agree with the works of [6] and [5]. It is important to mention that this study observed the PR interval durations for all the groups to have shown marked alterations with change in time of the day. Hence the A-V nodal delay fluctuated more frequently with change in the time of the day than other parameters of conducting activities of the heart. The study also observed that P-wave durations for all the groups revealed the least alterations with diurnal rhythm. Thus, the atrial depolarization fluctuated less frequently with change in the time of the day as compared to other parameters of conducting activities of the heart. The higher range of ECG interval variations in male athletes as compared to the male non-athletes may be as a result of the influence of the well-developed athlete's heart, demonstrating that exercise has a tremendous effect on variations in ECG parameters with changes in time of the day. For the female subjects, the PR interval, QT interval, and QTc interval durations have a higher range of variations in the female athletes compared to the female non-athletes. This was probably due to the effects of the well-developed heart in the athletes as earlier explained. However, the P-wave duration and QRS interval durations had a higher range of variations in the female non-athletes as compared with the female athletes. The reasons for this may be due to some physiological or endocrinal factors which were not measure in the present study. The QT interval on the surface ECG reflects the time for depolarization and repolarization of myocardium. Prospective studies have suggested that prolongation of QTc is strongly associated with sudden cardiac death, and the importance of QT prolongation in arrhythmia has been shown in several works, including those of [22], [18] and [17]. However in this study, QT intervals for all the groups were shorter during the day and decreased to the minimum values in the afternoon. It was, therefore, interesting to note that the appropriate timing for drug administration may be speculated, and can be given at the suitable time for manifestation of optimal effects.

Conclusion

The screening and recordings of the body parameters of all the subjects selected for this study did not show any indication of any confounding variable that may influence the validity of the result of this study. Hence, we conclude that the study clearly showed that there are diurnal variations in ECG intervals of non-athletes and athletes in Zaria, Nigeria. Furthermore, the study also revealed that ECG intervals of athletes showed more diurnal variations compared to those of the non-athletes, and those of males showed more variations than as seen in the females.

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