

# MR Volumetry of Pituitary Gland in Indian Adults to Establish Normal Reference Values

JOISH UPENDRA KUMAR, KAVITHA Y

## ABSTRACT

**Introduction:** Pituitary gland varies in size and shape among both genders, different age groups and also among different races and ethnicity. Pituitary gland volume measurement more reliably detects subtle changes in size which can be pathological. There is lack of data on normal reference values of pituitary gland volumes in Indian population.

**Aim:** To find out the range of pituitary gland volumes in Indian adults in different age groups across both genders by Magnetic Resonance Imaging (MRI) studies.

**Materials and Methods:** Total 50 apparently healthy individuals were subjected to MRI of pituitary gland. A T1 weighted multiplanar acquisition was performed in sagittal plane with a slice thickness of 0.9mm. Pituitary gland was

traced on all slices and volume was calculated. Paired 't' test was used to compare among different age groups and both genders.

**Results:** The mean pituitary volume found in males was 4.78 cm<sup>3</sup> and in females it was 4.8 cm<sup>3</sup>. The largest pituitary glands were seen in 11 to 20 years age group in the females which was significantly larger than that found in males. There was no significant difference in pituitary volume between the two genders at other age groups. The elderly individuals aged more than 50 years showed the smallest pituitary glands.

**Conclusion:** Normal values of pituitary glands with gender and age variations were found out in this study. The data established in this study is proposed to be used as normal reference range.

**Keywords:** Gender variations, Mean pituitary volume, T1 weighted multiplanar imaging

## INTRODUCTION

Pituitary gland being the master endocrine gland, is the vital link to many endocrine disorders. With the widespread use of Magnetic Resonance Imaging (MRI) in the evaluation of pituitary gland abnormalities, many changes in the size of the pituitary gland can be observed with or without identifiable focal lesions. Subtle convexity of the superior surface of the gland can be a normal variant but also mimic an underlying lesion [1]. Pituitary height is the most commonly used measurement to detect hyperplasia [2,3]. However, in some conditions like pregnancy [4], anorexia and endocrine disorders [5], overall size of the gland is increased which can be assessed by measuring volume of the gland. Pituitary gland volume measurements more reliably detect the changes in overall size of the gland. To ascertain whether such variations in glandular volume are significant, it is imperative to know the normal range of the pituitary gland volumes. It is also known that the pituitary gland volumes vary with ethnicity and also among different races [6]. There is lack of data on the normal range of pituitary gland volumes among Indian population till date.

## MATERIALS AND METHODS

A prospective study was carried out in the Department of Radiodiagnosis, JJM Medical College, Davangere, India, between May to September 2016 (5 months), in which 50 apparently healthy adults, aged between 15 years and 80 years, were subjected to MRI of the pituitary gland (power based sample size calculation was done). Persons with any known neurological disease, endocrine disease, psychiatric disease or any other co-morbidity likely to have an influence on pituitary gland and individuals with contraindications for MRI including claustrophobia were not considered for the study. Careful history eliciting and detailed general physical examination was carried out to exclude any of the above mentioned conditions.

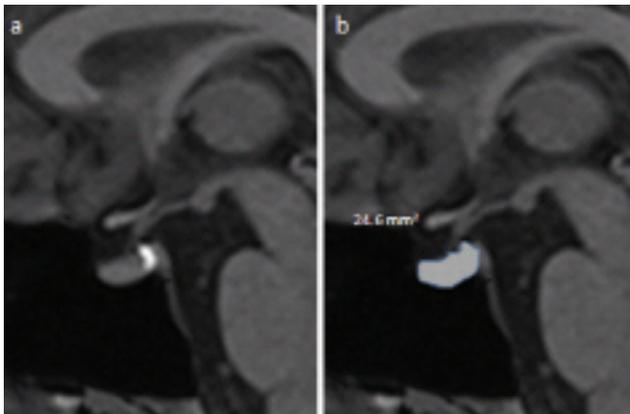
After taking informed consent from the individuals, MRI was performed with a 1.5 T imager (Achieva, Philips). A T1 weighted multiplanar imaging of brain was done with parameters as described in [Table/Fig-1].

The sagittal images were used for pituitary gland tracing. All

Slice Thickness	0.9 mm
Acquisition plane	Sagittal
Time of Repetition	1180 milliseconds
Time to Echo	4.4 milliseconds
Matrix Size	256x256
Field of view	24x24 cm

**[Table/Fig-1]:** T1 weighted multiplanar MRI protocol.

slices in which pituitary gland was seen were selected and the gland was manually traced in each of the slices by using the area tool for irregular shapes. The pituitary gland areas obtained for all slices were summed. Pituitary gland volume (in mm<sup>3</sup>) was obtained by adding areas of the gland in all slices and multiplying by a factor of 0.9, as slice thickness of images was 0.9 mm. Pituitary stalk was excluded from the tracings. However, both anterior pituitary and posterior pituitary bright spot were included in the tracing in each slice as depicted in [Table/Fig-2]. This method of tracing pituitary gland for volumetry is akin to that used by Takano K et al.,[7].

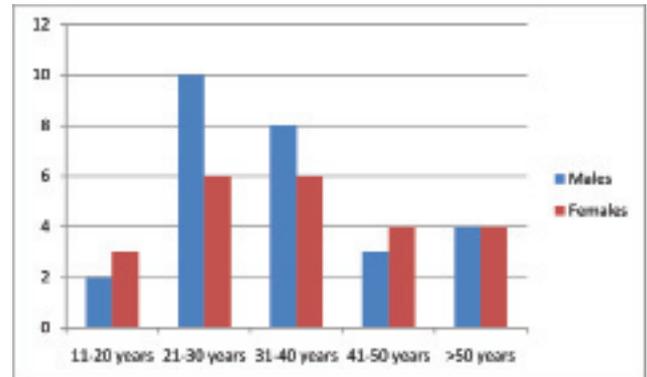


**[Table/Fig-2a-b]:** (a) Shows normal appearing pituitary gland on T1 weighted sagittal images. (b) Shows the tracing of pituitary gland in the same slice. The pituitary gland is shaded for better comparison and the area of the gland in this slice is also depicted in the figure.

The data obtained was tabulated into class intervals of different age groups and gender. Mean and standard deviation was calculated for each age group. Thereafter test for significance for variations of the mean volumes among different age groups was done using a two tailed paired 't' test.

## RESULTS

There were 27 males and 23 females included in the study. The mean age of participants was 36.3 years. The youngest of them was a 15 years old male and oldest an 80 years old male. Age group of 21-30 years comprised of the maximum number of individuals and included 10 males and 6 females. Gender and age distribution of the participants is depicted in [Table/Fig-3].



**[Table/Fig-3]:** Bar diagram depicting age and gender distribution of participants.

X axis – depicts the class intervals of age groups (Blue – males and Red – females)  
Y axis – Number of individuals

The mean pituitary volume found in males was 4.78cm<sup>3</sup> and in females it was 4.8cm<sup>3</sup>. Mean pituitary gland volumes and standard deviations obtained in different age groups are depicted in [Table/Fig-4]. The largest pituitary gland volumes were seen between 21-30 years in males with a mean of 5.34cm<sup>3</sup>. However, in females, the largest pituitary glands were seen in 11 to 20 years age group with a mean of 5.61cm<sup>3</sup> which was significantly larger than that found in males of similar age group (4.9cm<sup>3</sup>, p-value <0.05). There were no significant differences in pituitary volumes between the two genders at other age groups.

	Males		Females	
	Mean Pituitary Volume (in cm <sup>3</sup> )	*SD (in cm <sup>3</sup> )	Mean Pituitary Volume (in cm <sup>3</sup> )	*SD (in cm <sup>3</sup> )
11-20 years	4.9	1.26	5.61	0.42
21-30 years	5.34	0.48	5.36	0.25
31-40 years	4.87	0.69	4.6	0.46
41-50 years	4.21	0.51	4.52	0.39
> 50 years	3.51	0.52	3.96	0.27

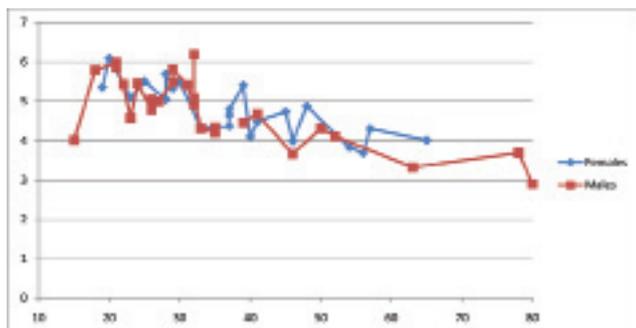
**[Table/Fig-4]:** Pituitary volumes – mean and standard deviations (SD).

The elderly individuals aged more than 50 years showed the smallest pituitary glands in both genders with a mean of 3.51cm<sup>3</sup> in males and 3.96cm<sup>3</sup> in females. These individuals had significantly lower pituitary volumes as compared to

Comparison between age groups	p-values for Males	p-values for Females
11-20 years and 21-30 years	0.71	0.41
21-30 years and 31-40 years	0.12	0.01
31-40 years and 41-50 years	0.15	0.77
41-50 years and more than 50 years	0.14	0.06

**[Table/Fig-5]:** Paired 't' test comparisons between different age groups.

individuals in 2<sup>nd</sup> to 4<sup>th</sup> decades of life (p-value of less than 0.04). Paired-'t' test values of significance of variations of pituitary gland volumes across different age groups is given in [Table/Fig-5]. A scatter diagram comparing the pituitary volumes between males and females is depicted in [Table/Fig-6].



**[Table/Fig-6]:** Scatter diagram of pituitary volume variations with age and gender.  
X axis – Age in years  
Y axis – Pituitary volume in cm<sup>3</sup>

## DISCUSSION

Variations of pituitary gland volumes with age and gender in Indian population were studied in view of scant data available on the same.

In the present study, the pituitary gland was traced on all sagittal slices obtained by T1 weighted protocol employing thin slices. The volume was measured by summing the areas of the gland on all slices and multiplying by 0.9 mm, the slice thickness. Takano K et al., [7] had used similar method to measure pituitary gland volume, but in adolescents. SN Lurie et al., [5], had also used sagittal T1 weighted images for volume measurements. However, the slice thickness obtained was 3 mm. Two types of volume calculations were done in that study. One employing the formula:-

Pituitary Gland Volume =  $\frac{1}{2}$  X Height (in Sagittal Plane) X Thickness (in Sagittal Plane) X Width (on Coronal Image),

same formula also used by Ibinaive PO et al., [8], but coronal images were chosen for height measurements.

The gland volume was also measured by tracing the area of the gland in sagittal images and multiplying by its width.

The mean pituitary gland volumes, among population of more than 50 years of age, in the present study (3.51cm<sup>3</sup> in males and 3.96cm<sup>3</sup> in females) was smaller than that obtained by SN Lurie et al., [5] (4.1cm<sup>3</sup>) that was done in American population. In people aged under 50 years, the pituitary gland volumes measured by SN Lurie et al., (5.17cm<sup>3</sup>) are comparable to similar volumes in the 2<sup>nd</sup> and 3<sup>rd</sup> decade age groups in the present study [5]. Ibinaive PO et al., [8], found pituitary gland volumes of 3.34cm<sup>3</sup> and 3.28cm<sup>3</sup> in Nigerian males and females respectively, which are significantly smaller than those

obtained in current study. A concise comparison of results of these studies is depicted in [Table/Fig-7].

	Present study		Ibinaive PO et al., [8] in Nigerian population		SN Lurie et al., [5] in American population
	Mean Pituitary Volume in cm <sup>3</sup> in Males	Mean Pituitary Volume in cm <sup>3</sup> in Females	Mean Pituitary Volume in cm <sup>3</sup> in Males	Mean Pituitary Volume in cm <sup>3</sup> in Females	Mean Pituitary Volume in cm <sup>3</sup>
11-20 years	4.9	5.61	3.7	3.19	5.17 (less than 50 years of age)
21-30 years	5.34	5.36	3.54	3.59	
31-40 years	4.87	4.6	3.48	3.45	
41-50 years	4.21	4.52	3.47	3.32	
> 50 years	3.51	3.96	<2.6	<2.6	4.1

**[Table/Fig-7]:** Comparison of results of present study with other studies.

There were no significant gender related variations reported by SN Lurie et al., [5] and Ibinaive PO et al., [8], in contrast to present study which shows significantly higher volumes in females of pubertal age group in comparison with male counterparts of similar age (p-value <0.03). Similar difference at pubertal age group was also noted by Takano K et al., [7] among Japanese, as also Elster AD et al., [3] and Tsunoda A et al., [2].

## LIMITATIONS

Though, a thorough history taking and general physical examination was done, no haematological examination or hormonal analysis was done, leading to possibility of missing subclinical conditions in the participants.

The sample size used in this study, though was based on power based sample size calculation formulae, was less than that used in some studies like Ibinaive PO et al., [8], but significantly more than that used by SN Lurie et al., [5].

Manual tracing of the pituitary gland was done in all sagittal slices. This could yield a more accurate measurement than that of formulae for volume measurement, due to variations in shape of the gland. Still there is a possibility of manual errors. Three dimensional volumetry software may be used as alternative, but it was observed that technical errors could lead to oversampling or under sampling of the gland. Hence, manual tracing was opted for.

## CONCLUSION

Pituitary volumes are best predictors of pituitary gland size due

to the variations in size and shape of the gland. Normal values of pituitary glands with gender and age variations, among Indian population, were found out in this study, as scarce data was available on the same. Pituitary gland volumes among Indians were found to be comparable to previously established measurements among Americans and were significantly larger than among the Nigerians. The establishment of normal pituitary gland values among Indians not only help to recognise subtle pathologies of the pituitary gland but also pave way for better understanding of behavioural and personality related differences among different ethnic groups. The data obtained in this study can be used as reference range for Indian population for further studies.

## ACKNOWLEDGEMENTS

Acknowledgements to Mr. Rajendra Kumar J, Bangalore, for tabulating data and providing statistical assistance.

## REFERENCES

- [1] Sharafuddin MJ, Luisiri A, Garibaldi LR, Fulk DL, Klein JB, Gillespie KN, et al. MR imaging diagnosis of central precocious puberty: Importance of changes in the shape and size of the pituitary gland. *Am J Roentgenol.* 1994;162:1167-73.
- [2] Tsunoda A, Okuda O, Sato K. MR height of the pituitary gland as a function of age and sex: especially physiological hypertrophy in adolescence and in climacterium. *Am J Neuroradiol.* 1997; 18: 551-54.
- [3] Elster AD, Chen MY, Williams DW, 3<sup>rd</sup>, Key LL. Pituitary gland: MR imaging of physiologic hypertrophy in adolescence. *Radiology.* 1990; 174:681-85.
- [4] Gonzalez JG, Elizondo G, Saldivar D, Nanez H, Todd LE, Villarreal JZ. Pituitary gland growth during normal pregnancy: an in vivo study using magnetic resonance imaging. *Am J Med.* 1988; 85:217-20.
- [5] Lurie SN, Doraiswamy PM, Husain MM, et al. In vivo assessment of Pituitary gland volume with magnetic resonance imaging: the effect of age. *Journal of Clinical Endocrinology and Metabolism.* 1990;71:505-08
- [6] Sahni D, Jit I, Harjeet, Neelam, Bhansali A. Weight and dimensions of the pituitary in Northwestern Indians. *Pituitary.* 2006; 9:19-26.
- [7] Takano K, Utsunomiya H, Ono H, Ohfu M, Okazaki M. Normal development of the pituitary gland: assessment with three-dimensional MR volumetry. *Am J Neuroradiol.* 1999;20:312-15.
- [8] Ibinaiye PO, Olarinoye-Akorede S, Kajogbola O, Bakari AG. Magnetic resonance imaging determination of normal pituitary gland dimensions in Zaria, Northwest Nigerian population. *Journal of Clinical Imaging Science.* 2015;5:29.

### AUTHOR(S):

1. Dr. Joish Upendra Kumar
2. Dr. Kavitha Y

### PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Radiodiagnosis, JJM Medical College, Davangere, Karnataka, India.
2. Assistant Professor, Department of Otorhinolaryngology, JJM Medical College, Davangere, Karnataka, India.

### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Joish Upendra Kumar,  
Department of Radiodiagnosis,  
Bapuji Hospital, OPD Block, JJM Medical College,  
Davangere, Karnataka-577004, India.  
E-mail: joishupendra@gmail.com

### FINANCIAL OR OTHER COMPETING INTERESTS:

None.

Date of Publishing: Jan 01, 2017