Study on Heart Measurements of the People between the age 20-40 Years Present to the Teaching Hospital Colombo North – Post mortem Study

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Abstract

Introduction: Presence of an enlarged heart provides a basis for determination of the cause and mechanisms of death. Gender, physical activity, and Body Mass Index (BMI) may affect the size of organs. Knowledge on such normal variations is needed in order to recognize the abnormalities.

Objectives- This research was conducted to study the dimensions of the heart(**heart weight, left ventricular thickness and valvular circumferences**) among the young adult healthy deceased autopsies and evaluate their association with different variables.

Methods: It was a descriptive cross-sectional study and 20-40 years of age healthy, young, adult, males and females in equal numbers who had died suddenly were studied by considering the inclusion and exclusion criteria. Details of the past history and the measurements were entered into a proforma and the anonymous data were used for analysis.

Results: The study revealed that the mean values of the heart weight was 280.52g (SD+/- 42.60), it was 293.94g (SD+/-39.29) for males and 267.10g (SD+/-42.64) for females. There was no significant association of heart weight with gender (P= 0.46410). There was a significant association between BMI and the heart weight of the females (P= 0.0387), no such association for left ventricular wall thickness. Further, there was a significant difference of the tricuspid valve circumference among two genders and the values were 11.6cm (SD+/-0.82) for males and 10.7cm (SD+/-0.6) for females.

Conclusions: Majority of the findings was consistent with the findings of the studies globally on Caucasians. Increased body mass index was significantly associated with increased heart weight among females which could probably be explained as a consequence of increased epicardial fat since there was no such association for left ventricular wall thickness.

Keywords: *Heart weight, Left ventricular thickness, BMI, gender*

Introduction and Literature Reviews

Cardiac enlargement is a common and important finding in a forensic autopsy. The presence of an enlarged heart may provide a basis for determination of the cause and mechanisms of death in an otherwise negative autopsy.

Several factors such as race, age, gender, physical activity, nutrition, and health status affect the size of organs such as the heart. [1] There are vast differences in body organs among races, as well as ethnic and nationality groups. [1] In some races, heart weights increase with age but decrease with age in other races. [2, 3, 4 5] In most races, the dimension of the heart was larger

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in men than women. [2, 4, 6, 7 8] Exercise and physical activity cause a reduction in fat tissue of the heart, but increases the muscle size of the heart. [1] Disease is also another factor that may change the size and anatomy of organs.

Many valveolar heart diseases cause damage to the heart and cardiac hypertrophy. [9] Severe damage such as endocarditis, dysplastic valve pathology, and rheumatic valve diseases are diagnosed by measuring the valvular length. [9] Thus, it is important to know the exact valvular dimension of the heart. Only limited number of studies are available regarding dimensions of the normal heart in Sri lanken population. Hence, the objective of this study was to evaluate the standard size of the normal heart among Ragama area population by fresh cadavers. The aim of the present study was to study the dimensions of the heart among the previously healthy deceased young adults (ages 20-40 years) brought for autopsy at Colombo North Teaching Hospital.

There we considered the weight of the heart, left ventricular thickness and valvular circumference in both male and female gender equally and the variation of above measurements with the Basal Metabolic Index (BMI) and the Gender. Further we plane to propose standard cardiac dimensions relevant to Sri Lankan population by Ragama area population in order to detect pathologically significant heart dimensions.

According to *Gray's Anatomy* [10] the heart length, width, and thickness are 12 cm, 8.5 cm, and 6 cm, respectively. In addition, the mean weight of the heart is 280-340 g in males and 230-280 g in females. The mean circumference of the mitral valve is 9 cm in males and 7.2 cm in females, whereas for the tricuspid valve it is 10.8 cm in females' and11.4 cm in males. The mean heart weight had reported to range from 248 to 345 g in men and 164 to 299 g in women in Asian populations. The mitral area was 8.8 cm in Japanese and 7-10 cm in Indians. [9, 12, 13] Left ventricular thickness was considered normal up to 1.5cm in studied done early. [40]

General Objective:

Study of the normal dimensions of the heart in cadavers between the ages 20-40 years subjected to medico- legal autopsy at Colombo North Teaching Hospital, Ragama **Specific Objective**

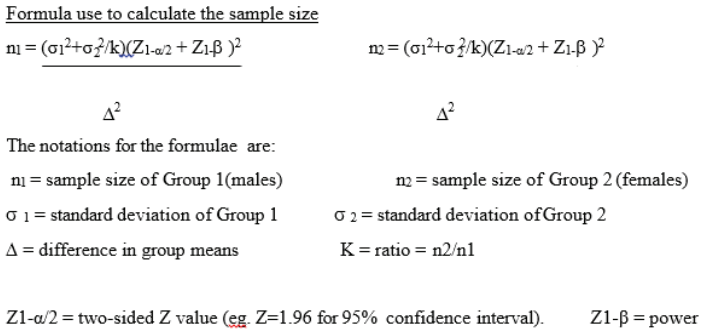
To investigate the normal heart size (**heart weight, left ventricular thickness and valvular circumferences**) in fresh cadavers and to study the variation of the above measurements according to the gender and BMI (Basal metabolic index) and to propose standard dimensions of the heart to be used in detecting cardiac pathology at post mortem investigation.

To propose standard cardiac dimensions relevant to Sri Lankan population by using this sample in order to detect pathologically significant heart dimensions

Methodology

The study was conducted for one year duration from **April 2017 – May 2018**. Sample size was calculated by the formula and the minimal sample needed to compare two variables was given as 19 from each gender. Deceased with congenital or any acquired heart disease or died with any condition that may affect heart and hearts with histological evidence of abnormalities were excluded and following are considered as inclusion and exclusion criteria.

Formula use to calculate the sample size



The minimum sample size needed to access the dimension of the left ventricle of the heart was 38 according to the above equation. However, we were planned to perform a descriptive cross-sectional study **on all the fresh cadavers** both males and females equally, referred to Teaching Hospital Ragama, after considering the inclusion and exclusion criteria, for one year duration. We expected to recruit around 100 bodies. But the recruitment of the dead bodies was difficult considering the inclusion and exclusion criteria given bellow. Hence the study was limited to the minimum number that was **38**.

Exclusion criteria

· Deceased with congenital abnormalities of the heart

· Deceased with known acquired heart diseases such as endocarditis/ myocarditis/ ischemic heart disease, coronary artery diseases.

· Diagnosed people with valvular heart diseases and with replaced valves.

· Evidence of trauma to the heart

· Known patients of arrhythmias

· Smoking[18]

· Deceased with history of heavy alcohol consumption (daily alcohol abuse, binge drinkers)[15,16]

· Died of a or died with a condition/disease that may affect the heart such as chronic lung disease, endocrine disorders, chronic kidney disease and hypertension.[18,19,20,21,22,23,2425,26,27,29,30,31,36, 40,41,42,43]

· Died while being managed for poisoning/drugs that has direct effects on heart.[14, 17,20]

· Cadavers with cardiac pathology detected at autopsy

· Cadavers with changes of decomposition

· Diseased died of Sepsis or septicemia

· Cadavers of trained athletes and hard working manual workers.[28]

· Pregnancy or post partum deaths.[33,34,)

· Diagnosed patients with auto immune disorders such as Systemic Lupus and diagnosed/features suggestive connective tissue disorders such as Marfans syndrome.[35]

· Any condition that may affect the dimensions of the heat detected at the autopsy

Inclusion criteria

· Only the deceased where consent of the next of kin for this study could be obtained and will be included

· Deceased between 20 to 40 years and are not included in above exclusion criteria will be considered in the study and age grouping will be done in a manner described in the methodology

· Both male and female dead bodies will be considered equally in the study.

· Social drinkers will be included in the study

· Histological analysis of the heart will be done and samples with normal histology will only be included in the analysis.

Digital scales (**Accura-6404**) were used to take measurements of weights. Lengths were measured using a metal ruler, a non-stretchable tape, and a plastic Venire Caliper. Data was entered in to a proforma. Other required information was gathered by interviewing the relations and by perusing the medical records and post-mortem records. Microscopic sections of the hearts were examined by the investigators under the supervision of the supervisor.

Study was conducted at the Medico-Legal Unit of the Teaching Hospital Ragama, where the work was shared by the Department of Forensic Medicine, Faculty of Medicine, University of Kelaniya and doctors who were postgraduate qualified in forensic medicine from the Ministry of Health.

Measuring the parameters of the heart

The pericardium was dissected by inverted Y shaped incision on it and heart was exposed in pericardial sac. Then the heart was separated from the thoracic contents by dissecting the root of the aorta and other great vessels

at the reflection of the pericardium.

Then the heart was dissected in standard way in the direction of the blood follow. [37] Then all the clots and blood were washed with water and the measurement had obtained. The weight of the heart was measured by the standard digital scale and recorded. The measurements of the valves (circumferences) were obtained by using a non stretchable tape measure which was placed along the bases of the each and every valve of the heart which was cut opened and properly placed on an even surface. The left ventricular thickness was obtained at the level of the 2cm distal to the mitral valve excluding the epicardial fat by a venire caliper. [38]

BMI (Basal metabolic index) calculation

The height of the cadaver was obtained as follows. The bodies were placed in a supine position at the edge of the autopsy table. We used elastic straps to stabilize the posture of the lower limbs with the heels supported on the edge of the autopsy table and the toes pointing upwards. Saggittal plane was established following the autopsy table axis. Then

the most superior point of the skull and the position of the heel were marked on the table using a marker pen and the length was measured between two marks using the tape and taken as the height of the body. Stature was taken in centimeters.

Weight of the body was measured by using a standard weighing scale (**Fidelity JBA 46s**). First the trolley with the body was measured in Kilograms and then the trolley was measured. The body weight was calculated by deduction of the second measurement from the first measurement. The following equation was used to calculate the BMI.

BMI= Body Weight (Kg)/Body height (m) x Body height (m)

Microscopy of the myocardium

The sections obtained were processed and prepared for microscopy and examined to exclude microscopic pathology of the heart. The cost needed for histopathology was borne by the investigators and slide preparation and Haematoxylin and Eosin staining was done by the investigator himself with the help of the laboratory assistant.

Comparisons

Since the sample was small the comparisons were made using **Fisher's exact test**.

Results

Majority 90% among the group were having heart weight between 200g to 350g. Heart weight of majority 74% of Females was between 200g to 300g.
Majority (68%) of the Males were having heart weight between 251 to 350g. The distribution/frequency of the weights of the hearts of the both genders is shown in **table 1.**

Table 1: Distribution of the weights of the hearts- whole group and the genders

Weight of the heart	Total N=38 % (n)	Males N=19 %(n)	Females N=19 %(n)
<200g	03 (01)	0(0)	5.26(01)
200g-250g	32(12)	21.05(04)	42.11(08)
251g-300g	34(13)	36.87(07)	31.58(06)
301g-350g	24(09)	31.58(06)	15.79(03)
351g-400g	08(03)	10.53(02)	5.26(01)

Among the sample, majority (66%) was having a normal body mass index (18.5 to 24.9).

The distribution/frequency of the BMI is shown in **Figure 01**

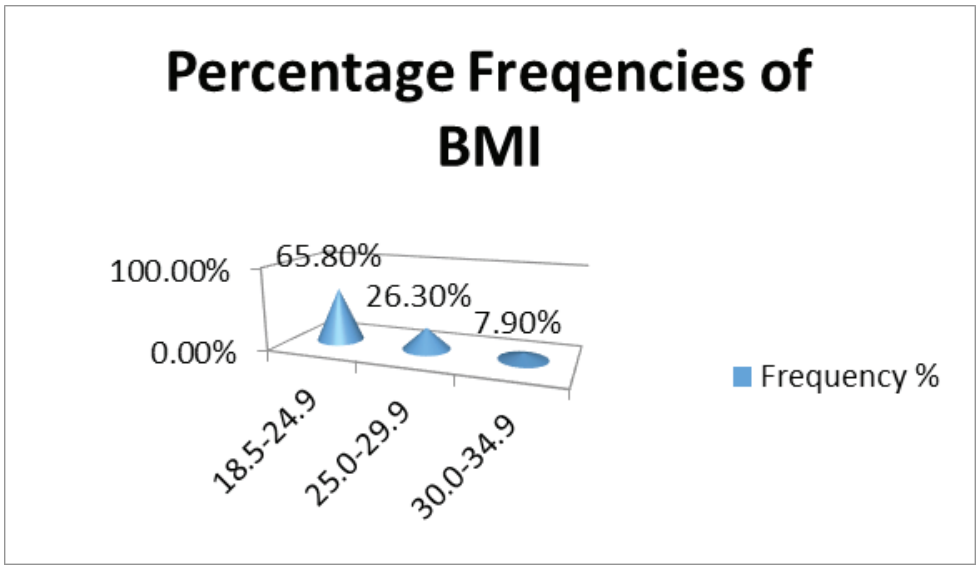


Figure 1: BMI percentage frequencies of the sample

Majority of the males (12) and majority of the females (13) were having BMI of 18.5 to 24.9, and those are equally distributed. The distribution is shown in **Table 02**. Fisher's exact test was used to calculate the P value.

Table 2: Gender vs. BMI Cross tabulation

BMI Sex	18.5-24.9 % (n)	25.0-29.9 % (n)	N=38 30.0-34.9 %(n)	P value
Male	48(12)	(5)	2	0.8189
Female	52(13)	(5)	1	

Mean heart weight in the group was 280.52g (SD+/- 42.60). Mean left ventricular wall thickness was 1.3895cm (SD+/-0.113). Mean heart weight for men was 293.94g (SD+/- 39.29) and 267.10g (SD+/-42.64) for females. Heart weight of majority of males was between 251 to 300g and 200g to 250 g among females. There was no significant association of heart weight with gender (P= 0.4884) (>0.05). The distribution was shown in **Table 3**. Fisher's exact test was used to calculate the P value.

Table 3: Mean values and standard deviations of heart measurements.

	Heart g		LV cm		Mit V cm		Tri V cm		Pul V cm		Aor V cm		BMI	
Mean	**280.5263**		**1.3895**		9.0684		11.1342		7.6889		7.0263		24.5000	
SD	**42.67143**		**.11340**		1.14517		.82176		.90786		.63275		3.05535	
Range	170.00		.50		4.40		2.70		4.00		3.40		10.70	
Minimum	194.00		1.10		6.40		9.50		6.10		6.00		20.40	
Maximum	364.00		1.60		10.80		12.20		10.10		9.40		31.10	
Gender specific Mean values and standard deviations of thecardiac measurements and BMI														
	Heart g		LV cm		Mit V cm		Tri V cm		Pul V cm		Aor V cm		BMI	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Mean	293.9474	267.1053	1.4158	1.3632	9.4842	8.6526	11.5579	10.7105	7.4526	7.9253	7.0895	6.9632	24.6474	24.3526
SD	39.29868	42.64048	0.08983	0.13	0.84147	1.27383	0.55809	0.83526	0.36722	1.2006	0.5849	0.68735	3.04291	3.14384
Std.Error Mean	9.01573	9.7824	0.02061	0.02982	0.19305	0.29224	0.12803	0.19162	0.08425	0.27544	0.13418	0.15769	0.69809	0.72125
Number	19	19	19	19	19	19	19	19	19	19	19	19	19	19

Out of the females of BMI of 18.5 to 24.9, majority (62%) had a heart weight of 200 to 250 g while among the ones with BMI of 25 to 29.9, heart weight in a majority (60%) was between 251 to 300g. **The association of heart weight of 200 to 250 in females with BMI of 18.5 to 24.9, was significant (P= 0.0458) (<0.05).** Males, BMI of 18.5 to 24.9, majority (50%) had a heart weight of 251 to 300 g while among the ones with BMI of 25 to 29.9, heart weight in majority (60%) was between 251 to 350g. The association of different heart weights of males with BMI variation was not significant (P= 0.6493) (>0.05). The distributions were shown in **Table 4**. Fisher's exact test was used to calculate the P value.

Table 4 Variation of heart weight in females and males according to the BMI

Females							
Heart weight / **BMI**	**<200g % (n)**	**200-250g % (n)**	**251-300g % (n)**	**301-350g % (n)**	**351-400g % (n)**	**N=19 Total %(n)**	**P value**
18.5-24.9	8(1)	**62(8)**	23(3)	8(1)	0(0)	13	
25.0-29.9	0(0)	0(0)	**60(3)**	40(2)	0(0)	5	**0.0458**
30.0-34.9	0(0)	0(0)	0(0)	0(0)	100(1)	1	

Cont... **Table 4 Variation of heart weight in females and males according to the BMI**

Males							
18.5-24.9	0(0)	17(2)	**50(6)**	25(3)	8(1)	12	0.6493
25.0-29.9	0(0)	40(2)	**20(1)**	**40(2)**	0(0)	5	
30.0-34.9	0(0)	0(0)	0(0)	50(1)	50(1)	2	

Majority of the males had the left ventricular thickness of 1.4cm (53%) and females had the left ventricular thickness of 1.3cm (37%). But the p value was 0.3667 (>0.05) hence there was no significant association between the gender and different left ventricular thickness. Left ventricular wall thickness of 1.3 cm followed by 1.4 cm was found among the females with BMI of 18.5 to 24.9 while similar finding was observed in the group with BMI of 25 to 29.9. There was no significant association between the two groups (P= 0.6977) (>0.05). Left ventricular wall thickness of 1.4 cm followed by 1.3 cm was found among the males with BMI of 18.5 to 24.9 while 1.3cm followed by 1.4cm was observed in the group with BMI of 25 to 29.9. There was no significant association between the two groups (P= 0.2272) (>0.05). The distributions of above were shown in **Table 5**. Fisher's exact test was used to calculate the P value.

Table 5: Variation of left ventricular wall thickness in females and males according to BMI

females								
Left v thickness / **BMI**	**1.10cm % (n)**	**1.20cm %(n)**	**1.30cm % (n)**	**1.40cm % (n)**	**1.50cm % (n)**	**1.60cm %(n)**	**Number =19**	**P value**
18.5-24.9	8(1)	15(2)	**38(5)**	31(4)	8(1)	(0)	13	0.6977
25-29.9	0(0)	0(0)	**40(2)**	20(1)	20(1)	20(1)	05	
30-34.9	0(0)	0(0)	0(0)	0(0)	0(0)	100(1)	01	
males								
Left v thickness / **BMI**	1.10cm % (n)	1.20cm %(n)	1.30cm % (n)	1.40cm % (n)	1.50cm % (n)	1.60cm %(n)	Number =19	P value
18.524.9	0(0)	0(0)	17(2)	**67(8)**	8(1)	8(1)	12	0.2272
25-29.9	0(0)	0(0)	60(3)	20(1)	20(1)	0(0)	05	
30-34.9	0(0)	0(0)	0(0)	0(0)	50(1)	50(1)	02	

Circumference of mitral valve in majority of males was 9.1cm to 10cm, while females 8.1cm - 9 cm. However, the association was not significant (P= 0.1695) (>0.05). Tricuspid valve circumference of majority of the males was 11.1cm to 12 cm while it was 10.1cm to 11 cm in females. The association was significant (P= 0.0199) (<0.05). Circumference of pulmonary valve in majority of males was 7.1cm to 8cm, while females it was the same. Association was not significant (P= 0.4800) (>0.05). Circumference of Aortic valve in majority of males was 6.1cm to 7cm, while in females it was the same. Association was not significant (P= 0.5922) (>0.05). The distributions of above were shown in **Table 6**. Fisher's exact test was used to calculate the P values.

Table 6: Variation of circumference of valves with gender

Gender	Valve circumferences					Number	P value
Mitral valve							
Male	6.1-7.0cm % (n)	7.1-8.0cm %(n)	8.1-9.0cm % (n)	9.1-10.0cm % (n)	10.1-11.0cm % (n)		
	0(0)	5(1)	16(3)	47(9)	32(6)	19	0.1695
Female	16(3)	16(3)	26(5)	21(4)	21(4)	19	
Tricuspid valve							
	9.10cm-10.00cm %(n)	10.10cm-11.00cm %(n)	11.10cm-12.00cm %(n)	12.10cm-13.00cm %(n)			
Male	(0)	16(3)	58(11)	26(5)		19	0.0199
Female	21(4)	42(8)	26(5)	10(2)		19	
	Pulmonary valve						
	6.10cm-7.00cm %(n)	7.10cm-8.00cm %(n)	8.10cm-9.00cm %(n)	9.10cm-10.00cm %(n)	10.10cm-11.00cm %(n)		
Male	16(3)	79(15)	5(1)	0	0	19	0.4800
Female	16(3)	58(11)	5(1)	10(2)	10(2)	19	
Aortic valve							
	5.1cm- 6cm %(n)	6.1cm- 7cm %(n)	7.1cm- 8cm %(n)	8.10cm-9.cm %(n)	9.1cm- 10cm %(n)		
Male	0	63(12)	26(5)	11(2)	0	19	0.5922
Female	5(1)	58(11)	32(6)	0	5(1)	19	

In the common sample, which was in the BMI of 18.5-24.9, majority of the circumference of mitral valve was distributed in 9.1cm-11cm range. BMI of 25-29.9, majority was distributed in 9.1cm-11cm range. In males, it was similar. In females who were in the BMI of 18.5-24.9, majority of the circumference of mitral valve was distributed in 9.1cm-10cm range and BMI of 25-29.9, majority was distributed in 8.1cm-11cm range.

The **P values** were **0.8904, 0.4457 and 0.1817** for common sample, males and females respectively. Hence there was no significant association between BMI and Circumference of the mitral valve irrespective of the gender.

Circumference of the Tricuspid valve in majority among the BMI 18.5-24.9 in the common sample was between 10.1cm-11cm and 11.1cm-12cm among the BMI 25-29.9. In males it was between 11.1cm-12cm among the BMI 18.5-24.9 and between 11.1cm- 13cm among the BMI 25-29.9.In females, Circumference of the Tricuspid valve in majority among the BMI 18.5-24.9, was between 10.1cm-11cm and 11.1cm-12cm among the BMI 25-29.9.The P values of the BMI and Circumference of the Tricuspid valve for both genders was not significant. Circumference of the Pulmonary valve in majority among the BMI 18.5-24.9 in the common sample was between 7.1cm-8cm and similar among the BMI 25-29.9. It was similar to both males and females. There was no significant association between circumference of pulmonary valve with BMI as the P values were >0.05.Circumference of the Aortic valve in majority among the BMI 18.5-24.9 in the common sample was between 6.1cm-7cm and similar among the BMI 25-29.9. It was similar to both males and females. There was no significant association between circumference of Aortic valve with BMI as the P value >0.05.

Discussion

Cardiac enlargement is a common and important finding in a forensic autopsy. Several factors such as race, age, gender, physical activity, nutrition, and health status affect the size of organs such as the heart [1]. There are vast differences in body organs among races, as well as ethnic and nationality groups [1]. In most races, the dimension of the heart was larger in men than women. [2, 4, 6, 8]

Only limited number of studies are available regarding dimensions of the normal heart in Sri lanken population. Hence, the objective of this study was to evaluate the standard size (heart weight, left ventricular thickness and dimensions of the valves) of the normal heart among Ragama area population by fresh cadavers and there variation with the gender and BMI.

Weights of the hearts among studied population

In our study, Majority (90%) among the studied population were having heart weight between 200g to 350g and mean value of the heart weight was 280.53 g. Weight of majority (74%) of the females in given sample was between 200g to 300g and means value was 267.10g (Majority (68%) of the males were having heart weight between 251 to 350g and mean value was 293.95g.

According to *Gray's Anatomy*, [10] the mean weight of the heart was 280-340 g in males and 230-280 g in females. Some of the studies had done early, shown the mean heart weight in males was 294.07(SD+/-48.97) g and females it was 287.10(SD+/-44.38) g in Caucasians. [39] Hence the mean values of the study findings were within the mean value ranges of standard Grays Anatomy and other studies carried out in Caucasians.

A prospective study which was undertaken in America of healthy men dying from sudden traumatic deaths aged 18 to 35 years showed that overall, heart weights ranged from 188 to 575 g with an average of 331 g and an SD of 56.7 g[43]. A reference range (95% inclusion) of 233 to 383 g for the adult male heart was proposed. In our study the mean value for the men was lesser than the above study and probably due to the different ethnicity and other factors like body weight and the Basal metabolic index in western community.

In our study, Out of the 12 hearts with weight of 200g to 250g, 8 (67%) are of females and 4 are males. Out of the 13 hearts with weight of 251 g to 300g, 7 are of males and 6 (46%) were of females. However there was no significant association of heart weight and gender (P= 0.4641) (>0.005).

Heart weight variation with the Basal Metabolic Index (BMI) among gender

In our study, majority (66%) was having a normal body mass index (18.5 to 24.9). Both males and females

were having almost equal distribution when body mass index was considered. Among males, there was no significant association of the body mass index (whether normal or high) with heart weight (P=0.6493).

When it comes to the female gender, **there was a significant association of body mass index with heart weight in females** (P= 0.0468) where it was noted that heart weight increases with high BMI. The significant association can be due to the high fat deposition in females than in males due to many factors including metabolic causes (abnormal fat metabolism) [41]use of oral contraceptives, and increase belly fat levels in women than in men. Increase BMI will increase the pericardial fat deposition in women than in men hence the heart weight will be increased.

Therefore further studies to be carried out to conclude the association between heart weights and the BMI according to the gender as this particular study was planned for a small area and limited to the deceased referred to the Teaching Hospital Colombo North during a limited period.

Left ventricular (LV) thickness among studied population

Left ventricular thickness was considered normal up to 1.5 cm in studies done before. [40] The mean value of the left ventricular thickness in given sample was 1.39cm. The mean value of the Left ventricular thickness in males was 1.42cm. The mean value of the Left ventricular thickness in females was 1.36cm. There was no significant association between gender and left ventricular thickness in given sample (P=0.3667).

Therefore mean value of the common sample can be considered as normal value irrespective of the gender in studied population and further it was compatible with the studies done globally. A study done in 2013 by computed tomography to the cadaveric hearts showed that there was no significant difference/association between heart wall thickness and gender. [42] Above finding further confirmed the findings of our study.

There was no significant association with elevating BMI with the left ventricular thickness in males (P= 0.2272) and females (P=0.6977). Even though there was a significant increase in heart weight with high BMI in females, there was no such association of left ventricular thickness. This further confirms that the increase weight of the heart in females with high BMI was due to increase pericardial fat rather than the muscle mass.

Mitral valve circumference among studied population

Circumference of mitral valve in majority of males was 9.1cm to 10cm, while females 8.1cm - 9 cm. The mean value of the Mitral valve circumference of the common sample was 9.07 cm. The mean valve of the Mitral valve circumference for males was 9.5cm. The mean value of the Mitral valve circumference for females was 8.6cm. However, there was no significant association of the valve circumference variation with the gender (P= 0.1695).

Study carried out in university of Nairobi showed that the females were having significantly larger annular circumference of mitral valve than in males [44]. This was probably due to the different ethnicity as the study had done among Africans in Kenya. In a Sri Lankan study had carried out in Jaffna showed the significant gender difference in mitral valve circumference and higher mitral annular circumference in males than in females. [45] In this particular study the age variation was 18-72 years and the sample was more than 300 but the considered female sample was less than 20% of the common sample. In our sample the age was limited and both genders were considered equally. Those can be the reasons for the significant difference between two studies. However both of above studies had shown different values than our study hence further studies had to be carried out to find the association between the Mitral valve and the gender, before come to a conclusion.

There was no significant association of the mitral valve circumference with the different BMIs of the whole group (**P = 0.8904), males (P=0.4457) or females (P=0.1817).** But the above Sri Lankan study [45] had shown a significant relationship between the mitral valve circumference with age, body weight and height. Further it had stated that the most significant variation was with the age which was limited in our study. Hence further studies to be planed before come to a conclusion.

Tricuspid valve circumference among studied population

Tricuspid valve circumference of majority of the males was 11.1cm to 12 cm while it was 10.1cm to 11 cm in females. **The association was significant** (P= 0.0199) **with males having high value than the females in given population**. An Indian study showed that the tricuspid valve circumference was high in males than in females. [49] It was consistent with our findings and the population was similar to our study.

There was no significant association of different BMI s with the circumference of the Tricuspid valve in whole sample and in males as well as females.

Pulmonary valve circumference among studied population

Circumference of pulmonary valve in majority of males was 7.1cm to 8cm, while females it was the same. Common pulmonary valve circumference was 7.69cm, while in males it was 7.4cm and it was 7.9cm for females. There was no significant association between the gender and the pulmonary valve circumference in given sample (P= 0.4537).

As there was no significant difference between the genders, common value can be considered for both male and female in studied population. Further, there was no significant association of the circumference of pulmonary valve with the high BMI.

There were no/minimal studies in Sri Lankan population to find the association between pulmonary valve circumference and the gender and BMI. Hence further studies should be carried out with large scale to give a definite conclusion as our study was limited to a targeted small area and the sample was small

Aortic valve circumference among studied population

The mean value of the common sample of aortic valve circumference was 7.03cm while it was 7.1cm in males and 7.0cm in females. There was no significant association between the gender and the aortic valve circumference (P = 0.5215). Thus, the common value can be considered as normal value for both genders in studied population. There was **no** significant association between the high BMI and aortic valve circumference in males and females as the P values were 0.5734 and 0.3529 respectively.

Here again, there were no/minimal studies done in Sri Lankan population to find the association between aortic valve circumference and the gender and BMI. Hence further studies should be carried out with large scale to give a definite conclusion as our study was limited to a targeted small area and the sample was small

Limitations

The sample was small and included only the deaths referred to the Teaching Hospital Ragama where the population is mainly from and around the Ragama area.

Conclusions

Mean values of the heart weights of the sample were within the mean value ranges of standard Grays Anatomy and other studies carried out in worldwide Caucasians. There was no significant association of the heart weight with gender difference in studied population. **However, the heart weight was significantly elevated with elevating BMI among females, but the same association was not there for left ventricular thickness indicating the effect of high epicardial fat distribution in females. Tricuspid valve length was significantly high among males** while, mitral, pulmonary and aortic valve lengths did not show such association. Further studies are needed with a large-scale sample island wide to give definite conclusion as our study was limited to a targeted small area and the sample was small.

Conflict of Interest – We have no conflict of interest

Source of Funding- funded by the author himself

Ethical Clearance: Taken

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