THE MEDICAL BULLETIN OF
SISLI ETFAL HOSPITAL

DOI: 10.14744/SEMB.2023.08365
Med Bull Sisli Etfal Hosp 2023;57(3):353–358

Original Research

Investigation of Kidney Morphology and Somatotype Components in Early-Stage Kidney Patients

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ABSTRACT

Objectives: The aim of this study is to examine the kidney morphology and somatotype components of adult patients with early-stage chronic kidney disease (CKD).

Methods: The sample consisted of 46 individuals with early-stage CKD (26 men and 20 women, mean age=45.92±16.53 years). The pathological subjects were compared with a control group consisting of 46 healthy subjects (28 men and 18 women, mean age=41.96±11.48 years). The Heath-Carter method was used to determine somatotype components. Abdominal computed tomography (CT) of patients with Stage 2 CKD and healthy volunteers taken within the past 3 months was scanned to determine kidney morphology. Kidney measurements were performed on CTs (length, width, depth, and volume of kidney).

Results: Kidney patients (mean somatotype: 6.33–5.37–0.6) were less ectomorphic and more endomorphic than the controls (mean somatotype: 4.35–4.40–3.02). Moderate effect size (ES) was found in endomorphy (ES=0.87; p=0.035) and ectomorphy (ES=1.08; p=0.012) between groups. No significant difference was observed in the kidney morphology (ES=0.04–0.19; p>0.05).

Conclusion: In the early-stage CKD, kidney morphology may not be the distinguishing factor. On the other hand, patients differed significantly in terms of endomorph components. Being overweight can also be one of the negative findings for kidney disease. Somatotype classification could be a suitable tool for monitoring kidney disease.

Keywords: Chronic kidney disease, computed tomography, morphology, somatotype

Please cite this article as "Er Ulubaba H, Cinarli FS, Ciftci R, Ulutas O. Investigation of Kidney Morphology and Somatotype Components in Early-Stage Kidney Patients. Med Bull Sisli Etfal Hosp 2023;57(3):353–358".

Chronic kidney disease (CKD) is defined as decreased glomerular filtration rate, increased urinary albumin secretion, or both. Its worldwide prevalence is predicted as 8–16%.[1] According to CKD prevalence research, the prevalence of CKD in general adult population is 15.7% and one out of every 6–7 individuals has various stages of CKD.[2]

Radiological imaging methods provide important information about the diagnosis and clinical evaluation of kidney diseases and determining treatment options. It was reported that kidney volume and size measurements made by various radiological imaging methods are closely associated with the functional parameters of kidney.[3] Computed

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Submitted Date: November 30, 2022 **Revised Date:** April 14, 2023 **Accepted Date:** April 14, 2023 **Available Online Date:** September 29, 2023

tomography (CT), one of the imaging methods, is a reliable and sensitive method for kidney volume measurement.[4,5] Changes in kidney anatomy, especially in kidney size and nephron mass, are important factors in the development of kidney diseases. Growth retardation in the cortex, medulla, and calyceal structures of the kidney results in pathology and anomalies.[6] Kidney volume and size are important parameters used in the evaluation of anomalies such as atrophy, hypoplasia, and hypertrophy.

There are many studies in the literature investigating the parameters of organ size and body composition.[7] In general, these studies aimed to develop prediction formulas by calculating the correlation or regression between body composition or various anthropometric parameters and organ sizes.[8] One study found a significant correlation between kidney size and body mass index and body weight.[9] Another study found an assignable variation between 11.8 and 22.4% between kidney sizes of healthy adult women and men with an endomesomorphic body type determined using somatotype components and multiple anthropometric parameters such as skinfold thickness and circumference measurements.[10]

On the other hand, it can be said that somatotype characters and organ morphologies of patients are affected by disease. Somatotype measurement method, which is used to determine the morphological shape of the body, provides the classification of patients in many diseases. It is known that there are somatotype components defined in terms of many diseases such as Alzheimer, Type 2 diabetes, and obstructive sleep apnea syndrome.[11] However, to the best of our knowledge, no studies have compared the somatotype components and kidney sizes of adult early-stage kidney patients and healthy adults so far. Therefore, this study may be important for a better understanding kidney disease by determining the dominant somatotype components and kidney morphologies of early-stage kidney patients.

The purpose of this study is to compare kidney morphology and somatotype components of adult early-period kidney patients with those of healthy adults.

Methods

Experimental Design

A cross-sectional study was conducted between August 2021 and September 2021. Two groups were then scanned from the hospital archives and patients who had abdominal CT within the past 3 months were selected. We divided the patients into those with early-stage CKD and those without CKD on the basis of their eGFR values. At screening, we retrospectively enrolled those with abdominal BTS within 3 months in PACS and measured the somatotypes of those with CT at PACS at the time of their examination in the nephrology clinic. Measurements were taken for somatotype classification of the patients in the two groups. All procedures were conducted in accordance with the 2008 Declaration of Helsinki.

Patients and Control Subjects

Sample size was determined by a priori power analysis using G-Power (3.1.9.3). Since there is no previous study examining kidney morphology and somatotype components in determining participant size, Udicki *et al*.[12] have used and the effect size (ES) for ectomorph body type between cancer patients and healthy subjects was determined as 0.55. The Type I error (α) was 0.05 and the discriminatory power (1-β) was 0.80 with a one-tail independent t-test. The model indicated a minimum sample size of 82 subjects. A group of 46 patients (26 men and 20 women, mean age=45.92±16.53 years) who referred to university hospital nephrology outpatient clinics, who were examined by a physician, and who were diagnosed by Stage 2 CKD and 46 healthy volunteers were included in the study. A group of 46 healthy individuals (28 men versus 18 women, mean age=41.96±11.48 years) was formed from individuals referred to the nephrology department of our hospital who had an eGFR > 90 mL/min/1.73 m^2, albuminuria, and no renal abnormality. Of the CKD patients, the patients who were classified as Stage 2 CKD according to guidelines approved by kidney dialysis initiative global outcomes study group and who had eGFR 60–89 mL/min/1.73 m^2 were included in the study.[13] The eGFR values of the patients were 68.8±7.9 mL/min/1.73 m^2 and those of the control group were 96.6±5.8 mL/min/1.73 m^2. In addition, When the etiology of the patients is examined, diabetic nephropathy (n=13), chronic glomerulonephritis (n=11), hypertensive nephropathy (n=9), nephrolithiasis, obstruction, etc. urological disease (n=5), and unknown (n=8). In addition, 20 out of 46 patients in the patient group had microproteinuria. The microprotein average of the patients with microproteinuria was 95.8 mg/dL in the spot urine test and + and ++ in the dipstick urine test. No proteinuria was detected in 66% of the patient group and in the control group in both tests. Since Stage 1 CKD would not have radiological findings, Stage 2 early CKD patients were included in the study. CTs of 46 patients with normal kidney functions and 46 Stage 2 CKD patients were selected. There were no known chronic diseases in the patient and control groups. Patients with congenital anomalies, large cortical cysts or masses, partial or total nephrectomy, and atrophic kidneys were excluded from the study.

Imaging Protocol

Images of the patients included in the study were obtained from Somatom Definition Flash, Simens Healthcare, Forchheim, Germany, dual source spiral CT at Inonu University University, Faculty of Medicine, Department of Radiology. The images were examined retrospectively and CTs taken within the past 3 months were selected. Linear measurements (length, lateral width, and anteroposterior depth) of the kidneys of both groups were made by a radiologist, right and left kidneys were measured for each patient, and their means were calculated. Images were analyzed in coronal, sagittal, and transverse planes for measurements. The maximum length of the kidney was measured in the plane with the highest longitudinal measurement (Fig. 1a). Width and depth measurements were made at the level of the renal hilum in the transverse plane. The width was measured from the renal capsule to the renal sinus. The depth measurement was taken perpendicular to the width (Fig. 1b). Kidney volume was estimated using the following ellipsoid formula: Kidney volume=length (average of sagittal and coronal lengths)×width×depth× (π/6).[14]

Somatotype Measurements

Somatotype measurement was made with Heath-Carter formula. Measurements taken for somatotype were body height and weight, skinfold thickness from the four skinfold sites (triceps, subscapular, suprailiac, and calf), biepicondyler humerus and femur breaths and girths of the mid-upper arm and calf. Somatotype calculations were made with "Somatotype for Windows 1.2.5 Trial Version" program.[15]

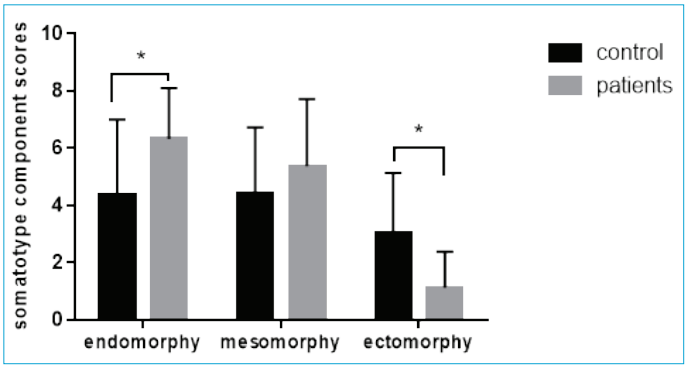

Figure 1. Measurement of kidney sizes in computed tomography. A: Coronal plane, B: Transverse plane, l: Length, w: Width, and d: Depth.

Statistical Analysis

All statistical analyses were performed using SPSS version 23 statistical software (SPSS, Chicago, IL, USA). The data distribution was assessed by the Kolmogorov–Smirnov test. A Levene test was used to determine homogeneity of variance. An independent sample t-test was performed to compare potential differences between healthy controls' and patients' kidney morphology and somatotype components. ESs (Cohen's d) and 95% confidence intervals (CI) were calculated to assess the difference between groups. ES values were: <0.2 trivial, 0.2–0.6 small, 0.6–1.2 moderate, 1.2–2.0 large, and >2.0 very large and >4.0 extremely large. The alpha level of statistical significance was set at $p<0.05$.

Results

There was no significant difference between the groups with respect to the demographic parameters ($p>0.05$), showing the homogeneity of the sample (Table 1).

Table 2 shows that there was not significant difference between the two groups in relation to the kidney morphology (ES=0.04–0.19; $p>0.05$). However, significant differences were found in the ectomorph (ES=1.08; p=0.12) and endomorph (ES=0.87; p=0.35) of somatotype components ($p<0.05$). Furthermore, there was a significant large difference in creatinine between groups (ES=1.88; p=0.001).

Fig. 2 shows that the patients had a greater endomorphy, while control group had a greater ectomorphy. Furthermore, dominant somatotype for patients was mesomorphic endomorphy (6.33–5.37–1.13) while control group was endomorph-mesomorphy (4.35–4.40–3.02). Moderate ES was found in endomorphy (ES=0.87; p=0.035) and ectomorphy (ES=1.08; p=0.012) between groups. However,

Table 1. Comparisons of demographic variables and creatinine between the groups

Parameters	Control (n=46)		Patient (n=46)		t	p	ES
	Min-max	Mean±SD	Min-max	Mean±SD			
Age (years)	20–65	41.96±11.48	20–66	45.92±16.53	–0.997	0.324	0.27
Height (cm)	158–186	170.85±9.70	155–177	168.08±7.60	0.810	0.426	0.31
Weight (kg)	56.2–100	68.71±12.05	65–95	77.45±9.67	–2.039	0.053	0.8

ES: Effect size with 95% confidence interval.

Table 2. Comparisons of kidney morphology variables and somatotype components between the groups

Parameters	Control (n=46)			Patient (n=46)			t	p	ES
	Min-Max	Median	Mean±SD	Min-Max	Median	Mean±SD			
Kidney Length (mm)	90–119	106.5	104.38±7.92	75.1–137	103.85	103.84±13.14	0.180	0.858	0.04
Kidney Width (mm)	42.4–61.3	52	52.75±4.82	43–66.2	53.86	53.86±6.39	–0.706	0.484	0.19
Kidney Depth (mm)	42.8–72	51.25	51.9±6.39	38–64	51.37	51.36±7.20	0.285	0.177	0.07
Kidney Volume (ml)	115–238	143	150.11±29.93	64–285	155.5	155.5±53.86	–0.446	0.658	0.12
Creatinine (mg/dl)	0.60–1.10	1	0.96±0.37	1.20–2	1.6	1.52±.20	–8.153	0.001**	1.88
Endomorphy	1.7–8.8	3.4	4.35±2.65	3.8–9	6.33	6.33±1.77	–2.234	0.035*	0.87
Mesomorphy	1.4–9.3	4.7	4.40±2.33	2.7–9,5	5.37	5.37±2.34	–1.065	0.297	0.41
Ectomorphy	0.1–6.2	3.1	3.02±2.11	0.10–3.5	1.13	1.13±1.25	2.767	0.012*	1.08

**: p<0.01; *: p<0.05; ES: Effect size with 95% confidence interval.

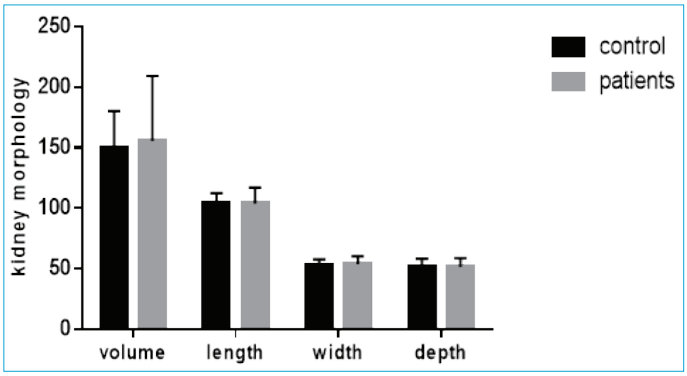

Figure 2. Comparisons of somatotype components between the groups.

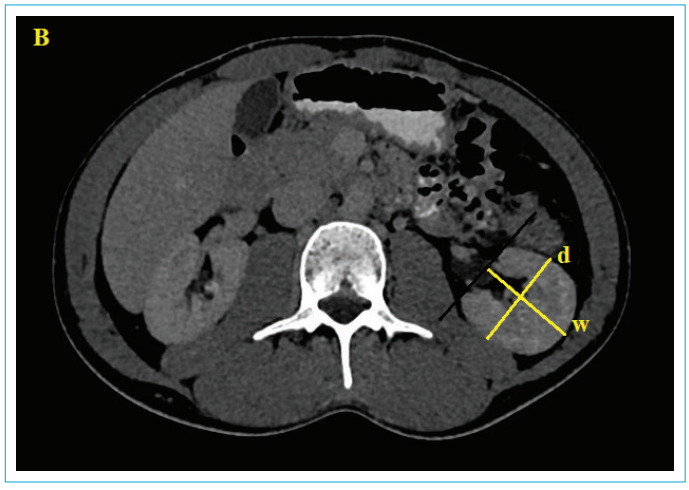

Figure 3. Comparisons of kidney morphology variables assessed with the computed tomography between the groups.

there was no significant difference in kidney morphology between groups for all variables (ES=0.04–0.19; p>0.05) (Fig. 3).

Discussion

Kidney morphology and somatotype body types of early-stage CKD patients were examined in the study. According to the results, no difference was found between the early-stage CKD patients and the control group in terms of organ morphology. However, when somatotype body types were examined, it was found that kidney patients had statistically higher endomorphy and lower ectomorphy body type.

Measurements of kidney length and volume are generally used in the diagnosis of kidney function and disease. In this study, no significant difference was found between Stage 2 CKD patients and healthy groups in terms of kidney volume and size with CT. In a study conducted with all stages of CKD, similarly no decrease was found in early-stages in terms of kidney length and volume.[16] Since GFR decreased in Stage 2 CKD patient group, creatinine levels were higher when compared with the healthy group. No studies were conducted on somatotype previously, and in studies conducted with BMI, kidney size and volume were found to be correlated with BMI.[17-19] We think that kidney volumes do not differ due to fat in renal sinus due to the predominance of endomorph somatotype in early-stage CKD patients. As a result, it can be stated that measurement of kidney sizes with CT could not be enough in detecting Stage 2 CKD patients.

Somatotype is an important classification technique used in the determination of human body type. Numerous clinical studies have found similarities between the somatotype body types of individuals with certain psychological

and physiological diseases.[20] Katzmarzyk et al.[21] stated that somatotype classification may be used as a prediction parameter in terms of predisposition to disease. Therefore, it can be expected for somatotype classification to be predominant in certain diseases. For example, the high level of correlation between coronary artery disease and endomorphy scores showing adiposity or the fact that Alzheimer patients being less mesomorphic or more ectomorphic may be concrete examples explaining this situation.[22]

To the best of our knowledge, no study has yet investigated the somatotypic body types of early-stage CKD patients. On the other hand, it is mentioned that there is a correlation between kidney disease and body composition.[23] Using the glomerular filtration rate, which is used in determining kidney disease, it was found that the prevalence of CKD was higher in obese participants than in normal weight participants.[24] A positive relationship is also referred to between body fat ratio and the risk of kidney stone formation.[25] The linear correlation between high serum uric acid, which is one of the important indicators of kidney disease, and obesity also explains this situation.[26] Therefore, it can be stated that endomorphic predisposition increases the risk of kidney disease. Statistically higher endomorphy scores of early-stage kidney patients in our study are correlated with the present literature (ES=0.87; 95% CI, $p<0.05$). On the other hand, in a regression study comparing the kidney morphology and ectomorphy scores of ectomorphic healthy women, it was found that ectomorphy content could predict healthy organ morphology at a high level (for the right kidney R^2 from 0.607 to 0.973; for the left kidney R^2 from 0.898 to 0.952).[10] In our study, it was found that ectomorphy scores of the control group consisting of healthy women and men were statistically higher than CKD patients (ES=1.08; 95% CI, $p<0.05$). At this point, it can be said that body fat is an important risk factor in the occurrence of kidney disease. Clinical studies conducted have found that body fat is significantly high in many diseases such as cancer, kidney stones, and non-alcoholic fatty liver.[27-29] Therefore, the excess endomorphic component may be an important feedback on the disease in kidney patients.

To the best of our knowledge, our study is the first to demonstrate that dominant somatotype is more endomorphic and less ectomorphic in early-stage CKD patients. However, there are some limitations of the study. The first one is the fact that it could not be possible to generalize the results due to a small number of patients. Since linear regression analysis was not performed due to the number of participants, the level of somatotype predicting kidney disease was not examined. The second limitation is that parameters that may be related with kidney disease such as waist and hip circumference were not examined. Multiple linear regression analyses may be performed by adding these parameters and increasing the number of patients. Finally, the relationship between body types and proteinuria has not been studied, as only 44% of patients had high microalbumin levels. However, it is believed that in future studies somatotype and proteinuria levels can be related and provide important results. Despite these limitations, it can be said that the study has important clinical finding, as it is the first study in the literature to examine the detailed somatotype classification of early-stage CKD patients and to show that they differ significantly from the control subjects.

Conclusion

The results obtained show that early-stage CKD patients do not differ from healthy individuals in terms of kidney morphology, while somatotype scores differ as an important distinguishing factor. Therefore, we think that somatotype classification is a parameter that can be applied in the clinic and may give important feedback about kidney disease in early-stage.

Disclosures

Ethics Committee Approval: The study was approved by the Ethics Committee of Malatya Inonu University Clinical Researches Ethical Board (No: 2021/207, dated 12.01.2022).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – H.E., O.U.; Design – H.E., O.U.; Supervision – F.S.C., H.E.; Fundings – R.C, F.S.C.; Materials – H.E.U., O.U.; Data collection and/or processing – R.C., F.S.C.; Analysis and/or interpretation – F.S.C.; Literature review – H.E., R.C.; Writing – F.S.C., R.C., H.E.U.; Critical review – O.U.

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