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Pattern Variation in Electrocardiogram T wave of Apparently Healthy in-School Children in Choba, Rivers State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: Electrocardiographic (ECG) patterns are graphical recordings of voltage versus time of the electrical waves of the heart using a resting 12-lead ECG machine. In children, ECG misinterpretation remains a problem and can result in clinical mismanagement. In electrocardiography, the T-wave represents the repolarization of the ventricles. This study aims to determine the T-wave inversion variation pattern in apparently healthy in-school Nigerian children in Choba.
Methods: A descriptive cross-sectional was carried out to determine pattern variations in T-wave inversion in in-school children across sex, age, and height. A simple random sampling method was used to select subjects from Primary 1 to 6. A total of 135 in-school children were recruited from a population of 203 from 2 primary schools in Choba. The subjects were randomly sampled across two sex groups (boys and girls) and three age groups (5-8, 9-11, and 12-14). Trends in weight,

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height, and blood pressure were also observed. A resting 12-lead electrocardiograph, a seca standiometer, a mercury sphygmomanometer cuffs, and a stethoscope were used. Data was collected using standard methods. The procedures were conducted by competent personnel.
Results: The girls have significantly higher mean age, height, weight, and systolic blood pressure than boys ($p<0.01$). Diastolic blood pressure between boys and girls showed no significant difference ($p<0.005$). The distribution of T wave inversion has no sexual preference ($\times 2=0.702$; $p=0.873$). The result also showed a correlation between measured variables in the study population. More V1-V2 T-wave inversion was found in both sexes compared with other T-wave inversions.
Conclusion: The T-wave inversion pattern in respondents is such that 11.85% had no inversion;16.3% had in V1 only, 24.96% had in V1& V2 and 28.89% had in V1, V2 &V3 precordial leads. Therefore, we consider T-wave inversion as normal findings in apparently healthy children.

Keywords: ECG; T-wave Inversion; children.

1. INTRODUCTION

Electrocardiographic patterns are graphical recordings of voltage versus time of the electrical waves of the heart using a resting 12-lead electrocardiographic machine [1]. In children, the electrocardiogram (ECG) misinterpretation remains a problem and can result in clinical mismanagement [2]. In electrocardiography, the T-wave represents the repolarization of the ventricles. T-wave inversions from V1 to V3 leads are frequently found and are normal in children [3].

Afolabi-Brown et al., [4] in the work “Global T-wave inversion on electrocardiogram: what is the difference?” said that T-wave represented ventricular repolarization and the electrical forces resulting from recovery of activated ventricular muscle fibers back to their resting states. They added that a major factor influencing T-wave configuration is the temporal and spatial patterns of myocardial excitation. Altered patterns of excitation secondarily alter the patterns of recovery and, thus, the formation of the T wave. Furthermore, they said that T-wave inversions as seen on electrocardiograms are associated with a variety of pathophysiologic states, including cardiac, Pulmonary, and cerebrovascular disease and acute electrolyte disorder [5].

T wave in children is normally upright after birth, inverted after the first week of life, and becomes upright again after 6 years [6]. Steve and Karen [7] added that the T-wave in lead V1 inverts by 7 days and typically remains inverted until at least age 7 years. Papadakis et al [8] in the work prevalence and significance of T wave inversions in predominantly Caucasian athletes stated that t wave remains inverted in ages less than 16 years. Despite the paucity of work in our geographical area concerning the T-wave inversion among the children population there are inconsistent reports already established which have motivated the interest of this study to evaluate the Pattern Variation in Electrocardiogram T-wave of Apparently Healthy in-school Children in Choba, Rivers State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Design

The present study employed a cross-sectional descriptive study design to generate data on the pattern variation in electrocardiogram T-wave of apparently healthy children. A total of 135 Children were used for the study and their ages ranged from 5-14 years. CPS Community Primary School and UDPS University Demonstration Primary School were used as study frames where the respondents were sampled using multi-stage random sampling techniques.

2.2 Selection Criteria

The study only comprised children population within the age interval of 5-14 years who are apparently healthy. The study excludes children with any form of health challenges like fever, cough, children under medication, heart palpitations, and headaches.

2.3 Methods of Data Collection

2.3.1 Blood pressure

Trained personnel were used to examine the blood pressure of the children. Blood pressure was measured using a mercury sphygmomanometer and appropriate size cuffs

after the participants had been seated in a chair for 5 minutes with the backs supported. Blood pressure was measured 3 times at an interval of 2 minutes and the mean of the second and third measurements was taken as the blood pressure. (Hiroyuki Takase et al., 2016)

2.3.2 Anthropometric data

The body weights of the children were collected and recorded using standard heights without shoes and weights wearing light clothes in all participants. They were measured in metres (m) and kilograms (kg) respectively using a standard scale (Seca model). To ensure accuracy in the readings, the children were asked to remove shoes, wristwatches, necklaces, and anything that could interfere with the correct readings of ECGs, blood pressure, body weights, and heights [9].

2.3.3 Determination of ECG parameters

A Cardiovit AT-2plus model standard resting 12-lead electrocardiogram (Schiller AG, Altgasse 68 CH 6341, Bear Switzerland) was used to determine electrocardiographic patterns of the hearts of the subjects (children) by the American Heart Association, American College of Cardiology/Heart Rhythm Society (AHA/ACCF/HRS) recommendations. The subjects rested first, then they were asked to lie on a couch in the supine position, exposing only their trunk. (The girls were allowed light gowns). The limb leads were placed on their wrist and their ankles. The chest leads were placed at appropriate points on their chests. The cotton wool swap was used to sterilize the point the leads were placed. Electrode gel was then applied to enhance the conductivity of electrical impulses from the heart to the leads.

2.4 Statistics

Data obtained from the study were subjected to statistical analysis using the International Business Machine of Statistical Package for Social Science (IBM SPSS version 23) and results were presented as mean±SD, frequency, and percentage. The mean and standard deviation were obtained for various parameters and are summarized in tabular and graphical forms. The t-test was done to compare quantitative variables, while the categorical variables were analyzed using the chi-square test. Confidence Interval was set at 95% and a P-value < 0.05 was considered significant. Pearson's correlation coefficient was used to determine the relationship between measured variables in the study population.

3. RESULTS

The mean age, height, and weight of girls were 9.98±2.30 years, 1.36±0.14m, and 30.60±9.16kg while boys were 8.87±2. 12years, 1.27±012m, and 25.17±6.02kg respectively. The difference in the values was significant in boys and girls (P<0.01); with girls having significantly higher mean values (Fig 1).

Fig. 1 A Boxplot Showing the Age, Weight, and Height Distribution of the study population.

Table 1, shows the mean SBP was significantly higher in girls (96.20±12.30mmHg) when compared to boys (87.20±12.40mmHg) (t=4.16; P<0.001), while the DBP was higher in boys 55.90±11.60mmHg when compared to girls 53.40±10.70mmHg; however, the difference was not significant (P>0.05) and the mean T-axis value was higher in boys (55.40±25.1) when compared to girls (49.60±24.1). However, the difference was not significant (0.174) (Table 2).

Table 3 shows Both boys (25; 34.1%) and girls (33; 42.86%) had more V1-V2 inversion when compared with other T-wave inversions; however, the distribution in the population has no sexual preference (χ^2=0.702; P=0.873). In the male subjects, the T wave inversions at V1 and V2 were more frequent than in V1 and V1 to V3. While in females the same V1 to V2 inversions were also more frequent when compared to inversions at the precordial leads. Comparing the male and female inversions at V1 and V2, the females have a higher percentage of V1 and V2 inversions (42.86%) than the males (34.1%). However, it was not statistically significant (χ^2=0.702; P=0.873). The value of girls that have no ST segment abnormality 74(96.1) is more than that of the boys 55 (94.83). However, it was not statistically significant (Table 4).

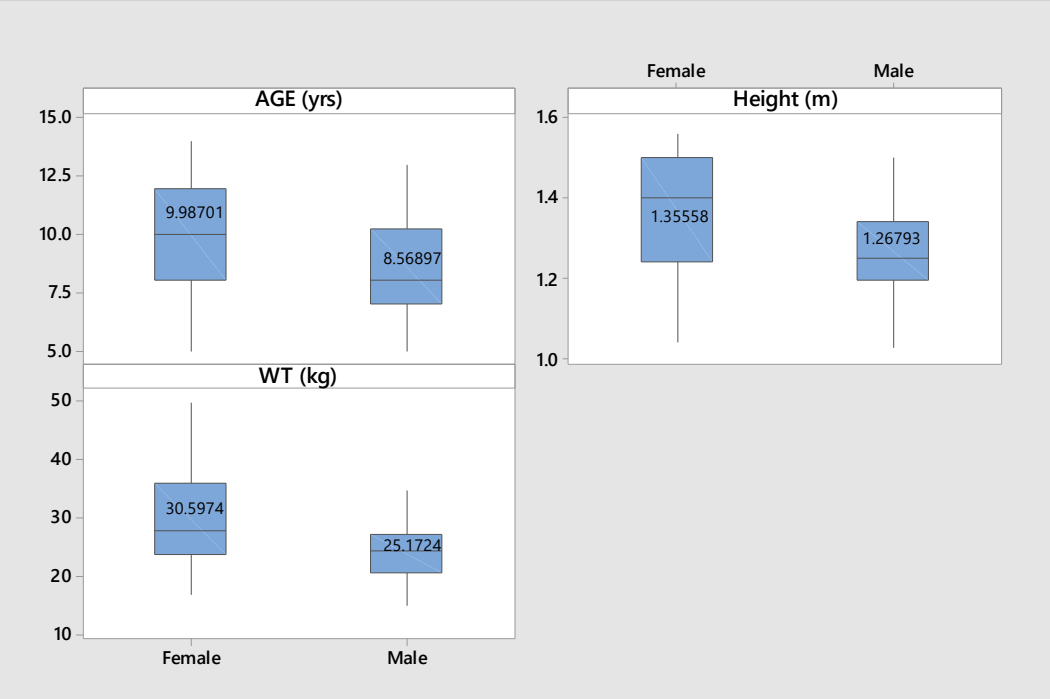

Fig. 1. The mean age, height, and weight of the male and female children

Table 1. The test of mean difference of the systolic and diastolic blood pressures (SBP & DBP) of the children

Sex	N	SBP (mmHg)	T-test		DPB (mmHg)	T-test	
		Mean±SD	T-Value	P-Value	Mean±SD	T-Value	P-Value
Male	56	87.20±12.40	-4.16	0.000	55.90±11.60	1.26	0.210
Female	77	96.20±12.30			53.40±10.70		

P value < (0.05)

Table 2. The test of mean difference in T-axis (^{0}) value of the male and female children

Sex	N	T- Axis (^{0})	T-test	
		Mean	T-Value	P-Value
Male	58	55.40±25.1	1.37	0.174
Female	77	49.60±24.1		

Table 3. Distribution of the T-wave inversion in boys and girls and test of association

Sex	T Wave Inversion				Chi-Square Analysis		
	NIL	V1	V1-V2	V1-V3	Chi-Square	DF	P-Value
Female	8 (10.39)	12 (15.58)	33 (42.86)	24 (31.17)	0.702	3	0.873
Male	8 (13.79)	10 (17.24)	25 (34.1)	15 (25.86)			
Total	16 (11.85)	22 (16.3)	58 (24.96)	39 (28.89)			

Table 5, shows age correlates positively and significantly with height (0.732), weight (0.708), SBP (0.702), DBP (0.337), and negatively with the T axis (-0.048) but not significant. Height correlates positively and significantly with weight (0.719), SBP (90.574), DBP (0.198), and negatively with the T axis (-0.164) but is not significant. Weight correlates positively and significantly with SBP (0.555), DBP (0.281), and negatively with Taxis (-0.143) but is not significant. SBP correlates positively and significantly with DBP (0.501) and negatively with the T axis (-0.041) but is not significant.

Table 4. Distribution of the ST-segment Abnormality in boys and girls and test of association

	ST Segment Abnormality			Chi-Square Analysis		
Sex	**None N (%)**	**Depression N (%)**	**Elevation N (%)**	**Chi-Square**	**DF**	**P-Value**
Female	74 (96.1)	1 (1.3)	2 (2.6)	0.127	3	NA
Male	55 (94.83)	1 (1.72)	2 (3.45)			
Total	129 (95.56)	2 (1.46)	4 (2.96)			

Table 5. The correlation between measured variables in the study population

Variables		**Height (m)**	**WT (kg)**	**SBP (mmHg)**	**DBP (mmHg)**	**T AXIS (^{0})**
AGE (yrs)	**R**	**.732****	**.708****	**.702****	**.337****	**-0.048**
	P-value	0	0	0	0	0.581
Height (m)	R	1	.719**	.574**	.198*	-0.164
	P-value		0	0	0.022	0.057
WT (kg)	R		1	.555**	.281**	-0.143
	P-value			0	0.001	0.098
SBP (mmHg)	R			1	.501**	-0.041
	P-value				0	0.64
DBP (mmHg)	R				1	-0.134
	P-value					0.123

*Note: Significant at * 0.05, ** 0.01; r=Pearson's correlation*

4. DISCUSSION

In Fig 1, The mean age in years of female and male responses are 9.99 years and 8.57 years respectively; mean weight is 30.60kg and 25.17kg respectively; and mean height is 1.35m and 1.26m respectively. The female children of the same grade are found to be older than the male children so the significantly higher weight and height were expected.

In Table 1, The mean systolic blood pressure (SBP) was significantly higher in girls (96.20±12.30 mmHg) than in boys (87.20±12.40 mmHg). This is quite surprising as most studies showed higher systolic blood pressure in males compared to female children of the same age [10, 11]. However, the diastolic blood pressure (DBP) shows no statistically significant difference between boys (55.90±11.60mmHg) and girls (53.40±10.70mmHg). In prepubertal girls in the age range 6–11 years, but not in boys, age is significantly associated with BP independently of body size and adiposity; and the association between age and BP could be different between genders because the progression to puberty occurs at different ages in boys and girls. [12]. Some findings suggested that gender might influence the association between BP and age in an early phase of life, possibly even during the prepubertal age, especially in populations with a high prevalence of overweight children [13]. Other studies have shown that Blood Pressure tends to change over time, reflecting the physiological changes that occur during aging. During childhood and adolescence, blood pressure generally increases in correlation with the growth and development of the cardiovascular system. However, it is during adulthood and advanced age that blood pressure variation requires closer attention. Further studies are therefore required on this topic.

In this study, the mean T-axis values of the children had no sex variation. No significant difference was seen. The t-axis typically tells us the direction of ventricular repolarization and this present study showed that values fell within the normal physiological range of 15^0 to 75^0 (Table 2).

T-wave inversions in the right precordial leads (V1 to V2) are apparently normal in children and it is important to observe and identify the prevalence and, or, pattern variations of these inversions in children taking into consideration their age, height, and weight. In Table 3, there was no significant association found between sex and the t-wave inversion pattern in the sampled population. The distribution has no sexual preference ($\chi^2 = 0.72$; $p = 0.873$). This is in line with [14]. However, further studies will test for its association with age groups when a larger population of children is sampled. This appears to be one of the limitations of this study.

Both boys (34.1%) and girls (42.9%) had more percentage of people with T-wave inversion in lead V1 and V2 compared to the percentage of those with T-wave inversion in lead V1 only and V1, V2, & V3. Comparing the boys and girls, the girls had a higher percentage of people with T-wave inversion at V1 and V2 than the boys, but it was not statistically significant.

This present study did not record any T-wave inversion at the inferior lateral leads. (V4, V5, V6). This is said to be rare in healthy children as it is associated with structural heart disease [3]

T-wave inversion can be a common electrical sign in cardiomyopathies but also a benign feature regressing with age in healthy children [15]. Unfortunately, not much is known about the age the T-wave inversion becomes reversed (positivization of anterior T-wave inversion) and what determines it in healthy children.

In Table 4, the study found no significant association between boys and girls with ST-Segment depression, ST-Segment Elevation, and boys and girls with none. Therefore, the distribution has no sexual preference. (χ^2 =0.127)

Table 5 shows the correlation between measured variables in the study population. The older the children, the higher the systolic blood pressure, diastolic blood pressure, and expectedly; weight and height. The T-axis however had a negative correlation with height, weight, and blood pressure parameters of the respondents but was not significant.

5. CONCLUSION

This study has found that T-wave inversions at V1, V2, and V3 are present in children of both sexes, although the inversion at V1 and V2 were found to be predominant compared to inversion at V1 only, V2 only, and V3 only. Therefore, T-wave inversion is a normal finding in apparently healthy children.

CONSENT AND ETHICAL APPROVAL

This research was carried out in conformity with the Helsinki Declaration of 1975 as amended in 2000 (World Medical Association, 2002.). Institutional ethical approval (UPH/R&D/REC/0434) was obtained from the University of Port Harcourt Ethics Committee. The Objectives and nature of the study were explained to each subject before enlistment. Informed consent was obtained from the parents and the head teachers of the schools before recruitment into the study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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