Introduction

1.1 Introduction:

Prostate is a compound tubuloalveolar exocrine gland of the male reproductive system. The function of prostate is to secrete slightly acidic fluid, which has the characteristic of milky or white in appearance (Prokar Dasgupta, 2012)

The secretion usually constitutes 20% to 30% of the volume of the semen along with spermatozoa and seminal vesicle fluid. In medical practice, most of the prostate abnormalities are diagnosed by measuring their volume (Prokar Dasgupta, 2012).

Normally, the prostate volume range has the size of 10 at birth to 30 sized at puberty. After puberty; the prostate volume will continuously grow as the age increase for most of the male's life (Prokar Dasgupta, 2012)

The American Cancer society found that prostate cancer is one of the most common cancers affecting the older men in developed countries. It is getting a serious attention from the world as it has become a significant cause of death for elderly men (Prokar Dasgupta,2012)

The prostate is a heterogeneous, oval-shaped organ that surrounds the proximal urethra. In the adult, the normal gland measures approximately 3.8 cm (cephalocaudal) by 3 cm (anteroposterior) by 4 cm (transverse).1 it normally weighs about 20 g, but it can be slightly larger in men older than 40 years (Sanders RC.2006).

The prostate is composed of glandular and fibro-muscular tissue and is located in the retroperitoneum between the floor of the urinary bladder and the urogenital diaphragm (Sanders RC.2006).

The base of the prostate, its superior margin, abuts the inferior aspect of the urinary bladder, the gland is bounded anteriorly by prostatic fat and fascia, laterally by the obturator internus and levator ani muscles, and posterior by areola tissue and Denonvilliers' fascia, which separates it from the rectum (Sanders RC.2006).

The seminal vesicles are two sac-like lateral structures that outpouch from the vas deferens and are situated on the posterior-superior aspect of the prostate between the bladder and the rectum (Sanders RC.2006).

The seminal vesicles join the vas deferens to form the ejaculatory ducts, which then enter the base of the prostate to join the urethra at the verumontanum. The verumontanum is a midpoint region between the prostatic base and apex and surrounds the urethra. The size and fluid content of the seminal vesicles are variable (Sanders RC.2006).

The prostatic urethra courses through the substance of the gland and is divided into a proximal and a distal segment, the proximal segment extends from the neck of the bladder to the base of the verumontanum, the distal segment begins at this point and extends to the apex of the gland. Blood supply to the prostate is from the internal iliac arteries, which eventually give rise to urethral and capsular arteries.

 Venous return is via the prostatic plexus, which drains into the internal iliac vein, the prostate produces seminal fluid, which is essential to the function of the spermatozoa (Sanders RC.2006).

1.2 Problem:

Lack of references for normal prostate gland volume using transabdominal ultrasonography in young adults Sudanese.

1.3 Objectives:

1.3.1 General objectives:

To estimate prostate gland by using transabdominal ultrasound.

1.3.2 Specific objectives :

To measure the length, width and thickness of prostate.

To correlate prostate volume with age, height and body mass index.

Literature Review

2.1 Anatomy of the Prostate:

The prostate gland is a compact, encapsulated organ that weighs about 20 grams and is shaped like a walnut, measuring approximately 2 cm by 3 cm by 4 cm. It is located immediately inferior to the bladder (Elsevier, 2008).

The prostate gland includes submucosal glands that produce mucin and more than 30 tubuloalveolar glands that open directly through numerous ducts into the prostatic urethra. Together, these glands contribute a component to the seminal fluid (Elsevier, 2008).
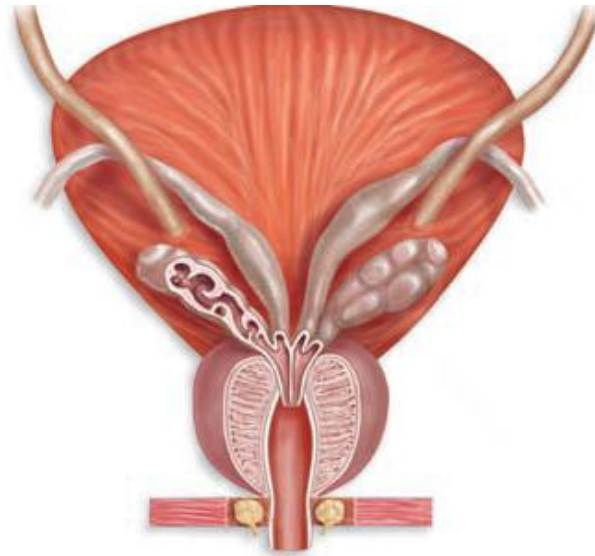

Figure (2-1) anatomy of prostate(Elsevier, 2008).

2.1.1 Zonal anatomy of prostate:

Peripheral zone anterior to the preprostatic urethra, the central zone surround the ejaculatory ducts posterior to the preprostatic urethra and is more or less conical in shape with its apex at the verumontanum.

The transition zone lies around the distal part of the preprostatic urethra just proximal to the apex of the central zone and the ejaculatory ducts. Its ducts enter the prostatic urethra just below the preprostatic sphincter and just above the ducts of the peripheral zone (Mundy AR, et.al, 1999).

The peripheral zone is cup-shaped and encloses the central transition zone and the preprostatic urethra except anteriorly, where the space is filled by the anterior fibro muscular stoma. Simple mucus-secreting glands lie in the tissue around the preprostatic urethra, above the transition zone and surrounded by the preprostatic sphincter. These simple glands are similar to those in the female urethra and unlike the glands of the prostate (Mundy AR, et.al, 1999).
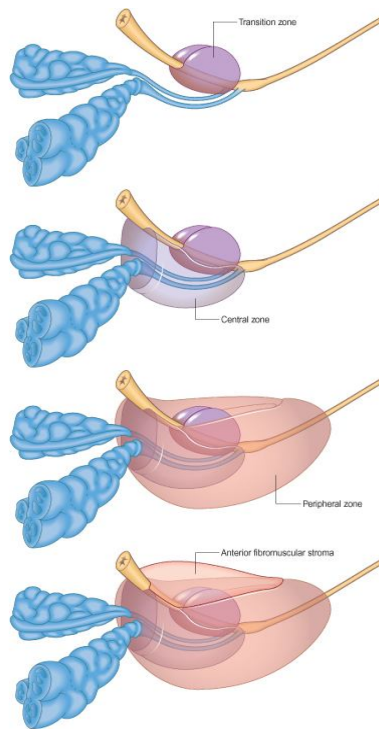
Figure (2-2) zonal anatomy of prostate(Walsh PC,et al, 2002)

2.1.2 Arteries:

The prostate is supplied by branches from the inferior vesical, internal pudendal and middle rectal arteries, they perforate the gland along a posterolateral line from the junction of the prostate with the bladder down to the apex of the gland.

2.1.3 Veins:

The veins run into a plexus around the anterolateral aspects of the prostate, posterior to the arcuate pubic ligament and the lower part of symphysis pubis, anterior to the bladder and prostate.

The chief tributary is the deep dorsal vein of the penis , the plexus also receives anterior vesical and prostatic ramie (which connect with the vesical plexus and internal pudendal vein), and drains into vesical and internal iliac veins.

2.1.4 Lymphatic Drainage:

Collecting vessels from the vas deferens end in the external iliac nodes, while

Those from the seminal vesicle drain to the internal and external iliac nodes.

Prostatic vessels end mainly in internal iliac, sacral and obturator nodes.

A vessel from the posterior surface accompanies the vesical vessels to the external iliac nodes and one from the anterior surface reaches the internal iliac group by joining vessels which drain the membranous urethra.(Mundy AR, et.al,1999)

2.2 Physiology:

2.2.1 Prostatic secretion:

Ejaculation is the process by which semen is expelled from the penis with the help of rhythmic contractions of the smooth muscle in the wall of the urethra.

Sympathetic innervations (from the lumbar splanchnic nerves) is responsible for ejaculation (Elsevier, 2008).

Although in most body systems sympathetic and parasympathetic innervations tend to perform opposite functions, the male reproductive system is an exception. Here, parasympathetic innervations is necessary to achieve an erection, while sympathetic innervations promotes ejaculation.

Relaxation of autonomic activity after sexual excitement reduces blood flow to the erectile bodies and shunts most of the blood to other veins, thereby returning the penis to its flaccid condition(Elsevier, 2008)

2.2.2 Control of urine or semen flow:

Seminal fluid from the accessory glands combines with sperm from the testes to make up semen. When released during intercourse, semen is called the ejaculate, and it normally measures about 3 to 5 milliliters in volume and contains approximately 200 to 500 million spermatozoa. In a sexually active male, the average transit time of human spermatozoa from their release into the lumen of the somniferous tubules, passage through the duct system, and appearance in the ejaculate is about 2 weeks. Since semen is composed primarily of seminal fluid,

 A male who is very active sexually may have a reduced sperm count because there are fewer sperm to be released from the epididymis; however, the total semen volume remains close to normal for that individual (2008 Elsevier).

2.2.3 Prostate-Specific Antigen (PSA):

The PSA is a glycoprotein produced exclusively by the prostate gland; when elevated the possibility of prostate cancer exists.

The higher the elevation, the more likely a cancer exists and that it has spread. About 97% of men with normal prostate glands without hyperplasia have PSA levels under 4 ng/ml.

"PSA can be elevated by virtually any abnormality affecting the prostate, whether benign or malignant including BPH, atrophy, inflammation, infarction and manipulation (Elsevier, 2008)

The prostate gland secretes a slightly milky fluid that is weakly acidic and rich in citric acid, seminalplasmin, and prostate-specific antigen (PSA). The citric acid is a nutrient for sperm health, the seminalplasmin is an antibiotic that combats urinary tract infections in the male, and the PSA acts as an enzyme to help liquify semen following ejaculation (Elsevier, 2008).

(Note that the slightly acidic secretion of the prostate does not cause the seminal fluid to be acidic, and thus the seminal fluid still functions to neutralize the acidity of the vagina.) (Elsevier, 2008)

2.3 Investigations done to prostate:

2.3.1 physical examination:

This examine done by a physician through the rectum and it is more important as a primary procedure to detect any enlargement in the prostate, which may be due to benign prostatic hyperplasia or carcinoma of the prostate (Harsh Mohan, 2002)

2.3.2 Laboratory Investigation:

These are including:

2.3.2.1 Urine general and for culture sensitivity if needed:

This is use in cases of inflamed prostate for isolation the organism "e.i E.coli and other gram negative rods". entrococcus or staphylococcus.(Kumar/ Cotran/ Robbins1997 -Harsh Mohan.2002)

2.3.2.2 Serum prostatic Investigations done to prostate Acid Phosphate: Measurements which are useful in the diagnosis and staging of patients with prostatic carcinoma. However, PSA measurements have largely replaced Acids phosphate levels in management of prostate cancer increasing its levels indicate the progressing of the carcinoma (Harsh Mohan.2002**)**

2.3.2.3 Serum PSA levels:

Serum PSA levels are elevated in patients with both localized and advanced carcinoma monitoring so this examine is useful in diagnosis of disease, also it's a useful in assessing response to therapy or progression of disease (Harsh Mohan.2002**)**

2.3.2.4 Histopathology:

Histopathology examination of tissues starts with surgery, biopsy or autosopy. The tissue is removed, and then placed in a fixative which stabilizes the tissues to prevent decay. The most common fixative is Formalin (10% formaldehyde in water) (Harsh Mohan, 2002)

2.6 TAUS of prostate gland

2.6.1 Technique:

 Assessment of the prostate is an important and integral part of this procedure. Several formulas have been used, but the most common one is the ellipsoid formula, which requires measurement of 3 prostate dimensions. The probe is angled approximately 30 degrees caudal using the bladder as a window. Slight compression to ensure the inferior portion of the prostate is not obscured by the shadow artifact from the base of the bladder, Dimensions are first determined in the axial plane by measuring the transverse and anteroposterior dimension at the estimated point of widest transverse dimension.

The longitudinal dimension is measured in the sagittal plane just off the midline because the bladder neck often obscures the cephalad extent of the gland. The

ellipsoid volume formula is applied, as follows:

Volume = height * width * length * 0.523

The prostate weighs approximately 20g by the age of 20 and has the shape of an inverted cone, with the base at the bladder neck and the apex at the urogenital diaphragm.

The prostatic urethra does not follow a straight line as it runs through the centre of the prostate gland but it is actually bent anteriorly approximately 35 degrees at the verumontanum (where the ejaculatory ducts joins the prostate).

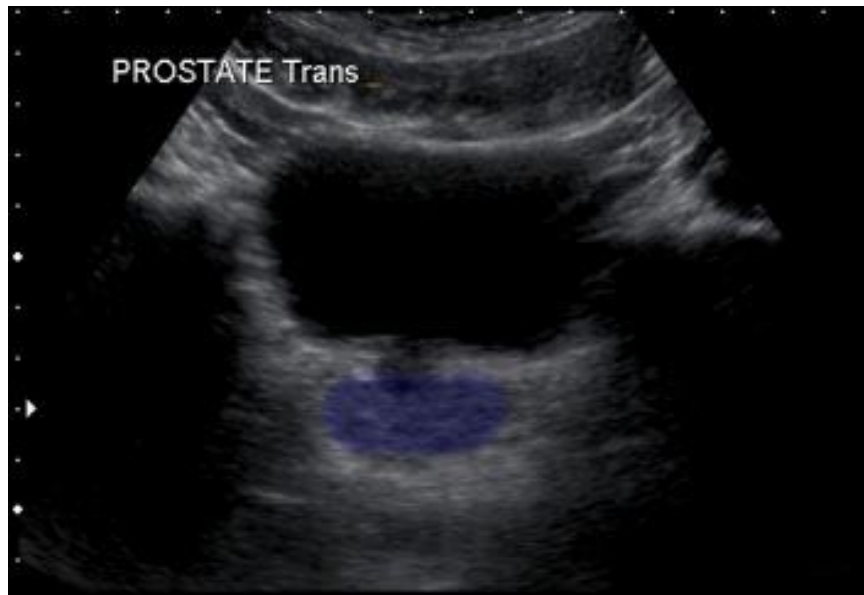**Figure (2-3) TAUS technique for normal prostate (Ultrasound pedia, 2014)**
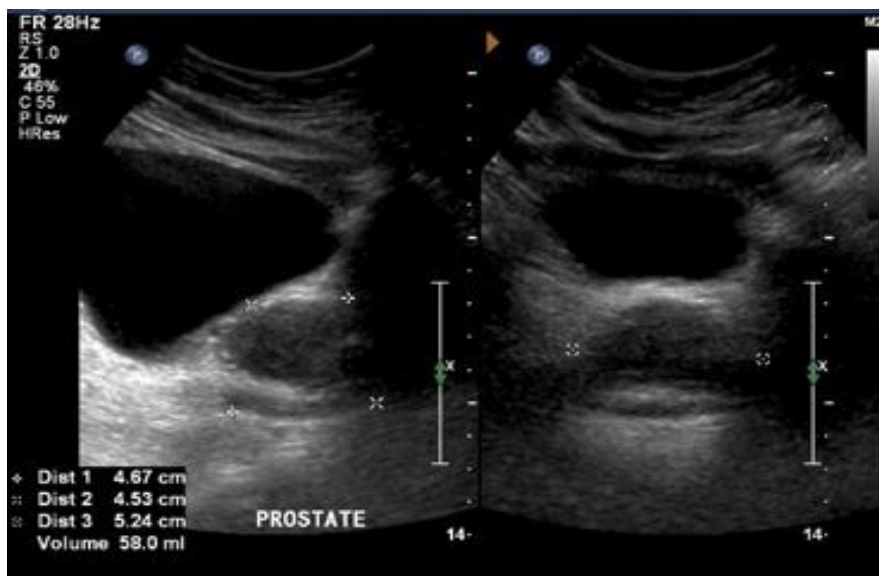
Figure (2-4) TAUS images of normal prostate (Ultrasound pedia, 2014)

2.7 previous studies:

 Study done by (Prokar Dasgupta, 2012) which is only research about TAUS say the results show that ultrasound is an easy and safe way to measure the prostate size. From the results, he conclude that the size of prostate is larger for a man with larger body size.

Also, it is suggested that another research is needed for computation to obtain the standard prostate size comparison which not only focuses on the age but also considers the body size of a man. It may help the researchers who intend to examine the prostate size analysis.

Other study was carried out to determine the range of volumes of the prostate gland in adult Sudanese males in our local environment using supra-pubic ultrasonography, and to provide acceptable range of normal prostate gland volumes. A prospective random selection of fifty asymptomatic adult males were recruited and measurements of the maximum length, height and width of their prostate gland were obtained and the volume was calculated. Subjects were selected, if they had no complaints related to the urinary system or signs of urinary tract disease. The transverse, AP and Longitudinal diameters mean values are (2.68) cm , (3.56) cm, and (3.02) cm respectively. The mean prostate volume obtained from the above parameters was 15.24ml. these results are discussed in details , from the data obtained . Finally, prostate volume measurement was conducted by using the ellipsoid formula which calculates volume by considering the largest anteroposterior height (H), transverse width (W), cephalocaudal length (L) diameters. The findings show that prostate volume increases linearly with body weight and age.

Materials and Methods

3.1 Materials:

3.1.1 Patients and sampling:

This study was carried out in Sudan-Khartoum (Medical Modern Center) during october-2016 to February 2017. and The study discusses estimation of normal prostate volume in adults using ultrasonography.

A total of "60" persons were selected randomly; all those patients have age below forty years, have normal prostate. Any has age above than forty was excluded from this study.

All patients were subjected to be examined by U/S scanning using 'Honda' Aloka and General Electric scanners with 3,5MHz probe and mind ray DC-8 with 7,5MHz probe.

3.2 Methodology:

3.2.1 Transabdominal scanning:

The patient lies supine. The patient should have a half full bladder .500 ml of water 1 hr before the scan if possible is recommended.

The probe is angled approximately 30 degrees caudal using the bladder as a window. Slight compression to ensure the inferior portion of the prostate is not obscured by the shadow artifact from the base of the bladder.

3.2.2 Data collection:

Using a special data collection sheet (questionnaire), a random sample of 60 persons were studied, the data collecting sheet was designed to cover the assessment of prostate   AP diameter, transverse diameter, thickness of prostate , volume, shape and echo-texture of prostate.

3.2.3 Results and Analysis:

There are 60 subjects who participated in this project from the age of 20 to 40years the prostate size measurements.

3.2.4 Ethical considerations:

Person's data were requested by clinicians, the data was collected from those who had been sent to the ultrasound examination or who are selected for evaluation of the prostate. No personal data will be published.

Results

4 Results

Table (4-1) shows age distribution

Age Groups	Frequency	Percent
From 20 to 25 years	18	30%
From 26 to 30 years	22	36.6%
From 31 to 35 years	12	20%
From 36 to 40 years	8	13.4%
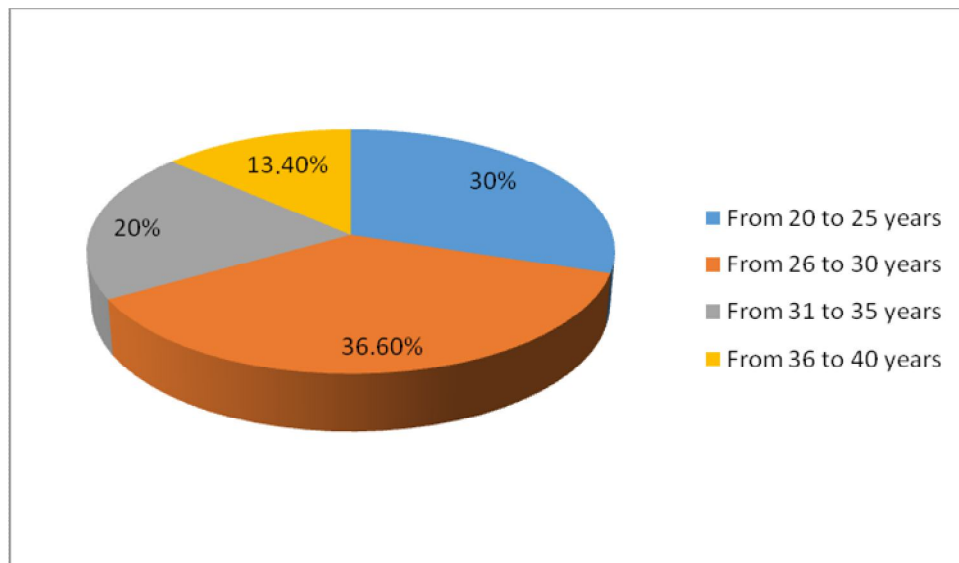
Figure (4-1) shows Age distribution

Table (4-2) shows height distribution

High	frequency	Percent
155 to 160	10	16.6%
161 to 165	15	25%
166 to 170	15	25%
171 to 175	12	20%
176 to 180	8	13.4%
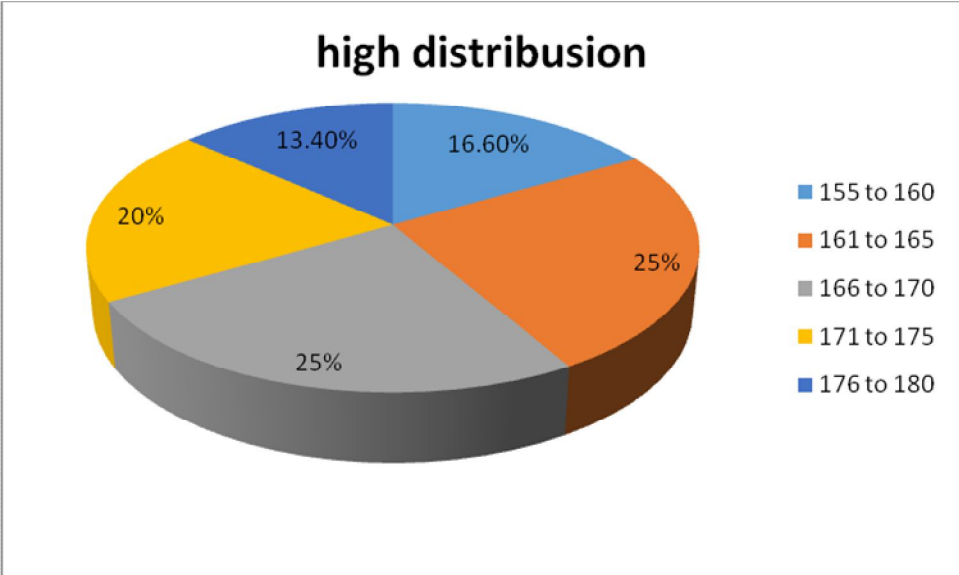
Figure (4-2) shows height distribution

Table (4-3) shows weight distribution

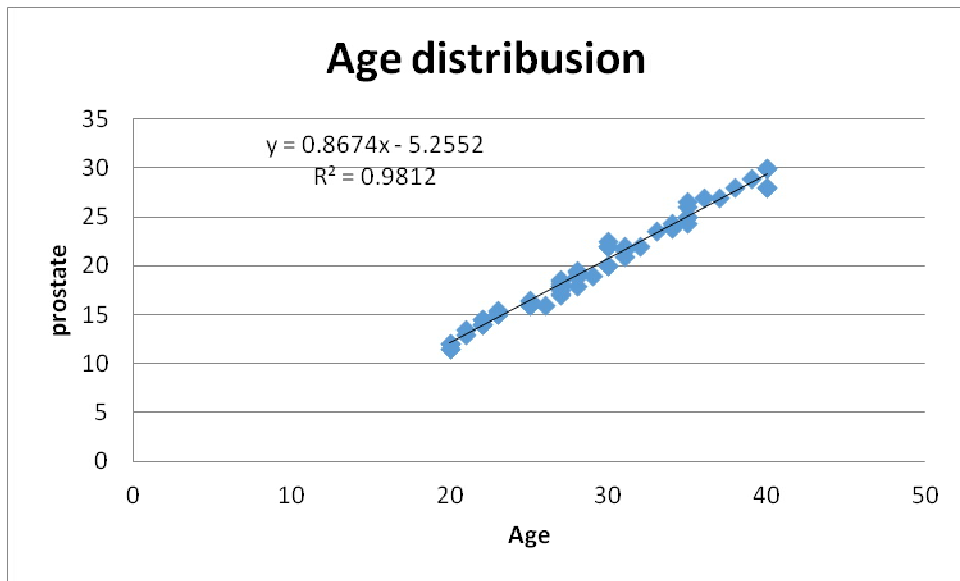| Weight	Frequency	Percent
50 to 60 kg	22	36.6%
61 to 70 kg	23	38.4%
71 to 80 kg	15	25%
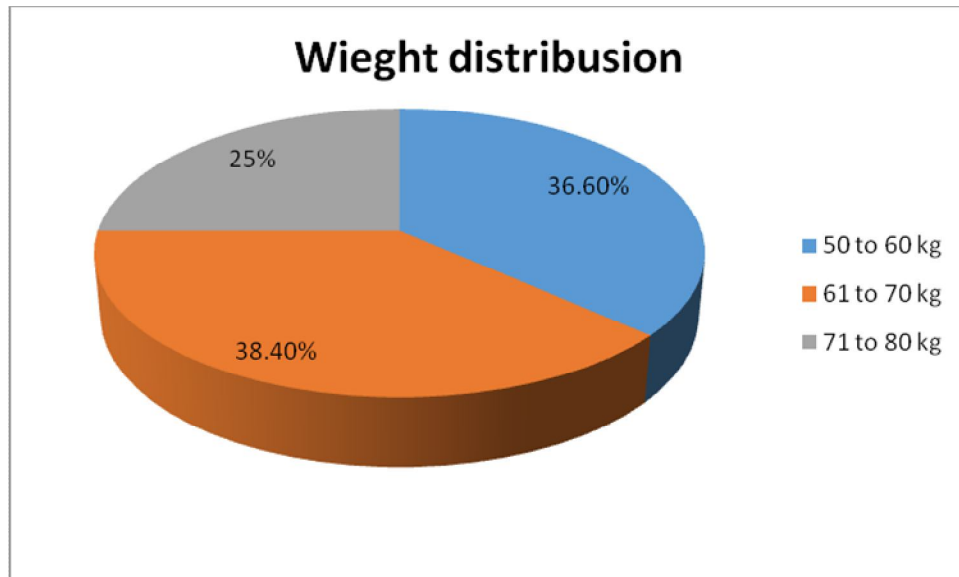
Figure (4-3) shows weight distribution

Figure (4-4) Graph of prostate volume and age.

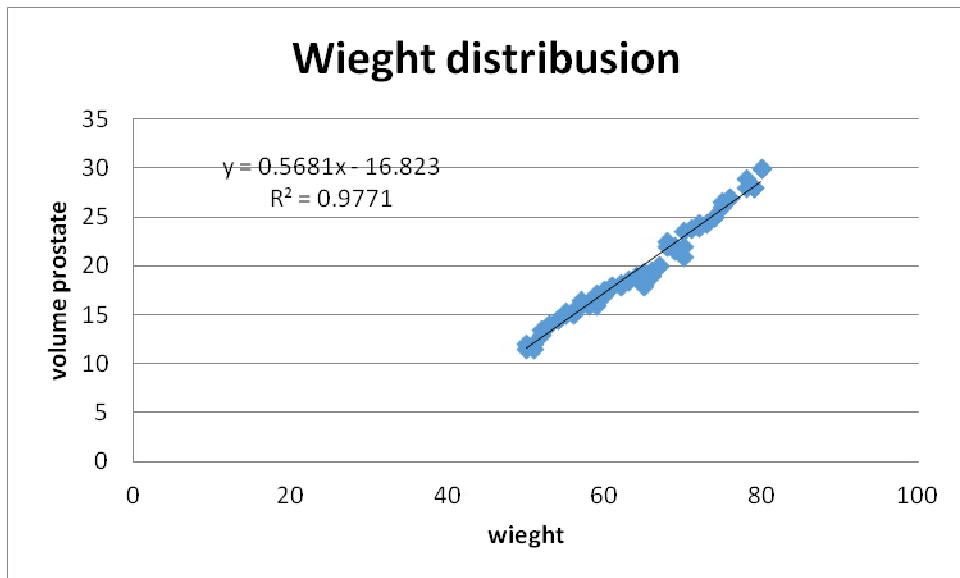Scatter plot shows the relationship between volume and age

Figure (4-5) Graph of prostate volume and body weight.

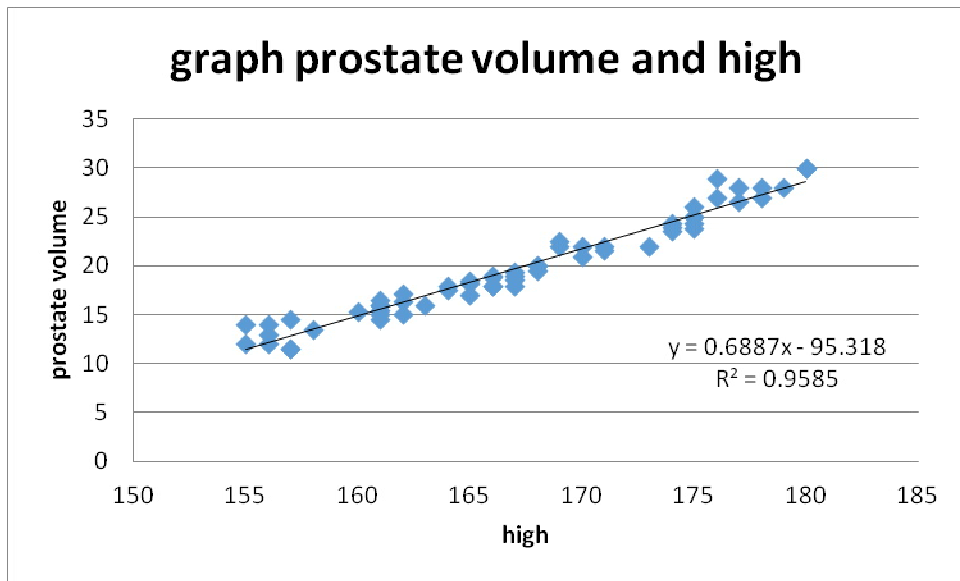Scatter plot shows the relationship between volume and weight.

Figure (4-6) Graph of prostate volume and height.

Scatter plot shows the relationship between volume and height.

Table (4-4) descriptive statistic between age and prostate volume

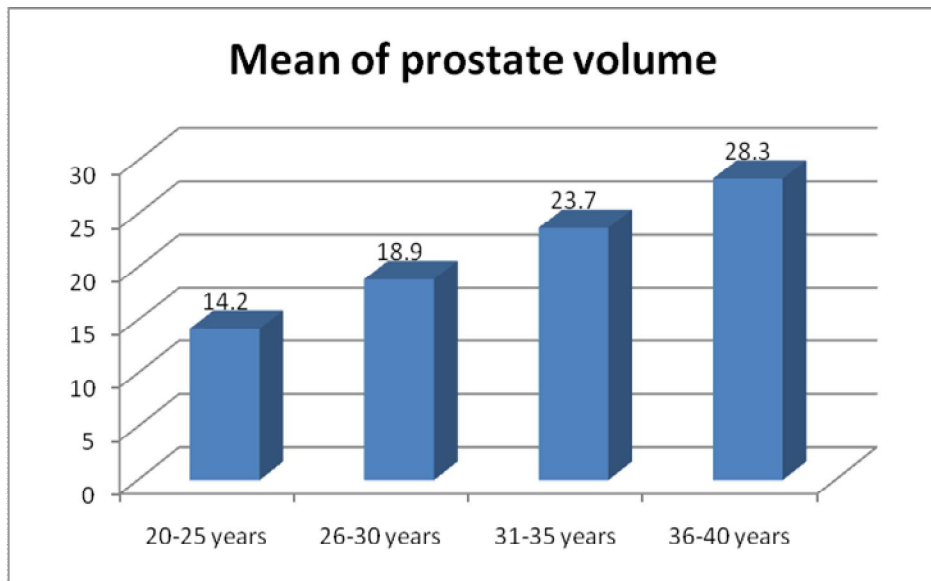| Age groups	Mean of age	Mean of prostate volume
20-25 years	21.2	14.2
26-30 years	28	18.9
31-35 years	33.4	23.7
36-40 years	38.7	28.3

Figure (4-7) shows mean of age with prostate volume

Table (4-5) descriptive statistic between height and prostate volume

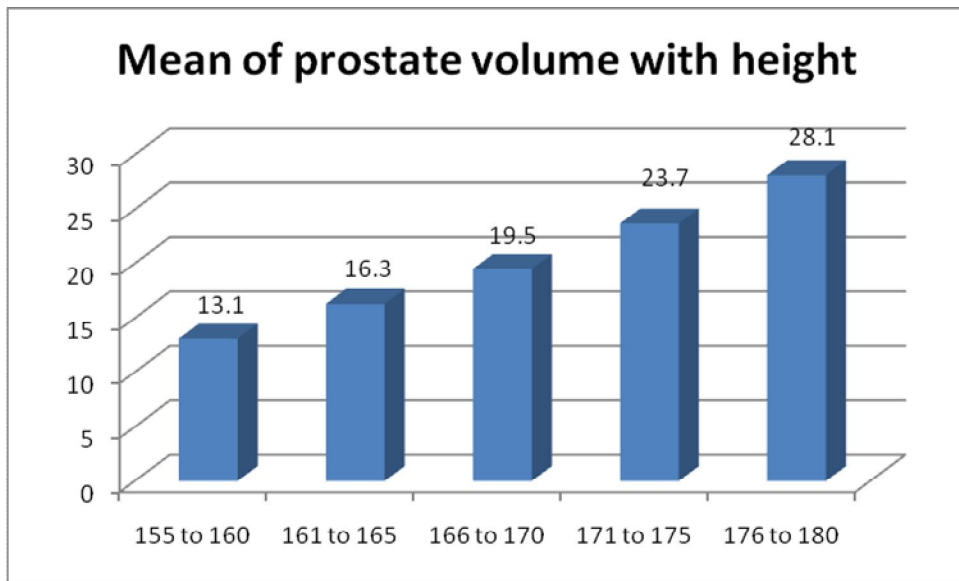| High	Mean of height	Mean of prostate volume
155 to 160	156.7	13.1
161 to 165	162.3	16.3
166 to 170	167.2	19.5
171 to 175	173.8	23.7
176 to 180	177.8	28.1

Figure (4-8) shows mean of height with prostate volume

Table (4-6) descriptive statistic between weight and prostate volume

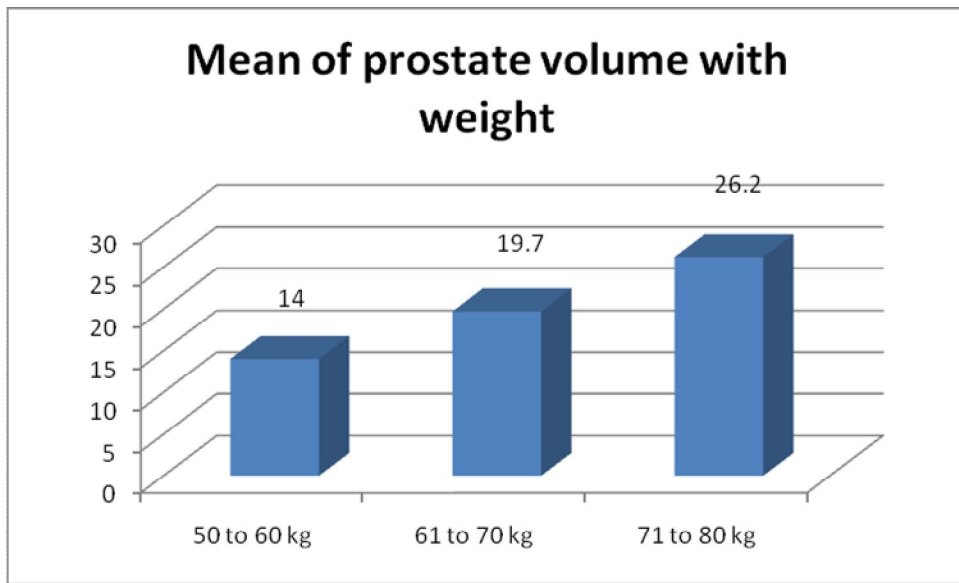| Weight groups	Mean of weight	Mean of prostate volume
50 to 60 kg	55	14
61 to 70 kg	65.5	19.7
71 to 80 kg	75.3	26.2

Figure (4-9) shows mean of height with prostate volume

Table (4-7) shows the mean for age,weight,high and prostate volume

Study	Mean
Age	28.9
Weight	64.6
Height	167.2
Prostate volume	19.8

Discussion, Conclusion and Recommendations

5.1 Discussion:

Regarding the age group (20-40y) study found that mean prostate volume was (22.3ml) $r^2 = 0.98$, $r^2 = 0.97$, $r^2 = 0.95$

The study found that the mean prostate volume (22.3ml), the mean of length, width and thickness were (2.6) (3.5) (3.2) cm respectively.

Normally, the prostate volume would show an increment if the age of person was increased as in figure (4-4) which showed relationship between age and prostate volume.

In table (4-5) and figure (4-5) which showed the relationship between prostate volume and weight of body, the prostate volume increased with increasing of body weight, this means that body weight usually affect prostate volume, this agree with Prokar Dasgupta, 2012 Abdallah, 2015.

Also there was strong positive correlation between prostate volume and height shown in table (4-6) and figure (4-6), this agree with Prokar Dasgupta 2012, but height of the subjects was not the only factor that affected prostate volume.

Regarding the age group (20-40y) the mean prostate volume was (22.3ml) $r^2 = 0.98$, $r^2 = 0.97$, $r^2 = 0.95$.

For the same height increment, the prostate volume was controlled by the weight of the subjects, so, this study found that the body weight and size also affected the prostate volume, a man with heavier body weight compared to a lighter one will have a larger prostate volume.

Body fat of a person will reflect the relationship of human growth and development, with the environment under the influence of a person's genotype.

The reason of difference was due to the different weight of the subjects. Therefore, the hypothesis is made due to this figures, the weight of the subject is the main

factor that affect the prostate volume.

So the research was significant with previous studies (Prokar Dasgupta, 2012 and Abdallah, 2015)

5.2 Conclusion:

Study found that U/S scanning was a good diagnostic tool for estimation of normal prostate volume. Also study concluded that the mean prostate volume (22.3ml), the mean of length, width and thickness were (2.6) (3.5) (3.2) cm respectively.

Prostate volume usually increased with increasing of person age, weight and height.

5.3 Recommendation:

The author recommends that the Government should introduce the trans rectal ultrasound machines and increased the training institutes of ultrasound for increasing the sonologists skills and experience and should increase the specialist hospitals for urology diseases because they increased in Sudanese now a days.

According to the high cost of scientific research which the researcher was faced, the government should appeal universities in Sudan and companies to support the researchers in order to improve plans of treating and management of such diseases.

Further studies should be carried out in this field on many aspects such as increasing the number of patients, to compare between the role of U/S scanning and other diagnostic tools, using a trans rectal ultra sonographic approach and color Doppler ultrasonography.

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