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Assessment of a Regression Method to Reclassify Deaths Attributable to Heart Failure

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Abstract

Background: Evaluation of cause-specific mortality for public health research depends on accurate death certificates and vital records. However, ill-defined causes of death (termed garbage codes), such as heart failure, are often listed as the underlying cause of death. We examined a regression method proposed by Ahern and colleagues for redistributing deaths attributed to heart failure and compared it to a simulation of the regression method by bootstrapping.

Methods: Deaths attributed to heart failure in four U.S. states (Maryland, Minnesota, Mississippi and North Carolina) were redistributed to a set of underlying causes of death using regression models that identified the proportion of deaths for each target code within a given state-age-sex-education group using ICD-10 mortality data. The results were compared with 3,000 bootstrapped samples with replacement regression.

Results: The odds of death from heart failure in the population studied increased with age, was higher in whites and lower in decedents with greater than a high school education compared to those with less than high school education. There were 18 (29.0%) subgroups that showed no significant redistribution targets for the Ahern regression method and 28 (45.2%) for the bootstrapped regression method. Ischemic heart disease was a distribution target for 28 (45.2%) of the Ahern regression subgroups and 22 (35.5%) of the bootstrapped regression subgroups. The Ahern regression method and bootstrapped regression methods were discordant in 19 (30.6%) out of the 62 subgroups examined.

Conclusion: The Ahern regression method tended to redistribute deaths attributed to heart failure to more target groups compared with the bootstrapped regression method. Both the Ahern regression and the bootstrap regression methods were computationally intensive and inefficient, and results appeared to be influenced by the choices of sex-age-education group strata. Other methods such as coarsened exact matching and improvements to the Ahern approach are desirable additions to the tools available to mitigate the impact of garbage codes on the accuracy of death certification.

Keywords: death certificates, epidemiology, heart failure, vital statistics

1. Introduction

Policymakers assess population-level disease burden, largely based on mortality statistics, in order to prioritize health interventions. Efforts to enhance the validity and standardization of the classification of causes of death have been extensive and are ongoing (Naghavi et al., 2010; World Health Organization). The World Health Organization (WHO) defines the underlying cause of death as "the disease or injury which initiated the train of morbid events leading directly to death, or the circumstance of the accident or violence which produced the fatal injuries" (World Health Organization). Despite releases by the WHO of a "list of conditions unlikely to cause death" in the Appendix of Volume 2 of the second edition of ICD-10, these conditions are frequently listed on death certificates as underlying causes of death, and the corresponding ICD codes have been termed garbage codes (Murray & Lopez, 1996), as they are not useful for public health analysis of cause-of-death. Garbage codes for cardiovascular disease include heart failure, congestive heart failure, and left ventricular failure (Murray & Lopez, 1996). Thus, it has been proposed that these garbage codes should be redistributed to improve the validity of cause of death statistics for public health research (Naghavi et al., 2010).

Naghavi et al. (Naghavi et al., 2010) distinguished three methods for assigning garbage code deaths to a set of underlying causes. The first method involved proportionate redistribution within an age-sex group for causes with little information content. The second identified the proportion of deaths from heart failure for each target code within a given age-sex group, by regressing age, sex and country development status using all available ICD-10 mortality data on the fraction of heart failure deaths from all deaths related to heart failure, including target causes. The third method included expert judgement or expert algorithms to assign the fraction of deaths within informative strata. Finally, a combination of all approaches could be used if warranted by the types of garbage codes identified. However, these methods are constrained by the scarcity of autopsy studies as a gold standard (Burnand & Feinstein, 1992).

Heart failure occurs during the end-stage of various cardiovascular and non-cardiovascular diseases, and thus is considered an intermediate rather than an underlying cause of death (Ahern et al., 2011). The quality of medical death certification and of nosologic coding of cause of death vary considerably around the world (Murdoch et al., 1998). In economically developed countries, listing of heart failure (ICD-9 50.9) as the underlying cause of death ranged from 6.9% in the USA between 1999 and 2006 to 94.6% in Austria between 2002 and 2007. Elsewhere, heart failure as the underlying cause of death was listed as 5.3% of deaths for Roderiques (Mascarene Islands) to 99.9% in the middle-east of North Africa (Ahern et al., 2011).

Ahern et al. (Ahern et al., 2011) developed a reclassification approach regressing the fraction of heart failure deaths from all deaths related to heart failure referenced to target causes, using all available ICD-10 mortality data in strata of age, sex and country development status. Here, we compare the results from the Ahern regression with a bootstrapped regression method for heart failure listed as the underlying cause of death from 1999 to 2010 in four U.S. states (Mississippi, Minnesota, Maryland and North Carolina). We carry out the analyses by state, age, sex, and education subgroups and compare the results of these two methods.

2. Methods

2.1 Participant (Subject) Characteristics

Multiple cause of death coding from 2,210,113 decedents in Maryland, Minnesota, Mississippi and North Carolina between 1999 and 2010 were obtained from the National Center for Health Statistics provided for 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. These 4 states were chosen since they include geographic areas under epidemiologic surveillance for heart failure by the Atherosclerosis Risk in Communities (ARIC) study (Anonymous, 1989). Exclusion criteria were age < 55 years or missing age, external underlying causes of death (ICD-10 codes V00-Y89), and ill-defined underlying causes of death (ICD-10 codes R00-R99, N17-N19, C76, C80, C97, I10, I46, I472, I490, I514, I515, I516, I519, I709) leaving 1,623,901 decedents. Heart failure before age 55 years typically reflects etiologies and coding practices that differ from those among older adults in industrialized countries. There were only 8 records with heart failure as the underlying cause of death among decedents under 55 years old.

2.2 Redistribution Method

The method described by Ahern et al. redistributes deaths with an underlying cause of death attributed to heart failure to multiple underlying causes of death while considering the association between the rates of miscoding to the prevalence of probable underlying causes of death (Ahern et al., 2011).

Ahern et al. (Ahern et al., 2011) described the following steps to redistribute heart failure deaths: 1. Develop a list of pathophysiologically plausible underlying causes of death using ICD codes and group the underlying causes of deaths into target groups (TG) of similar diseases; 2. Obtain a mortality dataset of interest; 3. Use regression ($\%TG = \alpha + \beta[\%\text{ heart failure}] + \varepsilon$) to define redistribution proportions for each cause, by state-age-sex-education group; 4. Redistribute deaths from heart failure to each target group by strata of state-age-sex-development status.

2.3 Heart Failure in the International Classification of Diseases

Heart failure as the underlying cause of death was identified as I50 and comprised the ICD-10 codes I50 (heart failure), I50.0 (congestive heart failure), I50.1 (left ventricular failure), and I50.9 (heart failure, unspecified).

2.4 Target Groups

A target list of pathophysiologically plausible underlying causes of death for heart failure redistribution was developed by Ahern et al. (Ahern et al., 2011). These underlying causes of death, termed target groups, and ICD codes were the following: aortic aneurysm (I71); chronic obstructive pulmonary disease (COPD; J43, J44);

chronic severe anemia (D50, D55, D56, D57, D58, D59); congenital heart abnormalities (Q20, Q21, Q22, Q23, Q24, Q25); hypertensive heart and kidney diseases (I11, I12, I13); ischemic heart disease (I21, I22, I23, I24, I25); other respiratory diseases (J60, J61, J62, J63, J64, J65); other valve diseases (I34, I35, I36, I37); pericarditis, endocarditis, myocarditis (I33, I40, I31.1); rheumatic heart disease (I05, I06, I07, I08), and thyroid disorders (E00, E01, E02, E03, E04, E05, E06, E07).

2.5 Regression Analysis and Interpretation

The regression coefficient represents the change in the proportion of the target group-attributed deaths within the heart failure universe as the proportion of the change in heart failure-attributed deaths over time (Ahern et al., 2011). A negative beta coefficient (β) indicates that the underlying cause of death in that group is misclassified as heart failure. A β of zero or a positive β indicates that the underlying cause of death in that group is not misclassified as heart failure. Therefore, we dropped target groups that had a zero or a significant positive β from the analysis.

We reran the regression with the smaller target group to ensure no changes in statistical significance in the revised heart failure universe then repeated the regressions until all coefficients were significant and negative (Ahern et al., 2011). The goal of this method is to obtain a universe of all target groups by using the constant values (y-intercept) from the regressions. The constant value from the target groups with statistically significant ($P < 0.05$) negative β parameter estimates were scaled to sum to one and represented the redistribution proportions (Ahern et al., 2011).

2.6 Statistical Methods

The SAS procedure SURVEYSELECT (SAS Institute Inc, 2012) was used to obtain an unrestricted random sample equal to the number of decedents in each stratum with equal selection probability and with replacement. Bootstrapping was carried out by generating 3000 samples and estimating the mean intercept and slope parameter estimates and standard errors for the negative β parameter estimates, and calculating the t-statistic and its p-value (Efron, 1979). Bootstrapping was carried out by assuming that there is a sample of size n and one wished to estimate a parameter and its precision. The empirical distribution in the sample was considered as the probability distribution with probability 1/n assigned to each sample value. The results were stratified by state, race, sex, age group and education. The mean value for the intercept and slopes were calculated and reported. Histograms of the bootstrap distributions, box plots, and Q-Q plots and mean, median, standard deviation and probability that the parameter estimates come from a normal distribution are shown in Appendix A.

Odds ratios for heart failure were calculated using the SAS procedure PROC LOGISTIC by age, sex, race and education, overall and by state.

3. Results

3.1 Population Characteristics

A large proportion of the heart failure deaths were from North Carolina (40.6%), were female decedents (51.1%), and were white (82.0%; Table 1).

Table 1. Distribution (n (%)) of 1,623,901 decedents by state and demographic characteristics, 1999 to 2010)

Year of death	All	MD	MN	MS	NC
1999	132,361 (8.2)	33,090 (8.4)	29,442 (8.6)	18,570 (8.2)	51,259 (7.8)
2000	133,888 (8.2)	33,148 (8.4)	28,520 (8.3)	19,085 (8.4)	53,135 (8.1)
2001	132,555 (8.2)	32,852 (8.3)	28,597 (8.3)	18,772 (8.3)	52,334 (7.9)
2002	134,738 (8.3)	32,947 (8.3)	29,298 (8.6)	19,164 (8.4)	53,329 (8.1)
2003	134,730 (8.3)	33,357 (8.4)	28,317 (8.3)	18,677 (8.2)	54,379 (8.2)
2004	131,674 (8.1)	32,020 (8.1)	28,011 (8.2)	18,441 (8.1)	53,202 (8.1)
2005	135,453 (8.4)	33,024 (8.4)	28,139 (8.2)	19,212 (8.4)	55,078 (8.4)
2006	133,723 (8.2)	32,559 (8.2)	27,691 (8.1)	18,739 (8.3)	54,734 (8.3)
2007	135,371 (8.3)	32,899 (8.3)	27,755 (8.1)	18,536 (8.2)	56,181 (8.5)
2008	139,708 (8.6)	33,206 (8.4)	28,950 (8.5)	19,503 (8.6)	58,049 (8.8)

2009	138,219 (8.5)	33,156 (8.4)	28,310 (8.3)	19,027 (8.4)	57,726 (8.8)
2010	141,481 (8.7)	33,161 (8.4)	29,573 (8.6)	19,283 (8.5)	59,464 (9.0)
Total	1,623,901	395,419 (24.3)	342,603 (21.1)	227,009 (14.0)	658,870 (40.6)
Sex					
Male	794,546 (48.9)	192,717 (48.7)	167,648 (48.9)	112,106 (49.4)	322,075 (48.9)
Female	829,355 (50.1)	202,702 (51.3)	174,955 (51.1)	104,903 (50.6)	336,795 (51.1)
Age					
≤ 79 years	805,115 (49.6)	192,971 (48.8)	144,116 (42.1)	122,976 (54.2)	345,052 (52.4)
≥ 80 years	818,786 (50.4)	202,448 (51.2)	198,487 (57.9)	104,033 (45.8)	313,818 (47.6)
Race					
White	1,330,997 (82.0)	301,975 (76.4)	333,419 (97.3)	162,775 (71.7)	532,828 (80.9)
Other	292,904 (18.0)	93,444 (23.6)	9,184 (2.7)	64,234 (28.3)	126,042 (19.1)
Education					
< High school	630,554 (38.8)	124,802 (31.6)	110,189 (32.1)	96,866 (42.6)	298,697 (45.3)
High school	560,822 (34.6)	157,125 (39.7)	130,746 (38.2)	79,394 (35.0)	193,557 (29.4)
> High school	432,525 (26.6)	113,492 (28.7)	101,668 (29.7)	50,749 (22.4)	166,616 (25.3)

MD = Maryland, MN = Minnesota, MS = Mississippi, NC = North Carolina.

Percentages are of total year of death row.

The distribution of decedents by age, race and level of formal education can be seen to differ by state, in accordance with the population characteristics recorded in the U.S. census. A large proportion of deaths among the target groups were coded as IHD or COPD, which accounted for 19.7% and 6.2% of deaths, respectively (Table 2).

Table 2. Number of deaths in each heart failure target group by state, 1999 to 2010

Year of death	All	MD	MN	MS	NC
Aortic Aneurysm	11,094	2,232	3,293	1,246	4,323
COPD	100,530	21,180	21,044	14,694	43,612
Cardiomyopathy	18,781	4,911	3,134	2,677	8,059
Chronic severe anemias	464	102	109	49	204
Congenital heart anomalies	458	91	124	56	187
Hypertensive heart disease	30,880	9,303	3,502	7,808	10,267
Ischemic heart disease	319,429	89,488	53,142	47,187	129,612
Other respiratory diseases	760	193	130	147	290
Other valve diseases	13,327	2,919	4,292	996	5,120
Pericarditis, endocarditis, myocarditis	753	184	183	97	289
Rheumatic heart disease	2,069	395	691	149	834
Thyroid disorders	1,787	553	480	122	632
Heart failure	52,211	7,737	12,808	14,558	17,108
Total deaths	1,623,901	395,419	342,603	227,009	658,870
Universe of heart failure	552,543	139,288	102,932	89,786	220,537

MD = Maryland, MN = Minnesota, MS = Mississippi, NC = North Carolina, COPD = chronic obstructive pulmonary disease.

Heart failure accounted for 3.2% of deaths overall, 2.0% in Maryland, 3.7% in Minnesota, 6.4% in Mississippi, and 2.6% in North Carolina. The universe of heart failure deaths (the sum of the numbers in the selected target groups) was 34.0% of the total deaths, ranging from 14.0% for Mississippi to 40.6% for North Carolina. Numbers of deaths were low for chronic severe anemias, congenital heart abnormalities, other respiratory diseases, pericarditis, endocarditis, myocarditis, and rheumatic heart disease and were not considered further.

3.2 Redistribution of Deaths Attributed to Heart Failure

Table 3 shows the odds ratios for death attributed to heart failure by age, sex, race, and education, overall and by state.

Table 3. Odds ratios (95% CI) for death attributed to heart failure by age, sex, race and high school (HS) education in decedents and state, 1999-2010

Year of death	Odds ratio (95% CI)
All (n=1,623,901)	
Age (years)	1.055 (1.054-1.056)
Male	0.994 (0.976-1.011) NS
Whites	1.063 (1.037-1.090)
Education > HS	0.894 (0.872-0.915)
Education < HS	1.114 (1.092-1.138)
North Carolina (n=658,870)	
Age (years)	1.052 (1.050-1.054)
Male	0.980 (0.950-1.010) NS
Whites	1.106 (1.061-1.153)
Education > HS	0.915 (0.876-0.956)
Education < HS	1.058 (1.019-1.098)
Maryland (n=395,419)	
Age (years)	1.054 (1.051-1.056)
Male	1.081 (1.033-1.131)
Whites	1.245 (1.172-1.322)
Education > HS	0.947 (0.895-1.003) NS
Education < HS	1.079 (1.023-1.137)
Minnesota (n=342,603)	
Age (years)	1.072 (1.070-1.074)
Male	0.997 (0.962-1.033) NS
Whites	1.071 (0.932-1.231) NS
Education > HS	0.900 (0.859-0.943)
Education < HS	1.108 (1.062-1.155)
Mississippi (n=227,009)	
Age (years)	1.051 (1.049-1.053)
Male	0.949 (0.917-0.982)
Whites	1.149 (1.103-1.197)
Education > HS	0.915 (0.872-0.961)
Education < HS	1.159 (1.113-1.207)

HS = high school, NS = not significant.

The odds of heart failure as the underlying cause of death increased by 55% with every 10 year increase in age, was 0.6% higher in females compared with males, and was 6.3% higher in whites compared to others. A heart failure death was 10.6% lower in decedents with a greater than high school education and 11.4% higher for decedents who had less than high school education compared to decedents with a high school education or less. While states had similar odds ratios for a heart failure death, males had significantly higher odds in Maryland and significantly lower odds in Mississippi compared with females; race (whites compared to others) was not significant in Minnesota and greater than high school education compared with high school education was not signficant in Maryland.

Of the 62 sub-group analyses, the Ahern regression and bootstrapped regression methods yielded 43 concordant results, as shown in Table 4.

Table 4. Summary of concordant redistribution of heart failure deaths between the Ahern regression and the bootstrapped regression

	Ahern regression	Bootstrapped regression
Females	95.3% IHD, 4.7% AA	95.3% IHD, 4.7% AA
White	95.6% IHD, 4.4% AA	95.6% IHD, 4.4% AA
Other	NS	NS
< HS	100% IHD	100% IHD
= HS	95.1% IHD, 4.9% AA	95.1% IHD, 4.9% AA
Age ≤ 79 years	94.5% IHD, 5.5% AA	94.6% IHD, 5.4% AA
Age ≥ 80 years	100% IHD	100% IHD
MS	100% IHD	100% IHD
NC	100% IHD	100% IHD
MD Males Age ≥ 80 years and < HS	76.6% COPD, 23.4% CM	76.8% COPD, 23.2% CM
MN Males Age ≥ 80 years and =HS	100% COPD	100% COPD
MN Females Age ≤ 79 years and = HS	100% IHD	100% IHD
MN Females Age ≤ 79 years and > HS	100% IHD	100% IHD
MN Females Age ≥ 80 years and = HS	100% IHD	100% IHD
MN Females Age ≥ 80 years and = HS	100% IHD	100% IHD
MS Females Age ≤ 79 years and < HS	100% IHD	100% IHD
MS Females Age ≤ 79 years and = HS	100% IHD	100% IHD
MS Females Age ≤ 79 years and > HS	92.5% IHD, 7.5% AA	93.2% IHD, 6.8% AA
MS Females Age ≥ 80 years and = HS	66.1% IHD, 27.5% COPD, 6.4% CM	66.8% IHD, 27.5% COPD, 5.7% CM
NC Males Age ≥ 80 years and < HS	100% COPD	100% COPD
NC Males Age ≥ 80 years and =HS	NS	NS
NC Males Age ≥ 80 years and > HS	NS	NS
NC Females Age ≤ 79 years and < HS	100% IHD	100% IHD
NC Females Age ≤ 79 years and = HS	100% IHD	100% IHD
NC Females Age ≤ 79 years and > HS	100% IHD	100% IHD
NC Females Age ≥ 80 years and < HS	88.7% COPD, 11.3% AA	88.7% COPD, 11.3% AA
NC Females Age ≥ 80 years and < HS	94.8% IHD, 5.2% AA	95% IHD, 5% AA

HS= high school, IHD = ischemic heart disease, COPD = chronic obstructive pulmonary disease, AA = aortic aneurysm, CM = cardiomyopathy, NS = not significant, MD = Maryland, MN = Minnesota, MS = Mississippi, NC = North Carolina.

There were no significant differences in redistribution proportions for Maryland females in both age groups, Minnesota males aged < 80 years, Mississippi males in both age groups, or North Carolina males age < 80 years (individual data not shown). Table 5 shows a summary of 9 discordant results where the Ahern regression resulted in significant redistribution proportions, whereas the bootstrapped regression showed no statistically significant results.

Table 5. Summary of discordant results comparing the Ahern regression to the bootstrapped regression

	Ahern regression	Bootstrapped regression
MD Males Age ≤ 79 years and < HS	100% CM	NS
MD Males Age ≤ 79 years and = HS	66.8% CM, 33.2% HHD	NS
MD Males Age ≤ 79 years and > HS	100% IHD	NS
MD Males Age ≥ 80 years and = HS	100% COPD	NS
MD Males Age ≥ 80 years and > HS	100% CM	NS
MN Males Age ≥ 80 years and > HS	100% COPD	NS
MN Females Age ≤ 79 years and < HS	92.5% IHD, 7.5% AA	NS
MS Males Age ≤ 79 years and = HS	100% AA	NS
NC Males Age ≤ 79 years and = HS	100% IHD	NS

HS= high school, IHD = ischemic heart disease, COPD = chronic obstructive pulmonary disease, AA = aortic aneurysm, CM = cardiomyopathy, NS = Not significant, MD = Maryland, MN = Minnesota, MS = Mississippi, NC = North Carolina.

There were 10 discordant results, where the Ahern regression redistributed heart failue deaths to more target groups than the bootstrapped regression (Figures 1 to 4). Overall, the Ahern regression and bootstrapped regression were discordant in 19 out of the 62 (30.6%) subgroups examined (Tables 5 and Figures 1 to 3). There were 18 (29.0%) subgroups that showed no significant redistribution targets for the Ahern regression and 28 (45.2%) for the bootstrapped regression (Tables 4 and 5). Ischemic heart disease was a distribution target for 28 (45.2%) of the Ahern regression subgroups and for 22 (35.5%) of the bootstrapped regression subgroups (Tables 4 to 6).

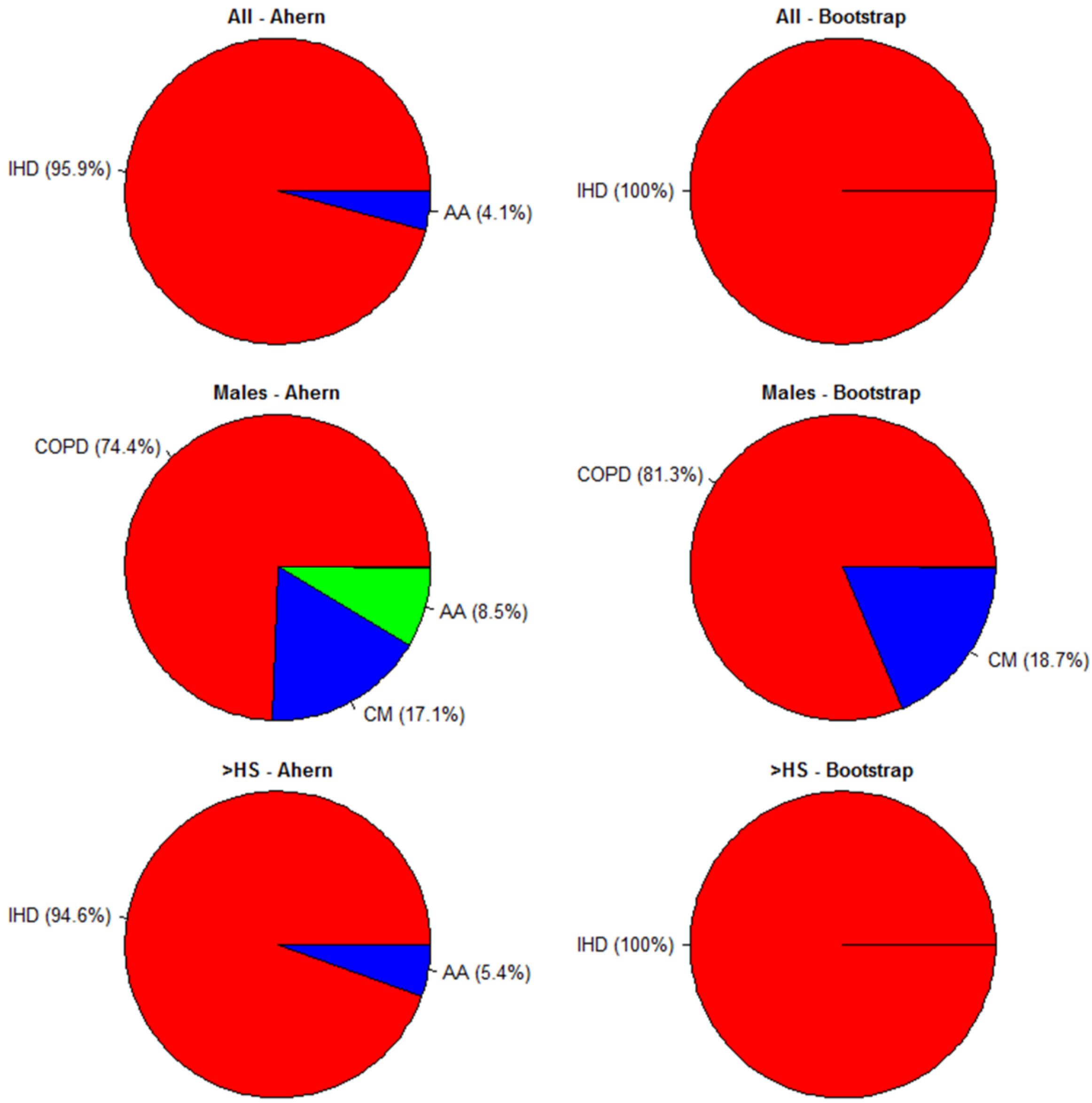

Figure 1. Discordant results between Ahern and bootstrapped regression methods for all participants, all males, and all > HS (education more than high school). IHD = ischemic heart disease, COPD = chronic obstructive pulmonary disease, AA = aortic aneurysm, CM = cardiomyopathy, HS= high school

The Ahern regression redistributed 12.8% of all heart failure deaths to other valve diseases in Maryland, but no redistribution to other valve diseases occurred in Maryland males or females in any age or education group. We looked further into the discordant results for an illustration (as all other discordant results showed similar findings); we use the results for the first pie graph in Figure 2 where the Ahern method distributed 65% to COPD, 22.2% to cardiomyopathy and 12.8% to other valve diseases. In contrast, the bootstrapped method distributed 100% to other valve diseases. We further examined the bootstrapped regression coefficients for cardiomyopathy and COPD. We note that in the Appendix B, the p-values for the bootstrapped regression coefficient for Maryland decedents were 0.06 and 0.07 for COPD and cardiomyopathy, respectively. These p-values were of borderline significance and when replicate samples of size 3,000 were taken from the sample they were no longer significant. The p-values were calculated by taking the mean of the 3,000 regression coefficients and standard errors and calculating the t-value and associated p-value. When we calculated the mean of the p-values for the 3,000 bootstrapped values we observed a p-value of 0.096 for COPD as the p-values were skewed towards the null values and a median p-value of 0.059. Similarly, the mean of the 3,000 bootstrapped p-values for cardiomyopathy was 0.108 and the median was 0.061.

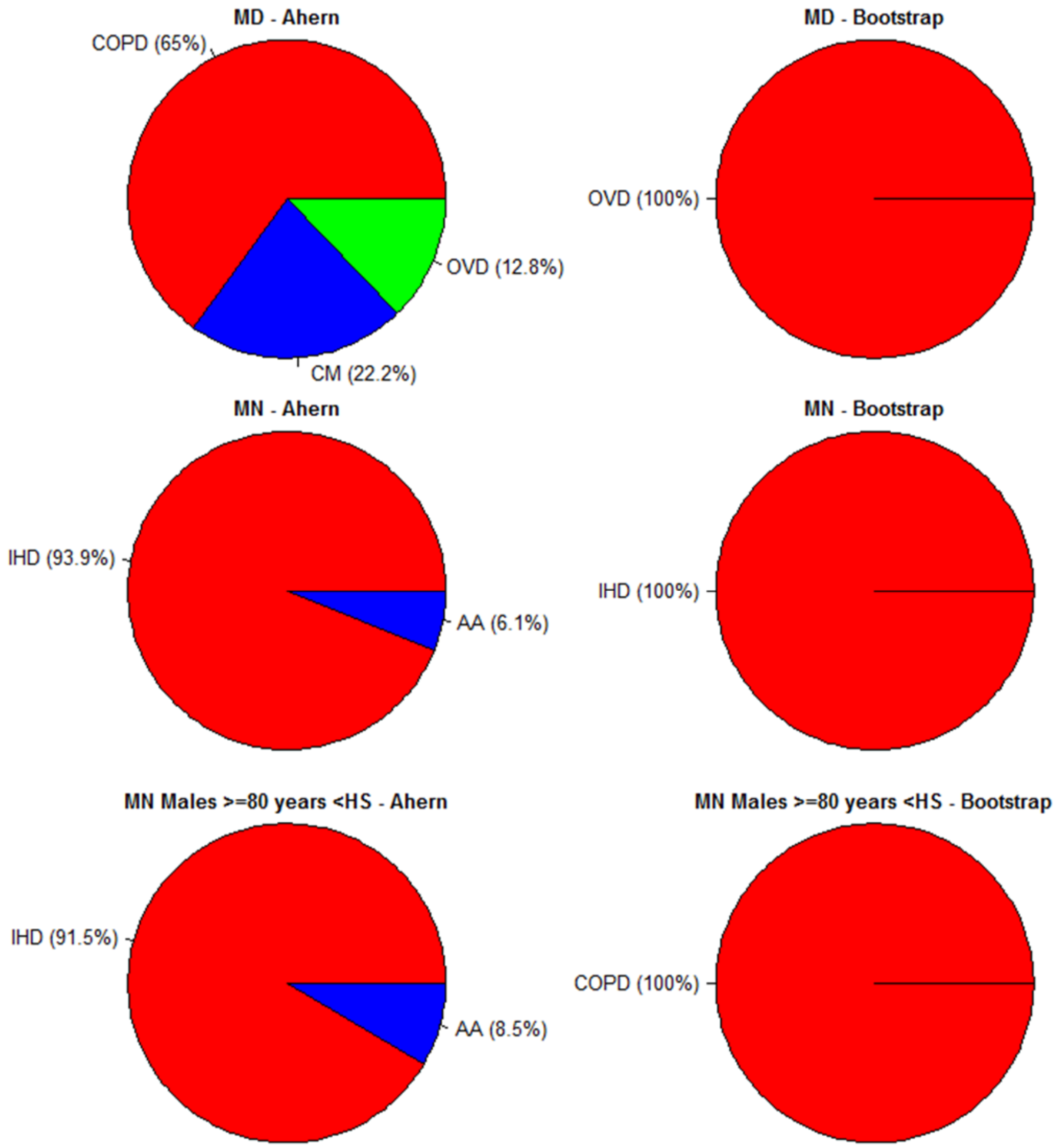

Figure 2. Discordant results between Ahern and bootstrapped regression methods for Maryland (MD), Minnesota (MN), and Minnesota males aged >= 80 years with < HS (education less than high school). IHD = ischemic heart disease, COPD = chronic obstructive pulmonary disease, AA = aortic aneurysm, CM = cardiomyopathy, OVD= other valve diseases, HS= high school

Although hypertensive heart disease was not an important redistribution target in decedents in Maryland, in decedents aged ≤ 79 years or decedents with a high school education, hypertensive heart disease represented 33.2% of the heart failure redistribution target in males aged ≤ 79 year with a high school education for the Ahern regression method, but not the bootstrapped regression. Despite IHD being a 100% redistribution target for heart failure in those aged ≥ 80 years by the Ahern regression, it was not a redistribution target in Maryland male or female decedents aged ≥ 80 years in any education subgroup. Similarly, despite aortic aneurysm representing a 6.1% heart failure redistribution target for the Ahern regression in Minnesota decedents, 4.9% redistribution target in the decedents with a high school and 5.5% in the greater than high school education groups, it was not a significant redistribution target in males of any age or education group. Other inconsistencies were noted but are not listed here (data not shown).

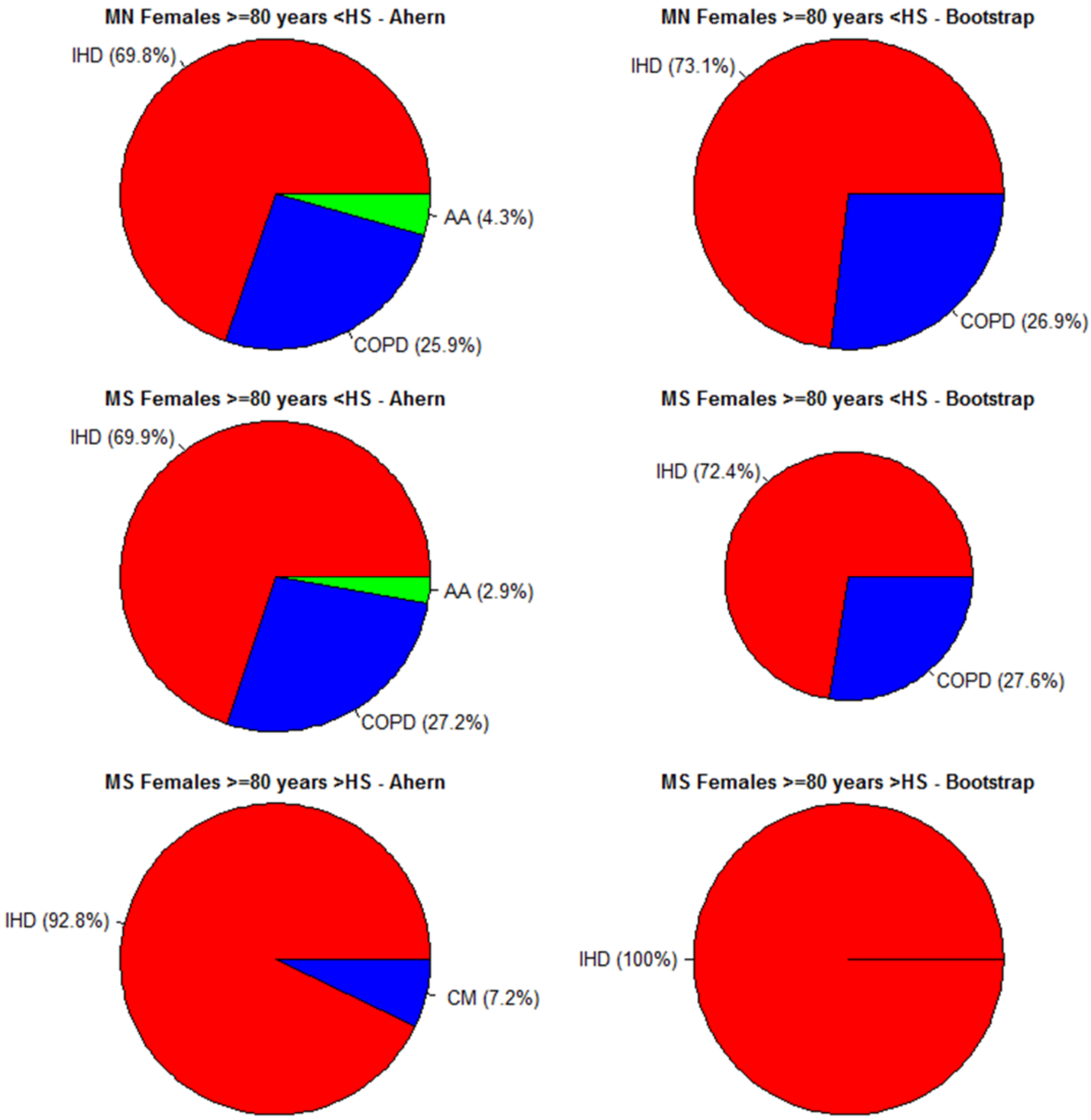

Figure 3. Discordant results between Ahern and bootstrapped regression methods for Minnesota (MN) females aged >=80 years <HS (education less than high school), Mississippi females aged >=80 years <HS, and Mississippi females aged >=80 years >HS (education more than high school). IHD = ischemic heart disease, COPD = chronic obstructive pulmonary disease, AA = aortic aneurysm, CM = cardiomyopathy, HS= high school

The intercepts of the regression equations with significant target codes were scaled to represent 100% and the significant target groups expressed as a proportion out of 100 (Appendix 1). While the majority of the intercepts added up to > 0.850 after dropping the positive β's for the Ahern regression, the following groups showed insignificant constants for IHD and significant constants for other disease or diseases that were less than the constant for IHD: decedents in Maryland had a total for the significant constants of 0.374 for COPD, cardiomyopathy and other valve diseases and a non-significant 0.487 for IHD; male decedents in Maryland aged ≤ 79 years with an education of less than high school had a significant constant for cardiomyopathy of 0.063 and a non-significant constant of 0.639 for IHD; male decedents in Maryland aged ≥ 80 years with a high school education had a significant constant of 0.098 for cardiomyopathy and a non-significant constant of 0.637 for IHD; Minnesota males aged ≥ 80 years with a high school education had a significant constant for COPD of 0.346 and an insignificant constant for IHD of 0.511; Minnesota males aged ≥ 80 years with a greater than high school education had a significant constant for COPD of 0.286 and an insignificant constant for IHD of 0.532; Mississippi males aged ≤ 79 years with a high school education had a significant constant for COPD of 0.050

and an insignificant constant for IHD of 0.645; and North Carolina females aged ≥ 80 years with a less than high school education had a significant constant for COPD and aortic aneurysm of 0.266 and an insignificant constant for IHD of 0.704.

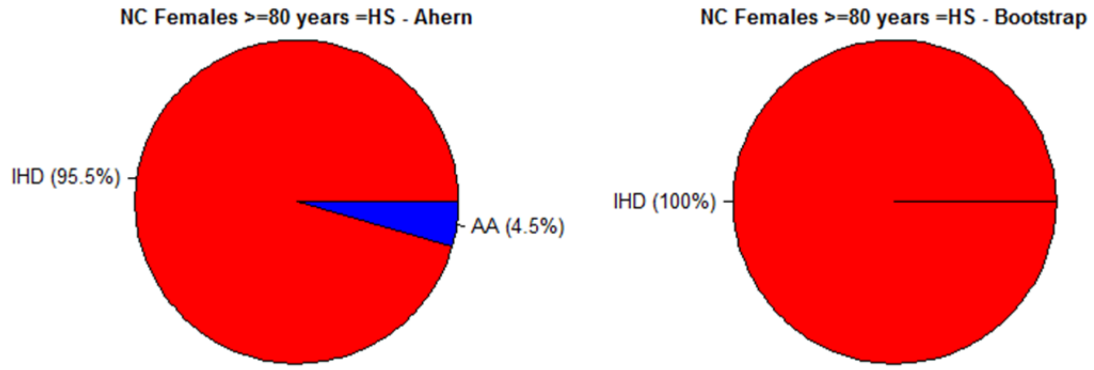

Figure 4. Discordant results between Ahern and bootstrapped regression methods for North Carolina (NC) females aged >=80 years <H=S (education less than high school). IHD = ischemic heart disease, AA = aortic aneurysm, HS= high school

4. Discussion

Although the predominant causes of heart failure are known to vary in different regions of the world, the main risk factors for heart failure typically include IHD, hypertension, rheumatic fever, valvular heart disease, cardiopulmonary disease, cardiomyopathy and “other”, as highlighted by a recent meta-analysis (Khatibzadeh, Farzadfar, Oliver, Ezzati, & Moran, 2013). Within Western high income countries, age and sex adjusted models showed that 51.6% of heart failure deaths were attributable to IHD, and approximately 25% to hypertension, 10% to valvular and rheumatic heart disease, 2% to cardiopulmonary disease, 5% to cardiomyopathy, and 3% to other (Murdoch et al., 1998). The contribution of education was not examined.

Previous studies have used education level as a surrogate for socioeconomic status to match the socioeconomic status of decedents’ (Khatibzadeh, Farzadfar, Oliver, Ezzati, & Moran, 2013; Snyder et al., 2014; Stevens, King, & Shibuya, 2010). Although the manuscript by Stevens et al. (Stevens, King, & Shibuya, 2010) only saw a noticeable SES gradient in HF redistribution in Mexico and Brazil, the authors inferred that death records for a certain demographic group might be of poorer quality than that of the reference group or that the multiple causes of death might be inconsistently listed for different demographic groups.

Consistent with the literature (Forman, Ahmed, & Fleg, 2013; Khatibzadeh, Farzadfar, Oliver, Ezzati, & Moran, 2013), we found that the odds of death attributed to heart failure in the population studied increased with age, was higher in whites and lower in decedents with greater than high school education compared to those with less than high school education. The regression method and bootstrapped regression methods were discordant in 19 (30.6%) out of the 62 subgroups examined. There were 18 (29.0%) subgroups that did not have significant redistribution targets for the Ahern regression and 28 (45.2%) for the bootstrapped regression. IHD was a redistribution target for 28 (45.2%) of the Ahern regression subgroups and 22 (35.5%) of the bootstrapped regression subgroups.

For the Ahern regression, cardiomyopathy represented 100% of heart failure deaths in Maryland males aged ≥ 80 years with a greater than high school education, 22.2% of heart failure deaths in Maryland, 17.1% of heart failure deaths in all male decedents and 7.2% of Minnesota females aged ≥ 80 years with greater than high school education (Table 4 and Table 6). Cardiomyopathy, however, was only significant for 18.7% of heart failure deaths in male decedents in the bootstrapped regression. In contrast, a world-wide meta-analysis reported a maximum median of approximately 20% in Latin American countries was due to cardiomyopathy, 26% in Caribbean and Sub-Saharan Africa countries, and approximately 5% due to cardiomyopathy in Western high income countries (Khatibzadeh, Farzadfar, Oliver, Ezzati, & Moran, 2013).

The current study found between 2.9% to 8.5% of aortic aneurysm as a target group for deaths attributed to heart failure as estimated from the Ahern regression and a slightly lower proportion (4.4% to 6.8%) for the bootstrapped regression. Prevalence figures for aortic aneurysm vary widely, from 11.6% in elderly patients with hypertension (Tsuchie et al., 2013) to 2% in middle-aged patients with acute coronary syndrome (Leong, Ariffin, Chuah, & Voo, 2013), and prevalences of aortic aneurysms of 3 to 4% are cited from epidemiological studies (Wilson, Choke, Dawson, Loftus, & Thompson, 2006). Overall, abdominal aneurysms are reported to be four to six times more common in males than in females (Vardulaki et al., 2000), yet both redistribution methods in the current study reported 4.7% of heart failure deaths attributed to aortic aneurysm in males compared to 4.4% in females. The current study also showed both methods estimated 5.4% of heart failure deaths to aortic aneurysm in males and females with a higher than high school education, a finding that doesn't appear to have been examined previously.

We considered an alternative to the Ahern regression method proposed by Murray et al (Murray et al., 2008) that uses multinomial logistic regression to estimate effects of individual and community factors on assigning a death to a given condition, or to estimate state-level cause-specific death rates standardized for individual and community factors (Murray et al., 2008). This method would be useful to adjust for covariates, but without adjustments this method only provides the crude proportions (when heart failure as the underlying cause of death is left out of the frequency table). Therefore, this method provides an easy way of calculating the proportionate redistribution to the well-defined causes of death conditional on factors such as age, sex or education level. Because our goal was to report redistribution proportions by age, sex, and education group, the multinomial model was not appropriate.

We conclude that the regression method proposed by Ahern et al. (Ahern et al., 2011) to redistribute ill-defined causes of death to target groups is model dependent. As noted by Iacus et al. (Iacus, King, & Porro, 2011), when there is no matching or units have been matched at all costs regardless of whether a reasonable match exists, the result is the production of highly model dependent inferences, which appears to have happened with both the Ahern method and the bootstrapped method. A better method of redistributing heart failure deaths appears to be that of coarsened exact matching (Stevens, King, & Shibuya, 2010), which has been reported on previously (Snyder et al., 2014). Although coarsened exact matching requires multiple-cause-of death information, it is a nonparametric and less computer-intensive method, not dependent on assumptions about the functional form, and is not affected by incorrect assumptions (Stevens, King, & Shibuya, 2010). Compared to multinomial and logistic regression, coarsened exact matching does not require pre-selecting underlying causes of death to which the garbage coded cause of death are to be reassigned (Stevens, King, & Shibuya, 2010) and for these reasons, coarsened exact matching offers a practical way to redistribute underlying causes of death attributed to garbage codes, such as heart failure.

4.1 Limitations

Both methods were computationally expensive and time consuming because of their iterative natures. The target groups had to be processed one at a time and if the slope of the regression coefficient was positive, that target group was dropped with a concomitant drop in the total number in the heart failure universe. This requires repeating the earlier regressions with the smaller universe to ensure that there were no changes to the statistical significance of the models. As is the case for most studies on mortality data, the current study is also limited by the lack of the gold standard autopsy data to determine the true underlying cause of death (Burnand & Feinstein, 1992). An alternate benchmark method of redistributing the deaths assigned to ill-defined causes would be a review and adjudication of the deaths by expert panels, with redistribution based on the adjudication. The associated costs inhibit the implementation of such studies, and it must also be noted, that it is not always possible to unequivocally assign an underlying cause of death (Coady et al., 2001; Rosamond et al., 2004). Ahern et al. developed their method using country-level data globally (Ahern et al., 2011), which is likely to have more variability than the four U.S. states used here.

5. Conclusions

In conclusion, the common reliance on the underlying cause of death for public health analysis should emphasize the value of standardized death certification and ICD coding for accurate cause of death certification and vital registration data. Improving the overall validity of death certificate information is important for public health planning. The Ahern regression had a tendency to redistribute to more targets compared to the bootstrapped regression. Both the Ahern regression and the bootstrapped methods required a large amount of computer programming, and importantly, the results appeared to depend on the choices of sex-age-education group strata. Other methods such as coarsened exact matching and improvements to the Ahern approach are desirable additions to the tools available to mitigate the impact of garbage codes on the accuracy of death certification.

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Competing Interests Statement

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Appendix A

Summary of the statistics and graphical distributions for the bootstrapped vector coefficients for females

Table A1. Mean, median, standard deviation and probability that the distribution of the parameter estimate comes from a normal distribution

	Mean	Median	Standard Deviation	KS Test p-value
AA intercept	0.044824	0.044813	0.001107	>0.1500
AA slope	-0.119355	-0.119299	0.007215	>0.1500
IHD intercept	0.908737	0.908338	0.001689	>0.1500
IHD slope	-0.869866	-0.869804	0.011256	>0.1500

KS test = Kolmogorov-Smirnov test for the probability that the parameter estimate comes from a normal distribution.

AA = Aortic aneurism, IHD = Ischemic Heart Disease.

Table A1 shows that the mean and median of the bootstrapped distributions for Aortic Aneurism and Ischemic heart disease were close and that the Kolmogorov- Smirnov test for the probability that the parameter estimates came from a normal distribution were not rejected. Histograms, boxplots and Q-Qplots for the aortic aneurysm intercept (Figure A1) and slope (Figure A2) and ischemic heart disease intercept (Figure A3) and slope (Figure A4) all show no evidence that the bootstrapped data did not come from a normal distribution.

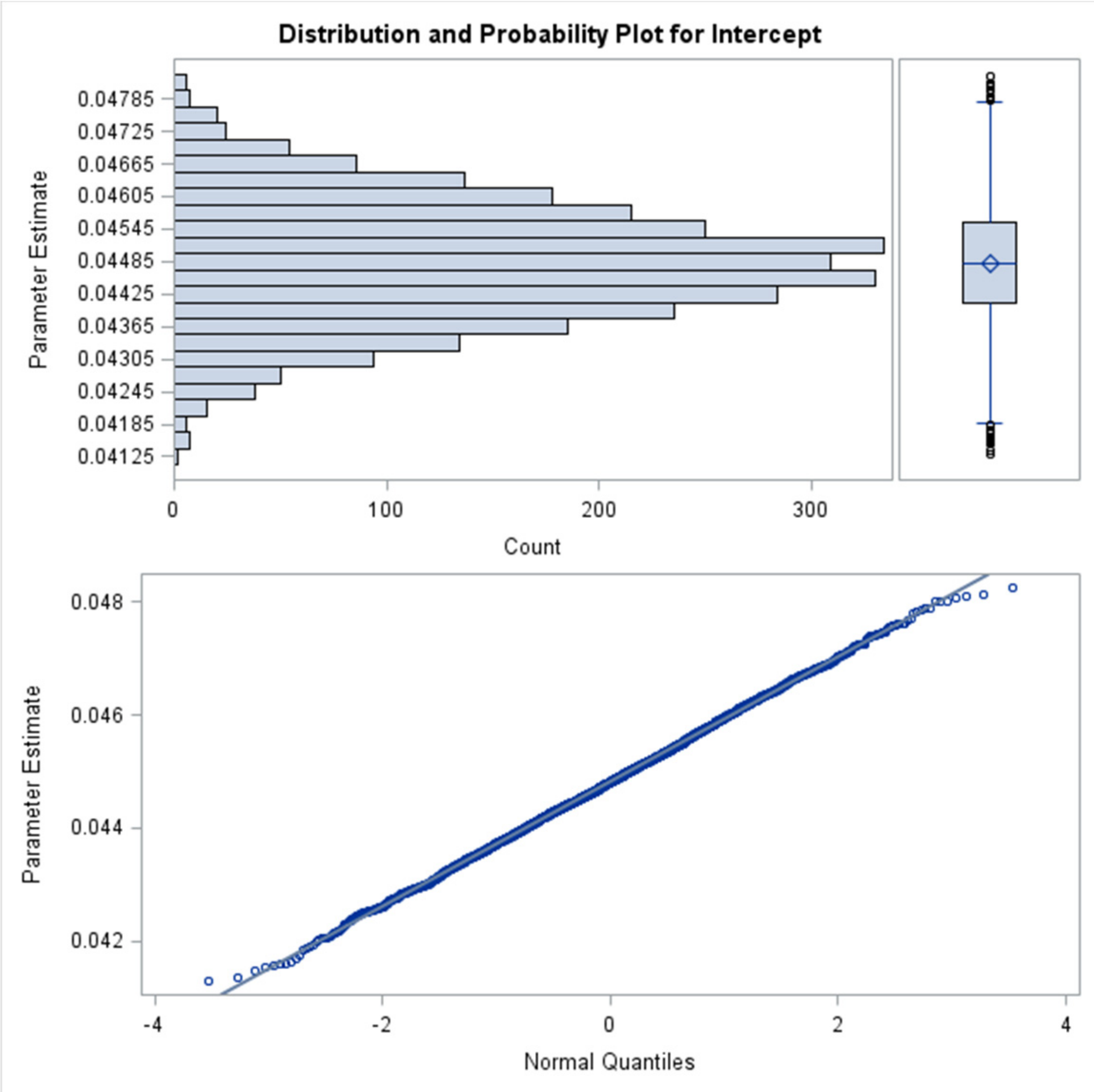

Figure A1. Histogram, boxplot and Q-Q plot of the Intercept coefficient for the target group Aortic Aneurism.

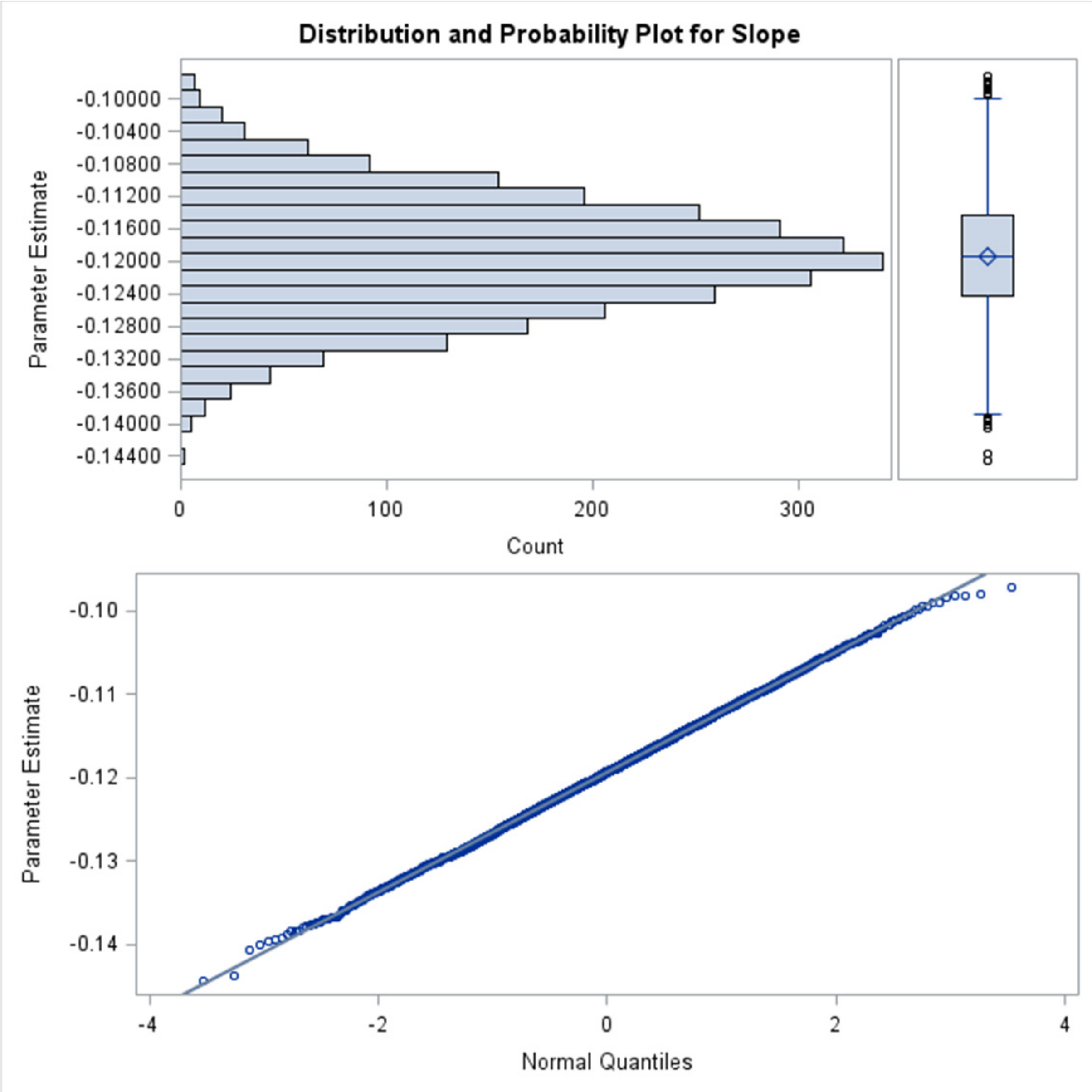

Figure A2. Histogram, boxplot and Q-Q plot of the Slope coefficient for the target group Aortic Aneurism.

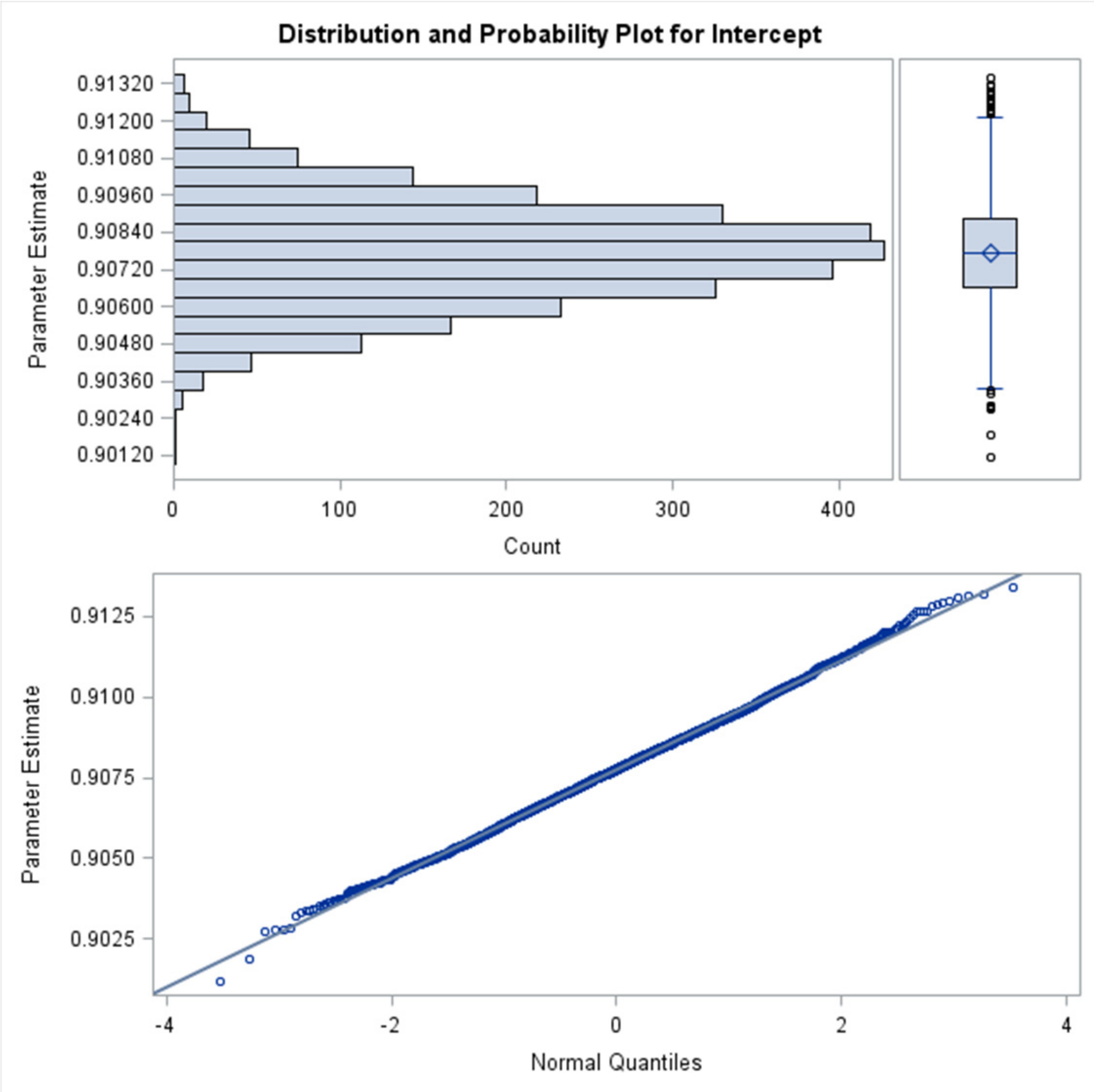

Figure A3. Histogram, boxplot and Q-Q plot of the Intercept coefficient for the target group Ischemic Heart Disease.

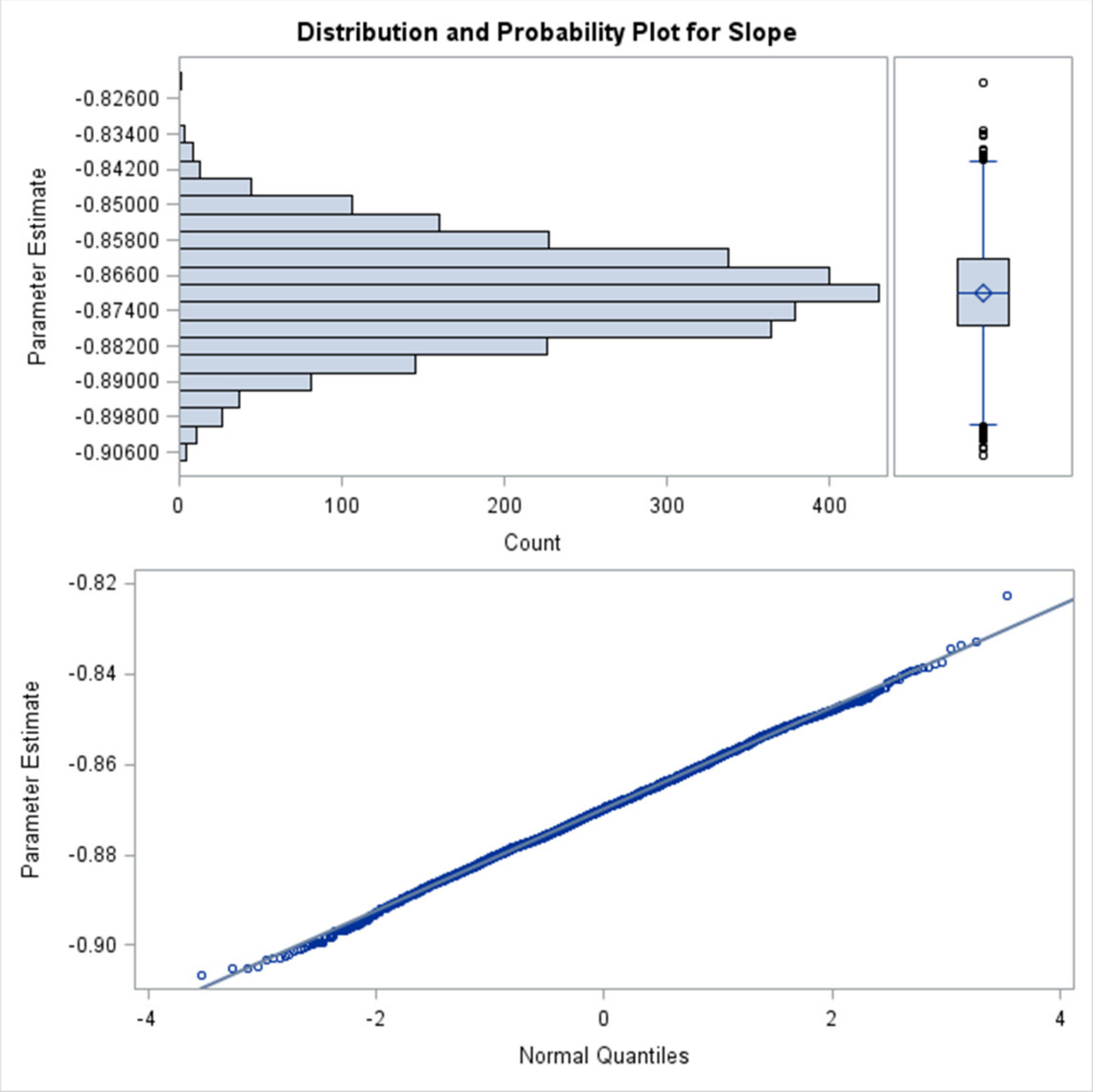

Figure A4. Histogram, boxplot and Q-Q plot of the Slope coefficient for the target group Ischemic Heart Disease.

Figure A5 shows that the bootstrapped redistribution proportions ranged from 4.4 to 5.0 percent for Aortic Aneurism and from 95.0 to 95.6 percent for Ischemic Heart Disease (Figure A6).

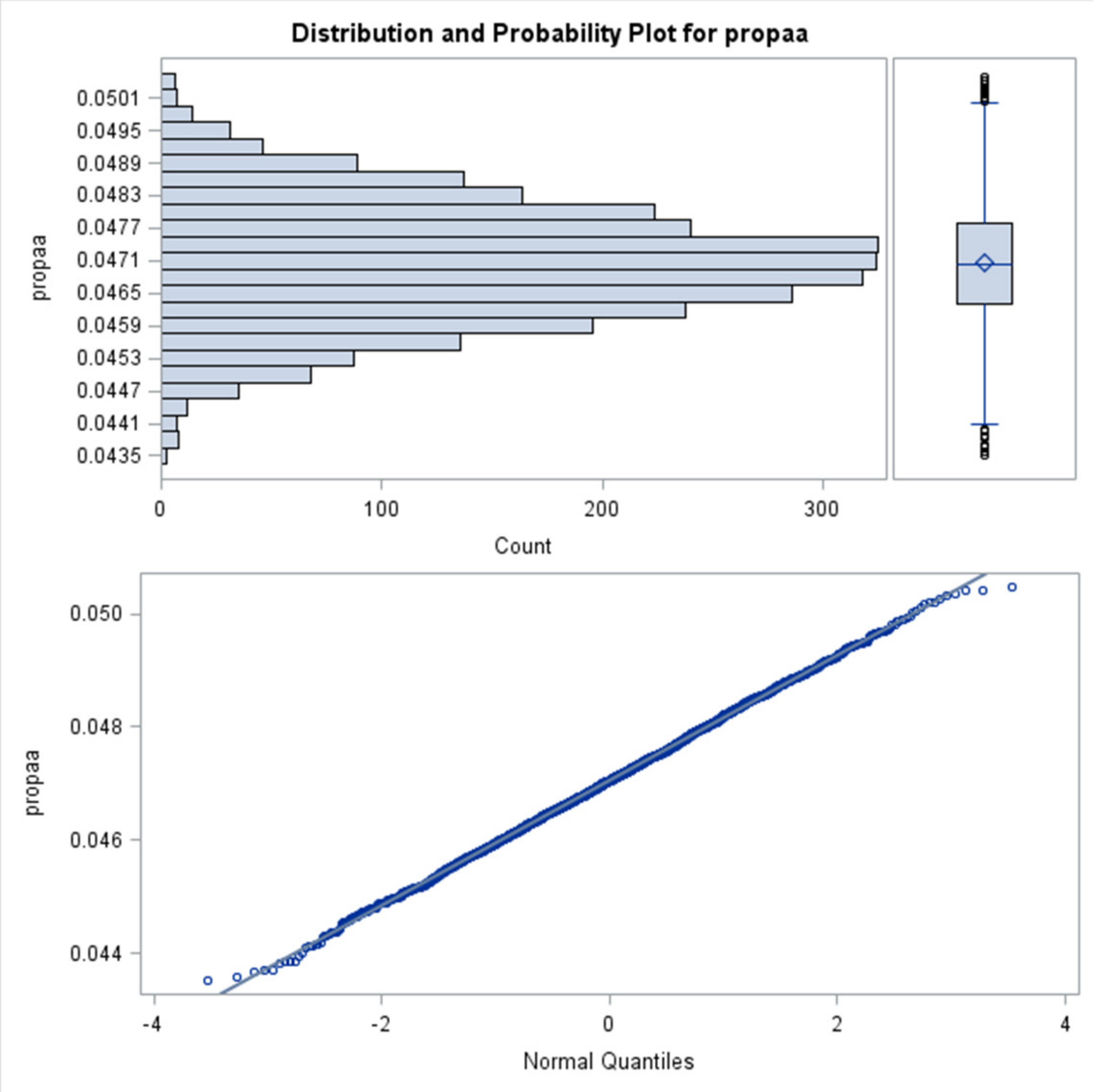

Figure 5. Histogram, boxplot and Q-Q plot of the 3,000 bootstrapped redistribution proportions for Aortic Aneurism (propaa = proportion with Aortic Aneurism).

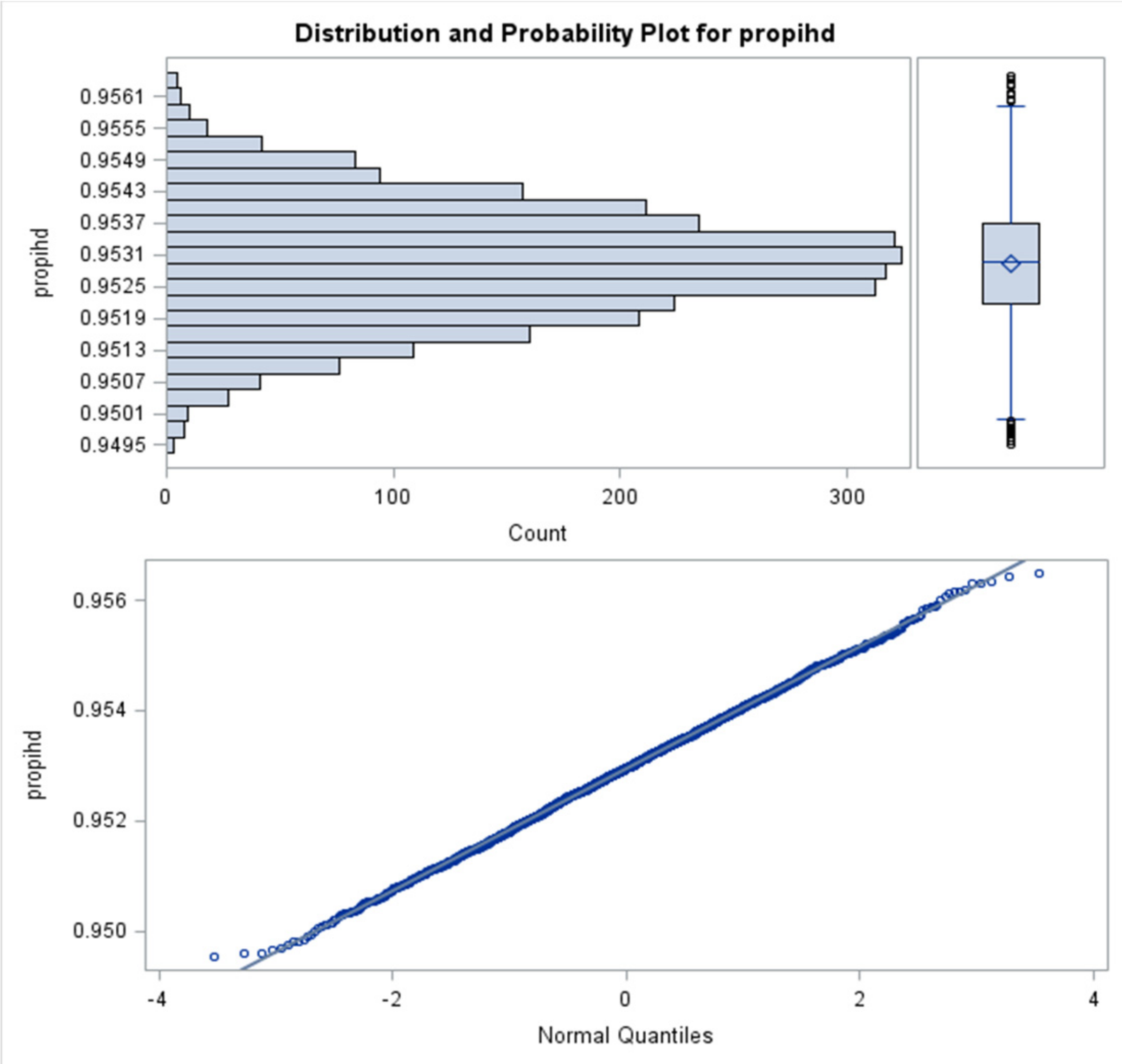

Figure 6. Histogram, boxplot and Q-Q plot of the 3,000 bootstrapped redistribution proportions for Ischemic Heart Disease (propihd = proportion with IHD).

Appendix B

Table B1. Complete Ahern and bootstrapped regression results. Results in boldface indicate significant (Target group) variables

Target Group	Beta	Constant	p	N	Result
Ahern regression All ARIC states n=1,623,901					
Aortic Aneurysm	-0.177	0.037	0.085	12	Non-significant
COPD	2.128	-0.019	0.010	12	Drop
Cardiomyopathy	0.214	0.014	0.018	12	Drop
Hypertensive Heart Disease	0.890	-0.028	<0.001	12	Drop
Ischemic Heart Disease	**-4.330**	**0.995**	**0.001**	**12**	**Target**
Other Valve Diseases	0.260	-0.001	0.026	12	Drop
Thyroid Disorders	0.014	0.002	0.337	12	Non-significant

Target Group	Beta	Constant	p	N	Result
All ARIC states					
Aortic Aneurysm	**-0.088**	**0.041**	**0.047**	**12**	**Target**
Ischemic Heart Disease	**-0.929**	**0.957**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.017	0.002	0.082	12	Non-significant

95.9% IHD, 4.1% AA

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression All ARIC states					
Aortic Aneurysm	-0.087	0.041	0.068	12	Non-significant
Ischemic Heart Disease	**-0.929**	**0.957**	**<0.001**	**12**	**Target**

100% IHD

Target Group	Beta	Constant	p	N	Result
Ahern regression Males n=794,546					
Aortic Aneurysm	**-0.146**	**0.033**	**0.045**	**12**	**Target**
COPD	**-1.295**	**0.294**	**0.001**	**12**	**Target**
Cardiomyopathy	**-0.361**	**0.068**	**<0.001**	**12**	**Target**
Hypertensive Heart Disease	0.252	0.032	0.016	12	Drop
Ischemic Heart Disease	0.195	0.580	0.603	12	Non-significant
Other Valve Diseases	0.228	0.002	0.002	12	Drop
Thyroid Disorders	0.129	-0.009	<0.001	12	Drop

Target Group	Beta	Constant	p	N	Result
Males					
Aortic Aneurysm	**-0.129**	**0.034**	**0.047**	**12**	**Target**
COPD	**-1.099**	**0.300**	**0.003**	**12**	**Target**
Cardiomyopathy	**-0.316**	**0.069**	**<0.001**	**12**	**Target**
Ischemic Heart Disease	0.544	0.596	0.095	12	Non-significant

74.4% COPD, 17.1% cardiomyopathy, 8.5% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression Males					
Aortic Aneurysm	-0.127	0.034	0.059	12	Non-significant
COPD	**-1.086**	**0.299**	**0.003**	**12**	**Target**
Cardiomyopathy	**-0.312**	**0.069**	**0.001**	**12**	**Target**

81.3% COPD, 18.7% CM.

Target Group	Beta	Constant	p	N	Result
Ahern regression Females n=829,355					
Aortic Aneurysm	**-0.182**	**0.039**	**<0.001**	**12**	**Target**
COPD	0.479	0.140	0.046	12	Drop
Cardiomyopathy	**-0.090**	**0.042**	**0.002**	**12**	**Target**
Hypertensive Heart Disease	0.589	-0.001	<0.001	12	Drop
Ischemic Heart Disease	**-2.142**	**0.785**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.275	-0.002	<0.001	12	Drop
Thyroid Disorders	0.071	-0.003	0.006	12	Drop

Target Group	Beta	Constant	p	N	Result
Females					
Aortic Aneurysm	**-0.120**	**0.045**	**<0.001**	**12**	**Target**
Cardiomyopathy	-0.010	0.047	0.719	12	Non-significant
Ischemic Heart Disease	**-0.870**	**0.908**	**<0.001**	**12**	**Target**

95.3% IHD, 4.7% AA

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression Females					
Aortic Aneurysm	**-0.119**	**0.045**	**<0.001**	**12**	**Target**
Ischemic Heart Disease	**-0.870**	**0.908**	**<0.001**	**12**	**Target**

95.3% IHD, 4.7% AA

Target Group	Beta	Constant	p	N	Result
Ahern regression Whites n=1,330,997					
Aortic Aneurysm	**-0.207**	**0.042**	**0.037**	**12**	**Target**
COPD	2.284	-0.021	0.005	12	Drop
Cardiomyopathy	0.199	0.012	0.015	12	Drop
Hypertensive Heart Disease	0.667	-0.022	<0.001	12	Drop
Ischemic Heart Disease	**-4.263**	**0.991**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.312	-0.003	0.011	12	Drop
Thyroid Disorders	0.007	0.003	0.651	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Whites					
Aortic Aneurysm	**-0.095**	**0.044**	**0.026**	**12**	**Target**
Ischemic Heart Disease	**-0.917**	**0.953**	**<0.001**	**12**	**Target**

95.6% IHD, 4.4% AA

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression Whites					
Aortic Aneurysm	**-0.094**	**0.044**	**0.044**	**12**	**Target**
Ischemic Heart Disease	**-0.917**	**0.953**	**<0.001**	**12**	**Target**

95.6% IHD, 4.4% AA

Target Group	Beta	Constant	p	N	Result
Ahern regression Other n=292,904					
Aortic Aneurysm	0.040	0.011	0.655	12	Non-significant
COPD	0.202	0.083	0.762	12	Non-significant
Cardiomyopathy	-0.023	0.050	0.869	12	Non-significant
Hypertensive Heart Disease	0.691	0.063	0.259	12	Non-significant
Ischemic Heart Disease	-1.835	0.771	0.182	12	Non-significant
Other Valve Diseases	-0.090	0.020	0.150	12	Non-significant
Thyroid Disorders	0.015	0.002	0.523	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression <HS n=630,554					
Aortic Aneurysm	-0.117	0.029	0.144	12	Non-significant
COPD	2.313	-0.052	0.003	12	Drop
Cardiomyopathy	0.206	0.010	0.004	12	Drop
Hypertensive Heart Disease	0.770	-0.020	<0.001	12	Drop
Ischemic Heart Disease	**-4.328**	**1.023**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.157	0.006	0.014	12	Drop
Thyroid Disorders	-0.002	0.003	0.893	12	Non-significant

Target Group	Beta	Constant	p	N	Result
<HS					
Aortic Aneurysm	-0.046	0.031	0.223	12	Non-significant
Ischemic Heart Disease	**-0.966**	**0.966**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.012	0.003	0.316	12	Non-significant

100% IHD

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression <HS					
Ischemic Heart Disease	**-0.966**	**0.966**	**<0.001**	**12**	**Target**

100% IHD

Target Group	Beta	Constant	p	N	Result
Ahern regression =HS n=560,822					
Aortic Aneurysm	**-0.282**	**0.046**	**0.024**	**12**	**Target**
COPD	2.251	-0.006	0.003	12	Drop
Cardiomyopathy	0.143	0.022	0.080	12	Non-significant
Hypertensive Heart Disease	0.891	-0.023	<0.001	12	Drop
Ischemic Heart Disease	**-4.384**	**0.967**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.362	-0.009	0.011	12	Drop
Thyroid Disorders	0.019	0.002	0.308	12	Non-significant

Target Group	Beta	Constant	p	N	Result
=HS					
Aortic Aneurysm	**-0.148**	**0.049**	**0.016**	**12**	**Target**
Cardiomyopathy	0.257	0.017	0.002	12	Drop
Ischemic Heart Disease	**-0.871**	**0.948**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.019	0.002	0.116	12	Non-significant

95.1% IHD, 4.9% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression =HS					
Aortic Aneurysm	**-0.143**	**0.049**	**0.038**	**12**	**Target**
Ischemic Heart Disease	**-0.874**	**0.949**	**<0.001**	**12**	**Target**

95.1% IHD, 4.9% AA.

Target Group	Beta	Constant	p	N	Result
Ahern regression >HS n=432,525					
Aortic Aneurysm	-0.245	0.046	0.094	12	Non-significant
COPD	1.239	0.052	0.064	12	Non-significant
Cardiomyopathy	0.151	0.024	0.169	12	Non-significant
Hypertensive Heart Disease	0.877	-0.028	0.006	12	Drop
Ischemic Heart Disease	**-3.245**	**0.893**	**0.004**	**12**	**Target**
Other Valve Diseases	0.191	0.011	0.175	12	Non-significant
Thyroid Disorders	0.032	<0.001	0.352	12	Non-significant

Target Group	Beta	Constant	p	N	Result
>HS					
Aortic Aneurysm	**-0.196**	**0.053**	**0.029**	**12**	**Target**
COPD	1.378	0.041	0.034	12	Drop
Cardiomyopathy	0.264	0.018	0.018	12	Drop
Ischemic Heart Disease	**-1.375**	**0.923**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.286	0.004	0.026	12	Drop
Thyroid Disorders	0.022	0.002	0.403	12	Non-significant

94.6% IHD, 5.4% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression >HS					
Aortic Aneurysm	-0.169	0.055	0.053	12	Non-significant
Ischemic Heart Disease	**-2.710**	**0.776**	**0.048**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression <= 79 n=805,115					
Aortic Aneurysm	-0.391	0.046	0.066	12	Non-significant
COPD	2.997	0.051	0.017	12	Drop
Cardiomyopathy	0.099	0.034	0.323	12	Non-significant
Hypertensive Heart Disease	1.432	-0.025	0.004	12	Drop
Ischemic Heart Disease	**-5.213**	**0.884**	**0.002**	**12**	**Target**
Other Valve Diseases	0.060	0.010	0.253	12	Non-significant
Thyroid Disorders	0.016	<0.001	0.519	12	Non-significant

Target Group	Beta	Constant	p	N	Result
<= 79					
Aortic Aneurysm	**-0.241**	**0.055**	**0.018**	**12**	**Target**
Cardiomyopathy	0.311	0.030	0.007	12	Drop
Ischemic Heart Disease	**-0.775**	**0.944**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.137	0.008	0.008	12	Drop
Thyroid Disorders	0.016	0.001	0.362	12	Non-significant

94.5% IHD, 5.5% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression <= 79					
Aortic Aneurysm	**-0.232**	**0.054**	**0.034**	**12**	**Target**
Ischemic Heart Disease	**-0.782**	**0.944**	**<0.001**	**12**	**Target**

94.6% IHD, 5.4% AA.

Target Group	Beta	Constant	p	N	Result
Ahern regression >= 80 n=818,786					
Aortic Aneurysm	-0.011	0.019	0.867	12	Non-significant
COPD	1.734	-0.072	0.026	12	Drop
Cardiomyopathy	0.299	-0.009	0.022	12	Drop
Hypertensive Heart Disease	0.567	-0.017	0.003	12	Drop
Ischemic Heart Disease	**-3.902**	**1.080**	**0.002**	**12**	**Target**
Other Valve Diseases	0.302	-0.005	0.084	12	Non-significant
Thyroid Disorders	0.010	0.003	0.632	12	Non-significant

Target Group	Beta	Constant	p	N	Result
>= 80					
Aortic Aneurysm	0.007	0.023	0.817	12	Non-significant
Ischemic Heart Disease	**-1.021**	**0.974**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.387	-0.021	0.003	12	Drop
Thyroid Disorders	0.014	0.004	0.272	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression >= 80					
Ischemic Heart Disease	**-1.020**	**0.973**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression MD n=395,419					
Aortic Aneurysm	0.402	-0.006	0.030	12	Drop
COPD	**-1.589**	**0.242**	**0.033**	**12**	**Target**
Cardiomyopathy	**-0.841**	**0.083**	**0.037**	**12**	**Target**
Hypertensive Heart Disease	-1.231	0.136	0.062	12	Non-significant
Ischemic Heart Disease	2.696	0.495	0.086	12	Non-significant
Other Valve Diseases	**-0.482**	**0.048**	**0.003**	**12**	**Target**
Thyroid Disorders	0.045	0.002	0.247	12	Non-significant

Target Group	Beta	Constant	p	N	Result
MD					
COPD	**-1.532**	**0.243**	**0.027**	**12**	**Target**
Cardiomyopathy	**-0.829**	**0.083**	**0.031**	**12**	**Target**
Hypertensive Heart Disease	-1.209	0.137	0.056	12	Non-significant
Ischemic Heart Disease	2.988	0.487	0.066	12	Non-significant
Other Valve Diseases	**-0.464**	**0.048**	**0.003**	**12**	**Target**
Thyroid Disorders	0.046	0.001	0.224	12	Non-significant

65% COPD, 22.2% CM, 12.8% OVD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression MD					
COPD	-1.277	0.228	0.060	12	Non-significant
Cardiomyopathy	-0.673	0.075	0.070	12	Non-significant
Other Valve Diseases	**-0.381**	**0.043**	**0.028**	**12**	**Target**

100% OVD.

Target Group	Beta	Constant	p	N	Result
Ahern regression MN n=342,603					
Aortic Aneurysm	**-0.203**	**0.058**	**0.007**	**12**	**Target**
COPD	1.204	0.056	0.078	12	Non-significant
Cardiomyopathy	0.076	0.021	0.265	12	Non-significant
Hypertensive Heart Disease	0.345	-0.009	0.004	12	Drop
Ischemic Heart Disease	**-2.925**	**0.890**	**0.004**	**12**	**Target**
Other Valve Diseases	0.490	-0.019	0.020	12	Drop
Thyroid Disorders	0.013	0.003	0.685	12	Non-significant

Target Group	Beta	Constant	p	N	Result
MN					
Aortic Aneurysm	**-0.073**	**0.061**	**0.021**	**12**	**Target**
COPD	1.348	0.041	0.036	12	Drop
Cardiomyopathy	0.170	0.013	0.011	12	Drop
Ischemic Heart Disease	**-0.935**	**0.934**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.009	0.005	0.675	12	Non-significant

93.9% IHD, 6.1% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression MN					
Aortic Aneurysm	-0.073	0.061	0.140	12	Non-significant
Ischemic Heart Disease	**-0.936**	**0.934**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression MS n=227,009					
Aortic Aneurysm	-0.070	0.025	0.150	12	Non-significant
COPD	1.298	-0.047	0.010	12	Drop
Cardiomyopathy	**-0.189**	**0.061**	**0.026**	**12**	**Target**
Hypertensive Heart Disease	0.977	-0.072	0.002	12	Drop
Ischemic Heart Disease	**-3.057**	**1.026**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.016	0.009	0.557	12	Non-significant
Thyroid Disorders	0.025	-0.003	0.088	12	Non-significant

Target Group	Beta	Constant	p	N	Result
MS					
Aortic Aneurysm	-0.036	0.027	0.127	12	Non-significant
Cardiomyopathy	-0.060	0.054	0.204	12	Non-significant
Ischemic Heart Disease	**-0.924**	**0.922**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.041	0.006	0.045	12	Drop
Thyroid Disorders	0.020	-0.002	0.052	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression MS					
Ischemic Heart Disease	**-0.922**	**0.922**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression NC n=658,870					
Aortic Aneurysm	-0.137	0.030	0.092	12	Non-significant
COPD	2.365	0.014	<0.001	12	Drop
Cardiomyopathy	0.225	0.019	<0.001	12	Drop
Hypertensive Heart Disease	0.397	0.016	0.002	12	Drop
Ischemic Heart Disease	**-4.073**	**0.911**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.218	0.006	0.001	12	Drop
Thyroid Disorders	0.005	0.002	0.713	12	Non-significant

Target Group	Beta	Constant	p	N	Result
NC					
Aortic Aneurysm	-0.054	0.035	0.242	12	Non-significant
Ischemic Heart Disease	**-0.960**	**0.963**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.014	0.003	0.192	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression NC					
Ischemic Heart Disease	**-0.960**	**0.963**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=M age<=79 edgp < HS n=28,180					
Aortic Aneurysm	0.059	0.015	0.713	12	Non-significant
COPD	0.086	0.194	0.905	12	Non-significant
Cardiomyopathy	**-0.657**	**0.062**	**0.003**	**12**	**Target**
Hypertensive Heart Disease	-0.363	0.091	0.350	12	Non-significant
Ischemic Heart Disease	-0.579	0.640	0.466	12	Non-significant
Other Valve Diseases	0.374	-0.002	0.010	12	Drop
Thyroid Disorders	0.054	0.001	0.403	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MD sex=M age<=79 edgp < HS					
Aortic Aneurysm	0.066	0.015	0.679	12	Non-significant
COPD	0.169	0.193	0.812	12	Non-significant
Cardiomyopathy	**-0.639**	**0.063**	**0.003**	**12**	**Target**
Hypertensive Heart Disease	-0.332	0.091	0.381	12	Non-significant
Ischemic Heart Disease	-0.344	0.639	0.659	12	Non-significant
Thyroid Disorders	0.056	<0.001	0.384	12	Non-significant

100% cardiomyopathy.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MD sex=M age<=79 edgp < HS					
Cardiomyopathy	-0.453	0.056	0.093	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=M age<=79 edgp = HS n=41,348					
Aortic Aneurysm	0.250	0.010	0.425	12	Non-significant
COPD	3.266	0.060	0.080	12	Non-significant
Cardiomyopathy	**-0.804**	**0.068**	**0.032**	**12**	**Target**
Hypertensive Heart Disease	**-1.521**	**0.137**	**0.014**	**12**	**Target**
Ischemic Heart Disease	-2.589	0.727	0.081	12	Non-significant
Other Valve Diseases	0.246	0.001	0.252	12	Non-significant
Thyroid Disorders	0.163	-0.003	0.143	12	Non-significant

66.8% CM, 33.2% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MD sex=M age<=79 edgp = HS					
Cardiomyopathy	-0.478	0.058	0.207	12	Non-significant
Hypertensive Heart Disease	-0.900	0.117	0.136	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=M age<=79 edgp > HS n = 29,921					
Aortic Aneurysm	0.041	0.018	0.870	12	Non-significant
COPD	2.669	0.045	0.073	12	Non-significant
Cardiomyopathy	-0.433	0.059	0.087	12	Non-significant
Hypertensive Heart Disease	-0.368	0.090	0.588	12	Non-significant
Ischemic Heart Disease	**-3.316**	**0.785**	**0.027**	**12**	**Target**
Other Valve Diseases	0.377	0.002	0.019	12	**Drop**
Thyroid Disorders	0.037	0.001	0.675	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=M age<=79 edgp > HS					
Aortic Aneurysm	0.047	0.018	0.848	12	Non-significant
COPD	2.706	0.044	0.067	12	Non-significant
Cardiomyopathy	-0.414	0.059	0.090	12	Non-significant
Hypertensive Heart Disease	-0.341	0.091	0.608	12	Non-significant
Ischemic Heart Disease	**-3.032**	**0.787**	**0.033**	**12**	**Target**
Thyroid Disorders	0.040	0.001	0.653	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MD sex=M age<=79 edgp > HS					
Ischemic Heart Disease	-2.262	0.761	0.084	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=M age>=80 edgp < HS n=33,145					
Aortic Aneurysm	0.020	0.010	0.819	12	Non-significant
COPD	**-2.084**	**0.283**	**<0.001**	**12**	**Target**
Cardiomyopathy	**-0.786**	**0.089**	**<0.001**	**12**	**Target**
Hypertensive Heart Disease	0.067	0.052	0.592	12	Non-significant
Ischemic Heart Disease	1.545	0.554	<0.001	12	Drop
Other Valve Diseases	0.105	0.016	0.463	12	Non-significant
Thyroid Disorders	0.133	-0.004	0.003	12	Drop

Target Group	Beta	Constant	p	N	Result
State = MD sex=M age>=80 edgp < HS					
Aortic Aneurysm	0.071	0.024	0.261	12	Non-significant
COPD	**-0.880**	**0.720**	**<0.001**	**12**	**Target**
Cardiomyopathy	**-0.387**	**0.220**	**<0.001**	**12**	**Target**
Hypertensive Heart Disease	0.248	0.119	0.009	12	Drop
Other Valve Diseases	0.196	0.037	0.067	12	Non-significant

76.6% COPD, 23.4% cardiomyopathy.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MD sex=M age>=80 edgp < HS					
COPD	**-0.866**	**0.716**	**<0.001**	**12**	**Target**
Cardiomyopathy	**-0.373**	**0.216**	**0.003**	**12**	**Target**

76.8% COPD, 23.2% cardiomyopathy.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=M age>=80 edgp = HS n=32,128					
Aortic Aneurysm	0.086	0.010	0.673	12	Non-significant
COPD	**-1.239**	**0.223**	**0.008**	**12**	**Target**
Cardiomyopathy	-0.544	0.074	0.108	12	Non-significant
Hypertensive Heart Disease	-0.069	0.059	0.814	12	Non-significant
Ischemic Heart Disease	0.701	0.607	0.242	12	Non-significant
Other Valve Diseases	-0.106	0.034	0.679	12	Non-significant
Thyroid Disorders	0.198	-0.008	0.014	12	Non-significant

100% COPD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MD sex=M age>=80 edgp = HS					
COPD	-0.865	0.197	0.071	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=M age>=80 edgp > HS n=27,995					
Aortic Aneurysm	0.145	0.004	0.422	12	Non-significant
COPD	-0.458	0.163	0.378	12	Non-significant
Cardiomyopathy	**-0.819**	**0.098**	**0.004**	**12**	**Target**
Hypertensive Heart Disease	-0.026	0.053	0.932	12	Non-significant
Ischemic Heart Disease	0.276	0.637	0.618	12	Non-significant
Other Valve Diseases	-0.252	0.053	0.188	12	Non-significant
Thyroid Disorders	0.134	-0.007	0.164	12	Non-significant

100% Cardiomyopathy.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MD sex=M age>=80 edgp > HS					
Cardiomyopathy	-0.467	0.070	0.094	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=F age≤79 edgp < HS n=26,578					
Aortic Aneurysm	-0.094	0.021	0.484	12	Non-significant
COPD	2.536	0.136	0.189	12	Non-significant
Cardiomyopathy	-0.700	0.061	0.066	12	Non-significant
Hypertensive Heart Disease	0.841	0.041	0.003	12	Drop
Ischemic Heart Disease	-4.086	0.748	0.060	12	Non-significant
Other Valve Diseases	0.423	-0.006	0.005	12	Drop
Thyroid Disorders	0.036	0.001	0.403	12	Non-significant

All still NS after dropping.

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = MD sex=F age≤79 edgp =HS n=40,058					
Aortic Aneurysm	0.005	0.019	0.984	12	Non-significant
COPD	2.367	0.106	0.169	12	Non-significant
Cardiomyopathy	-0.212	0.047	0.382	12	Non-significant
Hypertensive Heart Disease	0.275	0.063	0.482	12	Non-significant
Ischemic Heart Disease	-3.744	0.763	0.076	12	Non-significant
Other Valve Diseases	0.293	<0.001	0.053	12	Non-significant
Thyroid Disorders	-0.014	0.004	0.771	12	Non-significant

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = MD sex=F age≤79 edgp >HS n=26,886					
Aortic Aneurysm	0.056	0.020	0.861	12	Non-significant
COPD	1.230	0.120	0.341	12	Non-significant
Cardiomyopathy	0.020	0.046	0.908	12	Non-significant
Hypertensive Heart Disease	0.119	0.069	0.878	12	Non-significant
Ischemic Heart Disease	-2.354	0.729	0.224	12	Non-significant
Other Valve Diseases	-0.021	0.013	0.884	12	Non-significant
Thyroid Disorders	0.044	0.001	0.383	12	Non-significant

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = MD sex=F age≥80 edgp <HS n=36,899					
Aortic Aneurysm	-0.132	0.023	0.367	12	Non-significant
COPD	-1.180	0.220	0.060	12	Non-significant
Cardiomyopathy	-0.226	0.046	0.229	12	Non-significant
Hypertensive Heart Disease	1.141	-0.013	0.019	12	Drop
Ischemic Heart Disease	-0.909	0.716	0.261	12	Non-significant
Other Valve Diseases	0.090	0.019	0.754	12	Non-significant
Thyroid Disorders	0.169	-0.006	0.213	12	Non-significant

All still NS after drop.

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = MD sex=F age≥80 edgp =HS n=43,591					
Aortic Aneurysm	0.101	0.006	0.252	12	Non-significant
COPD	-0.607	0.182	0.142	12	Non-significant
Cardiomyopathy	-0.387	0.059	0.092	12	Non-significant
Hypertensive Heart Disease	0.355	0.034	0.585	12	Non-significant
Ischemic Heart Disease	-0.637	0.694	0.630	12	Non-significant
Other Valve Diseases	0.050	0.028	0.849	12	Non-significant
Thyroid Disorders	0.012	0.005	0.926	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MD sex=F age≥80 edgp >HS n=28,690					
Aortic Aneurysm	-0.156	0.028	0.246	12	Non-significant
COPD	0.289	0.124	0.595	12	Non-significant
Cardiomyopathy	-0.001	0.031	0.995	12	Non-significant
Hypertensive Heart Disease	0.373	0.029	0.411	12	Non-significant
Ischemic Heart Disease	-1.632	0.762	0.122	12	Non-significant
Other Valve Diseases	0.017	0.030	0.903	12	Non-significant
Thyroid Disorders	0.111	-0.003	0. 133	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=M age<=79 edgp < HS n=16,929					
Aortic Aneurysm	-0.614	0.071	0.282	12	Non-significant
COPD	-0.172	0.303	0.863	12	Non-significant
Cardiomyopathy	-0.108	0.040	0.651	12	Non-significant
Hypertensive Heart Disease	0.072	0.022	0.835	12	Non-significant
Ischemic Heart Disease	-0.079	0.535	0.948	12	Non-significant
Other Valve Diseases	0.031	0.020	0.942	12	Non-significant
Thyroid Disorders	-0.136	0.012	0.623	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=M age<=79 edgp = HS n=31,702					
Aortic Aneurysm	0.161	0.032	0.394	12	Non-significant
COPD	-0.369	0.289	0.834	12	Non-significant
Cardiomyopathy	-0.388	0.060	0.180	12	Non-significant
Hypertensive Heart Disease	0.230	0.011	0.335	12	Non-significant
Ischemic Heart Disease	-0.627	0.586	0.734	12	Non-significant
Other Valve Diseases	-0.022	0.022	0.872	12	Non-significant
Thyroid Disorders	0.067	-0.002	0.048	12	Drop

All still NS after drop.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=M age<=79 edgp > HS n=25,889					
Aortic Aneurysm	-0.281	0.056	0.360	12	Non-significant
COPD	1.649	0.135	0.457	12	Non-significant
Cardiomyopathy	0.019	0.048	0.957	12	Non-significant
Hypertensive Heart Disease	0.036	0.022	0.813	12	Non-significant
Ischemic Heart Disease	-2.260	0.704	0.301	12	Non-significant
Other Valve Diseases	-0.192	0.034	0.355	12	Non-significant
Thyroid Disorders	0.148	-0.004	0.268	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=M age>=80 edgp < HS n=38,070					
Aortic Aneurysm	0.017	0.022	0.756	12	Non-significant
COPD	**-1.779**	**0.460**	**0.002**	**12**	**Target**
Cardiomyopathy	**-0.112**	**0.043**	**0.024**	**12**	**Target**
Hypertensive Heart Disease	0.097	0.022	0.360	12	Non-significant
Ischemic Heart Disease	0.614	0.428	0.137	12	Non-significant
Other Valve Diseases	0.052	0.038	0.589	12	Non-significant
Thyroid Disorders	0.099	-0.011	0.003	12	Drop

Target Group	Beta	Constant	p	N	Result
State = MN sex=M age>=80 edgp < HS					
Aortic Aneurysm	0.019	0.022	0.726	12	Non-significant
COPD	**-1.736**	**0.455**	**0.001**	**12**	**Target**
Cardiomyopathy	**-0.107**	**0.042**	**0.028**	**12**	**Target**
Hypertensive Heart Disease	0.102	0.022	0.330	12	Non-significant
Ischemic Heart Disease	0.667	0.422	0.106	12	Non-significant
Other Valve Diseases	0.056	0.037	0.550	12	Non-significant

91.5% COPD, 8.5% cardiomyopathy.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=M age>=80 edgp < HS					
COPD	**-1.552**	**0.427**	**0.004**	**12**	**Target**
Cardiomyopathy	-0.097	0.041	0.154	12	Non-significant

100% COPD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=M age>=80 edgp = HS n=29,686					
Aortic Aneurysm	-0.215	0.061	0.209	12	Non-significant
COPD	**-1.067**	**0.345**	**0.003**	**12**	**Target**
Cardiomyopathy	-0.219	0.057	0.073	12	Non-significant
Hypertensive Heart Disease	0.280	-0.006	0.043	12	Drop
Ischemic Heart Disease	0.018	0.517	0.959	12	Non-significant
Other Valve Diseases	0.085	0.037	0.543	12	Non-significant
Thyroid Disorders	0.099	-0.009	0.126	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MN sex=M age>=80 edgp = HS					
Aortic Aneurysm	-0.188	0.059	0.254	12	Non-significant
COPD	**-0.099**	**0.346**	**0.002**	**12**	**Target**
Cardiomyopathy	-0.211	0.058	0.063	12	Non-significant
Ischemic Heart Disease	0.180	0.511	0.615	12	Non-significant
Other Valve Diseases	0.088	0.038	0.507	12	Non-significant
Thyroid Disorders	0.101	-0.010	0.103	12	Non-significant

100% COPD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=M age>=80 edgp = HS					
COPD	**-0.807**	**0.294**	**0.022**	**12**	**Target**

100% COPD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=M age>=80 edgp > HS n=25,372					
Aortic Aneurysm	-0.068	0.040	0.608	12	Non-significant
COPD	**-0.833**	**0.286**	**0.010**	**12**	**Target**
Cardiomyopathy	-0.260	0.073	0.099	12	Non-significant
Hypertensive Heart Disease	0.153	0.010	0.064	12	Non-significant
Ischemic Heart Disease	-0.028	0.532	0.914	12	Non-significant
Other Valve Diseases	-0.093	0.074	0.635	12	Non-significant
Thyroid Disorders	0.117	-0.012	0.128	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=M age>=80 edgp > HS					
COPD	-0.595	0.257	0.062	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=F age<=79 edgp < HS n=16,039					
Aortic Aneurysm	**-0.281**	**0.055**	**0.009**	**12**	**Target**
COPD	1.689	0.215	0.210	12	Non-significant
Cardiomyopathy	-0.056	0.035	0.719	12	Non-significant
Hypertensive Heart Disease	0.228	0.008	0.144	12	Non-significant
Ischemic Heart Disease	**-2.840**	**0.679**	**0.048**	**12**	**Target**
Other Valve Diseases	0.186	0.010	0.125	12	Non-significant
Thyroid Disorders	0.327	-0.017	0.029	12	Drop

Target Group	Beta	Constant	p	N	Result
State = MN sex=F age<=79 edgp < HS					
Aortic Aneurysm	**-0.277**	**0.055**	**0.009**	**12**	**Target**
COPD	1.711	0.214	0.202	12	Non-significant
Cardiomyopathy	-0.055	0.035	0.721	12	Non-significant
Hypertensive Heart Disease	0.235	0.008	0.135	12	Non-significant
Ischemic Heart Disease	**-2.802**	**0.678**	**0.048**	**12**	**Target**
Other Valve Diseases	0.189	0.010	0.120	12	Non-significant

92.5% IHD, 7.5% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=F age<=79 edgp < HS					
Aortic Aneurysm	-0.211	0.050	0.144	12	Non-significant
Ischemic Heart Disease	-2.192	0.633	0.084	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=F age<=79 edgp = HS n=30,967					
Aortic Aneurysm	-0.358	0.062	0.097	12	Non-significant
COPD	7.882	-0.131	0.003	12	Drop
Cardiomyopathy	-0.033	0.039	0.890	12	Non-significant
Hypertensive Heart Disease	0.534	-0.003	0.008	12	Drop
Ischemic Heart Disease	**-9.663**	**1.044**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.562	-0.009	0.033	12	Drop
Thyroid Disorders	0.112	-0.003	0.127	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MN sex=F age<=79 edgp = HS					
Aortic Aneurysm	0.089	0.058	0.374	12	Non-significant
Cardiomyopathy	0246	0.037	0.070	12	Non-significant
Ischemic Heart Disease	**-1.372**	**0.905**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.093	-0.003	0.072	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=F age<=79 edgp = HS					
Ischemic Heart Disease	**-1.272**	**0.895**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=F age<=79 edgp > HS n=22,590					
Aortic Aneurysm	0.003	0.046	0.994	12	Non-significant
COPD	4.346	0.022	0.045	12	Drop
Cardiomyopathy	-0.382	0.067	0.155	12	Non-significant
Hypertensive Heart Disease	0.388	0.005	0.150	12	Non-significant
Ischemic Heart Disease	**-6.031**	**0.864**	**0.012**	**12**	**Target**
Other Valve Diseases	0.645	-0.005	0.082	12	Non-significant
Thyroid Disorders	0.003	0.004	0.940	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MN sex=F age<=79 edgp > HS					
Aortic Aneurysm	0.138	0.055	0.525	12	Non-significant
Cardiomyopathy	-0.007	0.066	0.974	12	Non-significant
Hypertensive Heart Disease	0.410	0.006	0.065	12	Non-significant
Ischemic Heart Disease	**-1.581**	**0.874**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.667	-0.007	0.020	12	Drop
Thyroid Disorders	0.047	0.001	0.294	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=F age<=79 edgp > HS					
Ischemic Heart Disease	**-1.355**	**0.854**	**0.004**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=F age>=80 edgp < HS n=39,151					
Aortic Aneurysm	**-0.101**	**0.043**	**0.007**	**12**	**Target**
COPD	**-0.576**	**0.259**	**0.003**	**12**	**Target**
Cardiomyopathy	0.032	0.017	0.377	12	Non-significant
Hypertensive Heart Disease	0.316	-0.014	<0.001	12	Drop
Ischemic Heart Disease	**-1.000**	**0.695**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.259	0.006	0.003	12	Drop
Thyroid Disorders	0.070	-0.007	0.004	12	Drop

Target Group	Beta	Constant	p	N	Result
State = MN sex=F age>=80 edgp < HS					
Aortic Aneurysm	**-0.075**	**0.042**	**0.015**	**12**	**Target**
COPD	**-0.409**	**0.255**	**0.009**	**12**	**Target**
Cardiomyopathy	0.042	0.017	0.211	12	Non-significant
Ischemic Heart Disease	**-0.557**	**0.686**	**0.003**	**12**	**Target**

69.8% IHD, 25.9% COPD, 4.3% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=F age>=80 edgp < HS					
Aortic Aneurysm	-0.073	0.042	0.072	12	Non-significant
COPD	**-0.399**	**0.253**	**0.016**	**12**	**Target**
Ischemic Heart Disease	**-0.564**	**0.687**	**0.005**	**12**	**Target**

73.1% IHD, 26.9% COPD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=F age>=80 edgp = HS n=38,391					
Aortic Aneurysm	-0.089	0.046	0.086	12	Non-significant
COPD	0.031	0.184	0.869	12	Non-significant
Cardiomyopathy	-0.033	0.031	0.503	12	Non-significant
Hypertensive Heart Disease	0.361	-0.022	<0.001	12	Drop
Ischemic Heart Disease	**-1.763**	**0.784**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.397	-0.013	0.009	12	Drop
Thyroid Disorders	0.096	-0.010	0.006	12	Drop

Target Group	Beta	Constant	p	N	Result
State = MN sex=F age>=80 edgp = HS					
Aortic Aneurysm	-0.051	0.044	0.225	12	Non-significant
COPD	0.207	0.171	0.262	12	Non-significant
Cardiomyopathy	-0.006	0.029	0.887	12	Non-significant
Ischemic Heart Disease	**-1.150**	**0.756**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=F age>=80 edgp = HS					
Ischemic Heart Disease	**-1.111**	**0.748**	**<0.001**	**12**	**Target**

100% IHD

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MN sex=F age>=80 edgp > HS n=27,817					
Aortic Aneurysm	**-0.111**	**0.048**	**0.042**	**12**	**Target**
COPD	0.433	0.095	0.092	12	Non-significant
Cardiomyopathy	-0.132	0.050	0.085	12	Non-significant
Hypertensive Heart Disease	0.333	-0.011	0.006	12	Drop
Ischemic Heart Disease	**-2.184**	**0.859**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.535	-0.028	0.006	12	Drop
Thyroid Disorders	0.126	-0.013	0.004	12	Drop

Target Group	Beta	Constant	p	N	Result
State = MN sex=F age>=80 edgp > HS					
Aortic Aneurysm	-0.042	0.050	0.205	12	Non-significant
COPD	0.521	0.091	0.025	12	Drop
Cardiomyopathy	-0.049	0.051	0.370	12	Non-significant
Ischemic Heart Disease	**-0.909**	**0.899**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MN sex=F age>=80 edgp > HS					
Ischemic Heart Disease	**-0.908**	**0.899**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=M age<=79 edgp < HS n=25,402					
Aortic Aneurysm	0.027	0.009	0.783	12	Non-significant
COPD	-1.221	0.333	0.137	12	Non-significant
Cardiomyopathy	0.024	0.031	0.895	12	Non-significant
Hypertensive Heart Disease	-0.023	0.098	0.949	12	Non-significant
Ischemic Heart Disease	0.004	0.543	0.997	12	Non-significant
Other Valve Diseases	0.189	-0.014	0.032	12	Drop
Thyroid Disorders	-0.015	0.003	0.653	12	Non-significant

All NS still after drop.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=M age<=79 edgp = HS n=23,512					
Aortic Aneurysm	**-0.310**	**0.050**	**0.017**	**12**	**Target**
COPD	-0.051	0.203	0.927	12	Non-significant
Cardiomyopathy	0.025	0.029	0.815	12	Non-significant
Hypertensive Heart Disease	-0.069	0.078	0.835	12	Non-significant
Ischemic Heart Disease	-0.721	0.645	0.285	12	Non-significant
Other Valve Diseases	0.070	0.001	0.358	12	Non-significant
Thyroid Disorders	0.059	-0.004	0.122	12	Non-significant

100% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MS sex=M age<=79 edgp = HS					
Aortic Aneurysm	-0.192	0.038	0.167	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=M age<=79 edgp > HS n=15,514					
Aortic Aneurysm	-0.194	0.037	0.098	12	Non-significant
COPD	-0.513	0.209	0.114	12	Non-significant
Cardiomyopathy	0.284	0.009	0.035	12	Drop
Hypertensive Heart Disease	-0.128	0.083	0.562	12	Non-significant
Ischemic Heart Disease	-0.366	0.644	0.306	12	Non-significant
Other Valve Diseases	-0.112	0.019	0.173	12	Non-significant
Thyroid Disorders	0.016	0.001	0.720	12	Non-significant

All still NS after drop.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=M age>=80 edgp < HS n=22,531					
Aortic Aneurysm	-0.082	0.027	0.175	12	Non-significant
COPD	-1.450	0.483	0.250	12	Non-significant
Cardiomyopathy	-0.165	0.063	0.087	12	Non-significant
Hypertensive Heart Disease	0.459	-0.006	0.004	12	Drop
Ischemic Heart Disease	0.155	0.439	0.892	12	Non-significant
Other Valve Diseases	0.037	0.001	0.599	12	Non-significant
Thyroid Disorders	0.076	-0.014	0.137	12	Non-significant

All still NS after drop.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=M age>=80 edgp = HS n=14,700					
Aortic Aneurysm	-0.106	0.031	0.194	12	Non-significant
COPD	-0.109	0.184	0.920	12	Non-significant
Cardiomyopathy	-0.025	0.034	0.785	12	Non-significant
Hypertensive Heart Disease	0.464	-0.020	0.087	12	Non-significant
Ischemic Heart Disease	-1.421	0.792	0.167	12	Non-significant
Other Valve Diseases	0.147	-0.013	0.225	12	Non-significant
Thyroid Disorders	0.023	-0.002	0.236	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=M age>=80 edgp > HS n=10,447					
Aortic Aneurysm	-0.196	0.051	0.062	12	Non-significant
COPD	-0.133	0.153	0.806	12	Non-significant
Cardiomyopathy	-0.262	0.083	0.156	12	Non-significant
Hypertensive Heart Disease	0.009	0.072	0.956	12	Non-significant
Ischemic Heart Disease	-0.503	0.639	0.457	12	Non-significant
Other Valve Diseases	0.076	0.003	0.541	12	Non-significant
Thyroid Disorders	-0.072	0.017	0.288	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=F age<=79 edgp < HS n=22,908					
Aortic Aneurysm	-0.091	0.027	0.065	12	Non-significant
COPD	0.421	0.158	0.120	12	Non-significant
Cardiomyopathy	-0.125	0.045	0.062	12	Non-significant
Hypertensive Heart Disease	0.935	-0.017	0.006	12	Drop
Ischemic Heart Disease	**-2.181**	**0.783**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.030	0.004	0.470	12	Non-significant
Thyroid Disorders	0.031	-0.002	0.105	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MS sex=F age<=79 edgp < HS n=22,908					
Aortic Aneurysm	-0.070	0.027	0.080	12	Non-significant
COPD	0.614	0.149	0.068	12	Non-significant
Cardiomyopathy	-0.087	0.045	0.113	12	Non-significant
Ischemic Heart Disease	**-1.500**	**0.775**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.030	0.004	0.408	12	Non-significant
Thyroid Disorders	0.031	-0.002	0.071	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MS sex=F age<=79 edgp < HS					
Ischemic Heart Disease	**-1.392**	**0.759**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=F age<=79 edgp = HS n=22,235					
Aortic Aneurysm	-0.104	0.027	0.307	12	Non-significant
COPD	1.293	0.082	0.008	12	Drop
Cardiomyopathy	**-0.303**	**0.065**	**0.040**	**12**	**Target**
Hypertensive Heart Disease	1.134	-0.042	<0.001	12	Drop
Ischemic Heart Disease	**-3.150**	**0.869**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.097	0.001	0.182	12	Non-significant
Thyroid Disorders	0.062	-0.004	0.151	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MS sex=F age<=79 edgp = HS					
Aortic Aneurysm	-0.051	0.031	0.463	12	Non-significant
Cardiomyopathy	-0.148	0.070	0.101	**12**	Non-significant
Ischemic Heart Disease	**-0.927**	**0.900**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.102	0.001	0.064	12	Non-significant
Thyroid Disorders	0.034	-0.001	0.291	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MS sex=F age<=79 edgp = HS					
Ischemic Heart Disease	**-0.923**	**0.900**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=F age<=79 edgp > HS n=13,405					
Aortic Aneurysm	**-0.408**	**0.067**	**0.016**	**12**	**Target**
COPD	1.266	0.044	0.054	12	Non-significant
Cardiomyopathy	-0.115	0.047	0.360	12	Non-significant
Hypertensive Heart Disease	1.009	-0.033	0.021	12	Drop
Ischemic Heart Disease	**-2.948**	**0.887**	**0.002**	**12**	**Target**
Other Valve Diseases	0.184	-0.010	0.030	12	Drop
Thyroid Disorders	0.022	<0.001	0.216	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MS sex=F age<=79 edgp > HS					
Aortic Aneurysm	**-0.271**	**0.071**	**0.004**	**12**	**Target**
COPD	1.387	0.034	0.024	12	Drop
Cardiomyopathy	-0.027	0.051	0.728	12	Non-significant
Ischemic Heart Disease	**-0.718**	**0.881**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.023	<0.001	0.119	12	Non-significant

92.5% IHD, 7.5% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MS sex=F age<=79 edgp > HS					
Aortic Aneurysm	**-0.228**	**0.065**	**0.033**	**12**	**Target**
Ischemic Heart Disease	**-0.755**	**0.887**	**<0.001**	**12**	**Target**

93.2% IHD, 6.8% AA.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=F age>=80 edgp < HS n=26,025					
Aortic Aneurysm	**-0.071**	**0.028**	**0.005**	**12**	**Target**
COPD	**-0.636**	**0.274**	**<0.001**	**12**	**Target**
Cardiomyopathy	-0.059	0.041	0.088	12	Non-significant
Hypertensive Heart Disease	0.587	-0.030	<0.001	12	Drop
Ischemic Heart Disease	**-0.849**	**0.680**	**0.002**	**12**	**Target**
Other Valve Diseases	0.009	0.010	0.545	12	Non-significant
Thyroid Disorders	0.018	-0.002	0.807	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MS sex=F age>=80 edgp < HS					
Aortic Aneurysm	**-0.055**	**0.027**	**0.012**	**12**	**Target**
COPD	**-0.455**	**0.260**	**0.004**	**12**	**Target**
Cardiomyopathy	-0.035	0.040	0.229	12	Non-significant
Ischemic Heart Disease	**-0.488**	**0.668**	**0.003**	**12**	**Target**
Other Valve Diseases	0.015	0.009	0.282	12	Non-significant
Thyroid Disorders	0.048	-0.012	0.557	12	Non-significant

69.9% IHD, 27.2% COPD, 2.9% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MS sex=F age>=80 edgp < HS					
Aortic Aneurysm	-0.053	0.027	0.065	12	Non-significant
COPD	**-0.443**	**0.256**	**0.007**	**12**	**Target**
Ischemic Heart Disease	**-0.501**	**0.671**	**0.004**	**12**	**Target**

72.4% IHD, 27.6% COPD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=F age>=80 edgp = HS n=18,947					
Aortic Aneurysm	-0.069	0.027	0.058	12	Non-significant
COPD	**-0.584**	**0.276**	**0.002**	**12**	**Target**
Cardiomyopathy	**-0.176**	**0.064**	**0.004**	**12**	**Target**
Hypertensive Heart Disease	0.570	-0.040	0.001	12	Drop
Ischemic Heart Disease	**-0.835**	**0.676**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.076	-0.002	0.072	12	Non-significant
Thyroid Disorders	0.007	0.002	0.677	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MS sex=F age>=80 edgp = HS					
Aortic Aneurysm	-0.053	0.027	0.080	12	Non-significant
COPD	**-0.425**	**0.268**	**0.003**	**12**	**Target**
Cardiomyopathy	**-0.142**	**0.062**	**0.003**	**12**	**Target**
Ischemic Heart Disease	**-0.398**	**0.644**	**0.008**	**12**	**Target**
Other Valve Diseases	0.075	-0.002	0.050	12	Drop
Thyroid Disorders	0.008	0.002	0.615	12	Non-significant

66.1% IHD, 27.5% COPD, 6.4% cardiomyopathy.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MS sex=F age>=80 edgp = HS					
COPD	**-0.407**	**0.264**	**0.012**	**12**	**Target**
Cardiomyopathy	**-0.133**	**0.060**	**0.031**	**12**	**Target**
Ischemic Heart Disease	**-0.428**	**0.651**	**0.017**	**12**	**Target**

66.8% IHD, 27.5% COPD, 5.7% cardiomyopathy.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = MS sex=F age>=80 edgp > HS n=11,383					
Aortic Aneurysm	-0.038	0.018	0.162	12	Non-significant
COPD	-0.095	0.157	0.500	12	Non-significant
Cardiomyopathy	**-0.146**	**0.059**	**0.029**	**12**	**Target**
Hypertensive Heart Disease	0.517	-0.017	<0.001	12	Drop
Ischemic Heart Disease	**-1.315**	**0.776**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.057	0.009	0.206	12	Non-significant
Thyroid Disorders	0.001	0.003	0.921	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = MS sex=F age>=80 edgp > HS					
Aortic Aneurysm	-0.032	0.019	0.165	12	Non-significant
COPD	-0.008	0.153	0.948	12	Non-significant
Cardiomyopathy	**-0.121**	**0.059**	**0.032**	**12**	**Target**
Ischemic Heart Disease	**-0.917**	**0.762**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.057	0.010	0.161	12	Non-significant
Thyroid Disorders	0.002	0.004	0.869	12	Non-significant

92.8% IHD, 7.2% cardiomyopathy.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = MS sex=F age>=80 edgp > HS					
Cardiomyopathy	-0.112	0.057	0.092	12	Non-significant
Ischemic Heart Disease	**-0.897**	**0.757**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = NC sex=M age<=79 edgp < HS n=69,834					
Aortic Aneurysm	-0.178	0.026	0.353	12	Non-significant
COPD	-0.010	0.257	0.917	12	Non-significant
Cardiomyopathy	-0.061	0.041	0.800	12	Non-significant
Hypertensive Heart Disease	0.284	0.032	0.379	12	Non-significant
Ischemic Heart Disease	-1.374	0.647	0.137	12	Non-significant
Other Valve Diseases	0.276	-0.001	0.086	12	Non-significant
Thyroid Disorders	0.044	<-0.001	0.512	12	Non-significant

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = NC sex=M age<=79 edgp = HS n=61,641					
Aortic Aneurysm	0.299	0.009	0.183	12	Non-significant
COPD	1.188	0.163	0.116	12	Non-significant
Cardiomyopathy	-0.348	0.059	0.109	12	Non-significant
Hypertensive Heart Disease	0.062	0.047	0.834	12	Non-significant
Ischemic Heart Disease	**-2.449**	**0.722**	**0.019**	**12**	**Target**
Other Valve Diseases	0.280	<-0.001	0.095	12	Non-significant
Thyroid Disorders	-0.024	0.002	0.552	12	Non-significant

100% IHD.

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Bootstrapped regression State = NC sex=M age<=79 edgp = HS					
Ischemic Heart Disease	-1.816	0.693	0.061	12	Non-significant

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = NC sex=M age<=79 edgp > HS n=48,503					
Aortic Aneurysm	-0.438	0.052	0.207	12	Non-significant
COPD	-2.232	0.277	0.219	12	Non-significant
Cardiomyopathy	0.288	0.036	0.197	12	Non-significant
Hypertensive Heart Disease	0.576	0.019	0.070	12	Non-significant
Ischemic Heart Disease	0.936	0.595	0.650	12	Non-significant
Other Valve Diseases	-0.089	0.019	0.290	12	Non-significant
Thyroid Disorders	-0.074	0.005	0.398	12	Non-significant

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = NC sex=M age>=80 edgp < HS n=75,411					
Aortic Aneurysm	-0.204	0.036	0.139	12	Non-significant
COPD	**-3.672**	**0.544**	**0.027**	**12**	**Target**
Cardiomyopathy	-0.265	0.060	0.184	12	Non-significant
Hypertensive Heart Disease	0.588	-0.014	0.035	12	Drop
Ischemic Heart Disease	2.231	0.376	0.147	12	Non-significant
Other Valve Diseases	0.238	0.003	0.076	12	Non-significant
Thyroid Disorders	0.084	-0.006	0.095	12	Non-significant

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
State = NC sex=M age>=80 edgp < HS					
Aortic Aneurysm	-0.189	0.036	0.140	12	Non-significant
COPD	**-3.570**	**0.558**	**0.018**	**12**	**Target**
Cardiomyopathy	-0.254	0.062	0.155	12	Non-significant
Ischemic Heart Disease	2.682	0.346	0.083	12	Non-significant
Other Valve Diseases	0.244	0.003	0.057	12	Non-significant
Thyroid Disorders	0.088	-0.006	0.065	12	Non-significant

100% COPD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = NC sex=M age>=80 edgp < HS					
COPD	**-2.895**	**0.489**	**0.038**	**12**	**Target**

100% COPD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = NC sex=M age>=80 edgp = HS n=30,622					
Aortic Aneurysm	-0.260	0.044	0.125	12	Non-significant
COPD	-1.154	0.283	0.209	12	Non-significant
Cardiomyopathy	-0.211	0.054	0.331	12	Non-significant
Hypertensive Heart Disease	0.286	0.011	0.220	12	Non-significant
Ischemic Heart Disease	0.188	0.585	0.852	12	Non-significant
Other Valve Diseases	0.110	0.022	0.545	12	Non-significant
Thyroid Disorders	0.048	-0.001	0.224	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = NC sex=M age>=80 edgp > HS n=36,064					
Aortic Aneurysm	-0.222	0.044	0.122	12	Non-significant
COPD	0.257	0.128	0.696	12	Non-significant
Cardiomyopathy	0.003	0.035	0.992	12	Non-significant
Hypertensive Heart Disease	0.446	-0.010	0.202	12	Non-significant
Ischemic Heart Disease	-1.295	0.741	0.069	12	Non-significant
Other Valve Diseases	0.131	0.053	0.481	12	Non-significant
Thyroid Disorders	-0.058	0.010	0.436	12	Non-significant

Target Group	Beta	Constant	p	N	Result
Ahern regression State = NC sex=F age<=79 edgp < HS n=63,523					
Aortic Aneurysm	-0.194	0.028	0.066	12	Non-significant
COPD	2.723	0.147	0.050	12	Drop
Cardiomyopathy	-0.043	0.039	0.717	12	Non-significant
Hypertensive Heart Disease	0.677	0.009	0.001	12	Drop
Ischemic Heart Disease	**-4.333**	**0.771**	**0.005**	**12**	**Target**
Other Valve Diseases	0.132	0.006	0.010	12	Drop
Thyroid Disorders	0.038	<-0.001	0.084	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = NC sex=F age<=79 edgp < HS					
Aortic Aneurysm	-0.088	0.035	0.109	12	Non-significant
COPD	2.861	0.148	0.038	12	Drop
Cardiomyopathy	0.117	0.047	0.252	12	Non-significant
Ischemic Heart Disease	**-1.063**	**0.918**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.034	<-0.001	0.073	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = NC sex=F age<=79 edgp < HS					
Ischemic Heart Disease	**-1.051**	**0.916**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = NC sex=F age<=79 edgp = HS n=58,563					
Aortic Aneurysm	**-0.351**	**0.040**	**0.009**	**12**	**Target**
COPD	4.093	0.046	<0.001	12	Drop
Cardiomyopathy	**-0.245**	**0.051**	**0.007**	**12**	**Target**
Hypertensive Heart Disease	0.751	0.009	<0.001	12	Drop
Ischemic Heart Disease	**-5.460**	**0.850**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.171	0.005	0.067	12	Non-significant
Thyroid Disorders	0.032	0.001	0.411	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = NC sex=F age<=79 edgp = HS					
Aortic Aneurysm	-0.141	0.043	0.064	12	Non-significant
Cardiomyopathy	0.051	0.053	0.393	12	Non-significant
Ischemic Heart Disease	**-0.954**	**0.905**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.199	0.005	0.012	12	Drop
Thyroid Disorders	0.037	<0.001	0.239	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = NC sex=F age<=79 edgp = HS					
Ischemic Heart Disease	**-0.951**	**0.904**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = NC sex=F age<=79 edgp > HS n=42,988					
Aortic Aneurysm	**-0.345**	**0.046**	**0.018**	**12**	**Target**
COPD	5.032	-0.005	<0.001	12	Drop
Cardiomyopathy	-0.215	0.053	0.333	12	Non-significant
Hypertensive Heart Disease	0.980	<-0.001	0.003	12	Drop
Ischemic Heart Disease	**-6.707**	**0.899**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.161	0.009	0.260	12	Non-significant
Thyroid Disorders	-0.011	0.004	0.900	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = NC sex=F age<=79 edgp > HS					
Aortic Aneurysm	-0.053	0.046	0.564	12	Non-significant
Cardiomyopathy	0.166	0.050	0.377	12	Non-significant
Ischemic Heart Disease	**-1.188**	**0.906**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.243	0.008	0.048	12	Drop
Thyroid Disorders	-0.002	0.005	0.982	12	Non-significant

100% IHD.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = NC sex=F age<=79 edgp > HS					
Ischemic Heart Disease	**-1.147**	**0.903**	**<0.001**	**12**	**Target**

100% IHD.

Target Group	Beta	Constant	p	N	Result
Ahern regression State = NC sex=F age>=80 edgp < HS n=89,929					
Aortic Aneurysm	**-0.121**	**0.030**	**<0.001**	**12**	**Target**
COPD	**-0.665**	**0.236**	**0.010**	**12**	**Target**
Cardiomyopathy	-0.014	0.031	0.648	12	Non-significant
Hypertensive Heart Disease	0.447	0.005	<0.001	12	Drop
Ischemic Heart Disease	**-0.937**	**0.696**	**0.002**	**12**	**Target**
Other Valve Diseases	0.251	0.003	<0.001	12	Drop
Thyroid Disorders	0.028	<0.001	0.200	12	Non-significant

Target Group	Beta	Constant	p	N	Result
State = NC sex=F age>=80 edgp < HS					
Aortic Aneurysm	**-0.100**	**0.030**	**<0.001**	**12**	**Target**
COPD	**-0.490**	**0.236**	**0.033**	**12**	**Target**
Cardiomyopathy	0.007	0.032	0.815	12	Non-significant
Ischemic Heart Disease	-0.456	0.703	0.054	12	Non-significant
Thyroid Disorders	0.029	<0.001	0.160	12	Non-significant

88.7% COPD, 11.3% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = NC sex=F age>=80 edgp < HS					
Aortic Aneurysm	**-0.097**	**0.030**	**0.007**	**12**	**Target**
COPD	**-0.483**	**0.235**	**0.040**	**12**	**Target**

88.7% COPD, 11.3% AA.

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = NC sex=F age>=80 edgp = HS n=42,731					
Aortic Aneurysm	**-0.162**	**0.036**	**0.009**	**12**	**Target**
COPD	0.051	0.168	0.804	12	Non-significant
Cardiomyopathy	0.051	0.027	0.198	12	Non-significant
Hypertensive Heart Disease	0.405	0.004	0.002	12	Drop
Ischemic Heart Disease	**-1.668**	**0.761**	**<0.001**	**12**	**Target**
Other Valve Diseases	0.247	0.008	0.008	12	Drop
Thyroid Disorders	0.066	-0.003	0.025	12	Drop

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
State = NC sex=F age>=80 edgp = HS					
Aortic Aneurysm	**-0.139**	**0.036**	**0.011**	**12**	**Target**
COPD	0.194	0.167	0.352	12	Non-significant
Cardiomyopathy	0.076	0.027	0.070	12	Non-significant
Ischemic Heart Disease	**-1.132**	**0.769**	**0.001**	**12**	**Target**

95.5% IHD, 4.5% AA.

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Bootstrapped regression State = NC sex=F age>=80 edgp = HS					
Aortic Aneurysm	-0.128	0.035	0.058	12	Non-significant
Ischemic Heart Disease	**-1.099**	**0.765**	**0.001**	**12**	**Target**

100% IHD.

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
Ahern regression State = NC sex=F age>=80 edgp > HS n=39,061					
Aortic Aneurysm	**-0.243**	**0.047**	**0.001**	**12**	**Target**
COPD	0.826	0.071	0.049	12	Drop
Cardiomyopathy	-0.164	0.056	0.104	12	Non-significant
Hypertensive Heart Disease	0.470	-0.010	0.008	12	Drop
Ischemic Heart Disease	**-2.235**	**0.825**	**0.001**	**12**	**Target**
Other Valve Diseases	0.276	0.013	0.005	12	Drop
Thyroid Disorders	0.070	-0.002	0.099	12	Non-significant

Target Group	**Beta**	**Constant**	**p**	**N**	**Result**
State = NC sex=F age>=80 edgp > HS					
Aortic Aneurysm	**-0.156**	**0.049**	**0.002**	**12**	**Target**
Cardiomyopathy	-0.042	0.056	0.624	12	Non-significant
Ischemic Heart Disease	**-0.865**	**0.896**	**<0.001**	**12**	**Target**
Thyroid Disorders	0.062	-0.001	0.070	12	Non-significant

94.8% IHD, 5.2% AA.

Target Group	Beta	Constant	p	N	Result
Bootstrapped regression State = NC sex=F age>=80 edgp > HS					
Aortic Aneurysm	**-0.143**	**0.047**	**0.032**	**12**	**Target**
Ischemic Heart Disease	**-0.868**	**0.896**	**<0.001**	**12**	**Target**

95.0% IHD, 5% AA.

ARIC = Atherosclerosis Risk in Communities, MD = Maryland, MN = Minnesota, MS = Mississippi, NC = North Carolina, F = female, M = male, HS = High school, edgp = education group, IHD = ischemic heart disease, COPD = chronic obstructive pulmonary disease, AA = aortic aneurysm, CM = cardiomyopathy, OVD = other valve diseases.