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Cardiac Autonomic Dysfunction in Apparently Healthy young Adults in Nigeria

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Abstract

Assessment of Cardiac Autonomic Function (CAF) is often not carried out among apparently healthy young individuals. This study evaluated the pattern and prevalence of cardiac autonomic dysfunction among apparently healthy young adults in Ile-Ife, Nigeria. A total of 204 apparently healthy young adults, 98 (48%) males while 106 (52%) females) aged between 18-40 years with mean age of 22.72 ± 4.86 years who were residents of Ile-Ife participated in this study. Each participant was assessed with a battery of five tests of cardiac autonomic function; Systolic Blood Pressure (SBP) response to change of posture (supine to erect), Diastolic Blood Pressure(DBP) response to sustained handgrip at 30% maximum voluntary contraction (MVC), heart rate responses to Valsalva manoeuvre, deep breathing and change of posture. The cardiac autonomic status for each individual was classified into normal, sympathetic abnormality, parasympathetic abnormality or combined abnormalities (sympathetic and parasympathetic) depending on the value of the autonomic cardiovascular indices derived from the five tests. In the overall cardiac autonomic function assessment of the participants, the frequency of normal, sympathetic abnormality, parasympathetic abnormality and combined abnormalities were; 62%, 16%, 16% and 6% respectively. No significant gender difference was found in the cardiac autonomic dysfunction ($\chi 2$ = 3.550, P value = 0.314). This study revealed that sub-clinical autonomic abnormalities could occur among apparently healthy adults despite their normal clinical status. This may explain a few cases of unexplained sudden cardiovascular events such as sudden cardiac death among apparently healthy young adults.

Keywords: Cardiac autonomic dysfunction, Young adults, Nigeria.

Introduction

An abnormality of cardiac autonomic nervous system is referred to as cardiac autonomic dysfunction (CAD), which is a manifestation of many diseases. In many patients with diabetes mellitus, the presence of CAD increases the risk of death by five-fold[1-7]. This may be due to occurrence of silent ischaemia, acute coronary syndrome, dysrhythmia cardiac or respiratory functional lability. CAD may be seen in a diversity of diseases such as type II diabetes mellitus, alcoholism, Parkinson's disease, malnutrition, vitamin deficiencies, heavy metal poisoning, rheumatic arthritis and kidney disorders[8,9].

In most cases of diabetes mellitus, CAD predates classical manifestations of the disease and its severity is usually in advanced stage before the diagnosis of the underlying disease[10]. Hence, medical evaluation of patients with diabetes mellitus is incomplete without adequate assessment of cardiac autonomic function. Autonomic nervous system assessment involves reflex pathways[11].

The objectives of autonomic function tests include assessment of syncope, postural hypotension, CAD and its classifications, follow-up its course and management. Autonomic function tests play significant role in research into autonomic dysfunctions[12]. Evaluation of cardiac autonomic function is indicated in the management of diseases such as diabetes mellitus, amyloidosis, paraneoplastic neuropathy and acute panautonomic neuropathy[13,14]. The normal limits and the relationship between indices of autonomic function with age and sex among young adults black population had been described[15,16].

Data is sparse with regards to the abnormality of cardiac autonomic function especially among asymptomatic individuals, hence this study.

Materials and Methods

Study population: The targeted population for this study was the residents of Ile-Ife community between ages 18 and 40 years. A total of 204 subjects participated and completed the process after the initial clinical screening process. It was a cross-sectional descriptive study. They were all informed about the research and consents were obtained before participating. Ethical clearance was obtained from the Ethics and Research Committee of the Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria.

Materials for the Procedure: The materials for these procedures include: digital sphygmomanometer (Lumiscope), anaeroid sphygomanometer (Becton) guage, 5cc with disposable syringe (utilized as mouth piece), Littmann Cardiology III Stethoscope, ZT120 Health Scale and stadiometer, Dongjiang three channel electrocardiograph (ECG-32A) with its operational accessories , cardiograph paper (63mm by 30m), multi-purpose ultrasound gel, tissue paper, stopwatch, Smedley digital hand dynamometer (Model 12-0286), Tiger head alkaline batteries-AAA, calculator and examination couch.

Procedure: Each of the participant performed cardiac autonomic function tests which comprised of series of five procedures; Blood Pressure assessment in various positions (supine and errect), DBP check during sustained handgrip at 30% MVC, Valsava manoeuvre, Deep Breathing exercises and postural change while undergoing electrocardiographic assessment as described by Ogunlade *et al*[15].

Blood pressure response to change of posture: The SBP was measured by the use of a validated digital sphygmomanometer (Lumiscope). The resting supine SBP was measured three times and recorded, the average of the three was documented as the resting supine SBP. The subject was then asked to stand erect unaided for two minutes and the SBP measurement was repeated. The result was expressed as the difference between the mean of the supine SBP and the erect SBP:

SBP response to change of posture (mmHg) = mean supine SBP (mmHg) - erect SBP (mmHg)

Blood Pressure response to sustained handgrip: The resting DBP of the subject was recorded three times in sitting position with sphygmomanometer cuff attached to the dominant arm. The maximum voluntary contraction (MVC) of the subject was determined from the non-dominant arm by the use of a handgrip dynamometer. The handgrip was maintained at 30% of the maximum voluntary contraction for as long as possible (up to maximum period of 5 minutes). The DBP was measured repeatedly at a minute interval during the handgrip exercise. The result was expressed as the difference between the highest DBP during the handgrip exercise and the mean resting DBP:

DBP (mmHg) response to sustained handgrip = highest DBP (during handgrip) - mean resting DBP

Heart rate response to Valsalva maneouvre: The subject was asked to lie in supine position and the limb electrodes of the ECG were attached to the limbs. A resting ECG was recorded and the subject breathing normally was asked to perform Valsalva maneouvre by straining into a manometer gauge through a disposable plastic mouth piece. To perform the straining, the subject was asked to maximally breath into the mouthpiece of the modified aneroid manometer gauge and maintain a constant expiratory effort equivalent to an intraoral pressure of 40mmHg for 15s (strain period) during which a continuous long rhythm strip (lead II) of electrocardiogram (ECG) was recorded. After this, the expiratory straining was suddenly released and normal respiration was maintained as regularly as possible without gasping for breath. Continuous ECG recording was sustained until the count of 20 beats after the strain. An effective procedure was associated with neck vein engorgement, increased tension in the abdominal wall and expansion of the thoracic cage of the participant. On the ECG strip, the shortest RR interval observed during the strain and the longest RR interval which occurred within 20 beats after the maneouvre were assessed. The Valsalva Ratio (VR) was estimated as stated below:

$$VR = \frac{\text{Longest RR interval within 20 beats after the strain period}}{\text{Shortest RR interval during 15s of the strain}}$$

Heart rate response to deep breathing: After giving instructions and sufficient training about the procedure, the subject was made to lie quietly in supine position while the limb electrodes of ECG were attached to the limbs. Through verbal signal, the subject was asked to breathe in maximally for 5s and breathe out maximally for 5s. The cycle of deep inspiration and expiration was repeated continuously for 1minute while a continuous ECG was recorded for the whole period of the deep breathing with a marker delineating the phases of inspiration and expiration on the ECG strip. A total of six respiration cycles were performed in a minute. The maximum and minimum RR intervals were assessed during each breathing cycle and these were converted to heart rate in beats per minute. The result of the test was expressed as the greatest heart rate difference during each cycle as stated below:

Heart rate response to deep breathing (HDB) = maximum heart rate minus minimum heart rate

Immediate heart rate response to standing: During this procedure, the subject was asked to maintain a supine position on a couch while the limb electrodes of ECG were attached to the limbs and a continuous recording of long rhythm strip (lead II) ECG began. After 1-2 second(s) of recording of ECG in supine position, the subject was asked to stand up from the couch unaided and the point of rising up was marked on the ECG strip. Continuous ECG was recorded until 30 QRS complexes were counted in standing position. The result of the test was expressed as the 30:15 ratio as stated below:

$$30{:}15 \text{ ratio} = \frac{\text{Longest RR interval at around beat 30 after standing erect}}{\text{Shortest RR interval at or around beat 15 after standing erect}}$$

The criteria used for determination of cardiac autonomic function status were; Normal (all the five tests normal), Sympathetic abnormality (abnormality of one or both blood pressure tests), Parasympathetic abnormality (Abnormality of one or all the three heart rate tests) and Combined abnormality (Abnormality of any of the two blood pressure tests and any of the three heart rate tests) as shown in Table-1.

Results and Discussion

Two hundred and four (204) apparently healthy young adult participated in this study, 106 (52%) were female while 98 (48%) were males with age range of 18 - 40years with mean age ± SD of 22.72 ± 4.86 years. The mean ± SD for weight (kg), height (m), body mass index (kg/m^2) and body surface area (m^2) were 59.86±10.05, 1.66±0.08, 21.80±3.41 and 1.66±0.16 respectively. The performance of each of the autonomic cardiovascular indices were classified into normal and abnormal. Overall, among the participants, the frequency of normal, sympathetic abnormality, parasympathetic abnormality and combined (sympathetic and parasympathetic) abnormalities were; 62%, 16%, 16% and 6% respectively (Figure-1). Gender did not significantly alter the outcome of autonomic function test in the study population (Figure-2).

Table-1
Criteria for determination of cardiac autonomic function status

Category	Criteria
Normal	All the *five tests normal
Sympathetic abnormality	Abnormality of one or both blood pressure tests
Parasympathetic abnormality	Abnormality of one or all the three heart rate tests
Combined abnormalities	Abnormality of any of the two blood pressure tests and any of the three heart rate tests

*1. SBP responses to change of posture (supine to erect), 2. DBP responses to sustained handgrip at 30% MVC, 3-Valsalva Ratio, 4- Heart rate responses to Deep Breathing, 5. 30:15 ratio (Postural Tachycardia Index)

Discussion: This study showed that 127 (62%) of the participants had normal cardiac autonomic function while the cardiac autonomic dysfunction was present in 77 (38%).The percentage of people with CAD was higher than 9% reported by Kolo *et al*, in a study of apparently healthy young adults as control in Ilorin[17]. The lower percentage of the abnormality observed in the study of Kolo *et al* may be due to lower sample size (44) of the participants at Ilorin. Moreover, single abnormality (sympathetic or parasympathetic abnormality) occurred in equal proportion 33 (16%) each and were more frequent than combined abnormalities which occurred among 11 (6%) of the participants (Figure-1). In assessing severity of cardiac autonomic dysfunction, combined abnormality is more severe than either parasympathetic abnormality than sympathetic abnormality. In this present study, only 6% had combined abnormality. Data is sparse as regards to comparative studies of the various forms of cardiac autonomic dysfunction among healthy individuals however, 52% parasympathetic abnormality was reported among individuals with type II diabetes mellitus by Basu *et al*[18]. The association between gender and CAF was also observed in this study. However, this association was not statistically significant ($\chi 2 = 3.550$, p value = 0.314) but it appeared that gender played some roles in determination of pattern of CAF abnormalities (Figure-2). In the overall assessment, more men had normal CAF than women. The above observation was in concordance with earlier reports on influence of sex and age on cardiovascular autonomic functions and reported that age rather than sex played dominant role in influencing cardiovascular response during autonomic challenges[19,20]. It was also observed from this study that more men had sympathetic abnormalities than women and more women had parasympathetic and combined abnormalities than men which is in concordance with earlier reports on abnormalities of cardiac autonomic function [21-25]. These may be due to athletic muscular built, high level of testosterones and higher vagal tone in males.

N=204, Combined abnormalty- Sympathetic and parasympathetic abnormalities. Overall, abnormalities of either of the sympathetic and parasympathetic system occurred in equal frequency among the volunteers and were less frequent than combined abnormalities.

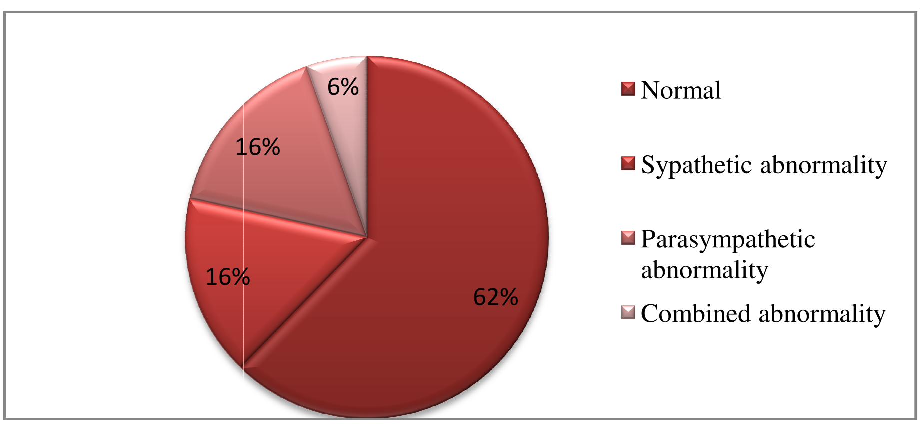

Figure-1
Cardiac autonomic function status

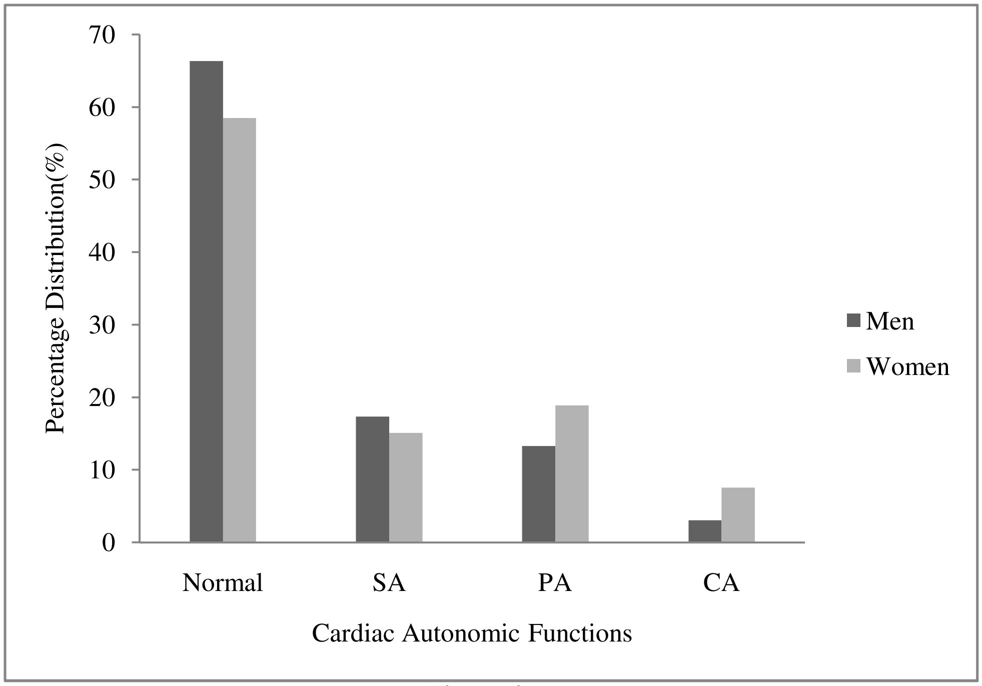

Figure-2
Cardiac autonomic function status according to gender

SA-Sympathetic abnormality, PA-Parasympathetic abnormality, CA-Combined sympathetic and parasympathetic abnormalities ($\chi 2$ = 3.550, P value = 0.314)

Conclusion

This study revealed that sub-clinical autonomic dysfunctions could occur among apparently healthy adults despite their normal clinical profile. Therefore, cardiac autonomic function assessment may be necessary for young people participating in strenuous activities like sports and military training.

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