Glomerular Filtration and Associated Factors in Hypertensive Individuals Treated at Primary Care Level

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Abstract

Background: In Brazil, arterial hypertension (AH) constitutes one of the main risk factors for chronic kidney disease (CKD). The monitoring of glomerular filtration (GF) is recommended for the assessment of kidney function in hypertensive individuals, as GF decrease precedes symptom onset.

Objective: To assess GF and its associated factors in hypertensive individuals.

Methods: A cross-sectional study was carried out from January to June 2008 in 297 individuals with arterial hypertension (AH) with or without diabetes mellitus (DM), treated at a primary care facility in the city of São Luís, Maranhão. Patients older than 20 years and of both sexes were included in the study. Sociodemographic and nutritional status data, GF rate and microalbuminuria levels in 24-hour urine were assessed, as well as blood pressure, glucose and serum creatinine levels and a lipidogram.

Results: Mean age was 60.6 ± 11.5 years, with a predominance of the female sex (75.1%), overweight/obesity (65.0%) and large waist circumference (60.6%). The prevalence of GF < 60 ml/min was 24.6% in the AH group without DM and 18.3% in the AH group with DM, with no significant difference. For the AH group without DM, there was an association only between reduced GF and age ≥ 65 years, which remained after adjustment. For the AH group with DM, there was an association between reduced GF and age ≥ 65 years, smoking habit and obesity. However, after the adjustment, age and smoking habit remained as associated factors.

Conclusion: In these patients, the prevalence of GF < 60 ml/min was high and after the adjustment, only age ≥ 65 years and smoking habit were shown to be factors associated to GF. This reinforces the need to systematically evaluate GF in hypertensive individuals, aiming at the secondary prevention of chronic kidney disease. (Arq Bras Cardiol 2010;94(6) : 731-738)

Key words: Kidney diseases/therapy/diagnosis; hypertension; hypertension, renovascular; food analysis; disease prevention; diet therapy.

Introduction

Arterial hypertension (AH) is a severe public health problem. It is estimated that more than 30 million Brazilian individuals have AH[1], with 12,410,753 of them using the Brazilian Public Health System (SUS)[2]. Additionally, more than one third is unaware of having the disease, and less than one third of the diagnosed hypertensive individuals present adequate pressure levels with the proposed treatment[3].

In Brazil, hypertension constitutes one of the main risk factors for chronic kidney disease (CKD) and, when associated to diabetes mellitus (DM), it is responsible for 50% of the cases of patients undergoing substitutive renal therapy (SRT)[3].

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Segura et al[4] identified the prevalence of kidney function deficit in hypertensive individuals (glomerular filtration < 60 ml/min) of 7.6%, using as criterion the measurement of serum creatinine and of 22.3% when they used glomerular filtration (GF) through creatinine clearance. In another study, New et al[5] observed a decrease in GF estimated at 31.3% in diabetic patients *versus* 6.9% in the general population. Unfortunately, we do not have population studies on CKD in Brazil at the initial stages and the attentions are mainly concentrated on the final stages, when the patient needs dialysis or kidney transplant[6].

To adequately evaluate the kidney function is fundamental to attain the diagnosis and establish the adequate treatment for CKD. Therefore, we recommend the monitoring of GF, which is considered the best marker of kidney function in healthy or unhealthy individuals[7], considering that its decrease precedes the onset of kidney failure symptoms.

Considering that the evolution of CKD depends on the quality of the medical care offered long before the

kidney failure onset, it is of utmost importance to estimate the prevalence of this disease at its initial stages - mostly asymptomatic ones -, which can help the development of policies aimed at its prevention and control. Furthermore, knowing the associated factors and attaining the early diagnosis of CKD allows the establishment of adequate treatment and prevents the progression to the final stage of the disease, of which therapy requires dialysis or kidney transplant.

The present study aims at assessing GF and associated factors in hypertensive individuals with or without diabetes treated at primary care level, as they are considered high-risk for the development of CKD.

Methods

A cross-sectional analytical study was carried out with hypertensive patients, with or without diabetes, from January to June 2008; the patients were recruited through the Program for Patients with Hypertension and Diabetes (HyperDia Program) of the Ministry of Health, among those being treated at the Basic Health Unit (BHU) of Vila Embratel in São Luís, state of Maranhão, Brazil.

The present study was approved by the Ethics Committee of *Hospital Universitário* of the Federal University of Maranhão (Protocol #1977/2007), according to the ethical norms established for research involving human subjects.

The sample calculation was carried out considering a population of 559 hypertensive individuals without diabetes mellitus (DM) and 116 hypertensive individuals with DM that participated in the program, with an expected prevalence of GF < 60 ml/min/1.73 m^2 of 22.3%, with a 4% margin of error and a confidence level of 95%. The total number of patients was estimated at 188 hypertensive individuals without DM and 91 with DM. With the objective of correcting eventual losses during the data collection process, we decided to increase the sample by 5%, totaling 307 hypertensive individuals, of which 100 had DM.

This study included hypertensive individuals aged 20 years or older, of both sexes and who agreed to participate. The exclusion criteria were: pregnant women, patients with any type of consumptive chronic disease (cancer or AIDS) and those undergoing SRT.

The selection process was started by obtaining a list from the BHU that contained the names of the hypertensive individuals treated through the HyperDia Program. Subsequently, a simple random selection was carried out by drawing lots, without replacement. The patients were located by the community health agents (CHA) of the Family Health Program (FHP) and when they came to the hospital, they were informed about the study.

The patients that agreed to participate were previously advised on the 24-hour urine collection technique. They were also asked to come to the BHU, on the day of their regular visit, on a 12-hour fast and to bring the collected urine sample. The patients received information on the urine collection technique in person, in addition to written instructions and recipients for the collection.

On the day of the regular visit to the BHU, the patients initially answered a structured questionnaire that contained sociodemographic data and clinical history. At this moment, the arterial pressure was measured and the nutritional assessment was carried out. A blood sample was also collected and the 24-hour urine sample was received. Subsequently, the biological material (blood and urine) was sent to the Laboratory of Clinical Analysis of the Presidente Dutra University Hospital of the Federal University of Maranhão (HUPD-UFMA).

The level of schooling was evaluated as years of schooling and categorized as $\leq$ 8 years or $\geq$ 9 years. The criterion of socioeconomic status classification was categorized in classes.[8] Every patient that declared having smoked at any time during his or her life, regardless of the moment and the amount of cigarettes, was considered a smoker. Similarly, patients that reported the consumption of any amount of alcoholic beverages, regardless of the frequency, were considered alcohol consumers.

The arterial pressure (AP) of each patient was measured with a digital sphygmomanometer (*Omron*™), through the indirect method, with the patient at rest, in the sitting position. Two measurements were performed, the first in the middle of the interview and the second at the end of the interview. The highest AP value was used. Controlled AP was considered when the systolic blood pressure (SBP) was < 140 mmHg and the diastolic blood pressure (DAP) was < 90 mmHg, for hypertensive individuals without associated diabetes and SBP < 130 mmHg and DBP < 80 mmHg for hypertensive individuals with associated diabetes[1].

The anthropometric assessment of the patients consisted of measurement of weight (in kilograms), in a portable digital scale (*Plena*™), and height (in meters), in a stadiometer (*Alturexata*™). The waist circumference (WC) and the hip circumference (HC) were also measured with an inextensible measuring tape. The WC (in cm) was obtained at midpoint between the last rib and the iliac crest, at the moment of expiration, and the HC (in cm) at the largest perimeter region between the waist and the thigh.

The assessment of the patients' nutritional status was carried out through the body mass index (BMI), the WC and the waist-to-hip ratio (WHR). The BMI was calculated by dividing the body weight in kilograms by the square height in meters. A cutoff of 25.0 kg/m^2 was used for eutrophic, 25.0 to 29.9 kg/m^2 for overweight and $\geq$ 30.0 kg/m^2 for obese individuals. The WC and WHR were obtained in order to evaluate the pattern of body fat distribution. The WHR was obtained through the ratio between the WC and the HC. The adopted cutoffs for very high risk regarding the WC were 88 cm and 102 cm and high-risk, regarding the WHR, of 0.85 and 1.00 for women and men, respectively, according to the classification of the World Health Organization (WHO)[8].

The metabolic and kidney function assessment were carried out through creatinine clearance and microalbuminuria levels in 24-hour urine, as well as serum creatinine, total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, fasting glycemia and glycated hemoglobin (for diabetic subjects). The methods adopted for the laboratory assessments and their respective reference values are shown in Chart 1.

Chart 1 - Laboratory parameters: analytic methods and reference values

Parameters	Methods	Normal reference values
Total cholesterol	Enzymatic	< 200.0 mg/dl[1]
HDL-cholesterol	Roschlan et al	> 40.0 mg/dl - AH without DM[1] > 45.0 mg/dl - AH with DM[1]
LDL-cholesterol	Friedewald	< 100.0 mg/dl[1]
Triglycerides	Enzymatic	< 150.0 mg/dl[1]
Fasting glycemia	Enzymatic	< 100.0 mg/dl - Normal[2] 90 - 130 mg/dl - Desirable for DM[2]
Glycated hemoglobin	Immunoturbidimetric	< 7.0%[2]
Serum creatinina	Optimized Kinetic U.V.	≤ 1.2 mg/dl[3]
Creatinine clearance	Immunoturbidimetric	≥ 60 ml/min[4]
Microalbuminuria	Immunoturbidimetric	30.0 - 300.0 mg/day[4]

Sources: V Brazilian Guidelines of Arterial Hypertension, 2006[1]; American Diabetes Association, 2007[2]; Normal reference value for the method[3]; National Kidney Foundation, 2002[4].

The GF was evaluated through endogenous creatinine clearance in 24-hour urine. The staging of CKD was carried out in five stages, according to the recommendation of the National Kidney Foundation[9] (Chart 2).

When a kidney function deficit was identified (GF< 60ml/min), the patients were referred to the Ambulatory of Nephrology of the HUPD-UFMA, a reference service in the city of São Luís, for specialized evaluation and treatment.

The qualitative variables are presented as frequencies and percentages and the quantitative ones as means and standard deviation (mean ± SD). To compare the quantitative variables of the hypertensive group without diabetes with the hypertensive group with diabetes, the Student's *t* test was used; for the qualitative variables, the Chi-square test and Fisher's Exact test were used. The normality of the quantitative variables was analyzed through the Shapiro-Wilk test.

Poisson's regression model was used to identify the factors associated with GF in each group and the level of significance was established at 5%. The prevalence ratios (PR) and their respective 95% confidence intervals (95%CI) were also estimated.

Chart 2 - Chronic kidney disease staging

Stage	Description	GF (ml/min/1.73m²)
I	Kidney lesion with normal or increased GF	≥ 90
II	Kidney lesion with mild GF decrease	60-89
III	Kidney lesion with moderate GF decrease	30-59
IV	Kidney lesion with marked GF decrease	15-29
V	Functional kidney failure or undergoing SRT	< 15

SRT- substitutive renal therapy. Source: National Kidney Foundation, 2002.

The variables that presented p value < 0.20 were considered in Poisson's multivariate regression model. The selection of variables was carried out by the stepwise method by elimination. Only the variables with a p value < 0.10 remained in the final model. The data were analyzed using the statistical program STATA 9.0.

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Results

A total of 297 hypertensive individuals that participated in the HyperDia Program and were treated at a BHU in São Luís were evaluated. There was a loss of 3.3% (n=10) due to lack of data for the analysis of kidney function or refusal to participate in the study. Thus, the final sample consisted of 199 hypertensive patients without DM and 98 with DM, according to the files of the HyperDia Program.

The mean age was 60.6 ± 11.5 years and there was a predominance of the female sex (75.1%), fewer than 9 years of schooling (83.1%) and socioeconomic classes D and E (79.5%). The percentage of smokers was 44.3% and of alcohol consumers was 20.9% (Table 1). The consumption of alcohol was associated with age < 65 years for the hypertensive individuals with DM (p = 0,046).

A higher prevalence of overweight (38.0%) and obese (27.0%) individuals was observed, according to the BMI. Among the obese hypertensive individuals, 85.3% were aged < 65 years and there was a significant association (p= 0.002). The distribution of abdominal fat was altered in 60.6% according to the WC and in 75.8% according to the WHR (Table 1).

As for the sociodemographic and anthropometric characteristics (Table 1), no statistically significant differences were observed between the AH group without DM and the AH group with DM.

The mean SBP and DBP values were 149.9 ± 1.7 mmHg and 89.2 ± 0.9 mmHg for the AH group without DM and 145.5 ± 2.0 mmHg and 86.5 ± 1.0 mmHg for the AH group with DM, respectively. There was a statistically significant difference (p < 0.0001).

The GF predominated within the interval between 60 and 89 ml/min/1.73 m² for both groups. The percentage of reduced GF (< 60 ml/min/1.73m²) was 24.6% in the AH group without DM and 18.3% in the AH with DM. No statistically significant difference was observed regarding GF between the two groups (Table 2).

In patients with reduced GF (< 60 ml/min/1.73 m²), serum creatinine was altered (> 1.2 mg/dl) in only 20.4% in the AH group without DM and in 44.4% in the other group (data not presented in a table).

In the AH group without DM, only age ≥ 65 years (PR = 2.20; 95%CI = 1.24-3.90) presented a significant association with reduced GF (< 60 ml/min/1.73 m²). In the AH group with DM, age ≥ 65 years (PR = 5.11; 95%CI = 1.80-14.50) and smoking status (PR = 2.94; 95% CI= 1.05-8.24) were

Table 1 - Demographic, socioeconomic and anthropometric characteristics of hypertensive individuals undergoing treatment

Variables	Total (n = 297)		AH without DM (n = 199)		AH with DM (n = 98)		p-value
	n	%	n	%	n	%	
Sex							0.330
Female	223	75.1	146	73.4	77	78.6	
Male	74	24.9	53	26.6	21	21.4	
Age (years)							0.944
Mean ± SD	60.6 ± 11.5		60.6 ± 11.6		60.4 ± 11.4		
Socioeconomic classification*							0.909
Classes B2 and C	61	20.5	41	20.6	20	20.4	
Classes D and E	236	79.5	158	79.4	78	79.6	
Schooling (years)							0.398
≤ 8	245	83.1	167	84.3	78	80.4	
≥ 9	50	16.9	31	5.7	19	19.6	
Smoker*							0.513
No	165	55.7	113	57.1	52	53.1	
Yes	131	44.3	85	42.9	46	46.9	
Alcohol consumption*							0.822
No	231	79.1	155	79.5	76	78.4	
Yes	61	20.9	40	20.5	21	21.6	
BMI (kg/m^2)							0.557
< 25,0	104	35.0	70	35.2	34	34.7	
25,0 - 29,9	113	38.0	79	39.7	34	34.7	
≥ 30,0	80	27.0	50	25.1	30	30.6	
WC (cm)							0.157
Lower risk	117	39.4	84	42.2	33	33.7	
Very high risk	180	60.6	115	57.8	65	66.3	
WHR							0.279
Lower risk	72	24.2	52	26.1	20	20.4	
High risk	225	75.8	147	73.9	78	79.6	

** n measured lower than total n; AH - arterial hypertension; DM - diabetes mellitus; Socioeconomic classification - Brazilian Association of Survey Enterprises (ABEP); BMI - body mass index; WC - waist circumference; WHR - waist-to-hip ratio.*

Table 2 - Glomerular filtration of hypertensive individuals undergoing treatment

GF ml/min/1.73m^2	CKD stages	AH without DM (n = 199)		AH with DM (n = 98)		p-value
		n	%	n	%	
> 90	I	69	34.7	33	33.7	0.864
60 - 89	II	81	40.7	47	48.0	0.235
30 - 59	III	45	22.6	18	18.3	0.400
15 - 29	IV	3	1.5	0	0.0	-
< 15	V	1	0.5	0	0.0	-

GF - glomerular filtration; CKD - chronic kidney disease; AH - arterial hypertension; DM - diabetes mellitus.

associated. Still considering this group, alcohol consumption and obesity (PR = 0.21; 95%CI = 0.04-0.93) were more frequent in patients with GF ≥ 60 ml/min/1.73 m² (Table 3).

At the adjusted analysis for AH group without DM, age ≥ 65 years (PR = 2.20; p = 0.007) remained associated with reduced GF. Similarly, for the other group, only age ≥ 65 years (PR = 5.10; p = 0.005) and smoking status (PR = 2.86; p = 0.073) remained associated.

Discussion

In this study there was a predominance of GF between 60 and 89 ml/min/1.73 m², which corresponds to stage II of CKD for both groups. The prevalence of reduced GF (< 60 ml/min/1.73 m²) was 24.6% in the AH group without DM and 18.3% in the AH group with DM. Kramer et al[10], in Brazil, found a prevalence of 12.7% of reduced GF in diabetic patients, with or without associated AH. European studies demonstrated a prevalence of reduced GF in 22.3% of hypertensive individuals[4], in 31.3% of diabetics and in 6.9% of the general population[5].

Although DM is the main cause of patients undergoing SRT in developed countries[11], in Brazil 35.8% of the cases are attributed to AH, followed by diabetes, with 25.7%[6]. In the present study, the fact that the hypertensive patient was diabetic did not increase the risk for GF decrease. This situation can be attributed to the more careful monitoring of kidney function in hypertensive patients with associated diabetes[5].

The female sex was predominant in the study sample. However, the male sex presented a higher risk for reduced GF in the two groups assessed in the study, although there was no significant association. The predominance of the female sex, a common finding in several studies with hypertensive populations[12-15] can be attributed to the fact that women more frequently seek systematic medical attention[16] and to the higher prevalence of these patients registered at the HyperDia Program[17]. Another possible explanation is that women present a higher frequency of AH from the sixth decade on[18], and a higher life expectancy at birth (76.5 years) when compared to men[16].

The mean age of 60.6 years reflects the aging process of the brazilian population[16]. Didier and Guimaraes[13] found, in the suburbs of the city of Salvador, state of Bahia, Brazil, a mean age of 58.1 ± 9.9 years in hypertensive individuals and other authors observed a prevalence of AH between 49.3% and 71.6% in individuals aged 60 years or older[12,15]. Age ≥ 65 years presented a significant association with reduced GF in both groups at the non-adjusted analysis and so it remained after the adjustment. National[10,20] and international studies[4,19] also observed a statistical significance of reduced GF with age. These findings confirm the increase in AP and CKD with age.

Regarding the socioeconomic situation, 79.5% of the patients belonged to the lower socioeconomic classes (classes D and E) and this adverse situation was much more unfavorable than the one found by Lessa et al[12], in the city of Salvador, which showed a frequency of 59.3% of hypertensive individuals in these classes. Similarly, the low level of schooling observed (up to 8 years of schooling) was higher than the 62.2% estimated for the brazilian population[16]. It is possible that such situation, among hypertensive individuals, brings difficulties for the understanding of the disease and the importance of treatment adherence. Stummer et al[13] emphasize that individuals in the lower socioeconomic classes and with lower levels of schooling present a lower probability of receiving adequate management in the treatment of hypertension.

The high percentage of smokers observed in the sample is also mentioned in other studies with hypertensive individuals[13,14]. Paradoxically, Boing and Boing[17] found lower values (18.2%) for patients registered at the HyperDay Program. This dissimilarity may be explained by the diversity of definition attributed to the smoking status, established by these authors as smoking one or more cigarettes a day during the interview period. In this study, smoking was significantly associated with a reduced GF in hypertensive individuals with DM, and so it remained after the adjusted analysis. As shown in the literature[21], the habit of smoking increases the risk of kidney function decrease and it is a modifiable factor.

Considering the diversity of the criterion adopted for alcohol consumption, some authors present discrepancies in their findings. In this study, 17.5% of the patients reported consuming alcohol. For the AH group with DM, there was a significant association with alcohol consumption and reduced GF; however, after the adjusted analysis, this association was no longer observed. This might be attributed to the fact that age ≥ 65 years is significantly associated with reduced GF and a lower frequency of alcohol consumption in these patients.

The excess of body weight was predominant in our sample, considering the BMI as indicator. Of the assessed patients, 65% presented overweight/obesity. A similar prevalence of excess weight was observed in hypertensive individuals by Sturmer et al[13] - in 75.4% of the patients. In this study, the patients with reduced GF presented a lower prevalence of overweight and obesity, but there was a significant association only for obesity in the AH group with DM.

Some epidemiological studies have suggested that excess weight can be a risk factor for CKD[22,23]. On the other hand, a population study[22] observed that presenting overweight/obesity at 20 years of age or at some time in the past had an association with increased risk for CKD, although no association was found with excess weight at the moment of the interview.

In this study, the association observed between obesity and reduced GF can be explained by the loss of weight as a consequence of the CKD progress, as a spontaneous decrease in protein consumption occurs with the decrease in the GF, increasing the risk for malnutrition[24,25].

Additionally, such association was not significant after the adjustment, which can be attributed to the confusion between the variables age and obesity.

The World Health Organization (WHO) emphasizes that the BMI, although it is a good measure of obesity, does not consider the variation in body fat distribution and it is not capable of detecting the increase in body fat that occurs with age[26]. Thus, other indicators were measured.

In general, we observed higher risk predominance for WC and WHR, but these measurements did not present a

Table 3 - Non-adjusted analysis of the demographic and clinical-laboratory characteristics of hypertensive individuals undergoing treatment according to the glomerular filtration

Variables	AH without DM (n = 199)				RP (IC95%)		AH with DM (n = 99)				PR (95%CI)	
	GF < 60		GF ≥ 60				GF < 60		GF ≥ 60			
	n	%	n	%			n	%	n	%		
Sex						0.205						0.514
Female	32	65.3	114	76.0			13	72.2	64	80.0		
Male	17	34.7	36	24.0	1.46 (0.81-2.63)		5	27.8	16	20.0	1.41 (0.50-3.96)	
Age (yr)*						0.007						0.002
< 65	20	41.7	101	67.3			5	29.4	61	76.3		
≥ 65	28	58.3	49	32.7	2.20 (1.24-3.90)		12	70.6	19	23.7	5.11 (1.80-14.50)	
Smoker						0.393						0.040
No	25	51.0	88	59.1			5	27.8	47	58.8		
Yes	24	49.0	61	40.9	1.28 (0.73-2.23)		13	72.2	33	41.2	2.94 (1.05-8.24)	
Alcohol consumption						0.737						0.013
No	38	77.6	117	80.9			18	100.0	58	73.4	-	
Yes	11	22.4	29	19.9	1.21 (0.57-2.19)		0	0.0	21	26.6	-	
BMI (kg/m^2)												
< 25,0	22	44.9	48	32.0		-	11	61.1	23	28.7		-
25,0 - 29,9	18	36.7	61	40.7	0.72 (0.39-1.35)	0.312	5	27.8	29	36.3	0.45 (0.16-1.31)	0.144
≥ 30,0	9	18.4	41	27.3	0.57 (0.26-1.24)	0.159	2	11.1	28	35.0	0.21 (0.04-0.93)	0.040
WC (cm)						0.214						0.150
Lower risk	25	51.0	59	39.3			9	50.0	24	30.0		
Very high risk†	24	49.0	91	60.7	0.70 (0.40-1.23)		9	50.0	56	70.0	0.51 (0.20-1.28)	
WHR						0.558						0.441
Lower risk	11	22.5	41	27.3			5	27.8	15	18.8		
High risk	38	77.5	109	72.7	1.22 (0.62-2.39)		13	72.2	65	81.2	0.67 (0.24-1.87)	
AP Control						0.502						0.499
Yes	25	51.0	67	44.7			3	16.7	20	25.0		
No	24	49.0	83	55.3	0.82 (0.47-1.44)		15	83.3	60	75.0	1.53 (0.44-5.30)	
Fasting glycemia						0.708						>0.999
Desirable	46	93.9	138	92.0			9	50.0	40	50.0		
High	3	6.1	12	8.0	0.80 (0.25-2.57)		9	50.0	40	50.0	1.00 (0.40-2.52)	
Glycated hemoglobin (%)*						-						0.167
< 7,0	-		-		-		11	68.8	35	47.3		
≥ 7,0	-		-		-		5	31.2	39	52.7	0.47 (0.17-1.37)	
Total cholesterol (mg/dl)						0.956						0.329
< 200	20	40.8	62	41.3			6	33.3	38	47.5		
≥ 200	29	59.2	88	58.7	1.02 (0.57-1.80)		12	66.7	42	52.5	1.63 (0.61-4.34)	
LDL cholesterol (mg/dl)*						0.962						0.260
< 100	8	16.3	25	16.7			1	5.6	14	18.2		
≥ 100	41	83.7	125	83.3	1.02 (0.48-2.17)		17	94.4	63	81.8	3.19 (0.42-23.95)	
HDL cholesterol						0.200						0.343
Desirable	37	75.5	96	64.0			5	27.8	33	41.2		
Low	12	24.5	54	36.0	0.65 (0.34-1.25)		13	72.2	47	58.8	1.65 (0.59-4.62)	
Triglycerides (mg/dl)						0.124						0.520
< 150	39	79.6	99	66.0			12	66.7	46	57.5		
≥ 150	10	20.4	51	34.0	0.58 (0.29-1.16)		6	33.3	34	42.5	0.72 (0.27-1.93)	
Microalbuminuria (mg/24h)*						0.906						0.474
No	41	85.4	125	86.2			14	82.4	57	73.1		
Yes	7	14.6	20	13.8	1.05 (0.47-2.34)		3	17.6	21	26.9	0.63 (0.18-2.20)	

** n measured lower than total n; † very high risk; GF - glomerular filtration (ml/min/1.73m^2); AH - arterial hypertension; DM - diabetes mellitus; PR - prevalence ratio; CI - confidence interval; BMI - body mass index; WC - waist circumference; WHR - waist-to-hip ratio; AP - arterial pressure.*

significant association with reduced GF. The consequence of abdominal adiposity in relation to kidney function impairment has been little documented and it is a noteworthy subject, considering its frequent association with hypertension and diabetes, which are the main causes of CKD in the world. Some studies have shown an association between the central distribution of fat, measured by the WHR, with hypertension[14,27], microalbuminuria[28] and CKD[29].

It has been well established that a strict control of AP is very important to minimize the progression of CKD[9,30]. The control of AP did not present a significant association with reduced GF, which can be justified by the lack of AP control also in the hypertensive individuals with GF $\geq$ 60 ml/min/1.73 m^2. It is noteworthy the fact that these patients present a high frequency of overweight and abdominal fat distribution, which contributes to the worsening of hypertension, as observed in other studies[3,12,14,15].

The maintenance of glycemia within the normal range for diabetics is fundamental for the prevention or decrease of macro and microvascular complications[31]. Its inclusion is recommended in the strategy of CKD prevention in diabetic patients[30-33]. In this study, the glycemic control was not associated to reduced GF, corroborating the findings by Kramer et al[10].

The increase in serum creatinine is a relatively late parameter for the detection of renal lesion, as it presents alteration only after the patient loses more than 50% of the GF capacity[34]. Of the patients with reduced GF, 79.6% of the individuals with AH without DM and 55.6% of those with AH and DM still presented serum creatinine levels within the normal range, demonstrating the low sensitivity of this marker for the early diagnosis of CKD. That confirms the importance of the measurement of GF, measured or estimated based on the serum creatinine, to evaluate kidney function in clinical practice[2,3,9,30]. In this regard, among the recommendations of the Kidney Diseases Outcomes Quality Initiative (K-DOQI)[9], is the sue of equations that aim at identifying renal patients faster and at a lower cost. The two most frequently used equations are the Cockcroft-Gault, from 1976 and the MDRD, developed during the study of the same name (Modification of Diet in Renal Disease - MDRD). However, these formulas, although recommended, still need validation in large samples, in individuals at very early stages of kidney dysfunction and in elderly individuals[35,36].

Microalbuminuria significantly increases with the reduced GF[4]. Therefore, its measurement constitutes an important element in the early diagnosis and follow-up of CKD[9,30]. In this study, the frequency of microalbuminuria found in the patients with reduced GF was 14.6% in the AH group without DM and 17.6% in the AH group with DM. National studies report a prevalence of microalbuminuria of 9.5% and 13.7% in hypertensive individuals undergoing treatment[37,38]. Such variations in prevalence can be attributed to differences in the methods of analysis of urinary excretion of albumin, due to variation sin age ranges, ethnicity or comorbidities in the studied groups[39]. It is also important to mention that the anti-hypertensive treatment is capable of reducing microalbuminuria[40].

Microalbuminuria did not present any association with GF. A possible explanation would be that the patients with reduced GF presented a lower frequency of excess weight and abdominal fat distribution in the AH group without DM, although there was no statistical significance. For the AH group with DM, the better glycemic control must be added, through the glycated hemoglobin levels. Maybe the combination of these factors contributed to the reduced microalbuminuria in these patients.

As this is a cross-sectional study, it was not possible to establish a causal association between the GF and associated factors in hypertensive individuals, but one can infer an association between these conditions. Another limitation is that the drug therapy was not assessed, which can interfere with the GF. However, one must consider that all patients were registered at and participated in the HyperDia Program and received the essential medications recommended by the Ministry of Health, available at all BHU.

The percentage of reduced GF observed in the study population was high. That reinforces the need for systematic assessment of GF through creatinine clearance or estimated by equations that have been well established in the literature, as the serum creatinine is a relatively late parameter. It is also important to remember that smokers, as well as those aged $\geq$ 65 years need special attention, as these factors were strongly associated with GF.

These findings reinforce the need to promote the continuing education for healthcare teams involved in the treatment of these patients, sponsoring the prevention and diagnosis of CKD at the early stages, when it is still possible to prevent the progression to the final stages, of which treatment requires dialysis or kidney transplant.

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Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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