# Current distribution pattern of biopsy-proven glomerular disease in Salvador, Brazil, 40 years after an initial assessment

## Padrão de distribuição atual da doença glomerular documentada por biopsia em Salvador, Brazil, 40 anos após a avaliação inicial

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## Abstract

**Introduction:** A report on the prevalence of glomerular disease diagnosed via renal biopsy in Salvador, BA, Brazil was published in 1973 and showed a predominance of membranoproliferative glomerulonephritis, which was frequently associated with hepatosplenic schistosomiasis. **Objective:** In this study, we investigate the potential changes in the distribution of glomerular diseases after a period of important epidemiological transition in Brazil. **Methods:** Pathology reports of all patients subjected to kidney biopsy from 2003 to 2015 in a referral nephrology service were reviewed. Clinical, laboratorial and pathological diagnoses were collected for analysis. Histological slides of the biopsies performed between 2003 and 2006 were reviewed to examine the accuracy of the estimates based on the pathology reports. **Results:** Among the biopsies performed during the time period, 1,312 met the inclusion criteria for the study. Focal and segmental glomerulosclerosis was the most prevalent diagnosis, followed by lupus nephritis. However, a trend toward a decrease in the prevalence of focal and segmental glomerulosclerosis was detected ($p < 0.05$), and an increase in lupus ($p < 0.0001$) and membranous glomerulonephritis ($p < 0.005$) was observed. **Conclusion:** The data presented herein suggest the occurrence of changes in the distribution of nephrological diseases in Salvador, Brazil. The disease that was most prevalent disease shifted from membranoproliferative glomerulonephritis to focal and segmental glomerulosclerosis from 1975 to 2006 and from focal and segmental glomerulosclerosis to lupus nephritis from 2006 to 2015.

**Keywords:** biopsy; glomerulonephritis; kidney diseases; needle.

## Resumo

**Introdução:** um relatório sobre a prevalência de glomerulopatia diagnosticada por biópsia renal em Salvador foi publicado em 1973, demonstrando o predomínio de glomerulonefrite membranoproliferativa, frequentemente associada a esquistossomose hepatoesplênica. **Objetivo:** no presente estudo, investigamos as possíveis mudanças na distribuição das glomerulopatias após um período de importantes transições epidemiológicas no Brasil. **Métodos:** foram revisados todos os relatos de pacientes submetidos a biópsia renal de 2003 a 2015 em um serviço de referência em nefrologia. Diagnósticos clínicos, laboratoriais e patológicos foram colhidos para análise. Lâminas histológicas das biópsias executadas entre 2003 e 2006 foram revisadas para avaliar a precisão das estimativas baseadas nos laudos anatomopatológicos. **Resultados:** entre as biópsias realizadas durante o período em questão, 1.312 satisfizeram os critérios de inclusão do estudo. Glomeruloesclerose segmentar e focal foi o diagnóstico mais prevalente, seguido de nefrite lúpica. Entretanto, foi detectada tendência de queda na prevalência da glomeruloesclerose segmentar e focal ($p < 0,05$) e de elevação nos casos de lúpus ($p < 0,0001$) e glomerulonefrite membranosa ($p < 0,005$). **Conclusão:** os dados apresentados neste estudo sugerem a ocorrência de mudanças na distribuição das doenças nefrológicas em Salvador. A doença mais prevalente passou de glomerulonefrite membranoproliferativa para glomeruloesclerose segmentar e focal de 1975 a 2006 e de glomeruloesclerose segmentar e focal para nefrite lúpica de 2006 a 2015.

**Palavras-chave:** biópsia por agulha; glomerulonefrite; nefropatias.

## Introduction

Glomerulopathies are among the leading causes of end-stage renal disease.[1,2] As reported in different parts of the world, focal and segmental glomerulosclerosis (FSGS) and IgA nephropathy are the most common primary glomerular diseases and lupus nephrits is the most common secondary glomerular disease.[3-6] However, the frequency of IgA nephropathy varies widely, and a low prevalence of FSGS has been reported in some places.[7,8]

The last biopsy-based survey on the prevalence of glomerular disease in Salvador, Bahia was reported in 1975 by Queiroz *et al.*[9] In that study, membranoproliferative glomerulonephritis (MPGN) accounted for at least 20% of all 101 kidney biopsies that were performed in a general hospital from 1970 to 1973. MPGN was the most prevalent glomerulopathy in adults with nephrotic syndrome and was frequently associated with hepatosplenic schistosomiasis.[9]

In this study, we estimated the frequency of glomerular diseases in patients who underwent renal biopsy for the diagnosis of renal disease in Salvador, Bahia, betweeen 2003 and 2015. We demonstrate that, the current pattern of glomerular diseases distribution in Salvador does not substantially differ from that reported in the most affluent areas of Brazil and in developed countries and exhibits a low frequency of MPGN and a predominance of FSGS and lupus nephritis.

## Methods

### Cases

This is a descriptive exploratory study that includes all of the native kidney biopsies performed for the diagnosis of glomerular diseases in referral nephrology services of public hospitals of Bahia State, Brazil and were examined at the Gonçalo Moniz Institute - Fiocruz (IGM-FIOCRUZ) between 2003 and 2015. Repeated biopsies from the same patient were analyzed as a single case.

### Renal biopsies

All renal biopsies were subjected to the following procedures: (1) fixed in alcoholic formalin or in Bouin's solution, paraffin-embedded, cut at 2-µm thickness and stained with hematoxylin and eosin, Periodic Acid Schiff, Periodic Acid Schiff-Methenamine Silver, Azan and Picro Sirius red, for conventional light optical microscopy - Congo Red stain was used if amyloidosis was suspected; (2) embedded in cryopreservation medium for immunofluorescence identification of abnormal immune deposits containing IgA, IgG, IgM, kappa chains, lambda chains, C1q, C3 and fibrinogen; and (3) fixed in 1% glutaraldehyde in cacodylate buffer, post fixed in osmium tetroxide and embedded in polybed for ultra-structural analysis when required.

### Clinical data

The following data were obtained from the biopsy request forms: age, gender, diagnosis of renal syndrome, serum creatinine concentration. For the purpose of this study, nephrotic syndrome was defined by urinary protein excretion was greater than 3.5 g/24 h and was associated with the presence of edema and hypoalbuminemia or when this diagnosis was reported by the assistant nephrologist. Renal failure was considered if the serum creatinine concentrations were higher than 1.2 mg/dL for children and women or above 1.5 mg/dL for men or when this diagnosis was reported in the request form. Children were defined as patients who were 16 years old or younger.

### Diagnosis of kidney disease

Renal disease diagnoses were collected from the pathology report and then adapted according to the nomenclature proposed by Churg *et al.*[10]

### Accuracy of the estimate based on the pathology reports

To assess the accuracy of the distribution of renal diseases estimated by the revision of the pathology records, all of the biopsies that had been performed between 2003 and 2006 were independently revised by three pathologists (WLCS, GMMS and MFSS), who were blinded to the diagnosis that had previously been attributed to the case. Cases were excluded from this analysis if they originated from transplanted kidneys, if their respective slides were not available for histological review, if the representation of the renal cortical tissue was insufficient for conventional microscopy or immunofluorescence, or if the availability of clinical information was insufficient for a diagnostic conclusion.

### Expression and analysis of the data

Data are expressed as absolute numbers and percentages and are summarized as the means ± standard

deviations or as medians and first and third quartiles. Information on the prevalence of nephrological diseases is presented in sufficient detail to allow comparisons with other series presented in the literature.

To improve comprehension of the age distribution of the disease, data are presented as trend lines that were calculated with the best non-linear fitness equations. Comparisons between groups were performed with the Chi-square test. The results were statistically significant if $p$ was < 0.05. Data were analyzed using Prism 5.01 (Graph Pad, San Diego, CA, USA) and StataIC11 software (StataCorp LP, College Stsation, TX, USA).

## Results

### General characteristics of the patients

Between 2003 and 2015, a total of 1,669 renal biopsies were examined in the IGM-Fiocruz. However, 206 of the biopsies were from transplanted kidneys, 166 had underrepresented renal parenchyma (mostly due to the absence of glomerulus for studies by immunofluorescence), 35 were from patients with an inconclusive diagnosis and 8 had been received for revision. A total of 353 cases were excluded from the study. Among the remaining 1,346 cases, 35 were repeated subsequent biopsies from the same patient and were analyzed as a single case. Hence, the study was based on the 1,312 remaining biopsies.

The main clinical and demographic characteristics of these patients are shown in Table 1. The age varied from 1 to 88 years old, with a median age of 27 [17-40; first and third quartiles, respectively] years old. Three hundred patients (24%) were children, and 971 (76%) were adults. The proportion of females and males was similar among both children and adults. Ethnic characteristics were reported in only 286 of the patients, and brown skin color predominated.

The main reported clinical presentation was nephrotic syndrome (46%), followed by signs of systemic lupus erythematous (23%) in adults and nephritic syndrome (11%) in children.

### Global distribution of renal diseases

FSGS (32%), diffuse proliferative glomerulonephritis (13%) and minimal change disease (13%) were the most prevalent diagnoses in children and lupus nephritis (26%), FSGS (23%), and membranous glomerulonephritis (11%) were the most frequent renal lesion patterns in adults. MPGN was present in 6% of patients, 2% of children and 7% of adults. The prevalence of lupus nephritis reached 36% in female adults. It was 6% in males (data not shown).

The relative frequency of lupus nephritis was higher in black skin collor (16/67) than in brown skin collor (11/130) skin color patients (Fisher exact test, $p < 0.0042$). No other difference was observed in the prevalence of the main glomerular diseases among the patients of the distinct ethnic groups.

### Histological review

Histological review of the cases diagnosed between 2003 and 2006 was limited to 154 renal biopsies. The prevalence of kidney diseases obtained via independent histological analysis and the consensus diagnosis achieved by the three pathologists was similar to those obtained from the biopsy reports (Table 2). Although mesangial proliferative glomerulonephritis had an estimated prevalence of 3% based on the data collected from the biopsy reports and was not reported in the histological review, the difference was not statistically significant.

### Age distribution of glomerular diseases

The age distribution of the main glomerular diseases is presented in Figure 1. FSGS is the most prevalent glomerular disease in the 1st and 2nd decades of life but is surpassed by lupus nephritis between the 3rd and 5th decade and by membranous glomerulonephritis in the 7th decade. The prevalence of lupus nephritis increases from the 1st to the 4th decade and declines from the 5th to the 7th decade.

The prevalence of membranous glomerulonephritis progressively increases from the 1st to the 8th decade and becomes the most common glomerular disease between the 7th and 8th decades of life. The prevalence of MPGN increases from the first to the 5th decade and becomes the 3rd most prevalent glomerulopathy pattern in the 8th decade of life.

### Trends of time distribution of glomerular diseases

The prevalence of FSGS decreased ($p < 0.05$), and the prevalence of lupus nephritis ($p = 0.0001$) and membranous glomerulonephritis ($p < 0.005$) increased during the study period. The decrease in the prevalence of FSGS was even more intense when only the adult population was considered ($p = 0.0001$) (Table 3). The prevalence of diffuse proliferative glomerulonephritis decreased

**Table 1** General characteristics of the patients subjected to kidney biopsy from 2003 to 2015 in referral hospitals in Salvador, BA, Brazil

| Parameter | Children (< 16 Years) | | Adults (> 16 Years) | | Total | |
|---|---|---|---|---|---|---|
| | N | (%) | N | (%) | N | (%) |
| N | 300 | (24%) | 971 | (76%) | 1,312 | (100%) |
| Age (1,271) | | | | | | |
| Mean ± sd | 10 | ± 4 | 35 | ± 14 | 30 | ± 16 |
| Median [1st quartile-3rd quartile] | 11 | [14 - 7] | 44 | [44 - 24] | 27 | [17 - 40] |
| Range | 1 | 1 - 16 | 17 | -88 | 1 | - 88 |
| Sex M:F (1,311) | | | | | | |
| Female | 155 | (52%) | 446 | (46%) | 621 | (47%) |
| Male | 145 | (48%) | 524 | (54%) | 690 | (53%) |
| Ethnic group (286): | | | | | | |
| Black | 9 | (16%) | 57 | (25%) | 67 | (23%) |
| Brown | 23 | (40%) | 106 | (47%) | 130 | (45%) |
| White | 26 | (45%) | 62 | (28%) | 89 | (31%) |
| Main clinical presentation (1,235): | | | | | | |
| Nephrotic syndrome | 150 | (53%) | 400 | (44%) | 565 | (46%) |
| Systemic lupus erythematous | 24 | (8%) | 212 | (23%) | 245 | (20%) |
| Nephritic syndrome | 32 | (11%) | 27 | (3%) | 60 | (5%) |
| Undefined proteinuria | 13 | (5%) | 46 | (5%) | 59 | (5%) |
| Acute kidney injury | 14 | (5%) | 42 | (5%) | 58 | (5%) |
| Systemic arterial hypertension | 1 | (0.3) | 48 | (5%) | 51 | (4%) |
| Undefined hematuria | 21 | (8%) | 25 | (3%) | 47 | (4%) |
| Chronic renal failure | 3 | (1%) | 42 | (5%) | 25 | (2%) |
| Nephrological diseases: | 300 | (100%) | 971 | (100%) | 1,271 | (100%) |
| Primary glomerular diseases | 258 | (86%) | 649 | (67%) | 907 | (71%) |
| Secondary glomerular diseases | 34 | (11%) | 273 | (28%) | 307 | (24%) |
| Non-glomerular diseases | 8 | (3%) | 49 | (5%) | 57 | (4%) |
| Main histological diagnosis: | | | | | | |
| Focal and segmental glomerulosclerosis | 97 | (32%) | 222 | (23%) | 319 | (25%) |
| Systemic lupus erythematous | 31 | (10%) | 249 | (26%) | 280 | (22%) |
| Membranous glomerulonephritis | 6 | (2%) | 106 | (11%) | 112 | (9%) |
| Diffuse proliferative glomerulonephritis | 39 | (13%) | 31 | (3%) | 70 | (6%) |
| Minimal change disease | 39 | (13%) | 38 | (4%) | 77 | (6%) |
| Membranoproliferative glomerulonephritis | 7 | (2%) | 69 | (7%) | 76 | (6%) |
| IgA Nephropathy | 8 | (3%) | 50 | (5%) | 58 | (5%) |
| Minor glomerular changes | 13 | (4%) | 25 | (3%) | 38 | (3%) |
| Focal and segmental glomerulonephritis | 6 | (2%) | 23 | (2%) | 29 | (2%) |
| Sclerosing glomerulonephritis | 4 | (1%) | 25 | (3%) | 29 | (2%) |
| Crescentic glomerulonephritis | 5 | (2%) | 17 | (2%) | 22 | (2%) |

**Continued Table 1.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Alport syndrome | 11 | (4%) | 4 | (0.4%) | 15 | (1%) |
| Mesangial proliferative glomerulonephritis | 6 | (2%) | 9 | (0.9%) | 15 | (1%) |
| Amyloidosis | 0 | (0) | 15 | (2%) | 15 | (1%) |
| Others | 38 | (13%) | 104 | (11%) | 135 | (11%) |

**Table 2** Comparison between the prevalence of glomerular diseases estimated by a review of the biopsy report or by a review of histological slides from the patients

| Parameter | Biopsy Report | | Histological Review | |
|---|---|---|---|---|
| | N | (%) | N | (%) |
| Focal and segmental glomerulosclerosis | 85 | (35%) | 54 | (37%) |
| Systemic lupus erythematous | 29 | (12%) | 21 | (14%) |
| Membranous glomerulonephritis | 18 | (7%) | 13 | (9%) |
| Diffuse proliferative glomerulonephritis | 23 | (9%) | 11 | (8%) |
| Membranoproliferative glomerulonephritis | 13 | (5%) | 11 | (8%) |
| Minimal change disease | 12 | (5%) | 8 | (6%) |
| IgA Nephropathy | 10 | (4%) | 8 | (6%) |
| Sclerosing glomerulonephritis | 8 | (3%) | 5 | (4%) |
| Focal and segmental glomerulonephritis | 7 | (3%) | 1 | (0.7%) |
| Mesangial proliferative glomerulonephritis | 7 | (3%) | 0 | (0%)* |
| Minor glomerular changes | 6 | (2%) | 2 | (1%) |
| Crescentic glomerulonephritis | 3 | (1%) | 2 | (1%) |
| Alport syndrome | 3 | (1%) | 2 | (1%) |
| Others | 21 | (9%) | 6 | (4%) |
| Total | 245 | (100%) | 144 | (100%) |

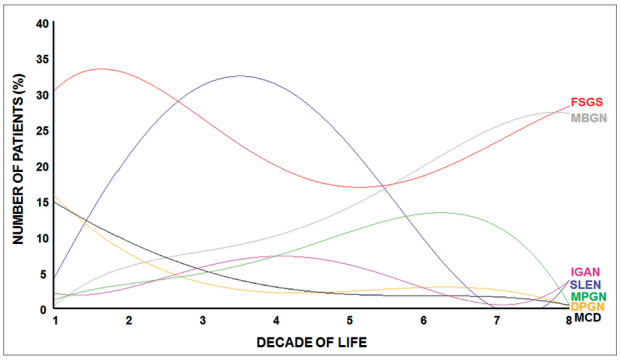
* $p = 0.05$. Chi-square *test*.

**Table 3** Prevalence of glomerular disease estimated by biopsy in three consecutive periods from 2003 to 2015

| Glomerular Disease | Period | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2003-2006 | | | 2007-2010 | | | 2011-2015 | | |
| | Child N (%) | Adult N (%) | Total N (%) | Child N (%) | Adult N (%) | Total N (%) | Child N (%) | Adult N (%) | Total N (%) |
| N | 97(100) | 141(100) | 245(100) | 92(100) | 323(100) | 431(100) | 111(100) | 507(100) | 636(100) |
| FSGS | 37(38) | 46(33) | 85(35) | 27(29) | 83(26) | 114(26) | 33(30) | 93(18)[c] | 129(20)[a] |
| SLEN | 6(6) | 23(16) | 30(12) | 14(15) | 90(28) | 107(25) | 11(10) | 136(27) | 151(24)[c] |
| MBGN | 2(2) | 14(10) | 18(7) | 0(0) | 26(8) | 27(6) | 4(4) | 66(13) | 70(11)[b] |
| DPGN | 13(13) | 10(7) | 23(9) | 12(13) | 8(2) | 20(5) | 14(13) | 13(3)[a] | 27(4) |
| MCD | 8(8) | 3(2) | 12(5) | 18(20) | 15(5) | 34(8) | 13(12) | 20(3) | 34(5) |
| MPGN | 1(1) | 12(9) | 13(5) | 1(1) | 21(7) | 23(5) | 5(5) | 36(7) | 44(7) |
| IGAN | 1(1) | 10(7) | 11(4) | 3(3) | 13(4) | 16(4) | 4(4) | 27(5) | 32(5) |

[a] $p < 0.05$, [b] $p < 0.005$, [c] $p = 0.0001$. Chi-square for trend.

**Figure 1.** Distribution of the most prevalent glomerular diseases according to patient age.




in adults ($p < 0.05$). The distribution of other glomerular diseases did not substantially change during the period.

## Discussion

In this study, we report the prevalence of nephrological diseases that were diagnosed via biopsy in Salvador, Brazil. We also show the changes in glomerular disease distribution that are associated with patient age and the temporal changes in the distribution of these diseases in biopsies that were performed over a 12-year period.

Only biopsies with a confirmed diagnosis via immunofluorescence and electron microscopy (when required) were included. Additionally, the prevalence of nephrological diseases, as estimated in the pathology reports, was compared with the prevalence that was obtained with a histological review of a sample of the biopsies that were performed during the period covered by the study.

This is the first survey on the prevalence of biopsy-proven glomerular diseases made in Salvador, BA, Brazil since the study conducted by Queiroz *et al.*[9] (1975). The study published by Queiroz *et al.*[9] included 47 biopsies from adult individuals with nephrotic syndrome that were identified among a total of 101 biopsies that had been performed over a 3-year period. MPGN was the most common pattern of glomerular lesion and was present in 43% of the patients with nephrotic syndrome (representing at least 20% of the 101 biopsies). FSGS was present in 19% of the lesions of the adult patients with nephrotic syndrome. In the present study, FSGS was the main observed glomerular lesion and was detected in 25% of the biopsies, whereas MPGN was present in only 6% of the cases.

Although biopsy-based estimates are subject to selection bias due to the clinical criteria used for biopsy indication, the difference between our study and the study by Queiroz *et al.*[9] may reflect an actual change in the pattern of glomerular disease distribution for the following reasons:

(1) MPGN is a non-specific pattern of renal disease that is frequently associated with massive sub-endothelial and mesangial immune complex and/or complement deposition.[11] This pattern of lesion is found in patients with infectious and autoimmune diseases.[12,13] Most of the cases of MPGN that were presented by Queiroz *et al.*[9] were associated with the hepatosplenic form of schistosomiasis. Hepatosplenic schistosomiasis combines shunt of portal blood to systemic circulation and high level of circulating *Schistosoma mansoni*-generated antigens. Since the late 70s mass chemotherapy against *S. mansoni* infection drastically reduced the number patients with hepatosplenic form of the disease.[14] Coinfections by bacteria and virus may further contributed to continuous immune complex circulation. In fact a parallel decline in the number of cases of MPGN and hepatosplenic schistosomiasis was reported by Correia *et al.*[15] and this clinical form of schistosomiasis is now uncommon among patients subjected to renal biopsies in Salvador, Brazil.[16] Furthermore, improved sanitation and prevention of viral infections thate took place in Brazil in the same period may also have contributed to the decrease in MPGN prevalence in Salvador observed in this study.[17,18]

(2) The pattern of renal disease distribution with a predominance of FSGS and lupus nephritis that is shown in this work is similar in many aspects to results that have been reported in other regions of Brazil and many other countries in the world.[5,19,20]

(3) The high prevalence of nephrotic syndrome followed by systemic lupus erythematous as the main clinical manifestations of the patients concur with the observed distribution of kidney diseases. The prevalence of kidney disease that was estimated with the biopsy report was further confirmed by the histological review of the biopsies that were performed between 2003 and 2006.

Lupus nephritis was the most common secondary nephrological disease in adults and in children. The high frequency of lupus nephritis is reported in most biopsy-based studies.[5,21]

In fact, although FSGS was the most common nephrological disease, a trend towards a decrease in the prevalence of this disease and an increase in the prevalence of lupus nephritis was observed in the study period. Membranous glomerulonephritis exhibited a slight increase in prevalence between 2010 and 2016. Although these changes in prevalence may be influenced by the decrease in the proportion of children who underwent a biopsy between 2006 (41%) and 2016 (18%), they persist when only the adult population is considered.

The potential explanation for this change may include an increased clinical awareness of other renal diseases and the prevention of conditions that lead to FSGS such as viral infections.[22] Hence, combining this study and the study by Queiroz *et al.*[9] shows two important changes in the distribution of nephrological diseases in Salvador, Brazil: from MPGN to FSGS (from 1975 to 2006) and from FSGS to Lupus nephritis (from 2006 to 2015) as the most prevalent disease.

The prevalence of IgA nephropathy was low and was detected in 5% of the biopsy-proven diseases reported in this study and 8% of the primary glomerular diseases in adults. Our reported prevalence is similar to that reported in other Latin American countries, Saudi Arabia and the subcontinent of India.[19,23-25] However, it is much lower than the prevalence observed in other regions of Brazil and in other countries.[6,20,21,26]

Such a low prevalence of IgA nephropathy may be explained by the ethnic composition of the Salvador population.[21] It is estimated that African descendants represent 73.1% of the Bahia State population.[27] However, there was no difference in the frequency of IgAN among the ethnic groups that were included in this study, although this characteristic was reported in only 286 of the 1,312 patients. Nevertheless, hematuria and nephritic syndrome, which are usual presentations of IgAN, were observed in only 9% of the patients in this study.

We do not know if this is the actual frequency of renal disease presentation in Salvador or if it reflects the criteria that are used for the recommendation of biopsy by assisting nephrologists in the town. The reported frequency of hematuria has been high in the studies that show a high prevalence of IgA nephropathy.[4,5,26,28] Hence, studies are required to define if the low frequency of IgA nephropathy observed in this study is due to an actual low prevalence of the disease or to the criteria that are used by the assisting doctors to indicate kidney biopsy.

The age distribution of glomerular diseases varies in studies that are published from different countries.[24,25,29] However, some aspects are similar in most of the studies, such as the decrease in the prevalence of minimal change disease and diffuse proliferative glomerulonephritis and the increase in the prevalence of membranous glomerulonephritis and amyloidosis with age. Our study also agrees with others that show a predominant occurrence of lupus nephritis and IgA nephropathy during the 2nd to 5th decades of life.[24,25] Furthermore, we show a high prevalence of FSGS in all ages, which decreases slightly between the 3rd and 5th decades of life.

## Conclusion

In conclusion, the data presented in this study show that the distribution pattern of biopsy-proven glomerular diseases has changed in Salvador, Brazil, since 1973 and has become similar to that observed in many affluent countries.

## List of abbreviations

FSGS - Focal and segmental glomerulosclerosis;
MPGN - Membranoproliferative glomerulonephritis

## Declarations

### Ethical considerations:

The study was conducted in accordance with resolution No. 196/96 of the National Health Council, and the procedures were approved by the Ethics Committee for Research Involving Human Subjects of IGM-Fiocruz, Protocol Nº. 206/09.

### Consent for publication:

Not applicable.

### Availability of data and materials:

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Competing interests:

The authors declare that they have no competing interests.

### Authors' contributions:

Designed the study: WLCS, GMS, MBT
Wrote the paper: WLCS, MBT, LG, GMS
Histology review: WLCS, GMS, MFSS
Analyzed the data: WLCS, MBT, CVBM, MBO
Clinical data support: MFC, RS, MCC, MB, DLB, MBO

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## References

1. Maisonneuve P, Agodoa L, Gellert R, Stewart JH, Buccianti G, Lowenfels AB, et al. Distribution of primary renal diseases leading to end-stage renal failure in the United States, Europe, and Australia/New Zealand: results from an international comparative study. Am J Kidney Dis 2000;35:157-65. DOI: http://dx.doi.org/10.1016/S0272-6386(00)70316-7
2. Sesso R, Lopes AA, Thomé FS, Bevilacqua JL, Romão Junior JE, Lugon J. Relatório do Censo Brasileiro de Diálise, 2008. J Bras Nefrol 2008;30:233-8.
3. Alves Júnior JM, Pantoja RKS, Barros CV, Braz MN. Estudo clínico-patológico das glomerulopatias no Hospital de Clínicas Gaspar Vianna. Rev Para Med 2008;22:39-47.
4. Ferraz F, Martins C, Cavalcanti J, Oliveira F, Quirino R, Chicon R, et al. Perfil das doenças glomerulares em um hospital público do Distrito Federal. J Bras Nefrol 2010;32:249-56. DOI: http://dx.doi.org/10.1590/S0101-28002010000300005
5. Malafronte P, Mastroianni-Kirsztajn G, Betônico GN, Romão JE Jr, Alves MA, Carvalho MF, et al. Paulista Registry of glomerulonephritis: 5-year data report. Nephrol Dial Transplant 2006;21:3098-105. DOI: http://dx.doi.org/10.1093/ndt/gfl237
6. Carmo PAV, Carmo WB, Bastos MG, Carlos L, Andrade F. Estudo das Doenças Glomerulares na Zona da Mata Mineira. J Bras Nefrol 2008;30:15-21.
7. Hanko JB, Mullan RN, O'Rourke DM, McNamee PT, Maxwell AP, Courtney AE. The changing pattern of adult primary glomerular disease. Nephrol Dial Transplant 2009;24:3050-4. DOI: http://dx.doi.org/10.1093/ndt/gfp254
8. Parichatikanond P, Chawanasuntorapoj R, Shayakul C, Choensuchon B, Vasuvattakul S, Vareesangthip K, et al. An analysis of 3,555 cases of renal biopsy in Thailand. J Med Assoc Thai 2006;89:S106-11. PMID: 17044461
9. Queiroz FP, Brito E, Martinelli R. Influence of regional factors in the distribution of the histologic patterns of glomerulopathies in the nephrotic syndrome. Nephron 1975;14:466-70. PMID: 1153046 DOI: http://dx.doi.org/10.1159/000180481
10. Churg J, Bernstein J, Glassock RJ. Renal disease: classification and atlas of glomerular diseases. 2nd ed. New York: Igaku-Shoin; 1995.
11. Alchi B, Jayne D. Membranoproliferative glomerulonephritis. Pediatr Nephrol 2010;25:1409-18. DOI: http://dx.doi.org/10.1007/s00467-009-1322-7
12. Martinelli R, Noblat AC, Brito E, Rocha H. Schistosoma mansoni-induced mesangiocapillary glomerulonephritis: influence of therapy. Kidney Int 1989;35:1227-33. PMID: 2504987 DOI: http://dx.doi.org/10.1038/ki.1989.114
13. Weening JJ, D'Agati VD, Schwartz MM, Seshan SV, Alpers CE, Appel GB, et al. The classification of glomerulonephritis in systemic lupus erythematosus revisited. Kidney Int 2004;65:521-30. DOI: http://dx.doi.org/10.1111/j.1523-1755.2004.00443.x
14. Andrade ZA. The situation of hepatosplenic schistosomiasis in Brazil today. Mem Inst Oswaldo Cruz 1998;93:313-6. PMID: 9921378 DOI: http://dx.doi.org/10.1590/S0074-02761998000700062
15. Correia EI, Martinelli RP, Rocha H. Is glomerulopathy due to schistosomiasis mansoni disappearing? Rev Soc Bras Med Trop 1997;30:341-3.
16. dos-Santos WL, Sweet GM, Bahiense-Oliveira M, Rocha PN. Schistosomal glomerulopathy and changes in the distribution of histological patterns of glomerular diseases in Bahia, Brazil. Mem Inst Oswaldo Cruz 2011;106:901-4. PMID: 22124564 DOI: http://dx.doi.org/10.1590/S0074-02762011000700017
17. Barreto ML, Genser B, Strina A, Teixeira MG, Assis AM, Rego RF, et al. Effect of city-wide sanitation programme on reduction in rate of childhood diarrhoea in northeast Brazil: assessment by two cohort studies. Lancet. 2007;370:1622-8. PMID: 17993362 DOI: http://dx.doi.org/10.1016/S0140-6736(07)61638-9
18. Souto FJ. Distribution of hepatitis B infection in Brazil: the epidemiological situation at the beginning of the 21 st century. Rev Soc Bras Med Trop 2016;49:11-23. DOI: http://dx.doi.org/10.1590/0037-8682-0176-2015
19. Arias LF, Henao J, Giraldo RD, Carvajal N, Rodelo J, Arbeláez M. Glomerular diseases in a Hispanic population: review of a regional renal biopsy database. Sao Paulo Med J 2009;127:140-4. DOI: http://dx.doi.org/10.1590/S1516-31802009000300006
20. Polito MG, de Moura LA, Kirsztajn GM. An overview on frequency of renal biopsy diagnosis in Brazil: clinical and pathological patterns based on 9,617 native kidney biopsies. Nephrol Dial Transplant 2010;25:490-6. DOI: http://dx.doi.org/10.1093/ndt/gfp355
21. Murugapandian S, Mansour I, Hudeeb M, Hamed K, Hammode E, Bijin B, et al. Epidemiology of Glomerular Disease in Southern Arizona: Review of 10-Year Renal Biopsy Data. Medicine (Baltimore) 2016;95:e3633. DOI: http://dx.doi.org/10.1097/MD.0000000000003633
22. Haas M. Incidences of membranous nephropathy versus focal segmental glomerulosclerosis: increase in the former or decline in the latter? Clin Kidney J 2013;6:365-7. PMID: 27293561
23. Chandra H, Chandra S. Patterns of Glomerulonephritis in Uttarakhand State 13 Years Single Centre Experience at Teaching Institute. Indian Med Gazette 2013;147:220-3.
24. Das U, Dakshinamurty KV, Prayaga A. Pattern of biopsy-proven renal disease in a single center of south India: 19 years experience. Indian J Nephrol 2011;21:250-7. DOI: http://dx.doi.org/10.4103/0971-4065.85482
25. Beniwal P, Pursnani L, Sharma S, Garsa RK, Mathur M, Dharmendra P, et al. A clinicopathologic study of glomerular disease: A single-center, five-year retrospective study from Northwest India. Saudi J Kidney Dis Transpl 2016;27:997-1005. DOI: http://dx.doi.org/10.4103/1319-2442.190876
26. Pesce F, Schena FP. Worldwide distribution of glomerular diseases: the role of renal biopsy registries. Nephrol Dial Transplant 2010;25:334-6. DOI: http://dx.doi.org/10.1093/ndt/gfp620
27. Brasil. Instituto Brasileiro de Geografia e Estatística - IBGE. Estudos sociodemográficos e análises espaciais referentes aos municípios com a existência de comunidades remanescentes de quilombos - Relatório técnico preliminar. Rio de Janeiro: IBGE; 2007.
28. Castro R, Sequeira MJ, Sameiro Faria M, Belmira A, Sampaio S, Roquete P, et al. Percutaneous kidney biopsy: eight years-experience. Acta Med Port 2004;17:20-6.
29. Swaminathan S, Leung N, Lager DJ, Melton LJ 3rd, Bergstralh EJ, Rohlinger A, et al. Changing incidence of glomerular disease in Olmsted County, Minnesota: a 30-year renal biopsy study. Clin J Am Soc Nephrol 2006;1:483-7. DOI: http://dx.doi.org/10.2215/CJN.00710805