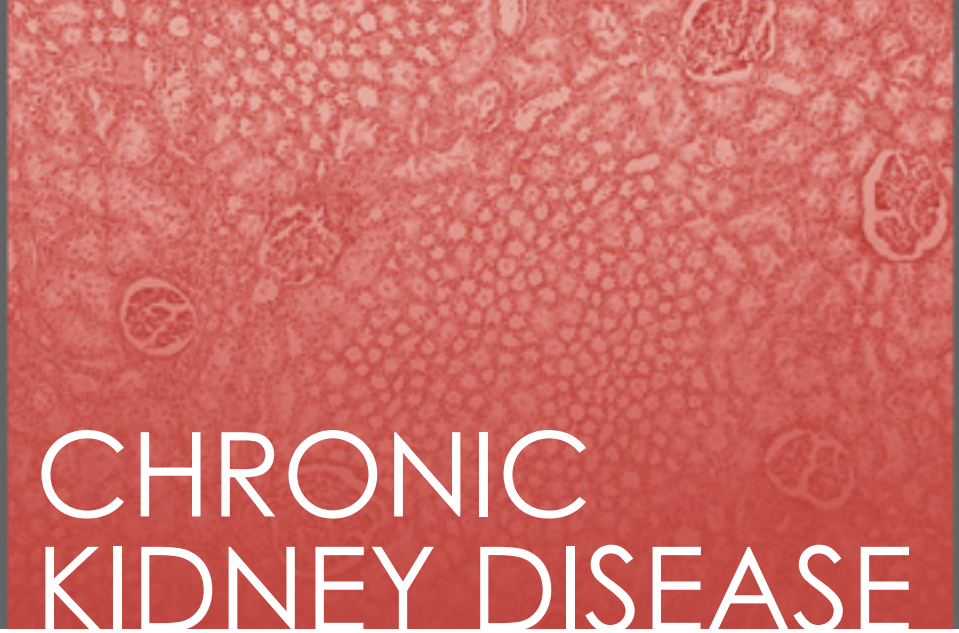


CHRONIC KIDNEY DISEASE

QUICK FACTS

Chronic kidney disease is a significant and growing health problem in the United States.[1]

Most kidney disease is associated with either diabetes or hypertension (high blood pressure) or both, although obesity and cardiovascular disease also contribute to the risk.[2]

Most of what we know about environmental exposures and chronic kidney disease comes from occupational settings.[3,4]

CDC estimates that more than 10% of adults in the United States are living with chronic kidney disease.[2] In 2011, the cost of care for Medicare patients with chronic kidney disease totaled $45.5 billion,18% of the Medicare budget, up from 3.8 % of the Medicare budget in 1993.[5] Kidney disease is the ninth leading cause of death in the United States and was responsible for the deaths of approximately 92,000 people in 2011.[6] Most of these deaths resulted from chronic (rather than acute) kidney disease.

WHAT IS CHRONIC KIDNEY DISEASE?

Chronic kidney disease (CKD) is a gradual decrease in kidney function that usually produces no symptoms until the disease is advanced. CKD affects over 10% of adults in the United States.[2] People with CKD are more likely to die from cardiovascular disease than develop kidney failure.[7]

The kidneys remove wastes and excess water from the blood. A patient is diagnosed with CKD if, over a period of at least three months, the kidneys' ability to purify blood deteriorates, usually from disease or injury. After CKD has been diagnosed, lifestyle changes and medication can slow the disease's progression.[2] In the most advanced stage of CKD, patients must receive dialysis (filtering blood through a machine) or a new kidney through transplantation to survive. At this point, the patient is considered as having end-stage renal disease (ESRD).

WHAT ARE THE RISK FACTORS FOR CHRONIC KIDNEY DISEASE?

NON-ENVIRONMENTAL RISK FACTORS

Diabetes or high blood pressure or both are the most important risk factors for developing CKD and are responsible for up to two thirds of all cases. Obesity and cardiovascular disease also contribute to the risk of developing CKD and its progression. Other identified risk factors include a family history of kidney disease, age, smoking, repeated or untreated urinary tract infections, gum disease (periodontitis), kidney defects present at birth, and diseases that affect the body's immune system. However, about 5% of patients with ESRD have no known risk factors.[1,2,3,8]

ENVIRONMENTAL RISK FACTORS

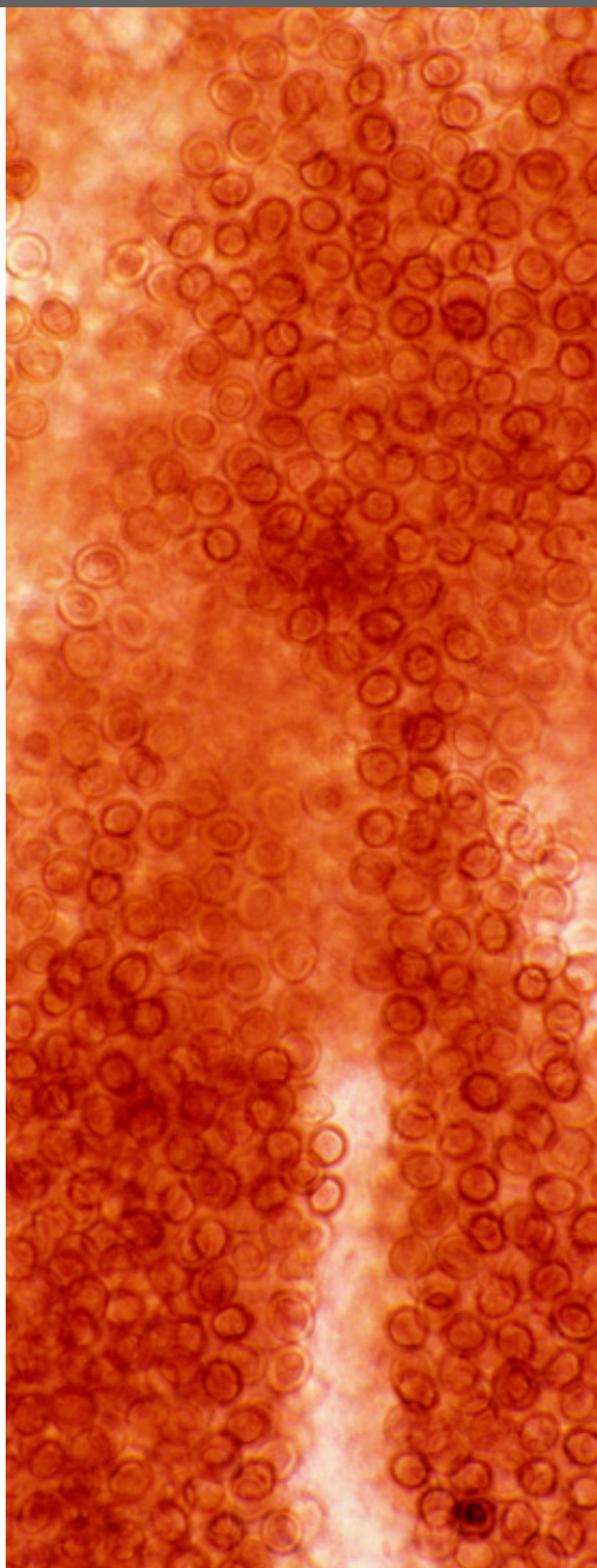
The contribution of environmental and occupational toxins to kidney disease remains largely unknown. Reports of impaired kidney function following occupational exposure to some substances—especially heavy metals—suggest that chronic, low-level environmental exposures may contribute to CKD. A growing body of evidence supports such links.[3]

Lead. Numerous studies have documented a connection between lead and CKD or other forms of kidney disease. While the minimum blood lead concentration that adversely affects the kidneys remains unknown, impaired kidney function has been observed at blood lead levels below 20 micrograms per deciliter and, possibly, below 10 micrograms per deciliter.[4,9] The CDC currently considers a blood lead level of 5 micrograms per deciliter or greater to be elevated and to require individualized case management.[10]

Cadmium. Many studies have correlated kidney damage with occupational exposure to cadmium fumes and cadmium oxide dust.[11] Additional studies suggest a link between environmental exposure to cadmium and kidney dysfunction[12,13,14,15,16,17] and failure.[18,19,20]

Mercury. Adverse kidney health effects are associated with both occupational and environmental exposure to mercury.[21,22]

Silicon. Occupational exposure to silicon-containing compounds has been linked to an elevated risk for CKD and ESRD.[23,24,25]



Organic Solvents. Exposure to organic solvents may be a risk factor for kidney disease, but more research on individual solvents or classes of solvents is needed to assess the risk of kidney damage.[4,25,26,27,28,29,30,31,32,33]

HOW ARE WE TRACKING CHRONIC KIDNEY DISEASE?

National surveillance data on chronic kidney disease are limited, particularly with respect to incidence rates of CKD prior to the onset of ESRD. ESRD has been much more thoroughly tracked than CKD; therefore, most of the available statistics pertain to ESRD. However, patients with ESRD account for only a small fraction of patients with CKD. For example, CDC estimates that more than 20 million people may have CKD while 113,000 people started treatment for ESRD in 2011.[2] The U.S. Renal Data System estimates of the prevalence of ESRD in December 2011 were 615,899 people.[34]

To derive an estimate of national CKD prevalence, results of kidney function tests are gathered from a sample of U.S. residents. These tests identify people who have CKD or are at high risk for developing CKD. Hospital discharge records provide another measure of the CKD burden,[35] and death certificates are used to estimate the number of deaths attributable to CKD.[36] In addition, the U.S. Renal Data System uses claims data from Medicare and employer group health plans to access CKD incidence in the general population.[37]

Although these data are useful, they do not reveal whether diseases like diabetes and hypertension precede and possibly cause CKD or vice versa, nor do they shed much light on the role of environmental pollutants in CKD development. To address these and other data needs, the Centers for Disease Control and Prevention (CDC), in collaboration with the University of Michigan and the University of California at San Francisco, is developing a comprehensive national surveillance system that will monitor trends in prevalence, risk factors, and care practices that impact on CKD prevention and control, and for monitoring kidney disease objectives for Healthy People 2020.[2,38] The National CKD Surveillance System, available through an interactive Web site (www.cdc.gov/ckd,) is crucial for documenting the burden of CKD and its risk factors in the U.S. population over time, and for tracking the progress of efforts to prevent, detect, and manage CKD and its complications.[38]

STATUS AND TRENDS

Calculations using death certificates, laboratory testing, and information gathered by the United States Renal Data System (USRDS) and the CDC indicate that kidney disease is a significant and growing health problem in the United States. Kidney disease is the ninth leading cause of death and accounted for about 92,000 deaths in persons of all ages in 2011.[6] The percentage of the U.S. population with CKD has been increasing. The estimated prevalence of pre-ESRD CKD during 1999 to 2010 was 15.8% of adult NHANES participants aged 20 years

or older (approximately 1 in 6 adults), compared with 14.2% (approximately 1 in 7 adults) calculated for 1988 to 1994. This represents an increase of 11.3%, based on crude estimates of prevalence. Some of the increase in pre-ESRD CKD between 1994 and 2010 could be attributed to the general aging of the population in those 16 years. These estimates have not been adjusted for age which is a major consideration in the onset of CKD.[38]

The rate of new ESRD cases increased or remained stable each year from 1996 to 2007. After a 2.1% decrease in the adjusted incidence rate of ESRD in 2007, the rate fell 0.9% in 2008, rose by 1.1% in 2009 and then decreased in both 2010 and 2011 by 1.9% and 3.8%.[34,39]

Prevalence rates for ESRD increased between 1.9% and 2.3% each year between 2003 and 2008.[37] Adjusted prevalence rates for ESRD rose in 2011 by 1.3%. This was lower than the increase in 2010, which was 1.8 percent. The rate of increase between 2004 and 2010 ranged between 1.7 and 2.2 percent. The prevalence rate for 2011 therefore shows a slower rate of increase compared to previous years.[34]

In 2011, the adjusted incident rate of ESRD averaged 449 per million population in the upper quintile and was highest in areas of the Ohio Valley, and in portions of Texas and California (Figure 1). Rates were adjusted for age, race, gender and ethnicity.[34]

Both pre-ESRD CKD and ESRD disproportionately affect racial and ethnic minorities and the elderly (Figure 2, Figure 4). In 2011, ESRD incidence rates for Non-Hispanic blacks/African Americans and Native Americans were 3.4 and 1.6 times greater than the ESRD incidence rates for whites. After rising in the middle of the decade, rates for both whites and Asians are now near the levels seen in 2000, while rates for blacks/African Americans and Native Americans are now 10.2 and 36 percent lower.[34]

Patient ethnicity became a required field on the 1995 revised medical report form. Because data for 1995 are incomplete, information on Hispanic patients is presented starting in 1996. The non-Hispanic category includes all non-Hispanics and patients with unknown ethnicity.[39]

Fourteen percent of new ESRD patients in 2011 were Hispanic, up from 12.6 percent in 2007. While the rate of ESRD among Hispanics fell 3.0 percent between 2010 and 2011, to 518, it remains 1.5 times greater than that seen in the non-Hispanic population. (Figure 3)[34]

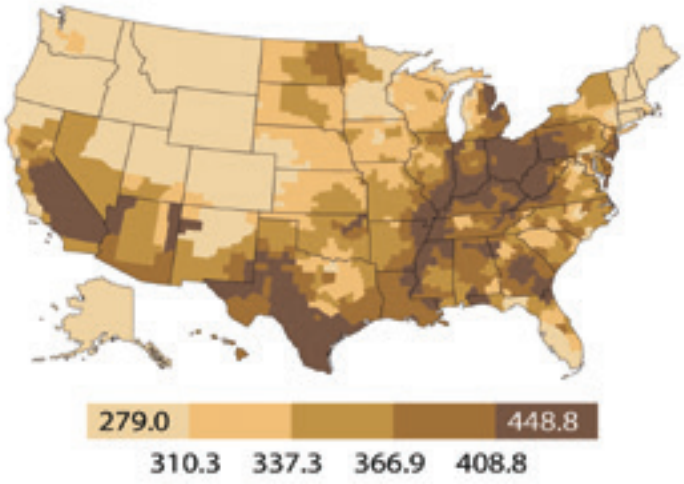


Figure 1. Geographic variations in adjusted incidence rates of ESRD per million population, 2011[34].

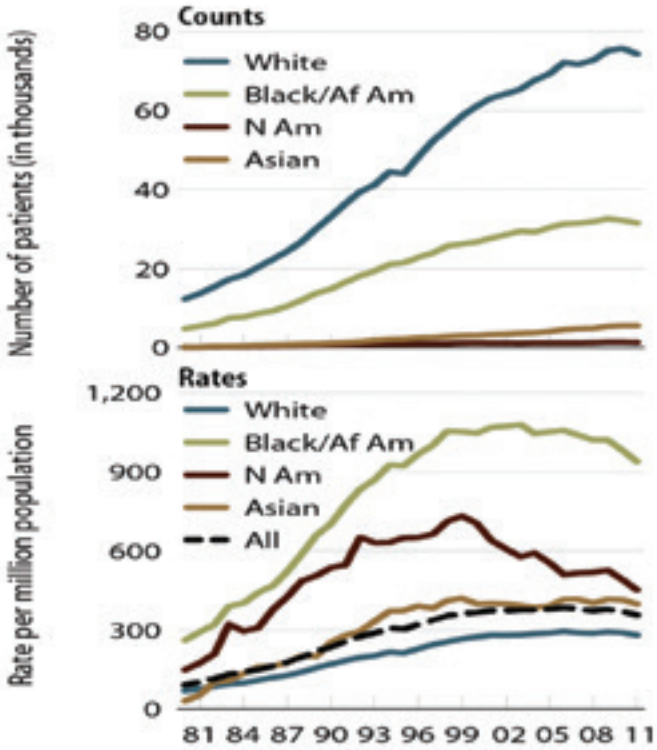


Figure 2. Trends in ESRD incidence rates from 1980 to 2011, by Race[34].

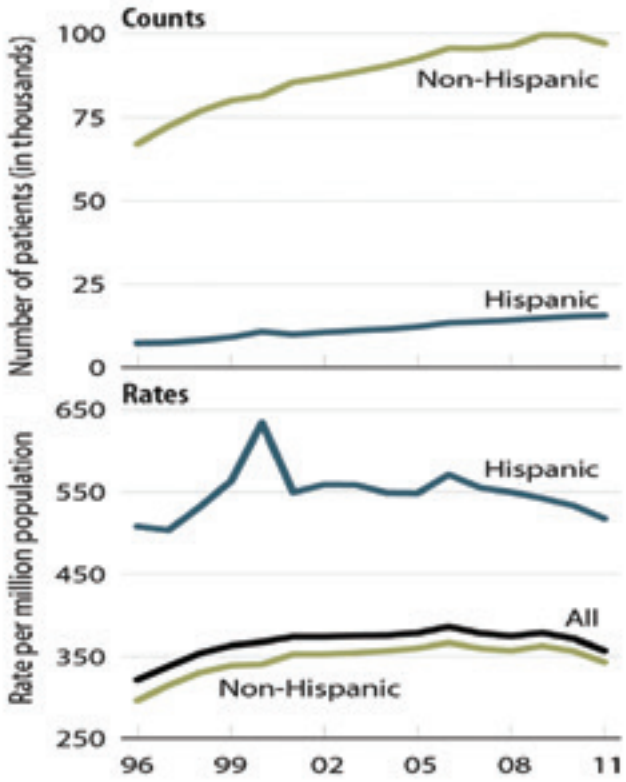


Figure 3. Incident counts & adjusted rates of ESRD, by Hispanic ethnicity[34].

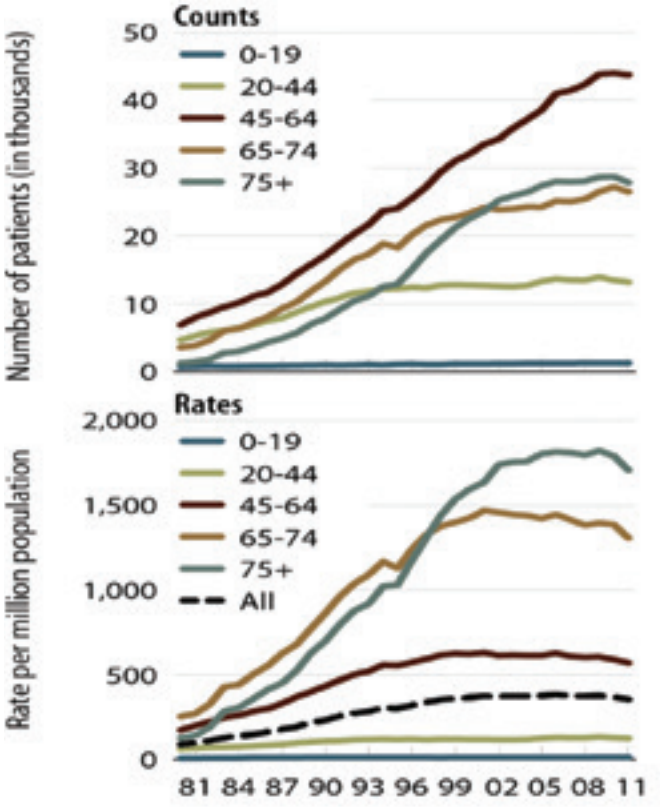


Figure 4. Incident counts & adjusted rates of ESRD, by age[34].

From 2000 to 2011, the adjusted incidence rate of ESRD grew 7.1 percent for patients age 75 and older, to 1,707 per million population (Figure 4).[34] Rates for those age 0–19 and 20–44 increased 10.1 and 4.1 percent, respectively, to 15.6 and 127 per million population. Rates for patients age 45–64 and 65–74, in contrast, though rising slightly during the decade, are now 8.1–8.3 percent lower than in 2000, at 571 and 1,307 per million population, respectively.[34]

The number of ESRD patients on dialysis in the United States has grown from 49,885 in 1980 to 430,273 in 2011.[34]

PREVENTION

Treatment and control of high-risk health conditions, particularly diabetes, hypertension, cardiovascular disease, and obesity, are most important in the prevention of kidney disease. Early detection of kidney disease can prevent or delay CKD.

WHAT CAN YOU DO TO PREVENT CHRONIC KIDNEY DISEASE?

- If you are at risk for diabetes, hypertension, or cardiovascular disease, seek the care of a health care provider to reduce your risk for these diseases and, therefore, the risk for developing kidney disease.
- If you have diabetes, hypertension, cardiovascular disease, or some combination of these illnesses, seek the care of a health care provider for treatment to reduce your risk of kidney disease.
- Take medication as prescribed by your health care provider.
- Maintain a blood pressure within the range recommended by your health care provider. Keep your blood sugar as close to normal as possible, and maintain a healthy weight.
- Do not smoke or use other tobacco products.
- Reduce your exposure to heavy metals. Avoid peeling paint or paint dust from housing built before 1978 because it might contain lead.
- Reduce your exposure to mercury by limiting your consumption of fish high in mercury, such as shark, swordfish, king mackerel, and tilefish. Pregnant women, women who might become pregnant, nursing mothers, and young children should not eat these fish at all and should limit their consumption of fish that are low in mercury, such as shrimp, canned light tuna, salmon, pollock, and catfish, to two meals a week.

ADDITIONAL RESOURCES

- The National Kidney Disease Education Program (NKDEP) of the National Institutes of Health at www.nkdep.nih.gov/index.htm.
- The United States Renal Data System (USRDS) at www.usrds.org/.
- Centers for Disease Control and Prevention Chronic Kidney Disease Surveillance System at http://apps.nccd.cdc.gov/CKD/default.aspx.
- Centers For Disease Control and Prevention National Chronic Kidney Disease Fact Sheet www.cdc.gov/diabetes/pubs/factsheets/kidney.htm
- National Kidney Foundation at www.kidney.org/

REFERENCES

1. U.S. Renal Data System, USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2013. [cited 2014 Jan 22]. Volume 1, Chapter 1 Chronic kidney disease in the general population. Available from URL: http://www.usrds.org/2013/pdf/v1_ch1_13.pdf

2. CDC. Diabetes Public Health Resource: National chronic kidney disease fact sheet 2014[online]. 2014. [cited 2014 Jan 22]. Available from URL: http://www.cdc.gov/diabetes/pubs/pdf/kidney_factsheet.pdf

3. Brewster UC. Chronic kidney disease from environmental and occupational toxins. Conn Med 2006;70(4):229–38.

4. Nuyts GD, D'Haese PC, Elseviers MM, de Broe ME, Van Vlem E, Thys J,et al. New occupational risk factors for chronic renal failure. Lancet 1995;346(8966):7–11.

5. U.S. Renal Data System, USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2013. [cited 2014 Jan 22]. Chapter 7. Costs of chronic kidney disease. Available from URL: http://www.usrds.org/2013/pdf/v1_ch7_13.pdf

6. U.S. Renal Data System, USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2013. ADR Reference Tables, Section H Mortality and Causes of Death. [cited 2014 Jan 22] Available from URL: http://www.usrds.org/reference.aspx

7. CDC. National Kidney Month and World Kidney Day. MMWR [online] 2009 Mar 6 [cited 2010 May 12];58(08):189. Available from URL: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5808a1.htm.

8. CDC. Prevalence of chronic kidney disease and associated risk factors—United States, 1999–2004. MMWR [online] March 2, 2007 [cited 2010 May12];56(08):161–5. Available from URL: http://www.cdc.gov/MMWR/preview/mmwrhtml/mm5608a2.htm.

9. Agency for Toxic Substances and Disease Registry(ATSDR). Toxicological profile for lead [online]. Atlanta, GA: U.S. Department of Health and Human Services, ATSDR; 2007. [cited 2010 May 12].p.85. Available from URL: http://www.atsdr.cdc.gov/toxprofiles/tp13-c3.pdf.

10. CDC. Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention Report of the Advisory Committee on Childhood Lead Poisoning Prevention [online]. 2012.[cited 2012 May 12]. Available from URL: http://www.cdc.gov/nceh/lead/ACCLPP/Final_Document_030712.pdf.

11. ATSDR. Toxicological profile for cadmium [online]. Atlanta,GA: U.S. Department of Health and Human Services, ATSDR; 2008 Dec. [cited 2010 May 12]. Available from URL: http://www.atsdr.cdc.gov/toxprofiles/tp5-c3.pdf.

12. Yamanaka O, Kobayashi E, Nogawa K, Suwazono Y, Sakurada I, Kido T. Association between renal effects and cadmium exposure in cadmium-nonpolluted area of Japan. Environ Res 1998;77(1):1–8.

13. Noonan CW, Sarasua SM, Campagna D, Kathman SJ, Lybarger JA, et al. Effects of exposure to low levels of environmental cadmium on renal biomarkers. Environ Health Perspect 2002;110(2):151–5.

14. Uno T, Kobayashi E, Suwazono Y, Okubo Y, Miura K, Sakata K, et al. Health effects of cadmium exposure in the general environment in Japan with special reference to the lower limit of the benchmark dose as the threshold level of urinary cadmium. Scand J Work Environ health 2005;31(4):307–15.

15. Åkesson A, Lundh T, Vahter M, Bjellerup P, Lidfeldt J, Nerbrand C, et al. Tubular and glomerular kidney effects in Swedish women with low environmental cadmium exposure. Environ Health Perspect 2005;113(11):1627–31.

16. Järup L, Hellström L, Alfvén T, Carlsson MD, Grubb A, Persson B, et al. Low level exposure to cadmium and early kidney damage: the OSCAR study. Occup Environ Med 2000;57(10):668–72.

17. Jin T, Wu X, Tang Y, Nordberg M, Bernard A, Ye T, et al. Environmental epidemiological study and estimation of benchmark dose for renal dysfunction in a cadmium-polluted area in China. BioMetals 2004;17(5):525–30.

18. Hellström L, Elinder C, Dahlberg B, Lundberg M, Järup L, Persson B, et al. Cadmium exposure and end-stage renal disease. Am J Kidney Dis 2001;38(5):1001–8.

19. Kido T, Nogawa K, Ishizaki M, Honda R, Tsuritani I, Yamada Y,et al. Long-term observation of serum creatinine and arterial blood pH in persons with cadmium-induced renal dysfunction. Arch Environ Health 1990;45(1):35–41.

20. Nogawa K, Kobayashi E, Okubo Y, Suwazono Y. Environmental cadmium exposure, adverse effects and preventive measures in Japan. BioMetals 2004;17(5);581–7.

21. ATSDR. Toxicological profile for mercury. [online]. Atlanta,GA: U.S. Department of Human Services, ATSDR; October 2007 [cited 2010 May 13]. Available from URL: http://www.atsdr.cdc.gov/toxprofiles/tp46-c2.pdf.

22. Franko A, Budihna MV, Dodic-Fikfak M. Long-term effects of elemental mercury on renal function in miners of the Idrija mercury mine. Ann Occup Hyg 2005;49(6):521–7.

23. Steenland NK, Thun MJ, Ferguson CW, Port FK. Occupational and other exposures associated with male end-stage renal disease: a case/control study. Am J Public Health 1990;80(2):153–7.

24. Steenland K, Rosenman K, Socie E, Valiante D. Silicosis and end-stage renal disease. Scand J Work Environ Health 2002;28(6):439–42.

25. Rapiti E, Sperati A, Miceli M, Forastiere F, Di Lallo D, Cavariani F, et al. End stage renal disease among ceramic workers exposed to silica. Occup Environ Med 1999; 56(8):559–61.

26. Zimmerman SW, Groehler K, Beirne GJ. Hydrocarbon exposure and chronic glomerulonephritis. Lancet 1975;306(7927):199–201.

27. Ravnskov U, Forsberg B, Skerfving S. Glomerulonephritis and exposure to organic solvents. A case-control study. Acta Med Scand 1979;205(1-6):575–9.

28. Harrison DJ, Thomson D, MacDonald MK. Membranous glomerulonephritis. J Clin Pathol 1986;39(2):167–71.

29. Jacob S, Hery M, Protois JC, Rossert J, Stengel B. Effect of organic solvent exposure on chronic kidney disease progression: the GN-PROGRESS cohort study. J Am Soc Nephrol 2007;18(1):274-81.

30. Ravnskov U. Hydrocarbons may worsen renal function in glomerulonephritis: a meta-analysis of the case-control studies. Am J Ind Med 2000;37(6):599–606.

31. Brautbar N. Industrial solvents and kidney disease. Int J Occup Environ Health 2004;10(1):79–83.

32. Yaqoob M, Bell GM, Percy DF, Finn R. Primary glomerulonephritis and hydrocarbon exposure: a case-control study and literature review. QJM 1992;83(2):409–18.

33. Fored CM, Nise G, Ejerblad E, Fryzek JP, Lindblad P, McLaughlin JK, et al. Absence of association between organic solvent exposure and risk of chronic renal failure: a nationwide population-based, case-control study. J Am Soc Nephrol 2004;15 (1):180–6.

34. U.S. Renal Data System, USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2013. ADR Volume 2 Atlas of End Stage Renal Disease, Chapter 1: Incidence, Prevalence, Patient Characteristics, and Modalities. [cited 2014 Jan 30] http://www.usrds.org/2013/view/v2_01.aspx

35. CDC. Hospitalization discharge diagnoses for kidney disease—United States, 1980–2005. MMWR [serial online] 2008 March 28 [cited 2010 May 16];57(12):309–12. Available from URL: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5712a1.htm.

36. Heron M, Hoyert DL, Murphy SL, Xu J, Kochanek KD, Tejada-Vera B. Deaths: Final data for 2006. Natl Vital Stat Rep [online] 2009 April 17 [cited 2010 May 16];57(14). Available from URL: http://www.cdc.gov/nchs/data/nvsr/nvsr57/nvsr57_14.pdf.

37. USRDS. 2010 Annual data report: Atlas of Chronic Kidney Disease and End-State Renal Disease in the United States [online]. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2010. [cited 2011 Aug 22]. Available from URL: http://www.usrds.org/atlas.htm.

38. Centers for Disease Control and Prevention. United States. Chronic Kidney Disease Surveillance System. Atlanta. U.S. Department of Health and Human Services, 2011. Available at http://www.cdc.gov/ckd . [cited 2014 Jan 30].

39. U.S. Renal Data System, USRDS 2011 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2011. Volume 2 – Atlas ESRD, Chapter 1 Incidence, prevalence, patient characteristics, and modalities. [cited 3 Feb 2014] http://www.usrds.org/2011/pdf/v2_ch01_11.pdf.