

Study of correlation of organ and body weight during autopsy with regard to age and sex in adult population at Solapur region

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Abstract

Organ weight is important indicator to discern normal condition from abnormal in forensic medicine. A total 706 cases of which 306 were females and 400 were males are studied for organ weights. Six organs brain, lungs, heart, spleen, liver and kidneys were studied. The mean weight of all organs are more in males than in females in all age groups.

The mean weight of liver in female is 1240.27±101 and in males it is 1352.16 ±99. The mean weight of brain in females is 1114.82±98 and in male is 1224±96. The weight of right lung in females is 487.52 ±53.53 and in males it is 524.6±45.65 the weight of left lung in females is 448.70 ±50.36 and in males it is 473.8±39. The weight of spleen in female is 1107.52±13.5 & in males it is 114.68 ±14.16. Weight of heart in female is 258.29±27.18 and in males is 267.84±25.49. The weight of left kidney was 108.74±16.17 and right kidney 107.96± 15.78 respectively in female. In males the weight of left kidney was 113.72±15.20 and right kidney 112.9± 14.96.

The findings in this study serve as baseline in establishing normal weight in population of this region.

Keywords: Internal organ weight, Post mortem, Autopsy.

Introduction

Weight of the organ is always an important criterion for any medico-legal as well as pathological autopsy. Normal organ weight particular for that region is very important to differentiate it from any traumatic, pathognomic or diseased condition hence in turn useful in elucidation of cause of death. Weight of organs also have significant role in estimation of approximate body weight and height of individual^{1,2}.

Apart from genetics and intrinsic factors like age, sex, race etc the weight of the person is influenced by many other multiple extrinsic factors including socioeconomic strata, dietary habits, working habits, addiction to particular intoxicants and many more to name a few.

These extrinsic factors were typical for different regions and two regions have never the same footmark in India due to varied cultural diversity and external environmental factors specific for different regions.⁽³⁾

The present study is carried out to find out the prevalent normal weight range of major internal organs in Solapur region (a region situated in Western Maharashtra, India with a close proximity with Andhra Pradesh and Karnataka States)

Also an endeavor been done to find out correlation between body weight and organ weight if any?

This is the first study of its own kind related to organ weights of the population in this region and would be helpful not only for Forensic specialists but also the data thus obtained helps the pathologists and anatomists apart from treating physicians.

Material and Method

Period: This simple prevalence study was carried out from June 2013 to June -2016 in the department of Forensic Medicine and Toxicology, Dr. Vaishampayan Memorial Government Medical College, Solapur.

Inclusion criterion:

- Only healthy organs not related to cause of death and any obvious gross pathology or diseases that could bring about any change of organ weight were included.
- Six organs brain, lungs, heart, spleen, liver and kidneys were studied.
- Age group was 20-70 years

Exclusion criterion:

- The death due to natural diseases and medical treatment such as intra venous infusion or blood transfusion were excluded as they affect the Internal organ weight.[IOW]⁽⁴⁾
- All unnatural manner of death cases which had been treated were excluded.
- Postmortem changes specially decomposed cases and deaths due to fire have some effect on internal organ weight, hence excluded⁽⁵⁾

Procedure: Each Body was weighed with electronic weighing Machine before autopsy. Standard autopsy protocol and procedure (as described in Current methods of Autopsy Practice by J Ludwig)⁽⁶⁾ were employed for removal of various organs.

Each organ was removed by cutting it as close to the anatomical boundary as possible and its peri-organ tissues stripped off.

Brain: The dura was cut open with small cut and folded along midline. The falx was freed then the brain was

removed from cranial cavity along with cerebrum and cerebellum by cut at medullary base.

Heart: It was extracted from origin of aorta & pulmonary trunk. All material in the four chambers of heart was washed out before being weighed.

Lungs: Both lungs were cut from both sides of pulmonary hilum respectively.

Spleen: The Spleen was detached from its various attachment and splenic vessels were cut near hilum after ligation. Then they were washed with tap water to clean the debris and the fatty tissue.

Liver: Ligament attached to liver and gall bladder was totally removed.

Kidneys: The capsules and fat tissues surrounding both of kidneys were stripped off.

After removing extraneous tissues and draining of blood each organ was weighed in grams on electronic weighing machine.

Ethical issue: As recording of organ weight and body weight is the routine mandatory criterion of every medico-legal postmortem memorandum in Maharashtra and as there is no disclosure of any identity ethical committee permission is not required.

Analysis: The data thus collected was analyzed by SPSS Program. The data was divided in two groups as per gender, male and female respectively. The mean, S.D. variance, maximum & minimum were applied for body weight (B.W) and internal organ weight (I.O.W). P Value of less than 0.05 was considers statistically significance.

Observations

Following observations were derived from the data thus collected is tabulated and statistically scrutinized as below:

Table 1: Mean Standard Deviation and Range of Organs weights as regard to the Age group 20-29 years and Gender

Female (n=60)					Male (n=80)				
	Mean	S.D.	Min	Max		Mean	S.D.	Min	Max
Age	25	2.922734	21	29	Age	24.5	2.555708	21	29
Body weight	65.6	8.988128	52	80	Body weight	71.7	9.829431	56	88
Liver	1226	114.1097	1000	1380	Liver	1336	94.63588	1200	1500
Brain	1073	76.80704	980	1240	Brain	1200	120.1687	1000	1410
Heart	292.8	34.85408	220	360	Heart	296.8	21.39821	268	350
Right lung	502	55.38157	400	580	Right lung	510	56.20937	450	650
Left lung	454	39.62536	380	510	Left lung	462	47.15716	400	560
Spleen	98.6	5.986425	88	110	Spleen	106.8	7.64795	98	120
Left. kidney	99.4	5.918085	88	108	Left. kidney	105.6	5.075631	98	112
Right kidney	97.4	5.848946	84	104	Right kidney	102.5	6.256136	90	110

Table 2: Mean Standard Deviation and Range of Organs weights as regard to the Age group 30-39 years and Gender

Female (n=60)					Male (n=80)				
	Mean	S.D.	Min	Max		Mean	S.D.	Min	Max
Age	34.2	2.582864	31	39	Age	35.7	2.848051	31	39
Body weight	62.2	7.80873	52	78	Body weight	68.7	9.201541	55	87
Liver	1230	65.86272	1100	1322	Liver	1384.8	62.02784	1322	1500
Brain	1113	74.52221	1000	1210	Brain	1267.2	116.4024	1100	1434
Heart	251	16.53963	220	280	Heart	285	22.61399	240	320
Right lung	478	43.44488	410	560	Right lung	521.8	49.73611	450	610
Left lung	441	41.44427	380	520	Left lung	458.2	31.1462	420	520
Spleen	109.4	12.72552	90	130	Spleen	119.8	18.49967	100	170
Left. kidney	110.6	15.67596	90	134	Left. kidney	114.2	11.14962	100	140
Right kidney	109.8	15.13196	90	132	Right kidney	112	11.94078	100	140

Table 3: Mean Standard Deviation and Range of Organs weights as regard to the Age group 40-49 years and Gender

Female (n=60)					Male (n=80)				
	Mean	S.D.	Min	Max		Mean	S.D.	Min	Max
Age	44.9	2.447413	41	49	Age	45.1	2.932144	41	49
Body weight	61.7	7.627559	52	76	Body weight	62	5.150888	54	69
Liver	1226.2	72.01384	1100	1322	Liver	1357	97.52481	1200	1488
Brain	1103	82.0562	1000	1210	Brain	1222	106.4064	1100	1360
Heart	251	16.53963	220	280	Heart	254.8	12.30663	240	270
Right lung	476	42.11365	410	550	Right lung	534	35.20644	480	580
Left lung	447	52.60341	380	560	Left lung	489	34.69943	420	530
Spleen	109.4	12.72552	90	130	Spleen	116.2	13.02617	100	134
Left. kidney	111.6	15.2751	90	134	Left. kidney	117	17.38907	90	142
Right kidney	111	14.77286	90	132	Right kidney	117.8	16.26241	98	142

Table 4: Mean Standard Deviation and Range of Organs weights as regard to the Age group 50-59 years and Gender

Female (n=60)					Male (n=80)				
	Mean	S.D.	Min	Max		Mean	S.D.	Min	Max
Age	54.81818	2.711282	51	59	Age	54.8	3.045644	50	59
Body weight	59.72727	6.587974	52	74	Body weight	60.6	5.193959	52	67
Liver	1194.727	78.49793	1100	1322	Liver	1354	110.7013	1180	1488
Brain	1076.727	85.51285	980	1210	Brain	1223.4	107.8134	1100	1360
Heart	247.4545	18.21089	210	280	Heart	252.3	10.38061	240	270
Right lung	461.0909	56.81623	380	570	Right lung	534	35.26392	480	586
Left lung	429.8182	62.75199	340	560	Left lung	486.2	31.91698	420	520
Spleen	105.6364	15.10134	88	130	Spleen	115.8	12.83823	100	134
Left. kidney	106.9091	17.88917	80	134	Left. kidney	116.4	17.0966	90	142
Right kidney	106.1818	17.30354	80	132	Right kidney	116.6	15.59097	98	142

Table 5: Mean Standard Deviation and Range of Organs weights as regard to the Age group 60-69 years and Gender

Female (n=60)					Male (n=80)				
	Mean	S.D.	Min	Max		Mean	S.D.	Min	Max
Age	64.4	2.929684	60	69	Age	64.4	2.923497	60	69
Body weight	59.9	5.051263	54	68	Body weight	59.9	5.040595	54	68
Liver	1329	114.4523	1180	1482	Liver	1329	114.2106	1180	1482
Brain	1212.2	101.2724	1100	1360	Brain	1212.2	101.0585	1100	1360
Heart	250.3	13.36362	224	270	Heart	250.3	13.3354	224	270
Right lung	523.2	44.87451	442	586	Right lung	523.2	44.77974	442	586
Left lung	473.6	39.96066	412	520	Left lung	473.6	39.87626	412	520
Spleen	114.8	13.65532	100	134	Spleen	114.8	13.62648	100	134
Left. kidney	115.4	18.33141	90	142	Left. kidney	115.4	18.2927	90	142
Right kidney	115.6	16.94177	90	142	Right kidney	115.6	16.90599	90	142

Table 6: Showing the correlation between Body weight and organ weight.

	Female(n=306)						Male(n=400)					
	Mean	S.D.	Min	Max	Correlation	p value	Mean	S.D.	Min	Max	Correlation	p Value
Weight	61.7843 14	7.574713	52	80			64.58	8.601661	52	88		
Liver	1240.27 45	101.5169	100 0	148 2	0.6084345	P<0.0 1	1352.1 6	99.02570 2	118 0	150 0	0.5547035	p<0.0 1
Brain	1114.82 35	98.04074 9	980	136 0	0.4867516	p<0.0 1	1224.9 6	112.3597 8	100 0	143 4	0.5252794	P<0.0 1
Heart	258.294 12	27.18844 6	210	360	0.3100851	P<0.0 1	267.84	25.49194	224	350	0.5838057	P<0.0 1
Rt.lung	487.529 41	53.53289 9	380	586	0.3344935	P<0.0 1	524.6	45.65227 6	442	650	0.3257871	P<0.0 1
Lt .lung	448.705 88	50.36130 2	340	560	0.403257	P<0.0 1	473.8	39.25777 5	400	560	0.2981731	P<0.0 1
Spleen	107.529 41	13.50898 1	88	134	0.33121	P<0.0 1	114.68	14.16896 3	98	170	0.3317016	P<0.0 1
Lt kidney	108.745 1	16.17264 6	80	142	0.3921793	P<0.0 1	113.72	15.20327 1	90	142	0.1496583	P<0.0 1
Rt kidney	107.960 78	15.78124 3	80	142	0.4037776	P<0.0 1	112.9	14.96428 5	90	142	0.0644725	P<0.0 1
Age	44.8627 45	14.27737 4	21	69	-0.2800395	P<0.0 1	44.9	14.29829	21	69	-0.5104434	p>0.0 5

Table 7 A: Showing mean age and S.D of weight of organs in Males as regard to age.

Age	20-29		30-39		40-49		50-59		60-69	
Subject	80		80		80		80		80	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
liver	1336	94.63588	1384.8	62.02784	1357	97.52481	1354	110.7013	1329	114.2106
brain	1200	120.1687	1267.2	116.4024	1222	106.4064	1223.4	107.8134	1212.2	101.0585
heart	296.8	21.39821	285	22.61399	254.8	12.30663	252.3	10.38061	250.3	13.3354
rt lung	510	56.20937	521.8	49.73611	534	35.20644	534	35.26392	523.2	44.77974
lt lung	462	47.15716	458.2	31.1462	489	34.69943	486.2	31.91698	473.6	39.87626
spleen	106.8	7.64795	119.8	18.49967	116.2	13.02617	115.8	12.83823	114.8	13.62648
lt. kidney	105.6	5.075631	114.2	11.14962	117	17.38907	116.4	17.0966	115.4	18.2927
rt kidney	102.5	6.256136	112	11.94078	117.8	16.26241	116.6	15.59097	115.6	16.90599

Table 7 B: Showing mean age and S.D of weight of organs in Females as regard to age.

Age	20-29		30-39		40-49		50-59		60-69	
Subject	60		60		60		66		60	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Liver	1226	114.1097	1230	65.86272	1226.2	72.01384	1194.727	78.49793	1329	114.4523
Brain	1073	76.80704	1113	74.52221	1103	82.0562	1076.727	85.51285	1212.2	101.2724
Heart	292.8	34.85408	251	16.53963	251	16.53963	247.4545	18.21089	250.3	13.36362
Rt lung	502	55.38157	478	43.44488	476	42.11365	461.0909	56.81623	523.2	44.87451
Lt lung	454	39.62536	441	41.44427	447	52.60341	429.8182	62.75199	473.6	39.96066
Spleen	98.6	5.986425	109.4	12.72552	109.4	12.72552	105.6364	15.10134	114.8	13.65532
Lt. kidney	99.4	5.918085	110.6	15.67596	111.6	15.2751	106.9091	17.88917	115.4	18.33141
Rt kidney	97.4	5.848946	109.8	15.13196	111	14.77286	106.1818	17.30354	115.6	16.94177

Discussion

Besides race, age, gender etc. human organs weight were also reported to be dependent on environmental and socioeconomic condition.⁽³⁾ Hence the organ weight reported in United States, Europe, Japan and other regions over the globe as well as various region of India are not applicable to the population of Solapur.

Indeed the use of incorrect table may lead to a wrong judgment on pathological features of organ especially in Forensic Medicine wherein microscopic

histological examination is not a routine practice. This implies the necessity to establish update reference tables from appropriate autopsy material that must be without any pathological change secondary to disease. There was no previous report on normal values of organ weight in population of this region. This is the first study in Solapur region of Western Maharashtra.

It was observed that Females have lower organ weight as compared to Males in all the age ranges, this is because female are generally smaller in size and their

natural genetic profile is different compared to Male. This is in accordance with the other Indian studies in this context.⁽⁷⁾

Liver: As evident from observatin the weight of liver in female is 1240.27 ± 101 & in males it is 1352.16 ± 99 . Thus the weight of liver in males is more than female. In present study the weight of liver was positively correlated with body weight in both sexes. Similar results were obtained by Yi- Suk – Kim et al,⁽⁸⁾ Chandra Prakash et. al,⁽⁹⁾ Chirachariyavej et. al⁽¹⁰⁾ and Sheikhzadi A. et. al.⁽¹¹⁾

While considering the relation with age, the weight of liver in females is more in 60-69 age groups and in males it is more in 30-39 age group. The study by Singh D. et. al⁽¹⁾ shows that peak weight of liver was found at age group 40-50 years. Sheikhzadi A. et. al.⁽¹¹⁾ and Grandmaison et al⁽¹²⁾ and Boyd et al⁽¹³⁾ shows that the weight was decreased after middle age. Study by Yi-Suk Kim⁽⁸⁾ shows that liver weight in age group 30-39, 40-49, 50-59 did not differ significantly and higher than other age groups in males. While in females liver weight in age group 40-49 and 50-59 did not differ significantly and were higher than other age groups. Study by Ogieu et al⁽¹⁴⁾ shows that the weight of liver was highest in their early forties. Chouker et al⁽¹⁵⁾ in their study mention that liver weight in German population reached in peak inmale in their forties and in female in their fifties.

Brain: The weight of brain in female was 1114.82 ± 98 and in male it was 1224 ± 96 .

The weight of brain in male is more than female. While co relating the weight of brain with body weight, we found positive co relation of brain weight with body weight in both sexes. The results were consistent with other studies by Matharaman P. et. al,⁽¹⁶⁾ Zschoch et. al,⁽¹⁷⁾ Yi- Suk Kim et al.⁽⁸⁾ Result by Chirachariyavej et. al.⁽¹⁰⁾ shows positive correlation only in male. The brain weight is maximum in 60-69 age group in females & 30-39 age groups in males. The study by Singh D. et al,⁽¹⁾ shows that in both genders, weight of brain increased upto 34 year. As per study by Sheikhzadi A et. al⁽¹¹⁾ the weight of brain was increased upto 34 years for both genders. Anderton et al.⁽¹⁸⁾ Carlson et al,⁽¹⁹⁾ in their study shows the brain weight of adults continued to remain constant or gradually decrease until age of 65, they justify that decrease of brain weight was due to gyral atrophy and widening of sulci with expansion of ventricle.

Heart: Weight of heart in female is 258.29 ± 27.18 and in males is 267.84 ± 25.49 . Thus the weight of heart in male is more than female.

In this study the weight of heart was positively correlated with body weight in both sexes. Similar result were obtained by Kitzman et. al,⁽²⁰⁾ Hanzlick & Rydzewski,⁽²¹⁾ Ogiu et al,⁽¹⁴⁾ Yi-Suk Kim et al.⁽⁸⁾ Chandra- Prakash et al,⁽⁸⁾ Coard K.C. et al.⁽²²⁾ The weight of heart in our study is less than weight of other studies. It is because of our exclusion of all cases that

likely involved in systemic hypertension which is frequently seen in middle and elder age group. The weight of heart in female is maximum in age group 20-29 year and in male it is maximum in age group 20-29 year. The study by Sheikhzadi A et al⁽¹¹⁾ shows increasing heart weight with age. The study by Yi-Suk-kim et al,⁽⁸⁾ shows that heart weight in age group of over 60 were higher than other age group in males & in females. Grandmaison et al.⁽¹²⁾ shows that the heart weight are increasing with age in Caucasoid population. Kitzman et al⁽²⁰⁾ in their study shows that heart weight in American male adult showed that male heart did not change in weight from 20 to 70 years of age, but female heart continued to increase during same period.

Lungs: The weight of right lung in females is 487.52 ± 53.53 and in males it is 524.6 ± 45.65 the weight of left lung in females is 448.70 ± 50.36 and in males it is 473.8 ± 39 . Thus weight of both lungs is more in male than female.

The weight of right and left lung was positively correlated with weight of person .similar results were obtained by other studies Yi-Suk-kim et al.⁽⁸⁾ Zschoch et al⁽¹⁷⁾ Singh D et al.⁽¹⁾ Study by Chandra Prakash⁽⁹⁾ shows that lung weight was positively correlated with weight of body in females but not in males.

The weight of lungs in female is maximum in age group 60-69 year & in male it is maximum in age group 40-49 year. As per study by Singh D et al⁽¹⁾ weight of lung attained their peak in their 40-50 years of age.

We found that there is individual variation probably due to terminal pulmonary oedema & congestion which differ from one individual to another because in acute death the post mortem lung weight may primarily depend on an individual's lung volume & persistent circulatory disturbance before death which is related to vital activity (Gender & Age) and survival time.

Spleen: As evident from observations the weight of spleen in female is 1107.52 ± 13.5 & in males it is 114.68 ± 14.16 . Thus the weight of spleen in males it more than female. Sprogoe Jakobson et al⁽²³⁾ shows no difference in spleen weight in both sexes. In present study the weight of spleen was positively correlated with body weight in both sexes. Similar results were obtained by Singh D et al⁽¹⁾ Yi-Suk-Kim et al,⁽⁸⁾ Chirachariyavej et. al.⁽¹⁰⁾ Grandmaison et al⁽¹²⁾ and Sprogoe Jakobson et al.⁽²³⁾ While considering the relation with age, the weight of spleen in females is more in 60-69 age group and in males it is more in 30-39 age group. The study by Singh D et al⁽¹⁾ shows that peak weight of spleen was found at middle age group. Grandmaison et al⁽¹²⁾ and Sprogoe Jakobson et al⁽²³⁾ did not found correlation in spleen weight and body weight. DeLand⁽²⁴⁾ in their study shows that spleen weight estimated by radionuclide imaging decreased from 20-29years of age and above 60years and remains constant from 30 to 59 years.

Kidney: As evident from observations the weight of left kidney was 108.74 ± 16.17 and right kidney 107.96 ± 15.78 respectively in female. In males the weight of left kidney was 113.72 ± 15.20 and right kidney 112.9 ± 14.96 . Thus the weight of both kidneys in males was more than females.

In present study the weight of each kidney was positively correlated with body weight in both sexes. Similar results were obtained by Yi- Suk – Kim et al,⁽⁸⁾ Chandra Praksh et. al⁽⁹⁾ & Chirachariyavej et. al.⁽¹⁰⁾ Sheikhzadi A. et. al.⁽¹¹⁾

While considering the relation with age, the weight of kidney in females is more in 60-69 age group & in males it is more in 40-49 age group. The study by Singh D. et. al⁽¹⁾ show that peak weight of kidney was found at age group 30-40 years. Study by Ogieu et al⁽¹⁴⁾ shows that the weight of kidney was highest in their early forties. Study by Sheikhzadi A. et. al.⁽¹¹⁾ shows that the weight of kidney was highest in 35-44 years. Study by Yi- Suk – Kim et al⁽⁸⁾ showed a regular pattern of change in organ weight according to age group. In Korean population the kidneys attained their peak in their middle age. The justification was that it was due to metabolic degradation of materials which occurs in kidney.

Conclusion

In this study we found that there is positive correlation between weight of organ and body weight. Male's organ weights are more than female organ weight. The findings in our study serve as a baseline in establishing normal weight in population of this region. These findings may offer standards for comparison with other population. This study is considered useful as anatomical data to understand the disease property of this regional population.

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