Journal of Morphological Sciences
J Morphol Sci
Brazilian Society of Anatomy

Case report
J Morphol Sci 2022;39:361-365

Postmortem Heart Weights and Valvular Circumference of Apparently Healthy Adult Nigerian Decedents - an Observational Study

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Disclose and conflicts of interest: none to be declared by all authors

ABSTRACT

Introduction: organ weights at postmortem examination of deceased Nigerians are compared with that of Caucasians to determine pathologies and cause of death. Indigenous data is needed because of the differences in race and lifestyle.

Materials end Method: this is an eleven-year retrospective study. Postmortem findings and summarized clinical notes of deceased Nigerians archived in the Department of Pathology, University College Hospital Ibadan, from January 1, 2008 to December 31, 2018 were reviewed. Inclusion criteria were age ≥18≤70 years, traumatic or sudden unexpected death with no pathology in the heart, and no history or postmortem features of hypertension. Data on Age, gender, cause of death, body length, heart weights, heart valves circumference and ventricular wall thickness were retrieved. Descriptive statistics, student t-test and regression analysis was done using SPSS 20. Confidence limit was set at $p < 0.05$.

Results: eighty-five cases fulfilled all the criteria comprising of 64 males and 21 females with mean age of 39.1±13.8 years and 37.21±11.0 years respectively. The mean heart weights for males and females differed significantly with a mean of 310.8±40.3g (220-405g) and 261.32±34.0g (200-325g) respectively ($p<0.000$). The mean body length for males and females also differed significantly with mean of 1.7±0.1m and 1.62±0.1m respectively ($p<0.002$). However, there was non-significant difference in age between males and females ($p>0.05$). Multiple regression analysis suggests that only gender is a likely predictor of heart weight ($p<0.001$). The mean circumference of the tricuspid, mitral, pulmonary and aortic valves were 11.2cm, 9.3cm, 7.2cm, and 6.4cm respectively whilst the mean left and right ventricular wall thickness were 1.3cm and 0.3cm respectively.

Conclusion: heart weights and valvular circumference of adult Nigerians Heart weights of apparently healthy adult Nigerians differ by gender and show ranges beyond values from other populations.

Keywords: Postmortem; Autopsy; Heart-weights; Deceased; Nigerians.

Introduction

Heart nomograms are essential to determine deviations from heart health and for interpretations of autopsy findings especially in medicolegal cases. Organ weights in death differ from those in life such that it is difficult to determine absolute normal weights[1]. This is because postmortem changes set in as soon as death occurs. There has been no consensus on what set of humans should constitute a normal population for the study of normal organ weights[2,3]. Subjects who died of accidents without gross haemorrhage, deaths from illness lasting less than 24 hours with no additional disease, or organs obtained from patients who have died from disease that have not affected the reference organ(s) have been variously defined as "normal population"[1,4]. At autopsy, heart weights are compared with nomograms documented in reference standard textbooks such as that by Ludwig irrespective of the local population.[5] These reference values are obtained from Caucasoid populations. There is evidence to suggest that heart weight is influenced by age, body weight, body length, body mass index, body surface area and diseases[6–9]. These variables differ according to race, dietary and lifestyle preferences of the population studied. For example, studies among Indians, North Koreans and Thai populations have shown deviations from the reference nomograms[6,10,11]. Recent data from Caucasian studies have suggested that reference values for organs need to be updated periodically according to local population demographic dynamics[8,12]. This will help to determine deviations from normal for a given population and has medico legal implications. Data suggesting probable normal heart weights of Nigerians is scarce or non-existent as at the time of this study. The aim of this study was to document our observation of heart weights at postmortem of apparently healthy adult Nigerian decedents. In addition, this study provides data on other examined morphometrical parameters of the heart which are predominantly lacking in most of the recent studies from other populations.

DOI: 10.51929/jms.39.361.2022
ISSN 2177-0298

Materials and Methods

This was an eleven-year retrospective study. Postmortem findings and summarized clinical notes of deceased Nigerians archived in the Department of Pathology, University College Hospital Ibadan, from January 1, 2008 to December 31, 2018 were reviewed. Inclusion criteria were age ≥18≤70 years, traumatic or sudden unexpected death with no pathology in the heart, and no history or postmortem features of hypertension. All the autopsies included in this study were conducted under the ethical guidelines of the institution with consent obtained from the relations. Confidentiality of the identity of the deceased and personal health information was maintained. Known hypertensives that died from accidents or sudden unexpected deaths and those with debilitating protracted illnesses capable of causing weight loss were excluded from the study. Other available data were age, gender, cause of death, body length and heart weights. All autopsies were performed following standard procedures, as is the practice in the department.[5] This involved the removal of the chest plate following which the pericardium was exposed and examined. The thoracic organs together with the heart were removed *en bloc*. The heart was then excised from the parietal pericardium, pulmonary veins, and the great vessels at 1cm to 2cm distance from the root of the great vessels. Thereafter the heart was cut open using the inflow – outflow method. For each side of the heart, the atrium was opened using a scissors and was examined for blood clots or any other abnormality. The ventricles were subsequently opened using a sharp knife along its inflow and outflow tracts following the direction of blood flow. This also laid open the heart valves, and all blood clots were removed from the cardiac chambers. The absolute heart weight comprising the ventricles, atria, and auricles was recorded to the nearest 5gm; the cardiac chambers were not further partitioned. The left and right ventricular walls thickness was measured at 1cm below the respective annulus. The circumference of each heart valve (tricuspid, pulmonary, mitral and aorta) were measured by running a thread along the attachments of the valve leaflets and cusps and the values were read off on a meter rule and documented. These values were compared with available reference values[5]. Hearts showing gross pathology, injury, congenital malformation, or valvular defects were further excluded. Descriptive statistics was performed to determine the proportions of cases in each age group and their occupations; independent student t-test statistics was used to determine the differences in means of the age, heart weights and body length between male and female gender; Pearson correlation statistics was used to determine the relationships between heart weights and body length, and between heart weight and age while multiple regression statistics was performed to determine the predictors of heart weight among age, gender, and body length. All statistical analysis was conducted using SPSS version 20. The results are expressed as frequencies, mean, tables and charts. Level of significance was set at $p < 0.05$.

Results

Eighty-five cases fulfilled all the criteria and comprised of 64 males and 21 females with an overall crude mean age of 35.9±11.8 years (and range 18-70 years). The most common cause of death was trauma 74 (87.1%) predominantly road traffic accident, gunshots, and occupational injury, the remaining dying from non-debilitating illnesses. Figure 1 depicts the age groups and Figure 2 gives the documented occupational distribution with about 20% being unclassified. The mean heart weights for males and females differed significantly with a range of 220-405g and 200-310g respectively (Table 1). The mean body length for males and females also differed significantly. However, there was non-significant difference in age between males and females ($p>0.05$). Overall, there was significant positive correlation between body length and heart weight ($r = 0.330$, $p < 0.002$) but not between age and heart weight ($r = 0.187$, $p > 0.087$). Multiple regression analysis showed that among age, body length and gender, only gender remained a significant predictor of heart weight (Table 2). There was no sustained progressive increase in heart weight with increasing age (Figure 3).

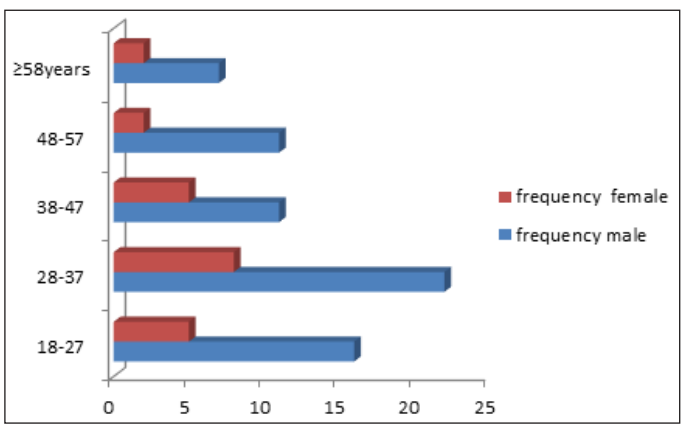

Figure 1. The age group of the cases in intervals of 10 years

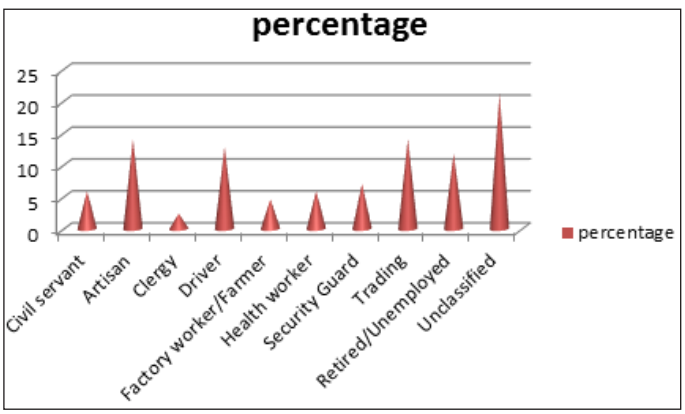

Figure 2. Occupational distribution of the study population.

The valve circumference and ventricular wall thickness data of the hearts is presented in Table 3. The valves were documented as unremarkable or normal. The circumference of the valves had wider interval in males except for the tricuspid valve which was wider in females. One male and female each had a tricuspid valve circumference of 13cm. The right and left ventricular walls were thicker in males than in females.

Table 1. Mean values of the age, heart weight and body length of the cases compared between male and female gender

Variable		Mean (SD)	Range	*P* value
Age (years)	F M	37.21(11.01) 39.08(13.82)	19-60 18-70	0.551
Heart weight (g)	F M	261.32(34.03) 310.75(40.32)	200-310 220-405	0.000*
Body Length (m)	F M	1.62(0.09) 1.70(0.08)	1.4-1.70 1.5-1.88	0.002*

**P < 0.05*

Table 2. Age, body length and gender and their influence on heart weight.

Variable	Relative Risk	95% Confidence Interval	*P* value
Age (years)	0.49	-0.123-1.105	0.116
Body Length (m)	82.23	-21.081-185.515	0.117
Gender (m/f)	43.55	22.804-64.293	0.000*

**P < 0.05*

Discussion

The demographics of this study population show that these were predominantly young adults. The mean age and preponderance of males are similar with most other studies elsewhere[7,8,11,13]. Similar studies suggest that men are often taller but not usually older than the women[2,11,12]. Men are also more likely to engage in high risk jobs than women which predispose them to occupational injuries and violent death[14]. In this study, men were both taller and older although the difference in age lacked statistical significance.

This data presented here shows average heart weights of 258g and 310g for females and males respectively, which differ from those of Koreans, Indians, Thais and Caucasians[6,7,11,12]. The range of heart weights for females (200-325g) and males (220-405g) in this study is at variance with 250-300g and 300-350g documented in the reference textbook that is often used to assess heart weights at autopsy in our environment[5]. Almost all studies are in agreement with

Figure 3. Distribution of heart weights (g) in females and males. The age group is in years [1 (18-27); 2 (28-37); 3 (38-47); 4 (48-57); 5 (≥58)]

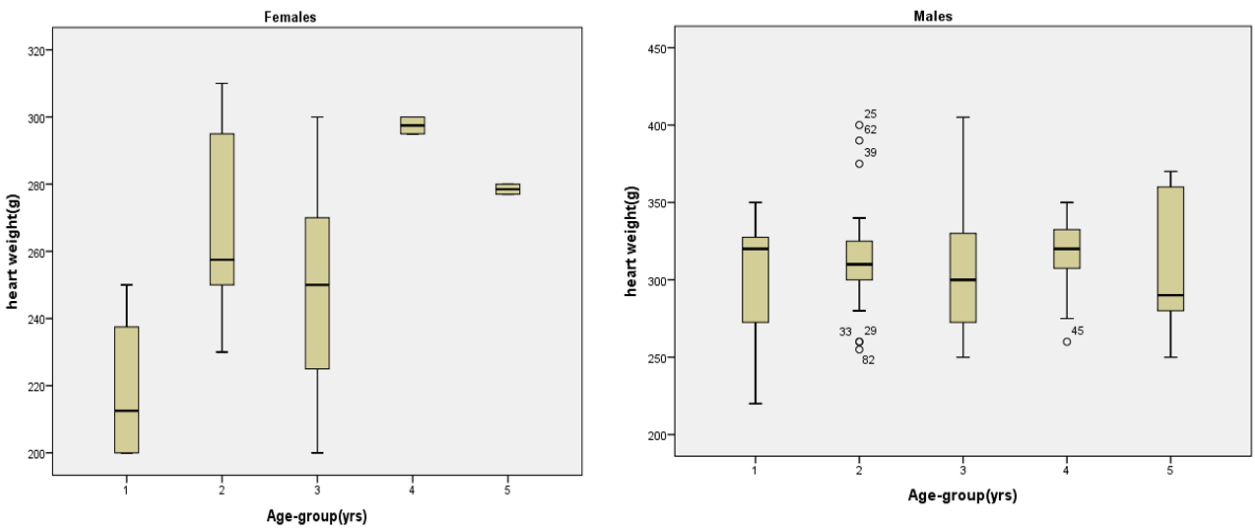

Table 3. Morphometric data on the circumferences of the valves and the thickness of the ventricular walls.

Variable	Female			Male		
	N	Mean(SD)	Range	N	Mean(SD)	Range
Tricuspid valve (cm)	21	11.2(0.9)	9-13	64	11.6(0.7)	10-13
Mitral valve (cm)	20	9.3(0.8)	8-10	64	9.5(0.8)	7.5-11
Pulmonary valve (cm)	21	7.2(0.7)	6-8.5	64	7.3(0.7)	5-9
Aortic valve (cm)	21	6.4(0.4)	5.7-7.6	64	6.8(0.1)	5.5-8.0
LVWT (cm)	21	1.3(0.1)	1.2-1.5	64	1.4(0.1)	1.2-1.6
RVWT (cm)	19	0.3(0.04)	0.3-0.4	64	0.4(0.1)	0.2-0.5

differential heavier hearts in adult males compared to adult females as has also been demonstrated here. Yet, the mean right and left ventricular wall thickness shown here are similar to that in reference data and in the study by McDonald *et al*[15].

Predictors of heart weights have varied according to populations studied. Age at death, body weight, body height, body mass index (BMI), body surface area (BSA), and gender were shown to predict heart weights in the study by Vanhaebost *et al*[8]. Mathuramon *et al* found that heart weight correlated well with body weight and body length[11]. Other authors found that heart weight correlated significantly with body height in males but not in females[12,16]. Although our study did not document body weight of the decedents, we found an overall significant correlation between body length and heart weight. This observation waned to insignificant level when taken for each gender and could be accounted for by the sample size. We also note here the wide ranges in heart weight of the study population with the minimum heart weigh of 200g. Differences in body build might account for this. A prospective study that documents BMI and BSA will address this concern.

The circumference of the heart valves in this study showed intervals similar to that among Indians[17] while the mean circumference is similar to that by Westaby *et al* among Americans[18]. Data from different studies have shown that the limits of these measurements can vary. For instance, the upper limit of the tricuspid valve circumference in the present study is 13cm, that by Ilankathir among Indians was 12.5cm[17]. In contrast, whilst our study showed aortic valve circumference of 5.5-8.0cm, that by Ilankathir was 6.0-9.99cm[17]. Likewise, studies showing mitral valve circumference upper limit of 12 cm[19] and 12.8cm[20] have been documented and this contrasts with the finding of 10.5cm shown in this study. While these outlying values may reflect true situations, they occur sparingly among the populations studied. Similar to the data presented here, Westaby *et al*[18] also observed that the valve circumferences were wider in males than females. This is perhaps due to increased volume of heart chambers in males compared to females.

Case selection for inclusion in studies of normal organ weights is often as varied as there are studies with age range being the most varied.[1] Some studies had included age 10 years and above while others have extended the age to 89 years[7,11]. Underlying this might be the difficulty with achieving adequate sample size to reach acceptable conclusions.[1] The lack of significant relationship between age and heart weight in this study agrees with the study by Smith which argued that increasing heart weight was independent of increasing age[1]. A larger sample size will be required to further assess this observation in our environment.

A possible confounding factor in this study would be the amount of exercise engaged in by the individuals. Athletic exertion is known to cause physiologic myocardial hypertrophy with concomitant increase in heart weight sometimes attaining a weight of 500g[21]. This effect has not been assessed in this study and also in all the literature cited here. However, a look at the occupational distribution of this study population shows that most of them engaged in trading, transportation services, and civil service or were unemployed/retired. Others were self-employed in crafts. These are therefore not high-end energy-demanding jobs and are not likely to have influenced the heart weights in this study.

Sample size was a limitation to this study. This was due to strictly attempting to define a "normal heart". Large age ranges could suggest different ages at maturity according to populations studied which consequently might derive from differences in genetic makeup and dietary habits. Age of 18 years is the constitutional age of maturity in Nigeria and was chosen as reference age for young adulthood in this study. That notwithstanding, the results of this study did not vary from data from similar studies elsewhere. A larger population will however be required to validate these findings.

In conclusion, the findings of this study suggests that average heart weights among adult Nigerians could differ from other studies on different populations although they are similar to the figures recorded in standard autopsy textbooks. We recognize that the sample size studied is small and may not be representative of the entire population despite that it showed a normal distribution. It is hoped that this observation will generate further interests among researchers culminating in a nationwide multi-center study with a view to establish a national nomogram.

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Received: May 3, 2022
Accepted: May 15, 2022

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