RESEARCH ARTICLE

Body Mass Index and the Relationship with Chronic Kidney Disease in a Tertiary Care Hospital in Romania

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Obesity and chronic kidney disease are epidemic size. Chronic kidney disease (CKD) appears to be more common in obese, although inter-relation is not supported by all authors. **Aim**: The aim of the study was to investigate the effects of overweight and obesity on glomerular filtration rate (GFR) and the relationship between body mass index (BMI) and other risk factors for CKD. **Methods**: This is a cross-sectional study on 627 patients admitted in a Nephrology Department between January 2007 - December 2011. Patients were divided according to eGFR in a CKD group and a non-CKD group. Patients were divided based on BMI in: normal (<25 kg/m2), overweight (≥ 25 kg/m2 and ≤30 kg/m2) and obese (>30 kg/m2). Demographical, clinical and laboratory data (serum creatinine, lipid parameters, etc) were used for the statistical analysis. The relationship between BMI (as a marker of obesity and overweight), glomerular filtration rate and other possible risk factors for chronic kidney disease was studied. **Results**: 43.70% patients were obese and 33.17% overweight. CKD prevalence was 58.69%. Logistic regression analysis showed that systolic blood pressure was the main determinant of CKD in our patients. **Conclusion**: Lack of association between BMI and CKD was demonstrated in our study.

Keywords: chronic kidney disese, body mass index, obesity

Introduction

Chronic kidney disease (CKD) is recognized as an important healthcare problem, with increasing prevalence and pandemic size [1,2].

The potential relationship between chronic kidney disease and obesity was postulated by a large number of experimental and epidemiologic studies and is a subject of wide debate. There are many pathways by which obesity may contribute to renal disease: hormonal factors, increased sympathetic activity, proinflammatory state, lipid disturbances, hemodynamic factors [3-7].

This relationship was found in the general population but studies are conflicting and difficult to compare taking into consideration that they relate to different races, different populations and different markers used to quantify obesity [8,9]

Preventing CKD and obesity and clarifying the relationship between them is an important task for current medicine because both obesity as well as chronic kidney disease confers an extremely high risk for cardiovascular morbidity and mortality and additional costs for health care systems [10,11].

The aim of this study was to investigate the relationship between BMI, chronic kidney disease and other risk factors for CKD in a population of patients with a high prevalence of chronic kidney disease.

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Methods

This cross-sectional study was performed in the Nephrology Department of Mures County Clinical Hospital from January 2007 to December 2011. All patients addmitted who had available data on body weight, blood pressure (BP) values, lipid profile, serum creatinine and glucose were included in the study.

The study was approved by the local Ethics Committee.

Body mass index was calculated with the formula $BMI = kg/m^2$. Patients were divided based on BMIs in three groups: normal (<25 kg/m^2), overweight (≥ 25 kg/m^2 and ≤30 kg/m^2) and obese (>30 kg/m^2)

eGFR was calculated using the four-variable Modification of Diet in Renal Disease Study equation (MDRD). All subjects with eGFR<60 ml/min/1.73 m^2 were included in the chronic kidney disease (CKD) group.

Statistical analysis. Data are presented as the mean ± SD for continuous variables and as proportions for categorical variables. Categorical variables were analyzed using chi-squared test. T test and one-way analysis of variance (ANOVA) was used to test the continuous variables between single and multiple groups, respectively. A value of p<0.05 was considered of statistical significance.

The association between obesity, CKD, and other possible risk factors for kidney disease was analysed using multiple regression and logistic regression analysis.

Two multiple regression analysis models using CKD as dependend variable were studied. In the first model age and BMI were independent variables. The second model was adjusted for BMI, systolic blood pressure and gender.

For both genders, two multiple regression analysis were studied. In the first model age and BMI were independent variables. The second model was adjusted for BMI, systolic blood pressure, blood glucose and total cholesterol.

Logistic regression analysis with CKD as a dependent variable and BMI, age, and systolic blood pressure as co-variates, was used in order to establish the significance of each factor for CKD.

Results

A total of 627 Caucasian patients (mean age 57.73±14.31 years, mean BMI 29.56±6.051 kg/m^2) were studied; 43.70% of them were obese and 33.17% were overweight.

The prevalence rate of chronic kidney disease was 58.69% (174 females and 194 males).

Chronic kidney disease etiology was diabetes nephropathy in 22.01% of cases, glomerular diseases in 19.83%, tubulointerstitial diseases in 25.00%, polycystic kidney disease in 2.98% and other causes in 17.11%.

Clinical characteristics of study subjects are presented in table I.

When analyzing patients grouped according to BMI values, we found that the higher BMI group have significant higher age, serum glucose, total cholesterol, triglycerides, serum proteins and hemoglobin and low values of cholesterol HDL (Table II).

No significant relationship between BMI groups and eGFR or the presence of CKD was found.

BMI was not found to be significantly correlated with eGFR in linear regression analysis.

Multiple regression analysis using CKD as dependent variable showed no association with BMI, but a significant association with age (model 1, p<0.05, Table III) and systolic blood pressure (model 2, p<0.05, Table III).

For both genders, CKD showed no relationship with BMI. Age and systolic blood pressure was associated with CKD in females and systolic blood pressure was associated with CKD in males (Table IV, V).

Logistic regression analysis using CKD as a dependent variable and BMI, age and systolic blood pressure as independent covariates showed that systolic blood pressure was the main determinant of CKD in our patients (Table VI).

Table I. Baseline clinical, laboratory and demographic data

Parameter	Mean ± SD
Age (years)	57.73 ± 14.31
BMI (kg/m2)	29.56 ± 6.051
eGFR (ml/min/1.73 m2)	53.15 ± 32.79
Systolic blood pressure (mmHg)	137.8 ± 21.51
Blood glucose (mg/dl)	115.5 ± 50.87
Hemoglobin (g/dl)	12.28 ± 2.317
Serum urea (mg/dl)	69.78 ± 52.12
Total cholesterol (mg/dl)	198.3 ± 69.28
Serum triglycerides (mg/dl)	182.6 ± 143.4
Cholesterol HDL (mg/dl)	45.36 ± 17.07
Serum albumins (g/l)	41.71 ± 19.52
Serum proteins (g/dl)	6.617 ± 0.9116
24h urinary proteins (g/24h)	1.307 ± 2.163

Table II. Comparative study of anthropometric, clinical and laboratory parameters in normal BMI, overweight and obese patients

	BMI<25 kg/m2 Mean ± SD	BMI≥25 kg/m2 and ≤30 kg/m2 Mean ± SD	BMI>30 kg/m2 Mean ± SD	p
Age (years)	53.24±17.47	58.21±14.93	59.74±11.17	<0.0001
Females (N /%)	73/50.34%	93/44.71%	162/59.12%	<0.05
Systolic blood pressure (mmHg)	136.0±22.76	137.5±24.57	139.0±18.10	NS
Blood glucose (mg/dl)	106.4±52.51	112.4±51.70	122.2±48.71	<0.05
eGFR (ml/min/1.73 m2) MDRD	51.75 ± 37.64	53.73±33.14	53.46±29.74	NS
Hemoglobin (g/dl)	11.53±2.297	12.46±2.491	12.56±2.097	<0.0001
Serum urea (mg/dl)	69.96±59.15	70.14±56.96	69.45±45.23	NS
Total cholesterol (mg/dl)	190.0±70.96	205.0±84.61	197.7±53.40	NS
Serum triglycerides (mg/dl)	147.5±89.59	187.5±187.3	197.5±124.9	<0.05
Cholesterol HDL (mg/dl)	50.44±20.40	45.30±16.51	42.65±14.85	<0.05
Serum proteins (g/dl)	6.371±0.9160	6.640±1.047	6.744±0.7564	<0.05
Serum albumins (g/l)	39.30±6.466	44.01±31.29	40.99±7.603	NS
Fibrinogen (mg/dl)	458.1±165.4	461.9±192.2	485.0±157.4	NS
24h urinary proteins (g/24h)	1.495±1.772	1.282±2.597	1.217±1.979	NS
Diabetes mellitus (YES/NO)	27/118	53/155	126/148	<0.0001
CKD (YES/NO)	90/55	115/93	163/111	NS

Table III. Multiple regression analysis models for all patients

		95.0% Confidence Interval		t	p	Colinearity statistics (VIF)
Model 1	(Constant)	0.152	0.608	3.275	0.001	
	AGE	0.002	0.008	3.465	0.001	1.032
	BMI	-0.009	0.004	-0.728	0.467	1.032
Model 2	(Constant)	-0.354	0.237	-0.391	0.696	
	BMI	-0.007	0.005	-0.307	0.759	1.024
	SEX	-0.179	-0.027	-2.663	0.008	1.025
	SBP	0.004	0.007	5.918	0.000	1.018

Table IV. Multiple regression analysis models in men

		95.0% Confidence Interval		t	p	Colinearity statistics (VIF)
Model 1	(Constant)	0.454	0.177	2.556	0.011	
	AGE	0.003	0.002	1.787	0.075	1.012
	BMI	0.000	0.005	-0.028	0.977	1.012
Model 2	(Constant)	-0.238	0.760	1.030	0.304	
	BMI	-0.005	0.015	0.968	0.334	1.028
	SBP	0.001	0.007	2.803	0.005	1.027
	GLU	-0.003	0.000	-2.612	0.010	1.048
	CHOL	-0.001	0.000	-1.984	0.048	1.009

Legend: BMI – body mass index, SBP – systolic blood pressure, GLU – plasma glucose, CHOL – total cholesterol

Table V. Multiple regression analysis models in woman

		95.0% Confidence Interval		t	p	Colinearity statistics (VIF)
Model 1	(Constant)	-0.035	0.571	1.742	0.082	
	AGE	0.002	0.010	2.908	0.004	1.058
	BMI	-0.011	0.006	-0.500	0.617	1.058
Model 2	(Constant)	-0.895	0.014	-1.909	0.057	
	BMI	-0.011	0.006	-.563	0.574	1.066
	SBP	0.005	0.010	5.270	0.000	1.065
	GLU	-0.001	0.001	0.255	0.799	1.031
	CHOL	-0.001	0.001	0.497	0.619	1.016

Legend: BMI – body mass index, SBP – systolic blood pressure, GLU – plasma glucose, CHOL – total cholesterol

Table VI. Logistic regression analysis with age and systolic blood pressure as independent variables

Variable	Coefficient	Std. Error	Odds ratio	95% CI	P
SBP	0.023737	0.0043666	1.0240	1.0153 to 1.0328	<0.0001
AGE	0.014977	0.0059596	1.0151	1.0033 to 1.0270	0.0120
CKD	-3.7457				

Legend: SBP – systolic blood pressure, CKD – chronic kidney disease

Discussion

Obesity and chronic kidney disease are becoming a worldwide epidemic. Both entities are associated with an enormous risk of cardiovascular disease and mortality.

Previous studies demonstrated that higher BMI was significantly associated with increased risk for CKD. In a large cohort of 11104 initially healthy men, Gelber et al showed that BMI was associated significantly with increased risk for CKD after 14 years of follow-up [12].

Ejerblad et al calculated that overweight (BMI>25 kg/m2) at age 20 was associated with a significant three-fold excess risk for chronic renal failure, relative to BMI<25 kg/m2 [13]. In a recent study made on a population screened for the presence of diabetes, increasing obesity measured by BMI was associated with a reduction in eGFR [14]. In a population-based, cross-sectional study of a Japanese community, Nomura et al found that BMI was a significant parameter independently correlated with CKD [15].

Some authors showed that the relationship is characterized by a gender difference.

Ishizaka et al showed that overweight and obesity are associated with low eGFR only in men in a group of 8168 Japanese subjects [16]. Similar results are reported by Shankar et al[8].

On the contrary, Wang and Komura find that obesity increases the risk for CKD in the general population and the association appears to be stronger in women than in men [17,18].

Our aim was to investigate the relationship between BMI (as a measure of overweight and obesity) and glomerular filtration rate in a population with high prevalence of CKD. The major finding of our study is that high BMI showed no clear association with CKD.

Our findings are consistent with previous studies of Brown et al where the association between obesity and the progression rate of chronic kidney disease was not demonstrated [19] and of Munkhaugen J et al who showed that the risk for CKD did not increase with increasing BMI in patients with normal blood pressure values [20].

Previous studies who investigated the association between chronic kidney disease and metabolic syndrome showed that BMI and abdominal obesity demonstrated little association with CKD after adjusting for possible confounders [6,21].

When analyzing patients grouped according to BMI values, we found significant differences between those with normal BMI and the overweight or obese subjects. The latter have significant higher age, serum glucose, triglycerides, serum proteins and hemoglobin and low values of cholesterol HDL. We have not shown statistically significant differences in terms of systolic blood pressure and glomerular filtration rate for the three groups of patients.

The relationship between obesity, triglycerides and HDL cholesterol was mentioned before and a possible explanation is genetics [22,23].

Some evidences about a correlation between obesity and high hemoglobin values exists, even if even if the relationship is not supported by all studies [24,25].

Patients with high body mass index had higher values for total serum proteins. It is possible that the link between the two parameters to be chronic inflammation, but our study did not show significantly higher values of inflammatory markers in patients with overweight and obesity [26].

In our patients systolic blood pressure and age are the parameters who correlates with chronic kidney disease (OR = 1.0240, respectively OR = 1.0151, Table VI).

The progressive decrease in glomerular filtration rate with increasing age is well known [27] and is also present in our patients. The effect of aging on kidney function appears to be stronger in men [28].

Previous studies and clinical trials are in agreement supporting that hypertensive patients have an elevated risk of CKD, especially if other metabolic conditions are present [29]. The relationship between hypertension and CKD has been shown to be stronger in men [30].

Hypertension is also a consequence of renal disease. The retrospective design of the present study does not allow us to establish clear if kidney damage is the cause or the consequence of hypertension.

In our study the percentage of patients with chronic kidney disease and also the number of overweight and obese patients is remarkable high compared with other studies. Selection bias may represent one answer for our results: the study was conducted on hospitalized patients, in a department where a high percentage of patients had chronic renal impairment.

The large percentage of overweight and diabetic patients may be explained, at least in part, by hypoproteic regimen recommended in chronic kidney disease. Lower protein intake is followed by an increase in the amount of carbohydrates and lipids in the diet, which may result in obesity.

Increased age and sedentary lifestyle can exacerbate this phenomenon. In our study, the group with BMI above 25 kg/m^2 showed statistically significantly higher mean age compared with normal weight patients.

The main limitations of this study are: the retrospective design which does not allow causality assessment, using BMI as the single marker of obesity [31-34], single serum creatinine measurement and the use of MDRD formula for estimation of GFR with possible misclassification of patients with eGFR close to 60 ml/min/1.73 mp [35].

In conclusion, our study demonstrate that obesity assessed by body mass index showed no clear association with CKD.

Conflict of interest
None to declare.

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