ANALYZING THE ASSOCIATION BETWEEN SOCIOECONOMIC FACTORS AND HOSPITAL READMISSION RATES IN CALIFORNIA

by

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ABSTRACT

Background: The Affordable Care Act (ACA) established the Hospital Readmissions Reduction Program in which hospitals receive up to a 1% reimbursement penalty for excessive 30-day readmission rates in acute myocardial infarctions (AMI), heart failure (HF), and pneumonia (PN). Many hospitals have voiced their concerns that the penalty disproportionately affects hospitals serving large, socioeconomically disadvantaged populations.

Objective: To determine the bivariate associations between hospital readmission rates for AMI, HF, and PN, and three socioeconomic factors: education, poverty, and income.

Design and Setting: This study involved a cross-sectional analysis of FY13 Medicare Provider Analysis and Review (MedPAR) files for California hospitals in the Hospital Readmissions Reduction Program.

Population: California acute care hospitals (n=191) with reported AMI, HF, or PN 30-day readmission rates for Medicare beneficiaries between 2008 to 2011.

Analysis: Each socioeconomic factor was categorized by bed size (Small=$X<218$, Large=$X\geq218$), and then each category was divided into quartiles. A t-test comparing the top 25% to the bottom 25% was conducted, along with a general linearized model (GLM). Three analyses were conducted: an unadjusted association between readmission rate and socioeconomic factor, an association adjusted for hospital size and geographic classification, and an association adjusted for hospital size, geographic classification, and DSH payment.

Results: Poverty and income showed statistically significant results for all three quality measures, while education only showed significant results for large hospitals for AMI and HF, and both large and small hospitals for PN. All quality measures showed greater associations as the association was adjusted for the covariates.

Limitations: This analysis only includes California hospitals, and has limited granularity due to the use of hospital-level and county-level data sets.

Conclusion: The association between readmissions and poverty and readmissions and income showed significant associations for all three quality measures, especially after adjusting for the covariates.

Public Health Significance: As the Centers for Medicare and Medicaid Services (CMS) increases the readmission penalty in future years, it is important to continually revise the penalty methodology to exclude factors outside of a hospital's control in order to avoid unintended consequences that may widen health disparities by discouraging hospitals from serving socioeconomically disadvantaged populations.

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1.0 INTRODUCTION

While the cost of healthcare has increased substantially in the United States over the last fifty years, health outcomes have not.[10] In 1970, the US spent $75 billion dollars on healthcare, and by 2010, these costs had soared to $2.6 trillion dollars.[10] While the ramifications of excessive US spending in healthcare affect most of the public, the cost of healthcare is disproportionately shared with only 5% of the population responsible for nearly half of the total costs of healthcare.[10] In particular, adults over 65 cost three times more on average than other age groups, and 40% of the top 10% of healthcare spenders are 65 and older, making Medicare a significant topic of interest in the pursuit to decrease the cost of healthcare.[10]

In 2012, $556 billion (21% of the total national health care spending) went to Medicare to cover 50 million elderly and disabled Americans.[9] Approximately two-thirds of that cost went to hospital procedures.[9] Over the next 10 years, as the US population continues to age and the volume, price, and use of healthcare services continues to increase, the proportion of spending for Medicare is expected to double from $560 billion in 2011 to $1.1 trillion by 2022, increasing the share of Medicare spending in the federal budget from 15.4% to 19.3%.[9]

In 2012, the Affordable Care Act (ACA) was passed by Congress. Of the many significant changes for healthcare included in the Act, the ACA also included plans for significant cuts to Medicare spending over the next 10 years, largely due to the huge inefficiencies in the current system.[4] The Kaiser Family Foundation currently estimates that more than 20% of total healthcare expenditures are due to healthcare errors and waste.[10] Factors such as overtreatment, fraud and abuse, gaps in care coordination, administration, and pricing failures all contribute to unnecessary healthcare costs.[10] Preventing these unnecessary costs could avoid $600 to $850 billion dollars in healthcare waste each year.[10] With the looming cuts to Medicare on the horizon, hospitals are now desperate to find new ways of improving care while cutting costs in order to provide the same quality of care to its beneficiaries using fewer future resources.[3]

One area of improvement that has received significant attention within the last few years is reducing hospital readmissions. Although some readmissions are unavoidable "planned" readmissions, a significant proportion of readmitted patients are considered "preventable". According to the Centers for Medicare and Medicaid Services (CMS), an estimated 1 in 5 Medicare patients are readmitted within 30 days of a hospital discharge.[12] National 30-day readmission rates for Medicare patients range from 15-25%, and CMS estimates that readmissions cost hospitals about $17 billion dollars in healthcare spending each year.[5,11]

The passage of the ACA implemented Section 3025: the Hospital Readmissions Reduction Program in October of 2012, which penalizes hospitals with excessive readmission rates in the hopes of lowering readmission rates. However, many hospitals have argued that the readmissions penalty methodology should be adjusted for factors that are considered outside of a hospital's control, such as socioeconomic factors, in order to exclude for factors that a hospital cannot control, and allow hospitals to focus on factors within its control.

In this paper, the associations between hospital readmission rates and three socioeconomic factors: poverty, income, and education, are explored for acute care hospitals in California to determine whether the evidence supports the argument that a socioeconomic adjustment factor is necessary in the Hospital Readmissions Reduction Program.

2.0 BACKGROUND

While the Hospital Readmissions Reduction program was developed out of a need to improve healthcare efficiency and reduce waste, one of the main criticisms of the program is that it does not adjust for the socioeconomic status of a hospital's patient population. Although the Center for Medicare and Medicaid Services (CMS) did not decide to include any adjustments during the initial release of the program, adjustment factors may be included in future revisions should the evidence indicate that adjustment factors may be necessary. While reducing readmissions is important to improving Medicare's efficiency, it is vital to also avoid any potential unintended consequences to its beneficiaries.

In Section 3025 of the Affordable Care Act (ACA), CMS created the Hospital Readmissions Reduction Program, designed to penalize hospitals with high 30-day readmission rates in order to avoid unnecessary costs and adverse events while incentivizing hospitals to deliver proper healthcare the first time a patient is admitted.[2] Starting on October 1, 2012, hospitals received up to a 1% reimbursement penalty for excess readmission rates in three quality measures: AMI, HF, and PN. Out of 3,104 participating hospitals, 2,217 experienced penalties, 307 hospitals received the full 1% penalty, and more than $280 million dollars were withheld from reimbursement.[14] With penalties expected to increase to 2% in FY2014 and 3% in FY2015 and beyond, readmissions has become a spotlight issue in hospitals.[3]

A readmission, as defined by the Hospital Readmissions Reduction Program, involves any individual discharged from a hospital to a non-acute setting, who is then admitted to the same or another acute care hospital within 30 days of discharge.[2] The readmissions measures are chosen by the Secretary of Health and Human Services and currently only include three measures[2] These three measures are endorsed by the National Quality Forum (NQF) and were chosen out of seven measures shown to be associated with 30% of potentially preventable readmissions, HF and PN being the top two most frequently diagnosed categories for total admissions and readmissions.[2] For FY2013, readmission penalties were calculated using hospital discharge data from July 1, 2008 through June 30, 2011. The readmission payment adjustment factor is calculated by taking the ratio of the number of predicted readmissions to the number of expected readmissions, multiplied by the national unadjusted readmission rate.[15] The methodology for calculating the "predicted" and "expected" number of readmissions for each hospital is specified in the 2012 Measures Maintenance Technical Report.[15] Only acute care hospitals are currently included in the readmissions penalty.[15] The data is obtained through principal discharge ICD-9-CM diagnosis codes and only includes patients over 65.[15] Hospitals must have a minimum of at least 25 discharges in each of the three measures to receive a readmissions penalty, but hospitals with less than 25 cases for measure can still participate in the program.[2] A 30-day readmissions period is utilized because this time frame is a generally accepted period that is considered to be highly influenced by factors under the hospital's control.[15] While the index admission must include HF, PN, or AMI, the readmission may be due to any cause, or an “all-cause readmission”.[15] AMI patients with planned readmissions are not included when calculating the penalty, but planned PN and HF readmissions are included.[15] AMI, HF, and PN are risk-adjusted for age, sex, comorbidities, and indicators of patient frailty for the 12 months prior to the index admission[15]. The full methodology for calculating the readmission penalties are currently available on QualityNet.org.[2]

Although readmissions reduction efforts have already begun, there is still a major debate over the actual percent of readmissions that are truly “avoidable” versus “expected”. Current estimates in the literature on the percentage of potentially avoidable hospital readmissions widely range from 5% to 79% due to the inclusion of so many different factors involved in the discharge process.[6] Some readmissions are unavoidable, especially for AMI patients, and these should ideally be excluded from the readmission penalties. Other patient-related factors, such as lack of family support, an inability to pay for medications, mental illness, or a lack of ability to care for oneself due to age or physical disability are also common factors for readmissions, but are factors the hospital should not be expected to handle. Factors that are under the hospital’s control include medication errors, lack of proper follow-up, and patient-related errors. Our ability to distinguish between variables that should be included and excluded from calculating readmissions will be key, not only from a research perspective by allowing the refinement of the definition of “avoidable readmissions”, but also from a policy perspective to ensure that we are measuring the correct factors when calculating readmissions.

One of the major criticisms of the Hospital Readmissions Reduction program regards the lack of a socioeconomic adjustment factor to calculate the reimbursement penalty. Many hospitals have argued that CMS should adjust for factors such as patient race, language, life circumstances, environmental factors, and socioeconomic status to avoid disproportionately hurting hospitals that serve large populations of patients in socioeconomically disadvantaged areas.[2] [12] Studies have shown that economically disadvantaged patients generally have a poorer overall health status, fewer community resources, and poorer access to primary care, all of which can significantly affect a hospital's readmission rates.[12], [6] Many of these hospitals already experience very limited resources and there is a major concern that further reducing their reimbursements may cause unintended adverse effects, such as causing hospitals to avoid serving socioeconomically disadvantaged patients to avoid readmission penalties, removing the financial means for hospitals to care for these patients, or even causing the main hospital serving a socioeconomically disadvantaged population to close which would further increase health disparities in that community.[12]

Despite a lot of criticism, CMS decided not to include a socioeconomic adjustment factor in the initial release of the Hospital Readmissions Reduction Program. CMS released the statement, "Since we believe that all hospitals should be working towards the goal of reducing readmissions on an ongoing basis, regardless of population, we believe that we do not need to postpone the implementation of the readmission payment adjustments in order to provide time to hospitals to implement readmission reduction programs."[7] The National Qualify Forum supported this decision by stating their desire to avoid hiding disparities in care by excluding the socioeconomic adjustment factor.[12] An article in JAMA by Kansagara succinctly summarizes the paradox of including an adjustment factor, and that "although the inclusion of such hospital level factors would conceivably improve the predictive ability of models, it would be inappropriate to include them in models that are used for risk-standardization purposes. Doing so would adjust hospital readmission rates for the very deficits in quality and efficiency that hospital comparison efforts seek to reveal, and which could be targets for quality improvement interventions."[6] Arguments against including a socioeconomic adjustment factor also include avoiding masking important disparities and minimizing incentives to improve outcomes for vulnerable populations. Risk-adjusting for the socioeconomic factors of a population would suggest that hospitals with low SES patients are held to different standards for patient outcomes than hospitals treating higher SES patient populations.[15]

Since the initial implementation of the Hospital Readmissions Reduction Program, additional research has been conducted that indicates current risk prediction models for hospital readmissions are in actuality quite poor and additional adjustments are necessary to make them effective tools in reducing readmissions.[6] In addition, a recent analysis by Kaiser Health News showed that 12% of hospitals serving the largest proportion of low-income patients received the maximum 1% penalty from CMS as compared to only 7% of hospitals serving the smallest proportion of low-income patients.[13] With the release of new evidence that not adjusting for the penalty may have a disproportionate effect on hospitals, it is necessary to conduct research on the association between socioeconomic factors and hospital readmission rates to determine whether the evidence supports the argument for the inclusion of a socioeconomic adjustment factor in the readmissions penalty methodology.

3.0 EXPECTED RESULTS

In exploring the possible inclusion of a factor to adjust for the socioeconomic demographics of a population, it is important to consider the hospital's disproportionate share hospital (DSH) payment, which is the current reimbursement adjustment given to hospitals to adjust for its proportion of low-income patients. Assuming that hospitals serving a larger proportion of low-income patients receive higher readmission rates, and because hospitals serving large proportions of low-income patients receive higher DSH payments, we would expect to see a positive correlation between hospitals with larger DSH payments and higher readmission rates. In regards to poverty, we expect for hospitals serving in communities with the highest poverty rates to obtain significantly higher readmission rates than communities with lower rates of poverty. In terms of income, we expect for hospitals in counties with higher median household incomes to have lower readmission rates. Lastly, we expect for communities that have the highest percentages of members with a bachelor's degree or higher to also observe lower readmission rates. In terms of the correlation between readmission rates and hospital size, we would expect for larger hospitals to receive higher readmission rates due to a higher capacity for admitting patients, which would also increase the chances of getting readmitted patients.

Following the discussion between the results of the analysis, recommendations for additional future research to continue exploring the association between readmission rates and socioeconomic factors will be presented.

4.0 METHODS

Study Design

The association between hospital readmission rates for AMI, HF, and PN, and three socioeconomic factors was determined in a cross-sectional analysis of California hospitals participating in the FY13 Hospital Readmissions Reduction Program. Hospital-level information on AMI, HF, and PN readmission rates, DSH payments, geographic classification, and hospital beds was obtained through CMS, and data on poverty, income, and education was obtained through county-level Census Bureau data. The data sets were merged to create a list of all hospitals within a given California county. All hospitals within that county utilized the same county-level socioeconomic statistics from the Census, but had hospital-level data on PAF, DSH, readmission rates for each measure, geographic classification, and number of hospital beds (Appendix I).

As shown in Table 1, each socioeconomic factor was first divided into two categories (Small = $X<218$, Large = $X \geq 218$), and then each category was split into quartiles. Three analyses were run for each category: 1. Without adjustments 2. Adjusting for geographic classification: rural or urban 3. Adjusting for geographic classification and DSH payments. A general linear model (GLM) was run for each analysis, and a t-test comparing the highest quartile of mean readmission rates to the lowest quartile of mean readmission rates was conducted.

Table 1. Analysis Summary

Analysis Summary							
Quality Measure	Socioeconomic Factor	Unadj.		Adj.		Adj. + DSH	
AMI	Poverty	Small	Large	Small	Large	Small	Large
	Income	Small	Large	Small	Large	Small	Large
	Education	Small	Large	Small	Large	Small	Large
HF	Poverty	Small	Large	Small	Large	Small	Large
	Income	Small	Large	Small	Large	Small	Large
	Education	Small	Large	Small	Large	Small	Large
PN	Poverty	Small	Large	Small	Large	Small	Large
	Income	Small	Large	Small	Large	Small	Large
	Education	Small	Large	Small	Large	Small	Large

AMI = Acute Myocardial Infarction

HF = Heart Failure

PN = Pneumonia

Poverty = People of All Ages in Poverty (%) 2007-2011

Income = Median Household Income, 2007-2011

Education = Educational Attainment, Bachelor's Degree or Higher in persons 25 or older (%), 2007-2011

Small = Number of Hospital Beds X<218

Large = Number of Hospital Beds X≥218

Unadj. = Unadjusted, measures the association between readmission rate and socioeconomic status.

Adj. = Measures the association between readmission rate and socioeconomic status, adjusted for hospital size and geographic classification

Adj. + DSH = Measures the association between readmission rate and socioeconomic status, adjusted for hospital size, geographic classification, and DSH payment

<u>Data Source</u>

The data for this analysis was acquired through publically reported data sets available online through CMS and the Census Bureau. Hospital-level data on the number of individual AMI, HF, and PN readmitted cases, discharged cases, readmissions payment adjustment factor (PAF), geographic classification (URGEO), hospital size (BEDS), and disproportionate share hospital (DSH) payment are listed by hospital provider ID through CMS Medicare Provider Analysis and Review (MedPAR) files. The following data sets were utilized: “FY 2013 Final Rule CN – IPPS

Impact File PUF-March 2013", and "FY2013 IPPS Finale Rule: Hospital Readmissions Reduction Program – Supplemental Data – Updated March 2013".

Data on socioeconomic factors was obtained through county-level data from the Census Bureau. The socioeconomic factors included in this analysis were education (EDU685211), income (INC110211), and poverty (PV020211).[1]

Study Population

Only 191 California acute care hospitals with reported readmission rates for AMI, HF, and PN, DSH payments, geographic classification, and hospital size were included in this analysis (Figure I). 118 hospitals were excluded from this study due to missing information in one or more categories. Out of 58 California counties, 13 did not list any hospitals and were excluded, leaving the remaining 45 to be included in this analysis. Data on hospital-level readmission rates were obtained through CMS MedPAR files for FY2013. These files capture all Medicare beneficiaries readmitted within 30-days for AMI, HF, or PN between July 2008 and June 2011, to a California acute care hospital. All measures are risk-adjusted for sex, age, and comorbidities. Hospitals receiving less than 25 cases for each measure are excluded from receiving a readmissions penalty. For the full methodology, please refer to the "2012 Measures Maintenance Technical Report: Acute Myocardial Infarction, Heart Failure, and Pneumonia 30-Day Risk-Standardized Readmission Measure" released by CMS.[15]

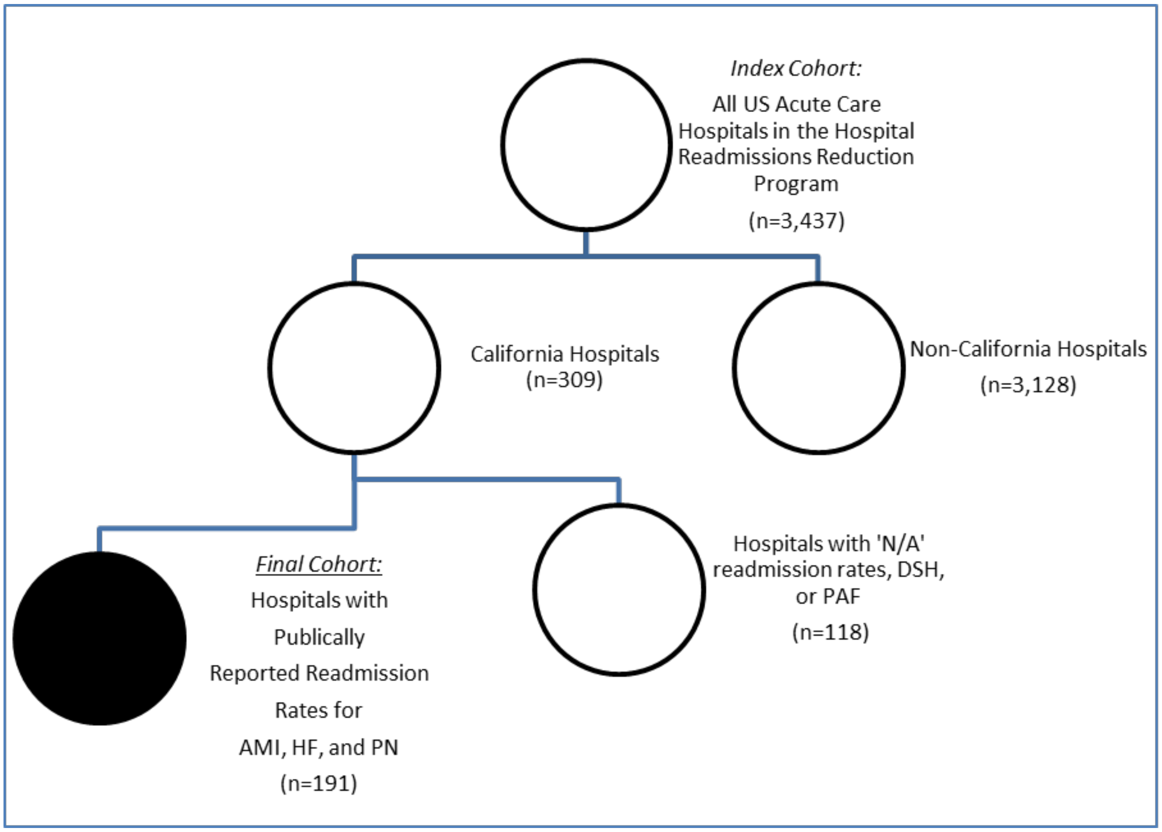


Figure 1. *Flow-Diagram of California Hospitals Included in the Analysis*

Outcomes Measures

The outcome measure for this study is individual hospital readmission rates for AMI, HF, and PN. All 30-day readmissions for AMI, HF, and PN for Medicare patients in California acute care hospitals between July 2008 and June 2011 were included except for planned AMI readmissions.

Key Independent Variables

The key independent variables for this study include county-level income, poverty, and education statistics from the Census Bureau. Income is calculated using county-level median household income. Poverty is calculated using the percent of all people in poverty. Education is measured by the percent of persons 25 and over with a bachelor's degree or higher. All independent variables utilized 2007-2011 Census data.

Covariates

In this study, the size of the hospital measured by the number of hospital beds, geographic classification of the hospital as urban or rural, and DSH payments were included as covariates.

<u>Statistical Analysis</u>

Statistical analysis for this study was performed using SAS version 9.3.

Before analyzing the data, univariate analysis was run on the following factors: individual and total readmission rates and discharges, payment adjustment factor (PAF), DSH payment, number of hospital beds, income, poverty, education, and geographic classification. We ran various Spearman correlations to explore the associations between each of our variables.

Analytic Model

A GLM model was run for each quality measure, adjusting for the three covariates. T-tests were conducted to compare the highest quartile to the lowest quartile of a quality measure with readmission rates as the outcome and the socioeconomic factor as the independent variable.

5.0 RESULTS

Since this analysis only focused on California hospitals in the readmissions reduction program, the demographics between California and the United States were first compared for generalizability. Table 2 compares the demographic characteristics of California's population with the US. The demographics of California's population appear to be generally comparable with the US for income, poverty, and the demographics of its Medicare beneficiaries. To note some differences, California has a larger percentage of Medicaid patients, and a different racial mix. California has a notably larger proportion of minorities, particularly Hispanics and Asians, which makes California a better cohort for analyzing the effects of socioeconomic factors.[8]

Table 2. Demographics of California vs. United States

Demographics: California vs. United States[8]				
	CA		US	
	Number	%	Number	%
Median Annual Income	$56,418		$50,022	
Population Living in Poverty	--	24%	--	20%
Uninsured Population	--	20%	--	16%
Medicaid Beneficiaries	--	30%	--	20%
CA Medicare Beneficiaries: General Demographics, 2011				
Total Beneficiaries*	5,000,198	13%	49,435,610	16%
Beneficiaries 65+	4,001,900	83%	39,132,700	82%
below FPL	4,737,000	--	49,918,700	--
Female	2,623,800	55%	25,985,500	55%
CA Medicare Beneficiaries: Race, 2011				
White	2,864,300	60%	36,268,500	77%
Black	329,100	7%	4,884,600	10%
Hispanic	901,600	19%	3,562,000	8%
Other	642,100	14%	2,203,600	5%
Total	4,737,00	100%	49,918,700	100%

*2012

Only hospitals that contained reported data on all three quality measures, DSH, geography, and hospital size were included in this study; all other hospitals were excluded. To ensure that the demographics of the excluded hospitals were not significantly different from the demographics of the included hospitals, a comparison between the two was conducted. 191 California acute care hospitals capturing 48 counties were included, while 118 California hospitals and 13 counties were excluded from the analysis, due to missing factors in one or more category in Table 3. The demographics of included and excluded hospitals seem very comparable for most of the variables. There is a noticeably higher mean number of hospital beds for included hospitals than excluded hospitals (242 vs. 137), which is likely due to larger hospitals having the resources to report data on readmissions to CMS. By sheer volume, more hospitals included in the study were urban, but since more than 97% of the hospitals were classified as “URBAN” the effect should be miniscule.

Table 3. Demographics Included vs. Excluded Variables

Included Variables

	Included Hospitals	Min	Q1	Median	Q3	Max	Mean	StDev	SE	N
Outcome Variables	AMI Discharges	25	61	135	234	599	159	117	8	191
	AMI Readmissions	2	13	27	42	124	30	22	2	191
	AMI Readmission Rate	0.0544	0.1592	0.1972	0.2333	0.4872	0.2033	0.0611	0.0044	191
	HF Discharges	31	196	349	482	1714	369	219	16	191
	HF Readmissions	7	47	82	121	428	90	56	4	191
	HF Readmission Rate	0.0986	0.2167	0.2436	0.2667	0.3548	0.2421	0.0412	0.0030	191
	PN Discharges	43	198	291	406	1146	308	171	12	191
	PN Readmissions	5	33	52	72	241	56	33	2	191
	PN Readmission Rate	0.0952	0.1566	0.1769	0.2040	0.3488	0.1829	0.0376	0.0027	191
Independent Variables	Payment Adjustment Factor	0.9900	0.9965	0.9988	1.0000	1.0000	0.9978	0.0027	0.0002	191
	PAF (Exclude PAF=1)	0.9900	0.9957	0.9978	0.9991	0.9999	0.9969	0.0027	0.0002	139
	Hospital Beds	47	122	218	321	856	242	142	10	191
	Poverty (%)	7	10.9	14.9	16.3	23.8	14	4	0	191
	Income	$37,588	$56,266	$57,920	$70,821	$89,605	$61,981	$11,884	$860	191
	Education (%)	12.30	24.00	29.20	36.20	54.00	29.79	9.18	0.66	191
	DSH	0.0397	0.2410	0.3586	0.5288	1.1936	0.3990	0.2149	0.0155	191

Table 3. Continued

Excluded Variables										
Excluded Hospitals		Min	Q1	Median	Q3	Max	Mean	StDev	SE	N
Outcome	AMI Readmission Rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
	HF Readmission Rate	0.115385	0.207547	0.244094	0.284314	0.38806	0.2517	0.0591	0.0073	65
	PN Readmission Rate	0.059702	0.1538462	0.179487	0.205084	0.34127	0.1809	0.0457	0.0055	68
	Total Readmission Rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Independent	PAF	0.9900	0.9988	1.0000	1.0000	1.0000	0.9990	0.0018	0.0002	120
	PAF (Exclude PAF=1)	0.9900	0.9972	0.9987	0.9995	0.9999	0.9979	0.0022	0.0003	58
	Beds	9	50	103.5	180	600	137	115	10	120
	Poverty (%)	7.00	11.25	15.60	16.30	23.40	14.73	3.92	0.35	128
	Income	$35,402	$53,764	$56,266	$69,914	$89,605	$60,215	$12,115	$1,071	128
	Education	12.3	19.5	29.2	34.2	54	28	10	1	128
	DSH	0.0000	0.0816	0.2942	0.6784	1.0161	0.3769	0.3160	0.0288	120

Geography			
	Geography		
	LURBAN	OURBAN	RURAL
Included	136	50	5
Excluded	80	35	5

Taking a look at the distribution of the number of readmissions for AMI, HF, and PN (Appendix II), it appears that HF and PN receive much higher readmissions by sheer volume than AMI. This is consistent with the literature as HF and PN are the two highest causes for readmissions. Because the distribution for number of readmissions in AMI, HF, and PN are not normally distributed, Spearman correlations were conducted instead of Pearson's. There is a strong correlation between the number of discharges for a hospital and the number of readmissions, which is also consistent with the literature that the utilization of a hospital is a strong predictor for its readmission rate (Appendix III). Looking at any correlations between the three quality measures, the correlation coefficients between AMI and HF (r=0.43532) and HF and PN (r=0.44554) are higher than the correlation between AMI and PN. Hospitals that serve more AMI patients are likely to also serve many HF patients due to a cardiovascular specialty or the patient population, and HF and PN show a strong correlation because they are the top two causes for readmissions (Appendix III).

Correlations were run between total readmission rates and the number of hospital beds to look for a correlation between larger hospitals receiving higher readmission rates. The correlation was r=0.03467, which indicates almost no correlation between the two factors. A correlation between total readmission rates and DSH payments were run with the expectation that hospitals receiving larger DSH payments, and therefore serving more socioeconomically disadvantaged patients, would receive higher readmission rates, and the correlation of r=0.38690 indicates this weak, positive correlation. Lastly a correlation between PAF and DSH were run with the expectation that hospitals receiving a smaller PAF, which indicates they received a larger readmissions penalty, would also receive a higher DSH payment. The negative correlation of r=-0.34380 supports this prediction.

Lastly, we explored the association between each of our socioeconomic factors, and obtained strong Spearman correlations between poverty and income (r=-0.94321), poverty and education (r=-0.78533), and income and education (r=0.87674) (Table 3).

Table 4. Spearman Correlation Coefficients

Measures	Spearman Coefficient
Total Readmission Rate vs. Number of Hospital Beds	R = 0.03467
Total Readmission Rate vs. DSH Payment	R = 0.38690
PAF vs. DSH Payment	R = - 0.34380

Table 4. Continued

	Income	Education	DSH	BEDS
Poverty	**-0.94321**	**-0.78533**	0.28369	0.01263
Income	X	**0.87674**	-0.2376	0.04392
Education	X	X	-0.18135	0.07038
DSH	X	X	X	0.17273
BEDS	X	X	X	X

	HF	PN
AMI	0.43532	0.30538
HF	X	0.44554
PN	X	X

For this analysis, GLM and t-tests were run on our outcome and independent variables, adjusted for the covariates. In general, the association between readmission rates and each socioeconomic factor became more significant when adjusted for each of the covariates (Table 5). All three quality measures showed significant associations between readmission rates and poverty, and readmission rates and income for both small and large hospitals (Table 5). Education only showed a significant association for large hospitals adjusted for hospital size, geography, and DSH payments for all three measures, and only PN showed a significant association for both large and small hospitals adjusted for all 3 covariates (Table 5).

Table 5. Readmission Rate Analysis Summary

AMI Readmission Rate Analysis							
		Level	**Mean**	**Std Dev**	**Unadjusted**	**Adjusted for Hospital Size and Geography**	**Adjusted for Hospital Size, Geography, and DSH**
POVERTY	Small	**1**	0.1837	0.0583	P-Value		
		2	0.2034	0.0743	0.0717	**0.0377**	**0.0492**
		3	0.2422	0.0323	F-Value		
		4	0.2311	0.0752	2.42	2.66	2.33
	Large	**1**	0.1709	0.0485	P-Value		
		2	0.1875	0.0518	**0.0282**	**0.0282**	**0.0015**
		3	0.1831	0.0237	F-Value		
		4	0.2084	0.0406	3.16	3.16	4.76
INCOME	Small	**1**	0.2192	0.0669	P-Value		
		2	0.2438	0.0784	**0.0248**	**0.0152**	**0.0240**
		3	0.1807	0.0447	F-Value		
		4	0.2153	0.0846	3.27	3.26	2.74
	Large	**1**	0.1969	0.0267	P-Value		
		2	0.2091	0.0419	**0.0413**	**0.0413**	**0.0019**
		3	0.1751	0.0575	F-Value		
		4	0.1846	0.0456	2.85	2.85	4.63
EDUCATION	Small	**1**	0.2211	0.0555	P-Value		
		2	0.2107	0.0846	0.8909	0.4358	0.3303
		3	0.2082	0.0792	F-Value		
		4	0.2193	0.0779	0.21	0.96	1.17
	Large	**1**	0.1921	0.0378	P-Value		
		2	0.1869	0.0226	0.7921	0.7921	**0.0061**
		3	0.1974	0.0516	F-Value		
		4	0.1865	0.0468	0.35	0.35	3.85

Table 5. Continued

HF Readmission Rate Analysis							
		Level	Mean	Std Dev	Unadjusted	Adjusted for Hospital Size and Geography	Adjusted for Hospital Size, Geography, and DSH
POVERTY	Small	**18**	0.2219	0.0485	P-Value		
		27	0.2486	0.0457	0.2121	0.0723	**0.0381**
		5	0.2377	0.0358	F-Value		
		43	0.2500	0.0525	1.53	2.23	2.47
	Large	**16**	0.2192	0.0242	P-Value		
		33	0.2345	0.0288	**<.0001**	**<.0001**	**<.0001**
		10	0.2327	0.0295	F-Value		
		39	0.2569	0.0294	8.05	8.05	10.30
INCOME	Small	**25**	0.2344	0.0472	P-Value		
		23	0.2685	0.0395	**0.0008**	**0.0007**	**0.0008**
		24	0.2162	0.0539	F-Value		
		21	0.2581	0.0405	6.15	5.29	4.69
	Large	**14**	0.2460	0.0358	P-Value		
		33	0.2576	0.0241	**0.0003**	**0.0003**	**<.0001**
		20	0.2272	0.0371	F-Value		
		31	0.2292	0.0235	**7.05**	**7.05**	**9.55**
EDUCATION	Small	**27**	0.2429	0.0465	P-Value		
		6	0.2356	0.0528	0.9799	0.4289	0.1195
		40	0.2442	0.0494	F-Value		
		20	0.2453	0.0564	0.06	0.97	1.81
	Large	**20**	0.2386	0.0369	P-Value		
		5	0.2392	0.0204	0.0544	0.0544	**<.0001**
		45	0.2493	0.0323	F-Value		
		28	0.2288	0.0233	2.63	2.63	7.90

Table 5. Continued

PN Readmission Rate Analysis							
		Level	**Mean**	**Std Dev**	**Unadjusted**	**Adjusted for Hospital Size and Geography**	**Adjusted for Hospital Size, Geography, and DSH**
POVERTY	Small	**1**	0.1702	0.0389	P-Value		
		2	0.1716	0.0288	0.1073	0.0546	**0.0294**
		3	0.2012	0.0318	F-Value		
		4	0.1889	0.0434	2.09	2.42	2.62
	Large	**1**	0.1599	0.0219	P-Value		
		2	0.1770	0.0310	**0.0001**	**0.0001**	**<.0001**
		3	0.1790	0.0288	F-Value		
		4	0.2029	0.0392	7.58	7.58	7.07
INCOME	Small	**1**	0.1891	0.0398	P-Value		
		2	0.1915	0.0455	0.1264	**0.0379**	**0.0201**
		3	0.1712	0.0358	F-Value		
		4	0.1708	0.0299	**1.96**	**2.66**	**2.84**
	Large	**1**	0.1872	0.0338	P-Value		
		2	0.2052	0.0389	**0.0002**	**0.0002**	**<.0001**
		3	0.1683	0.0294	F-Value		
		4	0.1724	0.0290	7.16	7.16	6.84
EDUCATION	Small	**1**	0.1936	0.0330	P-Value		
		2	0.1682	0.0573	0.2287	0.0752	**0.0223**
		3	0.1775	0.0430	F-Value		
		4	0.1745	0.0292	**1.47**	**2.20**	**2.78**
	Large	**1**	0.1829	0.0317	P-Value		
		2	0.1765	0.0051	0.0764	0.0764	**0.0022**
		3	0.1943	0.0412	F-Value		
		4	0.1721	0.0309	2.36	2.36	4.53

Lastly, a t-test was run to compare the mean AMI, HF, and PN readmission rate of the top quartile of a socioeconomic factor with the lowest quartile. Poverty observed significant differences for AMI and HF readmission rates in both large and small hospitals while only large hospitals showed a significant p-value for PN readmission rates (Table 6). Income did not show any statistically significant difference for all three measures in large and small hospitals, and neither did education except for PN readmission rates for small hospitals (Table 6).

Table 6. T-Tests

AMI Readmission Rate Analysis								
Poverty			**N**	**Mean**	**SE**	**95% CI**	**P-value**	**F-Value**
Small	1	X < 10.9	18	0.1837	0.0138	(0.1547-0.2127)	**0.0203**	1.66
	4	16.3 > X	43	0.2311	0.0115	(0.2079-0.2542)		
Large	1	X < 10.9	16	0.1709	0.0121	(0.1450-0.1967)	**0.0048**	1.43
	4	16.3 > X	39	0.2084	0.00649	(0.1953-0.2216)		
Income			**N**	**Mean**	**SE**	**95% CI**	**P-value**	**F-Value**
Small	1	X < $56,266	25	0.2192	0.0134	(0.1916-0.2468)	0.8616	1.6
	4	$70,821 > X	21	0.2153	0.0185	(0.1768-0.2538)		
Large	1	X < $56,266	14	0.1969	0.00713	(0.1815-0.2123)	0.3547	2.92
	4	$70,821 > X	31	0.1846	0.00819	(0.1679-0.2013)		
Education			**N**	**Mean**	**SE**	**95% CI**	**P-value**	**F-Value**
Small	1	X < 24%	27	0.2211	0.0107	(0.1991-0.2430)	0.9291	1.98
	4	36.2% > X	20	0.2193	0.0174	(0.1829-0.2558)		
Large	1	X < 24%	20	0.1921	0.00845	(0.1744-0.2098)	0.6604	1.54
	4	36.2% > X	28	0.1865	0.00885	(0.1683-0.2046)		

Table 6. Continued

HF Readmission Rate Analysis								
Poverty			N	Mean	SE	95% CI	P-value	F-Value
Small	1	X < 10.9	18	0.2219	0.0114	0.1978-0.2460	**0.056**	1.17
	4	16.3 > X	43	0.25	0.00801	0.2339-0.2662		
Large	1	X < 10.9	16	0.2192	0.00605	0.2063-0.2321	**<.0001**	1.48
	4	16.3 > X	39	0.2569	0.00471	0.2474-0.2664		
Income			N	Mean	SE	95% CI	P-value	F-Value
Small	1	X < $56,266	25	0.2344	0.00944	0.2149-0.2539	0.0773	1.36
	4	$70,821 > X	21	0.2581	0.00883	0.2397-0.2765		
Large	1	X < $56,266	14	0.246	0.00958	0.2253-0.2667	0.0675	2.33
	4	$70,821 > X	31	0.2292	0.00422	0.2206-0.2378		
Education			N	Mean	SE	95% CI	P-value	F-Value
Small	1	X < 24%	27	0.2429	0.00895	0.2245-0.2613	0.8723	1.47
	4	36.2% > X	20	0.2453	0.0126	0.2190-0.2717		
Large	1	X < 24%	20	0.2386	0.00825	0.2214-0.2559	0.2627	2.5
	4	36.2% > X	28	0.2288	0.00441	0.2197-0.2378		

PN Readmission Rate Analysis								
Poverty			N	Mean	SE	95% CI	P-value	F-Value
Small	1	X < 10.9	18	0.1702	0.00917	0.1509-0.1896	0.1198	1.25
	4	16.3 > X	43	0.1889	0.00662	0.1755-0.2023		
Large	1	X < 10.9	16	0.1599	0.00547	0.1482-0.1715	**0.0001**	3.21
	4	16.3 > X	39	0.2029	0.00627	0.1902-0.2156		
Income			N	Mean	SE	95% CI	P-value	F-Value
Small	1	X < $56,266	25	0.1891	0.00797	0.1726-0.2055	0.0909	1.78
	4	$70,821 > X	21	0.1708	0.00652	0.1572-0.1844		
Large	1	X < $56,266	14	0.1872	0.00903	0.1677-0.2067	0.1411	1.36
	4	$70,821 > X	31	0.1724	0.00521	0.1618-0.1831		
Education			N	Mean	SE	95% CI	P-value	F-Value
Small	1	X < 24%	27	0.1936	0.00635	0.1805-0.2066	**0.046**	1.27
	4	36.2% > X	20	0.1745	0.00654	0.1609-0.1882		
Large	1	X < 24%	20	0.1829	0.00709	0.1681-0.1978	0.2432	1.05
	4	36.2% > X	28	0.1721	0.00584	0.1601-0.1841		

6.0 DISCUSSION

Because the initial Spearman correlation analysis showed very strong correlations between our three socioeconomic factors, each individual socioeconomic factor was analyzed instead of combining all the factors into one model. Poverty shows very strong negative correlations with income (r=-0.94321) and education (r=-0.78533), and income and education show a very strong positive correlation (r=0.87674), which is to be expected. The association between AMI readmission rates and poverty were significant for both small and large hospitals, indicating that the poverty level of the community has an important impact on the readmission rates for that hospital, regardless of the size and resources of the hospital. The p-value became more significant when the model was adjusted for geography and DSH, which indicate that both these factors also influence AMI readmission rates. Similarly, the association between AMI readmission rates and poverty were significant for both small and large hospitals, which also signifies the important impact of income. This is supported by the strong Spearman correlation between poverty and income. Lastly education did not show a significant p-value except for large hospitals adjusted for both geography and DSH payments, which indicates that education may have a more significant impact depending on the proportion of low-income patients that the hospital serves.

The association between HF readmission rates and poverty showed significant differences for small hospitals adjusted for geography and DSH, and very significant differences for large hospitals in all three analyses. This may be interpreted as patients in areas with higher poverty rates are less able to maintain their health, and may be likely to see higher cardiovascular problems, including heart failure. The association between HF readmission rates and income were also significant for both small and large hospitals for all three analyses, which indicates that the income of the patient population has an important impact on the patient's ability to maintain chronic diseases, such as cardiovascular issues, that relate to HF readmissions. Lastly the association between HF readmission rates and education were only significant for large hospitals adjusted for geography and DSH, as was similarly seen for AMI readmission rates.

The association between PN readmission rates and poverty were very significant for large hospitals, and income was significant for both large and small hospitals. Again, this indicates that the poverty or income level of a hospital's population has an important influence on PN readmission rates. Lastly, the association between PN and education were only significant for large and small hospitals adjusted for geography and DSH.

To summarize, poverty and income appeared to have a much larger association with readmission rates for all three measures than education. The significance of the association was more distinct as we adjusted for whether a hospital was located in a rural or urban area, and by the size of the DSH payment. There is a particularly significance increase in strength of associations when we adjust for DSH, which again, indicates that the DSH payment, paid to hospitals serving a significant number of low-income patients, may be a strong indicator of the readmission rates of a hospital.

7.0 LIMITATIONS

This analysis only includes California acute care hospitals (n=191) with publically-available readmission rates for AMI, HF, and PN. 118 California acute care hospitals were excluded due to unreported or unavailable readmission rates. Because this analysis combines readmission rates for FY2013 (2008-2011) with census data from 2007-2011, there may be some discrepancies due to misaligned time frames, but reflect the latest information available. Lastly, due to the utilization of hospital-level and county-level data sets, there is a lot of granularity about the specific association between a hospital's readmission rates and the socioeconomic factors of its population that cannot be construed through this analysis

8.0 CONCLUSION

Based off the results of this preliminary analysis on socioeconomic factors and readmission rates, additional analysis to further explore the association between readmission rates and socioeconomic factors would be recommended. Based off our results, there is a much more significant association between poverty with readmissions than with income or education. Following the methodology used in this analysis, an analysis of all acute care hospitals participating in the FY13 Hospital Readmission Reduction Program could be conducted to see if similar results are observed with all participating hospitals. The specific relationship between poverty and readmission rates could also be explored by conducting additional research on hospitals in counties with high rates of poverty using hospital-specific information that will provide additional granularity on the relationship.

9.0 PUBLIC HEALTH RELEVANCE

With the passage of the ACA, CMS plans to make significant cuts to Medicare over the next ten years. With fewer resources available to provide to a growing Medicare population, it will be vital for Medicare to find new ways of efficiently providing an equal or better quality of care to their patient population with less resources. Reducing readmission rates will significantly cut down on avoidable and unnecessary costs, as well as help to ensure that patients receive proper care during their initial admission to the hospital.

As the Hospital Readmissions Reduction program continues to penalize hospitals in upcoming years, it will be important to adjust the current methodology to exclude for factors outside of the hospital's control. As additional research is conducted on the effects of various socioeconomic factors on readmission rates, factors unrelated to the hospital should be excluded to help hospital's focus on factors that are under their control. Excluding non-hospital related factors is also important in helping researchers distinguish between the definitions of "expected" readmissions and "potentially avoidable" readmissions, the latter of which is what readmission rates should be representing.

Specifying the definition of readmission rates to only capture aspects under the hospital's control is especially important to hospitals serving high proportions of socioeconomically disadvantaged communities. Excluding for socioeconomic factors will allow all hospitals to focus on improvements that are directly related to a hospital's transition of care process, instead of socioeconomic issues, such as a patient's lack of resources to purchase medication. Adjusting the Hospital Readmissions Reduction Program methodology will prevent hospital's serving large socioeconomically disadvantaged populations from not being able to care for the population due to a fear of readmissions penalties or a lack of resources due to the readmissions penalties. Adjusting the methodology is vital to ensuring that the Hospital Readmissions Reduction program will not cause any unintended consequences that could increase the health disparities of socioeconomically disadvantaged populations.

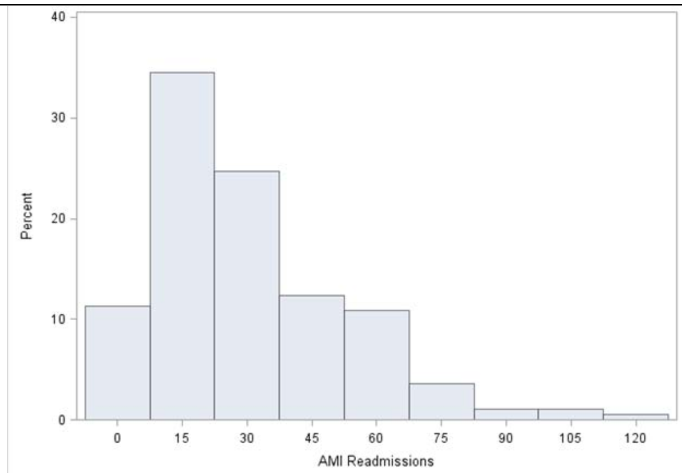
APPENDIX A

SAMPLE LIST OF DATA SET FOR ANALYSIS

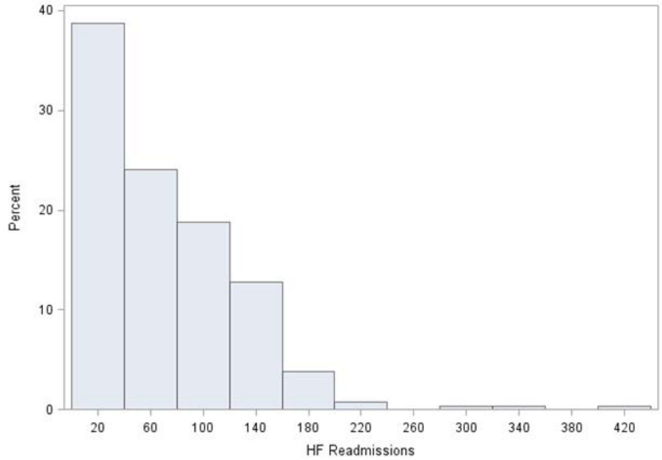
Obs	Hospital ID	Hospital Name	COUNTY	Education	Income	Poverty	PAF	URGEO	BEDS	DSH	Total Readmissions
1	50002	ST ROSE HOSPITAL	ALAMEDA	40.8	70821	11.8	0.995	LURBAN	141	0.6291	1.05587
2	50043	ALTA BATES SUMMIT MEDICAL CENTER -- SUMMIT CAMPUS	ALAMEDA	40.8	70821	11.8	0.996	LURBAN	354	0.4174	1.0486
3	50195	WASHINGTON HOSPITAL	ALAMEDA	40.8	70821	11.8	0.996	LURBAN	315	0.4108	1.0372
4	50211	ALAMEDA HOSPITAL	ALAMEDA	40.8	70821	11.8	0.997	LURBAN	92	0.2575	1.02313
5	50283	VALLEYCARE MEDICAL CENTER	ALAMEDA	40.8	70821	11.8	0.999	LURBAN	146	0.2124	0.955
6	50305	ALTA BATES SUMMIT MEDICAL CENTER - ALTA BATES CAM	ALAMEDA	40.8	70821	11.8	1	LURBAN	347	0.5727	0.97617
7	50488	EDEN MEDICAL CENTER	ALAMEDA	40.8	70821	11.8	0.999	LURBAN	155	0.3334	0.99383
8	50030	OROVILLE HOSPITAL	BUTTE	24	42971	19.8	0.99	OURBAN	133	0.4084	1.12323
9	50039	ENLOE MEDICAL CENTER	BUTTE	24	42971	19.8	0.998	OURBAN	300	0.2746	1.02387
10	50225	FEATHER RIVER HOSPITAL	BUTTE	24	42971	19.8	1	OURBAN	101	0.2776	0.92403

APPENDIX B

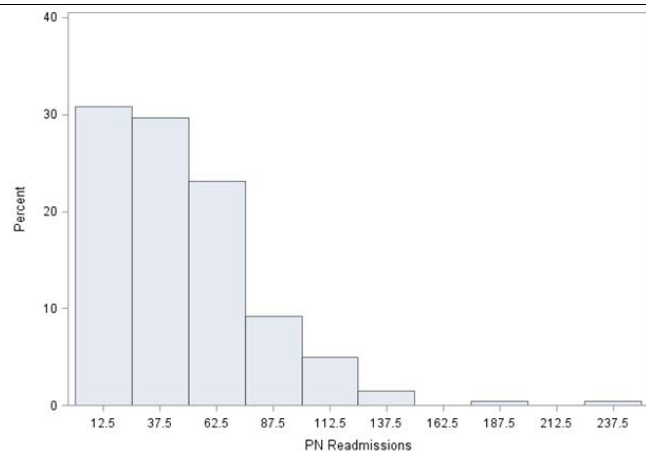
DISTRIBUTION OF NUMBER OF READMISSIONS AMI, HF, PN



Distribution of AMI Readmissions



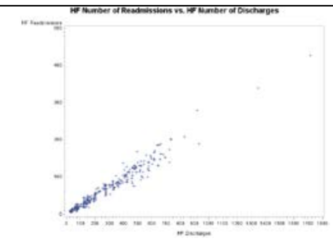
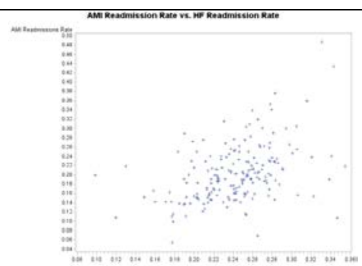
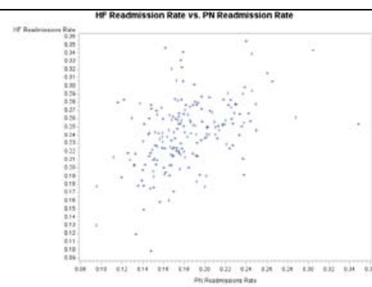
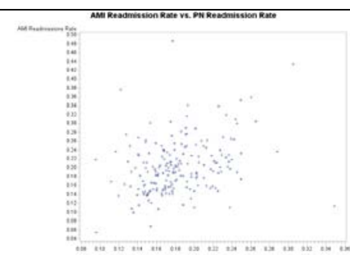
Distribution of HF Readmissions



Distribution of PN Readmissions

APPENDIX C

CORRELATION COEFFICIENTS BETWEEN AMI, HF, PN

		
AMI Readmissions vs. AMI Discharges	HF Readmissions vs. HF Discharges	PN Readmissions vs. PN Discharges
r=0.93590	**r=0.97779**	**r=0.96392**
		
AMI Readmissions vs. HF Readmissions	HF Readmissions vs. PN Readmissions	AMI Readmissions vs. PN Readmissions
r=0.43532	**r=0.44554**	**r=0.30538**

APPENDIX D

READMISSIONS RATE BOX PLOTS

D.1 AMI READMISSION RATES UNADJUSTED

<table>
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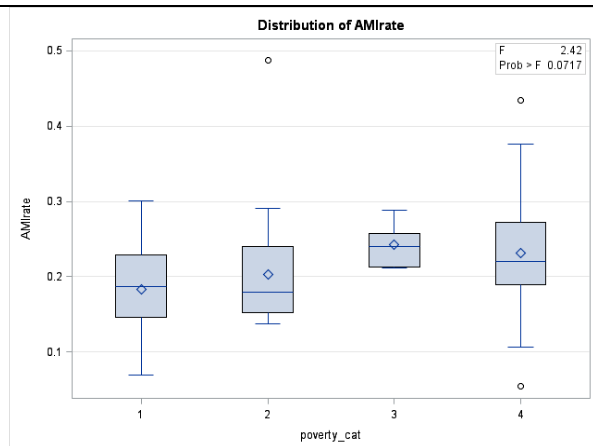
Poverty,
2007-2011</td><td>1</td><td>
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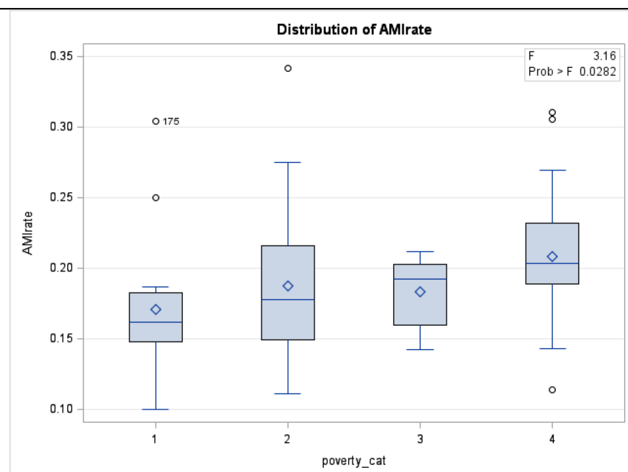
<tr><td>2</td><td>
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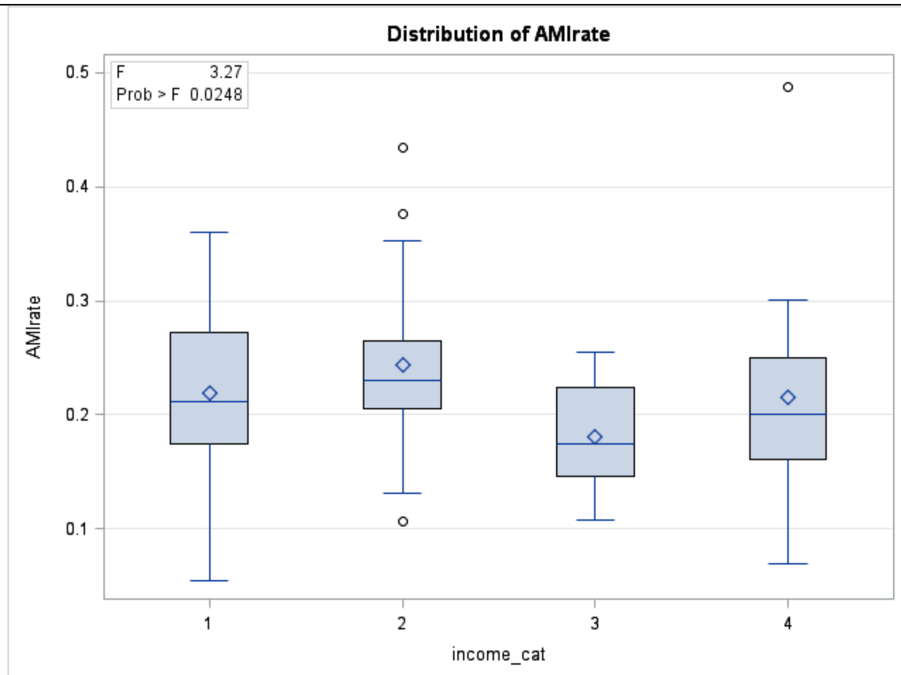
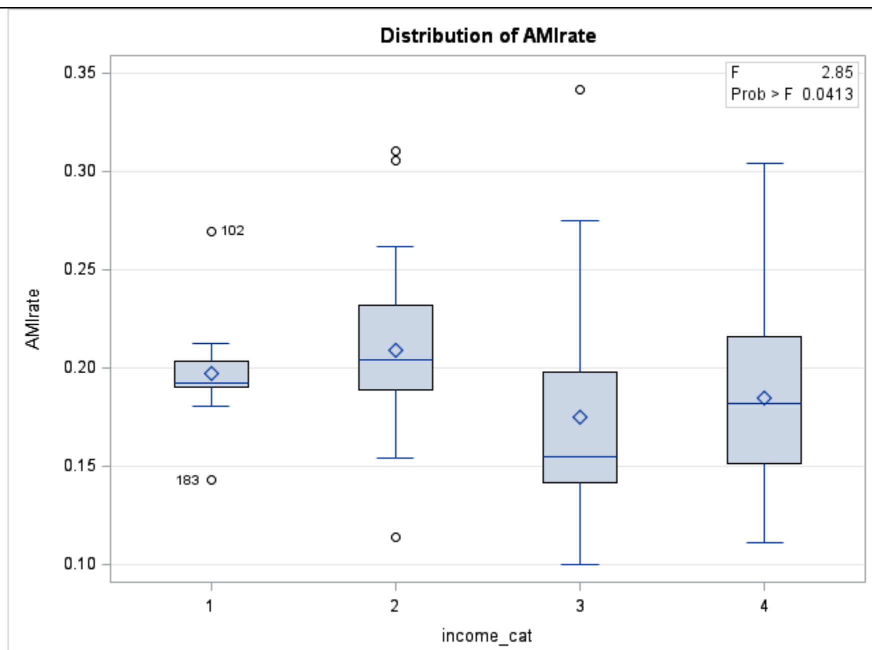
INCOME Median Household Income, 2007-2011	**1**	
	2	

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Percent with Bachelor’s Degree or Higher, 25 years or older, 2007-2011</td>
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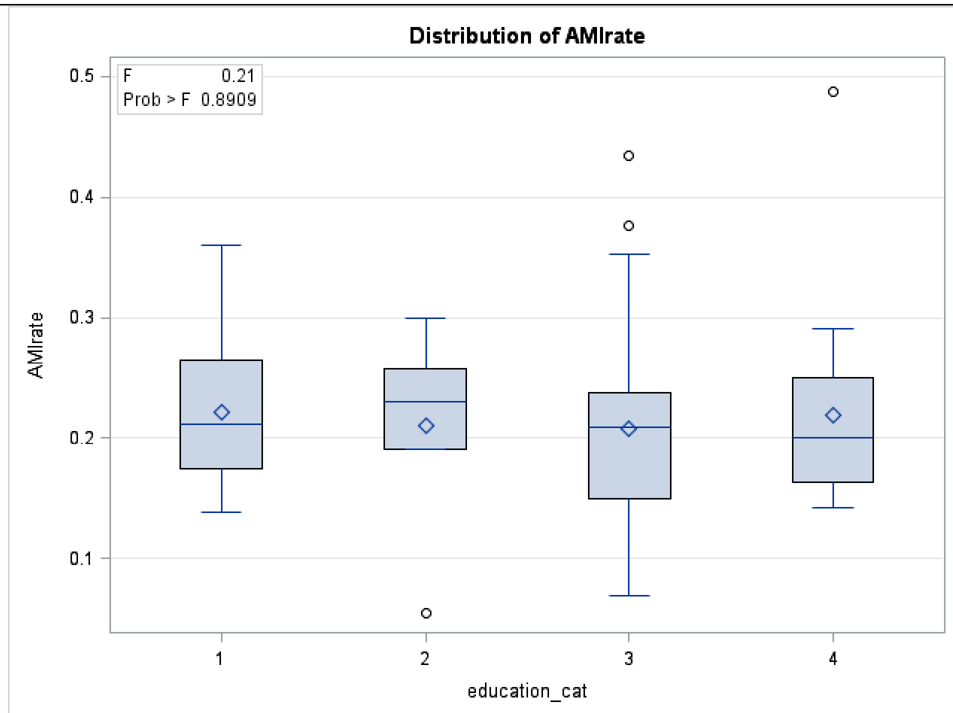
<td>
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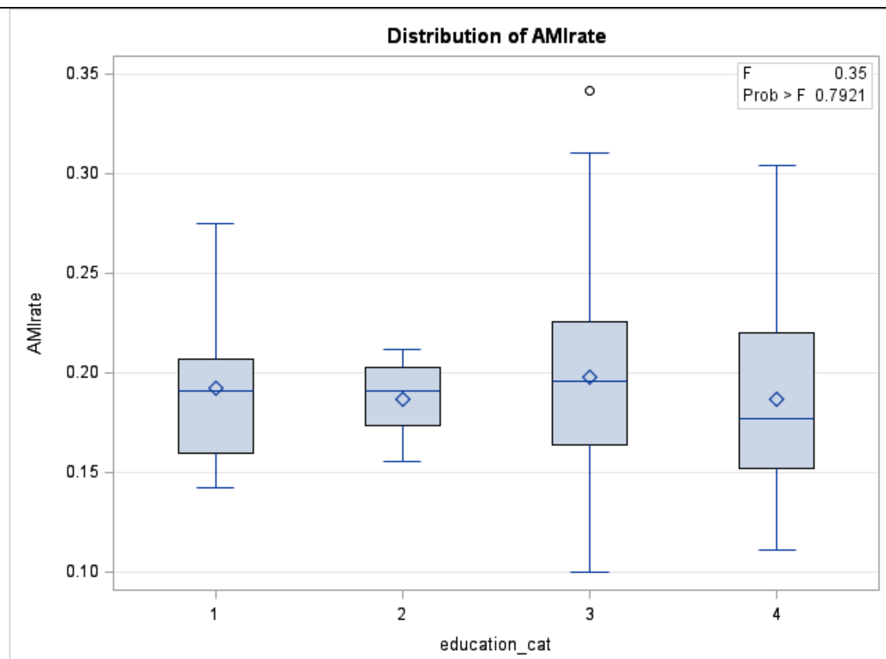
<td>
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D.2 HF READMISSION RATES UNADJUSTED

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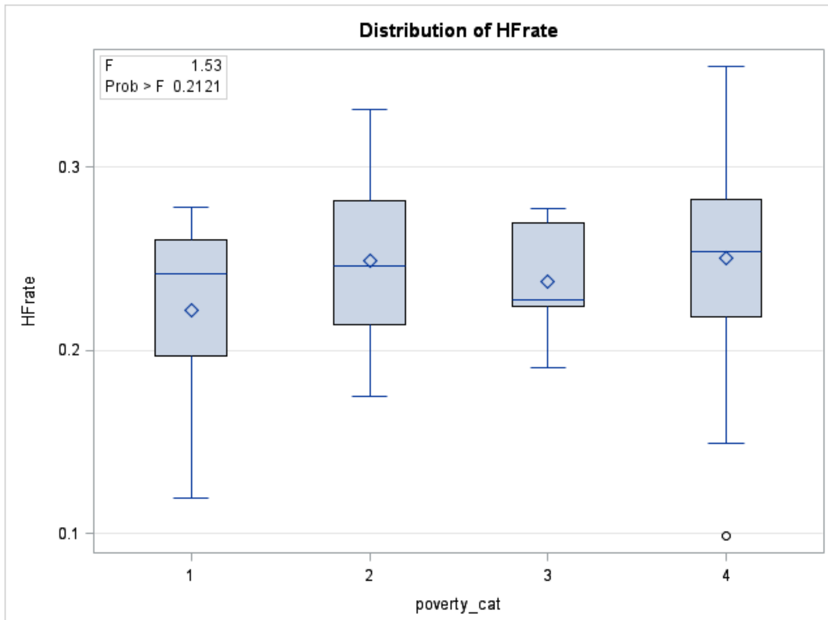
Percent People of All Ages in Poverty, 2007-2011</td><td>1</td><td>


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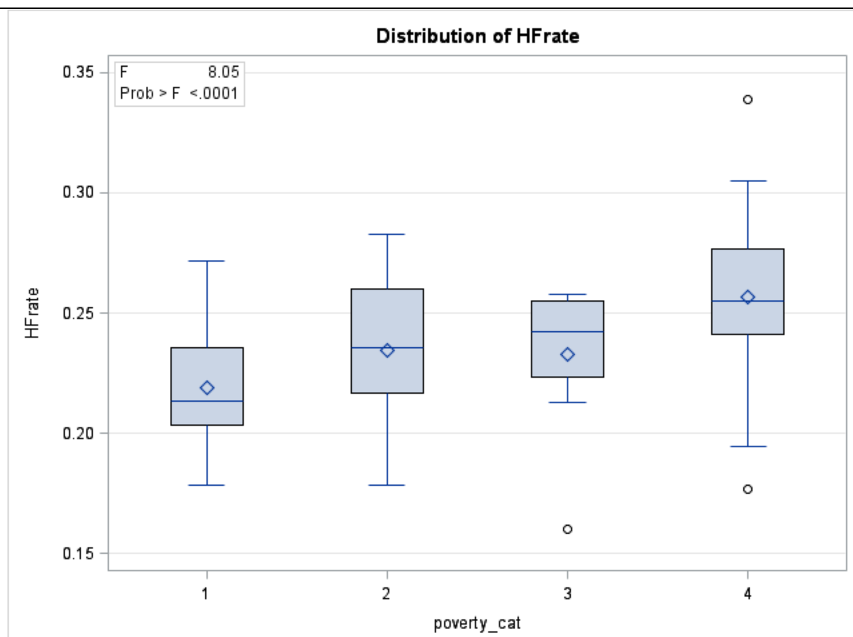

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Median
Household
Income, 2007-
2011</td>
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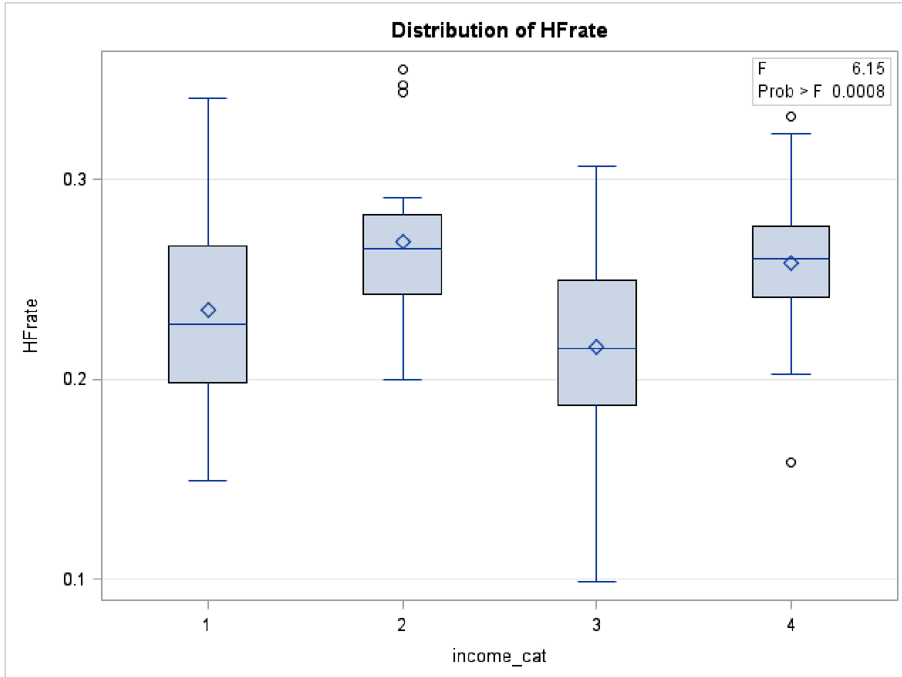
<td>
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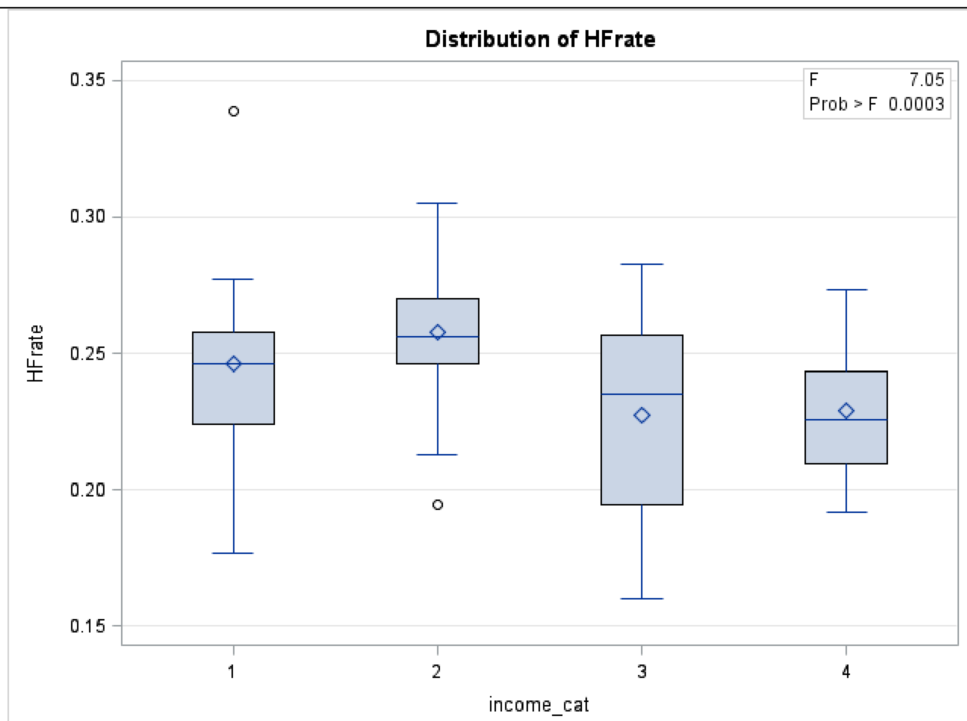
<td>
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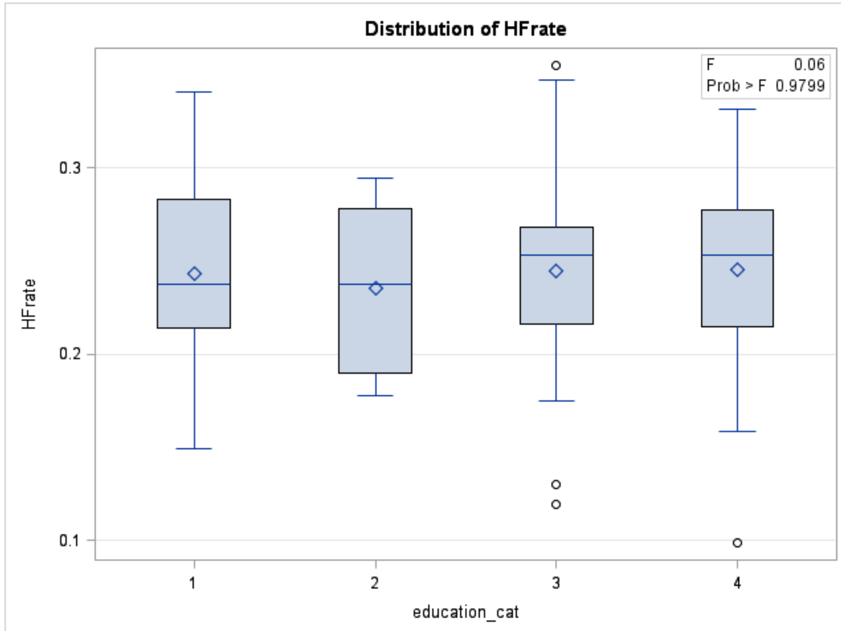
Bachelor’s
Degree or
Higher,
25 years or
older,
2007-2011</td><td>1</td><td>
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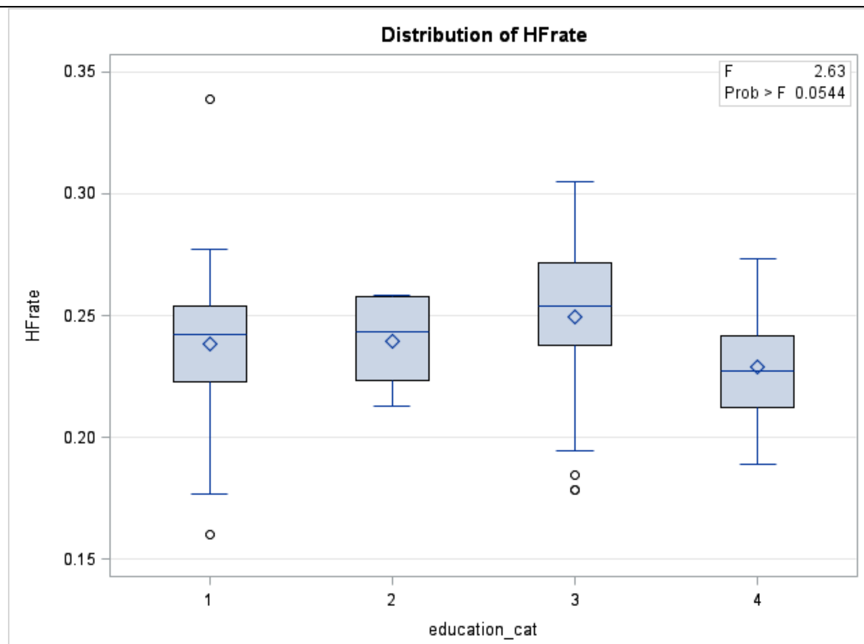
<tr><td>2</td><td>
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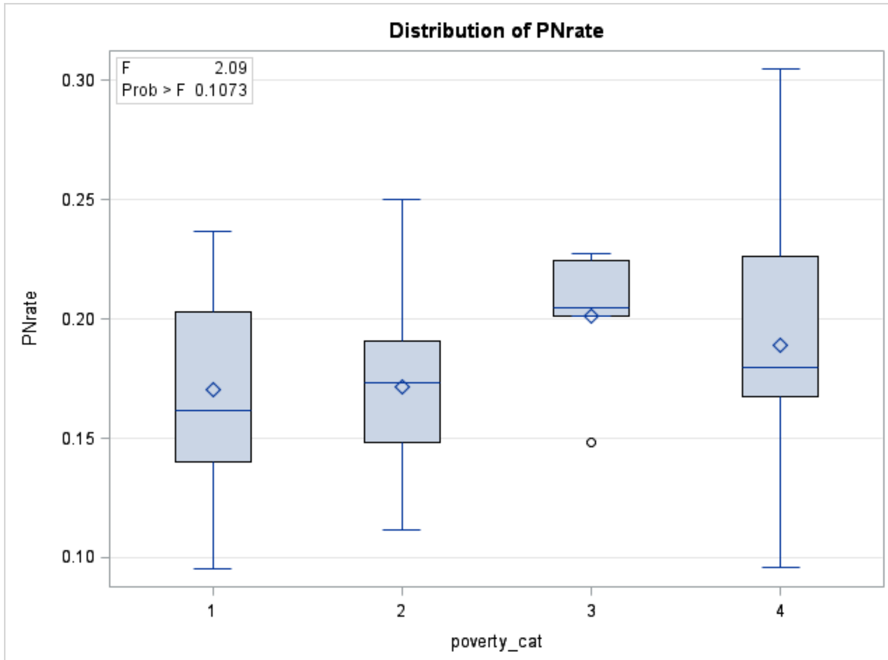
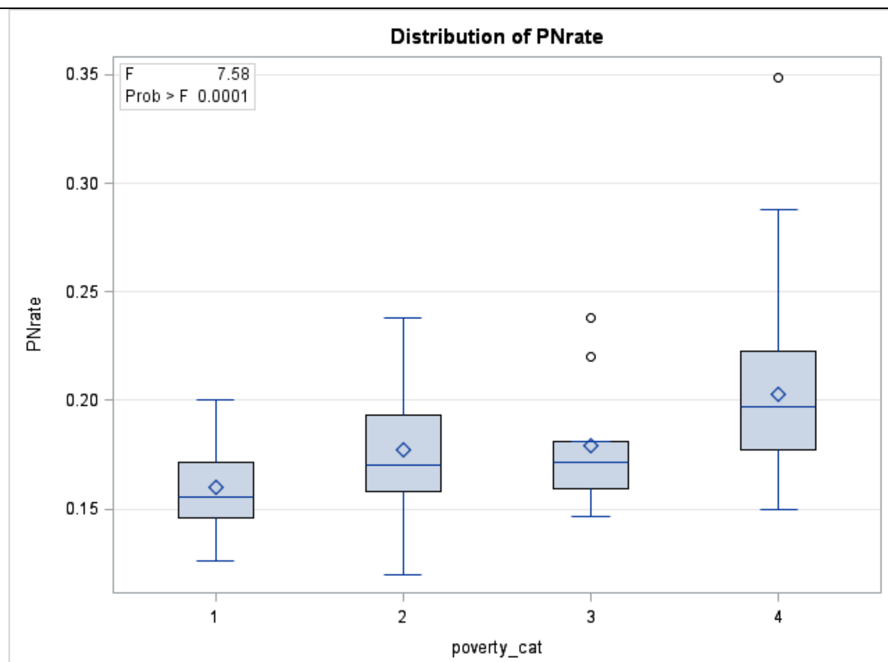
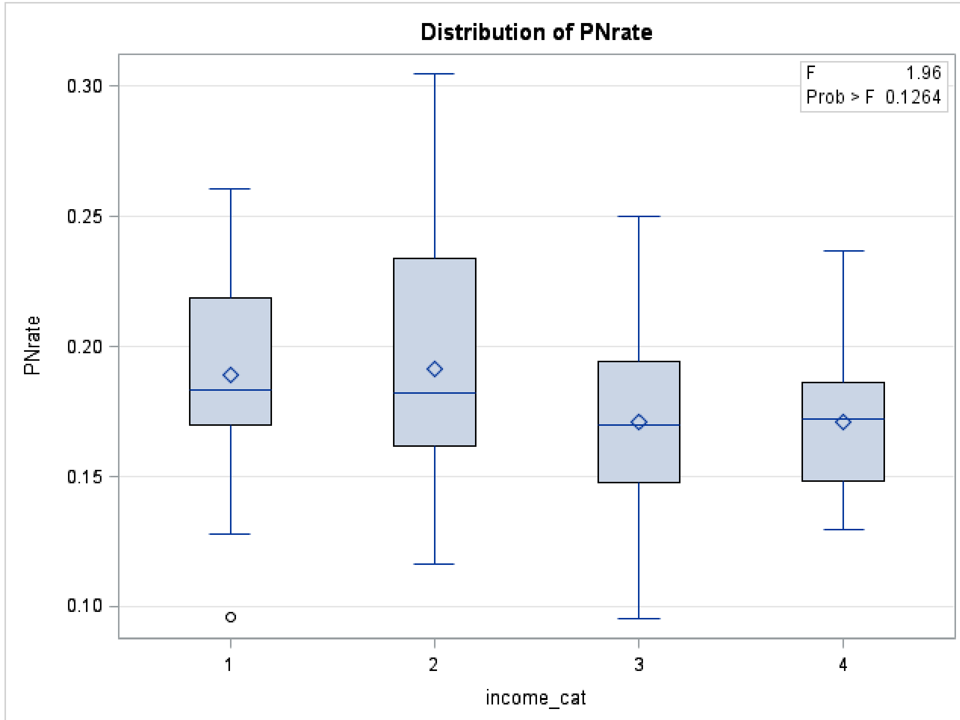
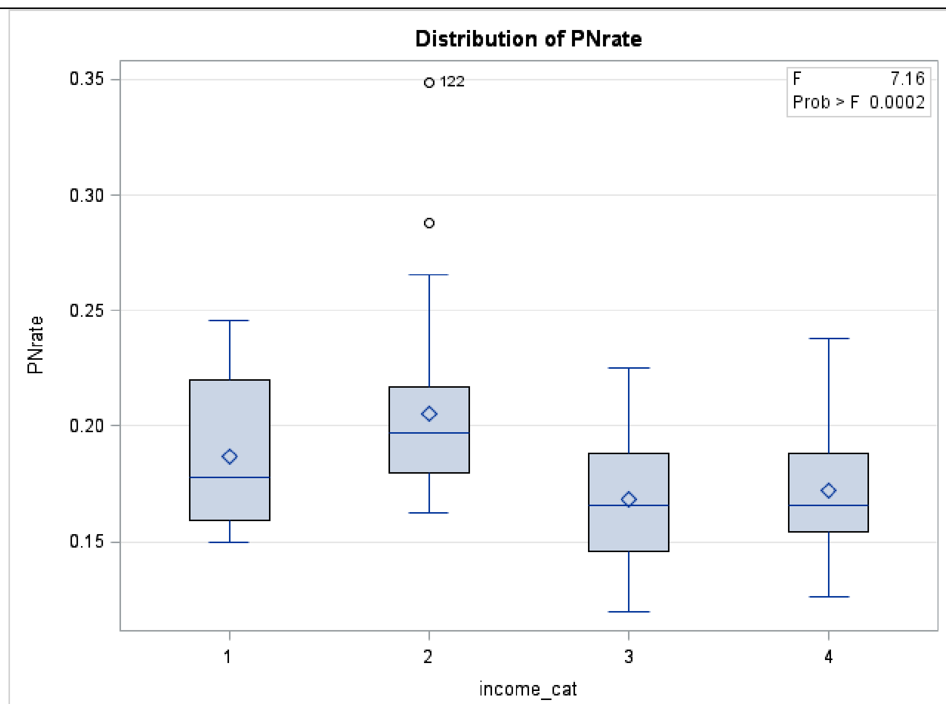
D.3 PN READMISSION RATES

PN Readmission Rates		
POVERTY Percent People of All Ages in Poverty, 2007-2011	**1**	
	2	

INCOME Median Household Income, 2007- 2011	**1**	
	2	

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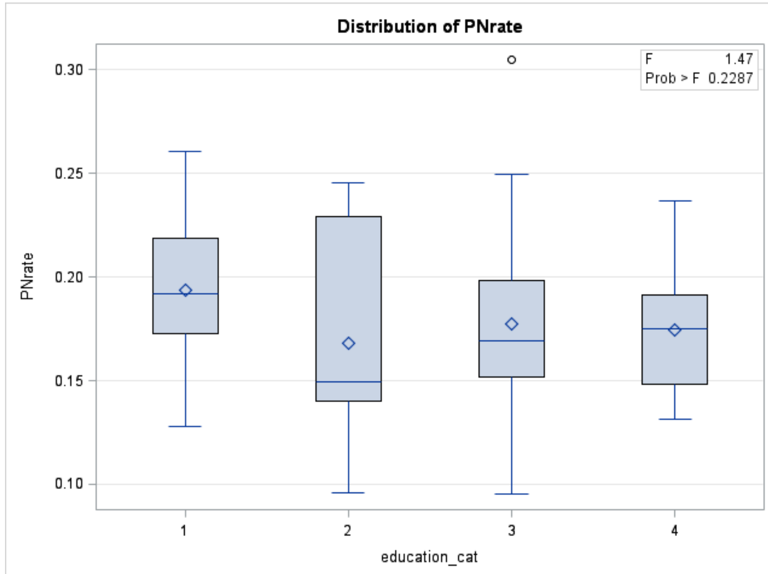
<td rowspan="2">EDUCATION
Percent with
Bachelor's
Degree or
Higher,
25 years or
older,
2007-2011</td>
<td>1</td>
<td>
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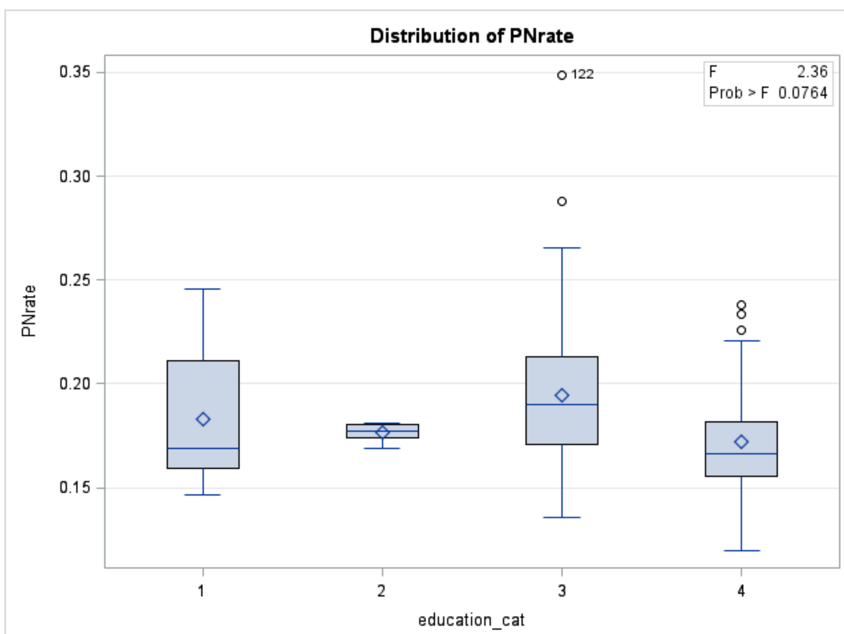
<td>
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