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ULTRASONOGRAPHIC INVESTIGATION OF KIDNEY SIZE, AND ASSOCIATED FACTORS AMONG DIABETIC PATIENTS AT JIMMA UNIVERSITY MEDICAL CENTER, SOUTHWEST ETHIOPIA

BY: DILIAB DESTA

A THESIS RESEARCH SUBMITTED TO ANATOMY CORSE UNIT, DEPARTMENT OF BIOMEDICAL SCIENCES, INSTITUTE OF HEALTH, JIMMA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN CLINICAL ANATOMY.

ADVISORS:

1. **TILAHUN ALEMAYEHU (MSC, ASSISTANT PROFESSOR IN ANATOMY)**
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ABSTRACT

BACKGROUND: *Ultrasonographic assessments of the kidney size is useful in diagnosis of chronic renal pathologies among patients with non-communicable diseases including diabetes mellitus (DM), which is one of the major public health problems in Ethiopia. Renal Doppler ultrasound is standard imaging modality in the investigation of kidneys.*

OBJECTIVES: *The study is aimed to investigate the effect of diabetes on the kidneys using ultrasonography, specifically on the anatomical size and vascularity of kidneys by Doppler ultrasound in diabetic patients.*

METHODS: *Hospital based cross sectional study was conducted from June 26 to August 26, 2018 at Jimma University medical center, chronic follow up clinic Jimma Ethiopia. Renal size was assessed by ultrasound among diabetic adult patients who fulfill inclusion criteria. The data were collected by using structured questionnaires and entered to Epi-Data version 3.1 and were analyzed using SPSS version 20.0. Descriptive statistics and linear regression analysis were used for analysis and statistically significance was declared at p< 0.05.*

RESULTS: *The mean lengths in all age groups of right and left kidney were 10.263±0.764cm and 10.421±0.714 respectively. The mean volume of right and left kidney in all age groups were 98.115±23.118 cm and 101.423±24.457 cm respectively. In bivariate analysis right kidney length has negative & positive correlation with Age (r=-0.163, p-value=0.031), body height(r=0.137,P-value=0.070), body weight (r=0.309, p-value=0.001), BMI(r=0.234 , p-value=0.002), duration of diabetes (r=-0.111, p-value=0.142), Type of DM (r=-0.095, p-value=0.211), DBP (r=0.115, p-value=0.128.In bivariate analysis of left kidney has negative & positive correlation between left kidney length, Age(r=-0.121,p-value=0.111) sex(r=-0.099, p -value=0.192), height(r= 0.198 ,p- value= 0.009), weight (r= 0.271, p- value= 0.001), BMI(r= 0.156, p- value= 0.036), Duration of DM (r=-0.121, p- value= 0.112), Type of DM (r=-0.124, p- value= 0.103), DBP(r=0.147, p- value= 0.05). Multivariable linear regression analysis, Age (p-value=0.001, p-value=0.013), body height (p-value=0.001, p-value= 0.000), BMI (p-value=0.000, p- value=0.001) showed significant correlations with right and left kidney length respectively. Regarding volume of the kidney only body height (p-value=0.003, p-value=0.017) and BMI (p-value=0.001, p-value=0.000) showed significant correlation with right and left kidney respectively.*

CONCLUSION AND RECOMMENDATION: *This study has provided measurements of renal length, width, thickness & predictors of kidney size among diabetic patients at chronic follow up clinic in Jimma University medical center. Renal length has a direct relationship with Age, Body height and BMI. To researcher further study has to be conducted with larger sample size. For clinical practitioners they can use this data as an input for clinical decisions particularly during diabetic patient management & kidney related problems in general.*

KEYWORDS*: Doppler ultrasound, kidney size, Diabetes Mellitus, JUMC*

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Table of Contents

Contents page

List of tables

List of figures

ACRONYMS AND ABBREVIATIONS

BSA	body surface area
cm	centimeter
CT	Computed Tomography
DBP	diastolic blood pressure
DM	Diabetes mellitus
FBS	Fasting blood sugar
g	gram
IRB	Institutional Review Board
JUMC	Jimma university medical center
kg	kilogram
LT	left
LTKL	left kidney length
LTKPT	left kidney parenchymal thickness
LTKS	left kidney size
LTKV	left kidney volume
LTKW	left kidney width
m	meter
mm	millimeter
MRI	Magnetic Resonance Imaging
RI	resistivity index
RT	right
RTKL	right kidney length
RTKPT	right kidney thickness
RTKS	right kidney size
RTKV	right kidney volume
RTKW	right kidney width
SBP	systolic blood pressure
SD	Standard deviation
UK	United Kingdom
WHO	World Health Organization
yr	year

CHAPTER ONE

INTRODUCTION

1.1. Background

Kidneys are paired bean shaped, freshly reddish-brown abdominal urinary organs situated high up in the abdominal cavity posteriorly at the overall vertebral levels extending between the upper border T12 and L4. They lie posteriorly behind the peritoneum, on each side of the vertebral column, and are surrounded by adipose tissue. The long axis and the transverse axis of each kidney is directed inferolaterally and posteromedially respectively, which means that the anterior and posterior aspects usually described are, in fact, anterolateral and posteromedial. An appreciation of this orientation is important in renal imaging and surgery. The right kidney usually lies, on average, 2 cm lower than the left, although, in 10% of cases, the left kidney sits lower than the right (1). The vertebral limits of the left kidney are T12–L3 or L4, while those for the right kidney are L1–L4. The upper poles of both kidneys lie anterior to 12^{th} ribs, and they lie anterior to the rib 11 in 30% (left) and 10% (right) of subjects. In supine adults at end-tidal inspiration, the center of the renal hilum usually lies at L1 or L2 on the left and at a slightly lower vertebral level on the right. It is important to note that both kidneys move vertically by a mean of about 2 cm during deep respiration and both can descend by several centimeters when moving from lying to standing (1) The central renal sinus of the kidneys is occupied by the renal calices and renal pelvis, segmental arteries and renal veins which are embedded in perinephric fat (2). A normal human kidney is 12 cm in length, 6 cm in width and 3 cm in thickness (1). In addition atlas of human anatomy book revield in adults, each kidney is measures 11 cm in length, 6 cm in breadth and 3 cm in anteroposterior dimension. The left kidney may be 1.5 cm longer than the right; for the right kidney to be more than 1 cm longer than the left is rare. The average weight is 150 g and 135 g in men and women respectively. Unusually in thin individuals with a lax abdominal wall, the lower pole of the lower right kidney may just be felt in full inspiration by bimanual lumbar examination (3). A principal anatomy and physiology text book reviled that a normal adult kidney measures 10-12 cm long, 5-7 cm wide and 3 cm thick (4). The external surface of the kidney surface is covered by a connective tissue capsule. The capsule consists of two distinct layers which are an outer layer of fibroblasts and collagen

fibers, and an inner layer with a cellular component of myofibroblasts. The capsule forms the connective tissue covering of the sinus and becomes continuous with the connective tissue forming the walls of the calyces and renal pelvis by passing inward at the hilum (5). In a fresh hemisected kidney cortex and medulla of the kidney can be seen with the necked eyes of individual in two distinct regions. The cortex is the outer reddish brown part of the kidney and it consists of renal corpuscles along with the convoluted tubules and straight tubules of the nephron, the collecting tubules, collecting ducts, and an extensive vascular supply. Medulla is much lighter-colored inner part of the kidney. It is characterized by straight tubules, collecting ducts, and, the vasa recta which is a special capillary network. The straight tubules of the nephrons and the collecting ducts continue from the cortex into the medulla (5). The parenchyma of the kidney is epithelial tissue that constitutes renal tubules and corpuscles. The stroma comprises the blood vessels, nerves, and supporting connective tissue of the kidney. Each kidney is supplied by renal artery which is branches from the abdominal aorta. The renal artery branches within the renal sinus to be segmental artery and sends interlobar arteries into the substance of the kidney and form arcuate arteries at the bases of the medullary pyramids. Interlobular arteries branch from the arcuate arteries and ascend through the cortex toward the capsule. As they traverse the cortex toward the capsule, the interlobular arteries give off branches, the afferent arterioles, one to each glomerulus. A single afferent arteriole may spring directly from the interlobular artery, or a common stem from the interlobular artery may branch to form several afferent arterioles. Some interlobular arteries terminate near the periphery of the cortex, whereas others enter the kidney capsule to provide its arterial supply (5). The nephron is the fundamental structural and functional unit of the kidney. There are approximately 2 million nephrons in each kidney (6).

Kidneys develop in three successions (Pronephroi, Mesonephroi, Metanephroi) beginning early in the fourth week of intrauterine life. The permanent kidneys develop in the sacral region. Each kidney develops from two distinct sources; metanephros and ureteric bud. The metanephros forms secretary system and the ureteric bud forms collecting system of the kidney (7). Renal agenesis results when the metanephric diverticula fail to develop or the primordia of the ureters degenerate. Inability of metanephric diverticula to penetrate the metanephrogenic blastema results in failure of kidney development because no nephrons are induced by the collecting tubules to develop from the metanephrogenic blastema (8). In the fetus and the newborn, the

kidney normally has 12 lobules; in the adult, these lobules are fused to present a smooth surface, although traces of lobulation may remain and can mimic a renal mass on radiographic imaging(9)

Some literature shows that renal size varies with age, gender, body mass index, pregnancy and co-morbid conditions (10). Estimation of renal size by sonography can be performed by measuring renal length, renal volume, cortical volume or thickness (11). Ultrasound measurement of renal size is essential when evaluating patients with possible renal disease. However, it requires prior knowledge of actual normal renal size in the population being studied by investigator. Renal ultra- sound is simple, inexpensive and can be done at the bed- side to provide the clinician with important anatomical details of the kidneys with a low inter-observer variability (12).Kidney size is also affected in variety of clinical disorders such as diabetes, renal artery stenosis, chronic hypertension, and chronic renal failure (13).

A renal ultrasound is typically obtained to measure the renal size, echogenicity and any abnormality in the kidneys. Renal enlargement may be seen early in diabetes due to hyper filtration, while in late stages the kidneys diminish in size from glomerulosclerosis (14).The kidney size of a diabetic patient is an important diagnostic parameter in urological and nephrologic practice. The impact of diabetes in renal system can also appear as a change in echogenicity of the cortical and thickness in case of diabetic nephropathy compared to normal ones. The ultrasound scanning has been the best choice for abdominal diagnosis and assessment of diseases. It reveals that the diabetes has direct impact on kidney morphology in view of early stage renal volume enlargement and cortical thickening, then atrophied and echogenic in late stage (15).Recent studies have shown that there is a close relationship between Doppler parameters (especially the resistive index) and tubule-interstitial and vascular damage (16). There is no studies conducted in this study area as far as investigators knowledge. As a result, the aim of this study is to assess the effect of diabetes on the kidney size using ultrasonography.

1.2. Statement of the problem

Diabetes mellitus (DM) is a syndrome of impaired carbohydrates, fat and protein metabolism caused by either lack of insulin secretion or decreased sensitivity of the tissue to insulin (17). DM is classified on the basis of the pathogenic process that leads to hyperglycemia, unlike to earlier criteria such as age of onset or type of therapy. There are two broad categories of DM, namely type 1 and type 2. Type 1 DM occurs as a result of complete or near-total insulin deficiency. Type 2 DM is characterized by variable degrees of insulin resistance, and increased glucose production (18). Unless adequately controlled, diabetes mellitus results in characteristic structural and functional abnormalities of several organ-systems of the body including the kidneys. The structural and functional abnormalities of kidneys due to diabetic causes are said to be diabetic nephropathy. The structural abnormalities include hypotrophy (diminish in size), hypertrophy (abnormal increase in size), thickening of glomerular and tubular basement membranes, accumulation of glomerular extracellular matrix in the glomerulus (glomerulosclerosis), tubular atrophy, and interstitial fibrosis(19).The kidney size of diabetic patients is therefore a valuable diagnostic parameter in urological and nephrologic practicefor evaluating the health status of kidneys(20)

The worldwide prevalence of DM has risen dramatically over the past two decades; from an estimated 30 million cases in 1985 to 422 million adults aged over 18 years in 2014. Based on current trends, 592 million individuals will have diabetes by the year 2035. The prevalence of type 2 DM is rising much more rapidly, because of increasing obesity, reduced activity levels as countries become more industrialized, and the aging of the population (21). The countries with the greatest number of individuals with diabetes in 2017 are China (114.4 million), India (72.9 million), United States (30.2 million), Brazil (12 million), Russian (8.5 million), Egypt (8.2 million), Germany (7.5 million), and Pakistan (7.5 million) (22). According to international diabetic federation, in 2017 more than 15.9 million people have diabetes in Africa. Top five countries in Africa who have high number of people with diabetes (18-99 years), in 2017 are Ethiopia(2,652,129), South Africa(1,865,021), Democratic Republic of the Congo(1,738,329), Nigeria(1,731,811), and United Republic of Tanzania(942,721).More than 321,000 deaths in Africa happened due to diabetes mellitus in 2017 (23). A systematic review of peer-reviewed literature done in Ethiopia from 2000-2016 showed that the diabetes prevalence across different

localities of Ethiopia, was 0.3% and 7.0% for the lowest and the highest prevalence respectively. And prevalence of diabetic nephropathy in different corner of the country shown as in Jimma in 2010- 9% for type 1 and 20% for type 2 DM, in Addis Ababa 2005 21%, Dessie 2015 -1%, Black Lion Hospital (Addis) 2015 -21% for type 1 and 15% for type 2 DM, Menelik II Hospital 2000- 23%, Mekelle 2008- 2% (24). Diabetes mellitus is one of the major health problems in Ethiopia, and the current study area, Jimma zone is not exceptional. DM is a destructive disease, causing not only ill-health but also affect the economy, the psychology and quality of life of the patient. Hence, any tool that can be used in the diagnosis, treatment, and management of DM is very helpful. Doppler ultrasound is one of the modality that can be used in such diseases. Ultrasound has been routinely used for several years in the diagnosis of different renal diseases owing to its great advantages i.e. being non-invasive, reliable, widely available, and affordable. Although the kidney is always affected in the course of DM (14).Literatures shows that renal size and volume varied with age, gender, body mass index and some diseases (10). Diabetes, hypertension, glomerulonephritis, interstitial nephritis and lupus nephritis are the most important co-morbid conditions affecting renal size (13). The ultrasound scanning has been the best choice for abdominal diagnosis and diseases assessment. It reveals that the diabetes has direct impact on kidney morphology in view of renal volume enlargement and cortical thickening in early stage, then atrophied and echogenic in late stage (15). Diabetic nephropathy has become the leading cause of chronic renal failure in developing countries (25). It is estimated that death due to renal disease is 17 times more common in diabetic than in non-diabetic patients (26). Small kidneys were associated with grade 2 or 3 nephropathy denoting underlying chronic renal failure (14). Ultrasound is one of the accessible, inexpensive diagnostic modality that can be used in such diseases, as differential diagnosis of kidney pathology due to diabetes and non-diabetes causes is possible. This is due to the impact of diabetes in renal system appear as a change in renal dimensions, overall renal size, cortical echogenesity and thickness in case of diabetic nephropathy relative to normal ones(15). Recent reports from Jimma showes prevalence of Major Micro vascular Complications among diabetic population on aregular follow-up at JUMC chronic follow up clinic showed that mor than 40% of study participants develop at least one major microvascular complication (27). However, scientific data on the impact of diabetes on the kidney structure in Ethiopia is scarce. As a result, the aim of this study is to assess the effect of diabetes on the kidney size using ultrasonography.

1.3. Significance of the study

Renal ultrasound is simple, inexpensive and can be done at the bedside to provide the clinician with important anatomical details of the kidneys with a low inter-observer variability. It is also an essential procedure when performing renal biopsy in adults or children, with both renal length and cortical thickness being important parameters that should be within normal limits before the procedure.

Renal size is an indicator for the state of kidney. Hence, it is valuable in monitoring unilateral kidney disease through comparison with the other, the healthy kidney.This information benefits both the health workers and the patients as it facilitates efficient and effective management of the problem of the clients.

In recent years, death from end-stage diabetic complications such as end stage renal failure is a global health tragedy, and the scenario is not different for Ethiopia. Although the country is facing a significant burden of diabetes, data on the magnitude and impact of diabetic complications is still inadequate. Furthermore, reports on kidney size in patients with diabetes mellitus are few and fragmentary. Very few data are also available concerning kidney size later in the course of diabetes and the relationship between kidney size and the duration of diabetes. Hence, the current study was designed to investigate the impact of diabetes mellitus on morphological and vascular parameters of kidneys by undergoing ultrasonographic investigation of diabetic patients on chronic follow-up at Jimma University Medical Center.

CHAPTER TWO

LITERATURE REVIEW

2.1. Gross Anatomy and Histology of the of Kidneys

Kidneys are paired, bean-shaped, reddish-brown organs located high up on the posterior wall of the abdominal cavity. Together with the two ureters, the single bladder, and the urethra, the kidneys make up the body's urinary system. The kidneys lay retroperitonealiy in the paraverteberal grooves approximately at the level of the twelfth thoracic to the third lumbar vertebrae (2). In situ, each kidney is encased in a thin transparent, fibrous membrane called a renal capsule reinforced by perirenal fat and renal fascia from outside. In an adult human, each kidney is about 12 cm long, 6 cm wide and 3 cm thick, and weights 150 g in male and 135 g in female on average. Scientific data on the influence of chronic diseases on the kidney size is scarce (1).

Each kidney has a concave medial border, hilum, where nerves and renal arteries enter and lymphatics, renal veins and ureter exit; a convex lateral border a superior pole, on which an adrenal gland sits and anterior and posterior smooth surfaces. Arterial blood supply of the kidney is carried by renal arteries, which arise directly from the abdominal aorta. Renal veins drain each kidney to the inferior vena cava. Coronal section of the entire organ shows three distinct regions. The outermost layer is the cortex, which is more compact granular tissue of characteristic echogenicity. Beneath the cortex lies the medulla, arranged into 8 to 15 cone-shaped masses known as renal pyramids. The tip of each pyramid points toward the center of the kidney. The cortex extends into the renal columns. At the center of the kidney is the third region, the pelvi-calyceal cavity, clinically known as renal pyelicsinus, formed by the funnel-shaped upper end of the ureter and associated calyxes (1). Anatomical location and vasculature of kidneys and a coronal section of the left kidney is illustrated in Figure 1 below.

Histologically, kidney consists of epithelial tissue parenchyma which forms the main bulk of the organ, and a connective tissue stroma (interstitium) which makes up only less 10% of the kidney mass. Renal interstitium is a scanty loose supportive tissue housing primarily of fibroblasts and macrophages.

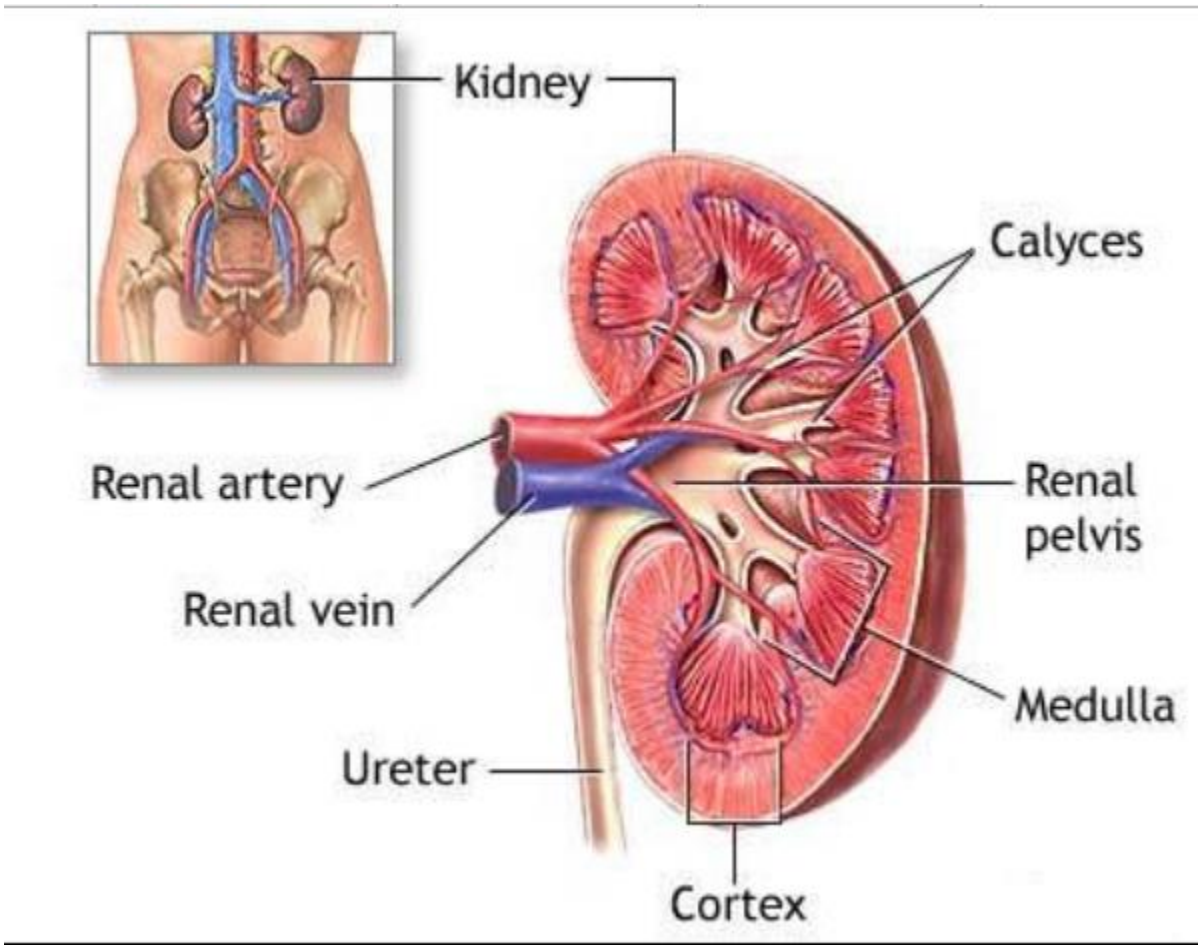

Figure 1:- Illustration of Gross Anatomy of kidneys

Renal parenchyma constitutes millions of microscopic tubes, uriniferous tubules, which modify fluid passing through the organ by a complex process involving filtration, absorption, and tubular secretion to form urine as the final output. The entire renal tubule is epithelial in nature and is, therefore, separated from the underlying connective tissue stroma by a thick intervening glomerular basement membrane (GBM) and tubular basement membrane (5) .

2.2. Factors Associated with Kidney Size

In general population, renal size varies considerably with age, gender, body mass index, pregnancy, and concomitant conditions such as chronic diseases. A recent study shows ultrasonographic measurement of renal size among normal adults in Abuja, Nigeria, the report included a mean renal dimensions of 10.1±0.8cm long, 4.1±0.6 cm width, 6.4±0.9 cm thick and

parenchymal thickness 15.2±3.6 mm for the right kidney. The corresponding readings for the left kidney length, width, and thickness were 10.7± 6.0 cm, 4.7±0.8cm, 6.5±0.8 cm, 16.8±4.1 mm respectively. Mean renal volume reported for the right was 139±34.2 cm^3 and 173.7±13.5cm^3 for the left kidney(28). The studys also revealed that significant progressive increase in renal sizes with increasing age from 18 years to 39 years, and then decline at 60 years of age. Their report also showed a positive correlation between renal size with BMI. There was no geneder difference with regard to ultrasonographic measurements of kidney size (28).

One report on 125 normal adults in Saudi Arabia, the mean kidney length, width, and thickness of right kidney reported was 9.8±0.9, 4.9 ± 0.7 and 4 ±0.7 cm, respectively. The mean kidney length, width, and thickness of left side were 10.7±0.3, 3.5± 0.7 and 4.3±0.7 cm, respectively. The mean renal volume was 90.84±1.1cm^3 for the right kidney and 93.35±1.5 cm^3 for the left kidney. In their report, mean renal volume of both the right (88.06±7.47cm^3)and left (87.4± 1.93cm^3) sides of the male subjects was greater than those of their female counter parts, 76.10± 12.4 cm^3on the right and 77.76 ± 10.3 cm^3on the left side. The largest mean renal volume for right and left kidney were recorded in age group 20-30 years in both genders, while the smallest mean renal volume for right and left kidneys were recorded in age group older than 60 years. Their conclusion was significant negative correlation between age and renal volume of both sides in both genders (29). Another study from the same nation, Saudi Arabia, among 98 University Students shows that the mean renal dimensions were 10.32 ± 0.69 cm and 10.77± 0.87 cm long, 5.07± 0.68 and 5.16 ±0.90cm wide, 4.94 ±0.84 and 4.46±0.69 cm thick for the right and left kidney respectively. The corresponding renal volumes were 130.82±36.64 and 127.56±32.46$cm^{3.}$ And regarding anthropometric measurement, the mean height were 1.72 ± 0.06 m and1.57 ±0.06m, while mean weight was 63.76 ± 9.13 kg and 60.31±10.21 kg, and mean body mass index was 21.69 ±3.04 kg/m^2 and 24.43± 4.33 kg/m^2 in male and female respectively. (30). Moreover, a report from a study comprising 200 health Indians show overall mean length of 9.44±1.18 cm on the right and 9.74±1.2 cm on the left, with statistically significant correlation in all age groups. The mean length of right kidney in male was 9.47±1.38cm, whereas in female it was 9.4±0.98 cm and that of left side was 9.82±1.4 cm in male and 9.66±1.0 cm in female. None of these associations were significant (31). A cross-sectional study conducted study done in Pakistan, on 250 individuals without known renal disease, the mean dimensions of right kidney were, length 10.81 ± 0.71 cm, width 4.77 ± 0.23 cm and thickness

4.36 ± 0.2 cm. The mean dimensions of left kidney were length 11.12 ± 0.73 cm, width 4.84 ± 0.23 cm and thickness 4.44 ± 0.19 cm. The mean volume of right and left kidneys were 118.80 ± 17.98 cm3 and 126.00 ± 18.36 cm3 respectively (29). Another study in Kuwait found the mean right and left renal lengths in population were 10.68 ± 1.4 and 10.71± 1.0 cm, respectively, with a significant correlation (r: 0.67, $p < 0.001$). Weight and height ranged from 37 to 124 kg and from 143 to 190 cm respectively. Renal lengths correlated significantly with body weight. Within the range of 60–120 kg, renal length increased by 0.23 cm for each 10-kg increase in body weight. Renal length, however, had no statistical correlation with height (r: 0.23, $p = 0.46$). Body surface area (BSA) correlated with renal length (Pearson: 0.71, $p = 0.02$) with a significantly higher BSA in males than in females. The BMI showed a correlation that corresponded with renal length, as it is dependent on weight. However cortical thickness did not show a similar correlation with weight or BMI. There was no difference between males and females in total renal length or cortical thickness (32). Study done in 194 patients without known kidney lesions in Pakistan the mean right kidney length was 10.4 ±0.9 cm, width was 4.2 + 0.7 cm, cortical thickness 1.5 ± 0.2 cm and renal size was 70±22 cm^3 and the mean left kidney length was 10.5±0.9 cm, width was 4.8±0.7 cm, cortical thickness 1.6±0.2 cm and renal size was 82±24 cm^3. Kidney length didn't have significant difference between right and left, however, kidney width, cortical thickness and size did ($p<0.05$). Right kidneys were smaller than the left ones. In univariate analysis, the mean renal size correlated with age, sex, BMI and absence or presence of hypertension and diabetes mellitus. In a multivariate analysis, however, the only significant factors affecting renal size were sex and BMI (33).

In another study which is done on 225 healthy individuals in Pakistan the mean kidney lengths were 9.85 cm on the right side and 10.00 cm on the left side ($p =0.028$). The mean kidney width was 4.61cm, cortical thickness 1.46 cm making the estimated average kidney size and volume to be 68.3 cm^3 and 35.7 cm^3 respectively. While renal length was similar for both genders (9.82 cm in men and 9.88 cm in females), males had significantly larger kidney sizes (71.3 cm^3) than females (60.1 cm^3) ($p<0.001$) (11). Study done in normal Renal Dimensions in Iranian Adults Correlations among renal lengths, parenchymal thickness, body height, weight and BMI, were individually assessed using the Pearson correlation coefficient. This test showed a significant positive correlation between both right and left renal length with the different anthropometric measurements, such as weight(r= 0.306, p- value = 0.002), height(r= 0.222 p-value=0.024),

BMI(r=0.185,p-value=0.062) for right kidney and weight (r= 0.325, p- value = 0.001), height (r= 0.211 p-value=0.032), BMI (r=0.210,p- value= 0.033) for left kidney (34).

2.3. Factors Associated with Renal Size in Diabetes mellitus

Kidneys, as key organs of excretion, eliminate various waste products of metabolism, drugs, and excess salt and water from the body, are target organs for secondary microvascular complications of non-communicable chronic diseases such as hypertension, degenerative vascular diseases and diabetes mellitus. The cumulative effect of these diseases on this vital organ represents a health problem of enormous socioeconomic cost. Further review of the literature shows that renal size varies with age, sex, body mass index, pregnancy and co-morbid conditions (10).Kidney size is also affected in variety of clinical disorders such as diabetes, renal artery stenosis, chronic hypertension, and chronic renal failure (13).

Case control study done in Sudane 50 diabetic and 100 controls showed that the mean the kidney dimention of diabetid pationt were 9.675 ± 0.961 cm long, 4.10± 0.524 wide, and 9.877 ±0.12 for right and left kidney respectively. In this study duration of diabetis has significant corelation with kidney side; as the diabetes duration increased the right kidney length decreased by 0.058mm starting from 96.74mm. While the right kidney width increased by 0.460mm starting from 41.31mm. For the left kidney length, as the diabetes duration increased the left kidney length decreased by 0.063mm starting from 99.14mm and as the diabetes duration increased the left kidney width increased by 0.377mm starting from 42.59 mm .(35). Study done in USA in tyep I diabetes the mean kidney size was larger in diabetic pationt than in normal subjects. Renal hypertrophy has been shown to correlate with the increased glomerular filtration rate in newly diagnosed diabetic subjects and in diabetic patients with up to 15 years of disease. However, kidney size did not correlate with the duration of diabetes (36). Case control study done in Serbia 31 patients with diabetic nephropathy, and 58 controls groupe showed that the mean the right and left kidney length of diabetid pationt were 11.510 ± 1.054 cm long, and kidney 11.677 ± 1.217 respectively and for control group 11.074 ± 0.847 and 11.194 ± 0.745 cm for right and left kidney respectively. In this study age has no significant corelation with kidney size; eventhough negative correlation was observed between the values of diabetic nephropathy and age (37).

Study done on Saudi Arabia on 400 type 2 diabetic patients found no statistically significant difference in the renal size of both kidneys in both genders (p value = 0.25 and 0.41 for the right and left sides respectively). Also, no statistically significance of the renal size abnormalities among different age groups was found (p value = 0.62 and 0.75 for the right and left sides respectively) (14).Study in a case-control design conducted at Indonesia with a sample of 75 control group and 150 Type 2 DM cases; the mean of BMI in case group was 24.84 ±4.28 was little higher than in control group mean 24.09±3.30. and the mean duration of illness (Week) was 320.31±108.71 weeks(38). A study done in 80 diabetic and 80 control group in Nigeria, the mean BMI found to be 27.66 ± 5.42 in diabetic and 26.57 ± 5.03 in control group (39). Study conducted in Turkey 618 type 2 diabetic patients, the mean duration of diabetes and BMI was 9.46 ± 6.2 years, 29.67 ± 5.08 kg/m^2 respectively(40). Similarly in other study done on 103 diabetic patient in Turkey showed the mean duration diabetes 8.58± 84.88 years and the mean BMI was 30.38±5.3 kg/m^2 (41). In case control(88 diabetic and 73 control groups) study in Italy the mean BMI and duration of diabetes were 28.9 and 10 respectively (42). Study done in Croatia on 43 type 2 diabetic patients the mean duration of diabetes showed to be 11.09±7.01 years(20).A comparative and cross-sectional study done in Nigeria which is conducted on 150 diabetic and 150 nondiabetic adults revealed that kidneys were found to be significantly enlarged by radiographic examination diabetic patients. The mean right kidney length, width, thickness and volume of diabetic group were 10.4 ±0.9 cm, 5.8±0.7, 4.4±0.6 and 140.7± 37.2 respectively, and for control group it was 9.5±0.9, 5.3±0.6, 4.4±0.6, 117.0±30.4 respectively. The mean left kidney length, width, thickness and volume of diabetic group were 10.6 ±0.8 cm, 5.8±0.7, 4.8±0.7 and 157.1±40.2 respectively and for control group it was 10.0±1.1, 5.7±0.6, 4.7±0.8, 144.0±41.1 respectively(22). In case control study done in Spain 10 diabetic and 10 healthy adults showed that mean right kidney length and width were 12.7±1.1cm and 6.4±0.6 cm and the mean left kidney length and width were 13.2±1.5cm and 12.3±1.5 cm respectively (43).

Case control study design done in Nigeria on 107 diabetic and 110 controls, the mean height 1.60±0.06 m in diabetic and 1.61 ± 0.007m in controls and weight showed to be 69.63±12.86 kg in diabetic and 66.30±11.43 kg in controls (44). The medical records of 477 patients in Kuwait mean body weight, 85 ± 19 kg in males and 70 ± 14 kg in females, the mean height 172 ± 6.5 cm in males and 158 ± 6.5 cm in females). In this study there is no difference in renal

length between males and females and also height of the patient didn't have an impact on renal size in this study, but there is significant correlation between renal size and BMI, this correlation between was due to body weight (32).

Study done in Nigeria in case control design the mean RI and PI values were significantly higher in diabetic patients than in controls (RI of 0.72 ± 0.06 vs. 0.63 ± 0.06, P < 0.0001) and (PI of 1.36 ± 0.24 vs. 1.08 ± 0.20, P< 0.0001) respectively. There was a graded increase in the mean values of the RI and PI with advancing age in diabetics as well as in controls. Significant positive correlation was also noted between the subjects ages and the renal Doppler values (p <0.05). Duration of diabetes also had a significant impact on the Doppler indices (RI and PI) which progressively increased with increasing duration. Gender did not have any influence on the renal Doppler indices (39). In some study which is done in Pakistan on 225 subjects was observed that both diabetics had larger kidney sizes than the healthy subset. It was associated with statistically significant increase in mean kidney length of 10.2 ± 0.76 cm in diabetic patients when compared to healthy individuals with a mean kidney length of 9.0 ± 0.80 cm (45). An association test performed using the Pearson correlation coefficient between left and right renal lengths and also renal length and parenchymal thickness showed a significant positive correlation between right with left renal length (r=0.616, P<0.001). For the left and right kidney length, the corresponding parenchymal thickness correlations were r=0.413(P<0.001) and r=0.404 (P<0.001), respectively (34).

Literature evidence on vascular changes of kidneys in chronic diseases is scarce. In another case control study done in Turkey the mean RI value was 0.72 ± 0.07 and 0.73 ± 0.077 from the right and left main renal artery in the patient group respectively, while it was found to be 0.64 ± 0.04 and 0.65 ± 0.05 from right and left main renal artery in the control group respectively. The mean PI value of the right main renal artery was 1.46 ± 0.36 and 1.05 ± 0.24 in the study and control group. The mean PI values measured from the left main artery were found to be 1.61 ± 0.42 and 0.99 ± 0.14, in the study and control groups, in sequence order. There were statistically significant differences found between the PI and RI values obtained from the right and left main renal arteries. The mean RI value obtained from the interlobular arteries was found to be 0.68 ± 0.074 in the patient group, whereas it was 0.64 ± 0.036 in the control group. The mean PI values measured from interlobular arteries were found to be 1.26 ± 0.31 and 1.02 ± 0.16, for the patient

and control groups, consecutively. Even though the mean RI taken from the interlobular arteries showed some difference between the two groups, this difference was not statistically significant. On the other hand, a statistically significant difference was found between the PI values of the case and control group. The mean RI values obtained from the left interlobular arteries were 0.69 ± 0.06 and 0.64 ± 0.03 for the study control group. The PI values, on the other hand, were found as 1.28 ± 0.25 and 1.06 ± 0.12, for the two groups, respectively. Statistically significant differences were found between the patient and control groups in terms of the RI and PI values obtained from the left renal interlobular arteries (16).

Regarding the renal parenchymal echogenicity, study done on 202 tyepe 2 diabetic pationts in Saudi Arabia most cases showed normal echogenicity (87.6% on the right side and 88.1% on the left side). No statistically significant difference was found between different grades of echogenicity of the right kidney in both male and female (p value = 0.21), while on the left side, normal renal echogenicity was more in females and grades one and two nephropathy were more common in males (p value = 0.048) (14) also study done on 205 known diabetic patients in Sudan 155(75%) has normal echogenicity, 45(22%) were hyperechoic, and 8(3.9%) was hypoechoic on both kidneys (42). Reports on kidney size among patients with diabetes mellitus are few and in fragmentary in general. Moreover, studies reporting the impact of diabetes on kidney size and vascularity from Ethiopia are lacking. And hence, the current study is impressive in contributing towards bridging the visible knowledge gap in the area.

2.4. Conceptual Framework

After reviewing large bodies of literatures factors contributing to kidney size variation in different settings were identified. The diverse group factors in literature associated with the kidney size in both general and diabetic population summarized in a conceptual frame work are given as Figure 2 below.

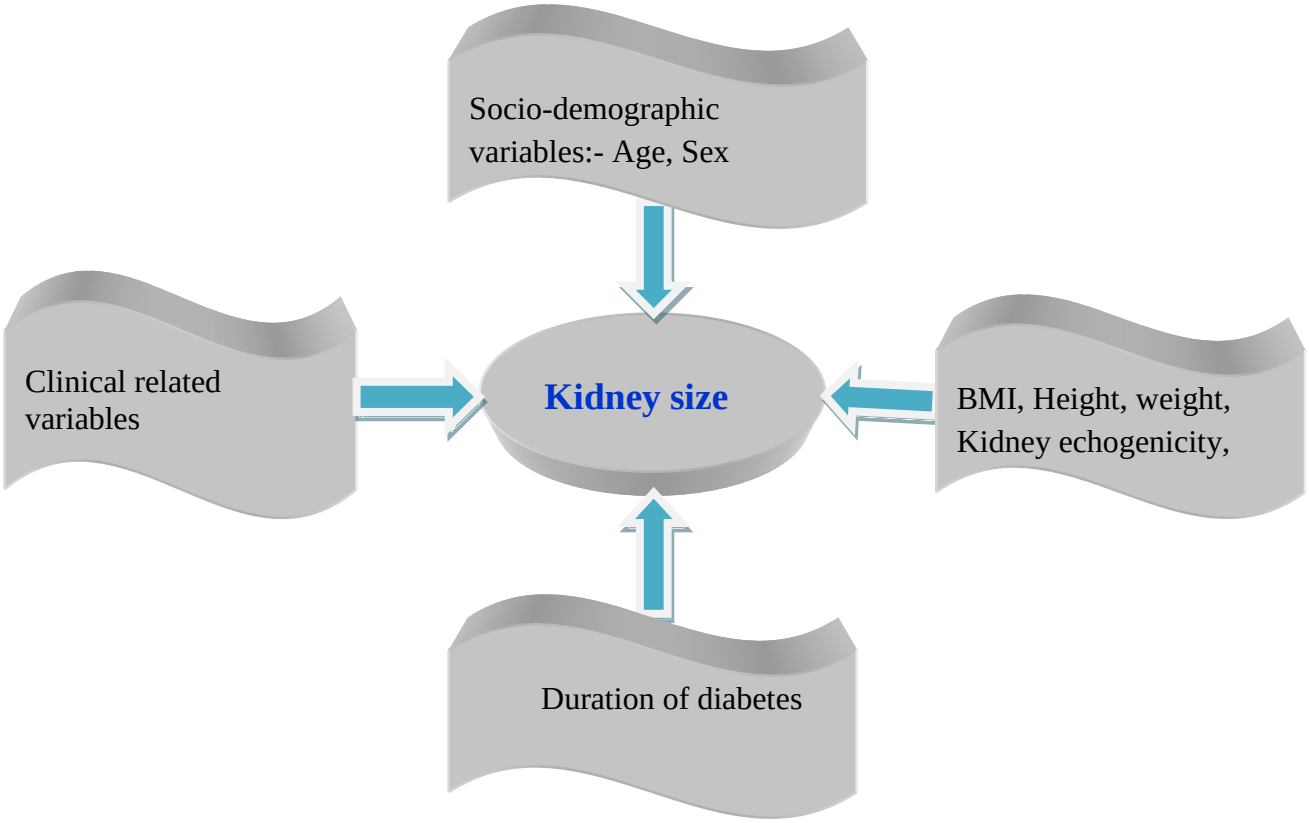

Figure 2:- Conceptual framework developed by principal investigator.

CHAPTER THREE

OBJECTIVES

3.1. General Objective

The overall goal of this study is to establish base line ultrasonographic values for kidney dimensions that can serve for diagnosis of organ damage due to chronic complications in a group of diabetic patients; and identify potential influencing factors, and to estimate their significance.

3.2. Specific objectives

- To determine mean kidney(both right and left) size of diabetic patients
- To assess kidney echogenicity (normal and hyperechoic)
- To assess correlation between body mass index and kidney size
- To assess correlation between duration of diabetics in years and kidney size

CHAPTER FOUR

METHODS AND MATERIALS

4.1. Study Area and Period

The study was conducted at Jimma University medical center, department of internal medicine & radiology department. Jimma town is found in south west of Ethiopia which is 352 km from the capital city, Addis Ababa. Jimma University is found in Jimma town in south west of Ethiopia. Jimma University medical center provides medical and training service and it is one of the referral hospital in south west Ethiopia. It provides many services in outpatient, in patient and emergency basis in various areas; namely; surgery, obstetrics and gynecology, pediatrics, anesthesia, ophthalmology, psychiatry, pharmacy, medical laboratory, dentistry and radiology. The study was conducted from June 26-August 26, 2018.

Chronic illness follow up clinic is one of the units in the department of internal medicine of JUMC. It gives service for different chronic illness such as Diabetes Mellitus, Hypertension, Cardiac illnesses, and Neurologic illness. The clinic has two follow up day per week for Diabetic patients. In a week an average of 48 diabetic follow up patients are served in JUMC chronic follow up clinic. Nearly 2400 diabetic patients have follow up in the unit.

4.2. Study design

Descriptive cross sectional study was employed using Doppler ultrasound on diabetic patients who have follow up at JUMC Chronic illness follow up clinic.

4.3. Population

4.3.1. Source population

The source population was all adult diabetic patients who have follow up at JUMC Chronic illness follow up clinic.

4.3.2. Study population

The study population was all adult diabetic patients who will undergo ultrasound examination of the kidney at JUMC during the study period. .

4.4. Inclusion and exclusion criteria

4.4.1. Inclusion criteria

All adult diabetic patients who have follow-up at JUMC Chronic illness follow up clinic from June 26-August 26, 2018.

4.4.2. Exclusion criteria

Patients with the following conditions shall be excluded from the study:

- ✓ Individuals younger than 18 years
- ✓ Pregnant women
- ✓ History of renal transplantation or hemodialysis or peritoneal dialysis,
- ✓ Recent unilateral or partial nephrectomy
- ✓ Individuals with poor ultrasound examination window (automatically elevated kidney, with interference in costal arches), or extreme obesity, and patients diagnosed with any visible congenital anomaly of kidneys were excluded from analysis associated with kidney size.

4.5. Sample size determination and sampling procedure

Non-probability convenience sampling technique was used. This is a method of sampling where elements are chosen from the population using non-random taken from a section of the population that is easily accessible or readily available to the researchers.

4.6. Study variables

4.6.1. Dependent variable

- Kidney size (right and left kidney)

4.6.2. Independent variable

- Age,
- Sex,
- Height
- Weight
- BMI
- Duration of diabetes
- Type of Diabetes
- Type of treatment taken

- FBS (mg/dl)
- Blood pressure
- Position of kidneys
- Shape of kidneys
- Renal morphologic anomaly
- Kidney echogenicity
- Renal pulsatality index
- Renal vascular resistive index
- Kidney echogenicity

4.7. Data collection instruments

- Structured questionnaire
- Doppler ultrasound (General Electric Health care LOGIQ P6. The probe is 4c convex and the frequency is 1.6 to 4.6MHz. The model of the machine is B-Model & pulsed Doppler mode.
- Beam balance
- Tape meter

Figure 3:- An ultrasonography that have been used during data collection

4.8. Data collection procedures

Data collection and testing Procedure (Protocol):

Two clinical nurses collected socio-demographic, clinical related variable, duration of diabetes data using structured questionnaire while kidney parameters were collected by radiologist. The patients were told to prepare themselves carefully for the scan by abstaining from food for the last six hours prior to investigation with continuous taking their drugs, imposing dietary restrictions, before the examination. Usually the examination was carried out with the patient in supine and lateral decubitus position. Additional scans in the prone were useful in some situations. A coupling agent gel was used to ensure good acoustic contact between the transducer and the skin. After informing the patients about the procedure and obtaining written consent from each of them, the area of interest in the abdomen was completely evaluated in at least two scanning planes.

Doppler ultrasound machine was used to measure the length of kidney in diabetic patients. Both left and right kidneys of the patients were measured. Kidney Echogenicity was determined from the machine for both kidneys. Ages, sex, height, weight, of the patients were recorded and BMI of the patients were calculated.

Figure 4:- Doppler US images showing an intrarenal arterial waveform

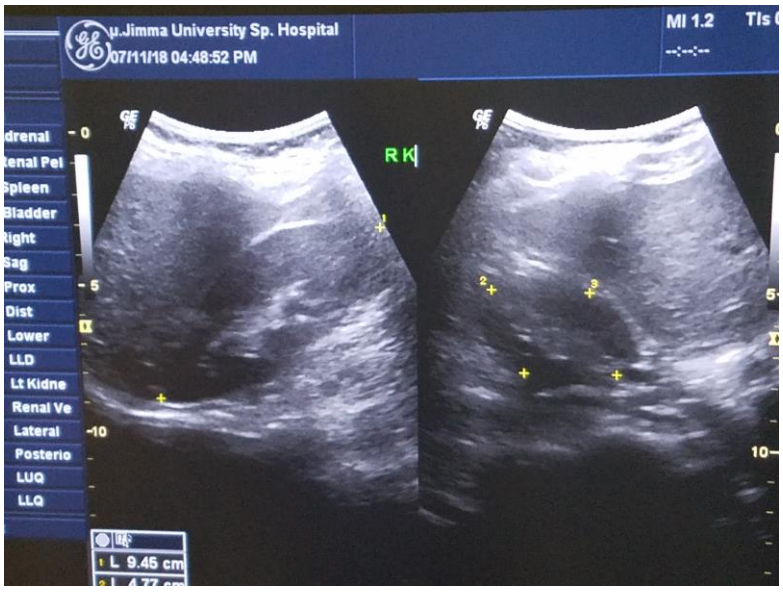

Figure 5:- Ultrasonografic measurement of length, width and thickness of the kidneys

4.9. Data quality control

Two clinical nurse data collectors' were trained about data collection procedures and quality. Supervision was done by principal investigator. Kidney parameters data were collected by one radiologist. He strictly followed the procedures consistently for all study participants to minimize intra-observer variability. The questionnaire was checked thoroughly for its completeness before it was distributed to data collectors. The data collectors made frequent checks in the data collection process, the completeness and the consistency of the gathered information. During data collection the investigator supervised the data collectors. Data cleaning was performed to check for accuracy, consistency, missed values, and variables.

4.10. Data processing and analysis

Collected data were edited, checked for completeness and errors. Data were entered to Epi-data version 3.1 and were exported to SPSS version 20 for analysis. Frequencies, proportion, tables, graphs, and summary statistics such as mean $\pm$SD was used to describe the study population in relation to relevant variables.

Bivariate analysis between predictors and outcome variable was carried out to select candidate variables for multivariable analysis. Variables with p- value less than 0.25 were entered to multivariable logistic regression analysis to identify the independent factors associated with dependent variable. Before the multivariable analysis, assumptions were checked using

collinearity diagnostics, as measured by Variance and VIF (Variance inflation factor), and normality tests**.** A p-value of less than 0.05 was considered to be statistically significant.

4.11. Ethical consideration

Ethical clearance was obtained from Jimma University Institute of health Ethical review board. All the study participants were informed about the objective of the study and their informed consent were obtained. Additionally confidentiality and privacy of the information was seriously kept.

4.12. Operational definition & definition of terms

- Kidney size is measured from pole-to-pole kidney length of right and left kidneys.
- Kidney volume= Kidney length x Width x Thickness x0.523.
- Diabetic patient – patient who have fasting blood glucose 126mg/dl or higher/ random blood glucose 200mg/dl or more.
- Resistivity index – Is a measure of pulsatile blood flow that indicates the resistance to blood flow through an artery. It is measured as RI = (peak systolic velocity − end diastolic velocity) / peak systolic velocity.
- Normal Resistivity index – RI= 0.60-0.70
- Decreased Resistivity index – RI= <0.60
- Increased Resistivity index – RI= >0.70
- Echogenicity is the ability of a tissue to reflect an ultrasound wave.
- Kidney echogenicity – means how bright or dark kidney parenchyma appears in comparison to the liver.
- Normal echogenicity – when the echogenicity of parenchyma of the kidney either equal to echogenicity of the liver parenchyma or less than liver parenchyma.
- Hyperechogenic kidney – increased echogenicity of the kidney compared with that of the liver.
- Hypoechogenic kidney – decreased echogenicity of the kidney compared with that of the liver.

CHAPTER FIVE

RESULTS

5.1. Distribution of age and somatic variables of the study population by sex

A total of 204 (112 male and 92 female) diabetic patients were studied. Twenty-seven (13.2 %) subjects were Type 1 diabetics, while 177 (86.8%) were Type 2 diabetic patients. The age of the participants ranged from 18 to 80 years, with a mean ± SD of 52.2 ± 12.9 years. Table 1 shows age distribution and somatic variables of the study participants by sex. In comparison anthropometric measurements of male and female, weight (68.169±12.918 kg and 65.5±12.591 kg), height (170.89±7.871 cm and 156.78±6.342 cm) and BMI (23.2796±3.696kg/m^2 and 26.657±4.879kg/m^2) for men and women respectively. **(Table 1)**

Table 1:- Distribution of age and somatic variables of the study population by sex

Variables	Males(n=112)			Females(n=92)		
	Min	Max	Mean ± SD	Min	Max	Mean ± SD
Age(yrs)	18	80	54.214±12.038	19	80	49.63±13.571
Weight(kg)	35	97	68.169±12.918	45	108	65.5±12.591
Height(cm)	151	192	170.89±7.871	144	176	156.78±6.342
BMI(kg/m^2)	14.57	32.38	23.2796±3.696	16.73	42.1	26.657±4.879

5.2. Clinical Characteristics of the patients

Clinical characteristics of the study subjects were given in Table 2. The mean duration of diabetes of individuals was 7.584±5.165with maximum of 26 years and a minimum of 3 months. Maximum FBS of patients were 324 mg/dl and the minimum were 71 mg/dl with a mean of 163.425±44.591. The mean systolic and diastolic blood pressures of the patients were 128.90±19.396 and 81.11±10.487 respectively (**Table 2**).

Table 2:- Clinical characteristics of diabetic patients at JUMC, 2018

Variables	Minimum	Maximum	Mean	Std. Deviation
Duration of diabetes (year)	0.25	26.00	7.584	5.165
FBS (mg/dl)	71.00	324.00	163.425	44.5912
Systolic blood pressure (mmhg)	80	190	128.90	19.396
Diastolic blood pressure (mmhg)	40	110	81.11	10.487

5.3. Ultrasonographic measurements of echogenicity, resistivity index and pulsitility index

According to renal artery resistivity index the right kidney resistivity index out of 204 patients, 172(84.3%) patients showed optimum resistivity index, low resistivity index was 3(1.5%) and high resistivity index was 29 (14.2%). And left kidney resistivity index, 176(86.3%) showed optimum, 3(1.5%) showed low and 25(12.3%) showed high resistance index. For right and left kidney majority (202,203) of participant has optimum pulsatility index respectively. In measurement of echogenicity of the patients majority has optimum echogenicity 202 for both kidneys (**Table 3**).

Table 3:- Ultrasonographic measurements of resistivity index , pulsitility index and echogenicity of right and left kidney of diabetic patients at JUMC, 2018

	RT RI	RT PI	LT RI	LF PI	RT echogenicity	LT echogenicity
Low	3 (1.5%)	1(0.5%)	3(1.5%)	0		
Optimum	172(84.3%)	202(99%)	176(86.3%)	203(99.5%)		
High	29(14.2%)	1(0.5%)	25(12.3%)	1(0.5%)		
Normal					202(99%)	202(99%)
Hyperechoec					2(1%)	2(1%)

RT= right, LT= left, RI=resistivity index, PI= pulsitility index

5.4. Kidney measurements for different age group

Data were collected from 204 Diabetic patients. Of this, 29 patients are excluded from analysis of measurement of kidney dimensions due to morphologic anomalies like Renal cyst (10 on the RT and 4 on the left), renal stone (1 on the RT and 4 on the left) CKD (2on the RT and 2 on the left), lipoma (1 on the RT and 1 on the left), others (hydronephrosis, ectopic kidney etc.) (4 on the RT and 6 on the left) found on their kidneys which can be affect measurement of the kidney size. As a result 175 participants (95 male and 80 female) were analyzed for the measurement of dimension of kidney.

The mean lengths in all age groups of right and left kidney were 10.263±0.764cm and 10.421±0.714 respectively. The mean volume of right and left kidney in all age groups were 98.115±23.118 cm and 101.423±24.457 cm respectively. The mean length of right kidney remained almost constant up to 30 – 40 years i.e. 10.46±0.67 cm. There was gradual decrease from 41 years of age up to 80 years of age (10.20±0.76 cm). The mean left kidney length in age group 18-29year was 10.56±0.82cm with a sharp decrease to 10.38±0.59 cm at 30-40 years of age. And again increase 10.54±0.83 at 41-50 years of age then after decrease from 51 years of age group up to 80 10.27±0.62cm. **(Table 4)**

Table 4:- Sonographic kidney measurement for different age group and side difference (data were presented as mean ± SD).

		Measurements			
Age group	Side	Length (cm)	Width (cm)	Thickness (cm)	Volume (cm^3)
18-29	Rt Kidney	10.49±0.902	5.09 ±0.66	3.45±0.47	98.43±29.74
	Lt Kidney	10.56±0.82	5.2±0.5	3.66±0.61	107.39±31.08
30-40	Rt Kidney	10.46±0.67	5.18±0.43	3.56±0.36	100.22±16.68
	Lt Kidney	10.38±0.59	5.17±0.51	3.66±0.36	103.55±19.40
41-50	Rt Kidney	10.18±0.88	5.23±0.55	3.53±0.433	99.85±26.84
	Lt Kidney	10.54±0.83	5.14±0.56	3.64±0.47	104.64±27.94
51-60	Rt Kidney	10.19±0.71	5.15±0.47	3.47±0.43	96.26±20.66
	Lt Kidney	10.44±0.75	5.25±0.44	3.76±0.42	104.21±22.54
61-80	Rt Kidney	10.20±0.76	5.08±0.59	3.52±0.50	96.90±26.99
	Lt Kidney	10.27±0.62	5.06±0.37	3.86±1.07	106.97±29.74

Figure 6: Sonographic image showing rt renal stone

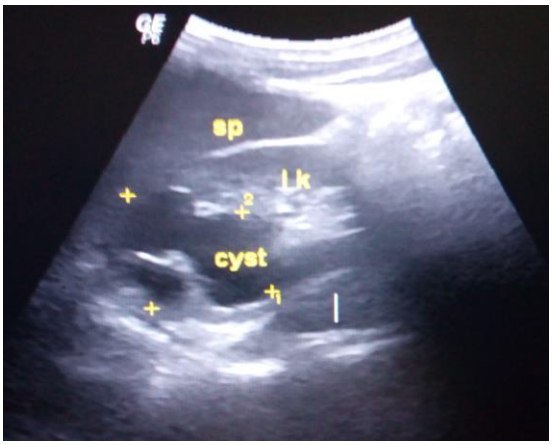

Figure 7: Sonographic image showing Lt kidney cyst

5.5. Pearson correlation coefficient between renal dimension and body parameters and duration of diabetes at different age group

In age grouped 18- 29 right kidney length has positive and negative correlation with height (r=0.503, p-value=0.168), weight (r=0.747, p-value=0.021), and duration of diabetes (r=-0.475, p-value=0.197) and also left kidney length has positive and negative correlation with height (r=0.508, p-value=0.163), weight (r=0.783, p-value=0.013).

In age grouped 30-40 right kidney length has positive and negative correlation with weight (r=0.45, p-value=0.005), BMI (r=0.394, p-value=0.014) and duration of diabetes (r=-0.277, p-value=0.092) and also left kidney length has positive and negative correlation with, weight (r=0.328, p-value=0.044), BMI (r=0.367, p-value=0.023) and duration of diabetes (r= -0.308, p-value=0.06). Duration of diabetes has strong positive correlation with right kidney length at only age 18-50; however it has negative correlation with left kidney length at age group 30-40. **(Table 5)**

Table 5:-Pearson correlation coefficient between renal dimension and body parameters and duration of diabetes at different age group

	Variables	RTKL		RTKV		LTKL		LTKV	
Age		r	p-value	R	p-value	r	p-value	r	p-value
18-29	Height	0.503	0.168*	0.158	0.684	0.508	0.163*	0.375	0.32
	Weight	0.747	0.021*	0.533	0.14*	0.783	0.013*	0.735	0.024*
	BMI	0.126	0.747	0.292	0.446	0.147	0.706	0.228	0.555
	Duration of diabetes	-0.475	0.197*	-0.260	0.499	-0.33	0.376	0.057	0.884
30-40	Height	0.165	0.323	0.157	0.347	-0.06	0.720	-0.18	0.28
	Weight	0.45	0.005*	0.214	0.197*	0.328	0.044*	0.121	0.469
	BMI	0.394	0.014*	0.159	0.340	0.367	0.023*	0.213	0.199*
	Duration of diabetes	-0.277	0.092*	0.062	0.710	-0.308	0.06*	0.093	0.577
41-50	Height	0.152	0.375	0.331	0.049*	0.282	0.095*	0.397	0.016*
	Weight	0.367	0.028*	0.328	0.051*	0.269	0.112*	0.514	0.001*
	BMI	0.275	0.105*	0.111	0.518	0.073	0.674	0.248	0.144*
	Duration of diabetes	-0.018	0.918	-0.118	0.494	-0.176	0.306	0.033	0.846
51-60	Height	0.24	0.084*	0.248	0.074*	0.049	0.728	0.049	0.725
	Weight	0.26	0.06*	0.28	0.043*	0.375	0.006*	0.375	0.006*
	BMI	0.118	0.399	0.121	0.389	0.377	0.005*	0.377	0.005*
	Duration of diabetes	0.056	0.689	-0.072	0.609	0.114	0.416	0.115	0.414
61-80	Height	0.04	0.808	-0.047	0.778	0.333	0.039*	-0.018	0.913
	Weight	0.402	0.011*	0.351	0.028*	0.288	0.075*	0.224	0.170*
	BMI	0.357	0.026*	0.373	0.019*	-0.002	0.989	0.248	0.128*
	Duration of diabetes	-0.120	0.469	-0.159	0.333	-0.105	0.524	-0.231	0.157*

* Those statistically significant in bivariate analysis at 0.25 significant levels

RTKL= Right kidney length, RTKV= Right kidney volume, LTKL= Left kidney length, LTKV=Left kidney volume, BMI = Body mass index,

5.1. Bivariate analysis shows relationship between dependent variable (kidney size) versus independent variables.

In bivariate analysis right kidney length has negative & positive correlation with Age (r=-0.163, p-value=0.031), body height(r=0.137,P-value=0.070), body weight (r=0.309, p-value=0.001), BMI(r=0.234 , p-value=0.002), duration of diabetes (r=-0.111, p-value=0.142), Type of DM (r=-0.095, p-value=0.211), DBP (r=0.115, p-value=0.128) similarly, bivariate analysis of in bivariate analysis of right kidney volume revealed correlation with Body height(r=0.151, p-value=0.047), Body weight (r=0.268,p-value=0.001), BMI(r=0.175, p-value=0.021), Duration of DM(r=-0.100, p-value=0.189), FBS(r=-0.113, p-value=0.136). in bivariate analysis of left kidney has negative & positive correlation between left kidney length, Age(r=-0.121,p-value=0.111) sex(r=-0.099, p -value=0.192), height(r= 0.198 , p- value= 0.009), weight (r= 0.271, p- value= 0.001), BMI(r= 0.156, p- value= 0.036), Duration of DM (r=-0.121, p- value= 0.112), Type of DM (r=-0.124, p- value= 0.103), DBP(r=0.147, p- value= 0.052), similarly bivariate analysis between left kidney volume has correlation with sex (r=-0.105, p-value=0.167), Body height (r=0.063, p-value=0.175), Body weight(r=0.311, p-value=0.001), BMI(r=0.260, p-value=0.001), SBP(r=0.132, p-value=0.082), DBP(r=0.116, p-value=0.125), at 0.25 significant level (p-value). **(Table 6)**

Table 6:- Bivariate analysis showing relationship between dependent variable (kidney size) versus independent variables

	RT kidney length		RT kidney volume		Lf kidney length		Lf kidney volume	
	r	p- value	r	p- value	R	p- value	r	p- value
Age	-0.163	0.031*	-0.087	0.251	-0.121	0.111*	0.063	0.407
Sex	0.024	0.756	-0.079	0.296	-0.099	0.192*	-0.105	0.167*
Body height	0.137	0.070*	0.151	0.047*	0.198	0.009*	0.106	0.175*
Body weight	0.309	0.001*	0.268	0.001*	0.271	0.001*	0.311	0.001*
BMI	0.234	0.002*	0.175	0.021*	0.156	0.036*	0.260	0.001*
Duration of DM	-0.111	0.142*	-0.100	0.189*	-0.121	0.112*	0.008	0.913

FBS	-0.061	0.422	-0.113	0.136*	-0.48	0.532	0.004	0.955
Type of DM	-0.095	0.211*	-0.023	0.763	-0.124	0.103*	-0.012	0.879
SBP	-0.005	0.951	-0.028	0.710	0.015	0.846	0.132	0.082*
DBP	0.115	0.128*	-0.013	0.868	0.147	0.052*	0.116	0.125*

* Those statistically significant in bivariate analysis at 0.25 significant levels

5.7. Multivariable analysis of relation between Renal size and Age, Sex, Body height, BMI.

Multivariable linear regression analysis was performed to assess the effect of independent variables own renal size (both right & left kidney size). The independent variables were those only statistically significant in bivariate analysis at 0.25 significant levels. Age (p-value=0.001), body height (p-value= 0.001), BMI (p- value=0.000) showed significant correlations with right kidney length. Similarly Age (p-value=0.013), body height (p-value= 0.000), BMI (p-value=0.001) showed significant correlation with left kidney length. Regarding volume of the kidney only body height (p-value=0.003, p-value=0.017) and BMI (p-value=0.001, p-value=0.000) showed significant correlation with right and left kidney respectively. **(Table 7)**

Table 7:- Multivariable analysis of relation between Renal size and Age, Body height, BMI

RT kidney length	B_0	Std. Error	B	t-cal	Sig.
(Constant)	6.379	1.106		5.767	0.000
Age	-.015	.004	-.246	-3.295	0.001**
Body height	1.888	.567	.247	3.330	0.001**
BMI	.057	.013	.341	4.471	0.000**
Duration of diabetes	-.010	.011	-.063	-.863	0.389
DBP	.004	.005	.048	.665	0.507
FBS	-.001	.001	-.039	-.546	0.585

RT kidney volume					
Constant	1.210	33.293		.036	0.971
Age	-.266	.140	-0.146	-1.901	0.059
Body height	53.297	17.603	0.231	3.028	0.003**
BMI	1.337	.390	0.265	3.427	0.001**
Duration of diabetes	-.362	.348	-0.077	-1.038	0.301
FBS	-.049	.037	-0.095	-1.310	0.192
LT kidney length					.
(Constant)	6.374	1.051		6.064	0.000
Age	-.011	.004	-.190	-2.498	0.013**
Body height	1.980	.539	.278	3.676	0.000**
BMI	.039	.012	.253	3.263	0.001**
Duration of diabetes	-.011	.011	-.075	-1.012	0.313
DBP	.006	.005	.089	1.196	0.233
FBS	.000	.001	-.026	-0.358	0.721
LF kidney volume	B	Std. Error	Beta	T	Sig.
(Constant)	-24.639	38.353		-.642	0.521
Age	-.089	.178	-.044	-.498	0.619
Body height	47.277	19.659	.186	2.405	0.017**
BMI	1.651	.443	.298	3.728	0.000**
Duration of diabetes	.048	.393	.009	0.123	0.902
SBP	.068	.138	.054	0.495	0.621
DBP	.068	.237	.028	0.288	0.774
FBS	.011	.042	.019	0.265	0.792

**Those statistically significant in Multivariable Analysis at 0.05 significant levels

SBP= Systolic blood pressure, DPB= Diastolic blood pressure, FBS= Fasting blood sugar

Equations

1. RT kidney length = 6.379– 0.246 (age)+ 0.247 (ht)+0.341 (BMI) –0.063 (DDM) + 0.048 (DBP) –0.039 (FBS) + Ɛ
2. RT kidney volume = 1.210– 0.146 (Age)+ 0.231 (ht) + 0.265(BMI) –0.077 (DDM) –0.095(FBS) + Ɛ
3. LT kidney length = 6.374 –0.190 (Age) + 0.278 (ht) + 0.253 (BMI) –0.075 (DDM) +0.089 (DBP) – 0. 026 (FBS) +Ɛ
4. LT kidney volume = –24.639–0. 044 (Age) + 0.186 (ht) +0.298 (BMI) – 0 .028 (DBP) +0. 054 (SBP) +0 .009 (DDM)+ 0.019 (FBS)+ Ɛ

Whereas: -

ht= height, BMI= Body mass index, DDM= duration of diabetes, TDM= Type of diabetes , FBS= Fasting blood sugar, SBP= systolic blood pressure, DBP= Diastolic blood pressure

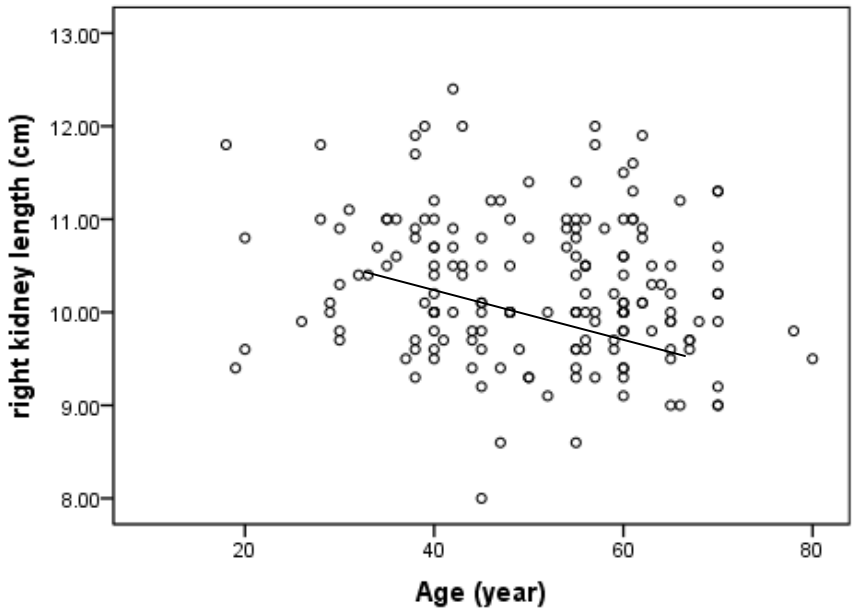

Figure 8:- Scatter plot showing very week negative correlation between age and right kidney length

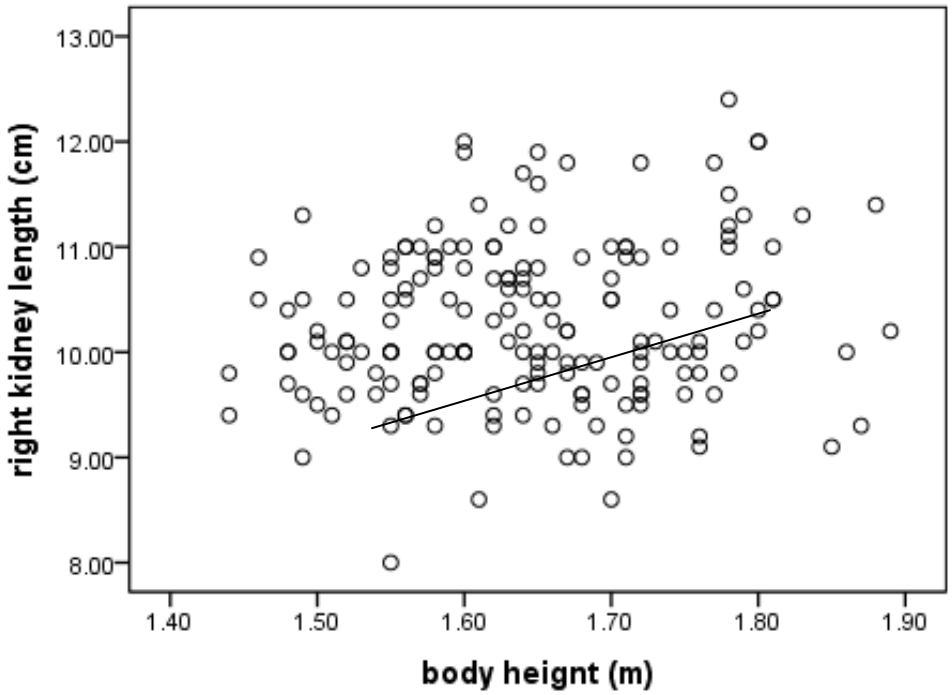

Figure 9:-Scatter plot showing positive correlation between body height and right kidney length

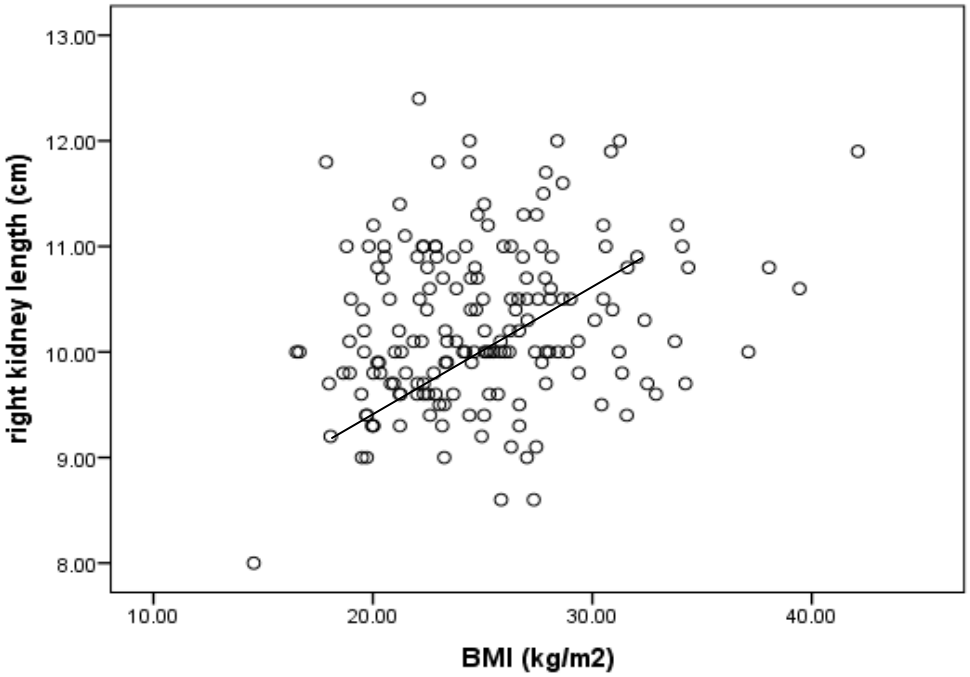

Figure 10:- Scatter plot showing positive correlation between BMI and right kidney length

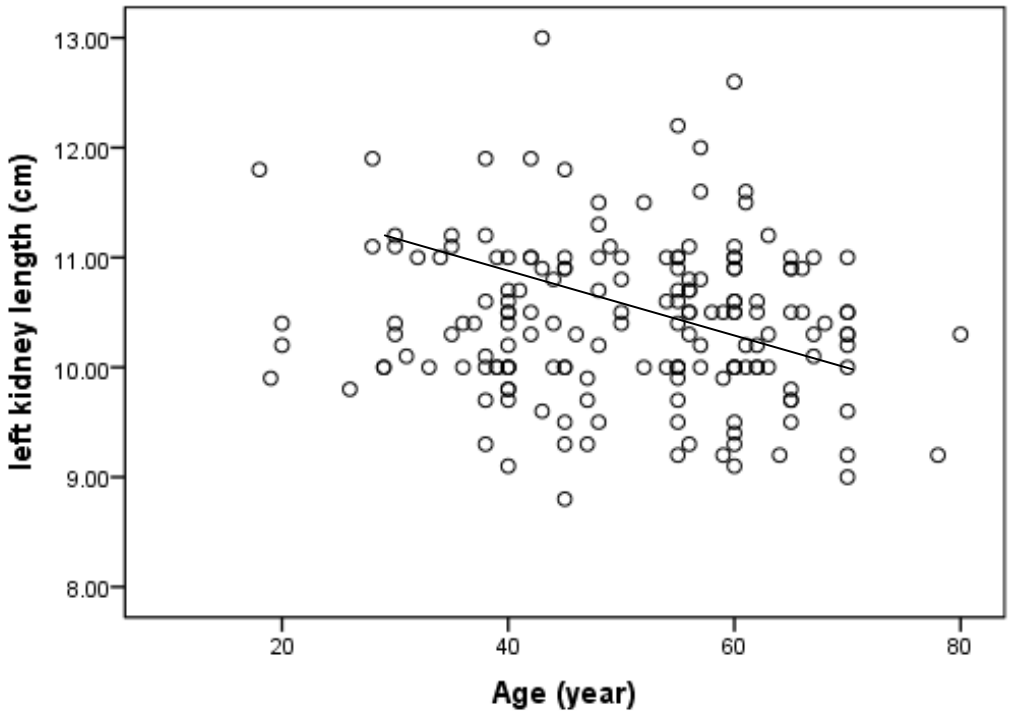

Figure 11:- Scatter plot showing negative correlation between age and left kidney length

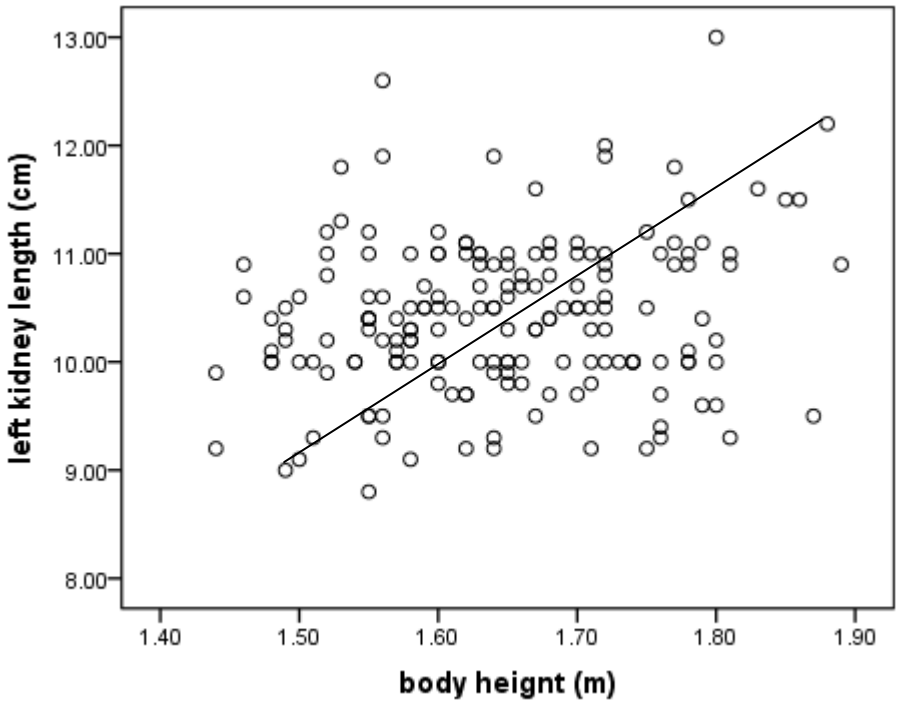

Figure 12:- Scatter plot showing positive correlation between body height and left kidney length

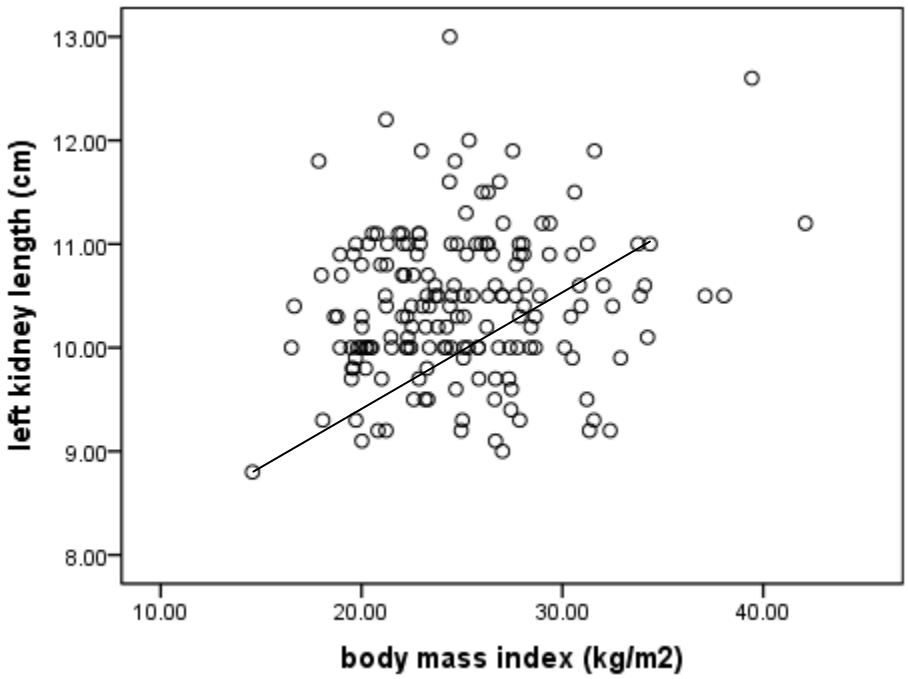

Figure 13:- Scatter plot shoeing correlation between BMI and left kidney length

CHAPTER SIX

6.1 DISCUSSION

This study in 204 individuals of Diabetic disease showed that the mean weight and height of all participants were 66.97±12.81 kg and 164.5±1 cm respectively. These findings correspond with the findings reported in Nigeria among 107 known type 2 diabetic patients(body weigh 69.63±12.86 kg, body height 1.60±0.06) but it is not consistent with study done in Boston among 30 diabetic adult patients(body weigh 62 ± 1 kg, body height 167 ± 2 cm).

In comparison of weight and height measurements of male and female, showed that 68.169±12.918 kg & 65.5±12.591 kg and mean body height were 170.89±7.871 cm & 156.78±6.342 cm respectively. These findings correspond with the findings reported in Saudi among 98 Saudi's University Students shows that the mean height in male and female were 1.72 ±0.06 m and 1.57 ±0.06, mean weight were 63.76 ± 9.13 and 60.31±10.21, and mean body mass index were 21.69 ±3.04 and 24.43± 4.33respectively. However; it is not consistent with the study done in Kuwait from the medical records of 477 patients (mean Weight, 85 ± 19 kg in males and 70 ± 14 kg in females, Height 172 ± 6.5 cm in males and 158 ± 6.5 cm in females). These variations might be related to genetic & environmental factors.

This study revealed that the mean body mass index and duration of diabetes of individuals were 24.81±4.581 and 7.58±5.165respectively with maximum of 26 years and a minimum of 3 months duration of diabetes. These findings are consistent with the study done in Surakarta(Indonesia) among 150 Type 2 Diabetes Mellitus Patients and 75 control groups, the mean BMI on diabetic patients were 24.84 ± 4.28 and mean duration of illness in week 320.31±108.71 weeks which becomes 6.67 in years. However, the current observations on BMI & duration of diabetes are lower than reports from Turkey on 103 Type 2 diabetic patients the mean diabetes duration was 8.58±4.88 years and the mean BMI was 30.11±5.87 kg/m^2 , in Turkey among 618 Type 2 Diabetes Mellitus Patients the mean BMI and duration of diabetes were 29.67 ± 5.08 kg/m^2 and 9.46 ± 6.2 years, in case control (88 diabetic and 73 control groups) study in Italy the mean BMI and duration of diabetes were 28.9 and 10 respectively, in Nigeria a case-control prospective study on 80 adult subjects the mean BMI 27.66 ± 5.42 kg/m^2

& Croatia on 43 patients with type 2 diabetes the mean duration diabetes was 11.0930±7.0129 years. The possible explanation might be related to sample size variation and genetic factors.

From the total 204 participants' measurement of echogenicity majority of them have normal echogenicity (202) in both right and left kidney and only 2 patients (1%) have hyperechoic in both kidneys. This finding is not consistent with the study done in Saudi Arabia among 202 adult type 2 diabetic patients (normal echogenicity 87.6% on the right side and 88.1% on the left side) and also study done on 205 known diabetic patients in Sudan 155(75%) has normal echogenicity, 45(22%) were hyperechoic kidney, and 8(3.9%) was hypoechoic on both kidneys. Sample size variation might be possible explanation for the difference and also it might be due to huge number (38.84%) of patients with renal abnormalities like renal stone, renal cyst, renal mass, patients with renal failure, renal Parenchyma disease, pyelonephritis among the study participants were included in the study, so that the presence of this renal abnormality have ability to increase echogenicity of the kidney.

The mean dimensions of right kidney were length 10.263±0.763cm, width 5.155±0.514cm, thickness 3.515±0.434cm and volume 98.116±23.117cm^3 while the mean dimensions of left kidney were length 10.421±.71368cm, width 5.167±0.472 cm, thickness 3.732±0.636 cm and volume 106.391±25.40078 cm^3. Similar findings were found from Pakistan on 225 subjects the mean kidney length was 10.2 ± 0.76, in Nigeria comparative, and cross-sectional study conducted on 150 diabetic and 150 nondiabetic adults the mean dimensions of right kidney in diabetic patient were, length 10.4 ± 0.9 cm, width 5.8 ± 0.7cm, thickness 4.4 ± 0.6 cm), volume140.7±37.2 cm^3 while the mean dimensions of left kidney were, length 10.6 ± 0.83 cm, width 5.8±0.7 cm and thickness 4.8±0.7 cm), volume 157.1±40.2 cm^3, from France 75 patients with diabetes and CKD, the mean lengths of the right kidney was (108 ± 13 mm i.e 10.8 ± 0.13cm) and the mean length left kidney was (108 ± 16 mm i.e 10.8 ± 0.16 cm)(46). However; current observation is lower than case control study done in Spain 100 diabetic and 10 healthy adults showed that mean right kidney length and width were 12.7±1.1cm and 6.4±0.6 cm and left kidney length and width were 13.2±1.5cm and 12.3±1.5 cm respectively. Also lower than case control study done in Serbia 31 patients with diabetic nephropathy, and 58 controls groupe showed that the mean the right and left kidney length of diabetid pationt were 11.510 ± 1.054

cm long respectively. This discrepancy might be due to sample size variation, and age of participants, and the time of study done.

Current observation also higher than case control study done Sudan in 50 diabetic patient and 100 healthy adults revels decrease in renal dimension on diabetic patients, the mean right kidney length, width, and cortical thickness of diabetic patient were 96.75±9.61 mm i.e 9.675±0.961 cm, 41.00±5.24 mm i.e 4.1±0.524 cm, 5.21±0.82 mm i.e. 0.521±0.082 cm respectively and the mean left kidney length, width, and cortical thickness of diabetic patient were 98.77±12.11 mm 9.877± 1.211 cm, 44.91±7.14 mm i.e 4.491±0.714 cm, 6.12±0.79 mm i.e 0.612±0.079 cm. The possible explanation of this variation might be sample size difference and instrument that was used for the measurement of kidney dimension (CT scan).

In bivariate analysis right kidney length has negative & positive correlation with Age (r=-0.163, p-value=0.031), body height(r=0.137,P-value=0.070), body weight (r=0.309, p-value=0.001), BMI(r=0.234 , p-value=0.002), duration of diabetes (r=-0.111, p-value=0.142), Type of DM (r=-0.095, p-value=0.211), DBP (r=0.115, p-value=0.128) similarly, bivariate analysis of in bivariate analysis of right kidney volume revealed correlation with Body height(r=0.151, p-value=0.047), Body weight (r=0.268,p-value=0.001), BMI(r=0.175, p-value=0.021), Duration of DM(r=-0.100, p-value=0.189), FBS(r=-0.113, p-value=0.136). in bivariate analysis of left kidney has negative & positive correlation between left kidney length, Age(r=-0.121,p-value=0.111) sex(r=-0.099, p -value=0.192), height(r= 0.198 , p- value= 0.009), weight (r= 0.271, p- value= 0.001), BMI(r= 0.156, p- value= 0.036), Duration of DM (r=-0.121, p- value= 0.112), Type of DM (r=-0.124, p- value= 0.103), DBP(r=0.147, p- value= 0.052), similarly bivariate analysis between left kidney volume has correlation with sex (r=-0.105, p-value=0.167), Body height (r=0.063, p-value=0.175), Body weight(r=0.311, p-value=0.001), BMI(r=0.260, p-value=0.001), SBP(r=0.132, p-value=0.082), DBP(r=0.116, p-value=0.125), at 0.25 significant level (p-value).

Multivariable linear regression analysis was performed to assess the effect of independent variables own renal size (both right & left kidney size). The independent variables were those only statistically significant in bivariate analysis at 0.25 significant levels. Age (p-value=0.001, p-value=0.013), body height (p-value= 0.001, p-value= 0.000), BMI (p- value=0.000, 0.001)

showed significant correlations with right and left kidney length respectively .These findings are consistent with findings from sonographic assessment of 103 healthy individuals both right and left kidneys length decrease significantly when the age increases (P=0.008, P= 0.14) respectively and also there was significantly positively correlate with height (P= 0.024,P= 0.062) and BMI (P= 0.032, 0.033) both right and left kidney respectively (34), again study conducted on 100 adult normal Malaysian populations shows a significant direct positive correlation between renal size with body height of the patient (47). Study done in Mexico on 153 healthy Mexican adults there was negative correlation between right kidney length and age(r=0.203, p-value=0.012) (48). (Height with P- value=0.024, 0.032, BMI with p-value=0.062, 0.000) positive significant correlation with both right and left kidney length respectively with findings from Iranian healthy 103 adults, and also consistent with study. Malaysia 320 university students showed a strong positive correlation between renal size and BMI (10). However it is inconsistent with study done in India on 100 healthy individuals age has no significant correlation with both right (p-value=0.238) and left (p-value=0.484) kidney length (13), also not consistent with finding from Kuwait 252 healthy individuals renal length, had no statistically significant correlation with height (r: 0.23, p = 0.46) (32) again inconsistent with study done on 205 patients with known Diabetic Mellitus in Sudan both right and left renal length has no statistical significant correlation with patients body height (p= 0.662) for right kidney and (p=0.05) for left kidney(49). It is also inconsistent with study done in Serbia on 31 patients with diabetic nephropathy, and 58 controls groupe showed that age has no significant corelation with kidney size; eventhough negative correlation was observed between the values of diabetic nephropathy and age (37). The possible explanation might be genetic and sample size difference.

Regarding volume of the kidney only body height (p-value=0.003, p-value=0.017) and BMI (p-value=0.001, p-value=0.000) showed significant correlation with right and left kidney respectively. These findings are consistent with findings from normal 98 Adult in Sudan was showed that kidney volumes was significantly correlated with BMI at p-value = 0.007, 0.009 with RT and left kidney volume, height at p-value=0.000, 0.000 with right and left volume(50) also consistent with a study done on 125 Sudanese healthy individuals renal volume correlated positively with BMI in the right and left side r = 0.85 and 0.92, (p = 0.000), respectively (51).

Limitation of the study

Baseline biochemical tests were not investigated. Single institutional based nature of the study and the relatively small sample size might limit the generalizability of the findings for all diabetic populations in Jimma zone or elsewhere in Ethiopia.

CHAPTER SEVEN

7.1. CONCLUSION

This study has provided measurements of kidney dimensions & predictors of kidney size among diabetic patients at follow up clinic in Jimma University medical center. The mean dimensions of right kidney & left kidney were length 10.263±0.764 cm and 10.421±0.714, width 5.155±0.5137 cm and 5.167±0.472 thickness 3.516±0.434 cm and 3.732 ± 0.636 respectively. And the mean volume of right and left kidney was 98.115±23.117 and 106.391 ± 25.40. Age, Body height, BMI and duration of diabetes were the main correlated variables with kidney size during bivariate analysis. In multivariable analysis; Age, Body height and BMI found to be important significantly associated factors of kidney size in our study participants. However, duration of diabetes has no significant association with kidney size.

7.2. RECOMMENDATIONS

To researcher further study has to be conducted with larger sample size. For clinical practitioners they can use this data as an input for clinical decisions particularly during diabetic patient management & kidney related problems in general.

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Annexs

Annex I

Information sheet and consent form (English and amharic version)

Verbal Consent Form for a Patient

Jimma University Institute of Health Sciences gives Information consent to take weight, height, and ultrasound scan for all eligible study subjects in JUMC from Apr 20-May 30, 2018. Title of study: ---------- My name is ----------. I am involved in a research study entitled ----------. We are asking you to take part in this research study because we are trying to learn more about correlation of ultrasonographic organometry and BMI. You will be asked to allow us to record your Height, age, sex, weight and ultrasound scan of kidney. This study is being conducted for the academic use and for future intervention not for other purpose. It has got ethical approval from the Ethical Review Committee of the health institute, Jimma University. You will not be paid for participating in this research study .Confidentiality of all records will be guaranteed and no information by participants can be identified, released or published. Your participation is voluntary All information that is collected from you during the study will be kept confidential, and your name will never be mentioned in any analysis and dissemination of findings. Taking part in this study is completely voluntary based. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify. However, the honest information you give us is highly valuable to the study and it has different parts that will take about 15-20 minutes. I am grateful to you for your consideration of this research and look forward to your response! The study has been explained to me and I understand a. What the study involves. That refusal to participate in the study will not affect my treatment or care in any way.

I therefore agree to participate in this study Full name _____
Signature of the participant _____
Date _____Tel_____ Postal address_____

I have been present while the procedure has been explained to the participant and I have witnessed his/her consent to take part in the study. Signature of witness _____ (The witness should be a person NOT connected with the study) Full name_____ Date _____Tel_____

የጥናቱ ተሣታፊ የስምምነት ቅፅ **መለያ ቁጥር፡ ----------**

እኔ ----------

የስኳር ሕክምና ተከታታይ ስሆን፣ የስኳር በሽታ በኩላልት ጤንነት ላይ ያለዉን ዝምድና ለማጥናት ዕቅድ ባለዉ የምርምር ፕሮጀክት ዉስጥ እንድሳተፍ ፍቃደኛ መሆኔን ወይም አለመሆኔን ተጠይቂያለሁ፡፡ ይህ ጥናት በተለይም የስኳር በሽታ በጊዜ ሂደት በኩላሊት ጠፍ ላይ ተጽህኖ ይኑረዉ ወይም አይኑረዉ በመመርመር የመፍትሔ አቅጣጫ የሚጠቁም መሆኑ ተነግሮኛል፡፡

ለዚህ ጥናትም የኩላሊት ጤንነት አልትራሳሆንድ ምርመራ እንዳካሄድ ተጠይቂያለሁ፡፡ በተጨማሪም ለዚሁ ጥናት የሚዳ ስለማህበራዊ አኗኗሬ የግል መረጃ፣ የሰዉነት ክብደት፣ ርዝመትና፣ የህክምና መረጃ፤ እንዲሁም ከሕክምና ካርድ ላይ ተመዘግበው ያሉትን የምርመራ ዉጤቶቼ እንደ አስፈላጊነቱ እንዲጠቀሙ ፍቃደኝነቴን ተጠይቂያለሁ፡፡

በአልትራሳሆንድ ምርመራ ወቅት ምንም አይነት ለጉዳት የሚጋልጥ ስጋት እንደሌለና ለዚህም ሲባል አልትራሳሆንድ ልምድ ባለዉ የጤና ባለሞያና የሕክምና ደንብ በሚቆጣጠረዉ የንፅህና አጠባበቅ ደረጃ እንደሚከናወን ተገልፆልኛል፡፡ ሁሉም መረጃዎችና የምርመራ ዉጤቶች ለምርምር ፍጆታ ብቻ እንደሚዉሉ፣ በምስጥር እንደሚጠዝና በጥቅል እንጂ በተናጥል የሚቀርቡ መሆኑን ተነግሮኛል፡፡ በዚህ ጥናት በመሣተፌ በቀጥታ የተለየ ጥቅም እንደማገኝና ነገር ግን የኩላሊት አልትራሳሆንድ ምርመራ ወጪ እንደሚሸፈንልኝ ተገንዝቤያለሁ፡፡ ከፈለኩ ምርመራ ዉጤን ማወቅ እንደሚቻልና ካልፈለኩ ደግሞ የግድ እንዳወቅ እንደማልገደድ ተገልፆልኛል፡፡ ከዚህ በተጨማሪ በፈለግሁ ጊዜ ከጥናቱ መዉጣት እንደምችልና ይህ ድርጊቴ በእኔ የሕክምና ክትትል ላይ ምንም አይነት ተፅዕኖ እንደማያሳድር ተነግሮኛል፡፡

ይህንን የስምምነት ቅፅ ከሙረማ በፊት እንዳስብበት በቂ ጊዜ ተሰጥቶኛል፡፡ ሲለዚህ ይህንን ስምምነቴን በምስጥበት ወቅት ሙሉ በሙሉ የገባሁትን ኃላፊነት ተረድቼና በጥናቱ ወቅት ሁሉ ለመተባበር በራሴ ፍቃድ መሆኑን በማንዘብ ነዉ፡፡

የተሣታፊዉ ስም ----------ፊርማ ------- ቀን----------

የአጥኚዉ ስም ---------- ፊርማ ------- ቀን ----------

Anne II -English version Questionnaire

Doppler Ultrasonography of the Kidneys in Diabetic Patients

Participant's code: _____

Medical Record_____

	Socio-demographic characteristics		
Q.01	Age		
Q.02	Sex	1. Male 2. Female	
	Clinical parameters		
Q.03	Body weight		
Q.04	Body height		
Q.05	Duration of diabetes		
Q.06	Type of Diabetes	1. Type I 2. Type II	
Q.07	Type of treatment taken	1. Insulin 2. Oral hypoglycemic agents 3. Both	
Q.08	FBS (mg/dl)	FBS 1_____ FBS 2_____FBS 3_____	
Q.09	Systolic Blood pressure		
Q.10	Diastolic Blood pressure		
Q.11	Do you have any known kidney diseases	1. Yes, specify _____ 2.No	
Kidney Parameters		**RT kidney**	**LF kidney**
Q.12	Position of kidneys		
Q.13	Kidney Size	Pole-to-Pole Length: _____cm Width: _____ cm Thicknes (at hilum) _____cm	Pole-to-Pole Length: _____cm Width: _____cm Thicknes (at hilum)_____cm
Q.14	Parenchymal thickness [a]		
Q.15	Kidney echogenicity	1. Normal 2.Hyperechoic 3. Hypoechoic	1. Normal 2. Hyperechoic 3. Hypoechoic

Q.16	Shape of kidneys	1. Normal 2. Abnormal	1. Normal 2. Abnormal
Q.17	Renal pulsatality index	1. Low 2. Optimum 3. High	1. Low 2. Optimum 3. High
Q.18	Renal vascular resistive index	1. Low 2. Optimum 3. High	1. Low 2. Optimum 3. High
Q.19	Renal morphologic anomaly [b]	1. Absent 2. Present, specify_____	1. Absent 2. Present, specify_____

NB: RAPI= Renal Artery Pulsatility Index, RARI= Renal Resistance Index

FBS 1= FBS before 2 months **FBS 2**= FBS before 1 month **FBS 3**= current FBS

[a]Parenchymal thickness is defined as the combined thickness of the cortex and medulla measured at the upper and lower poles and then averaged.

[b]Renal morphologic anomaly refers to renal morphologic anomalies (such as horseshoe kidney or ectopic kidney), renal parenchymal diseases, polycystic kidneys, multiple bilateral cysts (4 or more), a solitary cyst larger than 1 cm, hydronephrosis, renal tumors, qualitative stenosis of the renal arteries, infarctions, parapelvic cysts, and concrements, incomplete or complete double ureters, bifid pelvis, ureteric casts, casts in renal tubules, additional renal arteries,