

# Trends in the Epidemiology of Focal Segmental Glomerulosclerosis

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There is marked variation in the frequency of focal segmental glomerulosclerosis (FSGS) around the world. Recent studies of renal biopsy specimen archives from several institutions in the United States suggest that the incidence of FSGS has increased over the past 20 years. Indeed, FSGS has become the leading cause of idiopathic nephrotic syndrome in adults and has become increasingly common in children as well. Further, the data indicate that black individuals are at increased risk for developing idiopathic FSGS as well as FSGS in the setting of human immunodeficiency virus (HIV)-1 infection. Data from around the world suggest great variability in the proportion of glomerular disease that is attributed to FSGS, with recent increases seen in some countries and not in others. Epidemiologic data from the United States Renal Data Systems (USRDS) show that the incidence of end-stage renal disease (ESRD) owing to idiopathic FSGS has increased considerably, both as absolute numbers and as a fraction of the total ESRD incident population, with FSGS now accounting for 3.3% of incident ESRD cases. In the United States, the annual rate of incident FSGS ESRD cases is 7 per million for the general population, 20 per million for black individuals, and 5 per million for white individuals. The numbers of acquired immune deficiency syndrome (AIDS) nephropathy incident ESRD cases increased rapidly until reaching a plateau after 1995. The reasons for the recent increase in idiopathic FSGS and FSGS incident ESRD cases are complex, but these trends are likely caused, at least in part, by a real increase in the incidence of FSGS over the past 10 to 20 years.

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**I**N THE UNITED STATES, focal segmental glomerulosclerosis (FSGS) is currently a leading cause of nephrotic syndrome (NS) in adults. Previous studies from the 1970s and early 1980s list FSGS as being responsible for 15% to 20% of cases of idiopathic NS in adults.<sup>1</sup> Membranous glomerulopathy was the most common primary cause of adult NS in the United States and in Europe. Over the past 20 years, there has been a significant increase in the frequency of idiopathic FSGS in the United States, especially among black individuals. The incidence of FSGS as a cause of end-stage renal disease (ESRD) also is increasing. This article reviews recent trends in the epidemiology of FSGS among patients with glomerulonephritis and ESRD in the United States and worldwide.

## PRIMARY GLOMERULONEPHRITIS AND NS IN THE UNITED STATES

Recent studies from several institutions in the United States have shown that the frequency of FSGS is increasing in renal biopsy series (Fig 1). Indeed, over the past 20 years, FSGS has become the leading cause of idiopathic NS in adults<sup>2-4</sup> and has become increasingly common in children as well.<sup>5</sup> Thus, Korbet et al<sup>2</sup> found that among primary renal diseases, FSGS accounted for 29% of all adult patients presenting with nephrotic range proteinuria between 1975 and 1985, but accounted for 38% of such patients between 1985 and 1994. Other investigators also observed similar increases in the proportion of FSGS in adults undergoing a biopsy examination for proteinuria or NS.<sup>3,4</sup> In Texas, Bonilla-Felix et al<sup>5</sup> found that FSGS was diagnosed in 25% of pediatric patients undergoing a biopsy examination for NS before 1990 and in 47% after 1990. However, the increase in the frequency of FSGS as a cause of pediatric nephrosis was not confirmed in another study from Missouri.<sup>6</sup>

The frequency of FSGS also is shown to be increasing as a proportion of all native kidney biopsy examinations. This is significant because not all FSGS patients present with nephrotic range proteinuria.<sup>7</sup> The increase in the fractional contribution of FSGS to the etiology of primary NS could also be caused by changes in the demographics of patients undergoing renal biopsy examinations or a decline in the incidence of other diseases such as membranous glomerulopathy or minimal

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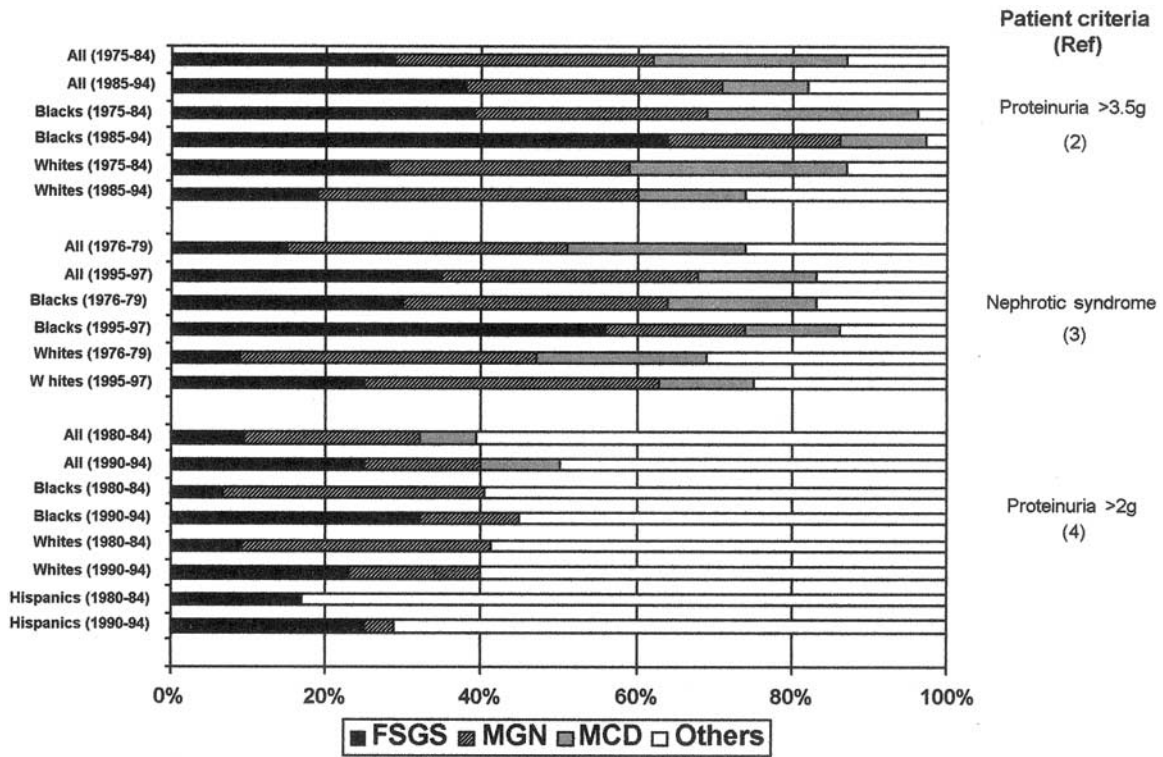


Fig 1. The relative frequency of primary glomerular diseases in adults with heavy proteinuria in the United States: trends in different races. MGN, membranous glomerulopathy; MCD, minimal change disease. For reference 3, no details are given for the frequencies of minimal change disease in the racial subgroups; this is included as the 'Others' group.

change disease. In New York, Barisoni et al<sup>8</sup> noted that the frequency of all forms of FSGS among biopsy examinations increased 7-fold from 1974 to 1993. Haas et al<sup>9</sup> confirmed the increases in the frequency of FSGS in Chicago and the midwestern United States. Among all adult native biopsy examinations, idiopathic FSGS increased from 4% to 12% over a 20-year period. The proportion with membranous glomerulopathy (9%) did not change, but the proportion with minimal change disease declined. In this study, the increase in idiopathic FSGS cannot be ascribed to an increase in the proportion of black patients in the biopsy population because this was constant. The percentage of patients with nephrotic range proteinuria in the FSGS population did not change, which suggests that a decreasing reluctance of clinicians to perform renal biopsy examinations on patients with nonnephrotic range proteinuria cannot account for the increasing incidence of FSGS. Taken together, these studies suggest that the absolute incidence of FSGS may have increased, especially in the adult

population. However, until population-based studies of incident FSGS cases are available, statements about a possible increase in FSGS incidence must be made with caution.

Racial background has a strong influence on the propensity to develop FSGS. Black subjects have an increased risk for idiopathic FSGS, as has long been recognized.<sup>10-12</sup> In a logistic regression analysis of adult patients with nephrosis, race remained the only significant predictor for FSGS, with black subjects 4 times more likely to have FSGS than white subjects.<sup>2</sup> In the black population, the increase in FSGS incidence in recent years has been shown consistently (Fig 1). Korbet et al<sup>2</sup> found that the proportion of FSGS as a cause of idiopathic nephrosis among adult black subjects increased from 39% to 64% over a 20-year period. By contrast, in white subjects, the proportion of FSGS tended to decrease from 28% to 19% over the same period. Membranous glomerulopathy accounted for 40% of nephrosis and remained the most common cause in the white subjects. The increase in

frequency of FSGS in the black adult population has been observed in other studies, and FSGS is now consistently the most common cause of nephrosis in this population.<sup>3,4</sup> Braden et al<sup>4</sup> have shown that FSGS also may be increasing among white subjects and has replaced membranous glomerulopathy as the most common cause of nephrosis, and noted an increase in Hispanic patients.<sup>3</sup> In this ethnic group, FSGS is second only to immunoglobulin (Ig)A nephropathy as a cause of glomerular disease. The effect of race on the proportion of FSGS also is shown in the pediatric population. FSGS accounts for 40% to 60% of renal biopsy examinations in black children with nephrosis, but only 20% of white or Hispanic children undergoing renal biopsy examination.<sup>5,6</sup>

The reason for the increased frequency of idiopathic FSGS that has occurred predominantly in the US black population is unknown. In black individuals, genetic predisposition and reduced nephron mass may predispose to a higher prevalence of hypertension and glomerulosclerosis.<sup>13</sup> However, these explanations may be insufficient to account for the recent increases in the FSGS frequency. Additional factors such as increasing obesity<sup>14</sup> or unknown secondary causes, including viruses, might contribute to the recent trends. Black individuals are also at increased risk for human immunodeficiency virus (HIV)-associated FSGS.<sup>15</sup> Occult HIV infection is unlikely to explain the increasing frequency of FSGS. Although screening for HIV is often not performed in patients with glomerulonephritis, most studies that show an increasing incidence of FSGS in black individuals exclude patients with known HIV, intravenous drugs usage, or the presence of tubuloreticular structures.<sup>2-4</sup> In at least one study with serologic testing for HIV, a high frequency of idiopathic FSGS also was shown in black subjects.<sup>12</sup> Other infectious agents such as parvovirus B19<sup>16</sup> and SV40<sup>17</sup> have been linked to the development of FSGS. Whether these viruses or other as yet unknown infectious agents may contribute to the increasing occurrence of FSGS in susceptible populations is yet to be determined.

Another consideration is the increase in the collapsing variant of FSGS. Barisoni et al<sup>8</sup> found an increasing incidence of FSGS with collapsing features among HIV-negative patients. This entity was not seen before 1979 and has more than doubled from 11% of all idiopathic FSGS between

1979 and 1985 to 24% from 1990 to 1993. The same group found that patients with collapsing FSGS were predominantly of black race.<sup>18</sup> The median renal survival from time to biopsy examination to ESRD was shorter in the collapsing group (13 mo) compared with the other FSGS group (63 mo). Other investigators confirmed the higher incidence of the collapsing variant in black subjects and the poor renal outcome associated with this condition.<sup>9</sup> However, these investigators reported that the collapsing variant only accounted for 4% of all FSGS and the number of cases did not increase with time. These discordant findings may be owing to differences in case definition or true population differences. Because of its rapid progression to renal failure, the collapsing variant likely contributes disproportionately to the FSGS patients reaching ESRD. This may in part account for a higher incidence of black subjects with FSGS ESRD (see later). Its relative importance to the overall increase in FSGS in the United States, however, is uncertain.

#### PRIMARY GLOMERULONEPHRITIS AND NS WORLDWIDE

The rates of FSGS diagnosis as reported by centers from around the world differ markedly.<sup>12,19-39</sup> These findings likely reflect both genuine differences in incidence that may be caused by variations in genetic susceptibility and environmental exposures, as well as differences in clinical practice with regard to renal biopsy examination. In recent studies of mostly adult populations from around the world, FSGS accounted for 2% to 41% of primary glomerulopathy (Table 1). FSGS is the most common primary glomerulopathy in Saudi Arabia (41%). Although there is some overlap, the relative frequency of FSGS is intermediate in Europe (6% to 15%) and tends to be lowest in Asia (2% to 11%). IgA nephropathy remains the most common primary glomerulopathy in Asia, Europe, and Australia, but is rare in Africa and among US black individuals.

Estimates of the annual incidence of FSGS in a population can be made when complete biopsy records are available from a national registry or from a database of all hospitals covering a geographic area. The annual estimated incidence of FSGS ranges from 1.4 per million in Korea to 21 per million population in Australia (Table 1). In many parts of the world, however, an incidence

**Table 1. FSGS Incidence and Frequency Worldwide**

Country (Reference)	Patient	Year of Study	Most Common Primary GN (% of all Primary GN*)	FSGS Frequency (% of Primary GN*)	FSGS Incidence (per mi pop/y)
<b>Primary GN</b>					
Zimbabwe <sup>27</sup>	All	1982-87	MSPGN (24); MCD (23)	A 17; P 15	
Saudi Arabia <sup>25</sup>	A	1989-94	FSGS	41	
United Arab Emirates <sup>30</sup>	A	1978-96	PRGN (36)	18	
			MSPGN (17); PRGN (36)		
Korea <sup>37</sup>	All	1973-77		A 6; P 0	
	All	1993-95	IgA (30); MCD (50)	A 12; P 13	
Japan <sup>31</sup>	All	Pre-1985	IgA (48)	2	
Singapore <sup>33</sup>	A	1976-86	IgA (56)	8	4
		1987-97	IgA (42)	9	1.4
Australia <sup>36</sup>	All	1995-97	IgA (40)	20	21
Denmark <sup>32</sup>	All	1985-97	MSPGN (incl IgA; 26)	15	6
France <sup>24</sup>	A	1976-80	IgA (29)	12	12
		1986-90	IgA (37)	6	4
Holland <sup>19</sup>	A	1974-84	IgA (22)	11	9
Italy <sup>28</sup>	All	1987-93	IgA (36)	12	2.3
Spain <sup>39</sup>	A	1994-99	IgA (17)	11	6.4
US <sup>12</sup>	A	1983-92	FSGS	36 (B 67; W 8)	
Peru <sup>34</sup>	A	1985-95	MPGN (24)	23	
<b>ESRD</b>					
Japan <sup>38</sup>	P	1998	FSGS	67	0.84
Australia <sup>36</sup>	All	1995-97	IgA (47)	25	3.5
France <sup>24</sup>	A	1976-80	IgA (21)	8.3	1.0
		1986-90	IgA (36)	9.7	1.5

Abbreviations: A, adults only; P, pediatric only; All, both pediatric and adults; MSPGN, mesangioproliferative glomerulonephritis; MCD, minimal change disease; PRGN, proliferative GN; IgA, IgA nephropathy; MPGN, membranoproliferative GN; B, Blacks; W, Whites.

NOTE. Relative frequency and population incidence (per million population per year) of focal segmental glomerulosclerosis (FSGS) among patients with primary glomerulonephritis (GN) and end-stage renal disease (ESRD). \* All primary GN is either defined by the authors or calculated by subtraction of secondary causes.

estimate cannot be made because of variations in access to health care, lack of biopsy data from all health care facilities serving a population, or incomplete population census. Even when available, these figures underestimate the true incidence of FSGS because not all patients undergo renal biopsy examination. The figures probably do reflect the minimum incidence of moderate to severe renal disease, at least in countries with adequate health care systems. Some of the variation in the incidence of FSGS from different centers may reflect differences in renal biopsy rates. For example, the renal biopsy rate was 7 times higher in Australia than in Italy.<sup>28,36</sup> In part, variations in renal biopsy rates may be explained by regional differences in the indications for renal biopsy. For example, based on responses to a questionnaire, 21% of nephrologists from Australia and New Zealand would perform renal biopsy examinations in pa-

tients with proteinuria less than 1 g/d, whereas the figures for North American and European nephrologists are 0% and 14%, respectively.<sup>40</sup> Similarly, patients with isolated microscopic hematuria were more likely to have a renal biopsy examination in Asia than other parts of the world. These differences in clinical practice can account, at least partly, for the higher incidence of FSGS in Australia and for the high incidence of IgA nephropathy in Asia because milder forms of these diseases are more likely to be diagnosed.

Most nephrologists would perform renal biopsy examinations in adult patients with nephrotic range proteinuria.<sup>40</sup> Therefore, the frequency of FSGS in patients with NS provides a useful index to compare the relative importance of this disease around the world, with less bias caused by differences in biopsy indications. Among both adults and pediatric patients with idiopathic NS, large differences



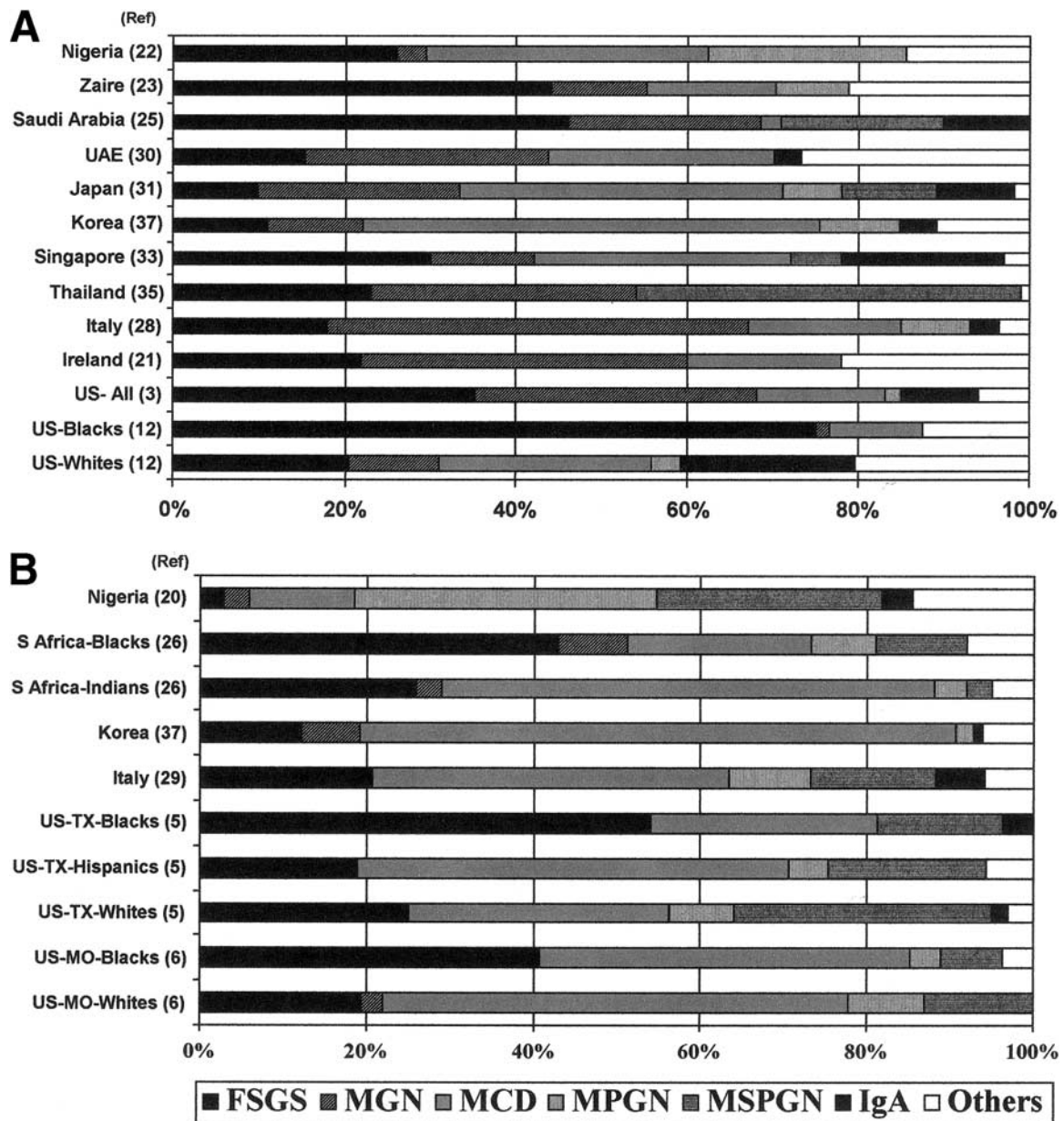


Fig 2. Renal biopsy findings in (A) adults and (B) children with idiopathic nephrotic syndrome caused by primary glomerular diseases. The proportion of each disease is expressed as a percentage of all primary glomerular diseases, which are either defined by the authors or calculated by subtraction of secondary causes. MGN, membranous glomerulopathy; MCD, minimal change disease; MPGN, membranoproliferative glomerulonephritis; MSPGN, mesangioproliferative glomerulonephritis; IgA, IgA nephropathy; Others, all other primary causes defined or undefined by the authors and may encompass categories listed in other studies; UAE, United Arab Emirates; TX, Texas; MO, Missouri.

exist in the frequency of FSGS among different countries. In adults, the proportion of FSGS among primary NS ranges from 10% to 78% (Fig 2A). Even within a single geographic region large differences can exist. Thus, FSGS contributes to over

40% of adult nephrotic patients in Saudi Arabia<sup>25</sup> and Congo (Zaire),<sup>23</sup> but only 17% in United Arab Emirates<sup>30</sup> and 23% in Nigeria.<sup>22</sup> US black adult nephrotic patients have among the highest frequency of FSGS in the world (56% to

78%).<sup>2,3,12</sup> In Europe, FSGS typically accounts for 20% of adult primary nephrotic patients,<sup>21,28</sup> which is a similar frequency to US white patients. The lowest rates are seen in Korea<sup>37</sup> and Japan,<sup>31</sup> where FSGS accounts for only 10% of adult primary NS. Within Asia, higher incidences are seen for Singapore<sup>33</sup> and Thailand.<sup>35</sup> A policy of a steroid trial before performing a kidney biopsy procedure in Thailand may overestimate FSGS by decreasing the proportion of steroid-sensitive minimal change disease or mesangioproliferative glomerulonephritis. As in US white subjects, membranous glomerulopathy remains the most common cause of adult primary NS in Europe, whereas minimal change disease and mesangioproliferative glomerulonephritis tend to be the most common in Asia.

In pediatric patients with NS, renal biopsy examination is reserved commonly for patients with steroid resistance, relapses after steroid therapy, or older children. Thus, a biopsy series would tend to underestimate the relative frequency of minimal change disease and overstate that of other less steroid-responsive forms of glomerulonephritis including FSGS. Despite this, minimal change disease is the most common cause of NS caused by primary renal disease in many populations. The relative frequency of FSGS in pediatric populations often tracks that of adult FSGS in the same region (Fig 2B). Thus, the highest FSGS frequencies are observed in black children in the United States<sup>5,6</sup> and South Africa,<sup>26</sup> whereas the lowest frequencies are observed in Korea<sup>37</sup> and Nigerian children.<sup>20</sup> As previously noted, idiopathic membranous glomerulopathy rarely is observed in the pediatric population.

Given the high frequency of FSGS in black patients in the United States, it is perhaps surprising that the frequency is highly variable in Africa and is as low as 3% in Nigerian children.<sup>20</sup> However, in studies reported before the 1990s,<sup>41</sup> a low incidence of FSGS was reported consistently from many African countries. The explanation for the lower incidence of FSGS in some African countries is not apparent. In Africa, the overall incidence of glomerulonephritis based on hospital admissions is 10- to 100-fold higher than in North America or Europe. Known secondary causes such as malaria, hepatitis B, and streptococcal infections can account for 50% to 80% of NS. Undiagnosed tropical infections may influence the pattern of glomerulonephritis observed.

Studies published since 1990 also suggest that the frequency of FSGS is increasing in some parts of Africa. In recent studies, FSGS was found in 41% of primary adult NS in Congo (Zaire).<sup>23</sup> An earlier report from the same region reported a frequency of only 6%.<sup>42</sup> Undiagnosed HIV-associated FSGS might be an important contributor to this increase in this region because serology testing is not performed routinely. In Africa, the increase in FSGS may not be limited to the black population. In South Africa, the frequency of FSGS has increased by 5- to 10-fold in both the black and in the Indian pediatric populations.<sup>43</sup> In other parts of the world, trends in the FSGS incidence are mixed. Increases in the frequency or incidence of FSGS have been reported in studies from Peru<sup>34</sup> and Korea,<sup>37</sup> but not in studies from Singapore,<sup>33</sup> Denmark,<sup>32</sup> France,<sup>24</sup> Spain,<sup>39</sup> and Italy.<sup>28</sup>

#### FSGS: A CAUSE OF PREVALENT AND INCIDENT ESRD CASES

The United States Renal Disease Systems (USRDS) database provides the opportunity to estimate the incidence and prevalence of FSGS ESRD cases in the United States. The physician who completes Health Care Financing Agency (HCFA) form 2728, typically a nephrologist, is asked "to indicate the primary cause of renal failure. If there are several probable causes of renal failure, choose one as primary." The USRDS database has a category FSGS and focal sclerosing glomerulonephritis, which we will abbreviate as FSGS. The numbers of prevalent ESRD cases (defined as cases present on December 31 of each year) attributed by the USRDS to FSGS has increased markedly over the past 20 years (Fig 3).

Figure 3 also shows that there are more black FSGS-prevalent ESRD patients than white patients, which is the reverse of the racial distribution of the general US population. During the period from 1995 to 1999, the annual FSGS-ESRD incidence rates were 7 cases/million for the general US population, 20 cases/million in black individuals, 5 cases/million in white individuals, 5 cases/million in individuals of Asian background, and 3 cases/million in Hispanic individuals (who can be of any racial background) (Fig 4). The increased risk for FSGS ESRD in black individuals may be owing to both a higher incidence of FSGS and differences in prognosis or response to treatment. Black individuals also have 4- to 6-fold increased risk for ESRD

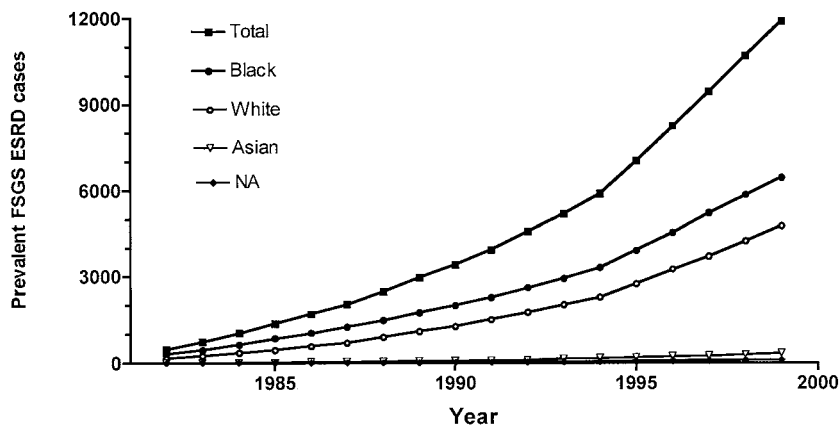


Fig 3. Prevalence of ESRD caused by focal segmental glomerulosclerosis. Data are derived from the USRDS during the years shown. NA, Native American.

owing to diabetes and hypertension, suggesting that this population has a greater propensity to have worse renal injury, which may be attributable to environmental or genetic factors.<sup>44</sup> Previously reported data have been conflicting as to whether<sup>11,45,46</sup> or not<sup>7</sup> black individuals with FSGS have a worse prognosis compared with other subjects.

Many patients who are in the USRDS database have not undergone renal biopsy examination, and it is useful to consider the potential impact of misclassification on the racial balance. It has been shown that black patients are more likely to undergo delayed referral to a nephrologist (defined as <4 mo between first visit and the initiation of dialysis) compared with white patients.<sup>47</sup> It is probable, although data are unavailable, that patients who are seen at this late state of renal disease are less likely to undergo renal biopsy examination, and therefore would appear in the USRDS diag-

nostic categories other glomerulonephritis or other kidney disease. Thus, there is reason to believe that more blacks than whites might have unbiopsied FSGS, and that if all patients underwent renal biopsy, the proportion of patients with FSGS might be even greater than it is at present.

The USRDS category FSGS may well be heterogeneous, but presumably most or all patients have undergone renal biopsy examination. The number of FSGS-ESRD incident cases has increased steadily over the past 20 years, with a sharper increase in 1995 (Fig 5). By contrast, incident ESRD cases attributed to acquired immune deficiency syndrome (AIDS) nephropathy, also increasing until 1995, has since stabilized and declined slightly, in association with the introduction of more effective antiretroviral therapy. The number of incident ESRD cases caused by membranous glomerulopathy has increased at a much slower pace and the number of incident ESRD

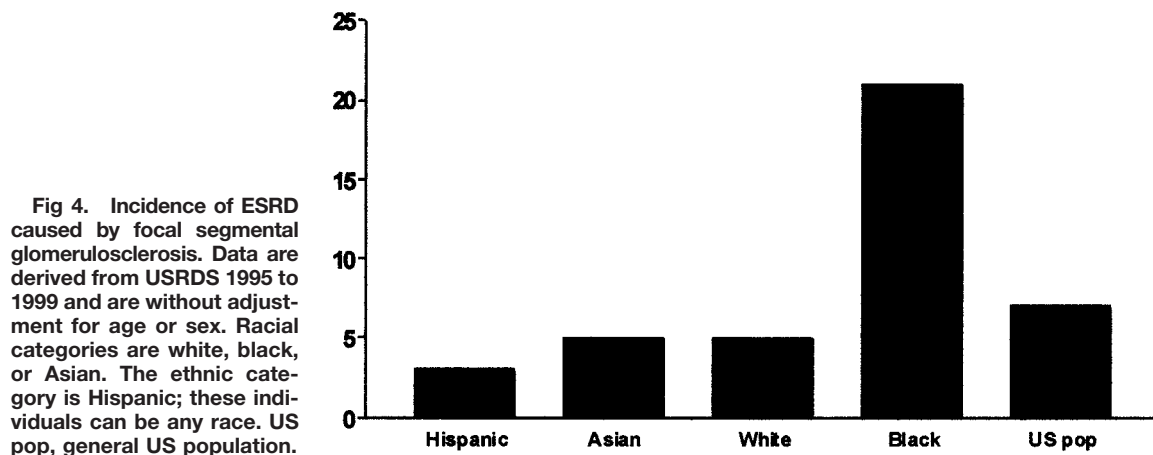
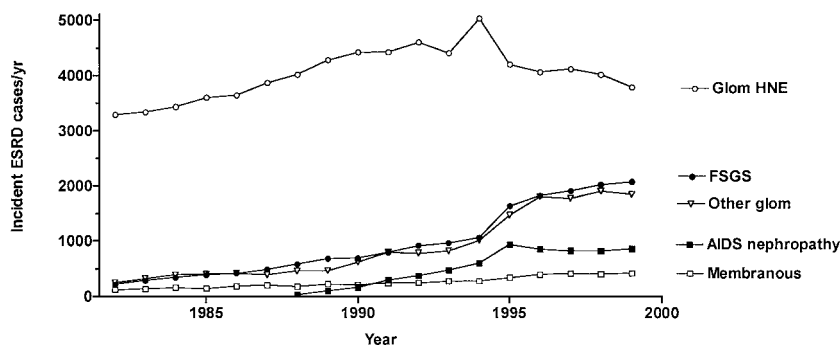


Fig 4. Incidence of ESRD caused by focal segmental glomerulosclerosis. Data are derived from USRDS 1995 to 1999 and are without adjustment for age or sex. Racial categories are white, black, or Asian. The ethnic category is Hispanic; these individuals can be any race. US pop, general US population.

**Fig 5. Incidence of ESRD caused by certain glomerular diseases. Data are derived from USRDS and are without adjustment for age or sex. Glom HNE, glomerular disease histologically not examined; Membranous, membranous glomerulopathy; Other glom, other glomerular disease (excluding the preceding 3 categories and excluding diabetic nephropathy and hypertensive nephropathy).**



cases caused by other glomerular disease has increased in a fashion very similar to that of FSGS.

The changes in incident ESRD cases caused by glomerular diseases shown in Figure 5 are likely driven by 5 different factors. First, renal biopsy examination was not as widespread in nephrology practice in the 1960s and 1970s when many patients who presented with ESRD in the early 1980s developed glomerular disease and would have been most likely to undergo renal biopsy examination. Improvement in biopsy examination techniques, especially the routine use of ultrasound guidance, likely would have increased the number of biopsy examinations performed as well as the number of glomeruli available for diagnosis. This may explain why the fraction of incident cases caused by specific glomerular diseases (FSGS, other glomerular diseases, and, to a lesser extent, membranous glomerulopathy) has increased whereas the category “glomerular disease, histologically not examined,” has been relatively stable and has declined in recent years. Second, the demographics of patients selected for renal biopsy examination may have evolved over time, particularly with regard to age or race. Third, the diagnosis of FSGS was not standardized until about 1970, so that patients reaching ESRD in the early 1980s may have undergone renal biopsy examination before this time.

Fourth, the sharp increase in incidence of ESRD caused by several diagnoses that occurred in 1995 may be in part an artifact caused by significant changes in patient inclusion and disease categorization by the USRDS. Before 1995, only Medicare-entitled patients were included in the USRDS database. Beginning in 1995, patients with other forms of insurance were included as well. In 1995, about 8% of all dialysis patients were not Medicare entitled and thus were newly included in the

USRDS database.<sup>48</sup> This change increased the total number of incident ESRD cases, and probably had a disproportionate impact on the age group less than 62 years. Although there was a modest expansion of the patient population in 1995, the major component of the rapid increase in FSGS incident ESRD cases that occurred in 1995 was probably caused by the changes in disease categories. Before 1995, HCFA form 2728 included options such as “Nephrotic syndrome,” which could have been selected even when a renal biopsy examination had been performed. After 1995, the HCFA form 2728 was revised and many overlapping or poorly defined disease categories were eliminated. It appears that many patients with FSGS had been listed previously under other, related diagnoses.

Fifth, the US population increased, but only by 18% between 1982 (231 million) and 1999 (273 million), a rate much smaller than the increase in FSGS. Sixth, the actual incidence of FSGS (or its propensity to progress to ESRD) indeed may have increased during this time. Given the changes in renal biopsy practice, renal biopsy interpretation, and USRDS data collection procedures, it is difficult to determine to what extent the observed epidemiologic trends truly reflect increasing incidence of FSGS ESRD. Nevertheless, the increase of the FSGS-ESRD incident cases, and particularly the continued increase after 1995, is unlikely to be entirely explained by changes in renal biopsy practice or disease classification. A provisional conclusion is that the apparent increase in FSGS incident ESRD cases over the past 20 years is real, although the precise magnitude of the actual change is difficult to determine with confidence.

The diagnostic category “AIDS nephropathy” was introduced into the USRDS database in 1990. This category likely includes many patients, prob-



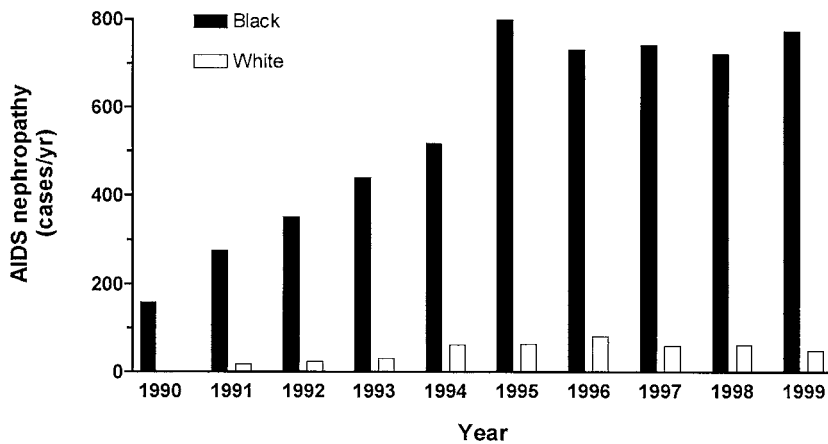


Fig 6. Incidence of ESRD caused by AIDS nephropathy. Data from USRDS are presented by racial background and are without adjustment for age or sex.

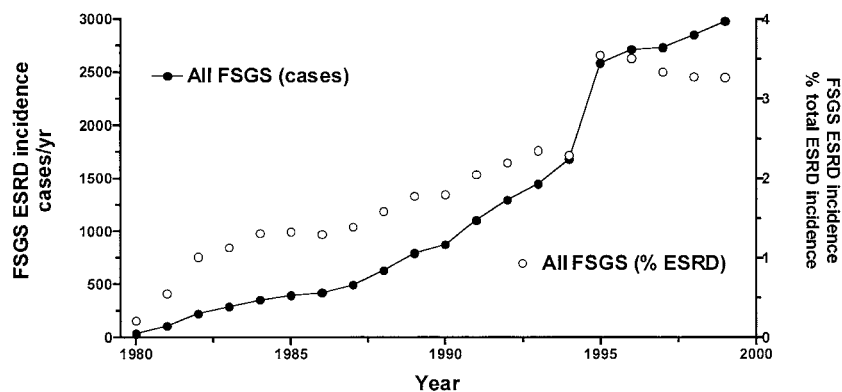
ably even a majority, who have not undergone renal biopsy examination. The large majority of these patients probably have FSGS, but a certain number of patients may have other causes for ESRD, including HIV-associated immune complex-mediated glomerulonephritis, HIV-associated thrombotic microangiopathy, and an assortment of other diagnoses, likely including diabetic nephropathy and hypertensive nephrosclerosis.<sup>15</sup> The incidence of AIDS nephropathy ESRD cases increased steadily until 1995 (Fig 6). With the widespread adoption of effective highly active antiretroviral therapy after 1995, the incidence of renal failure syndrome has reached a plateau. As has been recognized widely, patients with ESRD attributed to AIDS nephropathy are disproportionately of black race. When adjusted for the racial distribution of HIV-1 infection, the relative risk for AIDS nephropathy ESRD among blacks compared with whites is approximately 18.<sup>15</sup>

If we assume that all AIDS nephropathy cases in fact represented FSGS, then we can add the num-

bers of AIDS nephropathy incident ESRD cases to those of FSGS incident ESRD cases to arrive at an estimate of all FSGS incident ESRD cases (Fig 7). All FSGS now accounts for 3.3% of incident ESRD cases in the United States.

There is less information regarding the incidence of FSGS ESRD from around the world. FSGS accounts for 8% of ESRD owing to primary glomerulonephritis in France<sup>24</sup> and 25% in Australia.<sup>36</sup> In both countries, IgA nephropathy is the leading cause of ESRD owing to primary glomerulonephritis. Interestingly, FSGS is the most common cause of ESRD owing to primary glomerular disease in the Japanese pediatric population, despite quite low frequency of FSGS in the adult population.<sup>38</sup> Between 1986 and 1990, the annual incidence of FSGS ESRD in France was 1 per million population, which is substantially lower than in the United States.<sup>24</sup> In Australia, the annual incidence rates of FSGS ESRD is 3.5 per million population, which is comparable with the rates for white subjects in the United States.<sup>36</sup>

Fig 7. All FSGS as the cause of incident ESRD cases. The number of incident ESRD cases caused by FSGS or AIDS nephropathy (all FSGS cases) and the percentage of incident ESRD cases caused by these diagnoses (all FSGS % ESRD) are shown over the period 1980 to 1999. Data are from the USRDS database and are without adjustment for age or sex.



## CONCLUSIONS

Worldwide, there are marked differences in the frequency of FSGS. In the United States, the proportion of FSGS among patients with glomerulopathy has increased over the past 20 years. Idiopathic FSGS has emerged as the most common cause of adult nephrosis in US black subjects, who now have one of the highest rates of this disease in the world. Black individuals also show a striking increased risk for both ESRD caused by idiopathic FSGS and AIDS nephropathy, probably caused at least in part by genetic factors. FSGS-ESRD incidence has increased considerably, both as absolute numbers and as a fraction of the total ESRD incident population. By comparison, the numbers of AIDS nephropathy ESRD incident cases increased rapidly until reaching a plateau after 1995. The reasons for the recent increase in idiopathic FSGS and FSGS-ESRD incident cases remain unclear. Likewise, it is uncertain if these trends will continue. Already, in New York, there is evidence that the frequency of FSGS has decreased in the past 5 years.<sup>49</sup> A more thorough understanding of the epidemiology of FSGS along with further studies to elucidate its cause will be essential to the design of effective strategies for prevention and treatment of this increasingly important nephrologic problem.

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