

**Original article:**

**A postmortem study on the volume of the human adrenal glands**

*Siddiqua D<sup>1</sup>, Nurunnabi ASM<sup>2</sup>, Ara S<sup>3</sup>, Zohora F<sup>4</sup>, Hena H<sup>5</sup>, Pervin D<sup>6</sup>*

**Abstract**

**Objective:** A Cross-sectional descriptive type of study was done in the Department of Anatomy, Dhaka Medical College, Dhaka, from July 2008 to June 2009, to see the variation in the volume of the adrenal glands with age in Bangladeshi people. **Materials & Methods:** The study was performed on 140 post mortem human adrenal glands collected from 70 unclaimed dead bodies which were in the morgue under examination in the Department of Forensic Medicine, Dhaka Medical College, Dhaka. The samples were divided into four age-groups including group A (11-20 years), group B (21-30 years), group C (31-40 years) & group D (41-60 years). The length, breadth and thickness of each adrenal gland were measured by using a slide calipers. Then the volume of each adrenal gland was determined by the product of its length, breadth and thickness multiplied by 0.52, according to the prolate ellipsoid formula. **Results:** The mean volume of the right adrenal glands were found  $6.36 \pm 0.85$  cm<sup>3</sup> in group A (11-20 years),  $6.49 \pm 0.76$  cm<sup>3</sup> in group B (21-30 years),  $6.50 \pm 0.80$  cm<sup>3</sup> in group C (31-40 years),  $6.76 \pm 0.79$  cm<sup>3</sup> in group D (41-60 years). The mean volume of the left adrenal glands were found  $6.97 \pm 1.02$  cm<sup>3</sup> in group A (11-20 years),  $6.93 \pm 0.83$  cm<sup>3</sup> in group B (21-30 years),  $6.65 \pm 0.79$  cm<sup>3</sup> in group C (31-40 years),  $7.09 \pm 0.81$  cm<sup>3</sup> in group D (41-60 years). The differences between the right and left adrenal glands and the difference between age groups were not statistically significant.

**Key words:** Human adrenal gland, volume of adrenal gland.

**Introduction:**

The adrenal gland is a life-saving endocrine gland of the human body<sup>1</sup>. Adrenal pathology can manifest in various ways either hypofunctional (Addison's disease) caused by primary atrophy, tuberculous destruction, adrenal cancer etc. or hyperfunctional (Cushing's syndrome) caused by hyperplasia, adrenal tumour etc.<sup>2</sup>. Volume of different adrenal cortical layers are indicators of functional state of the gland and influenced by aging, alcohol consumption, stress and systemic disease<sup>3</sup>.<sup>7</sup> However, there are interobserver variations in different techniques of determining the volume of adrenal glands both in normal and diseased people<sup>4</sup>

<sup>7</sup>. Besides, it has been observed by various researchers that the dimensions of different organs in Bangladeshi population have got variations from those of the western population<sup>8</sup>. However, we have only a few studies on human organs especially in their gross anatomy e.g. studies on morphological variations of the adrenal gland in different age groups in Bangladeshi people. Moreover, the estimation of the size of the adrenal gland is important for the evaluation and management of the adrenal disorders and facilitatory to the radiologists, endocrinologists, pathologists and surgeons<sup>9</sup>. In the present study, the adrenal glands were collected from cadavers through a meticulous dissection. Then their surfaces were dried by a

1. Dr. Dilruba Siddiqua, Assistant Professor, Department of Anatomy, Ibn Sina Medical College, Dhaka.
2. Dr. Abu Sadat Mohammad Nurunnabi, Lecturer, Department of Anatomy, Dhaka Medical College, Dhaka.
3. Dr. Shamim Ara, Professor and Head, Department of Anatomy, Dhaka Medical College, Dhaka.
4. Dr. Fatema Zohora, Assistant Professor, Department of Anatomy, Faridpur Medical College, Faridpur.
5. Dr. Hasna Hena, Assistant Professor, Department of Anatomy, East-West Medical College, Dhaka.
6. Dr. Shahnaj Pervin, Assistant Professor, Department of Anatomy, Popular Medical College, Dhaka.

**Corresponds to:** Dr. Dilruba Siddiqua, Assistant Professor, Department of Anatomy, Ibn Sina Medical College, Dhaka, **E-mail:** shekhor19@yahoo.com

## A postmortem study on the volume of the human adrenal glands

blotting paper and volumetric measurements were taken after determining their length, breadth and thickness to get a more accurate result. The result of the present study can be used as a standard reference volume for the adrenal gland of Bangladeshi people and to determine the abnormalities in pathologic conditions.

### **Materials and Methods:**

#### **Materials of the study:**

A cross-sectional descriptive type of study was designed and done in the Department of Anatomy, Dhaka Medical College, Dhaka, from July 2008 to June 2009, based on collection of 140 human adrenal glands from 70 unclaimed dead bodies that were under examination in the Department of Forensic Medicine, Dhaka Medical College, Dhaka, from November 2008 to April 2009. All the samples were collected within 24-36 hours of death without any sign of putrefaction and taken from medicolegal cases excluding poisoning, any cutting or crushing injury to the adrenal glands, and adrenal glands found in one side and diseased. After isolation, the samples were divided into four age-groups i.e. group A (11-20 years), group B (21-30 years), group C (31-40 years) and group D (41-60 years) (Table-I), according to Kangarloo et al. (1986)<sup>9</sup>.

#### **Methods:**

##### **Estimation of the volume of the adrenal glands:**

At first, the length of the adrenal gland was measured from its upper pole to the lower pole, then its breadth was measured transversely at its maximum and the thickness was measured at the region of its maximum antero-posterior diameter (according to Ahmed et al. 2007)<sup>10</sup>. Then volume of each ovary was calculated by applying the ellipsoid formula which requires the measurement of these three dimensions. The prolate ellipsoid formula<sup>11</sup> is as follows:

$$\text{Volume} = \text{Length} \times \text{Breadth} \times \text{Thickness} \times 0.52$$

##### **Statistical processing of data:**

The comparison between right and left side was done by unpaired Student's 't' test and the comparison between different groups was done by One-way ANOVA. All the statistical analyses were done by using the SPSS 11.0 version.

**Table-I: Grouping of the sample of the present study (n = 140)**

Group	Age limit in years	Number of samples	
		Right	Left
A	11-20	10	10
B	21-30	15	15
C	31-40	25	25
D	41-60	20	20

#### **Results:**

##### **Right adrenal gland:**

In the present study, the mean volume of the right adrenal gland were found  $6.36 \pm 0.85 \text{ cm}^3$  in group A (11-20 years),  $6.49 \pm 0.76 \text{ cm}^3$  in group B (21-30 years),  $6.50 \pm 0.80 \text{ cm}^3$  in group C (31-40 years),  $6.70 \pm 0.79 \text{ cm}^3$  in group D (41-60 years). The highest mean volume was found in group D and the lowest mean volume was in group A. The difference between the groups was not statistically significant (Table-II).

**Table-II. Volume of right and left adrenal gland in different age group**

Group (n)	Volume ( $\text{cm}^3$ )		P value
	Right Mean $\pm$ SD	Left Mean $\pm$ SD	
A (10)	$6.36 \pm 0.85$ (5.27-7.54)	$6.97 \pm 1.02$ (5.55-8.70)	$> 0.10^{\text{ns}}$
B (15)	$6.49 \pm 0.76$ (5.27-7.64)	$6.93 \pm 0.83$ (5.55-8.29)	$> 0.10^{\text{ns}}$
C (25)	$6.50 \pm 0.80$ (5.06-7.80)	$6.65 \pm 0.79$ (5.11-7.96)	$> 0.50^{\text{ns}}$
D (20)	$6.76 \pm 0.79$ (5.27-8.12)	$7.09 \pm 0.81$ (5.47-8.58)	$> 0.10^{\text{ns}}$
	P value	P value	
A vs B	$> 0.50^{\text{ns}}$	$> 0.50^{\text{ns}}$	
A vs C	$> 0.50^{\text{ns}}$	$> 0.10^{\text{ns}}$	
A vs D	$> 0.10^{\text{ns}}$	$> 0.50^{\text{ns}}$	
B vs C	$> 0.50^{\text{ns}}$	$> 0.10^{\text{ns}}$	
B vs D	$> 0.10^{\text{ns}}$	$> 0.50^{\text{ns}}$	
C vs D	$> 0.10^{\text{ns}}$	$> 0.05^{\text{ns}}$	

Figures in parentheses indicate range. Comparison between the right & the left side done by unpaired Student's 't' test and in between different age group were done by Oneway ANOVA (PostHoc) ns = not significant.

##### **Left adrenal gland:**

In the present study, the mean volume of the left

adrenal gland were found  $6.97 \pm 1.02 \text{ cm}^3$  in group A (11-20 years),  $6.93 \pm 0.83 \text{ cm}^3$  in group B (21-30 years),  $6.65 \pm 0.79 \text{ cm}^3$  in group C (31-40 years),  $7.09 \pm 0.81 \text{ cm}^3$  in group D (41-60 years). The highest mean volume was found in group D and the lowest mean volume was in group C. The difference between the groups was not statistically significant (Table-II).

Moreover, no difference was found between the volume of the right and left adrenal glands in any age group (Table-II).

#### **Discussion:**

According to Arey (1966), Fawcett (1994), Glass and Mundy (2005) and Ross and Pawlina (2006), the volume of the adrenal gland is about  $7.5\text{-}8.5 \text{ cm}^3$  (12-15). In the present study, the mean highest volume of the adrenal gland was found  $6.70 \pm 0.79 \text{ cm}^3$  at right and  $7.09 \pm 0.81 \text{ cm}^3$  at left side. This value is slightly lower than that of the findings described by Arey, Fawcett, Glass and Mundy, Ross and Pawlina<sup>12-15</sup>. This dissimilarity

may be due to the racial variation and method of measurement. The study results have similarity with some other studies on weight and volume of different organs in Bangladesh<sup>16-19</sup>.

To the best of our knowledge, this is the first ever study to determine volume of the adrenal gland in Bangladeshi people. The results of the present study can be used as a standard volume reference for the adrenal glands of Bangladeshi people. However, further studies with larger sample and high technical backup are recommended.

#### **Ethical Clearance:**

This study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka.

#### **Acknowledgement:**

We would like to express our sincere gratitude to the authority of Health, Nutrition & Population Sector Programme (HNPS) of Directorate General of Health Services (DGHS) of the Government of the People's Republic of Bangladesh, and Dhaka Medical College, Dhaka, for the research grant.

#### **References:**

1. Kumar V, Abbas AK, Fausto N. eds. Robbins and Cotran pathologic basis of disease. 7th ed. New Delhi: Saunders; 2004: 1207-23.
2. Guyton AC and Hall JE. The adrenocortical hormones. In: Textbook of medical physiology. 11th ed. New Delhi: Elsevier; 2006: 869-83.
3. Grant CS. Surgical anatomy of the thyroid, parathyroid, and adrenal glands. In: Fischer JE, Bland KI, Callery MP, Clagett GP, Jones DB, LoGerfo FW, et al. eds. Mastery of surgery. Vol. 1. 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2007: 394-7.
4. Rebuffat P, Belloni AS, Rocco S, Andreis PG, Neri G, Malendowicz LK, et al. The effect of ageing on the morphology and function of the zonae fasciculata and reticularis of the rat adrenal cortex. *Cell Tissue Res* 1992; **270**(2): 265-72. <http://dx.doi.org/10.1007/BF00328012> PMID:1333363
5. Monsefi M, Bahoddini A, Nazemi S, Dehghani GA. Effects of noise exposure on the volume of adrenal gland and serum levels of cortisol in rat. *Iran J Med Sci* 2006; **31**(1): 5-8.
6. Meier J, Iruvuri S, Saad Alzeair S, Houseni M, Alavi A, Torigian D. Structural and functional changes in the adrenal glands with age as determined by FDG-PET and CT imaging. *J Nucl Med* 2007; **48**(Suppl 2): 67.
7. Grant LA, Napolitano A, Miller S, Stephens K, McHugh SM, Dixon AK. A pilot study to assess the feasibility of measurement of adrenal gland volume by magnetic resonance imaging. *Acta Radiol* 2010; **51**(1): 117-20. <http://dx.doi.org/10.3109/02841850903352620> PMID:20088645
8. Enayetullah M. Gross and histomorphological study of the thyroid and parathyroid glands in Bangladeshi people (M.Phil.Thesis). Dhaka: IPGMR, University of Dhaka; 1996: 17.

9. Kangarloo H, Diament MJ, Gold RH, Barrett C, Lippe B, Geffner M, et al. Sonography of adrenal glands in neonates and children: changes in appearances with age. *J Clin Ultrasound* 1986; **14**(1): 43-7. <http://dx.doi.org/10.1002/jcu.1870140109> PMID:3080485
10. Ahmed MS, Khalil M, Rahman MH, Mannan S, Sultana SZ, Ara ZG, et al. Morphological study of length, breadth and thickness of the ovary at different age group in Bangladeshi people. *J Bangladesh Soc Physiol* 2007; **2**: 24-7.
11. Sech S, Montoya J, Girman CJ, Rhodes T, Roehrborn CG. Inter examiner reliability of transrectal ultrasonography to estimate prostate volume. *J Urol* 2001; **166**: 125-9. [http://dx.doi.org/10.1016/S0022-5347\(05\)66091-0](http://dx.doi.org/10.1016/S0022-5347(05)66091-0)
12. Arey LB. Human histology. 2nd ed. Philadelphia: WB Saunders; 1966: 179-83.
13. Fawcett DW. A textbook of histology. 12th ed. NewYork: Chapman & Hall; 1994: 503-15.
14. Glass J, Mundy AR. Abdomen and pelvis. In: Stranding S, Ellis H, Heally JC, Johnson D, Williams A, Collins P, et al. eds. Gray's anatomy: the anatomical basis of clinical practice. 39th ed. Edinburgh: Elsevier Churchill Livingstone; 2005: 1245-9.
15. Ross MH, Pawlina W. Histology: a text and atlas with correlated cell and molecular biology. 5th ed. USA: Lippincott Williams & Wilkins; 2006: 578-86.
16. Alim A, Nurunnabi ASM, Mahbub S, Shamim A. Histomorphometric study of the human spleen. *Bangladesh Journal of Medical Science* 2012; **11**(04): 298-302. DOI: <http://dx.doi.org/10.3329/bjms.v11i4.12600>
17. MS Ahmed, H Rahman, ZG Ara, SZ Sultana, M Rahman. Morphological study of weight of the ovary at different age group in Bangladeshi people. *Bangladesh Journal of Medical Science* 2011; **10** (4): 266-268. DOI: <http://dx.doi.org/10.3329/bjms.v10i4.9498>
18. ASM Nurunnabi, A Alim, M Sabiha, B Manowara, K Monira, A Shamim. Weight of the Human Thyroid Gland – A Postmortem Study. *Bangladesh Journal of Medical Science* 2010; **09**(1): 44-48. DOI: 10.3329/bjms.v9i1.5230
19. Dilruba S, Shamim A, ASM Nurunnabi, Rukshana A, Parven AH. A postmortem study on the weight of the human adrenal glands. *Bangladesh Journal of Medical Science* 2010; **09**(4): 204-207. DOI: 10.3329/bjms.v9i4.6686