

A Report on A Study of End-Stage Renal Disease

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ABSTRACT

The factors related to the high rates of End-Stage Renal Disease (ESRD) in Muskegon County remain uncertain, particularly with regard to the most relevant ESRD health risk factors. The author examined socio-demography, health risk behaviors, family disease history, diagnosis, and other variables associated with ESRD among 442 Muskegon County residents. This is a case-control study conducted by a project team from the Muskegon County Health Department. The cases were 180 survivors with ESRD who received dialysis treatment at the Western Michigan Kidney Center (WMKC). A control group (N=262) with same gender, ethnicity, and age (± 5 years) were selected through telephone interviews throughout Muskegon County. A comparison between the two groups showed significant differences in a number of health-related variables. The ESRD patients were more likely to experience family histories with higher rates of hypertension, diabetes, and kidney diseases. The magnitude of alcohol consumption was greater among the ESRD patients than the controls. Other health-related unfavorable behaviors were also greater among the cases than the controls in terms of obesity and fewer medical checkups before ESRD occurrence. Demographically, ESRD patients in the study were less educated, had lower incomes, and were more likely to have been employed in heavy industry than were the individuals in the control group. Logistic regression was used to estimate the degree to which various factors predicted ESRD. The relative risk estimates correlated with ESRD were greatest among individuals who drank alcohol frequently (odds ratio (OR) = 6.05), who did not have routine physical checkups regularly (OR = 1.82), were overweight (OR=2.4), and had a diagnosis of hypertension or diabetes. Their relative risk estimate was also increased by industrial employment. These results add to the evidence of an association between an increased risk of ESRD and multiple health risk factors. These findings call attention to the great need for more aggressive and effective efforts in prevention and intervention.

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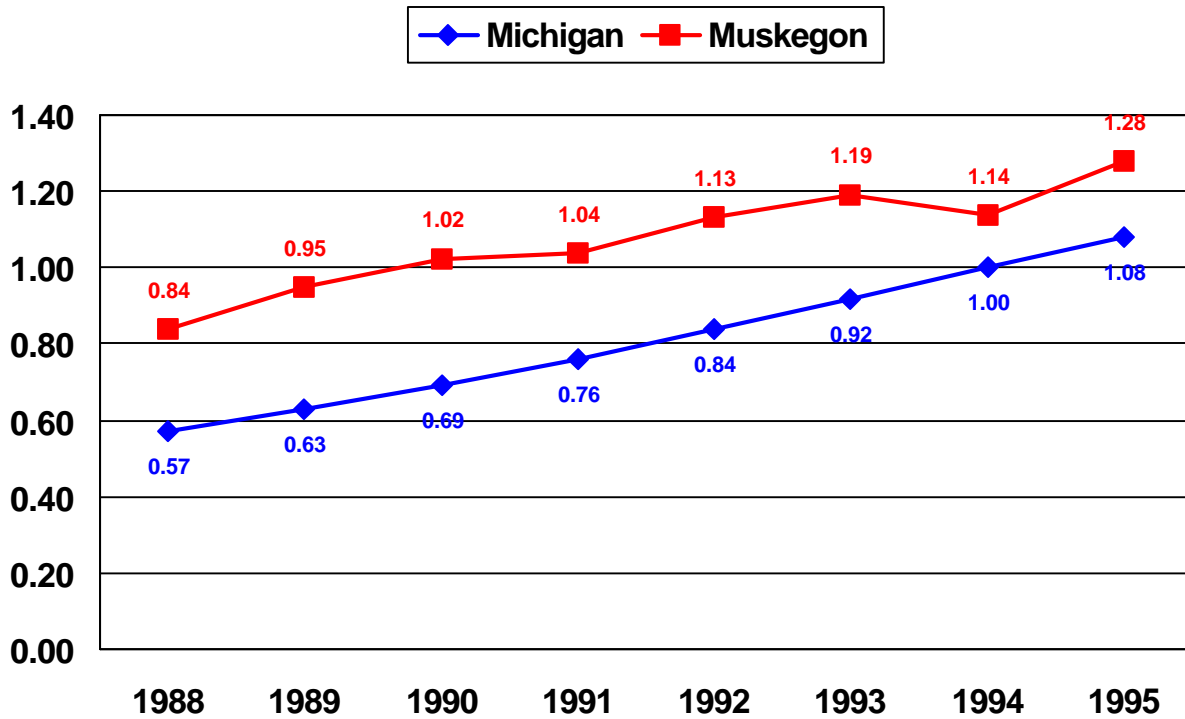
INTRODUCTION

Muskegon ranks among the highest counties in Michigan with End-Stage Renal Disease (ESRD). According to data obtained from the US ESRD Network 11, ESRD prevalence rates in both the state and Muskegon County experienced similar steady increases, but the rates in Muskegon County were at least 14% higher for each year when compared with the state from 1988 to 1995 (see Figure 1). The continued increase in the number of new ESRD patients is also remarkable. On the average, Muskegon County suffered incidence rates of ESRD which were 30.5% higher than the state during the past 8 years.

Several factors may explain this continued increase in the treated incidence throughout the U.S. and may apply to Muskegon County as well. First, the changes in US demographics, specifically the growing aged population, partially contribute to the increase in patients requiring renal replacement treatment. Second, improved prevention of cardiovascular disease, strokes, and other conditions results in more patients living long enough to develop ESRD. Third, there has also been a steady decline in the mortality of ESRD patients, extending the average lifetime during which patients require treatment (AJKD, 1995). In addition, there has been a broader acceptance of patients into treatment. For example, the acceptance criteria in clinical practice during 1972 and 1973 excluded patients over age 65 from ESRD treatment (Friedrich & Port, 1992). Only 3.9 and 5.1% of new patients accepted were older than 65 years during these 2 years, respectively. Now, the median age for new patients had reached 61 years in the United States, i.e., 50% of new patients are older than 61 years. This combination of factors may have led to the escalated rates of growth in the ESRD patients. However, the increase of ESRD cannot be fully explained by the changes in demographics.

In the past years, many efforts have been made to understand some of the reasons for this growth in prevalence. Analysis on US ESRD surveillance data indicated that the magnitude and distribution of ESRD varied from population to population. For example, the US Renal Data System 1995 Annual Data Report illustrated a general profile of ESRD patients. ESRD rates for males predominated over females --- the sex-specific prevalence rates were 94 for males and 67 for females per 100,000 populations. Of the racial groups, Blacks predominated over Whites --- the prevalence rates of Blacks were 250 and the rates of Whites were 60 per 100,000 population. Meanwhile, prevalence over these years increased faster for older age groups. Specifically, more than 50% of ESRD patients were older than 60 years. Individuals who were older than 70 years constituted about 20% of the patient population.

Figure 1.
ESRD Prevalence: Michigan and Muskegon County
(1988-1995)
Per 1,000 Population



Source: Renal Network 11.

Investigations on the etiological factors in ESRD were also made to understand the origin of this disease. Some research revealed that certain chronic conditions contributed to ESRD incidence. For example, the largest proportion of new cases of ESRD in 1993 was due to diabetes and hypertension, the two major causes of the disease (Michigan Renal Plan Task Force, 1995). But there was no determination on hypertensive nephrosclerosis as to whether the kidney damage was prior to or followed by hypertension. Studies also showed that some potential risk factors might be associated with ESRD. Ethnic background (Livingston, 1993 & Klag, 1997), socio-economic status (McClellan, 1993 & Klag, 1997) and harmful environmental exposure (Churchill et al, 1983; Finn et al, 1980, & Steenland, 1990) were among the many variables associated with this disease.

However, the increased incidence of ESRD in Muskegon County cannot be fully understood from these past studies. Why has Muskegon County suffered from ESRD in terms of having much higher rates than the rest of the state? Who are more likely to be afflicted with this disease? Which are the risk factors, other than mentioned above, associated with this disease? Is ESRD related to certain locations or demographic groups in this community?

In order to answer those questions, the first Muskegon ESRD project was initiated by the Muskegon County Health Department. In particular, this study had the following specific aims:

1. A population study on ESRD patients to describe these patients demographically and geographically.
2. A population study on ESRD patients to assess their diagnoses and co-morbidity.
3. The study group was matched with a control group to determine the differences between the two groups in the magnitude and nature of ESRD-related risk factors.
4. To examine dimensions of ESRD related factors: health risk behaviors, family disease history, and socio-economic factors, to determine which risk factors are associated with ESRD.

METHODOLOGY

The basic design of this project was a case-control study. By definition, a case-control study includes individuals with ESRD (the cases) and individuals without the given disease (the controls). The proportion of cases and controls who have certain background characteristics or who have been exposed to possible risk factors are then determined and compared.

Cases (the ESRD patients): Cases were defined as individuals with ESRD who represent a stage of kidney failure that requires dialysis (hemodialysis and peritoneal dialysis) or kidney transplantation to sustain life. The eligible cases in this study were patients who were diagnosed with ESRD and who were treated at the Western Michigan Kidney Center (WMKC). Possible cases were ascertained from WMKC patients' name list. The criterion for recruiting cases was patients who were receiving dialysis treatment in the time period between April and August of 1996. Pediatric patients were excluded from this study. Among approximately 200 patients who were eligible for inclusion, a total of 180 patients voluntarily participated in the study. The medical records of the cases were abstracted for diagnostic and medical information.

Controls: A control group with a proportion of age, gender, and ethnic profiles was matched with the cases. An appropriate control group should be selected in an unbiased manner from those individuals who would have been included in the case series, had they developed the disease under study (Miettinen 1985). The control group in this study was defined as a random sample of individuals from the same community where the ESRD patients resided but who had not developed ESRD. The data collection of controls was based on 262 completed telephone surveys conducted county wide, covering the same major zip codes as the case group.

Two thousand telephone numbers for potential controls were purchased from Survey Sampling, Incorporated of Fairfield, CT. The methodology used by SSI was age targeted samples. A telephone number database was collected from all white-page telephone directories across the county and supplemented with auto registration information from the state. Each record in this database carries an age predictor of the head of household. The age predictor is a value based on either known age-related data or a statistical estimate of age, predicted on individual household characteristics and U.S. Census demographic information. As a final step in the prediction process, statistical estimates of age are adjusted at the state level to reflect the most recent available state age distribution released by the US Census Bureau.

All the numbers on the list were age specified to match the cases' profile. For instance, cases were composed of the ESRD patients with average age of 60 years. The cases' ethnic background was matched by controls with 35% of Blacks and the rest Whites. According to the 1990 Census, 40% of African Americans in the county resided in Muskegon Heights. Therefore, in order to match the cases, the controls from Muskegon Heights were over sampled. The zip code residential variable was then matched between the cases and controls with about 35% in Muskegon Heights, 30% in Muskegon Township, 15% in Northern Muskegon, 18% in Norton Shore, and 2% in Eastern Muskegon.

Interviews: The interviewers were well-trained health professionals using standardized interview techniques when approaching the potential respondents. The same persons interviewed both the cases and controls. The participants were interviewed with a standard questionnaire that included questions concerning socio-demography, detailed occupational history, cigarette usage, alcohol consumption, weight indicators, medical insurance coverage, regular physical check-ups, history of diabetes mellitus, hypertension, and renal diseases, family disease history, and the participants' treatment and hospitalization history for ESRD. Interviews took about 30-40 minutes for each group depending on the scope and severity of respondents' health problems.

Cases were interviewed from April through August 1996. They were interviewed in a face-to-face fashion either at the hospital when patients were on dialysis treatment or at their home for peritoneal dialysis patients. In interviewing the potential cases, surrogate interviews of a close family member were completed for those patients who were too ill to participate.

The controls were selected through telephone-interviews between January 20 and April 17, 1997. The first step in the telephone survey, after a residential telephone number was reached, started with a brief introduction. Then the interviewers approached the respondents for a census of age, gender, and ethnic background in order to determine eligibility for inclusion. If the respondent was ineligible, the interview was terminated. For these eligible respondents, either an interview took place or an appointment was made to set up the next interview. After at least 4 attempts were made to reach the initial household, dialing at different times and days of the week, a new number was selected.

In all, 1319 attempts were made and 1059 phone numbers were used. Results included: 24.7% of the eligible respondents were surveyed and completed; 25% of the calls were rejected; 28.8% of the calls failed to reach the eligible respondents; and the remaining 21.5% of the calls

failed to reach the respondents due to a busy signal, disconnection, or answering machines.

The refusal rates for interviews in both potential cases and controls were lower than expected with only 10% in the cases' group and 25% of potential controls declining interviews. The low refusal rates were probably due to the fact that most of these trained interviewers were public health nurses. It was easier to build trusting relationships when interviewers were medical staff who could ask sensitive medical questions of respondents appropriately.

Measurements: Measurement on major variables is described as follows. Ethnicity was assessed by a self-reported question coded as "white," "black," and "other." The frequency of alcohol consumption was measured as: (1) everyday, (2) several times a week, (3) once a week or only on weekends, (4) several times a month, and (5) irregularly or occasionally. The classification for a current or former smoker was defined as ever "smoked at least 100 cigarettes" in entire life. It was assessed by the actual number of cigarettes the respondents smoked. The frequency of routine medical check-up for the cases referred to the activity prior to ESRD occurrence. It was measured as (1) every year, (2) every other year, (3) every 3 to 5 years (4) no regular time, and (5) did not see a doctor until suffering symptoms. Education level was assessed by years of schooling in three categories: (1) Less than high school, (2) high school graduate, and (3) some college and more. Household income was measured using the 1990 US Census household income categories.

Data Analyses: Data were compiled by the Public Health Epidemiologist using the SPSS data system. The data were analyzed on two levels. First, simple descriptive analysis, Chi-square tests (for dichotomous, categorical, or ordinal variables), and T-test (for continuous variables) were used to calculate the distributions and to make a comparison between the two groups. Second, because bivariate tests only permit analysis of one independent variable at one time, a logistic regression analysis was conducted to determine the likelihood of each independent variable contributing to the dependent variable (ESRD) while controlling for all other variables in the model.

FINDINGS

First, general findings on the 180 patients with ESRD can be summarized with the following characteristics (see Table 1):

Cases:

1. They can be described as an aged group with 60% of the patients 60 years or older.
2. There were slightly more men than women (52% vs. 48%).
3. While the majority of the patients (75.5%) were residents of Muskegon County, the remaining 24.5% resided in the surrounding counties when the interviews occurred.
4. Primary causes of ESRD among the patients were diabetes (60.5%), hypertensive nephropathy (52.2%), and inflammation of kidney (glomerulonephritis)(14.4%).
5. The racial composition of the patients was 64.4% White, 35% African Americans and other minorities. Comparing this racial composition to the US census data in 1990, African Americans represented disproportionately higher numbers with ESRD. The rates of African Americans with ESRD were almost three-fold higher than White patients.

Table 2 displays a comparison between White and Black ESRD patients with numerous variables.

- * On the average, Black patients were 5 years younger than white patients (57.5 years vs. 62.8 years old).
- * There were more female patients among Blacks than among Whites (53.1% vs. 45.2%).
- * Black patients had lower annual household income than the Whites --- 60% of the Blacks versus 22.9% of the Whites with a household income of less than \$10,000. More whites lived in their own houses than did the blacks (69.0% vs. 36.4%).

**Table 1. Demographic Characteristics of Study Population
(N=442)**

		Cases (n=180)	Controls (n=262)	Significance p(Chi-square)
Age at Interview	44 and Under	16.7%	23.7%	n.s
	45-59	23.3%	17.1%	
	60-74	41.1%	40.1%	
	75+	18.9%	19.1%	
Gender	Male	52.0%	47.3%	n.s
	Female	48.0%	52.7%	
Ethnic Background	White	64.4%	67.6%	n.s
	Black	35.0%	30.9%	
	Other	0.6%	1.5%	
Education	Less than High School	41.1%	26.7%	b
	High School Graduate	32.8%	35.5%	
	Some College and More	26.1%	37.8%	
Employment Status	Management/Administration	15.4%	11.7%	a
	Professional/Technical/Engineering	12.6%	28.5%	
	Sales	2.9%	9.0%	
	Industry/Laboring	45.7%	24.2%	
	Clerk/Secretary	4.0%	8.6%	
	Service	17.7%	18.0%	
	Farm/Forest/Fish	1.7%	---	
Household Annual Income	Less than \$14,999	58.1%	39.3%	a
	\$15,000-\$24,999	26.9%	21.4%	
	\$25,000-\$34,999	5.6%	16.0%	
	\$35,000-\$49,999	8.1%	11.2%	
	\$50,000+	1.3%	12.1%	
Living Arrangement	Own Home	57.8%	80.9%	a
	Other's Home/Apt.	14.3%	8.4%	
	Rental House/Apt.	14.9%	5.0%	
	Low Income Housing	3.1%	0.8%	
	Other	9.9%	5.0%	
Marital Status	Married	46.1%	50.0%	n.s
	Divorced/Separated	18.9%	13.0%	
	Widowed	22.2%	24.4%	
	Never Married	12.8%	12.6%	

NOTE: Chi-square statistics for comparison of patients and controls

a. p<.001

b. p<.01

c. p<.05

**Table 2. A Comparison Between White and Black Patients with ESRD
(N=180)**

		White (n=116)	Black (n=64)	Significance p(Chi-square)
Age	22-44	14.7%	20.3%	n.s
	45-59	19.0%	31.3%	
	60-74	44.8%	34.4%	
	75+	21.6%	14.1%	
	Mean	62.8 yrs	57.5 yrs	
Gender	Male	54.8%	46.9%	n.s
	Female	45.2%	53.1%	
Household Income	Less than \$10,000	22.9%	60.0%	a
	\$10,000-\$15,000	21.9%	23.6%	
	\$15,000-\$20,000	18.1%	7.3%	
	\$20,000-\$25,000	17.1%	3.6%	
	\$25,000-\$35,000	7.6%	1.8%	
	\$35,000-\$50,000	11.4%	1.8%	
\$50,000+	1.0%	1.8%		
Housing	Own Home	69.0%	36.4%	a
	Someone Else's House/Apt.	12.3%	18.2%	
	Rental House/Apt.	1.9%	29.1%	
	Low Income Housing	1.9%	5.5%	
	Other	9.4%	10.9%	
Medical Insurance Coverage	Since the Past Year	3.6%	8.1%	b
	The Past 2 Years	4.5%	3.2%	
	The Past 3 Years	2.7%	11.3%	
	5 or More Years Ago	35.7%	46.8%	
Always Having Insurance	53.6%	30.6%		
Frequency of Physical Checkup before Having Renal Disease				c
	Every Year	63.2%	49.2%	
	Every Other Year	2.6%	4.9%	
	Every 3 to 5 Years	0.0%	4.9%	
	No Regular Time	17.5%	26.2%	
Not Seeing a Doctor until Sick	16.7%	14.8%		

NOTE: Chi-square statistics for comparison of Whites and Blacks

a. p<.001

b. p<.01

- * All reported having some kind of medical insurance coverage. However, more Whites had longer period of coverage than the Blacks (“always having insurance”) (53.6% vs. 30.6%).
- * Before becoming sick with ESRD, more Whites visited a doctor for physical checkups every year than did the Blacks (63.2% vs. 49.2%).

Tables 3 and 4 compared the White and Black patients with family disease history and diagnosis. Only one variable differed significantly. Blacks were more likely to report that they had immediate family members with hypertension (70.3% vs. 54.3%) and a higher percentage were diagnosed with hypertensive ESRD than Whites (60.9% vs. 47.4%).

The cases and controls:

A total of 442 respondents were included in the analysis (180 cases and 262 controls). Controls were selected to match to each case according to sex, ethnicity, age (± 5 years), and residential zip code. Both cases and controls were 60% in ages of 60 years and above. Genders were about 50% for each sex. Cases’ ethnic background was matched by controls with about 35% of Blacks and the rest were Whites. The cases’ zip code residential variable was matched to controls with about 35% in Muskegon Heights, 30% in Muskegon Township, 15% in Northern Muskegon, 18% in Norton Shore, and 2% in Eastern Muskegon.

When these four background characteristics were matched between the cases and controls, the rest of demographic and health risk factors related to ESRD were compared and determined.

Differences in Demographic Variables:

The distribution of levels of education, occupation, household annual income, and living arrangement were significantly different between the two groups. Compared to the controls, ESRD patients can be portrayed as having lower levels of education, less income, heavy industrial employment, and fewer owned houses. In particular:

- * more than 40% of the patients did not finish high school compared to only 26.7% among the controls. About 26% of the patients compared to 37.8% of the controls had some college or more.

Table 3: Self Reported Family History (N=180)

N=180	Ethnic Background		Significance p(Chi-square)	Total %
	White (116)	Black (64)		
Hypertension	54.3%	70.3%	c	60.0%
Renal DS	31.0%	23.4%	n.s	28.3%
Diabetes	57.8%	53.1%	n.s	56.1%
Any Heart DS	53.4%	46.9%	n.s	51.1%
Cardiovascular DS	31.0%	39.1%	n.s	33.9%
Cancer	51.7%	50.0%	n.s	51.1%

NOTE: Chi-square statistics for comparison of various groups
c. $p < .05$

Table 4: Diagnoses: A Comparison between White and Black ESRD Patients

N=180	Ethnic Background		Significance p(Chi-square)	Total %
	White (116)	Black (64)		
Hypertension	47.4%	60.9%	n.s	52.2%
Renal DS	17.2%	9.4%	n.s	14.4%
Diabetes I	37.9%	42.2%	n.s	39.4%
Diabetes II	21.6%	20.3%	n.s	21.1%
Any Heart DS	15.5%	10.9%	n.s	13.9%
Cancer	6.0%	3.1%	n.s	4.6%

n.s = Chi-square Statistics not significant at $p < .05$.

- * almost 60% of the cases had a household annual income of less than \$14,999 compared to only about 40% of the controls.
- * almost one-half of the cases had worked as industrial laborers compared to 24.2% of the controls.
- * less than 60% of the cases lived in their own homes compared to 80.9% of the controls.

Differences in Health Risk Factors:

Table 5 presents a comparison between the cases and controls with a series of health risk factors including family disease history, using alcohol and smoking cigarettes, frequency of routine physical checkups, and diabetes and hypertension, the two major chronic conditions which are considered as major causes of ESRD.

Overall, the cases showed a high profile of unfavorable health risk factors.

More ESRD patients than the controls reported having immediate family members with hypertension (60% vs. 44.7%), diabetes (56.7% vs. 43.1%), and any kind of kidney disease (26.1% vs. 12.2%).

Substance use was tested by patterns of using alcohol and smoking cigarettes. Included were length and frequency of use, daily use, and current use. There were significant differences in the use of alcohol between the two groups. For instance, the cases reported much longer years of drinking history (averaged 19.5 years compared to 10.3 years in controls), more drinks per day than the controls (3 vs. 2), and drinking more frequently than the controls. But currently drinking showed otherwise: more controls than the cases were presently drinking alcohol. The percentages were 13.7% of the cases versus 40.1% of the controls.

There were no significant differences in smoking patterns between the two groups. About 58% of the cases and 56.1% of the controls had ever smoked at least 100 cigarettes during their lifetimes (both ex-smoking and current smoking status). The percentages of average years of smoking and average cigarettes smoked per day were identical between the two groups. The percentage of current smoking was slightly higher among the controls than the cases (33.7% of the cases vs. 39.2% of the controls).

**Table 5. Health Risk Factors of Study Population
(N=442)**

	Cases (n=180)	Controls (n=262)	Significance* p(Chi-square)
Family Disease History			
Family Hypertension	60.0%	44.7%	b
Family Diabetes	56.7%	43.1%	b
Family Cerebrovascular Diseases	33.9%	30.2%	n.s
Family Heart Disease	51.1%	50.4%	n.s
Family Renal Disease	26.1%	12.2%	a
Family Cancers	51.1%	55.7%	n.s
Using Alcohol			
Average Years of Drinking Alcohol	19.5	10.3	a*
Average Drinks per Day	3	2	n.s*
Frequency of Drinking			a
Every Day	21.8%	13.6%	
Several Times a Week	16.0%	8.4%	
Once a Week/Only on Weekend	29.4%	25.7%	
Occasionally	32.8%	52.4%	
Current Using Alcohol	13.7%	40.1%	a
Smoking Cigarettes			
Ever Smoked at least 100 Cigarettes in Life	57.8%	56.1%	n.s
Average Years of Smoking	26.2	23.2	n.s*
Average Cigarettes Smoked per Day	22.1	19.1	n.s*
Current Smoking Cigarettes	33.7%	39.2%	n.s
Overweight	60.6%	48.1%	b
Frequency of Routine Physical Check-ups			
Every Year	58.3%	79.6%	a
Every Other Year	3.4%	2.7%	
Every 3 to 5 Years	1.7%	1.5%	
No Regular Time	20.6%	7.7%	
Only Seeing a Doctor When Becomes Ill	16.0%	8.5%	
Diabetes	52.2%	18.3%	a
High Blood Cholesterol	40.0%	30.4%	a
Hypertension	89.9%	51.1%	a

NOTE: Chi-square statistics for comparison of patients and controls.

a. p<.001 b. p<.01 c. p<.05

*Two Tail T-test at .05 Level

There was a significant difference between the two groups in frequency of routine physical checkups. Almost 40% of the cases had not visited a doctor on a routine basis as compared to less than 20% among the controls. A higher percentage of cases than the controls reported that they had diabetes (52.2% vs. 18.3%). A greater majority of the cases (89.9%) had hypertension compared to 51.1% of the controls.

Multivariate Analysis:

Although the Chi-square tests revealed certain differences between the two groups, these tests only allowed analysis of one independent variable at one time, which could not identify the relationships between a set of risk factors and the disease outcome. Some questions still remained unanswered. Among them were: Are these risk factors independent of each other in causing ESRD? Do these risk factors act together to influence the probability of ESRD? And which of these risk factors were more likely to predict ESRD? These fundamental questions could only be answered by using a multivariate approach when controlling for all the other variables in the model. Therefore, a logistic regression model was selected in testing these questions. As Table 6 shows, 3 dimensions of independent variables were put into the equation, including subjects' demographic background (3 variables), family disease history (3 variables), risk factors of End-stage renal disease (6 variables).

Table 6 presents the results for the final logistic regression model. The odds ratios in column 4 indicate the association between the dependent and independent variables, as it approximates how likely the outcomes are to occur. Values greater than 1 mean that the odds of ESRD are increased and values less than 1 indicate a decrease in the odds of End-Stage Renal Disease. For example, the odds ratio for the subjects with heavy industrial occupations (2.16) can be interpreted as --- they were 100.16% more likely than those who did not have these occupations to develop such a disease.

First, the model Chi-Square significantly improved the ability to predict the likelihood of ESRD (Chi-Square = 82.81; $p < .01$). Second, when controlling for all the other variables in the model, 7 out of 12 independent variables significantly combined together in predicting the increase of the risk of ESRD. Household income, individuals with hypertension and diabetes, frequency of drinking, and routine physical checkups were especially important. In terms of occupation, the odds ratio was calculated with management as a reference group. The result showed that industrial employment increased the relative risk of ESRD (odds ratio=2.16; $p < .01$).

Table 6. Logistic Regression Model Predicting the Likelihood of ESRD among the Study Group (N=442)

Predictors	Coefficient	S.E	Odds Ratio
EDUCATION			
Less than High School	.19	.28	1.21
High School Graduate	.24	.26	.78
OCCUPATION			
Professional	.08	.47	.92
Technical & Engineering	.59	.69	.54
Sales	1.01	.67	.36
Clerk/Secretary/Service	.26	.40	.77
Industry Labor	.77*	.35	2.16
HOUSEHOLD ANNUAL INCOME			
	.34	.09	.71
FAMILY HISTORY			
Diabetes	.11	.40	1.11
Hypertension	.76	.39	.46
Renal Disease	.82	.47	.43
DIAGNOSIS			
Hypertension	2.16**	.51	8.68
High Blood Cholesterol	.21	.39	.80
Diabetes	1.69**	.42	5.45
FREQUENCY OF DRINKING			
Every Day	1.79**	.63	6.05
Several Times a Week	.45	.54	1.56
Once a Week	.22	.51	.80
Several Times a Month	2.20	1.67	.11
ROUTINE PHYSICAL CHECK-UPS			
	.60**	.13	1.82
OVERWEIGHT			
	.87*	.40	2.40
Model Chi-Square			
	82.81	20	

*p<.05

**p<.01

Individuals who suffered from hypertension increased the chance of ESRD (odds ratio=8.68;p<.01;). Diabetic patients were more likely to develop ESRD (odds ratio=5.45;p<.5.45). Compared to those who only drank occasionally, individuals who used alcohol every day were 6 times more likely to increase the chance of ESRD (odds ratio=6.05;p<.01). Those who did not go to a doctor for routine physical checkups increased ESRD risk (odd ratio=1.82;p<.01). Risk of ESRD was also increased with overweight (odds ratio=2.40;p<.05). Other significant variables were annual household income (odds ratio=.71;p<.05) and a family history of hypertension (odds ratio=.46;p<.46). Following these factors was individuals with diabetes (odds ratio=.27;p<.27).

The outcomes from the regression analyses were as expected. The correlation revealed that each these 12 variables in Table 2 was significantly related to the outcome variable when testing each single independent with the dependent variable. However, when controlling for other variables by a logistic regression model, 4 of these independent variables, education, a family history of diabetes or renal disease, and high blood cholesterol, reduced their significance. Because the 8 factors -- occupation, annual household income, routine physical checkups, family hypertension history, diagnosis with hypertension or diabetes, frequency of drinking, and overweight -- were stronger indicators resulting in End-Stage Renal Disease.

SUMMARY

The primary goals of this study were to examine factors contributing to the high rates of ESRD in Muskegon County. This was accomplished by examining the significant differences between ESRD patients and controls who were not ESRD patients in terms of various dimensions of health risk factors and demographic characteristics.

A general profile of ESRD patients described them as older, with hypertensive ESRD, diabetic ESRD, and inflammation of kidney (glomerulonephritis). Gender was about 50% for each. Besides those who were out-of-county residents (25%), patients mostly came from the 4 metro areas in which the majority of the population of the county was concentrated. Blacks were heavily over-represented among ESRD patients. Compared with White patients, Blacks had lower incomes, less insurance coverage, less access to care, and were more likely to have a family history of hypertension, and more likely to be diagnosed with hypertensive ESRD.

Differences between the two groups:

A case-control study on 180 ESRD patients was then matched with 242 controls who were same sex, same ethnic background, similar age (± 5 years), and resided in the same community of Muskegon County.

1. Demographically, ESRD patients in the study were less educated. Only 26.7% had graduated from high school compared to 40% of the controls. About 60% of the patients had an annual income of less than \$14,999 compared to about 40% of the controls. Almost one-half of the patients were industrial workers compared with 24.2% of the controls.
2. Health risk behaviors: The two groups also showed statistically significant differences in a number of health risk factors.

More ESRD patients reported that they had immediate family members diagnosed with hypertension, diabetes, and kidney diseases.

The magnitude of alcohol consumption was greater among the ESRD patients than the controls in terms of the length of drinking history, frequency of drinking, and quantity of drinks per day. “Currently drinking” showed a higher percentage among the controls than among the cases.

Although the percentage of cases showed a slightly higher percentage on certain aspects of smoking cigarettes, there were no significant differences between the two groups in terms of “ever smoking cigarettes,” duration of smoking, and the frequency of smoking. However, current smoking among the controls was slightly higher than among the cases.

The cases were more likely to report having overweight problems.

Frequency of medical checkups was measured in terms of the frequency of routine physical checkups. The cases were more likely than the controls not to have visited a doctor for routine physical checkups on a yearly basis.

Risk Factors Associated with ESRD:

With age, gender, ethnic, and location variables already matched between the cases and the controls, any observed remaining differences within the matched set could not be attributed to these variables since these variables were essentially constant within each set. Our attention was therefore focused on the other variables which would differentiate these two groups. When multivariate analysis was used to test the likelihood of ESRD incidence, 7 independent variables were significantly correlated with the outcome variable.

- a. Low family income was correlated with ESRD. Also those who were industrial workers, were as twice as likely to have ESRD as individuals who had management or professional jobs.
- b. Health risk behaviors: Relative ESRD risk was increased with being overweight, drinking frequently, and having fewer physical checkups
- c. Diagnoses: Risk of ESRD was also increased with a diagnosis of diabetes or hypertension.

DISCUSSION and IMPLICATION

When ESRD was used as the outcome, a significant association between a complex of many factors with ESRD was apparent. Included were age, ethnic background, occupation, income, the diagnosis of diabetes or hypertension, and routine physical checkups. The most important findings from this study **high-lighted the multi-causal factors** which could be associated with the probability of experiencing ESRD.

But first we must put the development of public health in perspective. Much of the progress has involved understanding and conquering infectious diseases arising from fairly specific and controllable biological causes. For instance, a parasite may infect a human host with a parasitic disease. Tuberculous bacteria may cause tuberculosis. However, today's world no longer suffers the traditional pattern of early death and high infant mortality from infectious diseases. Rather, the disease pattern has shifted to one of increased life expectancy with so-called chronic diseases. Heart disease, cancer, stroke, diabetes, hypertension, and other physical chronic conditions have become prominent. ESRD, as one of these chronic diseases, results from a

complex combination of factors.

It is not yet known exactly how these factors directly or indirectly caused ESRD, but they are statistically associated with the risk of ESRD. These multi-causal factors for ESRD serve as the conceptual basis for epidemiologic investigations and policy development.

Therefore in trying to make sense of this pattern of significantly associated factors, it may be helpful to discuss these variables particularly with an eye on relevance to public health policy. Some variables are amenable to individually focused education, like health risk behaviors, while others are “givens” which cannot be changed but need to be understood like family disease history. Still others, like occupation, seem to call for governmental action outside of public health, as well as within it. Some can be more readily understood as immediate “medical” “trigger” causes like diabetes and hypertension, although even here prevention and treatment are not solely a doctor’s responsibility. That is, ESRD has no one cause, least of all a discoverable killer germ. There seem to be many routes into this condition.

Race: The present study showed that Blacks were over-represented in the ESRD population. A number of risk factors, such as socio-economic status, diagnosis of hypertension or diabetes, and access to care, were all related to the greater risk for ESRD among Blacks. The results of the present study were supported by the other findings as well. The most consistent findings from epidemiologic research on the racial disparity was the high level of hypertensive ESRD among African Americans (Sugimoto & Rosansky, 1984; Livingston, 1993). It has been suggested that most of this high incidence among blacks has been attributed to the prevalence of “primary hypertension” among this population. Freedman (1993) suggested a family history of hypertension might explain some of the greater risk of ESRD in African Americans. The presence of a first-degree relative was associated with increased risk of ESRD. Klag (1997), however, suggested hypertension that and lower socio-economic status were stronger predictors than ethnic background. His study found that higher blood pressure and lower socio-economic are associated with a higher incidence of ESRD in both African American and White men. Among African Americans, hypertensive ESRD tended to be the most significant underlying cause of ESRD.

Among the estimated 60 million hypertensives in the U.S., African Americans represented a disproportionately higher number compared with White Americans. The severity of the disease, with resultant organ damage, is reported also to be greater among African

Americans than white Americans (Weir & Heise, 1991). Mortality from hypertensive disease was 6-13 times higher for Blacks than for Whites. The cause of death was not hypertension, but the resultant organ damage. The logical conclusion is that given the generally poorer socio-economic status of African Americans, effective treatment of their hypertension was inhibited by socio-economic and psychological factors. For instance, access to care, medical insurance coverage, cost of treatment, and education deficits all play a role in disease management and control.

Occupational Factor: One of the findings from the present study was the correlation between occupation and ESRD. The ESRD patients were more likely to report that they worked in heavy industrial jobs than did the controls. Included in the tests were education and income indicators, all together might present a real phenomenon. That is, ESRD patients were at a lower socio-economic status than those without such a disease. In terms of occupational factor itself, this study couldn't examine directly how these patients had been exposed to possible occupational toxins. However, in light of Muskegon's history of a heavy concentration of foundries, findings from this study may suggest that the occupational exposure might have had some influence on the high level of ESRD in Muskegon. Individuals with lower levels of education tend to seek employment in this type of heavy industry.

Waxweiler (1981) indicated that acute exposures to heavy metals, solvents and silica may play a role in chronic renal disease. Steenland et al (1990) examined occupational variable in their case-control study of 325 men with ESRD. They found a correlation between regular occupational exposures to solvents or silica and the occurrence of ESRD. Particular occupational exposures with elevated risk included solvents, used as cleaning agents and degreasers, silica exposure in foundries, brick factories, or sandblasting. While there is little existing research supporting occupational exposure theses, a few reached a similar conclusion. The correlation between occupational exposures and ESRD in Muskegon County needs further investigation.

Socio-economic factors: from a sociological perspective, the concept of socio-economic status (SES) is usually defined in terms of education, income and occupation, which were significantly correlated with a high incidence of ESRD in this study. This finding corroborated Rosland's (1992) observation that there was a strong positive association between SES and ESRD. His study suggested SES might influence medical care seeking behaviors. Individuals with a low SES experienced difficulties in access to the medical care system. A report from Brancati et al (1993) also indicated that ESRD rates varied with racial composition of

neighborhoods as defined by zip code within a single city. McClellan (1993) examined features of the counties associated with high ESRD rates. After controlling for age and race effects, they found a strong association with measures of poverty and lower socio-economic status.

The correlation between ESRD and SES suggested a greater risk for ESRD in lower socio-economic groups. Probably due to low-educational and economic status and different health care seeking behaviors, patients in these groups might have had difficulties in accessing the medical care system, getting physical checkups routinely, and purchasing expensive medications necessary to control chronic conditions. The mechanism of this link was partially revealed by our finding that the poor had less access to medical care, hence probably neglected their chronic symptoms until they may have been difficult or impossible to cure.

Health risk behaviors: Certain life styles were increasingly recognized as triggers in developing certain chronic diseases. The present study showed the ESRD patients reporting excessive health risk behaviors, such as problems as being overweight and drinking alcohol. A convincing body of epidemiologic research showed the following evidence: an inverse association between physical activity and the incidence of coronary heart disease (Haapanen at al., 1996); obesity and body fat distribution as independent risk factors for a number of chronic diseases (Ducimetiere, 1986); improper diet caused colon cancer (Willett, 1989). Many chronic diseases, coronary heart disease, ESRD, and much diabetes can be considered diseases of substance usage, uncontrolled blood pressure, and other unhealthy lifestyles (Stolley, 1995).

In this sense, “individuals are their own enemies and their behaviors are the main cause of mortality” (Kraus, 1997). In some ways this is good news because it suggests that these diseases can be controlled by making lifestyle changes. People can adopt healthier habits and life-styles, reducing their known risk factors. People must want to change, no one can change for them. That relies on individuals’ awareness and knowledge of their health problems and their beliefs about their susceptibility to health problems, and the benefits and costs of any behavioral change.

Diagnosis: The two primary diagnoses for treated ESRD patients in the current study were diabetes (65%) and hypertension (52.2%). We were cautious when using the diagnoses as references. For example, some physicians might have classified a patient as nephrosclerotic on the basis of high blood pressure at the time of diagnosis, without clarifying whether the high blood pressure occurred prior to, or following, the kidney disease. (We are not so confident that

the diagnosis in the patients medical records was sufficiently accurate to allow us to divide the data into the principal diagnostic groups.)

The high percentages of diabetes and hypertension, as the two major causes of ESRD patients in Muskegon County, seemed to fit with the general ESRD profile in the state. That is, diabetes continues to be the most common immediate cause of treated ESRD, accounting for about 35% of new cases for each year (ESRD Network 11). Hypertension was the second most common reported cause of ESRD with rates that are increasing by 9.1% per year according to the U.S. Renal Data System's report.

Muskegon County patients suffered much higher rates of diabetes as a primary cause of ESRD compared to the state (about 20% higher than the state, Figure 2). The high percentage of diabetes was also documented in The 1996 Muskegon Behavioral Risk Factor Survey (Hembroff, 1997). It indicated higher rates of diabetes among Muskegon's general population than that of the state (8.4% vs. 5.4%).

RECOMMENDATIONS

Because it is known that certain conditions or multi-factors increase the probability of ESRD, it is reasoned that greater efforts should be placed on prevention and control. The devastating consequences of ESRD underscore the importance of the need for more aggressive and effective efforts in the entire community. Primary prevention, which involves preventing ESRD from occurring, is clearly the best and most desirable approach to take. It is suggested that there are two main approaches of preventing ESRD: the general population and the high-risk population. The former focuses on reducing risk factor levels in the population as a whole, while the latter aims to reduce the risk for individuals identified as being at high risk.

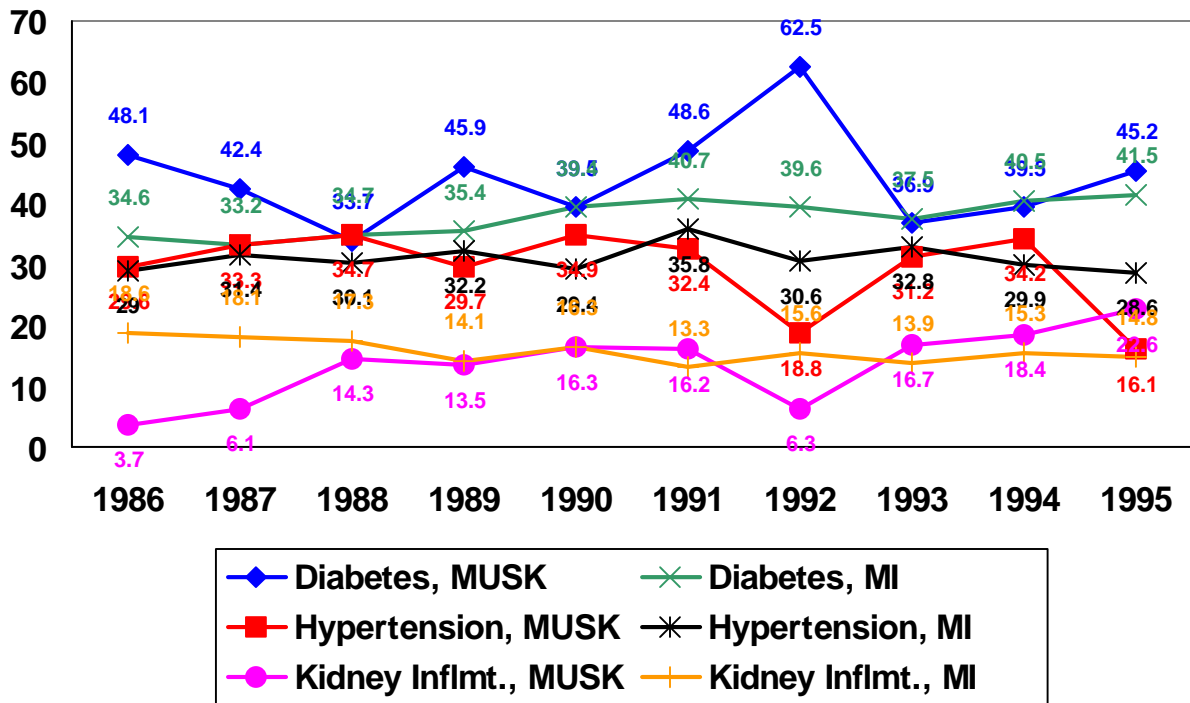
1. Population Health Education

Health education is usually the principal intervention method, the objective being to persuade people to change behaviors related to ESRD risk. Because mass diseases require a general population approach for their control, a mass or population approach needs to take place with the aim of risk reduction in the whole population. This requires shifting the population

**Figure 2.
Primary Causes of ESRD
(1986-1995)**

A Comparison between Michigan and Muskegon

	Muskegon	MI
Diabetes	44.3%	37.9%
Hypertension	29.5%	31.0%
Kidney DS	13.4%	15.9%



Data Source: ESRD Network 11.

distribution of the determinants of ESRD in a favorable direction. That involves primary care, especially regarding lifestyle change which could prevent or slow the progression of ESRD.

The general population approach can involve action within a wide variety of settings --- primary health care, schools, workplaces, churches, and different organizations --- are just a few of the many existing in our local community. It is important to blend the resources of the public health practice and the community. Health education is a fundamental piece in the population approach, the aim being to persuade people to change behavior related to ESRD. Various educational methods are needed to reach out to the community in terms of changing unfavorable health behaviors, such as poor eating habits or sedentary life-style. It is also essential to educate the public about the importance of detection and treatment of hypertension and diabetes. An education program should also target primary providers, since management of uncomplicated diabetes and hypertension is provided through primary health care. To be included are public health nurses, nurse assistants, or anyone who is frequently involved with medical care.

2. Identifying and dealing with high-risk groups

Special emphasis needs to be placed on the proper identification of people at risk. Risk factors include: individuals with ESRD report family histories of hypertension, diabetes, and renal failure. Screening these families may be a means to identify individuals with latent renal disease. Individuals who have a long duration of diabetes and young age at diagnosis should be included. Those many of these risk factors need comprehensive evaluation and appropriate interventions for primary and secondary prevention.

For example, African Americans are disproportionately represented in the ESRD population. Frequent screening, therefore, needs to be carried in at risk black communities. Aggressive health education messages should be tailored in culturally sensitive and specific styles, and conveyed, not only through the conventional channels, e.g. Health Department or Hospital, but also through black or minority organizations, such as HealthCARE and the Urban League of Greater Muskegon. These methods of screening and education are considered as an alternative model to serve African Americans in the community. Since the prevalence of ESRD is negatively associated with socio-economic status, those in the lower socio-economic groups should be targeted more specifically.

Both the population approach and the high risk or individual approach are complementary. The population approach is aimed at changes in the mean risk levels for the whole population. It has the greatest potential for saving the most lives. The individual approach that identifies and manages certain individuals at high risk clearly increases their chances of a longer and healthier life.

BIBLIOGRAPHY

- National Kidney Foundation
1995 American Journal of Kidney Disease, Vol 26, No 4.
- Brancati, FL., Whelton, PK, Whittle, JC, & Klag, MJ
1993 "Epidemiologic Analysis of Existing Data to Investigate Hypertensive Renal Disease: An Example from the Maryland End-Stage Renal Disease Registry," American Journal of Kidney Disease, 21:15-24
- Churchill, J.; Fine, A.; Gault, M.
1983 "Association between hydrocarbon exposure and Glomerulonephritis," Nephronology, pp. 169-172.
- Finn R., Fennery, A.; & Ahmad, R.
1980 "Hydrocarbon Exposure and Glomerulonephritis," Clinical Nephrology, 4(4):173-175.
- Freedman, B.I; Spray, BJ. Tuttle, AB; Buckalew VM Jr.
1993 "The Familial Risk of End-stage Renal Disease in African Americans," American Journal of Kidney Disease, 21:387-393.
- Hembroff, L.A.
1997 Muskegon County Behavioral Risk Factor Survey, The Survey Research Division of the Institute for Public Policy and Social Research, Michigan State University
- Kraus, K. A.
1997 Implications of Behavioral Risk Factor Survey, Presentation at BRFS Data Releasing Conference. April 23, 1997.
- Klag, M., Whelton, P., Randall, B., Neaton, J., Brancati, F., & Stamier, J.
1997 "End-stage Renal Disease in African-American and White Men," JAMA, Vol. 277, No, 16, p1293-1298
- McClellan, W.M.
1993 "The Epidemic of End-Stage Renal Disease in the United States: A Public Health Perspective on ESRD Prevention," AKF Nephrology Letter, Vol 10:29-40.
- Miettinen, OS.
1985 "The Case-control" Study: Valid Selection of Subjects," Journal of Chronic Disease, 38:543-548.
- Rothman, KJN
1981 "Induction and Latent Periods," American Journal of Epidemiology, 144:253-259.

- Stolley, P.D. & Lasky, T.
1995 Investigating Disease Patterns: The Science of Epidemiology, Scientific American Library, New York.
- Sugimoto, T. & Rosansky SJ
1984 “The Incidence of Treated End-stage Renal Disease in the Eastern United States: 1973-79,” American Journal of Public Health, 74:14-17.
- Steenland, N.K.; Thun, M.J.; Ferguson, C.W.; & Port, F.K
1990 “Occupational and Other Exposures Associated with Male End-Stage Renal Disease: A Case/Control Study,” AJPH, Vol. 80, No.2
- Waxweiler, R. Roscoe, R, & Archer, V.
1981 “Mortality Follow-up through 1977 of the White Underground Miners Cohort Examined by the US Public Health Service,” In Gomez, M (ed): Radiation Hazards in Mining. New York: Society of Mining Engineers.
- Weir, M.R. & Heise, M.K.
1991 “Hypertensive Renal Disease,” in Cardiovascular Diseases in Blacks, (Edited by Saunders E.). Davis, Philadelphia.