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COMORBIDITIES OF MEDICARE BENEFICIARIES WITH ALZHEIMER'S DISEASE IN FLORIDA, 2010

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Comorbidity associated with Alzheimer's Disease (AD) is highly prevalent but largely understudied. In this study, we sought to determine 1) the prevalence of AD by race (White, African American, and Hispanics); 2) 20 chronic conditions' commonly comorbid with AD and the prevalence, mortality rate, and health care expenditure of common AD and comorbid condition by race. A sample of 86,875 Florida 2010 Medicare beneficiaries aged 65 and older with 12 months of fee-for-service (FFS) enrollment were used in this study. In the present analysis, the prevalence of AD was highest among elderly Hispanic beneficiaries. Among 20 chronic diseases, heart disease (Heart Failure, Ischemic Heart Disease, Atrial Fibrillation) were the most prevalent, most deadly, and most costly comorbidities associated with AD. Hypertension and Hyperlipidemia were highly prevalent comorbidities. Persons with AD had an increased risk of depression. Persons with AD and Chronic Kidney Disease were associated with a high likelihood of mortality and high health care costs. Hip Fracture was one of the most costly comorbid conditions, and was also associated with a high mortality rate for Whites and Hispanics. The results revealed a comprehensive picture of certain comorbid conditions associated with AD and suggested the need for further investigation in this area.

Background | Alzheimer's disease is the most common form of dementia for people aged 65 and over (Mayo Clinic, 2011). There were 5 million Americans living with Alzheimer's disease (AD) in 2013, and this number may triple to 14 million by 2050 (Centers for Disease Control and Prevention, 2015). The Centers for Disease Control and Prevention (2015) reported that AD was the sixth leading cause of death among U.S. adults, yet this number was shown to be underreported (James et al., 2014; Weuve et al., 2014). The estimated costs of AD were more than 159 billion dollars in 2010, and are projected to be over 379 billion dollars annually by 2040 (Centers for Disease Control and Prevention, 2015). The high mortality rate and huge expenditures caused by AD makes it a pressing concern for many researchers and the public health community.

On the other hand, the prevalence of comorbidities in U.S. population is also high and growing (Vogeli et al, 2007). Ward et al. (2013, 2014) estimated that the prevalence of multiple chronic diseases in U.S. adults is 26% in 2010, and 25.5% in 2012 based on data from

the National Health Interview Survey (NHIS). In particular, the prevalence of comorbidities among Medicare beneficiaries is profoundly high — Lochner et al. (2013) reported that 68.4% of Medicare beneficiaries had multiple chronic diseases in 2010, i.e., 2.6 times of that for general U.S. adults (Ward et al., 2014) in the same year.

In spite of the fact that extensive research has been conducted on the screening, diagnostic, prevention, treatment, quality of care, and prevalence of AD, comorbidities associated with AD are relatively less studied. For elders, AD is commonly associated with several chronic conditions. Some of these conditions may accelerate clinical development of AD and complicate the management (Solomon, 2011). For these reasons, an investigation of comorbidities with AD is especially important to improve the quality of long-term care for AD patients.

Purpose | Preliminary studies showed that the etiology of dementia differs by race (Miles et al., 2001). Florida is the third-most populous state in the country (U.S.

Census Bureau, 2014) with a wide variety of racial and ethnic backgrounds, which makes research on how the prevalence of comorbidities among Florida Medicare beneficiaries differs by race of interest. In addition, Florida contains the highest percentage of people over 65 (U.S. Census Bureau, 2011). Therefore, an investigation of the comorbidity associated with AD and the corresponding health care cost could improve planning for the Florida health system in the long term.

In this study, we examined the demographic characteristics of Medicare participants in Florida. Specifically, we compared the differences in co-existing chronic diseases among White, African-American, and Hispanic beneficiaries with AD. To our best knowledge, no such studies have been published before.

Methods | STUDY DESIGN. This retrospective study examined 86,875 White, African American, and Hispanic Florida 2010 Medicare beneficiaries aged 65 and over who had full FFS coverage (i.e. 12 months of Medicare Part A and B), using a 5% sample of Medicare FFS claim data.

SETTING. Medicare is a U.S. government health insurance program for people who are 65 or older and disabled people under 65. This study used the 2010 national Medicare claim data from six sources: carrier, inpatient, outpatient, skilled nurse facility (SNF), hospice, and home health agency (HHA). Prescription drug data were not available. The original data from Carrier provided records of a 5% sample of U.S. Medicare beneficiaries. The carrier file sample was linked with the 100% files from the other five sources and the denominator file to create a 5% sample of Florida 2010 beneficiaries.

STUDY POPULATION. Our analyses were based on data from a 5% sample consisting of 1,711,151 U.S. national Medicare participants in 2010. Of these eligible participants, 86,875 subjects were selected as the final study sample based on the following exclusion steps: 1) subjects with duplicates or inconsistent records were excluded; 2) subjects with less than 12 months in the traditional FFS Medicare, less than 65 years of age, and non-Florida residents were excluded; 3) Asian, North American Native, and subjects with other or unknown races were excluded due to small sample size. See Figure 1 for study population flow chart.

The final study sample consisted of 86,875 individuals, with age of mean and standard deviation (SD) of 76 (± 7.8).

MEASURES. Persons with one or more of 21 chronic diseases: Alzheimer's Disease (AD), Acquired Hypothyroidism, Ischemic Heart Disease, Cancer (including Breast Cancer, Colorectal Cancer, Prostate Cancer, Lung Cancer, Endometrial Cancer), Anemia, Asthma, Atrial Fibrillation, Benign Prostatic Hyperplasia, Cataract, Chronic Kidney Disease, Chronic Obstructive Pulmonary Disease (COPD) and Bronchiectasis, Depression, Diabetes, Glaucoma, Heart Failure, Hip Fracture, Hyperlipidemia, Hypertension, Osteoporosis, RA/OA (Rheumatoid Arthritis/ Osteoarthritis), and Stroke/ Transient Ischemic Attack were identified. Indicator variables were created to identify the diagnosis of these conditions based on ICD9-codes from claim records, using the disease identification algorithm provided by Chronic Condition Data Warehouse (CCW, 2014). Each beneficiary may have up to 21 comorbid diagnoses.

Another outcome variable of interest was health care expenditure. A new variable was constructed to compute the total expenditure for each subject as the sum of amounts of payments made by Medicare, secondary insurance, and beneficiary.

Demographic variables included age, sex, race, vital status (live/dead), and state Medicaid buy-in status. The vital status was constructed based on the variable of date of death in the original data. A state Medicaid buy-in insurance indicator was constructed based on the Medicaid buy-in variable with one or more months.

DATA ANALYSIS. Statistical tests were applied to access differences in sample characteristics across race and ethnic groups, with χ^2 test for qualitative variables and ANOVA test for continuous variables. Data analysis was performed using SAS version 9.4. All analyses were stratified by race.

Results | Table 1 presents demographic characteristics of the study sample. Beneficiaries were more likely to be female (56.9%), White (90.6%), and between 65 and 74 years old (48.7%). Among 86,875 Medicare beneficiaries aged 65 and over in Florida, 2010, 6.8% or 5,879 individuals had AD.

Table 1. Sample characteristics in Florida Medicare Beneficiaries, 2010 (N=86,875)

	n	%
Female	49429	56.9
Age (years)		
65-74	42346	48.7
75-84	30651	35.3
≥85	13878	16
Race		
White	78725	90.6
African American	5049	5.8
Hispanic	3101	3.6
Alzheimer's Disease	5879	6.8
Mortality	5274	6.1
State Medicaid Buy-In Insurance Status	11433	13.2

Table 2 presents demographic characteristics of the study sample by race. The average and standard error (SE) of age was 76 (±7.7), 75(±7.7), 78(±8.1) (data not shown) for White, African American, and Hispanic participants respectively (data not shown). There were statistically significant differences in gender, age group, AD presence, mortality, and state Medicaid buy-in insurance status between three race

groups (p < 0.01). Beneficiaries were more likely to be female and 65-74 years of age regardless of race groups. Compared to White and African Americans, Hispanics were more likely to be older, female, and insured. More importantly, Hispanics were at higher risk of AD (18.7%) than White (6.2%) and African Americans (7.8%).

Table 2. Sample characteristics by race and ethnicity, n(%), in Florida Medicare Beneficiaries, 2010 (N=86,875)

	White (N=78,725) (%)	African American (N=5,049) (%)	Hispanic (N=3,101)(%)	χ^2^s	p
Female	44303 (56.3)	3032 (60.1)	2094 (67.5)	174.75 ^a	**
Age (years)				205.88 ^b	**
65-74	38292 (48.6)	2798 (55.4)	1256 (40.5)		
75-84	27872 (35.4)	1603 (31.8)	1176 (37.9)		
≥85	12561 (16.0)	648 (12.8)	669 (21.6)		
Alzheimer's Disease	4904 (6.2)	394 (7.8)	581 (18.7)	748.77 ^a	**
Mortality	4707 (6.0)	345 (6.8)	222 (7.2)	12.75 ^a	*
State Medicaid Buy-in Insurance Status	6994 (8.9)	1947 (38.6)	2492 (80.4)	16364.05 ^a	**

Notes:

^s Based on Chi-square test.

^a 2 degrees of freedom (df); ^b 4 df;

*=p<0.01; **=p<0.0001

Table 3 compares mean count of chronic conditions, mean health care expenditure, and the mortality rate by race between the entire sample of 86,875 Florida 2010 FFS elder Medicare beneficiaries and the subsample of 5,879 beneficiaries with AD. The results in Table 3 shows that beneficiaries with AD had two more conditions on average than beneficiaries in general. Beneficiaries with AD also

cost more on average, and had a higher mortality rate, compared to beneficiaries in general. Among the beneficiaries with AD, White had a slightly higher (see Table 3) mortality rate than African American and Hispanic, in spite of a lower prevalence rate (see Table 2). This finding is in line with the review of U.S. Department of Health and Human Services (2012).

Table 3. Comparisons of mean count of chronic conditions, mean cost, and mortality rate by race between two samples.

	All Beneficiaries in the sample (N=86,875)				Beneficiaries with AD in the sample (N=5,879)			
	All	White	African American	Hispanic	All	White	African American	Hispanic
Mean count of conditions	4.6	4.5	4.8	6	6.8	6.6	6.9	7.9
Mean expenditures	\$12,717	\$12,349	\$15,204	\$18,027	\$25,517	\$24,927	\$27,919	\$28,873
Mortality rate	6%	6%	6.8%	7.2%	22.1%	22.7%	21.2%	17.4%

Table 4 listed top five co-existing diseases associated with highest risk of AD between three race groups, ranked by odds ratio (OR) for AD. There were four diseases in common for three race groups: Hip Fracture, Heart Failure, Anemia, and Depression. However, the level of AD risk associated with each disease might differ by race. From Table 4, Heart Failure was associated with similar levels of risk for AD between Whites, African Americans and Hispanics (2.77 (2.6, 2.94), 2.32 (1.88, 2.87), 2.21 (1.84, 2.67)); so was Anemia (OR=2.76 (2.61, 2.93),

2.77 (2.23, 3.43), 2.3(1.91, 2.77)). Depression was associated with a higher risk of AD for Whites (OR=4.8 (4.51, 5.12)) and African Americans (OR=4.95(3.92, 6.25)) than for Hispanics (OR=2.56 (2.13, 2.77)). Hip Fracture was significantly associated with a high risk of AD for White (5.26 (4.49, 6.18)) and Hispanic (OR=4.1 (1.92, 8.76)), but not for African American (OR=2.12 (0.29, 15.57), data not shown); the reason is to be further investigated.

Table 4. AD co-existing diseases with the highest odds ratio by race in Florida Medicare Beneficiaries (N=86,875), 2010

Rank#	Co-existing Disease	White (N=78,725)		African American (N=5,049)		Hispanic (N=3,101)	
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)		
1	Hip Fracture	5.26 (4.49, 6.18)	Depression	4.95 (3.92, 6.25)	Hip Fracture	4.1 (1.92, 8.76)	
2	Depression	4.8 (4.51, 5.12)	Stroke/ Transient Ischemic Attack	4.09 (3.16, 5.29)	Depression	2.56 (2.13, 3.08)	
3	Heart Failure	2.77 (2.6, 2.94)	Anemia	2.77 (2.23, 3.43)	Anemia	2.3 (1.91, 2.77)	
4	Anemia	2.76 (2.61, 2.93)	Heart Failure	2.32 (1.88, 2.87)	Heart Failure	2.21 (1.84, 2.67)	
5	Stroke/Transient Ischemic Attack	2.75 (2.51, 3.02)	Hip Fracture	2.12 (0.29, 15.57)	Ischemic Heart Disease	2.08 (1.69, 2.54)	

Notes: AD: Alzheimer's Disease. OR: Odds ratio. CI: confidence interval.

Rank is based on odds ratio for AD given presence of a second disease. An individual record may have up to 20 second diseases.

Tables 5-7 refer only to the subsample of 5,879 Florida older Medicare beneficiaries with AD. Table 5 lists the five most frequent co-existing diseases among 5,879 Florida Medicare beneficiaries with AD by race. Four diseases in common for three race groups were Hypertension, Ischemic Heart Disease, Anemia, and Hyperlipidemia. Among these diseases,

Hypertension was more common among African American (82%) and Hispanic (86.4%) AD patients than among White (76.5%), so was Anemia (64%, 63.7%, 54.9%). Ischemic Heart Disease was more common among Hispanic AD patients (75%), than among White (60%) and African American (59.4%), so was Hyperlipidemia (62.1%, 48.5%, 50%).

Table 5. The most frequent co-existing diseases by race in Florida Medicare Beneficiaries with AD (N=5,879), 2010

Rank [#]	White (N=4,904)		African American (N=394)		Hispanic (N=581)	
	Co-existing Disease	N (%)	Co-existing Disease	N (%)	Co-existing Disease	N (%)
1	Hypertension	3752 (76.5)	Hypertension	323 (82)	Hypertension	502 (86.4)
2	Ischemic Heart Disease	2943 (60)	Anemia	252 (64)	Ischemic Heart Disease	436 (75)
3	Anemia	2693 (54.9)	Ischemic Heart Disease	234 (59.4)	RA/OA ^a	389 (67)
4	Hyperlipidemia	2454 (50)	Diabetes	203 (51.5)	Anemia	370 (63.7)
5	RA/OA ^a	2025 (41.3)	Hyperlipidemia	191 (48.5)	Hyperlipidemia	361 (62.1)

Notes: AD: Alzheimer's Disease.

Rank is based on frequency of co-occurrences of a second disease. An individual record may have up to 20 second diseases.

^a Rheumatoid Arthritis/ Osteoarthritis.

Table 6 lists the top five diseases associated with highest mortality rate among 5,879 Florida Medicare Beneficiaries with AD by race. Three diseases in common for three race groups were Chronic Kidney Disease, Heart Failure, and Atrial Fibrillation. Among these diseases, the mortality rate associated with Chronic Kidney Disease did not differ much

between White, African American and Hispanic AD patients (34.9%, 30.5%, 33.5%), so was the case with Heart Failure (32.7%, 26.8%, 28.3%), however, the mortality rate associated with Atrial Fibrillation was much higher among Hispanic AD patients (51.9%), than among White (28.7%) and African American (32.4%).

Table 6. The co-existing disease with highest mortality rate, n(%), by race in Florida Medicare Beneficiaries with AD (N=5,879), 2010

Rank [#]	White (N=4,904)		African American (N=394)		Hispanic (N=581)	
	Co-existing Disease	Mortality n (%)	Co-existing Disease	Mortality n (%)	Co-existing Disease	Mortality n (%)
1	Chronic Kidney Disease	460 (34.9)	COPD ^a and Bronchiectasis	21 (32.8)	Atrial Fibrillation	27 (51.9)
2	Hip Fracture	70 (33.7)	Atrial Fibrillation	12 (32.4)	Chronic Kidney Disease	55 (33.5)
3	Heart Failure	596 (32.7)	Chronic Kidney Disease	46 (30.5)	Hip Fracture	4 (30.8)
4	COPD ^a and Bronchiectasis	314 (29.9)	Heart Failure	42 (26.8)	Stroke/ Transient Ischemic Attack	20 (29)
5	Atrial Fibrillation	207 (28.7)	Cancer	9 (25.7)	Heart Failure	72 (28.3)

Notes: AD: Alzheimer's disease.

Rank is based on mortality rate given the presence of a second disease. An individual record may have up to 20 second diseases.

^a Chronic Obstructive Pulmonary Disease.

Table 7 lists the five most costly co-existing diseases among 5,879 Florida Medicare Beneficiaries with AD by race, ranked by average annual health care expenditure. Two diseases in common for three race groups were Hip Fracture, with lower cost among

African American AD patients (\$47,311) than among White (\$60,588) and Hispanics (\$59,126), and Atrial Fibrillation, with higher cost among African American (\$52,232) and Hispanic (\$57,652) than among White (\$39,380).

Table 7. The most costly co-existing disease by race in Florida Medicare Beneficiaries with AD (N=5,879), 2010

Rank [#]	White (N=4,904)		African American (N=394)		Hispanic (N=581)	
	Co-existing Disease	Mean Expenditures	Co-existing Disease	Mean Expenditures	Co-existing Disease	Mean Expenditures
1	Hip Fracture	\$60,588	COPD ^a and Bronchiectasis	\$60,336	Hip Fracture	\$59,126
2	COPD ^a and Bronchiectasis	\$40,501	Asthma	\$54,200	Atrial Fibrillation	\$57,652
3			Atrial Fibrillation	\$52,232	Stroke/ Transient Ischemic Attack	\$48,136
4	Asthma	\$40,298	Hip Fracture	\$47,311	Cancer	\$45,549
5	Atrial Fibrillation	\$39,380	Stroke/ Transient Ischemic Attack	\$45,605	Chronic Kidney Disease	\$45,114
	Chronic Kidney Disease	\$39,354				

Notes: AD: Alzheimer's disease.

[#] Rank is based on expenditures given the presence of a second disease. An individual record may have up to 20 second diseases.

^a Chronic Obstructive Pulmonary Disease.

Discussion | PREVALENCE. While there are many articles about dementia including race as a risk factor, only a small number of studies (U.S. Department of Health and Human Services, 2014) focused on how prevalence of AD varies. In this study, the prevalence of AD was two times higher in Hispanics than in Whites, and 25.8% higher in African American than in Whites. The results in this study, agreed with previous studies (Tang, 1998; Alzheimer's Association, 2019, p.21) in that African-Americans and Hispanics were more likely than Whites to have a diagnosis of AD. In contrast to previous studies which suggested the highest risk of AD in African Americans, the present analyses showed that Hispanics had 2.4 times the risk of AD than African Americans among Florida older Medicare beneficiaries.

In this study, the mean cost of total health care expenditure per person for beneficiaries with AD was found to be twice that of for beneficiaries in general (\$25,517 vs \$12,717). Furthermore, among Florida Medicare beneficiaries with AD, the payments were 12 percent higher for older African Americans, and 16 percent higher for older Hispanics, than for older Whites. This finding is in line with Alzheimer's association's report (2019, p.57) that average Medicare Payment per person for beneficiaries 65 and older with a dementia diagnosis was higher for African American and Hispanics than for Whites in 2006.

COMORBIDITY. A dementia diagnosis may reduce identification of co-existing chronic diseases such as Diabetes, as found in previous studies (Thorpe, 2012), and would accordingly detract from treatment of

additional conditions (Fox, 2014). Patients with dementia were reported to have on average 2-8 (Sanderson, 2002; Schubert, 2006) chronic conditions. Consistent with those estimates, the AD patients in the study sample had 5.8 (SD= 2.8) additional diseases on average.

Despite the high prevalence of co-existing conditions, comorbidity of AD is largely understudied. Only a small number of studies (Duthie, 2011; Poblador-Plou, 2014; Sanderson, 2002; Schubert, 2006; Thorpe, 2012) emphasized the impact of certain conditions for AD patients. This study is one of the first to investigate the association between AD and a wide range of chronic conditions by race among Medicare beneficiaries in Florida. For each of 20 diseases, we screened the strength of the association (in terms of OR), the prevalence, the mortality rate, the average health care cost when it co-occurred with AD. In the following of the article, we focus on six major chronic conditions which were found to be either associated with highest risk AD, most frequently, or most costly when co-existing with AD: Heart Disease, Anemia, Depression, Hypertension, Hyperlipidemia, Chronic Kidney Disease, and Hip Fracture.

HEART DISEASE. Heart disease screened in the present study includes several chronic conditions related to heart: Heart Failure, Ischemic heart Disease, and Atrial Fibrillation. The three heart disease conditions were associated with some of the highest degrees of co-occurrence, mortality, and high health care expenditures. The results in this study indicated heart disease not only showed a strong association

(heart failure) and a high prevalence (Ischemic Heart Disease) of co-occurrence with AD, but also caused high mortality rate (Heart Failure, Atrial Fibrillation) and extremely high health care cost (Atrial Fibrillation) for AD patients, regardless of gender. The strong association between heart disease and dementia, AD, and/or cognitive impairment was noted frequently in previous studies (Justin, 2013; Newman, 2005; Ott, 1997; Qiu, 2006; Soneira, 1996).

HYPERTENSION, HYPERLIPIDEMIA. In previous literature, no consensus on the association between blood pressure and AD was determined. Some articles (Launer, 2000; Freitag, 2006; Skoog, 1996) reported that elevated blood pressure in mid-life is a strong risk factor for dementia and/or AD, whereas other studies (Landin, 1993; Guo, 1996; Sanderson, 2002) claimed that hypertension is associated with a reduced risk of AD.

There is no clear picture from the literature about the association between Hyperlipidemia and AD either. Both positive (Solomon, 2009; Kivipelto, 2001) and negative (Reitz, 2004, 2010; Mielke, 2005) association between cholesterol and AD were previously reported. Some studies (Kalmijn, 2000; Tan, 2003) also suggested no significant association between the two.

The finding in this study showed that Hypertension and Hyperlipidemia were both highly prevalent among 2010 Florida older Medicare beneficiaries, especially for Hispanics. But Hypertension was found to be significantly associated with an increased risk of AD for White and Hispanic (1.74 (1.63, 1.86) for White, 1.29 (0.99, 1.69) for African American, 1.65 (1.28, 2.13) for Hispanic; data not shown), while Hyperlipidemia was significantly associated with a decreased risk of AD for White (OR= 0.62 (0.58, 0.66), data not shown) and African American (0.73 (0.59, 0.91); data not shown), but not for Hispanic (0.91 (0.76, 1.1); data not shown).

ANEMIA. Research on the association between Anemia and dementia is scarce. In this study, the results showed Anemia was both highly prevalent among elder Medicare beneficiaries, and significantly associated with an increased risk of AD for all races. Previous studies (Beard, 1997; Hong, 2013) also have noted Anemia as a risk factor for dementia. One study by Sanderson et al. (2002) observed no significant association between Anemia and any dementia subtypes, possibly because their study sample included patients discharged with AD diagnosis from hospitals. Anemia, unlike other chronic conditions in this study, generally does not require hospitalization. Diet deficits among the elderly in general and the AD

in particular are likely associated with these findings and may potentially be mitigated.

DEPRESSION. In the results of this study, Depression was not among the top five in prevalence, but still highly prevalent among AD patients. This was especially true for Hispanic (49.4%), while White and African American beneficiaries with AD have a prevalence of 36% and 33% respectively. Depression was also significantly associated with an increased risk of AD regardless of race. This finding was supported by some studies which concluded that depression (Andersen, 2005; Saczynski, 2010; Geerlings, 2008; Green, 2003; Diniz, 2013) was a risk factor for later development of AD.

CHRONIC KIDNEY DISEASE. Chronic Kidney Disease was found to be one of most deadly and costly comorbidities for beneficiaries with AD, with a prevalence of 26.9% for White, 38.3% for African Americans, and 28.2% for Hispanic.

HIP FRACTURE. Even with a low prevalence among beneficiaries with AD (4.2% for White, 0.5% for African Americans, and 2.2% for Hispanic), Hip Fracture was found to be one of most costly comorbidities for beneficiaries with AD regardless of race. It was also associated with the highest mortality rate for White and Hispanic, but not for African American, at least in this study sample (mortality number is 0, data not shown). No deaths among African American beneficiaries with AD and a Hip Fracture were observed in this study.

Limitations | The present study has several limitations. First, this study was based on a sample of fee-for-service Medicare beneficiaries in Florida in 2010 and did not include any Medicare Advantage patients using private managed care companies. Approximately 32% (Centers for Medicare and Medicaid, 2012) of Florida Medicare beneficiaries were enrolled in Medicare Advantage in 2010. Medicare Part D drug claims were not available for analysis so the expenditure estimates only include medical treatments. The use of a 5% sample may have introduced some small differences in the point estimates as compared with a 100% sample which was not available for Carrier file claims. Lastly, race and ethnicity are recorded in the Medicare data as a single variable and are based on self-report. This may have led to classification errors in race and ethnicity categories. Findings from this study may not be generalizable to other states or years.

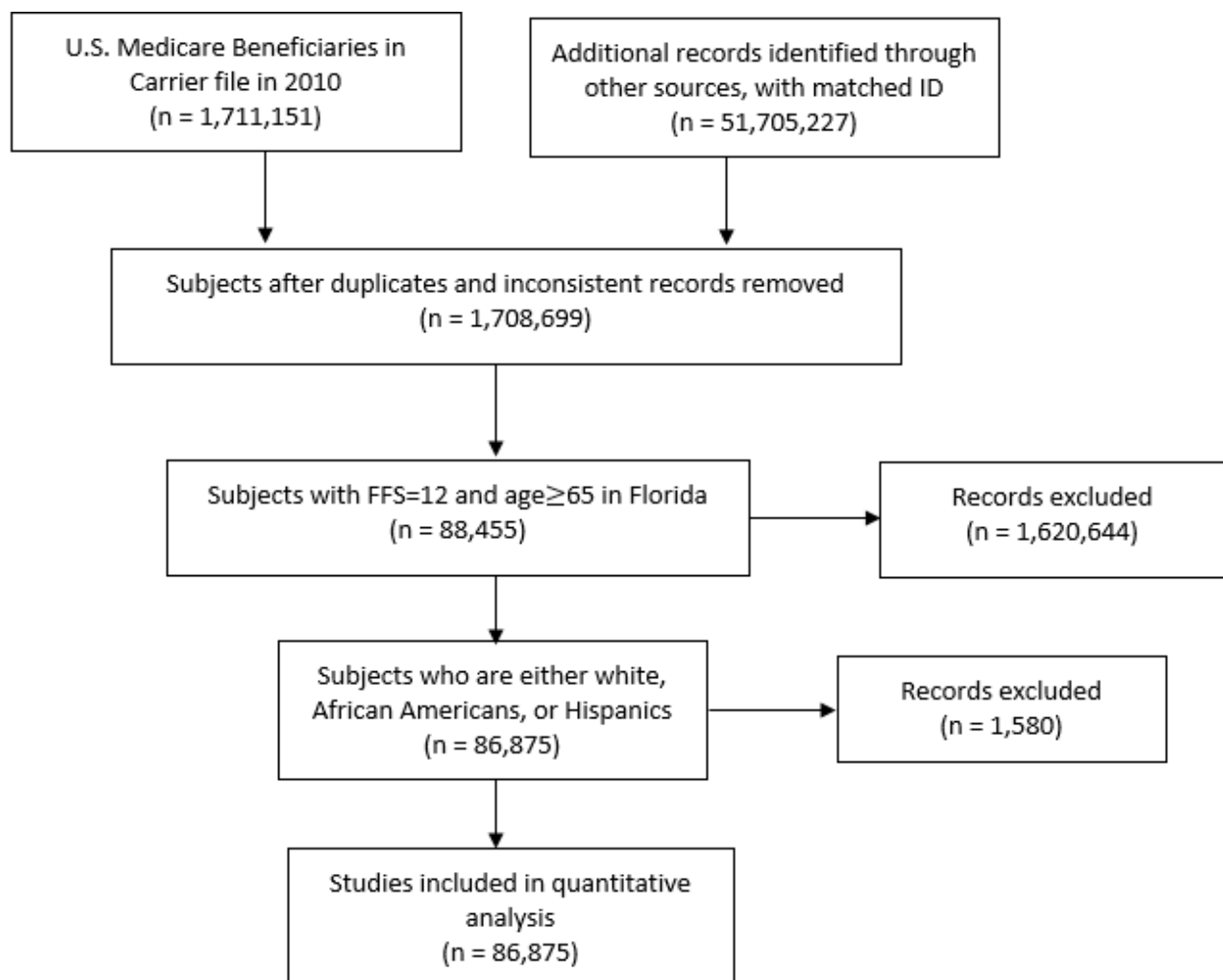
Implications | Comorbidities may exacerbate the development of AD (Solomon, 2011). In addition, the presence of AD may adversely affect the management

of co-existing conditions (Thorpe, 2012). However, only a small number of studies have focused on comorbidities associated with AD. The findings from this study have important implications for healthcare providers, public health professionals, and policy makers interested in the treatment and control of Alzheimer's disease.

In this study, we find that three types of heart diseases (Heart Failure, Ischemic heart Disease, Atrial Fibrillation) were most prevalent, most deadly, and most costly co-existing conditions among beneficiaries with AD. Hypertension and Hyperlipidemia were two of most prevalent comorbidities among beneficiaries with AD. Research on association between Anemia and AD is scarce.

According to this study, Anemia is both highly prevalent, and significantly associated with an increased risk of AD for all races. This is plausibly due to poor diet among the AD population, but no literature was identified directly supporting this speculation. Depression is also significantly associated with an increased risk of AD regardless of race. Chronic Kidney Disease is one of most deadly and costly comorbidities for beneficiaries with AD. With a low prevalence, Hip Fracture is one of most costly comorbidities for beneficiaries with AD. Give a lack of studies in this field, more efforts are called for to look into the impact, quality of control, and management of these comorbidities among AD patients.

Figure 1. Study sample exclusion flowchart



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