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Prevalence of chronic kidney disease in an urban Mexican population

Dante Amato, Cleto Alvarez-Aguilar, Rutila Castañeda-Limones, Ernesto Rodriguez, Marcela Avila-Diaz, Francisco Arreola, Anel Gomez, Hiram Ballesteros, Raquel Becerril, and Ramon Paniagua

Unidad de Investigacion Medica en Enfermedades Nefrologicas, Hospital de Especialidades, Centro Medico Nacional Siglo XXI, Mexico City, Mexico; Unidad de Investigacion en Epidemiologia Clinica, Hospital General Regional "Gabriel Mancera," Mexico, Mexico; Centro de Investigacion Biomedica de MichoacWl, Morelia, Mexico; Hospital General de Zona I, Morelia, Mexico, Instituto Mexicano del Seguro Social, Mexico City, Mexico

Prevalence of chronic kidney disease in an urban Mexican population.

Background. The present study was primarily designed to assess the prevalence of chronic kidney disease in a Mexican urban population residing in Mexico and to evaluate certain biologic and socioeconomic conditions as risk factors for the development of renal disease.

Methods. A population-based cross-sectional survey was conducted, which included 3564 patients of either gender aged >18 years, who were randomly selected from lists of patients assigned to primary care facilities in the city of Morelia. A questionnaire about personal current health status, kidney disease, diabetes, hypertension, or heart disease in close relatives, anthropometric and blood pressure measurements, and blood and urine samples to measure glucose, blood urea nitrogen, and creatinine was obtained for each patient. Creatinine clearance (Ccr) was calculated by the Cockcroft-Gault formula. Patients were classified in 1 of the 5 Ccr categories established by the Kidney Disease Outcomes Quality Initiative guidelines.

Results. The prevalence rate of Ccr < 15 mL/min was 1142 per million population, and that of Ccr <60mL/min 80,788 per million population. Alcohol and tobacco consumption, female gender, age >65 years, educational level < primary school, and income <US $4.00/day were significantly associated with reduced Ccr.

Conclusion. Chronic kidney disease prevalence in this population is similar to that seen in industrialized countries. If these figures are similar to those of the entire Mexican population, only l out of 4 patients requiring renal replacement therapy in the country currently has access to it.

Resumen

Antecedentes. El presente estudio se diseñó primariamente para determinar la prevalencia de la enfermedad renal crónica (ERC) en una población urbana de México y secundariamente para evaluar algunas condiciones biológicas y socioeconómicas que pudieran ser factores de riesgo para el desarrollo de la enfermedad renal.

Métodos. Se realizó un estudio transversal en una población que incluyó a 3,564 sujetos, de ambos géneros, con edad >18 años, seleccionados al azar de los listados de las personas asignadas a clínicas de atención primaria en la ciudad de Morelia, México. Se aplicó un cuestionario a cada individuo, que incluía su estado de salud actual y la presencia de enfermedad renal, diabetes, hipertensión arterial o enfermedad vascular en familiares cercanos; se tomaron además en cada sujeto sus medidas antropométricas y presión arterial, así como muestras de sangre y orina para la determinación de glucosa, nitrógeno ureico y creatinina. La depuración de creatinina (DCr) se calculó con la fórmula de Cockcroft-Gault. Los sujetos se clasificaron en una de las cinco categorías de DCr, de acuerdo a lo establecido por las guías K/DOQI.

Resultados. La prevalencia de la DCR < 15 mL/min fue de 1,142 por millón de habitantes (pmh), en tanto que la DCr < 60 mL/min fue de 80,788 pmh. Los factores asociados a una baja DCr fueron el consumo de tabaco y alcohol, el género femenino, la edad >65 años, una escolaridad menor al nivel primario e ingresos económicos < $ 4.00 USD/día.

Conclusión. La prevalencia de ERC en esta muestra es similar a la reportada en países industrializados. Si estas cifras son similares a la totalidad de la población mexicana, solo 1 de 4 pacientes que requieren terapia de reemplazo renal tienen acceso a ella.

Chronic kidney disease (CKD) is a growing problem all over the world. The incidence and prevalence rates of CKD and end-stage renal disease (ESRD) have increased steadily for the last 3 decades [1, 2], and the expenditures that the care of these patients generates have also grown [3]. In developed countries, knowledge about the incidence and prevalence rates of ESRD requiring renal replacement therapy (RRT) is obtained through national registries. The numbers shown by registries in developed countries are believed to be a very close estimation of the burden of kidney disease, because opportune detection and therapy are available and accessible to virtually all patients who need them. In Mexico, there is no national registry of renal patients. Thus, the knowledge about the

Key words: chronic kidney disease, prevalence, epidemiology, Mexico.

epidemiology of CKD and ESRD is very limited. In a Mexican survey of patients with ESRD treated with peritoneal dialysis at the Instituto Mexicano del Seguro Social (IMSS) in 1992, the prevalence rate of patients on peritoneal dialysis was 200 patients per million population (pmp). This figure was considered to be very close to the total number of patients in substitutive therapy for ESRD, because in Mexico, at that time, peritoneal dialysis was the therapeutic modality used for more than 91% of the patients receiving RRT [4]. This prevalence rate is strikingly different from the corresponding figures in the United States and Japan, both with more than 1000 pmp, and also lower than the prevalence rates reported from Latin American countries such as Puerto Rico, Uruguay, Argentina, or Chile [2]. It is accepted that surveillance systems based on national registries may underestimate real ESRD prevalence rates in some countries because of treatment selection bias, and that this underestimation may contribute to observed differences among various countries [2]. The wide gap of prevalence rates seen in patients receiving RRT between Mexico and other Latin American countries suggests that the true prevalence rate of ESRD in Mexico is importantly underestimated. Additional information supporting this assumption comes from studies performed in Mexican American populations in the United States. In these groups, the rate of patients receiving RRT is higher than that in the white American population [5]. Also, the increase in the ESRD incidence rate in Mexican Americans is greater than that in black or white Americans [6]. Because appropriate Mexican registries of renal patients are lacking, an available alternative to estimate the prevalence rate of CKD in Mexico is a population-based cross-sectional survey. The primary objective of the present study is to assess the prevalence of CKD in a Mexican urban population residing in Mexico. The secondary objective is to evaluate the role of certain biological conditions, such as ischemic heart disease, hypertension, stroke, and diabetes mellitus in close relatives, and certain socioeconomic conditions such as age, gender, marital status, salaried job, income, and educational level, as risk factors for the development of renal disease.

METHODS

A population-based cross-sectional survey was conducted. The protocol was approved by the research and ethics committee of the Hospital General de Zona 1, Morelia, of the IMSS. The city of Morelia in the Mexican State of Michoacan was selected for the study. It has 600,000 inhabitants and average characteristics among major Mexican cities regarding income [7], child mortality, access to health services, and prevalence of hypertension and diabetes [8]. Michoacan is located in the region of Mexico that had the highest density of emigrants to the United States.

The IMSS provides health care services to salaried workers and their families. Each individual entitled to receive these services is assigned to a primary health care facility. There are 3 primary care facilities in the city of Morelia. The study sample was randomly selected from the list of patients assigned to each facility. The number of patients sampled from each facility was proportional to the total number of patients assigned to them. Only patients aged 18 years or older were considered. The sampling was stratified by age and gender according to the distribution of these variables in the city's population. Selected patients were contacted in their homes by telephone call or personal visit, and invited to participate in the study. If they accepted, an informed consent form was signed. A scheduled visit was programmed to 1 out of 3 data collection centers, where questionnaires were administered, anthropometric and blood pressure measurements were taken, and blood and urine samples were collected. The sample size was calculated with a formula for descriptive studies designed to find out a proportion [9] and to meet the following criteria: a confidence level of 99%, acceptable error ±3%, and expected prevalence of CKD 600 pmp. There were approximately 40,000 patients aged 18 years or older in the lists. The calculated sample size was 3961 patients; 397 (10.02%) were excluded because they were not found, refused to participate, or did not show up for the scheduled visit. Therefore, the final number of patients included in the sample was 3564. The fieldwork was done from June 1999 to February 2000.

Surveyors were trained to uniformly administer the questionnaire, take height, weight, and blood pressure measurements, and perform blood and urine sampling.

The questionnaire included information about personal current health status, and presence of kidney disease, diabetes, hypertension, or heart disease in close relatives.

Weight and height were measured while patients wore light clothing and no shoes. With these data, body surface area and body mass index were calculated with standard formulas. Blood pressure was measured on 3 different days from 8:00 to 10:00 AM, with the patient sitting after 5 minutes of rest with a mercury sphygmomanometer.

Systolic and diastolic blood pressure was considered as Korotkoff's phases I and V, respectively.

After patients fasted for 12 hours, a blood sample was drawn from an antecubital vein for serum glucose, creatinine, and blood urea nitrogen, with automated equipment (Synchron CX-5; Beckman, Brea, CA). From all known patients with diabetes, heparinized blood aliquots were stored to measure glycosilated hemoglobin (HbA_{1c}) by ionic exchange chromatography [10]. In a casual urine sample, voided from 8:00 to 10:00 AM, a 11-reagents dipstick test (Combur-test; Lakeside, Chicago, IL) was

conducted and scored visually against a colored chart. In addition, in patients with diabetes and/or hypertension who had a normal dipstick test, microalbuminuria was assessed by nephelometry (Array, Beckman) and corrected by creatinine excretion.

Creatinine clearance (Ccr) was calculated by the Cockcroft-Gault method [11]. Patients were classified in 1 of 5 strata of Ccr ≥ 90, 60 to 89, 30 to 59, 15 to 29, and < 15 as established by the Kidney Disease Outcomes Quality Initiative clinical practice guidelines for CKD [12]. A patient was classified as diabetic when he or she had been previously diagnosed as diabetic, was receiving insulin or oral hypoglycemic agents, or had a fasting serum glucose level >126 mg/dL [13]. A patient was classified as hypertensive when he or she had been previously diagnosed as hypertensive, was receiving antihypertensive drugs, or the average of 3 blood pressure measurements was >140 mm Hg for the systolic or >90 mm Hg for the diastolic [14].

Statistical analysis

Data are presented as frequencies, percentages, or mean ± standard deviation as appropriate. Intergroup differences were assessed by χ^2 test for nominal variables and the Student *t* test for continuous variables. Multivariate analyses were performed by logistic regression. All statistical analyses were done with SPSS Version 8.0 for Windows (Chicago, IL, USA).

RESULTS

Table 1 shows the actual distribution of 3564 patients and estimated prevalence for each of the 5 Ccr strata. The estimated prevalence rate of patients with Ccr ≥15 mL/min 1.73 m^2 is 1143 pmp aged 18 years or older, with a 95% confidence interval (CI) from 206 to 2078. Only 11.1% of patients with Ccr <60 mL/min were aware of having renal disease, while 25% of the patients with Ccr <15 mL/min knew they had kidney disease. On the other hand, 208 patients reported having kidney disease, but their Ccr levels were 90 mL/min and their urine dipstick tests were normal. Being unaware of kidney disease was not associated with educational level, income, or employment status. A comparison of the percentage of patients in each Ccr strata for the present study and for the American population, according to calculations done by the Kidney Disease Outcomes Quality Initiatives group using the National Health and Nutrition Examination Survey III data, [12] is shown in Table 2.

The estimated prevalence of diabetes mellitus is 10.9% (95% CI = 9.9–11.9). Less than half (48.6%) of the patients with diabetes were aware of having diabetes mellitus. The estimated prevalence of hypertension is 20.6% (95% CI = 19.3–21.9), and 56.4% of the patients with hypertension were aware of having hypertension. Diabetes mellitus was present in 25% of the patients with Ccr <60 mL/min and in 40% of the patients with Ccr <15 mL/min. Hypertension was present in 34% of the patients with Ccr <60 mL/min and in 58% of the patients with Ccr < 15 mL/min.

Table 1. Distribution of 3564 studied patients and estimated prevalence for each of 5 Ccr strata

Ccr (mL/min/1.73m^2 BSA)[a]	*N*	Prevalence (pmp)[b]	$_{95\%}$ CI
≥90	2226	626,034	612,628–639,442
60–89	1034	289,181	276,618–301,744
30–59	290	80,788	73,237–88,339
15–29	10	2855	1367–4333
≤15	4	1142	206–2078
Total	3564	1,000,000	

Abbreviations are: Ccr, creatinine clearance; BSA, body surface area; pmp, per million population; $_{95\%}$CI, 95% confidence interval.
[a]Calculated with the Cockroft-Gault formula [11].
[b]Age ≥18 years old.

Table 2. Comparison of the percentage of patients in each Ccr strata for present study calculations done by the K/DOQI group

Ccr (mL/min/1.73 m^2 BSA)	Present study (%)	K/DOQI (%)[a]
≥90	62.5	64.3
60–89	29.0	31.2
30–59	8.1	4.2
15–29	0.3	0.2
≤15	0.1	0.2

Abbreviations are: K/DOQI, Kidney Disease Outcomes Quality Initiatives; Ccr, creatinine clearance; BSA, body surface area.
[a]Percentage of patients in each Ccr strata for the American population according to calculations done by the K/DOQI group using the NHANES data [12].

Proteinuria was detectable by dipstick in 8.7% of the patients with Ccr ≥60 mL/min. In patients with diabetes mellitus and hypertension, proteinuria was more frequent (12.5%) and higher (0.35 ± 0.94 g/mg Cr) than in patients with diabetes without hypertension (6.3%, 0.13 ± 2.0 g/mg Cr, $P < 0.05$). All patients with diabetes with Ccr <60 mL/min had proteinuria. Only 2.8% of the patients with hypertension without diabetes had proteinuria. The patients with diabetes with Ccr <60 mL/min and hypertension had higher levels of proteinuria (0.72 ± 2.0 g/mg Cr) than the patients with diabetes with Ccr <60 mL/min without hypertension (0.35 ± 2.0 g/mg Cr, $P < 0.05$). In patients with diabetes, HbA_{1c} was positively correlated with fasting glucose levels ($r = 0.55$, $P < 0.01$), proteinuria ($r = 0.20$, $P < 0.05$), and microalbuminuria ($r = 0.19$, $P < 0.05$). Only 2.7% of the patients with hypertension with Ccr ≥60 mL/min had proteinuria, and 4.7% of the patients with hypertension with Ccr ≥60 mL/min had microalbuminuria.

Patients with Ccr <60 mL/min had close relatives with diabetes, hypertension, heart disease, and stroke more frequently than patients with Ccr ≥60 mL/min (Table 3).

Table 3. Association of CKD with ischemic heart disease, hypertension, stroke, and diabetes mellitus in close relatives

	Normal renal function[a]	CKD	*P* value
Ischemic heart disease (father)			
Yes	87	13	0.01
No	92	8	
Ischemic heart disease (mother)			
Yes	87	13	0.02
No	92	8	
Hypertension (siblings)			
Yes	86	14	0.01
No	92	8	
Stroke (siblings)			
Yes	80	20	0.01
No	92	8	
Ischemic heart disease (siblings)			
Yes	86	14	0.01
No	92	8	
Diabetes mellitus (siblings)			
Yes	84	16	0.01
No	92	8	

[a]Values are shown as percentages; normal renal function, Ccr >60 mL/min.

Table 4. Logistic regression model including hypertension, ischemic heart disease, stroke, and diabetes mellitus in siblings as risk factors for CKD

	OR	95% CI	*P* value
Hypertension	1.4162	0.90–2.24	0.1331
Ischemic heart disease	101588	0.53–2.52	0.7102
Stroke	2.1576	0.93–5.00	0.0733
Diabetes mellitus	1.9681	1.34–2.90	0.0006

Abbreviations are: OR, odds ratio; 95% CI, 95% confidence interval.
P values < 0.05 were considered statistically significant.

Table 5. Association of CKD with age, gender, marital status, educational level, employment, and income

	Normal renal function	CKD	*P* value
Age (y)[a]	37.32 ± 12.83	63.12 ± 17.33	< 0.01
Gender			
Male	96	4	< 0.01
Female	84	16	
Educational level (<primary)			
Yes	85	15	< 0.01
No	95	5	
Salaried job			
Yes	95	5	< 0.01
No	79	21	
Spouse			
Yes	93	7	< 0.01
No	66	34	
Income (<USD $4.00/d)			
Yes	79	21	< 0.01
No	95	5	

All values are percentages except for age,[a] shown as mean ± standard deviation; normal renal function, CCR >60 mL/min.

Table 6. Logistic regression model including spouse, salaried job, income, educational level, age, and gender as risk factors for CKD

	OR	95% CI	*P* value
Spouse (yes)	0.9953	0.67–1.49	0.9815
Salaried job (yes)	1.2021	0.8–1.80	0.3706
Income (>USD $4.00/d)	0.5365	0.36–0.76	0.0004
Education (<primary)	1.9688	1.37–2.83	0.0003
Age (>65 y)	1.1158	1.10–1.13	0000
Gender (male)	0.3204	0.22–0.48	0000

Abbreviations are: OR, odds ratio; 95% CI, 95% confidence interval.
P values < 0.05 were considered statistically significant.

However, when tested together in a regression model to assess their role as independent risk factors for CKD, only the presence of diabetes in siblings remained significantly associated with a Ccr <60 mL/min (Table 4).

Alcohol ($P < 0.01$) and tobacco ($P < 0.02$) consumption was significantly associated with a Ccr <60 mL/min. Length of exposure to these substances was also significantly longer in patients with Ccr <60 mL/min as compared with that of patients with Ccr >60 mL/min (data not shown). Being elderly, female, single, widowed, or divorced, having a low educational level, being unemployed, and having low income were significantly associated with a Ccr <60 mL/min when tested separately (Table 5). However, in a logistic regression model that includes all of these variables together, only gender, age, educational level, and income remained independent risk factors for CKD (Table 6).

DISCUSSION

Our results show that this Mexican population living in Mexico has prevalence rates of CKD similar to or higher than those in developed countries with national registries of renal patients. Diabetes and hypertension are important risk factors for renal function impairment. The association of reduced renal function and the presence of diabetes and cardiovascular diseases in close relatives suggest an important role for underlying genetic factors in the development of renal disease. On the other hand, the association of renal disease and certain social and economic factors suggests that the lack of opportune preventive health care interventions focused on risk factors may aggravate this problem.

The unawareness of hypertension in our sample (43.6%) was lower than the figure recently reported by Arroyo et al (72.0%) for urban Mexican population [15]. This difference may be explained by the fact that health services are more available for patients of our sample than for the general Mexican population. Unawareness of diabetes in our sample was 51.3%. It is noteworthy that unawareness of renal disease was strikingly high: 89.0% of the patients with Ccr <60 mL/min and 75% of the patients with Ccr <15 mL/min did not know they had a renal disease. The strategy to cope with this problem should be directed to educational programs for primary care physicians and other members of the health care team such as nurses, nutritionists, and clinical laboratory staff. However, even in the United States, the wealthiest country in

the world, there is concern that patients requiring RRT, who represent only 0.8% of the Medicare population, consume 5.2% of total Medicare expenditures. In Mexico, the IMSS spends approximately 10% of its health care budget to care for patients who require RRT. If the present data reflect the picture in the whole country, no more than 20% of patients who should receive RRT actually receive it. Mexican health care institutions may not be able to support the heavy economic burden of providing RRT for all patients who need it. Beyond the monetary issue, there is lack of trained nephrologists and nephrology nurses needed to care for these patients. It would take many years to educate and train the required number of such health care professionals. Currently, approximately 300 nephrologists are certified by the Mexican Board of Nephrology (Consejo Mexicano de Nefrologia) in Mexico. The current number of specialists is not enough to care for patients requiring RRT, not to mention patients with Ccr < 60 mL/min who could benefit from nephrology consultation. [16, 17]. All Mexican parties interested in these issues should begin to analyze different options to cope with this impending problem.

High incidence and prevalence rates of renal disease have been previously reported in Mexican Americans living in the United States [4, 5, 18–23]. Diabetes plays a major role in the development of renal disease. Diabetes prevalence rate is as high as 25% in populations at the low socioeconomic strata [24]. Our data show a lower figure for diabetes prevalence (10.9%); however, it is higher than that reported for white Americans. The progression rate of renal damage has been reported to be faster in Mexican Americans than in white Americans [25], which suggests a role for genetic and/or environmental factors. Moreover, the presence of microalbuminuria is more frequent in Mexican patients with diabetes or hypertension than in their white American counterparts [26, 27].

Diabetic nephropathy accounts for 44% of Mexican patients receiving RRT [4]. The fact that diabetes is more frequent in Mexicans than in other ethnic groups may not be the only explanation for this high figure, because in our sample only 10.0% of patients with Ccr <15 mL/min, and 25.2% of patients with Ccr <60 mL/min had diabetes mellitus. Diabetes has been reported as a predictor for early referral to a nephrologist [28], which suggests that primary care physicians are more likely to recognize the risk of renal disease in the setting of diabetes compared with nondiabetic causes of renal failure.

The prevalence rate of hypertension in Mexican patients in this and other studies [29] is similar to that reported for white Americans [30]. The lack of opportunity for diagnosis and treatment of hypertension plays an important role in the development and progression of renal damage, as has been previously reported [31, 32]. Patients with diabetes with hypertension showed a higher frequency of proteinuria and also a higher level of urinary protein excretion than patients with diabetes without hypertension. Mexican Americans show higher cardiovascular mortality rates than white Americans, which may be partially explained by genetic factors related to hypertension and heart disease. A study of Mexicans living in San Antonio, Texas, suggested that there are genetic factors related to obesity, lipid metabolism disorders, and atherosclerosis in this group [33]. A direct relationship between atherosclerosis and renal disease has not been demonstrated. However, the association shown in the present study between CKD and the presence of ischemic heart disease, stroke, and diabetes, may represent a pathophysiologic link. This is particularly relevant for the elderly, because it has been reported that vascular damage may be responsible for loss of renal function in the elderly [34].

It has been shown that tobacco consumption is a risk factor for the progression of kidney disease in diabetic nephropathy [35] and other renal diseases [36]. In the present study, patients with CKD had a significantly higher frequency of tobacco use and a longer exposure time. The association of certain indices of poverty and a Ccr <60 mL/min that we observed is not likely to represent a causal link. However, there are mechanisms that may explain the effect of poverty and low educational level on the development of CKD. Socially marginal populations from many countries have been shown to be more susceptible to renal disease [37–39]. Prematurity and low birth weights are more prevalent at lower socioeconomic levels and may be risk factors for CKD [37, 40]. It has been shown in some studies that premature and low-birth-weight newborns have fewer nephrons than term infants do, and that this lower nephron number is associated in adult age with hyperfiltration and renal damage [41]. In the present study sample, less than 10% of the patients knew their birth weight and, therefore, this factor could not be assessed. In Mexico, the prematurity rate is 10.2%, and 5.03% of term infants have a birth weight <2,500 g; [8] therefore, this hypothesis is plausible.

Poverty and low educational level may also predispose to inadequate alimentary habits. In Mexican Americans living in the United States the prevalence rate of obesity is 50% and that of diabetes is 25%, figures that are higher than those seen in many other ethnic groups [24, 42]. The prevalence rates of obesity and diabetes are even higher for women in the poorest strata. In Mexico, the prevalence rate of obesity is also very high, perhaps due to inadequate nutritional habits. Mexican Americans living in the United States are more reluctant to use high-technology medicine, less compliant with chronic treatments, and more willing to delegate the decisions about health care and treatment to health care team members

or relatives as compared with the white American population [43]. These practices may considerably delay diagnosis and treatment, and impair the quality of health care for chronic diseases.

CONCLUSION

The prevalence rates of CKD and the need for RRT in Mexico seem to be similar or higher compared to those in industrialized countries. The high prevalence rate of renal diseases may be partially explained by the higher frequency of diabetes in Mexicans, but other genetic and socioeconomic factors may also play a role.

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Reprint requests to Dante Amato, MD, Unidad de Investigacion Medica en Enfermedades Nefrologicas, Hospital de Especialidades, Centro Medico Nacional Siglo XXI, Instituto Mexicano del Seguro Social, Av. Cuauhtemoc 330, Colonia Doctores, Mexico City 06725, Mexico.
E-mail: jamatom@cis.gob.mx

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