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Asthma-Chronic Obstructive Pulmonary Disease Overlap and Cost-Related Medication Non-adherence among Older Adults in the United States

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Background: Cost-related medication non-adherence (CRN) can negatively impact health outcomes in older adults with asthma and chronic obstructive pulmonary disease (COPD) overlap (ACO) by reducing access and adherence to essential medications. The objective of this study is to examine the association of ACO to any CRN and specific forms of CRN among a nationally representative sample of older (age ≥ 65 years) adults.

Methods: We adopted a cross-sectional study design using data from pooled cross-sectional Medicare Current Beneficiary Surveys (2006-2013) and linked fee-for-service Medicare claims. Unadjusted and adjusted logistic regressions that accounted for the complex survey design examined the association of ACO to any CRN and specific forms of CRN.

Results: Among older adults with ACO, 16% reported any CRN. The most common form of CRN was “failing to get prescription”. As compared to older adults with no asthma and no COPD, those with ACO were more likely to report any CRN (AOR = 1.50, 95%CI= [1.14, 1.96]) and all forms of CRN. However, when the number of unique medications were added to the model, there were no statistically significant differences in CRN between the two groups.

Conclusions: Older adults with ACO represent a vulnerable population with increased risk for CRN. Multiple factors can contribute to CRN including: a higher number of prescribed medications, multiple co-morbidities, and cost of therapies. Medication comprehensive review interventions have the potential of reducing the risk of CRN among the older Medicare beneficiaries with ACO.

Keywords: asthma COPD overlap; Medicare beneficiaries; cost-related medication non-adherence;

INTRODUCTION

Asthma and chronic obstructive pulmonary disease (COPD) are the two most common respiratory diseases worldwide. Combined, more than 435 million adults suffer from asthma and COPD (1,2). In many cases where airway obstruction is noted, asthma and COPD can coexist as “Asthma-COPD overlap” (ACO), which can be as high as 50% among elderly (age ≥ 80 years) patients with either asthma or COPD (3). Treatment for both asthma and COPD focuses on symptom management rather than clinical cure; similarly, ACO is managed with pharmacotherapy recommended in both disease states. Adherence is critical in ACO as therapy is primarily maintenance therapy (i.e. taken daily) versus as needed to maximize effects on reducing inflammation, bronchoconstriction, and sputum production (4,5). However, studies demonstrate many individuals with either asthma or COPD do not adhere to prescribed medication regimens with non-adherence rates often $\geq 20\%$ (6–8). While many factors influence medication adherence, older adults with chronic conditions often report cost-related barriers as a reason for medication non-adherence (9–11). High out-of-pocket (OOP) prescription costs can overwhelm some older adults

compelling them to adopt cost-coping strategies such as (1) failing to fill a prescription; (2) delaying filling prescriptions; (3) skipping medication doses; and (4) using less than prescribed doses of a medication (12,13).

Although there are no published studies on cost-related non-adherence (CRN) among older adults with ACO, it is expected that ACO individuals may be particularly vulnerable to CRN based on studies focusing on either asthma or COPD. In a 2004 study of disease-specific rates of CRN by Piette et al (14), asthma and COPD were among diseases with the highest rates of CRN. Castaldi et al estimated that over one third of older adults with chronic pulmonary diseases reported CRN (15). However, this study did not compare the risk of CRN for different types of chronic pulmonary diseases including ACO.

Insight into the association of CRN to ACO is important because CRN has downstream effects and can lead to higher healthcare utilization (16), morbidity (17), and mortality (18). Information on contributors to CRN among adults with ACO can be used to develop a portfolio of programs targeting these contributors and subsequently help improve adherence and reduce the risk of mortality and morbidity among older adults with ACO.

Therefore, our primary objective was to assess the association of ACO to CRN as compared to no-asthma and no-COPD and explore the factors that may affect the association of ACO to CRN among older adults (age ≥ 65 years), using a nationally representative sample of Medicare beneficiaries in the US.

METHODS

Study Design

We adopted a cross-sectional study design with data from the annual Medicare Current Beneficiary Survey (MCBS) from 2006 through 2013.

Data Source

The data sources for this study were the Medicare Current Beneficiary Survey (MCBS) and fee-for-service Medicare claims that are linked to the survey respondents. The MCBS is a rotating panel survey of a nationally representative sample of the Medicare population and has been carried out since 1991. The goals of the survey are to collect information on healthcare access, expenditures, sources of payment, health outcomes, health status, and satisfaction with care of Medicare beneficiaries (19). To improve the accuracy and completeness of healthcare use and costs, survey data are matched, reconciled, and supplemented with fee-for-service Medicare claims creating best of both survey and claims data worlds (20).

From 1992 to 2013, the MCBS released two data files, the “Access to Care” (AC) and the “Cost and Use” (CU) files, annually. While both AC and CU files include some common elements, AC files provide additional information on access to care, information needs, patient-provider relationships, and satisfaction with care on “always enrolled” Medicare beneficiaries. CU files include detailed data on reconciled cost and use information on “ever enrolled” Medicare beneficiaries (19). Medicare claims have information on all reimbursed healthcare encounters of fee-for-service Medicare beneficiaries including International Classification of Diseases 9th Edition (ICD-9) codes, payments, procedures, and other treatments.

For this study, we used AC and CU files and fee-for-service Medicare claims from 2006 to 2013. We selected these years because of the introduction of Medicare Part D program beginning in 2006.

We used AC files to capture information on CRN. We used CU files for deriving other variables. We identified asthma-COPD status by using fee-for-service inpatient, outpatient, physician, and home healthcare Medicare claims files.

Study Sample

The study sample included community-dwelling elderly (age ≥ 65 years) Medicare beneficiaries who were enrolled in fee-for-service (Parts A and B) during the full calendar year (2006-2013) and alive throughout the calendar year. We further restricted our study sample to those with available information in both AC and CU files of the MCBS and those without missing data for CRN measures (N = 37,571). (Appendix 1)

Measures

Dependent Variable: Any CRN (Yes/No) and Specific Forms of CRN

In MCBS, four questions queried CRN-related behaviors. The validity and reliability of using these questions for measuring CRN have been confirmed in previous studies (21–23). Respondents were asked, “Please tell me how often during (CURRENT YEAR) you did any of the following behaviors (1) decided not to fill a prescription because it cost too much, (2) delayed getting a prescription filled because the medicine cost too much, (3) skipped doses to make the medicine last longer, (4) taken smaller doses of a medicine to make the medicine last longer”. The answers were recorded on a 3-point scale (often, sometimes, and never). If respondents answered “often or sometimes” to any of these questions, the respondents were considered to have any CRN, and those who responded never to all the questions were considered to have no CRN. For all specific forms of CRN, we combined “often” and “sometimes” to create indicator variables (Yes/No).

Key Independent Variable: Asthma and COPD categories

The key independent variable was asthma-COPD status. The first step of preparing this variable was identification of individuals with either asthma or COPD by using the ICD-9 codes available in Medicare claims (Appendix 2). These diagnosis codes for asthma and COPD have been utilized in previously published research (24,25). Individuals with at least one inpatient visit or two outpatient visits (14 days apart) for either asthma or COPD codes were considered to have diagnosed asthma or COPD. Based on the presence of asthma or COPD, we created the following four categories: 1) asthma COPD Overlap (ACO); 2) asthma-only; 3) COPD-only; and 4) no-asthma no-COPD.

Other independent Variables

We used Anderson’s health behavior model as well as published literature to guide the selection of other independent variables associated with CRN. We selected Andersen behavior model for this study as it gives us a comprehensive list of factors associated with CRN. Per the framework, CRN may be affected by: 1) pre-disposing variables (Sex (Male/female); age (65-74/75-84/85 years or older); race/ethnicity (White/Black/Hispanic/or other races)); 2) enabling factors (marital status (married/not married); education level (less than high school/high school/and above high school); poverty status [based on income relative to the level of federal poverty line (FPL)] ($< 200\%$ of FPL $\geq 200\%$ of FPL); high burden of OOP prescription cost [annual OOP prescription costs $>$ annual 10% of income] (yes/no); high burden of OOP medical costs [annual OOP medical costs $>$ annual 10% of income] (yes/no); and prescription drug coverage (yes/no); 3) need factors (the number of chronic conditions); the number of unique medications; 4) personal health practices (obesity status (yes/no) and smoking status (never-smoker/former/current smoker). Prescription drug

coverage was “yes” if the respondent had Part D or any other forms of coverage for prescription drugs. The number of chronic conditions was the sum of six chronic conditions of cancer, diabetes, hypertension, heart disease, arthritis, and osteoporosis. All these six conditions were derived from the survey data. For calculating number of unique medications, all medications were identified by generic name from the prescription file to make sure that unique medications were counted once.

Statistical analyses

Unadjusted group differences in terms of asthma-COPD status were tested with Rao-Scott Chi-square tests. We used separate logistic regression models to examine the unadjusted and adjusted associations between asthma-COPD status and CRN (i.e. any CRN and specific forms of CRN). Results are presented in terms of unadjusted (UOR) and adjusted odds ratios (AOR) and 95% confidence intervals (CI). All analyses utilized the SURVEY procedures of Statistical Analysis Software (SAS®) version 9.4 to account for the complex survey design of MCBS.

RESULTS

The study sample consisted of 37,571 person-years and included elderly (age ≥ 65 years) community-dwelling, full-year fee-for-service Parts A and B Medicare beneficiaries, without missing data on CRN measures between 2006 and 2013. (Appendix-3) The overall prevalence of ACO, asthma-only, COPD-only was 1.5%, 2.3%, and 8.8% respectively during the study period.

There were significant differences between asthma-COPD status groups in terms of sex, age, race/ethnicity, marital status, education level, poverty status, prescription coverage, high burden of prescription cost, high burden of medical cost, the number of chronic conditions, and number of unique medications (Table 1). For example, individuals with ACO have the highest rates of high burden of prescription costs (9.3%) and medical costs (28.3%) compared to individuals with asthma-only (6.2% & 17.1%), COPD-only (9.0% & 20.9%), and no-asthma no-COPD (4.0% and 11.0%). The number of unique medications was the highest among individuals with ACO (16.21 ± 0.34) compared to those with asthma-only (12.74 ± 0.29), COPD-only (12.51 ± 0.17), and no-asthma no-COPD (7.37 ± 0.06).

Unadjusted and Adjusted Associations of ACO to any CRN

The prevalence of any CRN was 9.7% among older Medicare beneficiaries. Individuals with ACO had the highest percentage of any CRN (16.0%) compared with individuals with asthma-only (14.5%), COPD-only (13.0%), and no-asthma no-COPD (9.1%) (Figure 1). Compared to individuals with no-asthma no-COPD, individuals with ACO (UOR = 1.89, 95% CI = [1.45, 2.45]) were more likely to report CRN (Table 2). In models without adjustments for number of unique medications, individuals with ACO were more likely to report (AOR = 1.50, 95% CI = [1.14, 1.96]) any CRN compared to individuals with no-asthma no-COPD (Table 2). In the fully adjusted model for any CRN, those with ACO were as likely as those with no asthma and COPD to report CRN (AOR = 1.23, 95% CI = [0.92, 1.63], $p = 0.15$).

Association of ACO to specific forms of CRN

Those with ACO had the highest percentages of three specific forms of CRN including: failing to fill prescription (10.1%), delaying filling prescription (7.9%), and skipping medication doses (6.9%) (Figure 1). In the unadjusted and adjusted models, without number of unique medications, individuals with ACO had higher odds of “failing to fill prescription”, “delaying filling prescriptions”, and “skipping medication doses”, compared with individuals with no-asthma no-COPD (Table 3).

In the fully adjusted model that included the number of medications as one of the independent variables, those with ACO (AOR = 1.43, 95% CI = [0.99, 2.07], $p = 0.05$), had marginally higher odds of “failing to fill prescription” compared to those with no asthma and no COPD. In the fully adjusted models for other specific forms of CRN, we did not observe statistically significant differences among adults with ACO and adults with no asthma and no COPD.

Comparison ACO with asthma-only and COPD-only groups

Comparisons were also made among asthma or COPD categories (asthma-only, COPD-only). As indicated in Table 2, we also used COPD-only or asthma-only as reference groups. In all the models, there were no statistically significant group differences among asthma-only, COPD-only, and ACO.

DISCUSSION

One in six older Medicare beneficiaries with ACO reported any CRN between 2006 and 2013. The most prevalent form of CRN was “failing to fill prescription,” which was almost twice as high among Medicare beneficiaries with ACO compared to those with no-asthma and no-COPD.

Older adults with ACO had higher odds of reporting any CRN compared to older adults with no-asthma no-COPD; while not directly studied, this likely has significant later-in-life morbidity and mortality consequences (16,17). This is not surprising because older adults who had high OOP spending burden compared to those with neither asthma nor COPD and high OOP spending burden was significantly associated with CRN. The high OOP spending burden among adults with ACO can be explained by the high cost of brand-name inhaler therapies and the high medication burden per individualized regimen to adequately manage ACO (often 2 to 3 inhaler therapies). Although, we did not distinguish between asthma and COPD-related medications, we speculate that those with ACO need to use inhalers for the management of ACO, as these are first line therapy per the most recent guidelines (26). The cost of inhalers dramatically increased in 2008, after the banning of chlorofluorocarbon propellants (27). This led to phasing out generic inhalers, save only brand-name inhalers (28). A study by Tseng et al indicated that although inhalers were universally covered by Medicare Part D plans, it required high cost-sharing by Medicare beneficiaries (29). This can be seen as patients experience higher annual plan deductibles and elevated copay costs (inhalers are often included in higher tiers of formularies because of their brand status) despite Medicare covering a portion of the prescription. For instance, using a single inhaler each month had projected annual OOP costs of \$900 under a standard Part D plan in 2015 (29). Our study findings suggest that policy makers may need to re-evaluate coverage of inhalers under Part D plans.

In our study, increased odds of any CRN among ACO individuals compared to those with no-asthma no-COPD is apparent by adjusting all factors without number of unique medications. However, the inclusion of number of unique medications attenuated this association, suggesting that number of medications may be a key link between ACO and CRN. Notably, the mean number of unique medications is approximately 16 among individuals with ACO which is significantly higher compared to individuals with asthma-only (~13), COPD-only (~12.5) and no-asthma no-COPD (~7). Individuals with ACO have a higher number of unique medications due to two following reasons: (1) individuals with ACO may need to use a higher number of respiratory medications to adequately control respiratory symptoms. The Latin American Project for the Investigation of Obstructive Lung Disease (PLATINO) study found that 49% of individuals with ACO used respiratory medications which was significantly higher than individuals with asthma-only (38%) or COPD-only (20%) (30); (2) ACO individuals may need to use a greater number of non-respiratory medications due to higher risk of comorbid medical conditions. In our study, 43% of ACO individuals had 4-6 other chronic conditions, while this number was lower among individuals with asthma-only (33%), COPD-only

(36%), and no-asthma no-COPD (23%). A population survey in the US similarly found that 90% of individuals with ACO had at least one other co-existing condition (compared with 71% in asthma-only and 84% in COPD-only) (31).

Taken together, all these findings suggest that reducing the number of medications may be a pathway to reduce any CRN odds, and subsequently alleviate the high burden of OOP prescription cost among older adults with ACO. As documented in published literature, clinicians and pharmacists can play an important role in reducing the number of medications. For example, during annual wellness visits, now covered by Medicare, a comprehensive review of medications can be performed and highlight opportunities for prescription regimen optimization (32). Providers can proactively participate in deprescribing by: 1) discontinuing unnecessary therapy, 2) discontinuing duplicate therapies, 3) combining therapies as appropriate (i.e. combination inhalers), and 4) replacing high-cost therapies with more affordable options. In a survey of elderly Medicare beneficiaries, more than 30% of individuals reported they did not have the chance of talking with their provider about their medications in the last 12 months (33). Intensive, chronic care management can be optimized through team-based care (34).

Strengths & Limitations

To date, ours is the first study to examine the association between ACO and CRN among a nationally representative sample of fee-for-service community-dwelling Medicare beneficiaries. Medicare claims enabled us to identify current asthma and COPD status. Survey data provided the opportunity to control for a comprehensive set of covariates that are otherwise not available in claims data.

This study also has some limitations. Many variables in this study including CRN are self-reported, which may be subject to recall bias and social desirability bias. The findings of this study are not generalizable to all elderly Medicare beneficiaries as Medicare HMO enrollees or institutionalized beneficiaries were not included in this study. Despite the benefits of linked survey modules with claims, information about the age of onset, and the severity of ACO, asthma, COPD were not available in the dataset. Another limitation of this study is that CRN measures are for all types of medications and not for a specific medication group (e.g. inhalers). Moreover, claim data was used for capturing asthma-COPD status which may cause misclassification bias. Finally, the study design is a cross-sectional study which makes it hard to establish a cause and effect relationship. Future cohort studies may help to evaluate the association between ACO and CRN.

CONCLUSIONS

CRN remains an issue among elderly Medicare beneficiaries. Individuals with ACO are vulnerable for any CRN and its specific forms. The high number of medications used among ACO individuals explained the association of ACO to CRN. Interventions targeting reducing therapy burden and cost are needed to reduce CRN and prevent downstream effects of medication non-adherence in patients with ACO.

Declaration of interests

The authors report no conflict of interest and this research has not been submitted in manuscript form anywhere else. The authors have disclosed that they have no significant relationships with or financial interests in any commercial companies related to this study or article.

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Appendix 1 Attrition Table of Individuals Included in the Analysis Based on Inclusion and Exclusion Criteria

Number of individuals available in MCBS 2006-2013
131,007
Number of individuals at least 65 years old
74,689
Number of individuals with at least one full year enrollment
70,470
Number of individuals with community-dwelling status
68,512
Number of individuals who were alive during calendar year
63,923
Number of individuals who are enrolled in fee-for-service program
61,870
Number of individuals whose information was available in both "access to care" and "cost and use" files
37,817
Number of individuals without any missing values for cost-related medication non-adherence
37,571

Appendix 2. Diagnosis ICD-9-CM Codes for Asthma and COPD

Asthma: 493.0, 493.1, 493.2, 493.8, 493.9

COPD: 491.1, 491.2, 491.8, 491.9, 492, 492.8

Appendix 3. Characteristics of Elderly Community-Dwelling Fee-for-Service Medicare Beneficiaries

	N	Wt. %
ALL	37,571	100.0
Sex		
Female	21,186	56.2
Male	16,385	43.8
Age in Years		
65-74	14,893	47.4
75-84	15,447	37.5
85 and above	7,231	15.1
Race/Ethnicity		
White	31,130	82.7
Black	2,563	6.6
Latino	2,112	5.7
Other race	1,688	4.8
Marital Status		
Married	19,507	54.2
Not married	18,050	45.7
Education		
Less than high school	9,145	22.2
High school	13,573	35.5
Above high school	14,711	41.9
Poverty Status		
Less than 200% FPL	18,120	45.6
At least 200% FPL	19,451	54.4
Prescription Coverage		
Yes	23,380	61.6
No	14,191	38.4
OOP High Burden-Prescription Costs		
Yes	1,805	4.5
No	35,766	95.5
OOP High Burden – Medical Costs		
Yes	4,885	12.3
No	32,686	87.7
Number of Unique Medications		
0	1,665	5.0
1-4	9,142	25.3
5-7	8,906	23.5
8-11	8,810	22.9
12 and more	9,048	23.3
Number of Other Chronic Conditions		
0-1	7,687	22.2
2-3	20,037	53.1
4-6	9,842	24.7
Calendar Year		
2006	5,694	13.2
2007	5,321	12.3
2008	4,904	11.7
2009	4,265	11.4
2010	4,001	11.4
2011	4,581	13.4
2012	4,546	13.2
2013	4,259	13.3

Note: Based on 37,571 person-years of community-dwelling elderly (age ≥ 65 years) Medicare beneficiaries continuously enrolled in fee-for-service Part A and Part B during the calendar year,

alive during the calendar year, had information in both cost and use and access to care files and did not have missing information on any cost-related medication non-adherence measures.

FPL: federal poverty level; N: unweighted number; Wt: weighted.

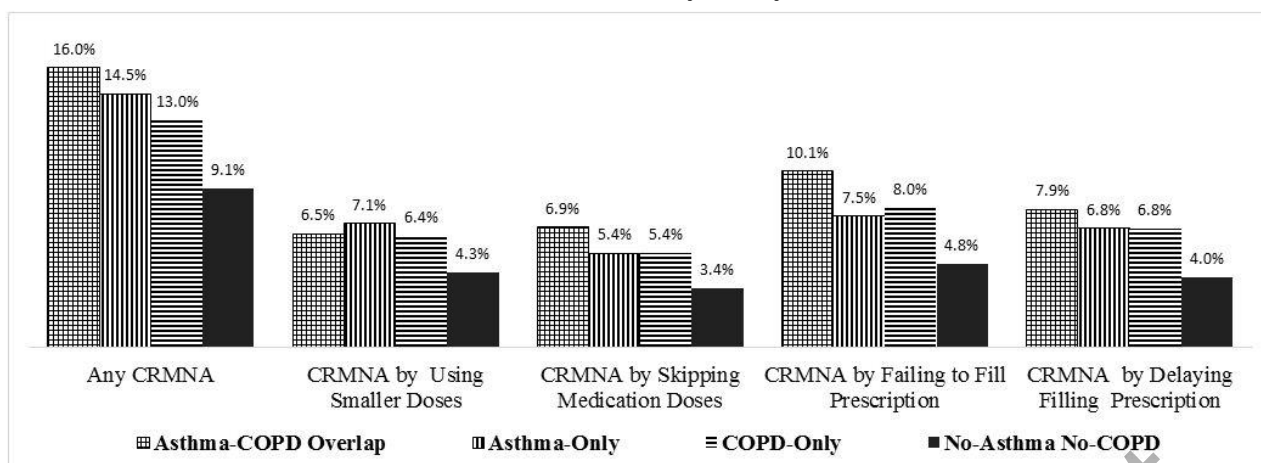
Appendix 4. Adjusted Odds Ratios (AOR) and 95% Confidence Intervals from Logistic Regressions on Any Cost-related Medication Non-adherence Older (age > 65 years) Medicare Beneficiaries Medicare Current Beneficiary Survey, 2006-2013

	AOR	95% CI	Sig
Asthma/COPD status			
Asthma COPD Overlap	1.23	[0.92, 1.63]	
Asthma-only	1.22	[0.97, 1.54]	
COPD-only	1.12	[0.96, 1.30]	
No-asthma no-COPD	Ref		
Age (year)	0.94	[0.94, 0.95]	***
Sex			
Female	1.32	[1.19, 1.47]	***
Male	Ref		
Race/ Ethnicity			
White	Ref		
Black	1.24	[1.02, 1.51]	
Latino	0.86	[0.68, 1.09]	
Other races	1.26	[1.01, 1.57]	*
Marital Status			
Married	0.98	[0.89, 1.08]	
Not married	Ref		
Education Level			
Less than high school	1.01	[0.88, 1.17]	
High school	0.97	[0.86, 1.08]	
Above high school	Ref		
Poverty Status			
Less than 200% FPL	1.75	[1.60, 1.91]	***
At least 200% FPL	Ref		
Prescription coverage			
Yes	0.59	[0.53, 0.65]	***
No	Ref		
Number of Other Chronic Conditions	1.17	[1.12, 1.23]	***
Number of unique medications	1.03	[1.02, 1.04]	***
Obesity Status			
Yes	1.06	[0.94, 1.19]	
No	Ref		
Smoking Status			
Current/old smoker	1.04	[0.95, 1.14]	
Never smoker	Ref		

Note: Based on 37,571 person-years of community-dwelling elderly (age > 65 years) Medicare beneficiaries, continuously enrolled in fee-for-service Part A and Part B during the calendar year and alive during the calendar year, and had information in both cost and use and access to care files.

COPD: Chronic Obstructive Pulmonary Disease; Ref: reference group; Sig: significance; *** $p < .001$; ** $.001 \leq p < .01$; * $.01 \leq p < .05$

Figure 1. Prevalence of any CRN and Specific Types of CRN By Asthma-COPD Status (i.e., Asthma-COPD Overlap, Asthma-Only, COPD-Only, Neither Asthma nor COPD) Older (age ≥ 65 years) Medicare Beneficiaries Medicare Current Beneficiary Survey, 2006-2013



Note: Based on 37,571 person-years of community-dwelling elderly (age ≥ 65 years) Medicare beneficiaries, continuously enrolled in fee-for-service Part A and Part B during the calendar year and alive during the calendar year, and had information in both cost and use and access to care files.

Table 1. Unweighted N and Weighted Percentages of Characteristics of By Asthma and Chronic Obstructive Pulmonary Disease (COPD) Status (Column %) Older (age $\geq$ 65 years) Medicare Beneficiaries Medicare Current Beneficiary Survey, 2006-2013

		Asthma COPD Overlap		Asthma-only		COPD-only		No-asthma no-COPD		Sig
		N	Wt. %	N	Wt. %	N	Wt. %	N	Wt. %	
ALL		576	1.5	849	2.3	3,446	8.8	32,700	87.4	
Sex										***
	Female	382	67.4	650	77.7	1,686	49.7	18,468	56.1	
	Male	194	32.6	199	22.3	1,760	50.3	14,232	43.9	
Age in Years										***
	65-74	205	40.3	391	53.5	1,199	41.2	13,098	48.0	
	75-84	261	43.5	318	33.9	1,605	43.6	13,263	36.9	
	85 and above	110	16.1	140	12.6	642	15.2	6,339	15.1	
Race/Ethnicity										***
	White	444	77.2	655	78.6	2,982	86.7	27,049	82.7	
	Black	46	8.0	84	9.3	164	4.7	2,269	6.8	
	Latino	48	7.8	59	6.5	142	3.9	1,863	5.8	
	Other race	37	7.0	51	5.7	151	4.7	1,449	4.7	
Marital Status										***
	Married	220	39.5	401	48.1	1,658	49.3	17,228	55.2	
	Not married	355	60.5	447	51.9	1,786	50.7	15,462	44.8	
Education										***
	Less than high school	191	31.7	174	19.1	1,131	31.8	7,649	21.3	
	High school	211	37.4	286	31.8	1,264	36.7	11,812	35.6	
	Above high school	172	30.8	387	49.2	1,040	31.5	13,112	43.1	
Poverty Status										***
	Less than 200% FPL	357	59.8	411	45.1	2,036	57.7	15,316	44.2	
	At least 200% FPL	219	40.2	438	54.9	1,410	42.3	17,384	55.8	
Prescription Coverage										***
	Yes	405	70.7	582	66.8	2,250	65.2	20,143	60.9	
	No	171	29.3	267	33.2	1,196	34.8	12,557	39.1	
High Burden of OOP Prescription Cost										***
	Yes	55	9.3	55	6.2	320	9.0	1,375	4.0	
	No	521	90.7	794	93.8	3,126	91.0	31,325	96.0	
High Burden of OOP Medical Cost										***
	Yes	171	28.3	149	17.1	740	20.9	3,825	11.0	
	No	405	71.7	700	82.9	2,706	79.1	28,875	89.0	
Number of Other Chronic Conditions										***
	0-1	53	9.0	93	11.0	419	13.0	7,122	23.6	
	2-3	273	47.6	471	56.4	1,754	50.7	17,539	53.4	
	4-6	250	43.3	285	32.6	1,272	36.3	8,035	23.0	
Number of Medications		16.21 [†]	0.34 [‡]	12.74 [†]	0.29 [‡]	12.51 [†]	0.17 [‡]	7.37 [†]	0.06 [‡]	***
Obesity Status										***
	Yes	204	38.8	294	36.6	881	26.9	7499	24	
	No	372	61.2	555	63.5	2565	73.1	25201	76	
Smoking Status										***
	Current/old smoker	426	74.8	409	49.4	2900	85	18082	56.3	
	Never smoker	149	25.2	440	50.6	544	15	14573	43.7	
Calendar Year										
	2006	86	13.2	122	12.7	504	13.2	4,982	13.2	
	2007	72	10.6	120	13.0	493	12.6	4,636	12.3	
	2008	81	12.2	97	9.9	460	11.8	4,266	11.7	
	2009	64	11.1	93	11.0	407	11.9	3,701	11.4	
	2010	56	10.6	94	12.4	392	12.4	3,459	11.3	
	2011	82	15.5	115	14.1	404	13.2	3,980	13.4	
	2012	66	12.3	109	13.8	406	12.5	3,965	13.3	
	2013	69	14.6	99	13.3	380	12.6	3,711	13.3	

Note: Based on 37,571 person-years of community-dwelling elderly (age ≥ 65 years) Medicare beneficiaries, continuously enrolled in fee-for-service Part A and Part B during the calendar year and alive during the calendar year, and had information in both cost and use and access to care files.

Significant group differences in asthma-COPD status were based on Rao-Scott chi-square tests. ANOVA test was used for number of unique medications.

FPL: federal poverty level; N: unweighted number; Sig: significance; Wt: weighted; †: Mean; ‡: Standard Error; *** $p < .001$

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Table 2. Unadjusted Odds Ratios (UOR), Adjusted Odds Ratios (AOR) and 95% Confidence Intervals from Separate Logistic Regressions on Any Cost-related Medication Non-adherence Older (age $\geq$ 65 years) Medicare Beneficiaries Medicare Current Beneficiary Survey, 2006-2013

		Ref= No-asthma no-COPD			Ref= Asthma-only			Ref= COPD-only		
		UOR	95% CI	Sig	UOR	95% CI	Sig	UOR	95% CI	Sig
Unadjusted Models										
	Asthma COPD Overlap	1.89	[1.45 , 2.45]	***	1.11	[0.78 , 1.59]		1.30	[0.96 , 1.76]	
	Asthma-only	1.69	[1.34 , 2.14]	***	Ref			1.17	[0.89 , 1.53]	
	COPD-only	1.45	[1.26 , 1.67]	***	0.86	[0.65 , 1.13]		Ref		
	No-asthma no-COPD	Ref			0.59	[0.47 , 0.75]	***	0.69	[0.60 , 0.79]	***
		AOR	95% CI	Sig	AOR	95% CI	Sig	AOR	95% CI	Sig
Adjusted Models with All Factors except Number of unique medications										
	Asthma COPD Overlap	1.50	[1.14 , 1.96]	**	1.08	[0.76 , 1.54]		1.19	[0.88 , 1.61]	
	Asthma-only	1.38	[1.09 , 1.75]	**	Ref			1.10	[0.84 , 1.43]	
	COPD-only	1.26	[1.09 , 1.45]	**	0.91	[0.70 , 1.18]		Ref		
	No-asthma no-COPD	Ref			0.72	[0.57 , 0.91]	**	0.79	[0.69 , 0.92]	**
Fully Adjusted Models										
	Asthma COPD Overlap	1.23	[0.92 , 1.63]		1.00	[0.70 , 1.44]		1.10	[0.80 , 1.50]	
	Asthma-only	1.22	[0.97 , 1.54]		Ref			1.10	[0.84 , 1.43]	
	COPD-only	1.12	[0.96 , 1.30]		0.91	[0.70 , 1.19]		Ref		
	No-asthma no-COPD	Ref			0.81	[0.65 , 1.02]		0.90	[0.77 , 1.04]	

Note: Based on 37,571 person-years of community-dwelling elderly (age $\geq$ 65 years) Medicare beneficiaries, continuously enrolled in fee-for-service Part A and Part B during the calendar year and alive during the calendar year, and had information in both cost and use and access to care files.

COPD: Chronic Obstructive Pulmonary Disease; CRN: Cost-related Medication Non-Adherence; Ref: reference group; Sig: significance

*** $p < .001$; ** $.001 \leq p < .01$; * $.01 \leq p < .05$

Table 3. Unadjusted Odds Ratios (UOR), Adjusted Odds Ratios (AOR) and 95% Confidence Intervals from Separate Logistic Regressions on Specific Forms of CRN Older (age $\geq$ 65 years) Medicare Beneficiaries Medicare Current Beneficiary Survey, 2006-2013

		Unadjusted Models			Fully Adjusted Models without Number of unique medications			Fully Adjusted Models		
		UOR	95% CI	Sig	AOR	95% CI	Sig	AOR	95% CI	Sig
CRN by Using Smaller Doses										
	Asthma COPD Overlap	1.54	[0.98 , 2.43]		1.21	[0.75 , 1.94]		0.97	[0.60 , 1.58]	
	Asthma-only	1.72	[1.16 , 2.55]	**	1.42	[0.95 , 2.10]		1.24	[0.83 , 1.84]	
	COPD-only	1.49	[1.23 , 1.82]	***	1.25	[1.02 , 1.52]	*	1.10	[0.89 , 1.37]	
	No-asthma no-COPD									
CRN by Skipping Medication Doses										
	Asthma COPD Overlap	2.16	[1.41 , 3.31]	***	1.58	[1.00 , 2.50]	*	1.36	[0.87 , 2.11]	
	Asthma-only	1.62	[1.09 , 2.40]	*	1.28	[0.87 , 1.87]		1.16	[0.79 , 1.70]	
	COPD-only	1.59	[1.32 , 1.91]	***	1.31	[1.09 , 1.58]	**	1.20	[1.00 , 1.46]	
	No asthma and No COPD									
CRN by Failing to Fill Prescription										
	Asthma COPD Overlap	2.25	[1.59 , 3.17]	***	1.75	[1.24 , 2.47]	**	1.43	[0.99 , 2.07]	
	Asthma-only	1.61	[1.20 , 2.15]	**	1.30	[0.97 , 1.73]		1.15	[0.87 , 1.52]	
	COPD-only	1.65	[1.42 , 1.92]	***	1.41	[1.20 , 1.66]	***	1.25	[1.05 , 1.49]	*
	No-asthma no-COPD									
CRN by Delaying Filling Prescription										
	Asthma COPD Overlap	2.07	[1.47 , 2.93]	***	1.48	[1.02 , 2.14]	*	1.26	[0.87 , 1.81]	
	Asthma-only	1.79	[1.30 , 2.46]	***	1.37	[0.99 , 1.90]		1.24	[0.89 , 1.71]	
	COPD-only	1.69	[1.37 , 2.09]	***	1.41	[1.14 , 1.74]	**	1.28	[1.02 , 1.60]	*
	No Asthma and COPD									

Note: Based on 37,571 person-years of community-dwelling elderly (age $\geq$ 65 years) Medicare beneficiaries, continuously enrolled in fee-for-service Part A and Part B during the calendar year and alive during the calendar year, and had information in both cost and use and access to care files.

CI: Confidence Interval; COPD: Chronic Obstructive Pulmonary Disease; CRN: Cost-related Medication Non-Adherence; Sig: significance

*** $p < .001$; ** $.001 \leq p < .01$; * $.01 \leq p < .05$