Association of Anthropometric Indices with Albumin to Creatinine Ratio and Glomerular Filtration Rate, as Indices of CKD: A Population-based Study

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Introduction. This study was an attempt to detect the relationship between chronic kidney disease (CKD) and anthropometric indices in presence of confounding variables.
Methods. A cross-sectional study of 3375 participants was designed in Isfahan city. Waist-height ratio (WHtR), waist-hip ratio (WHR), body mass index (BMI) and waist circumference (WC) were measured. Participants were divided into CKD and non-CKD groups according to the calculated albumin to creatinine ratio (ACR) and estimated glomerular filtration rate (eGFR). Then, the groups were subdivided into sub-groups of high and normal anthropometric indices.
Results. To evaluate CKD in relation to anthropometric indices, odds ratio was calculated; in the female group, no association was observed ($P > .05$). However, in the male group high levels of WHtR and BMI were associated with CKD (P value of .002 and .015, respectively). To evaluate the association between ACR and eGFR with anthropometric indices linear regression analysis was performed. There was no significant relation between ACR and eGFR with anthropometric indices in both sexes in a fully adjusted state ($P > .05$).
Conclusion. High WHtR and BMI probably are associated with CKD in male. WHR and WC have no relation to the occurrence of CKD. There are no significant changes in regard to ACR and eGFR.

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INTRODUCTION

Prevalence of chronic kidney disease (CKD) is widely increasing, affecting one in 10 people in developed countries.[1,2] Patients with CKD are at high risk of developing end-stage kidney disease (ESKD) and cardiovascular morbidity and mortality.[3,4] CKD is defined as estimated glomerular filtration rate (eGFR) of less than 60 mL/min/1.73m² for at least three months regardless of its causes, or presence of albumin-creatinine ratio (ACR) of more than 30 mg/g in a random urine sample.[1] Moderately increased albuminuria is defined as urinary ACR between 30 to 300 mg/g and minimally increased albuminuria below 30mg/g.[5] Kidney damage is usually asymptomatic and its prevalence has increased over the past decade; therefore, knowing its different risk factors, and early diagnosis and treatment of them, is of high value and slows down the progression of CKD.[6,7]

Different studies have shown that various

risk factors, e.g., advanced age, increased fasting plasma glucose (FPG), diabetes mellitus (DM), hypertension (HTN), smoking, and a history of cardiovascular disease (CVD), have an impact on CKD.[2,4,7,8] Obesity is considered to be one of the risk factors of increasing incidence of CVD, HTN and microalbuminuria, which in turn causes progression of renal damage.[8,9] Abdominal obesity is significantly associated with microalbuminuria as well.[8] Anthropometric indices including body mass index (BMI), waist circumference (WC), waist-height ratio (WHtR), and waist-hip ratio (WHR) have been used to measure obesity.[10] In previous studies, anthropometric indices have shown different relationships with CKD, and it might be due to differences in their sample population and considering risk factors for CKD. [2,4–6,10,11] Ideal measurement of obesity in CKD patients is not confirmed yet.[10] Although in some studies, it has been suggested that WC, WHtR, and WHR have more correlation with CKD than BMI, there are other studies which suggest an increased risk of CKD with BMI.[10,11] Some studies suggest WHtR as a more acceptable predictor of CKD.[4,9] Therefore, there is no consensus regarding the relationship between CKD and different anthropometric indices. The main purpose of this study was to evaluate the effect of BMI, WHR, WC, and WHtR on CKD in a large population in the middle east for the first time.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional population-based study was conducted in Isfahan, Iran from January 2017 to January 2018. Participants included 3375 participants, selected from those visiting affiliated health care centers related to Isfahan university of Medical Sciences. This study was conducted following the Declaration of Helsinki and Institutional review board of ethics committee of Isfahan University of Medical Sciences (IR.MUI.REC.1396.1.086). Informed consent was obtained from all the study participants. Participants were selected in different areas of the city which were covered by the health care system according to the latest statistics of municipalities, on the basis of age, sex. All participants were residents of Isfahan city and above 18 years old. The study exclusion criteria were presence of fever and common cold within the past week, heavy exercise forty-eight hours before laboratory tests, fasting, unwillingness to participate in this study, pregnancy or menstruation period.

Blood pressure (BP) was measured in sitting position after fifteen minutes of rest. Participants should not consume tea, coffee, or food, smoke, or do any physical activity for at least thirty minutes before BP measurement. Bladder should be emptied before taking BP. Digital sphygmomanometers (Omron BF511, Omron Corp, Kyoto, Japan) was used to measure BP from right arm of the participants. In cases of high blood pressure (BP ≥ 140/90 mmHg) then after five minutes, a second measurement was done, and average of both calculated BP measurements were considered as actual BP. The diagnosis of HTN is made by a systolic BP (SBP) ≥ 140 mmHg and diastolic BP(DBP) ≥ 90 mmHg measured in two different days. Grade one HTN is defined as SBP 140 to 159 mmHg and DBP 90 to 99 mmHg. Grade two HTN is defined as SBP ≥ 160 mmHg and DBP ≥ 100 mmHg.[12,13] Participants were considered hypertensive, if there is any usage of anti- hypertensive medications and/or above criteria.[12,13] Known cases of HTN include participants with high BP, taken in health care centers and usage of anti-hypertensive medications.[12,13]

Anthropometric Variables

Anthropometric indices were measured in the affiliated health care centers related to Isfahan University of Medical Sciences. A mechanical scale, GL-6000-20 (G-tech, Seoul, Korea) was used for weight measurement with accuracy of 0.01 kg, without wearing shoes and with minimum clothing.[5] For height measurement, a stadiometer was used at an accuracy of nearly one millimeter (mm) with no shoes on (SECA 255; SECA, Hamburg, Germany).[5] BMI was calculated with the use of equation "weight (kg)/squared height (m^2).[14] Participants were divided into five categories based on BMI: 1) underweight (BMI < 18.5 kg/m^2); 2) normal (BMI: 18.5 to 24.9 kg/m^2); 3) overweight (BMI: 25 to 29.9 kg/m^2); 4) class one obesity (BMI: 30 to 34.9 kg/m^2); 5) class two obesity (BMI: 35 to 39.9 kg/m^2) and BMI > 40 is considered as a high-risk obesity.[5,15,16] WC was measured at a midpoint between the lowest margin of lower rib and iliac crest of hip at the level of mid-axillary line with minimum clothing. Hip circumference

was measured at the widest area around hip.[7] WHtR was calculated by dividing ratio of WC to height and WHR was calculated by dividing ratio of WC to hip circumference.[6,10,11,17]

Laboratory Tests

Blood samples were collected after an overnight fast of about twelve hours.[17] Albumin and creatinine (Cr) were measured from first morning random urine sample. Sulfosalicylic acid procedure (MN analyticon) kit) was used for measuring urinary albumin. Urine Cr and serum Cr milligram (mg) per deciliter (dL) were measured by Jaffe calorimetric method on Hitachi-917 auto-analyzer (PARS Azmun kit, Iran).[6] ACR was measured as the ratio of random urine albumin to random urine creatinine levels (milligram per gram).[5,10] All urinary cases of ACR > 30 mg/g were double checked, even if eGFR > 60 mL/min/ 1.73m². eGFR was measured by Chronic Kidney Disease-Epidemiology Collaboration (CKD-EPI) equation.[18] eGFR is expressed as mL/min/ 1.73m². FPG, serum level of cholesterol, High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL) and serum triglyceride (TG) were calculated by enzymatic colorimetric method (Azmun kits on Hitachi-917 auto analyzer). Blood Urea Nitrogen (BUN) was measured by Urease GLDH method on Hitachi-917 analyzer (Adit kit).

Statistical Analysis

Descriptive analysis was performed in this study. Quantitative variables were presented as mean ± SD and qualitative variables were presented as percentage (number). Both men and women were divided into two groups of CKD and non-CKD individuals according to calculated eGFR and ACR. Each group was subdivided into two subdivisions of high and normal anthropometric indices and analyzed based on various risk factors by using the Chi-square test. The t-test was used to determine the prevalence of CKD according to the four groups of anthropometric indices. To evaluate the relationship between CKD and anthropometric indices in both males and females, odds ratio was performed with adjustment of different confounding variables in four models. The association between ACR and anthropometric indices in both sexes was conducted by using beta regression analysis with adjustment of different confounding variables in four different groups and association between eGFR and anthropometric indices in both male and female participants was done by odds ratio and adjustment of confounding variables in four models. Statistical analyses were conducted using SPSS version 20. A probability (P) of < .05 was considered significant.

RESULTS

A total of 3375 participants were included in this study. Mean age in female participants was 48.08 years, and in the male participants it was 51.09 years, with average of 49.3 years in both sexes. 59.3% of the total population were female; 18.6% were CKD patients, 85.5% of the study participants were married and 36.3% had elementary education. Most of the study population were non-smoker (84.1%), non-alcoholic (96.3%) and non-opioid user (96.8%).[19]

Participants were divided into two groups of CKD and non-CKD and each group was subdivided into normal and high anthropometric indices and different risk factors including age, smoking, eGFR, serum Cr, ACR, FBG, cholesterol, TG, LDL, HDL, history of DM, CVD and cerebrovascular disorders were analyzed (Table 1).

The optimal cut-off levels for WHtR was considered as 0.56 cm for men and 0.48 for women participants. In the non-CKD group, differences in risk factors between the two subgroups were significant (< .05), except for CVD. In the CKD group differences in risk factors were significant (P < .05) except for CVD, HDL, TG and ACR (Table 1).

The optimal cut-off levels for WHR in men and women were considered 0.87 cm and 0.78 cm, respectively. In CKD participants only age, eGFR, cholesterol, TG and HDL were significant between normal and high WHR subgroups (P < .05). In non-CKD participants all criteria were significant between two subgroups except ACR. In CKD group differences in risk factors between two subgroups is significant exclusively for age, eGFR, cholesterol, TG and HDL (Table 1). In non-CKD group it is significant (P < .05) except for ACR.

The optimal cut-off levels for WC in men and women were 84 cm and 98 cm, respectively. In the non-CKD group, differences in risk factors between two subgroups of normal and high WC was significant, except for CVD. In the CKD group it was significant except for smoking, LDL, HDL

Table 1. Characteristics of Male and Female Participants Who Were Categorized as Obese and Non-obese Based on Anthropometric Indices

	Non-CKD n (%) = 2746 (81.4%)		*P*	CKD n (%) = 629 (18.6%)		*P*
	Normal WHtR n (%) = 801 (29.3%)	High WHtR n (%) = 1929 (70.7%)		Normal WHtR n (%) = 113 (18.0%)	High WHtR n (%) = 515 (82.0%)	
Age	42 (34 to 55)	50 (40 to 60)	< .001	44 (32 to 64)	56 (44 to 66)	< .001
Smoking Use in Lifelong	238 (29.7%)	217 (11.2%)	< .001	25 (22.1%)	49 (9.5%)	< .001
GFR	96 (86 to 107)	90 (79 to 99)	< .001	94 (77 to 104)	81 (63 to 94)	< .001
Cr	0.92 (0.83 to 1.00)	0.82 (0.74 to 0.92)	< .001	0.92 (0.83 to 1.03)	0.85 (0.76 to 1.02)	.031
ACR	8 (6 to 11)	10 (7 to 13)	< .001	21 (10 to 52)	29 (11 to 52)	.388
FBG	81 (75 to 88)	84 (77 to 92)	< .001	83 (75 to 93)	87 (79 to 98)	.003
Cho	162 (136 to 192)	171 (142 to 202)	< .001	161 (129 to 190)	170 (141 to 201)	.015
TG	136 (92 to 185)	148 (108 to 190)	< .001	132 (91 to 183)	144 (110 to 189)	.140
LDL	89 (71 to 111)	98 (78 to 119)	< .001	85 (67 to 105)	93 (70 to 114)	.041
HDL	48 (41 to 55)	51 (44 to 58)	< .001	48 (42 to 57)	49 (42 to 56)	.951
Diabetes Mellitus	50 (6.2%)	265 (13.7%)	< .001	14 (12.4%)	120 (23.3%)	.010
Hypertension	68 (8.5%)	407 (21.1%)	< .001	19 (16.8%)	182 (35.3%)	< .001
Cardiovascular Disorders	20 (2.5%)	62 (3.2%)	.317	3 (2.7%)	32 (6.2%)	.135
Cerebrovascular Accident	94 (11.7%)	432 (22.4%)	< .001	12 (10.6%)	160 (31.1%)	< .001
	Normal WHR n (%) = 373 (14.0%)	High WHR n (%) = 2294 (86.0%)	*P*	Normal WHR n (%) = 63 (10.1%)	High WHR n (%) = 559 (89.9%)	*P*
Age	38 (32 to 47)	50 (39 to 59)	< .001	41 (33 to 58)	56 (43 to 67)	< .001
Smoking Use in Lifelong	79 (21.2%)	361 (15.7%)	.009	4 (6.3%)	70 (12.5%)	.151
GFR	97 (85 to 109)	90 (80 to 100)	< .001	93 (76 to 105)	82 (64 to 96)	.003
Cr	0.85 (0.77 to 0.95)	0.85 (0.76 to 0.95)	.711	0.84 (0.77 to 0.99)	0.86 (0.77 to 1.03)	.303
ACR	9 (7 to 13)	9 (7 to 13)	.244	26 (9 to 49)	28 (11 to 52)	.231
FBG	80 (75 to 87)	83 (77 to 91)	< .001	83 (78 to 92)	86 (78 to 98)	.084
Cho	159 (131 to 188)	170 (142 to 200)	< .001	156 (131 to 182)	170 (141 to 200)	.007
TG	116 (82 to 164)	149 (108 to 191)	< .001	100 (78 to 144)	148 (112 to 191)	< .001
LDL	89 (70 to 110)	97 (77 to 117)	< .001	85 (63 to 104)	92 (69 to 114)	.122
HDL	52 (44 to 61)	50 (43 to 57)	< .001	53 (46 to 62)	48 (42 to 55)	< .001
Diabetes Mellitus	14 (3.8%)	292 (12.7%)	< .001	8 (12.7%)	126 (22.5%)	.072
Hypertension	28 (7.5%)	442 (19.3%)	< .001	12 (19.0%)	187 (33.5%)	.020
Cardiovascular Disorders	7 (1.9%)	74 (3.2%)	.159	0 (0.0%)	35 (6.3%)	.039
Cerebrovascular Accident	30 (8.0%)	483 (21.1%)	< .001	7 (11.1%)	164 (29.3%)	.002

Table 1. Continued

	Normal WC n (%) = 1050 (39.1%)	**High WC n (%) = 1632 (60.9%)**	***P***	**Normal WC n (%) = 191 (30.7%)**	**High WC n (%) = 431 (69.3%)**	***P***
Age	43 (35 to 56)	51 (41 to 60)	< .001	48 (35 to 66)	56 (45 to 66)	< .001
Smoking Use in Lifelong	253 (24.1%)	191 (11.7%)	< .001	28 (14.7%)	46 (10.7%)	.157
GFR	95 (84 to 105)	89 (79 to 99)	< .001	88 (71 to 102)	81 (64 to 94)	.002
Cr	0.89 (0.79 to 0.99)	0.82 (0.74 to 0.92)	< .001	0.91 (0.79 to 1.07)	0.85 (0.76 to 1.00)	.011
ACR	9 (7 to 12)	10 (7 to 13)	< .001	18 (10 to 48)	30 (11 to 53)	.037
FBG	81 (75 to 88)	84 (77 to 93)	< .001	83 (77 to 91)	88 (79 to 100)	< .001
Cho	163 (136 to 193)	173 (144 to 203)	< .001	162 (133 to 192)	171 (143 to 201)	.003
TG	132 (90 to 180)	153 (111 to 193)	< .001	128 (93 to 177)	150 (114 to 192)	< .001
LDL	90 (72 to 113)	99 (78 to 119)	< .001	88 (67 to 111)	93 (70 to 114)	.161
HDL	49 (42 to 57)	51 (44 to 58)	.008	49 (42 to 57)	48 (42 to 56)	.385
Diabetes Mellitus	76 (7.2%)	233 (14.3%)	< .001	31 (16.2%)	103 (23.9%)	.032
Hypertension	112 (10.7%)	360 (22.1%)	< .001	39 (20.4%)	160 (37.1%)	< .001
Cardiovascular Disorders	26 (2.5%)	56 (3.4%)	.161	8 (4.2%)	27 (6.3%)	.300
Cerebrovascular Accident	125 (11.9%)	391 (24.0%)	< .001	30 (15.7%)	141 (32.7%)	< .001
	Normal BMI n (%) = 2114 (79.2%)	**High BMI n (%) = 555 (20.8%)**	***P***	**Normal BMI n (%) = 452 (73.3%)**	**High BMI n (%) = 165 (26.7%)**	***P***
Age	47 (37 to 58)	51 (42 to 59)	< .001	55 (41 to 67)	56 (45 to 64)	.297
Smoking Use in Lifelong	364 (17.2%)	78 (14.1%)	.088	52 (11.5%)	22 (13.3%)	.764
GFR	92 (81 to 102)	88 (79 to 99)	< .001	84 (64 to 98)	81 (65 to 94)	.239
Cr	0.85 (0.76 to 0.96)	0.83 (0.76 to 0.93)	.011	0.85 (0.77 to 1.03)	0.86 (0.78 to 1.02)	.494
ACR	9 (7 to 13)	9 (7 to 13)	.466	23 (10 to 50)	33 (13 to 64)	.008
FBG	82 (76 to 90)	85 (78 to 93)	< .001	85 (77 to 96)	88 (80 to 101)	.012
Cho	167 (138 to 196)	178 (150 to 209)	< .001	167 (135 to 196)	172 (150 to 207)	.005
TG	142 (101 to 185)	160 (119 to 204)	< .001	137 (101 to 183)	152 (120 to 205)	.002
LDL	94 (74 to 115)	103 (79 to 122)	< .001	91 (69 to 113)	92 (69 to 116)	.898
HDL	50 (43 to 57)	50 (43 to 58)	.779	49 (43 to 57)	47 (41 to 53)	.013
Diabetes Mellitus	228 (10.8%)	80 (14.4%)	< .001	91 (20.1%)	41 (24.8%)	.327
Hypertension	327 (15.5%)	145 (26.1%)	< .001	127 (28.1%)	71 (43.0%)	< .001
Cardiovascular Disorders	60 (2.8%)	22 (4.0%)	.295	26 (5.8%)	9 (5.5%)	.772
Cerebrovascular Accident	369 (17.5%)	151 (27.2%)	< .001	113 (25.0%)	56 (33.9%)	.003

Abbreviations: GFR, glomerular filtration rate; Cr, creatinine; ACR, albumin-creatinine ratio; FBG, fasting blood glucose; Cho, cholesterol; TG, triglyceride; LDL, low density lipoprotein; HDL, high density lipoprotein; BMI, body mass index; WHtR, waist-height ratio; WHR, waist-hip ratio; WC, waist circumference.

and CVD (Table 1). The optimal cut-off levels for BMI were considered to be 25 in both sexes. In the CKD group differences in risk factors between two subgroups were significant except for age, smoking, eGFR, serum Cr, LDL, DM and CVD (Table 1). In the non-CKD group, it was significant except for smoking, ACR, HDL.

To evaluate CKD in relation to anthropometric indices in the male participants; odds ratio (95% CI) was calculated in four different models to reduce the effects of confounding variables as shown in Table 2. In crude model, all anthropometric indices are significant ($P < .05$). In model one all anthropometric indices are significant except for WHR. In models two and three, BMI and WHtR were significant (Table 2). It is noteworthy that in females, all anthropometric indices in all four models were not significant (Table 2).

To evaluate the association between ACR and anthropometric indices in females, linear regression analysis was performed in four different models to reduce the effects of confounding variables (Table 3). In crude model all anthropometric indices were significant except for WHR ($P < .05$). In model one, BMI and WHtR were significant (P value in order: .014 and .002). All four anthropometric indices were not significant in model two and three. In male participants, there was a significant association between WHtR and WHR with high levels of ACR in crude state (P value in order .011 and .007, Table 3).

To evaluate association between eGFR and anthropometric indices in male, linear regression analysis was performed in four different models by removing the effect of confounding variables step by step. In crude model all anthropometric indices are significant except BMI ($P = .053$). In model one, WC was significant ($P = .045$). All four anthropometric indices were not significant in model two and three (Table 4). All anthropometric indices were significant, except WHR in female in crude model (P value 0.665) and all four anthropometric indices in female were not significant in all models (Table 4).

DISCUSSION

This study was an attempt to detect the relationship between CKD and anthropometric indices. In this study, in fully adjusted models, WHtR and BMI associated with CKD in male

Table 2. Odds Ratios for Incident CKD in Relation to Anthropometric Indices in Male and Female

	Crude Model		Model One		Model Two		Model Three	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
BMI								
Male	1.938 (1.378 to 2.726)	< .001	2.022 (1.418 to 2.883)	< .001	1.659 (1.128 to 2.441)	.010	1.620 (1.097 to 2.394)	.015
Female	1.136 (0.885 to 1.458)	.317	1.032 (0.801 to 1.329)	.810	0.972 (0.744 to 1.269)	.835	0.975 (0.746 to 1.276)	.856
WHtR								
Male	1.938 (1.378 to 2.726)	< .001	2.043 (1.488 to 2.805)	< .001	1.760 (1.256 to 2.464)	.001	1.702 (1.211 to 2.393)	.002
Female	1.007 (0.704 to 1.440)	.969	0.712 (0.488 to 1.041)	.079	0.675 (0.455 to 1.002)	.051	0.677 (0.456 to 1.005)	.053
WHR								
Male	2.592 (1.472 to 4.564)	< .001	1.781 (0.995 to 3.189)	.052	1.670 (0.914 to 3.051)	.095	1.696 (0.923 to 3.116)	.089
Female	1.104 (0.791 to 1.540)	.560	0.893 (0.633 o 1.259)	.518	0.796 (0.557 to 1.137)	.210	0.790 (0.553 to 1.129)	.195
WC								
Male	1.749 (1.308 to 2.338)	< .001	1.531 (1.136 to 2.065)	.005	1.282 (0.932 to 1.764)	.126	1.245 (0.901 to 1.719)	.184
Female	1.126 (0.868 to 1.461)	.372	0.872 (0.661 to 1.149)	.330	0.836 (0.624 to 1.120)	.230	0.841 (0.627 to 1.128)	.248

Abbreviations: BMI, body mass index; WHtR, waist-height ratio; WHR, waist-hip ratio; WC, waist circumference. Model One = Age Model Two = Model One + Blood Pressure + Smoking Use in Lifelong + FBG + Cho + TG + LDL + HDL Model Three = Model Two + Diabetes Mellitus + Hypertension + Cardiovascular Disorders + Cerebrovascular Accident

Table 3. Association Between ACR and Anthropometric Indices in the Study Male and Female Participants

	Crude Model		Model One		Model Two		Model Three	
	Beta std.	***P***	**Beta std.**	***P***	**Beta std.**	***P***	**Beta std.**	***P***
BMI								
Male	0.038	.172	0.035	.200	0.015	.610	0.014	.635
Female	0.060	.010	0.058	.014	0.027	.277	0.031	.208
WHtR								
Male	0.070	.011	0.052	.073	0.032	.302	0.029	.351
Female	0.093	< .001	0.079	.002	0.050	.066	0.049	.074
WHR								
Male	0.074	.007	0.056	.054	0.042	.167	0.039	.200
Female	0.000	.999	0.000	.987	-0.002	.929	-0.002	.938
WC								
Male	0.044	.108	0.033	.238	0.013	.672	0.010	.740
Female	0.060	< .001	0.066	.007	0.036	.165	0.035	.170

Abbreviations: BMI, body mass index; WHtR, waist-height ratio; WHR, waist-hip ratio; WC, waist circumference. Model One = age Model Two = Model One + Blood Pressure + Smoking Use in Lifelong + FBG + Cho + TG + LDL + HDL Model Three = Model Two + Diabetes Mellitus + Hypertension + Cardiovascular Disorders + Cerebrovascular Accident

Table 4. Association Between GFR and Anthropometric Indices in the Male and Female Study Participants

	Crude Model		Model One		Model Two		Model Three	
	Beta std.	***P***	**Beta std.**	***P***	**Beta std.**	***P***	**Beta std.**	***P***
BMI								
Male	-0.055	.053	-0.036	.085	-0.014	.524	-0.013	.565
Female	-0.113	< .001	0.002	.929	0.001	.968	-0.002	.918
WHtR								
Male	-0.256	< .001	-0.032	.139	-0.011	.625	-0.008	.728
Female	-0.191	< .001	0.024	.305	0.032	.195	0.031	.213
WHR								
Male	-0.242	< .001	-0.019	.391	-0.002	.922	-0.002	.940
Female	-0.010	.665	-0.013	.528	-0.012	.561	-0.012	.561
WC								
Male	-0.157	< .001	-0.042	.045	-0.021	.338	-0.018	.403
Female	-0.152	< .001	0.011	.612	0.019	.413	0.018	.447

Abbreviations: BMI, body mass index; WHtR, waist-height ratio; WHR, waist-hip ratio; WC, waist circumference. Model One = age Model Two = Model one + Blood pressure + Smoking use in lifelong + FBG + Cho + TG + LDL + HDL Model Three = Model Two + Diabetes Mellitus + Hypertension + Cardiovascular Disorders + Cerebrovascular Accident

group but not in women. Considering risk factors of CKD, high levels of WHR, WHtR, WC were associated with CKD in women in a previous study,[10] while there was a lack of association between anthropometric indices and CKD for women in the present study. It might be due to differences in the method of study. Previous study found that WHtR was associated with CKD in females; that is inconsistent with finding of this study, this association may have resulted from the failure to determine diabetes, cardiovascular disease, and cerebrovascular disorders as risk factors.[4] Valkengoed *et al.* study also suggests that high WHtR was associated with an increase in ACR level but not in fully adjusted model.[9] This difference may be due to the wide range of CKD risk factors considered and gender-based classification. Chen *et al.* has suggested that WC, WHtR, and WHR are more sensitive indices for prevalence of CKD in women.[10] This study found, no association of the above indices with CKD in women.

Considering risk factors of CKD, high level of BMI was associated with CKD in both sexes in an earlier study, while this relationship was seen only in male group in this study.[6] Age differences is one of the key factors which causes variation in result, as in previous study; only women between 18-39 years were evaluated. In comparison with previous studies, present study had a wide range of age differences between participants. A significant association between high BMI and development

of stage 3 CKD in both sexes was observed in Takehiko *et al.* study in Japan.[12] In another study, it was demonstrated that high level of BMI is associated with increasing risk of CKD in male group only, which is in line with the present study. The only difference is that they did not consider CVD and cerebrovascular disorders as confounding variables.[3] Ryuichi *et al.* study showed that high BMI is associated with decrease in eGFR score in both sexes.[20]

In our study high WHR in CKD participants is associated with age, cholesterol, TG, HDL and increased risk of HTN, CVD and cerebrovascular disorders. Without considering any CKD risk factors, association of WHR with CKD, high level of ACR, and decrease in eGFR score is significant. The effect of confounding variables in present study indicates a lack of association between WHR and WC with CKD, increased ACR and decreased eGFR. In H-S Zhang *et al.* study, WHR is considered as a non-associative index for CKD[2]. In a cohort study, the association of high WHR with decreased eGFR and increased ACR level is seen.[11] While the effect of confounding variables in the present study demonstrates a reverse result.

In the present study high WC in CKD participants is associated with age, FBS, cholesterol, TG and increased risk of DM, HTN, and cerebrovascular disorders. Considering CKD risk factors in both sexes, the present study reveals no change in CKD, ACR, and eGFR by WC. H-S Zhang *et al.* study indicates that BMI and WC are better predictors of CKD.[2] The significant difference of their study with this study is that we evaluated large number of CKD risk factors. He *et al.* study suggested that, high WC has a close relationship with CKD risk in women in non-adjusted state that supports our results.[6] A cross-sectional study has shown that high level of WC is associated with increased CKD, particularly in a male group, which is in contrast with our study. This difference t might be due to the small sample of that study compared to the present one.[17]

In the present study, data were collected from all parts of Isfahan city, Iran, the majority of which was gathered from participants who were referred to health care centers. It is suggested to perform follow up studies and their progress records during diseases course in the future. Observation and follow up of present study are recommended in order to get more impressive outcomes.

CONCLUSION

High WHtR and BMI are associated with CKD in males. WHR and WC have no relation with the occurrence of CKD and there are no significant changes in regard to ACR and eGFR.

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CONFLICT OF INTEREST

Authors declared no conflict of interest.

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