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Changes in Pituitary Gland's Size and Shape in Adult Sudanese Population Using MRI: impact of Age and Gender

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ABSTRACT

Magnetic resonance imaging (MRI) is a valuable diagnostic modality in evaluating the pituitary gland, which varies between normal individuals depending upon age, gender, hormonal status, and ethnic factors. The objective is to study pituitary gland's shape and size changes concerning age and gender-related of adult Sudanese population using MRI. This study is a cross-sectional conducted in Sudan at Al Amal national hospital. MRI evaluated 100 individuals of varying age and normal pituitary gland. Mid-sagittal and axial sequences were used to measure the gland's Height, length, and width, whereas the volume was calculated using these parameters. Data were stratified into four groups based on age and gender to detect the variances. Data were statistically analyzed using SPSS version 16. The mean volume of the pituitary gland was 411.44±86.06cc. Furthermore, the mean values of pituitary length, Height, and width were 11.33±1.39 mm, 5.97±0.92 mm, and 12.24±1.63mm, respectively. There is a significant difference in mean sagittal length measurement in different gender; the male had a more sagittal length of the pituitary gland than the female, while the female had more sagittal depth than the male. There was a significant difference in mean sagittal depth measurement in different age groups (p-value = 0.001*), the younger adult in the age group 20-30 years had more depth than other age groups. The sagittal length increased gradually with age, while the sagittal depth is decreased significantly with increasing age. The PG's concave shape is more prevalent in females than in males. The study concluded that the shape and size of the normal pituitary gland varies and is influenced by age. The pituitary gland in females have prominent convex shape and is slightly larger pituitary height than males. The pituitary volume and depth (Height) decreased after the first thirty years of life due to the effects of aging and the gland's physiological change.

1. INTRODUCTION

The pituitary gland (hypophysis cerebri) is an important endocrine gland in the body, and it lies within the hypophyseal fossa of the sphenoid bone. The gland weighs about 500 mg and measures 8 mm in anteroposterior diameter and 12 mm in transverse. It is composed of two distinct lobes: a larger anterior lobe (adenohypophysis) and the smaller posterior lobe (neurohypophysis) [1]. The useful gland role in regulating other glands' activities and secreting essential hormones that control metabolism, growth, and reproduction. Furthermore, the pituitary gland is responsible for connecting the two main homeostatic body systems: the endocrine and nervous systems [2]. Measurements of the normal pituitary gland for various age groups in both females and males and evaluating its shapes are essential factors in diagnosing and predicting pathological changes in the gland.

Recently, the rapid development of MRI technology with fast sequences, multi-planar scan, and higher contrast resolution enable MRI to replace the Computerized Tomography (C.T.) and conventional radiography in the investigation of the Sella and parasailer regions and the evaluation of the pituitary gland morphology and its biochemistry. Therefore, MRI is considered safe for human studies because it does not utilize hazardous ionizing radiation like C.T. or conventional radiography. Instead, it can generate tissue contrast based on differences in hydrogen atomic nuclei's magnetic properties. Furthermore, there is no documented adverse effect from the strong external magnetic field and radiofrequency waves [3]. The coronal image is the best and preferred single view for imaging the pituitary gland, which is essential to identifying small microadenomas, while the sagittal image is the strongest to evaluate the relationship between the midline structures [4].

However, in previous studies, different changes in size, shape, and signal intensity of the pituitary gland have been recorded in other age groups and gender. The pituitary gland tends to have a spherical shape at birth, while the shape of the gland's upper Surface may change to be either concave, flat, or convex, relying on the age, gender, hormonal status, and even due to ethnic factor [5]. Young adults have a convex upper margin with a nearly filled pituitary fossa, while the older individuals would have a relatively empty pituitary fossa [6]. [7] studied the shape and size of normal adult female pituitary gland using an MRI unit (1.5 Tesla) in India. They observed that the most prevalent pituitary gland shape was flat, and the Height of the pituitary gland decreased as age increased, except for age groups of 40-49 years. Significant measurement changes of the pituitary gland have been recorded during the second and third decade of life, attributed to rapid hormonal changes in puberty [8], [9]. Studying the PG.'s normal measurement is very important to predict pathological and physiological changes in the gland.

There is a lack of data on the pituitary gland's dimensions in the normal Sudanese population. Therefore, the present study will fill this knowledge gap by studying the normal pituitary gland's size and shape in adult age groups in females and males using MRI machines and comparing our findings with other previous studies.

2. Materials and methods

This cross-sectional study of the PG. of healthy Sudanese people was conducted in Sudan at Al Amal national hospital. The study period extended from November 2018 to December 2019.

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2.1 Sampling

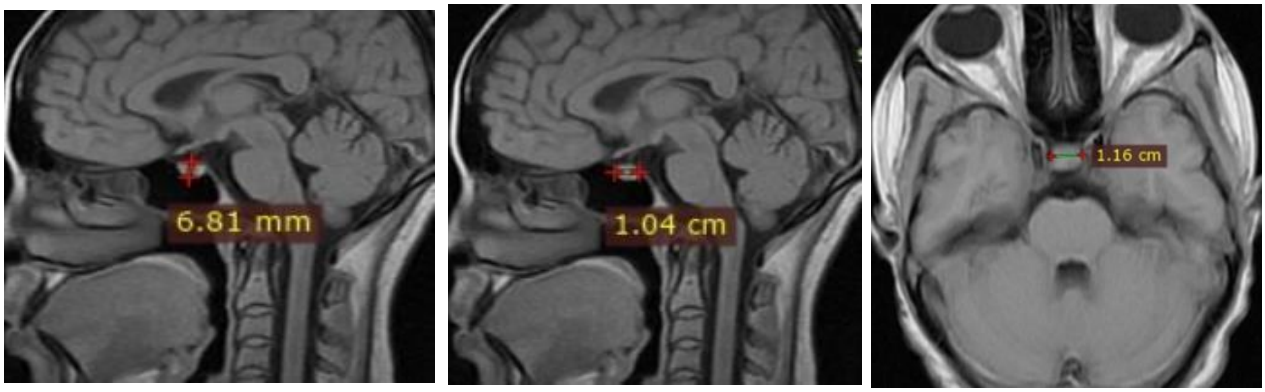
The sample size was 100 subjects (41 males and 59females) who underwent MRI examination forehead at Amal National Hospital's radiology department. The age ranged between 20 to 60 years old and divided into four age groups (20-30, 31-40, 41-50, 51-60). Inclusion criteria include Sudanese people of the aged range (20 – 60) years and provided oral consent. The exclusion criteria included neuropsychiatric or neuroendocrine disease, hormonal imbalance and or hormonal therapy, space-occupying lesions, head injury, or any genetic syndrome. Furthermore, pregnant or breastfeeding women were also excluded from this study at the time of examination. An apparent empty Sella was also excluded from the study. We took the upper limit of 4 mm to describe a partial empty Sella.

2.2 MRI Protocol

All the participants were examined using MRI 1.5 Tesla scanner closed magnet, Philips medical system (intera), body transmit coil type, and head receives coil. Routine MRI brain was performed using T1 axial, sagittal, and coronal spin-echo images, coronal T2 image, and DWI. MRI protocol T1 weighted spin-echo sequences. Matrix was 256x256, FOV was (24x18) cm, and 5 mm slice thickness were taken. In this study, the MRI sagittal and axial T1 protocol were used.

2.3 Measurement techniques

The PG measurements were performed in the workstation as the most significant distance (in mm) between two surfaces (the Height from upper to lower, the length from the anteroposterior, and width from right to left) built-in electronic calipers provided by MRI software. Vertical Height was measured as the pituitary gland's vertical distance, defined by a line connecting two maximum superior-inferior points in the sagittal T1 section, where a cerebral aqueduct was apparent (figure1). The AP dimension (length) was measured as the longitudinal distance, defined by the line connecting between two surfaces of the pituitary gland longitudinally (figure 2) in the T1 sagittal section, using the midline image. The pituitary gland width was measured in the axial plane from right to left, at the axial cuts which thP.G.G. appear in maximum width (figure 3). Indirect volume calculations were performed to estimate pituitary volume by multiplying the Height (H) by length (L) by width (W) by 0.52. The factor of ".52" was obtained from the sphere volume equation coefficient and cubic volume calculation [10]: $(4/3\pi)$ (r3)/ (2r) 3=3.1416/6=0.52). The shape of the pituitary gland's superior surface was also evaluated in the mid-sagittal T1WI. The shape of the superior surface of the gland was found to be convex when the upper Surface curved or bowed outward (round shape), (Flat): when the upper surface of the gland flat with no curved and (Concave): when the upper surface of the gland curved inwards (figure 4).



A B C

Figure 1: A. Measurement of pituitary vertical (Height) in mid-sagittal T1W MR Image. B. Measurement of pituitary AP diameter (length) in mid sagittal T1W MR Image. C. Measurement of pituitary transverse

diameter (width) in axial T1W MR image

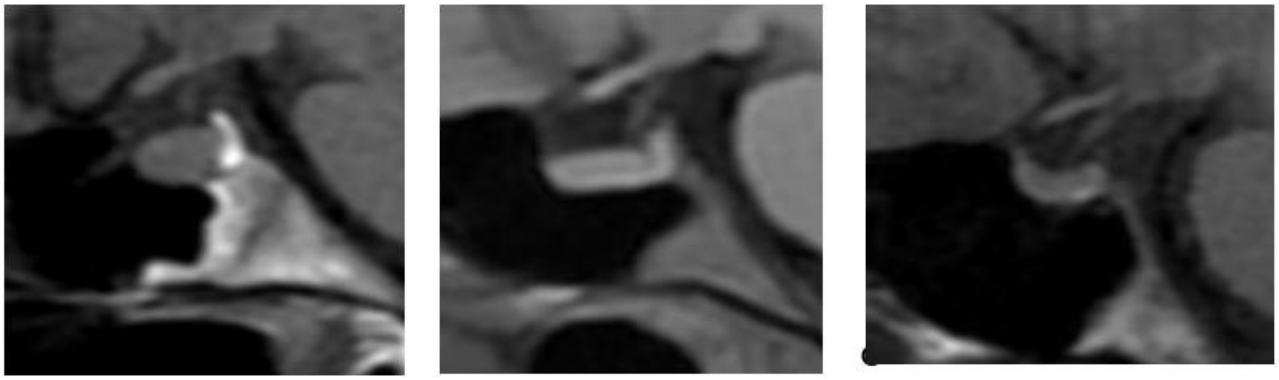


Figure 2: shows different pituitary glands' upper surface shapes: A: (Convex) - when the upper surface curved or bowed outward (round shape). B: (Flat) - when the gland flat's upper surface with no curved inwards or outwards. C: (Concave) - when the gland's upper Surface curved inwards.

2.4 Statistical analysis

All images were assessed using the radiant DICOM image program, and all the collected data were analyzed statistically with the origin program SPSS version 16. Frequency and percentage are taken for continuous variables, then the mean and standard deviation (SD) were taken for all measurements. The independent sample t-test (student t-test) was performed to assess gland measurement's relationship in a different gender. Simultaneously, one way ANOVA test was used for comparing mean measurements of the gland related to age. P-value is considered significantly if it measures less than 0.01 and 0.05, respectively.

3. Results

Out of the 100 participants examined (41 males, 59 females) (table 1), the mean age of the participants was 37±13.18 years (age ranges from 20 up to 60 years). The frequency distribution of age group and gender is presented in (table 1). The mean pituitary volume was 411.44±86.06cc. Furthermore, the mean pituitary length, Height, and width were 11.33±1.39 mm, 5.97±0.92 mm, and 12.24±1.63mm, respectively (Table2). There is a significant difference in mean sagittal length measurement in different gender (p-value = 0.013*); the male had a longer pituitary gland than the female. Otherwise, there was no significant difference in sagittal depth, axial width, and volume in both genders (p-value > 0.05); females had more sagittal depth than males. A significant difference in mean sagittal depth measurement in different age group (p-value = 0.001*), the younger adult in the age group 20-30 years had more depth than another age group, no significant difference in sagittal length, axial width, and volume in different age group (p-value > 0.05). (Table 3)

Figure (3, 4) shows the relationship between gender and pituitary gland shape and measurements. The study clarified that the length and depth were significantly correlated with age (p-value < 0.05 and <0.01, r= 0.207*and -0.355**, respectively), the sagittal length increased gradually with age. In contrast, the sagittal depth is decreased significantly with increasing age. The width and volume had no significant correlation with age (p-value=0.49), as shown in Table 4. The concave shape of the pituitary gland is seen more frequently in females in the age group 20-30 years than in male, while concave more in female 30-40 years age, flat more in female 50-60 years than male, as shown in Table 5.

Table 1: Distribution of gender and age of individuals

Variables	Frequency	Percentage
Gender		

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Male	41	39.2
Female	59	60.8
Total	100	100.0
Age group		
20-30	38	38
31-40	23	23
41-50	17	17
51-60	22	22
Mean age = 37.41±13.18 years (ranged 20-60 yrs.)		

Table 2: Measurement of the pituitary volume, length, Height, and width

Measurements	N	Minimum	Maximum	Mean± SD
Sagittal length(mm)	100	6.13	14.70	11.33±1.39
Sagittal depth(mm)	100	4.02	8.32	5.97±0.92
Axial width (mm)	100	8.66	17.00	12.24±1.63
Volume (mm^3)	100	249.3	617.1	411.44±86.06
Valid N (listwise)	100			

Table 3: Compare means of pituitary volume, length, Height and width in different age group and gender.

Age group\ years	Sagittal length	Sagittal depth	Axial width	Volume
	Mean± Std. Deviation			
20-30	10.97±1.43	6.43±0.74	12.05±1.51	422.78±78.30
31-40	11.41±1.58	5.68±0.90	12.21±1.62	395.07±95.71
41-50	11.40±1.05	5.74±1.11	12.36±1.40	403.08±90.22
51-60	11.84±1.23	5.62±0.79	12.52±2.01	414.18±88.74
P-value	0.131	0.001**	0.745	0.653
Females	11.06±1.46	6.01±.92	12.46±1.60	411.14±84.01
Males	11.74±1.18	5.90±.93	11.91±1.63	411.89±90.14
P-value	0.013*	0.580	0.099	0.976

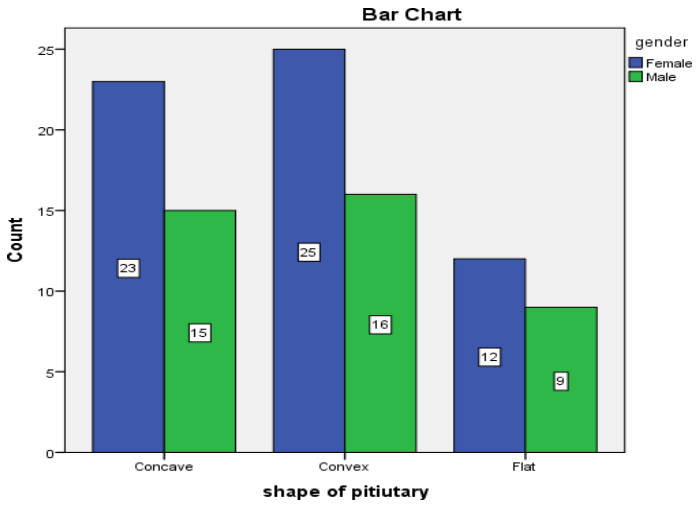

Figure 3: Variation of pituitary gland shapes concerning gender

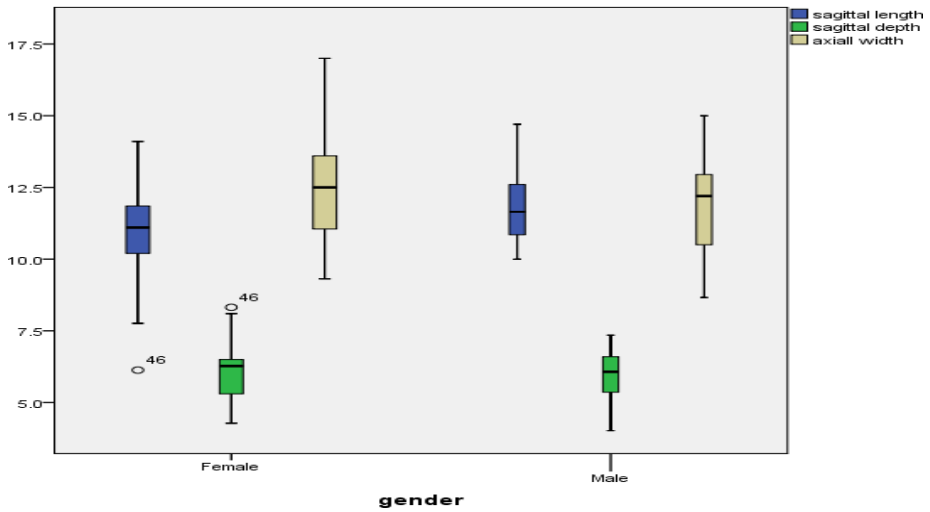

Figure 4: Plot box shows the mean measurement of the pituitary gland in males and females.

Table 4: Correlation of pituitary glands' dimensions and volume with age and gender.

Characteristic		Sagittal Length	Sagittal Depth	Axial Width	Volume
Age	Pearson Correlation	0.207*	-0.355**	0.070	-0.09
	Sig. (2-tailed)	0.039	0.000	0.490	0.326
	N	100	100	100	100

Table 5: Variation of pituitary gland shapes in different age groups and gender

Age groups (years)	**Gender**	**Shape of the pituitary**			**Total**
		Concave	**Convex**	**Flat**	
20-30	Males	4	8	2	14
	Females	6	16	3	25
31-40	Males	2	3	4	9
	Females	9	4	0	13
41-50	Males	3	2	0	5
	Females	6	2	4	12
51-60	Males	6	3	3	12
	Females	2	3	5	10

4. Discussion

The pituitary gland is the master and vital endocrine gland which secretes necessary hormones. Evaluation of pituitary size and its shape for various age ranges in both males and females are helpful to diagnose and understand pathological changes in the pituitary gland. For this reason, the Growth Hormone Society Review Statement of 2000 revealed the need for further research on pituitary measurements [11]. Therefore, several studies have been recently conducted to gain insight into the size, shape, and structure of the normal pituitary gland [12], [13]. But we noticed that there is still a considerable lack of pituitary gland dimensional studies

on the African population. Consequently, in the current study, we reported MRI data on assessing the pituitary gland morphological dimensions and their relationship with age and gender of 100 normal PG Sudanese individuals (40 males and 60 females).

The study results showed that the mean value for pituitary height was 5.90 ± 0.9 mm and 6.01 ± 0.9mm in males and females, respectively. Females were found to have higher pituitary heights than males, which was consistent with [14], which reported 5.82 ± 0.15 mm and 6.03 ± 0.16 mm for males and females, respectively. Reported means of 5.8 ± 0.15 mm and 6.0 ± 0.16 mm for males and females, respectively [15]. Lower Height has been reported by (5.35 ± 1.2 mm and 4.93 ± 1.0 mm in males and females, respectively) [16]. Additionally, greater Height has been noted by (6.3 ± 0.14 mm) [17].

The current study found that the pituitary gland gradually increased to its maximum Height at adolescence and declined in 31-50 years. This change is attributed to fast hormonal changes in youth, particularly in gonadotropin levels LH and FSH. Also, a comparatively higher pituitary height in young patients, both male and female, maybe due to physiological variations in neuro-endocrine hormones among younger and older individuals. Consistent with previous studies [16], [18], our study showed the Height of the gland correlated negatively and significantly with age and peak pituitary height in the third decade of life (20- 30years of age). The lowest values were recorded in the advanced age groups, whereas some previous studies reported peak values in the second decade [19], [20].

Females were noted to have higher pituitary width than males, which similar results have been observed by [20]. The pituitary width did not show any significant correlation with age.

It was found that the length of the pituitary gland correlated positively and significantly with age ($P < 0.05$), and the maximum length was noted in the older age group (11.84 ± 1.23 mm). It was observed that when the age increased, the Height of the pituitary gland decreases, and the length of the pituitary gland consequently increases. However, our findings on pituitary length differed from [13], who reported no age-related effect on gland length. These differences in results may be due to ethnic variations among the studied populations.

The volume of the pituitary gland variation relying on the hormonal condition. Commonly, adult younger individuals have larger glands [22]. In the current study, the mean values for pituitary volume are 411.89± 90.14 mm and 411.14± 84.01mm in males and females, respectively. Males were found to have slightly higher pituitary volumes than females, although not statistically. Other previous studies showed gender differences in pituitary volumes, with females having relatively greater glands [23], [24]. This present study, which was done in age groups 20-60 years, noted that the pituitary gland's volume varies with age. The maximum mean value of pituitary volume was obtained for 20–30 years (424.27± 78.80 mm). The results in this study demonstrated a gradual linear increase in pituitary gland volume over the first thirty years of life, which was consistent with [25]. Additionally, there was decreased trend up to 40 years and then gradually increased the value up to 60 years, with greater depth and axial width in females, which may be attributable to hypertrophy following a significant postmenopausal loss of gonadal steroid feedback system.

Previous studies have highlighted different changes in the shape of the pituitary gland's upper surface at various stages of life, which also indicate the consequent change in hormonal levels [26]. The results of the present study are in agreement with previous studies. The convex upper border was more prevalent in females than in males, specifically in the younger age group (20-30) years old, observed in 24% of individuals. The superior concave surface was seen predominantly in the middle age group (31-40) and (41- 50) years old. The excellent flat surface was seen more in the advanced age group (51-60). The decline in the upper pituitary

surface due to age may explain the process of aging and a physiological pituitary change [27]. A similar finding was reported by who wrote a higher frequency of convex upper border in females than males in the Nepalese population [15]. However, this is contrary to [28], who found that in all the age groups and both males and females, the most common shape was flat. Also, [29], reported that the most frequency grade shape of the upper surface of the pituitary gland was the type of "flat" in male all age groups and female groups except age group (11-20 years), which higher frequency type of "convex." The variances in results in these studies may be attributed to racial differences.

5. Conclusion

The study concluded that the pituitary size decreased gradually after the first thirty years of life due to aging and physiological change of the gland. The Height of the pituitary gland decreased as age increased; no significant difference was found in different gender in the pituitary gland volume. In females, the pituitary gland was found to have a more convex shape and slightly larger Height compared to males. Further evaluation using MRI with higher field strength and thinner slices thickness larger sample size is recommended.

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7. Conflict of interest

Not declared.

8. Funding source

No funding source available.

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