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Original Research Article

An Autopsy Based Study to Find Correlation between Organ Weights and Body Weight

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Abstract

Background: Organ weight assessment is integral to autopsy interpretation because deviation from expected organ weight may indicate occult pathology, systemic disease, or abnormal physiologic loading. Population-specific reference data remain necessary because organ weights vary with sex, stature, body composition, ethnicity, and geographic setting.

Aim: To determine the weight profile of the heart, liver, and kidneys in a medicolegal autopsy cohort and to evaluate the correlation between organ weights and body weight.

Methods: This cross-sectional autopsy-based study included 60 adults aged 20–50 years (30 males and 30 females) undergoing medicolegal autopsy at the Department of Forensic Medicine, Lady Hardinge Medical College, New Delhi. Only organs without gross pathology and unrelated to the cause of death were included; decomposed bodies, cases with intravenous fluid/blood transfusion history, deaths due to fire, explosion, drowning, heat stroke, dehydration, or prolonged postmortem interval were excluded. Body weight was measured before autopsy, and the heart, liver, right kidney, and left kidney were dissected by standard technique, cleared of extraneous tissue, and weighed using a digital organ weighing machine. Statistical analysis was performed using descriptive statistics, Student's t-test, and Pearson correlation.

Results: The mean age of the study population was 38.87 ± 10.17 years and the mean body weight was 58.90 ± 11.09 kg. Mean organ weights were 294.77 ± 49.54 g for the heart, 1439.92 ± 271.29 g for the liver, 123.18 ± 23.59 g for the right kidney, and 131.70 ± 23.01 g for the left kidney. Males had significantly greater left kidney (133.54 ± 27.55 vs 114.13 ± 14.71 g; p=0.001), right kidney (142.71 ± 25.48 vs 122.06 ± 15.39 g; p<0.001), and liver weights (1553.36 ± 301.71 vs 1340.66 ± 197.49 g; p=0.002) than females, whereas body weight and heart weight differences were not statistically significant. Body weight showed a non-significant positive correlation with left kidney weight (r=0.241, p=0.064), but significant positive correlations with right kidney weight (r=0.323, p=0.012), liver weight (r=0.295, p=0.022), and heart weight (r=0.445, p<0.001).

Conclusion: In this autopsy cohort, organ weights were generally higher in males, the left kidney was heavier than the right, and heart weight demonstrated the strongest positive correlation with body weight. These findings support the need for regional autopsy reference data and reinforce the interpretive value of body-weight-adjusted organ assessment in forensic practice.

Keywords: Autopsy; Organ Weight; Body Weight; Heart; Liver; Kidney; Forensic Pathology.

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Introduction

Assessment of organ weight is a routine but clinically decisive component of medicolegal and hospital autopsy practice. At the time of postmortem examination, organ enlargement or reduction may offer one of the earliest objective clues to systemic disease, pressure overload states, congestion, chronic malnutrition, or occult pathology. Contemporary autopsy guidelines continue to emphasize that organ weights should be recorded carefully and interpreted against appropriate reference standards rather than against anecdotal expectations alone [1,2]. Bell and colleagues, using a large modern autopsy database, showed that several commonly weighed organs are heavier in current populations than in older reference tables, underscoring the need to periodically update reference values [1]. Similarly, the European recommendations on cardiac

hypertrophy at autopsy stress that heart weight must be interpreted with consideration of sex and body size if it is to be used reliably as evidence of true hypertrophy rather than constitutional variation [2].

In forensic pathology, the problem is not only whether an organ is heavy or light, but whether its observed weight is appropriate for the body habitus and demographic profile of the deceased. de la Grandmaison et al., in 684 adult autopsies, demonstrated that most organ weights correlate with at least one external parameter, including body weight, body height, age, or body mass index [3]. Thai investigators also reported that internal organ weights differ by sex and relate to body size, although the strength and pattern of association vary across organs and between men and women [4,5]. In Tehran, organ weights were again found to correlate with body habitus, and most organs showed better association with anthropometric measures than with age alone [6]. These studies collectively show that a universal normal organ-weight table is conceptually weak because the biologic determinants of organ mass are population-specific.

Sex is one of the most consistent modifiers of organ weight. Across multiple autopsy populations, male organs are usually heavier than female organs, even after restricting analysis to adults without gross pathology [3-7]. This difference is not merely a function of total body size; it is also shaped by differential lean body mass, endocrine milieu, cardiac and renal structural dimorphism, and nutritional background.

Studies focused specifically on normal organ weights in men and women by Molina and DiMaio provided separate reference ranges for the heart, liver, kidneys, and other viscera, emphasizing that pooled reference tables may obscure clinically relevant sex differences [8-11]. Gholamzadeh et al. likewise demonstrated that several organs in South Iranian autopsies were significantly heavier in males than in females, further validating the need for sex-stratified interpretation [12].

The kidneys and liver deserve particular attention because they are metabolically active organs whose weights are influenced by body composition, blood volume, and constitutional size. In Malaysian autopsy data, Jothee et al. argued that reliance on Western standards can distort the interpretation of normality in local populations and therefore proposed region-specific reference ranges [15].

A Swiss autopsy study by Kalucki et al. showed that left kidneys are typically heavier than right kidneys and that both absolute and relative renal weights differ by sex [16]. Such laterality is anatomically plausible and has been observed in several older series, but the degree of asymmetry varies between populations. Likewise, liver weight may be influenced by sex, nutritional state, and body size; therefore, a single cut-off cannot be applied confidently across all populations [3,9,11].

The heart remains especially important because cardiomegaly and hypertrophy are frequent autopsy questions in sudden and unexplained deaths. Hanzlick and Rydzewski demonstrated that heart weight rises with body weight even in relatively young adult men, suggesting that constitutional body size exerts a measurable effect independent of overt disease [18]. For this reason, heart weight cannot be interpreted in isolation, and a heavy heart in a large person may have different implications than the same weight in a smaller person. Current practice increasingly favors contextual interpretation using sex- and body-size-aware reference ranges rather than absolute cut-offs alone [1,2,18].

Another major reason for conducting local organ-weight studies is the wide geographic variability reported in the literature. Indian studies from Jamnagar, Solapur, and Uttarakhand have all demonstrated that regional populations can differ meaningfully from foreign reference tables and, in some cases, from one another [7,13,17]. Vaibhav et al. further strengthened the quality of this evidence by histologically excluding abnormal organs before incorporating weights into reference datasets, thereby highlighting how hidden pathology can distort nominally normal averages [17]. Even within India, dietary patterns, body composition, socioeconomic background, and healthcare access may influence anthropometry and thereby organ mass. As a result, regional data from North India remain valuable not only for descriptive purposes but also for strengthening forensic inference.

The present autopsy-based study was therefore undertaken to evaluate the relationship between body weight and organ weights in an adult medicolegal autopsy population from Lady Hardinge Medical College, New Delhi. The specific objectives were to estimate the weight profile of the heart, liver, and kidneys; compare these measurements between males and females; and assess the magnitude and statistical significance of the correlation between body weight and individual organ weights. Given the continuing need for Indian reference data that are grounded in contemporary autopsy practice, the study aimed to generate evidence that is directly useful for day-to-day forensic interpretation while also permitting comparison with established international and regional literature [1-18].

Materials and Methods

This cross-sectional autopsy-based observational study was conducted in the Mortuary, Department of Forensic Medicine, Lady Hardinge Medical

College, New Delhi, after institutional academic and ethical clearance. The study population comprised medicolegal autopsy cases received during the study period from November 2022 to March 2024. A total sample of 60 adults was included, with equal representation of males and females (30 each). Only individuals aged 20–50 years were eligible for analysis. Organs were included only when they showed no gross pathology, were not directly related to the cause of death, and were considered suitable for normal-weight assessment. Cases were excluded when there was a history of intravenous infusion or blood transfusion, when the body showed putrefactive change, when death occurred due to fire, explosion, drowning, heat stroke, or dehydration, or when the postmortem interval exceeded 72 hours according to police or hospital records. Consent for autopsy procedures and research use was obtained according to routine medicolegal practice from relatives of the deceased or the investigating authority. Body weight was recorded before autopsy using a digital body weighing machine. Standard autopsy protocol was followed for organ removal. The heart was removed close to the roots of the aorta and pulmonary trunk; all chamber contents were washed out before weighing. The liver was freed of ligaments and the gallbladder was removed before weighing. Both kidneys were removed after stripping the capsules and perinephric fat. After drainage of blood and removal of extraneous tissue, each organ was weighed in grams using a digital organ weighing machine. Any organ suspected of pathology was subjected to histopathological examination and excluded from analysis if disease was subsequently confirmed. Quantitative data were summarized as mean and standard deviation, whereas categorical variables were expressed as frequency and percentage. Sex-wise comparisons were evaluated using Student's t-test. The relationship between body weight and organ weight was examined using Pearson's correlation coefficient.

A two-sided p value <0.05 was considered statistically significant. Additional 95% confidence intervals and effect-size descriptors presented in the tables were derived from the reported summary statistics to enhance interpretability.

Results

Sixty autopsies fulfilled the inclusion criteria. The cohort was evenly distributed by sex, with 30 males and 30 females. The mean age was 38.87 ± 10.17 years, indicating a mature adult cohort within the predefined 20–50-year study window. Mean body weight was 58.90 ± 11.09 kg (range, 35.5–95.6 kg).

The mean heart weight was 294.77 ± 49.54 g, mean liver weight was 1439.92 ± 271.29 g, mean right kidney weight was 123.18 ± 23.59 g, and mean left kidney weight was 131.70 ± 23.01 g. The left kidney was heavier than the right by approximately 8.5 g at the cohort level. Organ-weight variability was greatest for the liver and lowest for the kidneys.

Sex-stratified analysis showed that males had higher mean body weight, heart weight, liver weight, and bilateral kidney weights than females. However, the between-sex difference reached statistical significance for both kidneys and the liver, but not for body weight or heart weight. The largest standardized differences were observed for kidney weights.

Pearson correlation analysis showed a weak positive but non-significant relationship between body weight and left kidney weight (r=0.241, p=0.064). In contrast, body weight had statistically significant positive correlations with right kidney weight (r=0.323, p=0.012), liver weight (r=0.295, p=0.022), and heart weight (r=0.445, p<0.001). Among all organs studied, heart weight showed the strongest association with body weight, explaining nearly one-fifth of the observed variance.

Table 1: Demographic and anthropometric profile of the study population

Variable	N	Summary	95% CI	Range	Remark
Age (years)	60	38.87 ± 10.17	36.24 to 41.50	Not reported	Adult autopsy population aged 20–50 years
Male sex	30	50.0%	—	—	30/60
Female sex	30	50.0%	—	—	30/60
Body weight (kg)	60	58.90 ± 11.09	56.04 to 61.76	35.5–95.6	Wide body-mass distribution

95% confidence intervals were calculated from the reported means, standard deviations, and sample sizes.

Table 2: Overall distribution of internal organ weights

Organ	N	Minimum (g)	Maximum (g)	Mean ± SD (g)	95% CI of mean	Approx. central 95% interval*
Right kidney (g)	60	86	236	123.18 ± 23.59	117.09 to 129.27	76.9 to 169.4
Left kidney (g)	60	82	214	131.70 ± 23.01	125.76 to 137.64	86.6 to 176.8
Liver (g)	60	900	2369	1439.92 ± 271.29	1369.84 to 1510.00	908.2 to 1971.6
Heart (g)	60	185	385	294.77 ± 49.54	281.97 to 307.57	197.7 to 391.9

*Approximate central 95% interval calculated as mean ± 1.96 SD and shown for descriptive reference only.

Table 3: Sex-wise comparison of body weight and organ weights

Variable	Male (n=30)	Female (n=30)	Mean difference	95% CI of difference	t value	p value	Cohen d
Body weight (kg)	61.80 ± 13.59	56.35 ± 7.67	5.45	-0.28 to 11.18	1.944	0.057	0.49
Left kidney (g)	133.54 ± 27.55	114.13 ± 14.71	19.41	7.92 to 30.90	3.464	0.001	0.88
Right kidney (g)	142.71 ± 25.48	122.06 ± 15.39	20.65	9.72 to 31.58	3.854	<0.001	0.98
Liver (g)	1553.36 ± 301.71	1340.66 ± 197.49	212.70	80.47 to 344.93	3.269	0.002	0.83
Heart (g)	306.96 ± 58.94	284.09 ± 37.34	22.87	-2.73 to 48.47	1.818	0.074	0.46

Cohen d values were derived from pooled standard deviations using the reported sex-specific summary statistics.

Table 4: Correlation of body weight with organ weights

Outcome organ	Pearson r with body weight	95% CI for r	p value	R^2 (%)	Interpretation
Left kidney (g)	0.241	-0.014 to 0.466	0.064	5.8	Non-significant weak positive
Right kidney (g)	0.323	0.075 to 0.533	0.012	10.4	Weak positive, significant
Liver (g)	0.295	0.044 to 0.511	0.022	8.7	Weak positive, significant
Heart (g)	0.445	0.215 to 0.628	<0.001	19.8	Moderate positive

R^2 indicates the proportion of variance in organ weight statistically explained by body weight.

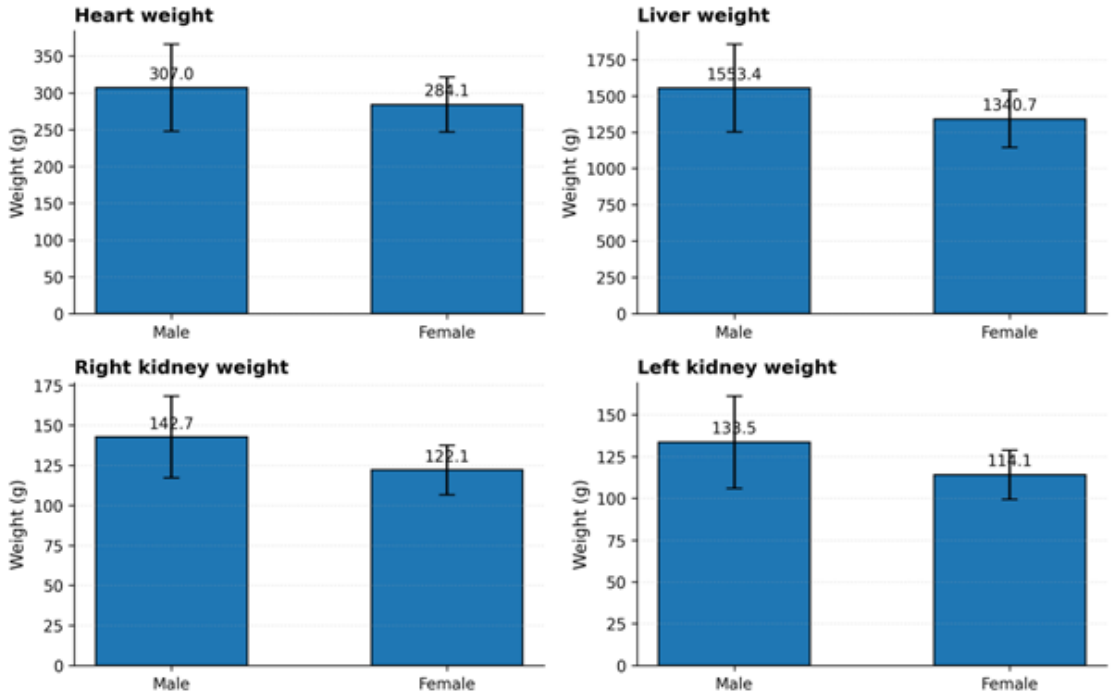

Figure 1: Sex-stratified mean organ weights (mean ± SD)

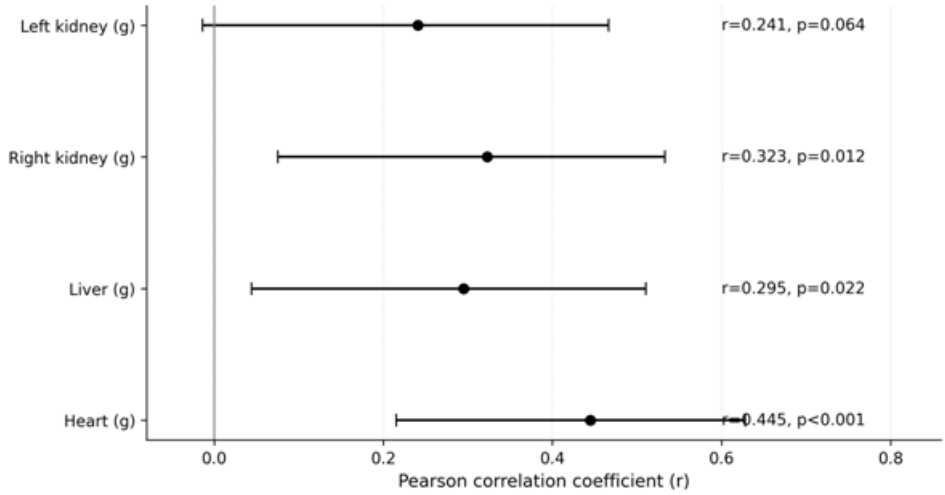

Figure 2: Forest plot of Pearson correlation coefficients between body weight and organ weights with 95% confidence intervals

Discussion

The present study evaluated the relationship between body weight and the weights of the heart, liver, and kidneys in a balanced autopsy cohort of adult men and women from North India. The principal findings were that organ weights were generally higher in males; the left kidney was heavier than the right; body weight showed significant positive correlations with the right kidney, liver, and heart; and the strongest association was observed for heart weight. These findings are clinically relevant because autopsy interpretation depends not on isolated organ mass alone, but on whether a measured organ weight is proportionate to sex and constitutional body size [1-3].

The mean heart weight in the present series was 294.77 g, which lies within the broad range reported for adult autopsy populations but is lower than the heart weight described in some Western male-focused series. Hanzlick and Rydzewski reported a mean heart weight of 371 g in white men aged 20–39 years and showed a positive relationship between heart weight and body weight [18]. That study, however, involved a different sex composition and a more narrowly defined demographic subgroup. More recent sex-specific reference work by Molina and DiMaio proposed distinct male and female heart-weight ranges, thereby supporting the view that pooled reference values should be interpreted cautiously [8,10]. In the present study, heart weight differed numerically between males and females but this difference was not statistically significant, whereas the correlation between heart weight and body weight was moderate and highly significant. This suggests that, within this cohort, constitutional body size contributed more strongly to heart weight variation than sex alone. This pattern is also consistent with current autopsy guidance recommending interpretation of heart weight in the context of body habitus before inferring pathologic hypertrophy [2].

The liver showed a significant sex difference and a significant positive correlation with body weight. The mean liver weight of 1439.92 g was close to values reported in the Thai series by Chirachariyavej et al. and in broader modern reference tables, while remaining higher than some African and regional Indian reports [4,14]. Mathuramon et al. also found that liver weight correlated with body size in Thai adults [5]. de la Grandmaison et al. demonstrated that liver weight increases with anthropometric parameters and cannot be judged adequately without reference to body habitus [3]. The present findings therefore reinforce the biological plausibility that heavier individuals tend to have heavier livers, likely reflecting a combination of greater lean mass, blood volume, and constitutional organ scaling rather than pathology alone. The significant male-female difference in liver weight observed here is also in agreement with the Uttarakhand autopsy study by Vaibhav et al., where male liver weights exceeded female values after histologic exclusion of abnormality [17].

Kidney findings in the current study deserve special attention. The left kidney was heavier than the right, which is in keeping with established anatomic expectation and with several autopsy studies from different populations. Mubbunu et al. in Zambia reported that the left kidney was heavier than the right in both sexes, while Kalucki et al. in a Swiss autopsy study found left kidneys to be approximately 8 g heavier and slightly longer than right kidneys [14,16]. The magnitude of asymmetry in the present study closely parallels that Swiss observation. Sex-wise, both kidneys were significantly heavier in males than in females, again consistent with the literature [3,12,16]. These differences likely reflect sex-based differences in

nephron mass and overall body composition rather than disease in a carefully selected normal-organ series.

Interestingly, correlation with body weight was not identical for the two kidneys. Although both kidneys trended positively with body weight, only the right kidney reached statistical significance in the present study. This asymmetric statistical finding may reflect sample size limitations rather than a true biologic divergence because the confidence interval for the left kidney correlation only narrowly crossed the null. Studies with larger samples have often reported significant positive correlations for both kidneys. For example, Mubbunu et al. observed positive body-weight correlations for both kidneys in men and for the right kidney in women [14]. Thai studies also generally demonstrated positive associations between kidney weight and body size [4,5]. Conversely, Kalucki et al. showed that renal weight is influenced by body height, body weight, and autopsy blood congestion status, implying that kidney-weight analysis is particularly sensitive to multiple concurrent determinants [16]. Therefore, the absence of statistical significance for the left kidney in this 60-case study should be interpreted conservatively and not as evidence of a lack of biologic relationship.

Comparison with Indian literature is instructive. Vadgama et al. from Jamnagar reported positive associations between organ weights and body weight, although the significance pattern varied by organ and sex [7]. Bhoi et al. from Solapur, working on a much larger autopsy series, also found that mean organ weights were higher in males across age groups and confirmed the overall influence of body size on organ mass [13]. Vaibhav et al. further highlighted a methodological strength that is highly relevant to the present study—namely, the value of excluding histologically abnormal organs before constructing reference ranges [17]. The current study likewise excluded organs with gross pathology and removed those later found abnormal on histopathology, thereby improving the forensic applicability of the observed averages.

From a forensic standpoint, the most important practical message of this study is that body weight should be taken into account routinely when interpreting organ mass, especially for the heart and liver. Bell et al. showed that modern populations may differ appreciably from older reference sets [1]. Jothee et al. similarly argued that regional reference ranges are indispensable because pathologists often rely on foreign tables that may not reflect local anthropometry [15]. The present results support this view for a North Indian population. A heart weighing around 300 g, a liver around 1.44 kg, and kidneys averaging roughly 123 g and 132 g in this cohort should be interpreted as context-dependent normal values rather than rigid thresholds for all adults. Such contextualization is particularly necessary in medicolegal work, where overcalling organomegaly may distort opinion about cause of death, chronic disease, or neglect.

The study has limitations that should be acknowledged. The sample size was modest, the data were drawn from a single institution, and the age range was restricted to 20–50 years, limiting generalizability to elderly adults and adolescents. Body height, body mass index, and multivariable modeling were not available for analysis, although previous studies suggest that these parameters may add explanatory value beyond body weight alone [3,6,16]. Finally, because this was an autopsy-based sample, the reference values are most applicable to forensic and pathological settings rather than to living imaging populations. Despite these limitations, the study contributes useful contemporary regional data, demonstrates consistent internal biologic patterns, and supports sex-aware and body-weight-aware interpretation of organ weights in routine autopsy practice.

Conclusion

In this adult autopsy cohort, males had greater mean liver and kidney weights than females, the left kidney was heavier than the right, and body weight showed significant positive correlations with right kidney, liver, and especially heart weight. Heart weight exhibited the strongest association with body weight, indicating that cardiac mass should be interpreted with particular attention to constitutional body size. These findings provide regionally relevant reference information for forensic practice and support the use of sex-specific and body-weight-adjusted standards when deciding whether an organ is truly normal or pathologically enlarged.

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