



The Burden of Kidney Disease in North Carolina, 2007

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II. Executive Summary 8

KIDNEY DISEASE MORTALITY

- Kidney disease is the tenth most common cause of death in North Carolina, accounting for 7,161 deaths between 2001-2005.
- In 2005:
 - The age-adjusted kidney disease death rate was 18.6 per 100,000 in North Carolina.
 - North Carolina minorities had a death rate more than twice as high as that of whites (35.1 versus 14.9 per 100,000).
 - The death rate for North Carolina males was 21.0 per 100,000; for females it was 17.0 per 100,000.
- Between 2001-2005, the counties with the highest age-adjusted kidney disease-related death rates were Pamlico, Warren, Duplin, Hoke and Columbus, ranging from 27.8 to 34.8 per 100,000.

KIDNEY DISEASE INCIDENCE AND PREVALENCE

- The incidence and prevalence rates of end-stage kidney disease (ESKD) have increased steadily between 1994 and 2005 and have been higher in North Carolina than in the United States.
- In 2004:
 - North Carolina was ranked 10th highest for ESKD prevalence (37.5 per 100,000) and 12th highest for ESKD incidence (37.5 per 100,000) among the 50 states and the District of Columbia.
 - The crude incidence rate for black males (89.6 per 100,000) was 3.3 times higher than it was for white men (27.4 per 100,000).
 - The crude incidence rate for black females (84.7 per 100,000) was 4.3 times higher than it was for white females (19.7 per 100,000).
 - The counties with the highest crude prevalence rates of ESKD were Martin, Northampton, Swain, Lenoir, and Bertie, ranging from 347.5 to 350.0 per 100,000.

EARLY STAGES OF CHRONIC KIDNEY DISEASE

- The estimated number of North Carolinians currently living with early chronic kidney disease (CKD), stages 1 through 4 (prior to developing ESKD), is approximately 941,770.

THE KIDNEY AND ITS FUNCTION

The human kidneys are two bean shaped organs located near the middle of the back, just below the rib cage. The kidneys have one of the highest blood flow rates per weight of any of the body's organ systems (20-25% of blood pumped from the heart). The main function of kidneys are: 1) filtering wastes from the blood and 2) maintaining salt and water balance. Wastes filtered by the kidney join with water and are directed to the bladder through the ureters to make urine (NKDEP, 2007).

The level of kidney function is most commonly measured by estimating the glomerular filtration rate (GFR). GFR can be estimated from serum creatinine which is obtained from a routine laboratory blood test. Kidney function can also be measured by urine dipstick to look for blood or protein in the urine (NKDEP, 2007).

DEFINITION OF CHRONIC KIDNEY DISEASE (CKD)

According to the National Kidney Foundation (NKF) Kidney Disease Outcomes Quality Initiative (K/DOQI), chronic kidney disease is defined in stages based on GFR and kidney damage, such as protein in the urine.

End-stage kidney disease (ESKD) (or kidney failure or stage 5 chronic kidney disease) is the result of progressive kidney function decline over many years. Once a person reaches ESKD, their kidney function is so low that they require some form of renal replacement therapy (dialysis or kidney transplant) to survive. (NKF, 2007)

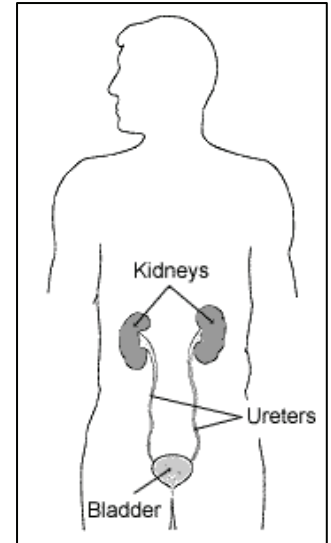


Table 1. Stages of Chronic Kidney Disease

Stage of CKD	Description	GFR (ml/min/1.73m2)
Pre-CKD	At increased risk	>=90 (with risk factors)
1	Kidney damage with normal or increased GFR	>=90
2	Kidney damage with normal or increased GFR	60-89
3	Moderately decreased GFR	30-59
4	Severely decreased GFR	15-30
5	Kidney failure (End Stage Kidney Disease)	<15

Earlier stages of chronic kidney disease (stages 1-4) are difficult to identify in populations because often there are no symptoms and the classification is dependent on knowledge of a person's level of GFR. (NKF, 2007)

Nephrosis is a condition associated with blood and protein in the urine and cellular proliferation of the glomerulus (the filtering unit of the kidney). Nephrotic syndrome occurs when the filtering units of the kidney are damaged and leads to massive loss of urinary protein leading to low blood proteins and edema (or swelling). Nephritis is an inflammation of the kidneys. (NKF, 2007).

When kidneys fail, they are not able to remove wastes and extra fluid from the body. Renal replacement therapies (dialysis or kidney transplant) are the only treatments for kidney failure. There are two types of dialysis; hemodialysis (where blood is sent through a machine that filters away waste products and clean blood is returned to the body) and peritoneal dialysis (where a fluid called dialysate is put into the abdomen to capture waste products from the blood and is then drained away). A kidney may also be transplanted from either a living donor or deceased donor (NKDEP, 2007).

COST OF KIDNEY DISEASE

Medicare costs for ESKD have been increasing steadily in the U.S. and currently exceed \$20 billion. ESKD costs represent 6.7 percent of the Medicare budget, while ESKD patients represent only 1.1 percent of the Medicare population. The per person per year cost of dialysis in the Medicare population approached \$250,000 in 2003 (USRDS, 2006). CKD patients were estimated to have increased per person per year costs of as much as \$4676, depending on stage of disease, compared to patients without CKD. Also, patients with CKD had 2.5 times as many prescriptions, 1.9 times as many office visits, and were 2.2 times as likely to be hospitalized as controls (Smith DH et al, 2004).

RISK FACTORS FOR KIDNEY DISEASE

The main risk factors for CKD and ESKD are:

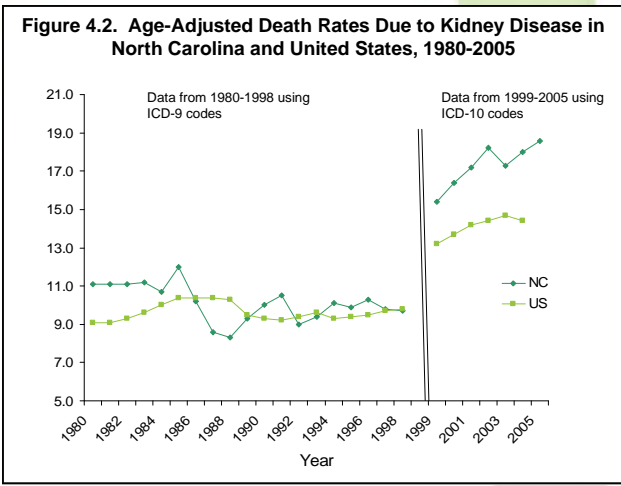
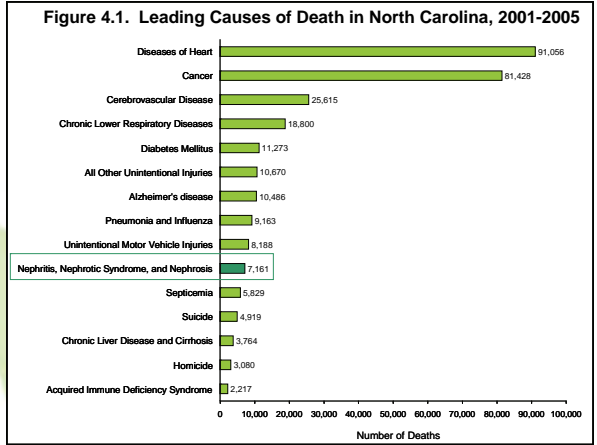
- **Diabetes:** Both Type 1 and Type 2 diabetes can damage the blood vessels in the kidneys. About a third of people with diabetes may eventually develop CKD.
- **High Blood Pressure:** Having high blood pressure, also called hypertension, can damage the small blood vessels in the kidneys, preventing the kidneys from filtering wastes from the blood.
- **Cardiovascular Disease:** Also called atherosclerosis, it can result in hardening of the arteries and small arterioles of the heart and kidney due to a build up of plaques.
- **Family History of Kidney Disease:** Family members of patients being treated for ESKD have higher rates of undiagnosed CKD.

Other risk factors for kidney disease include older age, African-American or Native American race, low socioeconomic status, smoking, and obesity (Fox CS et al, 2004; Nzerue CM et al, 2002; Shoham DA et al, 2007).

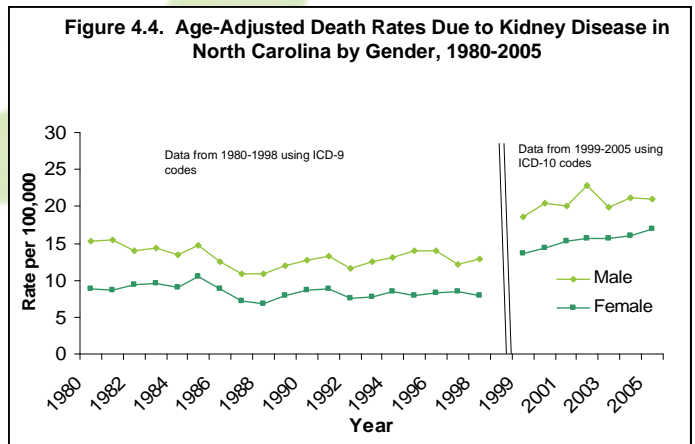
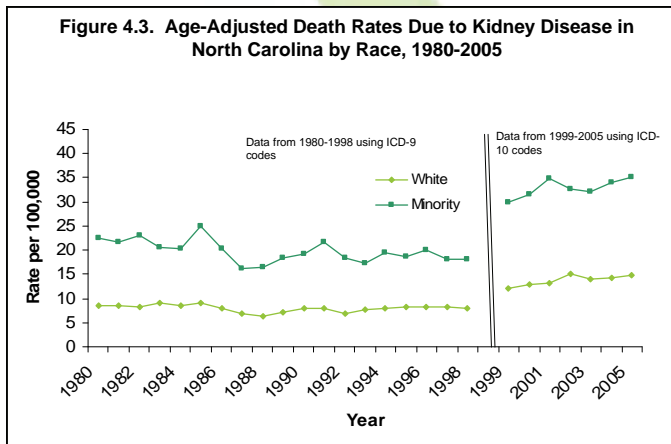
IV. Mortality from Kidney Disease in North Carolina

Kidney disease (defined by ICD-9 coded nephritis, nephrotic syndrome, or nephrosis) is the tenth most common cause of death in North Carolina. Between the years 2001 and 2005, nephritis, nephrotic syndrome, or nephrosis resulted in 7,161 deaths in North Carolina (Figure 4.1). The age-adjusted death rate for North Carolina in 2005 was 18.6 per 100,000.

The age-adjusted death rates in North Carolina and the U.S. have been increasing steadily since 1999 (Figure 4.2). North Carolina demonstrated consistently higher kidney disease death rates than the U.S. between 1999 and 2005. The dramatic increase in death rates after 1998 was due to changes in diagnostic coding. The change from ICD-9 to ICD-10 resulted in a more comprehensive classification of kidney disease deaths.



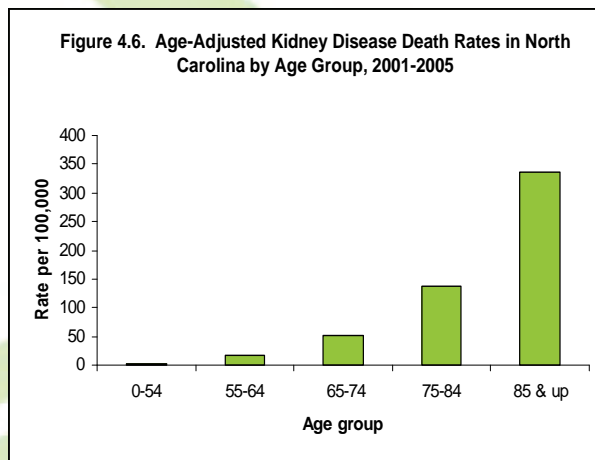
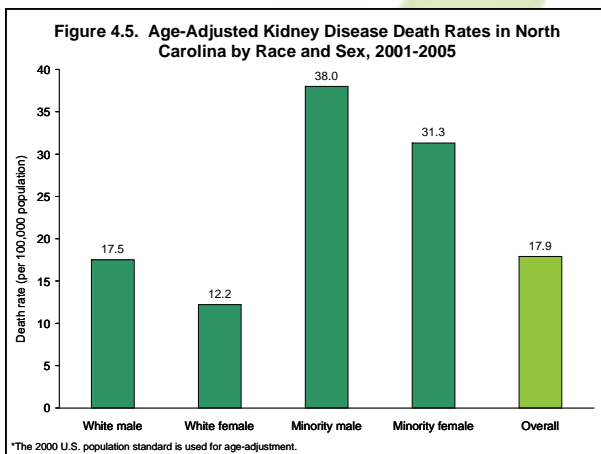
In North Carolina, the age-adjusted death rates for kidney disease have been higher in minorities than whites for over two decades (Figure 4.3). Minorities included African American, American Indian/Alaskan Native, and Asian/Pacific Islander. In 2005, North Carolina minorities had a death rate more than twice as high (35.1 per 100,000) as that of whites (14.9 per 100,000). In North Carolina males have had consistently higher age-adjusted death rates than females for kidney disease since 1980 (Figure 4.4). In 2005, the death rate for North Carolina males was 21.0 per 100,000, and for females it was 17.0 per 100,000.



Mortality (cont.) 8

Between 2001 and 2005 the kidney disease death rate for minority males in North Carolina was 38.0 per 100,000 compared to 17.5 for white males. During the same period the death rate was 31.3 per 100,000 for minority females versus 12.2 per 100,000 for white females (Figure 4.5).

Older persons had the highest death rates due to kidney disease in North Carolina. The age-specific death rates ranged from 1.8 per 100,000 among persons less than 55 years of age to 336.9 per 100,000 among persons 85 years of age and older (Figure 4.6).



The geographic distribution of age-adjusted death rates for kidney disease by North Carolina county is shown in Figure 4.7. The highest mortality rates are observed in the eastern part of the state in predominantly rural counties. Between 2001-2005, the counties with the highest age-adjusted kidney disease-related death rates were Pamlico, Warren, Duplin, Hoke and Columbus, ranging from 27.8 to 34.8 per 100,000

Figure 4.7. Age-Adjusted Death Rates Due to Kidney Disease in North Carolina by County, 2001-2005

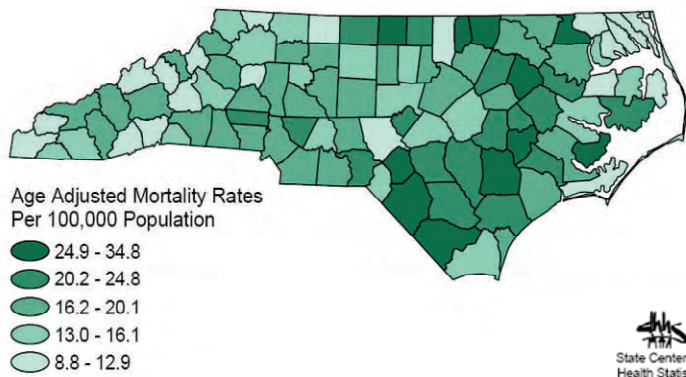


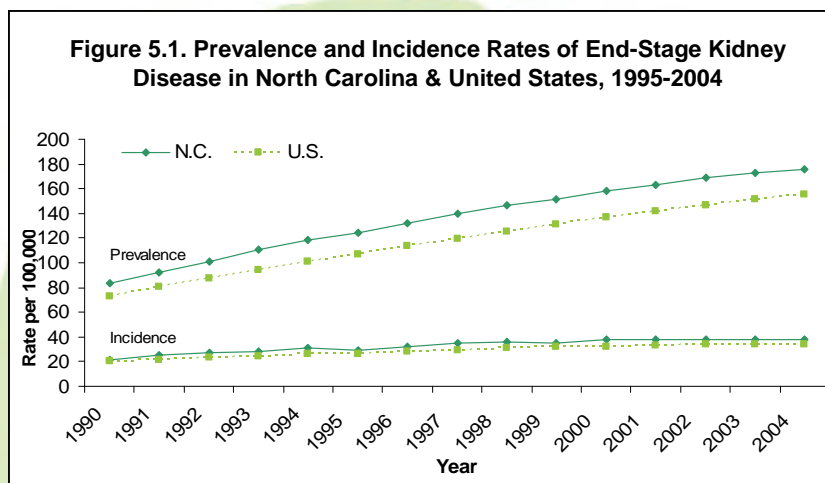
Table 4.1. Premature Deaths Due to Kidney Disease in North Carolina by Race and Gender, 2005

	Frequency (%)			
	White male	White female	Black male	Black female
Death prior to 65 years of age	81 (17.8)	68 (12.3)	79 (36.6)	69 (23.0)
Death at 65 years of age or later	375 (82.2)	486 (87.7)	137 (63.4)	231 (77.0)

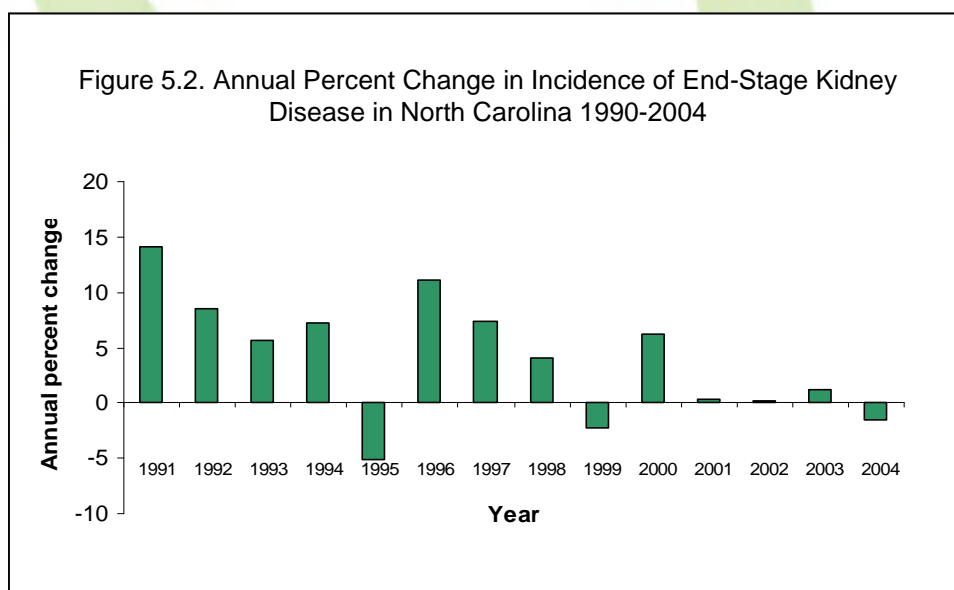
Of the 1,526 deaths from kidney disease in North Carolina in 2005, 297 (19.5%) deaths occurred in people under 65 years of age (Table 4.1). The proportion of these premature deaths was highest for black males. Of the 216 deaths from kidney disease in black men that occurred in 2005, 79 (36.6%) occurred before the age of 65.

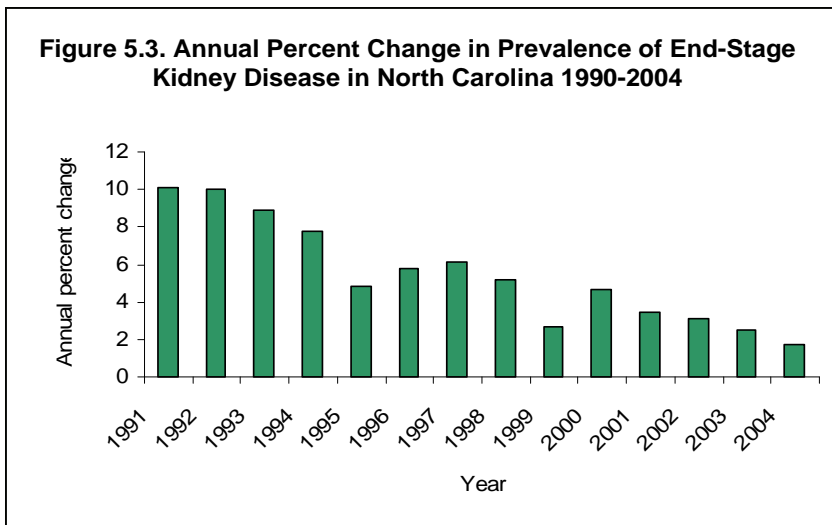
V. Prevalence & Incidence of ESKD in North Carolina 8

The incidence and prevalence of end-stage kidney disease (ESKD) between 1994 and 2005 has been increasing progressively in both North Carolina and the United States (Figure 5.1). North Carolina has demonstrated crude incidence and prevalence rates that have been consistently higher than rates reported for the nation. In 2004, North Carolina ranked 10th highest for ESKD prevalence and 12th highest for ESKD incidence among the 50 states and the District of Columbia (not shown).

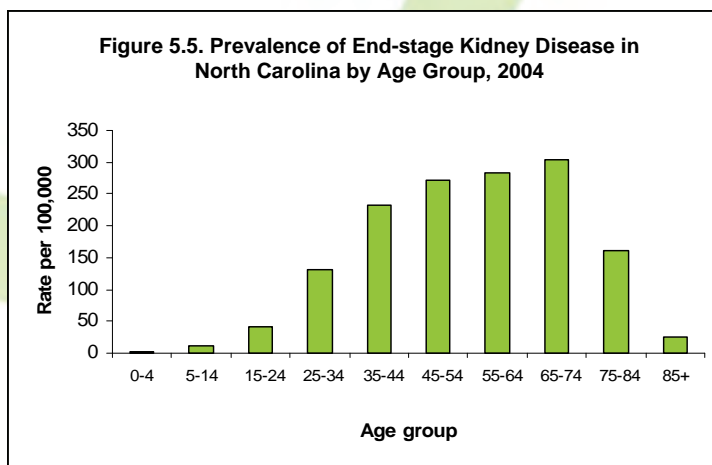
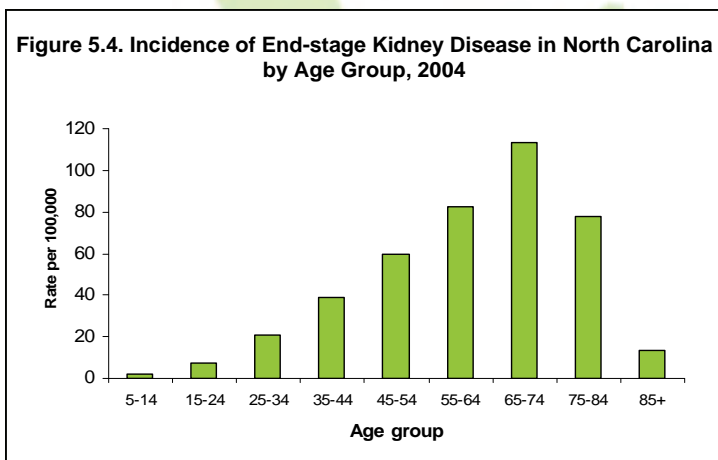


Because every year more people are being newly diagnosed with ESKD (the incident population) than are dying from it, the number of people living with ESKD (the prevalent population) is growing faster than the new cases. In 2004, the overall crude prevalence and incidence of ESKD in North Carolina was 37.5 and 175.7, respectively, per 100,000 population. The average annual increase in the incidence rates in North Carolina since 1990 has been 4.1 percent (Figure 5.2). Recent years show a leveling trend of incidence rates in North Carolina. These follow national trends in changes in annual ESKD incidence rates. The average annual increase in prevalence rates in North Carolina since 1990 has been 5.5 percent (Figure 5.3). Recent years show continuing, although more gradual, growth in the prevalence of ESKD in North Carolina.



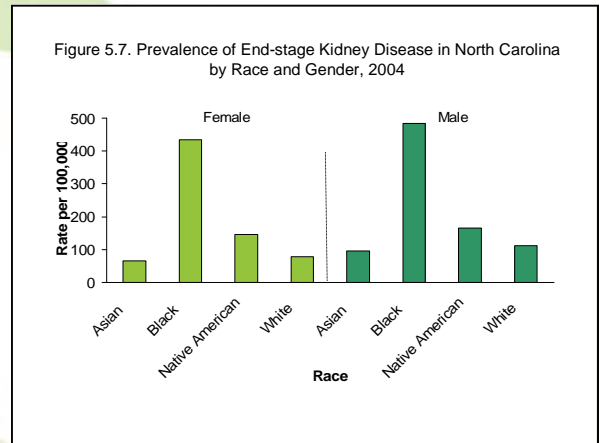
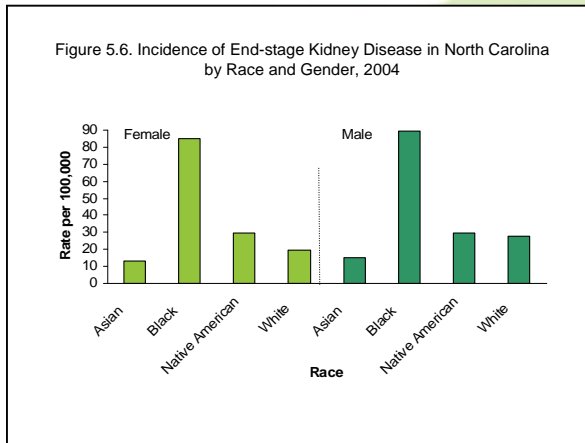


The crude incidence and prevalence rates of ESKD in 2004 are presented by age groups in figures 5.4 and 5.5. For the incident population, persons aged 55-84 years had the highest rates of ESKD, ranging from 77.8 to 113.1 per 100,000. For the prevalent population, persons aged 35-74 years had the highest rates of ESKD, ranging from 232.3 to 304.1 per 100,000.



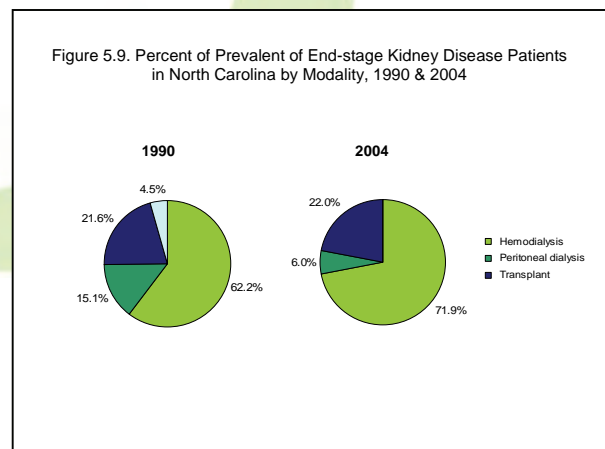
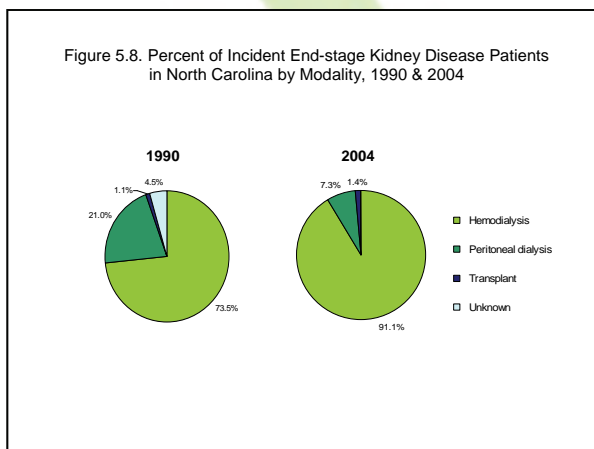
Prevalence & Incidence (cont.) 9

Both the incidence and prevalence of ESKD in North Carolina in 2004 were higher among blacks than among any other races, and higher in males than females (Figures 5.6 and 5.7). The incidence rate for black males (89.6 per 100,000) was 3.3 times higher than it was for white males (27.4 per 100,000). The incidence rate for black females (84.7 per 100,000) was 4.3 times higher than for white females (19.7 per 100,000).



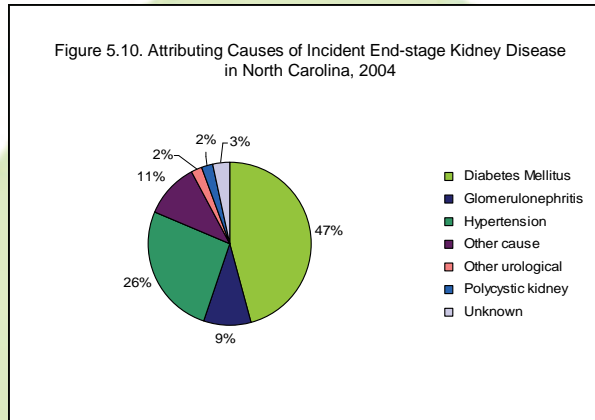
In 2004, 91.1, 7.3, and 1.4 percent of the incident ESKD population were treated with hemodialysis, peritoneal dialysis, and transplants, respectively (Figure 5.8). In 2004, 71.9, 6.0, and 22.0 percent of the prevalent ESKD population were treated with hemodialysis, peritoneal dialysis, and transplants, respectively (Figure 5.9). The hemodialysis population has increased and the peritoneal dialysis population has decreased over the last decade and a half. The proportion of ESKD patients receiving a kidney transplant has not changed substantially over time.

The primary attributing causes of incident ESKD among North Carolinians were diabetes, hypertension, and glomerulonephritis, accounting for 47, 26, and 9 percent of new cases of ESKD in 2004, respectively (Figure 5.10). Other causes accounted for 11 percent of new cases of ESKD in 2004.

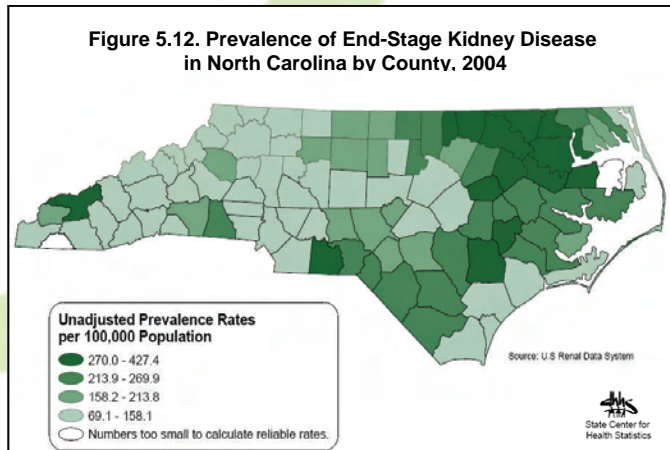
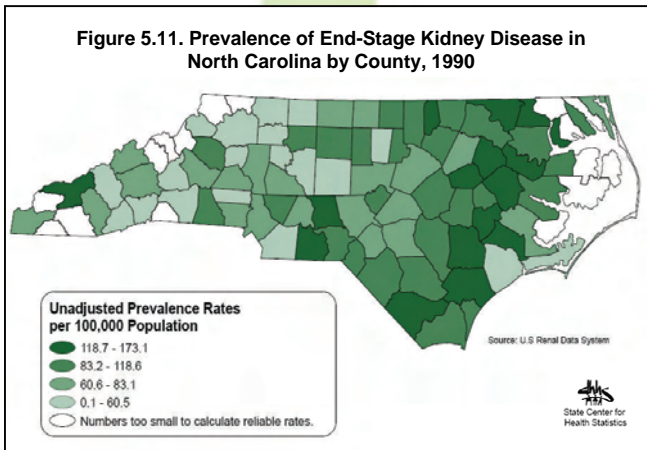


Prevalence & Incidence (cont.) 8

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The geographic trends of ESKD prevalence in North Carolina are shown for 1990 and 2004 in Figures 5.11 and 5.12. The prevalence rates for ESKD have undeniably increased since 1990 across North Carolina (as also demonstrated in previous figures); however, the county-level distribution of prevalence rates has remained similar over the last decade and a half. The highest ESKD prevalence rates seem to cluster in counties of Eastern North Carolina. The exception is Swain County with the 3rd and 5th highest ESKD prevalence in 2004 and 1990, respectively. The highest prevalence rates were Martin Northampton, Swain, Lenoir, and Bertie counties, ranging from 347.5 to 350.0 per 100,000. Of the 15 counties with the highest prevalence rates of ESKD in 2004, 10 also had the highest ESKD prevalence in 1990.



VI. Early Stages of Chronic Kidney Disease in North Carolina 9

Preventing ESKD in the future will require attention to chronic kidney disease (CKD) before it progresses to kidney failure. The burden of earlier stages of CKD is more difficult to report because there currently are no published data on these early stages (stages 1-4) in North Carolina. Future efforts should focus on obtaining statewide estimates of the prevalence of CKD across all stages of severity. In the absence of such data, the following available data is presented below.

NORTH CAROLINIANS WITH CHRONIC KIDNEY DISEASE

Published data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES) report the prevalence of CKD stages in a representative population of the U.S. The number of cases of CKD in North Carolina are calculated (Table 6.1) using these national prevalence estimates and based on the 2000 population estimate for North Carolina (8,049,313 persons). Table 6.1 shows that the estimated number of North Carolinians currently living with CKD, stages 1 through 4, may be as high as 941,770.

Table 6.1. Estimated Number of Persons with Chronic Kidney Disease in North Carolina

Stage of CKD	GFR (ml/min/1.73m ²)	Prevalence in the U.S. ¹	Estimated CKD cases in N.C. ²
1	>=90 (with kidney damage)	3.8%	305,874
2	60-89	4.0%	321,973
3	30-59	3.7%	297,825
4	15-30	0.13%	10,464
Total stages 1-4	--	11.7%	941,770

¹ from Coresh et al. J Am Soc Nephrol 2005;16(1):180-8
² based on 2000 population estimates from the U.S. Census Bureau

THE KIDNEY EDUCATION OUTREACH PROGRAM (KEOP)

Between October 2005 and January 2007, the UNC Kidney Center's Kidney Education Outreach Program (KEOP) conducted 14 kidney screenings in Anson, Edgecombe, Montgomery, and Orange counties. These screenings were conducted in collaboration with locally sponsored church health ministry initiatives, employee health screenings, senior citizens' fairs and fitness events. Questionnaires on demographics, medical history, and lifestyle behaviors were administered and urine samples were tested. Of the total 669 persons who were screened, the mean age was 48 years, 71 percent were female, and 72 percent had a high school education or greater. After excluding persons with evidence of bacteriuria or hematuria, data on 369 screening participants were available. As expected, the prevalence of microalbuminuria in this targeted screening population was high at 50 percent (Table 4). Screening participants with microalbuminuria were more commonly African-American than Hispanic or White (40% versus 31% and 26%, respectively). Those with microalbuminuria were also more likely to be obese than those with normal albuminuria. Other characteristics of UNC Kidney Center's screening participants are shown in Table 6.2.

Table 6.2. Characteristics of UNC Kidney Center Screening Population*

	Overall N=369	Normoalbuminuria N=184	Microalbuminuria N=185	P-value
Age, mean (SD)	47.9 (15.3)	48.6 (15.8)	47.2 (14.8)	0.408
Female, %	59.3	62.3	56.4	0.262
Race/ethnicity, %				
White	32.2	38.9	25.7	0.008
African-American	32.8	25.1	40.2	0.003
Hispanic	32.8	34.3	31.3	0.548
High school education, %	70.0	66.1	73.7	0.117
Smoke 100 cigs in life, %	62.2	35.9	39.6	0.504
# of days per month drinking alcohol, %				0.427
0 days	30.7	28.6	32.2	
1-5 days	51.3	57.1	47.1	
>5 days	18.0	14.3	20.7	
Physical activity, %				0.913
None/little	36.4	36.7	36.1	
Moderate/heavy	63.6	63.3	63.9	
Last exam by doctor, %				0.762
≤1 year	84.4	85.0	83.8	
>1 year	15.6	15.0	16.2	
Diabetes, %	16.9	13.4	20.3	0.083
Hypertension, %	39.6	34.9	44.3	0.075
BMI, mean (SD)	29.1 (6.8)	28.2 (6.5)	29.9 (6.9)	0.023
Obese (BMI>30kg/m ²)*, %	37.7	29.1	45.9	0.002
Family hx of diabetes, %	61.3	57.2	65.2	0.159
Family hx of hypertension, %	73.8	72.5	75.0	0.626
Family hx kidney disease, %	25.8	28.5	23.4	0.315
NC County, %				0.136
Anson	12.7	11.4	14.1	
Edgecombe	8.4	5.4	11.4	
Montgomery	46.6	47.8	45.4	
Orange	32.3	35.3	29.2	
Microalbuminuria†, %	50.1	--	--	--

*Excluding those with evidence of bacteriuria and hematuria

†Microalbuminuria defined as urine albumin concentration >20mg/L (using semi-quantitative Micral strips)

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VIII. Appendix 8

METHODS

Kidney Disease Mortality:

Age-adjusted mortality rates for the U.S. from 1980 through 2005 were obtained via CDC WONDER at <http://wonder.cdc.gov> from the compressed mortality file compiled by the National Center for Health Statistics, Centers for Disease Control and Prevention (CDC). Age-adjusted mortality rates for North Carolina from 1980 through 2005, as well as age-adjusted mortality rates by county, were obtained from the North Carolina State Center for Health Statistics. The direct method of age-adjustment was applied using the 2000 U.S. population standard. The number of deaths due to kidney disease prior to 1999 was determined using the International Classification of Diseases, 9th Revision (ICD-9) codes for nephritis, nephrotic syndrome, and nephrosis 580-589. The number of deaths for 1999 and after was determined using the International Classification of Diseases, 10th Revision (ICD-10) codes N00-N07, N17-N19, and N25-N27.

End-Stage Kidney Disease Incidence and Prevalence Rates:

The incidence and prevalence rates for the U.S. and North Carolina were obtained from the online RenDER public access data available through USRDS at www.usrds.org/odr/xrender_home.asp. All of the incidence and prevalence rates presented are crude (unadjusted) and so do not account for differences in the distributions of demographic factors, most importantly age.

The incident population consists of patients diagnosed with ESKD at any point during the specified incident year. The point prevalent population consists of all ESKD patients living as of December 31 of the specified prevalent year.

Rates for North Carolina were computed based on the population estimates obtained from the U.S. Bureau of the Census. The calculated rates were unsmoothed and unadjusted. All unknown values for age, gender, and race/ethnicity were dropped. The incidence of ESKD was defined as patients treated by dialysis or kidney transplantation, whose records are registered, classified, stored and maintained in the USRDS in a given calendar year.

Information on patient race and ethnicity were addressed in separate questions on the Medical Evidence form. The revised Medical Evidence Form in which patient ethnicity was first required was in 1995. The non-Hispanic category includes all patients whose ethnicity is missing or unknown.

The treatment modalities were defined as follows:

Hemodialysis was hemodialysis treatment received at a dialysis center, administered by the patient at a dialysis center, or administered by the patient at home. Peritoneal dialysis (PD) was defined as any patient undergoing continuous ambulatory/cyclic peritoneal dialysis (CAPD/CCPD), or other known PD (such as intermittent PD). Renal transplantation was considered any functioning kidney transplanted from either a living donor (a blood relative or other living person) or a cadaveric donor. Unknown dialysis was applied when the dialysis modality was not known at time of data collection (such as when the dialysis sessions are performed in a hospital).

Primary causes of ESKD were obtained from the Medicare Evidence form and grouped as follows (with accompanying ICD-9 codes):

- Diabetes: 250.00 and 250.01
- Hypertension: 403.9, 440.1, and 593.81
- Glomerulonephritis: 580.0, 580.4, 582.0, 582.1, 582.9, 583.1, 583.2, 583.4, and 583.81
- Cystic Kidney: 753.13, 753.14, and 753.16
- Other Urologic: 223.0, 223.9, 590.0, 592.0, 592.9, and 599.6
- Other Cause: all other ICD-9-CM codes covered in the list of primary causes on the Medical Evidence form, with the exception of 799.9
- Unknown Cause: 799.9 and other ICD-9-CM codes not covered in the primary causes on the Medical Evidence form
- Missing Cause: no ICD-9-CM code listed

GLOSSARY

Age-adjusted rate: a rate calculated based on a standard age distribution to allow comparison of rates in populations with different age structures.

Bacteriuria: evidence of bacteria in the urine indicating a possible urinary infection.

Chronic kidney disease: the presence of kidney damage or decreased level of kidney function for three months or more, irrespective of diagnosis. In this report, it specifically refers to certain types of kidney diseases: nephritis, nephrotic syndrome, and nephrosis.

Diabetes: a chronic disorder of metabolism affecting the way the body uses digested food for growth and energy.

Dialysis: the process by which metabolic waste products are removed by cleansing of the blood directly through extracorporeal filtration membranes (hemodialysis) or indirectly by diffusion of waste products through the peritoneal membranes into instilled fluids (peritoneal dialysis).

Edema: retention of fluid in the body.

End-stage kidney disease (ESKD): chronic kidney failure requiring either dialysis or a kidney transplant to sustain life.

Glomerulus/glomeruli: tiny, round structure composed of capillary blood vessels that filters the blood to reabsorb useful materials and remove wastes. There are one million glomeruli in the kidney.

Glomerular disease: damage of the glomeruli, letting protein and sometimes red blood cells leak into the urine.

Glomerular filtration rate (GFR): a calculated measurement that indicates how well a person's kidney functions. It may be estimated from one's blood level of creatinine.

Hematuria: blood in the urine.

Hypertension: High blood pressure. A medical condition in which constricted arterial blood vessels increase the resistance to blood flow, causing an increase in blood pressure exerted on vessel walls.

Incidence: the number of new cases of disease occurring in a specific population over a specific period of time, usually one year.

Prevalence: the number of persons with a disease or an attribute at a specified time.

Proteinuria: abnormal amount of proteins in the urine.

Renal replacement therapy: hemodialysis, peritoneal dialysis or kidney transplantation.

Serum creatinine: a waste product in a person's blood that comes from muscle activity. It is normally removed from one's blood by the kidneys; however, when kidney function slows down, the creatinine level rises.

ABBREVIATIONS

CDC= Centers for Disease Control and Prevention

CKD = Chronic kidney disease

ESKD = End-stage kidney disease

GFR = Glomerular filtration rate

ICD-9 = The International Classification of Diseases, 9th Revision

ICD-10 = The International Classification of Diseases, 10th Revision

NCHS = The National Center for Health Statistics

RenDER= Renal Data Extracting and Referencing system

USRDS = The United States Renal Data System



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