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Epidemiological mapping of primary glomerulopathies in Lima: A single-center observational study.

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Abstract

Introduction: Primary glomerulopathies (PGs) constitute a heterogeneous group of kidney diseases that primarily affect the glomeruli without an identifiable etiological cause. They present clinically with a broad spectrum of manifestations, ranging from proteinuria, hematuria, and nephrotic syndrome to acute or chronic kidney failure. The epidemiology of GP varies geographically; in Peru, focal segmental glomerulosclerosis (FSGS) has increased significantly, positioning itself as the most prevalent form.

Methods: A retrospective study was conducted using kidney biopsies from a referral center in Lima between 2006 and 2015. Patients over 18 years of age with a biopsy-confirmed diagnosis of GP were included. The samples were processed for light microscopy and immunofluorescence, and glomerular lesions were classified according to their morphological pattern and type of immune deposits.

Results: Of the 1259 GP biopsies, 960 met the inclusion criteria. FSGS was the most common form (67%), followed by membranous glomerulopathy (MG) (21%) and glomerulopathy with a membranoproliferative pattern (MPP) (7%). The annual incidence of MG is 13.2 patients per million people.

Conclusion: The prevalence of FSGS has doubled in the last decade, displacing MPP, suggesting an epidemiological shift in the Peruvian population.

Keywords:

Primary glomerulopathies; focal and segmental glomerulosclerosis; renal biopsy; membranous glomerulopathy.

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Primary glomerulopathies (PGs) [1] constitute a heterogeneous group of kidney diseases characterized predominantly by glomerular involvement, and the etiology of kidney damage has not been identified. Clinically, these entities manifest a variable spectrum of signs and symptoms, including proteinuria, hematuria, and acute or chronic kidney failure, or they can be detected incidentally through abnormalities in laboratory tests. For definitive diagnosis in adults, kidney biopsy remains the diagnostic tool of choice, allowing the identification of specific morphological alterations at the glomerular level, which is essential for their classification and management. Classification as a GP is performed by ruling out an identifiable etiology, different from secondary glomerulopathies, in which there are known underlying causes, such as autoimmune diseases, infections, or drug exposure [2].

The epidemiology of GP presents a considerably diverse geographical distribution [3]. Globally, immunoglobulin A nephropathy (IgAN) is the most prevalent subtype in regions of Asia [4, 5] and Europe [6- 8]. In contrast, in the United States [9, 10] and Brazil [11, 12], focal segmental glomerulosclerosis (FSGS) has been reported as the predominant form of GP. The causes of these epidemiological differences have not been elucidated, although it is speculated that genetic, environmental, and socioeconomic factors could play essential roles in geographical variation [3].

In Peru, the epidemiology of GP has been studied since the 1970s, with reports published at regular intervals every ten years between 1975 and 2005 [13-15]. These studies have provided valuable information on the prevalence and characteristics of GPs in the adult population, particularly in Lima. However, knowledge about potential changes in epidemiological patterns during the decade from 2006 to 2015 is limited. Therefore, the present study aims to analyze the characteristics of GPs in Peru from 2006 to 2015, identifying possible variations in prevalence, clinical presentation, and histopathological results.

Materials and methods

Study design

This study is observational, and the source is retrospective.

Scenery

The study was conducted in the renal pathology service of the "Patólogos AS SAC" Institute, a reference center for renal biopsies in Lima, Peru. It lasted from January 1, 2006, to December 31, 2015.

Participants

Renal biopsy samples from elderly patients referred to the institution were included. Reports of secondary glomerulopathies were excluded. Samples containing fewer than 8 glomeruli, limiting the diagnosis degree, were excluded.

Variables

The variables studied included age, sex, the presence of nephrotic syndrome, renal failure, and hematuria. The histological diagnoses comprised minimal change glomerulopathy, mesangial glomerulopathy, focal segmental glomerulosclerosis, membranoproliferative glomerulopathy, and membranous nephropathy.

Data sources/measurements

The source was indirect; an electronic form was completed using institutional medical records. Renal biopsies were processed for light microscopy (LM) and immunofluorescence (IF), with diagnoses made by renal pathology experts. For LM, histological sections were stained with hematoxylin–eosin (HE), PAS, Masson's trichrome, and methenamine silver. The following parameters were analyzed for each biopsy: the number of glomeruli, the type of glomerular lesion (proliferative vs. nonproliferative), and the pattern of glomerular damage (focal or diffuse). The presence of tubular atrophy and interstitial fibrosis was semiquantified on a scale of 0 to 3 crosses. For IF, fluorescently labeled mouse anti-human IgG, IgM, IgA, C3, C4, and C1q antibodies were used, and the following were assessed: the number of glomeruli, the presence of immune complexes or antibodies, the type of immunoglobulin deposited, and their location within the glomerulus (diffuse or focal pattern, segmental or global location, capillary loops, mesangium, Bowman's capsule). GP classification was performed based on the pattern of glomerular damage [16].

Clinical definitions

The nephrotic syndrome status was as follows: proteinuria > 3.5 g/day, with or without edema, and hypoalbuminemia (serum albumin < 3.5 g/dl). Renal failure: creatinine levels > 1.2 mg/dl in women and > 1.4 mg/dl in men. Hematuria: > 5 dysmorphic red blood cells per high-power field urine.

Histological definitions

Minimal change glomerulopathy (MCG): absence of alterations in the glomerular structure in the OM and of immune complex deposits via immunofluorescence (IF). Mesangial glomerulopathy (MesGM): increased matrix and/or cellularity at the mesangial level, without alterations in the capillary basement membrane. IF: deposits of IgG, IgM, or IgA at the mesangial level. Focal segmental glomerulosclerosis (FSGS): normal glomeruli and fewer than 50% of the glomeruli involved with hyaline/sclerotic lesions in segments or parts of the glomerulus in the OM. IgM and C3 deposits are present in the mesangial hyaline areas in IF. Glomerulopathy with membranoproliferative pattern (GPMP): proliferation of mesangial cells and expansion of the mesangial matrix, with segmental thickening of the capillary loops in the OM, involving most of the

glomeruli. In IF, IgG, IgM, and C3 deposits are present at both the mesangial and capillary levels in the glomeruli. MN: diffuse thickening of capillary loops in the absence of cell proliferation. In IF, deposits of IgG are present at the level of the glomerular capillaries with overall involvement; to a lesser extent, deposits of IgM and C3 are present in capillary loops.

Biases

Applying the participant selection criteria avoided observation and selection bias. To prevent potential interviewer, information, and recall bias, the principal investigator always maintained the data via a guide and records approved in the research protocol. Two researchers independently analyzed each record in duplicate, and the variables were entered into the database after verifying their concordance.

Study size

The sample was probabilistic. The rate of chronic kidney disease in Peru is 11%. The National Institute of Statistics (INEI) reported that the province of Lima had a population of 10,292,408 in 2024. This represents 1,029,240 possible cases of chronic kidney disease in stages 1 to 5. Using EPI info (CDC, Atlanta), with an expected biopsy diagnosis frequency of 25%, a 5% confidence limit, and a 99.9% confidence level, the sample size was 811 cases.

Quantitative variables

Descriptive statistics were used. The results are presented as frequencies and percentages. Scale variables were not converted into categorical.

Statistical analysis

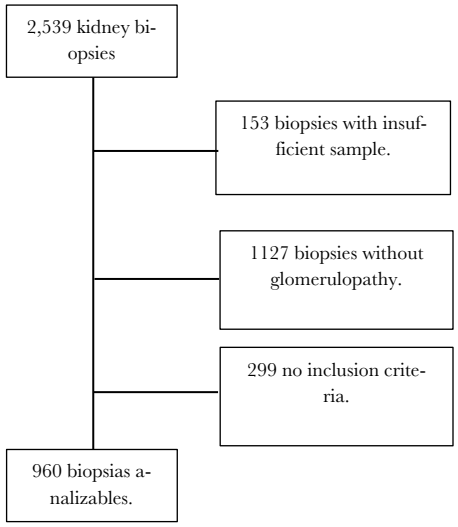
Qualitative variables are presented as frequencies and percentages. Proportions were compared via the chi-square test. The statistical package used was IBM Corp. (released from 2018). IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.

Results

Participants

A total of 2,539 renal biopsies were performed in patients older than 18 years of age. In 153 patients, the sample size was insufficient, and 1259 (49.6%) had glomerulopathies, of which 960 (76%) met the inclusion criteria. The included cases met 100% of the sample size (Figure 1).

Figure 1. Flowchart.



Main characteristics of the study group

The mean age was 42.6 ± 16.0 years for all glomerulopathies, which was greater for membranous nephropathy (45.6 ± 14.3) and lower for minimal change glomerulonephritis (31.6 ± 12.4), with no significant difference. A total of 56% of the patients were male, and all patients were of mixed races. The clinical presentation at the time of biopsy was similar among the different glomerulopathies: edema in 69%, hematuria in 35%, nephrotic syndrome in 55%, proteinuria at 5.32 ± 4.47 g/day, and renal failure in 35% of the patients. The average serum creatinine level was 1.65 ± 1.71 mg/dl.

Types of glomerulopathies

Focal segmental glomerulosclerosis was the most common glomerulopathy in 67% of patients. The most frequent variant was nonspecific (NOS) in 95% of patients, followed by the tip variant in 2.4%, the perihilar variant in 1.5%, and the cellular variant in 1%. Compared with other glomerulopathies, patients with mesangial glomerulopathy presented with less edema and nephrotic syndrome, as well as more hematuria (31% vs 69%, 24% vs 55%, and 60% vs 35%, P = 0.001). The most common indication for renal biopsy was nephrotic syndrome in 65% of patients. Immunofluorescence analysis revealed a predominance of IgM in focal segmental glomerulosclerosis, IgG in membranous nephropathy, IgG, C3, and C1q in glomerulopathy

with membranoproliferative patterns, and IgA and IgM in mesangial glomerulopathy (Table 1).

Table 1. Characteristics of the study group.

	GEFS n=646	NM n=198	GMP n=67	GMes n=40	GCM n=9	Total n=960
Percentage (%)	646 (67)	198 (21)	67 (7)	40 (4)	9 (1)	960
Sex % (male)	56	66	44	27 *	55	56
Age (years)	41.8±16.5	45.6±14.3	40.8±14.8	42.4±13.7	31.6 ±12.4	42.6±16.0
Edema (%)	60	72	73	31 *	89	69
Hematuria (%)	33	28	50	60 *	22	35
Nephrotic syndrome	54	70	55	24 *	33	55
Proteinuria (g/day)	5.01±4.29	6.33±5.08	4.27±2.79	3.26±4.40	6.14 ± 4.37	5.32±4.47
Kidney failure (%)	39	34	45	50	33	35
Creatinine (mg/dl)	1.63±1.60	1.32±1.27	1.83±1.57	1.21±0.84	1.36±0.52	1.65±1.71
Nephrotic syndrome (%)	1 (0.7%)	2 (2.1%)	0.33			
Nonnephrotic proteinuria (%)	0 (0%)	2 (2.1%)	-			
Kidney failure water (%)	2 (1.43%)	0 (0%)	-			
Hematuria (%)	0 (0%)	2 (2.1%)	-			
Histology						
Glomeruli	12 ±4	19 ±6	13 ±3	15 ±4	12 ±7	14 ±4
IF Ig G (%)	20%	97%	52%	0%	0%	34%
IF Ig M (%)	68%	60%	67%	45%	0%	64%
IF Ig A (%)	7%	15%	32%	45%	0%	58%
IF C3 (%)	61%	97%	79%	60%	0%	71%
IF C1q (%)	12%	10%	45%	8%	0%	14%

Membranoproliferative pattern G , MesG : Mesangial G, CMG: Minimal change G, AKI: Acute kidney injury. IF: Immunofluorescence, * $P = 0.001$

Table 2. Characteristics of glomerulopathies by years.

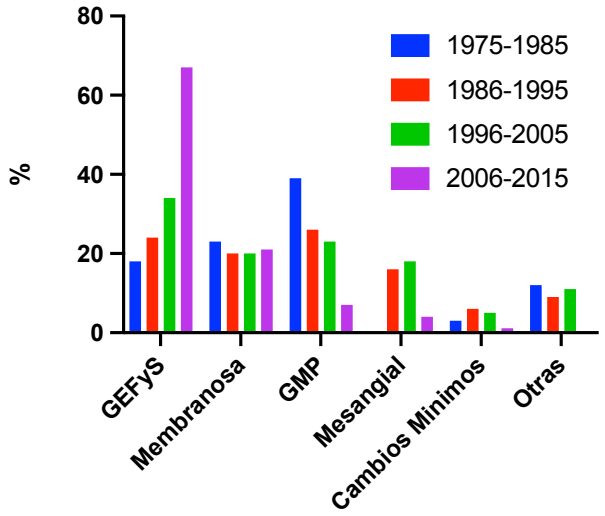
Period	1975-1985	1986-1995	1996-2005	2006 - 2015
Number of patients	116	731	977	1259
Age (years)	36	34.6	37.1	42.6
Men (%)	88	49	46	56
Patients (pmp/year)	10.5	12.6	13.4	13.2
Type of Glomerulonephritis				
Focal segmental glomerulosclerosis (%)	18%	24.1%	33.7%	67%
Membranous nephropathy (%)	23%	19.7%	19.5%	21%
Membrane proliferative glomerulonephritis (%)	39%	25.6%	23.4%	7%
Mesangial glomerulonephritis (%)	-	16.4%	17.9%	4%
Minimal change glomerulopathy (%)	3%	5.5%	5.3%	1%
Others (%)	12%	8.7%	11.4%	-

pmp: per million population.

Population rates

The rate of patients with glomerulopathies was 13.2 patients pmp/year, similar to that reported in the last decade. Focal segmental glomerulosclerosis has increased from 33% to 67% compared with the previous decade, with a rate of 8.8 patients pmp/year. Membranous nephropathy has remained stable over time, and glomerulopathy with membranoproliferative patterns has decreased from 39% to 7%, moving into third place (Table 2, Figure 2).

Figure 2. Bar chart of incidence of glomerulopathies 1975-2015, Lima-Peru.



FSGS : focal segmental glomerulosclerosis. MPG: membranoproliferative glomerulonephritis .

Discussion

A study of 960 biopsies from patients over 18 years of age diagnosed with GP between 2005 and 2016 revealed that FSGS (67%) was the primary cause of GP in Peru, a trend observed in previous studies carried out in the past three decades by the same group of nephrologists and pathologists [13- 15]; the characteristics of patients with FSGS were as follows: average age of 41.8 ± 16.5 years, predominance of males (56%), creatinine of 1.63 ± 1.60 mg/dl, and proteinuria of 5.01 ± 4.29 g/day, characteristics similar to those of the other GPs studied [10, 17], except for GMes, which had less edema (31%), nephrotic syndrome (24%) and greater hematuria (60%). The histological findings of patients with FSGS revealed that the NOS variant was the most common (95%). FSGS is the leading cause of GP in Peru, as described in Brazil [11, 12], in the United States [9, 10], with a rate of 8.8 patients pmp/year, similar to that reported internationally in the same period [18]. Its frequency has increased from 33--67% in this study, from 22.3--33.9% in Brazil between 1979--1993 [19], and 15--35% in the United States from 1970--1997 [20]. The factors that determine this increase in frequency are unknown, and the proposed hypotheses are linked to environmental and genetic factors. Concerning ecological factors, the following factors are mentioned: a) low birth weight, which conditions a nephron deficit inducing glomerular hyperfiltration as an adaptive mechanism, which would condition FSGS [21, 22]; this information is not always available at the time of the biopsy to make the association; in Peru during the study period, the incidence of underweight children was 10.1% [23]; b) another suggested factor is overweight/obesity, which is associated with the appearance of FSGS [24], and the frequency of overweight/obesity is increasing worldwide and is a factor to consider [25]. In the United States, a relatively high frequency of FSGS has been described in the African-American population [20], which is related to genetic variants of the apolipoprotein L1 gene [26]. The populations evaluated in this study were all Mestizo (Latino) individuals, and no genetic studies were performed. Therefore, further research is essential to clarify the mechanisms underlying these changes.

The prevalence of NM reportedly increases with age [27]. In the population studied, the average age was greater than that reported in previous decades; however, the frequency of NM has remained stable over time.

GMP has decreased from 39% to 7%, ranging from first to third, similar to what has been reported in some European countries [28]. This decrease could be due to an epidemiological transition. The "hygiene hypothesis" states that childhood exposure to bacterial antigens, as occurs in poor countries, alters the balance of T helper 1/T helper 2 lymphocytes; the opposite happens in industrialized countries. GMP has been associated with increased expression of T helper 1 lymphocytes [29, 30].

The most significant limitation is that it is a retrospective study, which introduces classification bias in the primary versus secondary nature of the GP studied and the loss of relevant clinical and/or laboratory information.

Conclusions

This retrospective study on the characteristics of GP during the period 2006-2015 identified FSGS as the leading cause of GP in Peru, and further analysis of its growth compared to previous decades is needed. New studies are required to investigate the factors that influence the observed changes.

Abbreviations

G: glomerulopathy.
GEFS: Focal and segmental glomerulosclerosis.
NM: Membranous nephropathy
GMP: G with a proliferative membrane pattern.
GMes: G mesangial.
GCM: G minimal changes.
AKI: Acute kidney injury.
IF: Immunofluorescence.

Additional information

No supplementary materials have been declared.

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Not applicable.

Authors' contributions

Raúl Junior Gonzales Navarro: Conceptualization, methodology, research, writing - original draft.
Abdias Nicanor Hurtado Arestegui: Conceptualization, methodology, research.
Carmen Asato Higa: Conceptualization, data curation, project management, supervision, validation, visualization, writing, review and editing.
Julia Sumire numbers: Formal analysis, funding acquisition, methodology.
All the authors read and approved the final version of the manuscript.

Financing
The authors self-funded the study. The patient's insurance provider covered the costs of hospitalization and transplant surgery.

Availability of data or materials
Not applicable.

Statements

Ethics committee approval and consent to participate
The Ethics Committee of the Laboratorio Patólogos AS SAC approved the study, Clínica Las Américas, San Isidro, Lima, Peru.

Consent for publication
When no patient-specific photographs, X-rays, or CT scans are published, they are not needed.

Conflicts of interest
The authors declare that they have no conflicts of interest.

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