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Original Article

Medication adherence in Medicare-enrolled older adults with asthma before and during the coronavirus disease 2019 pandemic

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ABSTRACT

Background: Data regarding medication adherence in older adults with asthma before and during the coronavirus disease 2019 (COVID-19) pandemic are lacking.
Objective: To evaluate medication adherence and determine factors associated with adherence in Medicare-enrolled older adults with asthma before and during the COVID-19 pandemic.
Methods: This was a retrospective cohort analysis of Medicare-enrolled patients with asthma. Medication adherence was measured using rates of proportion of days covered for dates January to July 2019 and January to July 2020. Patients less than 65 years of age, with chronic obstructive pulmonary disease, or with cystic fibrosis were excluded. Paired *t* tests assessed change in adherence between 2019 and 2020. Logistic regression evaluated association of age, sex, depression, moderate or severe asthma, use of a 90-day supply, having 3 or more albuterol fills, number of medications, medication-related problems, prescribers, pharmacies, controller medication classes, and systemic corticosteroid fills with high adherence (proportion of days covered ≥ 80%).
Results: Mean adherence to asthma controller medications ranged from 75% to 90%, in 2019. Adherence significantly decreased ($P < .001$) from 51% to 70% for all controller medications, except theophylline in 2020. Similar results were observed among patients with moderate or severe asthma. In 2019 and 2020, number of controller medications, 3 or more albuterol fills, and having a 90-day supply were associated with high adherence ($P < .001$).
Conclusion: Adherence to asthma controller medications decreased considerably during the COVID-19 pandemic among Medicare-enrolled patients with asthma. Patients with markers for more severe asthma, overuse of albuterol, and a 90-day supply of controller medications were more likely to have high adherence. These findings can be used to identify opportunities to improve adherence and prescribing among adult patients with asthma.

Introduction

Asthma and other chronic lower respiratory conditions were the fourth leading cause of death in the United States in 2019.[1] Annual costs related to asthma were estimated to be nearly $80 billion in the United States, according to data collected from 2008 to 2013.[2] Older adults with asthma have an increased risk of morbidity and mortality compared with younger adults.[3-5]

The use of asthma controller medications is necessary to reduce inflammation and prevent airway constriction among patients with asthma. One study found substantial underutilization of controller medications for asthma control among recently hospitalized older adults in a Medicaid program.[6] Another study reported that approximately 80% of adults with moderate-to-severe asthma were not fully adherent to their inhaled corticosteroids.[7] Serhal et al[8] observed that 72% of adults with asthma had not started using or were considered nonadherent to their controller medications. Systematic reviews of studies in both adult and pediatric populations have found higher rates of adherence to be generally associated with fewer asthma exacerbations despite several studies noting positive or null associations between adherence and exacerbations.[9-11] However, although 1 study found that older adults with any respiratory condition were with an average medication possession ratio of approximately 25% for fluticasone and salmeterol combination inhalers,[12] rates of adherence to controller medications are unknown among older adults with asthma.

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The coronavirus disease 2019 (COVID-19) pandemic created unexpected life-changing disruptions, potentially affecting access to health care services, including access and utilization of medications for asthma.[13] There are no data, however, on the influence of the COVID-19 pandemic on medication adherence in older adults with asthma. The primary objectives of this investigation were as follows: (1) to examine medication prescribing and adherence among older adult Medicare-eligible patients with asthma; (2) to determine the impact of the COVID-19 pandemic on medication adherence; and (3) to evaluate the associations of patient characteristics with medication adherence in older adults with asthma.

Methods

Study Design

This was a retrospective, longitudinal cohort analysis of Medicare-enrolled patients with asthma. Patients with International Classification of Diseases, Tenth Revision (ICD-10) codes for asthma in 2019 (eTable 1) were included. Patients under 65 years of age or with diagnosis codes for chronic obstructive pulmonary disease or cystic fibrosis (eTable 1) were excluded. Patients were included in this analysis if they had at least 2 prescription claims for the same controller medication. Controller medications assessed in this study were inhaled corticosteroids (ICSs), long-acting β-agonists (LABAs), long-acting muscarinic antagonists (LAMAs), leukotriene receptor antagonists (LTRAs), and theophylline (eTable 2). This study was approved by the Institutional Review Board as a retrospective record review (approved September 22, 2020; study ID: 2020H0393).

Study Population

Patients included in this study were enrolled in one Medicare plan and eligible for medication therapy management (MTM) services for the years 2019 and 2020. Eligibility for MTM services was dependent on presence of certain chronic conditions, total number of unique medications, and annual drug cost exceeding a specific value.[14] Eligibility was determined by the health plan provider.

Data Sources

Prescription claims data range from January 1, 2019, to July 31, 2019, and January 1, 2020, to July 31, 2020. ICD codes represented diagnosis codes received in a health care encounter in 2019. Data were collected from the MTM provider and provided by the Medicare plan provider. Data included patient age, sex, number of unique Medicare part D drug claims in the 4 months before MTM qualification, number of unique pharmacies used to fill medications, number of unique prescribers, number of medication-related problems (MRPs) in 2019, ICD codes, prescription claims data (including brand and generic drug name, dose, days' supply, and fill count), and the proportion of days covered (PDC) for controller medications by medication class (eTable 2). MRPs reflected potential problems related to drug-drug interactions, drug-disease interactions, use of high-risk medications, gaps in therapy, and medication adherence to therapies for specific chronic diseases identified in the electronic prescription claims data.

Medications Assessed and Adherence

Adherence was evaluated for asthma controller medication classes for a fixed period of January 1 to July 31, 2019, and January 1 to July 31, 2020. Medications assessed in this study were only those for which claims were processed under Medicare part D. Biological medications were not included because those claims are mostly processed under Medicare part B. The list of medications assessed by class can be found in eTable 2. PDC was utilized to compare adherence to controller medications between the 2019 and 2020 evaluation period.[15] The PDC reflected the percentage of days a person had access to a medication within a specific period. The numerator was the sum of days a medication within a medication class was available to the patient with the start date beginning at the date of the first prescription fill. The denominator was the number of days between the first fill and the analysis end date. PDC was reported by medication class to avoid underestimation of adherence when prescribing of medications within the same therapeutic class was modified because of dose or formulary changes. High adherence was defined as PDC greater than or equal to 80%. Number of albuterol inhalers and that of oral corticosteroid claims were collected. Number of controller medications was determined by adding the number of controller medication classes used by a patient in each period.

Statistical Analyses

Data were coded and organized using Microsoft Excel (2016 MSO, Redmond, Washington) and IBM SPSS software (version 26.0, IBM Corp, Armonk, New York). Counts, percentages, means, and SDs were used to describe demographic characteristics and medication prescribing as appropriate. In this analysis, age (65-74, 75-84, ≥85 years), number of medications (8-10, 11-13, 14-16, and ≥17), number of MRPs (0, 1, 2, 3, 4, and ≥5), number of prescribers (1-5, 6-10, 11-15, and ≥16), number of pharmacies (1, 2, 3, and ≥4), number of controller medications (0, 1, 2, 3, ≥4), and corticosteroid fills (0, 1, 2, ≥3) were transformed into ordinal variables. Sex (male, female), albuterol inhaler fills (<3, ≥3 fills), having received a 90-day supply for a controller medication (yes, no), and being diagnosed with depression and moderate or severe asthma (yes, no) were evaluated as binary variables.

Paired *t* tests assessed differences in adherence between 2019 and 2020 for each medication class. This analysis was performed among the entire asthma cohort and repeated among individuals with ICD codes for moderate or severe asthma in 2019. The count and percentage of individuals with high adherence per medication class in each period were reported.

A logistic regression characterized the relationship between patient characteristics and medication use with high adherence to any controller medication in 2019 and 2020. Variables included in this regression were age, sex, number of medications, number of MRPs, number of prescribers, number of pharmacies, diagnosis of depression, diagnosis of moderate or severe asthma, number of controller medication classes for asthma, number of albuterol inhaler fills, receipt of a 90-day supply, and number of oral corticosteroid claims. The logistic regression assessing patients with high adherence in 2020 included a dichotomized variable reflecting if the patient was highly adherent in 2019. A Bonferroni adjustment was utilized in each analysis to determine the *P* value that would establish statistical significance.

Results

This analysis included 1637 patients. Patients were 76 ± 7 SD years of age, with 7 ± 3 SD prescribers in the first 7 months of 2019, used 3 ± 2 SD pharmacies to fill medications, and were prescribed 13 ± 4 SD medications. Patients were predominantly of female sex (1356, 83%). In this cohort, 624 (38%) were diagnosed with having moderate or severe asthma and 329 (20%) with depression. Most patients utilized 2 or more controller medication classes for asthma (1252, 76%), filled 3 or more albuterol inhalers (1102, 67%), and did not require corticosteroids (971, 59%) in the first 7 months of 2019. Complete information can be found in Table 1.

Table 1
Descriptive Statistics and Results From Logistic Regression Evaluating Relationship Between Patient Characteristics and High Adherence to Controller Inhalers in 2019

Characteristic	Without high adherence N = 368 (22)	With high adherence N = 1269 (78)	*P* value	Adjusted odds ratio (95% confidence interval)	Overall cohort (N = 1637)
	N (%)	N (%)			N (%)
Age, y			.02		
65-74 (reference)	172 (47)	565 (45)	—	—	737 (45)
75-84	169 (46)	532 (42)	.86	0.98 (0.75-1.28)	701 (43)
≥85	27 (7)	172 (14)	.01	1.86 (1.16-2.98)	199 (12)
Sex					
Female	306 (83)	1050 (83)	.95	1.01 (0.72-1.42)	1356 (83)
Male (reference)	62 (17)	219 (17)	—	—	281 (17)
Number of medications			.05		
8-10 (reference)	118 (32)	318 (25)	—	—	436 (27)
11-13	114 (31)	353 (28)	.51	1.12 (0.81-1.55)	467 (29)
14-16	68 (19)	272 (21)	.03	1.53 (1.04-2.25)	340 (21)
17-19	39 (11)	179 (14)	.02	1.72 (1.08-2.75)	218 (13)
≥20	29 (8)	147 (12)	.03	1.84 (1.07-3.17)	176 (11)
Number of medication-related problems			.001		
0	33 (9)	208 (16)	<.001	2.93 (1.80-4.77)	241 (15)
1	73 (20)	248 (20)	.03	1.59 (1.06-2.40)	321 (20)
2	71 (19)	252 (20)	.02	1.62 (1.09-2.40)	323 (20)
3	47 (13)	147 (12)	.25	1.30 (0.83-2.04)	194 (12)
4	46 (13)	120 (10)	.36	1.24 (0.78-1.96)	166 (10)
≥5 (reference)	98 (27)	294 (23)	—	—	392 (24)
Number of prescribers			.96		
1-5 (reference)	169 (46)	560 (44)	—	—	729 (45)
6-10	155 (42)	534 (42)	.76	1.04 (0.79-1.39)	689 (42)
11-15	38 (10)	148 (12)	.74	0.92 (0.58-1.48)	186 (11)
≥16	6 (2)	27 (2)	.96	1.03 (0.37-2.84)	33 (2)
Number of pharmacies			.28		
1 (reference)	93 (25)	382 (30)	—	—	475 (29)
2	113 (31)	345 (27)	.11	0.76 (0.54-1.07)	458 (28)
3	70 (19)	258 (20)	.80	0.95 (0.65-1.39)	328 (20)
≥4	92 (25)	284 (22)	.14	0.76 (0.52-1.10)	376 (23)
Depression					
Yes	63 (17)	266 (21)	.11	1.33 (0.94-1.90)	329 (20)
No (reference)	305 (83)	1003 (79)	—	—	1308 (80)
Moderate or severe asthma					
Yes	89 (24)	376 (30)	.18	1.21 (0.91-1.61)	624 (38)
No (reference)	279 (76)	893 (70)	—	—	1013 (72)
Number of controller medication classes for asthma			<.001		
1 (reference)	107 (29)	278 (22)	—	—	385 (24)
2	200 (54)	394 (31)	.08	0.77 (0.57-1.03)	594 (36)
3	55 (15)	495 (39)	<.001	3.22 (2.21-4.71)	550 (34)
≥4	6 (2)	102 (8)	<.001	5.45 (2.23-13.34)	108 (7)
Number of albuterol inhalers					
<3 (reference)	155 (42)	380 (30)	—	—	535 (33)
≥3	213 (58)	889 (70)	<.001	1.70 (1.30-2.22)	1102 (67)
Number of oral corticosteroid fills			.002		
0 (reference)	204 (55)	767 (60)	—	—	971 (59)
1	86 (23)	242 (19)	.001	0.59 (0.43-0.81)	328 (20)
2	45 (12)	132 (10)	.01	0.58 (0.38-0.89)	177 (11)
≥3	33 (9)	128 (10)	.06	0.65 (0.41-1.03)	161 (10)
Evidence of 90-d supply for controller medications					
No (reference)	291 (79)	737 (58)	<.001	2.47 (1.84-3.32)	1028 (63)
Yes	77 (21)	532 (42)	—	—	609 (37)

NOTE. High adherence: with proportion of days covered for any controller medication for asthma ≥ 80%.
Bonferroni-adjusted *P* value = .004.

More than one-half of patients were considered highly adherent to their controller medications (ICS [64%], LABA [63%], LAMA [73%], LTRA [81%], and theophylline [63%]) in 2019. In the first 7 months of 2020, during the COVID-19 pandemic, the proportion of patients considered highly adherent decreased (ICS [52%], LABA [51%], LAMA [46%], montelukast [64%], and theophylline [44%]). Mean PDC, indicated by the filling of ICS, LABA, LAMA, and LTRA, significantly decreased between 2019 and 2020 ($P < .001$). Owing to an adjusted Bonferroni *P* value, mean PDC did not significantly change for theophylline between 2019 and 2020 ($P > .005$). Although the mean adherence was higher, and the proportion of patients considered highly adherent was greater, similar results were observed among patients diagnosed with having moderate or severe asthma. Complete medication use data has been provided in Table 2.

There were 1153 (70%) patients who received an ICS and LABA combination inhaler in 2019. In 2020, the number of patients receiving an ICS and LABA combination inhaler decreased to 1061 (65%). Approximately 1% of patients received a LAMA and LABA or an ICS, LABA, and LAMA combination inhaler in 2019 and 2020. Among patients with moderate or severe asthma, 503 (81%) received an ICS and LABA combination inhaler in 2019. In 2020, 486 (78%) of patients with moderate or severe asthma received an ICS and LABA combination inhaler. Similar to the overall cohort, 1% of patients with moderate or severe asthma received a LABA and LAMA or ICS, LABA, and LAMA combination inhaler in 2019 and 2020. Complete data can be found in Table 2.

Variables significantly associated with high adherence to controller medications in 2019 were number of MRPs ($P = .001$), number of

Table 2
Adherence and Prescribing of Controller Medications to Treat Asthma in 2019 and 2020

Medications	January 1-July 31, 2019	January 1-July 31, 2020	*P* value[a]	Patients with less than 2 fills in January-July 2020 N (%)
All patients with asthma (N = 1637)				
PDC for medications to treat asthma (average ± SD %)				
ICS (N = 1384)	82 ± 20	65 ± 38	<.001	304 (22)
LABA (N = 1080)	82 ± 20	64 ± 39	<.001	243 (23)
LAMA (N = 173)	84 ± 21	57 ± 42	<.001	50 (29)
LTRA (N = 1009)	90 ± 16	70 ± 40	<.001	222 (22)
Theophylline (N = 16)	75 ± 30	51 ± 47	.03	6 (38)
Proportion of individuals with high adherence (PDC ≥ 80%) to their controller medications				
	N (%)	N (%)		
ICS (N = 1384)	885 (64)	715 (52)		
LABA (N = 1080)	685 (63)	541 (51)		
LAMA (N = 173)	126 (73)	80 (46)		
LTRA (N = 1009)	817 (81)	648 (64)		
Theophylline (N = 16)	10 (63)	7 (44)		
Proportion of patients with at least 1 combination inhaler (N = 1637)				
ICS and LABA	1153 (70)	1061 (65)		
ICS, LABA, and LAMA	14 (1)	19 (1)		
LABA and LAMA	16 (1)	15 (1)		
Patients with moderate or severe asthma (N = 624)				
PDC for medications to treat asthma (average ± SD)				
ICS (N = 559)	84 ± 19	71 ± 35	<.001	85 (15)
LABA (N = 468)	84 ± 19	70 ± 36	<.001	77 (17)
LAMA (N = 114)	85 ± 20	59 ± 42	<.001	33 (29)
LTRA (N = 437)	91 ± 15	74 ± 38	<.001	79 (18)
Theophylline (N = 12)	83 ± 25	59 ± 46	.05	4 (33)
Proportion of individuals with high adherence (PDC ≥ 80%) to their controller medications				
	N (%)	N (%)		
ICS (N = 559)	387 (69)	323 (58)		
LABA (N = 468)	325 (69)	265 (57)		
LAMA (N = 114)	86 (75)	55 (48)		
LTRA (N = 437)	361 (83)	296 (68)		
Theophylline (N = 12)	9 (75)	6 (50)		
Proportion of patients with at least one combination inhaler (N = 624)				
ICS and LABA	503 (81)	486 (78)		
ICS, LABA, and LAMA	8 (1)	7 (1)		
LABA and LAMA	5 (1)	3 (1)		

Abbreviations: ICS, inhaled corticosteroid; LABA, long-acting β-agonist; LAMA, long-acting muscarinic antagonist; LTRA, leukotriene receptor antagonist; PDC, proportion of days covered.
NOTE. Bonferroni-adjusted *P* value = .005.
[a]Results from paired *t* test.

controller medications for asthma ($P < .001$), having 3 or more albuterol medication claims (odds ratio [OR], 1.70; 95% confidence interval [CI], 1.30-2.22; $P < .001$), number of corticosteroid claims ($P = .002$), and having a 90-day supply for controller medications (OR, 2.47; 95% CI, 1.84-3.32; $P < .001$). Patients with 0 MRPs compared with individuals with 5 or more MRPs, were 2.93 times more likely to be adherent to their medications ($P < .001$). Patients with 3 or more controller medication classes compared with individuals with 1 controller medication were with 3.22 to 5.45 times the odds of being adherent to asthma controller medications ($P < .001$). Patients with 1 oral corticosteroid claim were less likely to be adherent compared with individuals without claims for corticosteroids (OR, 0.59; 95% CI, 0.43-0.81; $P = .001$). Table 1 includes complete information and lists nonsignificant variables (Bonferroni-adjusted $P > .004$).

In 2020, variables associated with adherence to controller medications included number of controller medication classes ($P < .001$), having 3 or more albuterol medication claims (OR, 1.95; 95% CI, 1.51-2.53, $P < .001$), having a 90-day supply for controller medications (OR, 3.06; 95% CI, 2.34-4.00; $P < .001$), and being highly adherent to a controller medication in 2019 (OR, 1.99; 95% CI, 1.48-2.66; $P < .001$). Table 3 includes complete information and lists nonsignificant variables (Bonferroni-adjusted $P > .0038$).

Discussion

To our knowledge, this is the first study to examine medication adherence and prescribing patterns among Medicare-enrolled, MTM-eligible older adults with asthma before and during the first months of the COVID-19 pandemic. This study found a marked reduction in adherence to controller medications for asthma in the first 7 months of 2020. Important indicators for adherence to controller medications between 2019 and 2020 were surrogate markers for disease severity (number of controller medication classes for asthma and number of albuterol inhalers) and having filled a 90-day supply for a controller medication. These findings suggested that access to controller medications for patients with asthma may have been interrupted during the early months of the COVID-19 pandemic.

Our data found that the proportion of patients considered highly adherent to specific controller medications ranged from 63% to 81% in 2019 and 44% to 64% in 2020. Patients in this cohort were with higher adherence compared with the results of a survey where 43% of older adults with asthma reported that they were with good adherence[16] and another study that found older adults with any respiratory condition were on average with a calculated adherence of 25% to their fluticasone and salmeterol combination inhaler.[12] The COVID-19 pandemic may have resulted in barriers to medication adherence owing to many factors, including fears of infection, delays among mail-order pharmacies, drug shortages, and disruptions to continuity of care. Health care providers and insurance plans should prioritize 90-day supplies of controller medications to improve adherence to these medications by reducing disruptions to access during disaster events, such as the COVID-19 pandemic.

Patients in this cohort treated with a greater number of controller medication classes were more likely to be highly adherent to their medications. These findings are consistent with the health belief

Table 3
Results From Logistic Regression Evaluating Relationship Between Patient Characteristics and High Adherence to Controller Medications in 2020 (N = 1637)

Characteristic	Without high adherence N = 555 (34) N (%)	With high adherence N = 1082 (66) N (%)	*P* value	Adjusted odds ratio (95% confidence interval)	Overall cohort (N = 1637) N (%)
Age, y			.13		
65-74 (reference)	246 (44)	491 (45)	—	—	737 (45)
75-84	249 (45)	452 (42)	.91	1.02 (0.78-1.33)	701 (43)
≥85	60 (11)	139 (13)	.05	1.53 (1.00-2.33)	199 (12)
Sex					
Female	453 (82)	903 (84)	.34	1.18 (0.84-1.64)	1356 (83)
Male (reference)	102 (18)	179 (17)	—	—	281 (17)
Number of medications			.50		
8-10 (reference)	170 (31)	266 (25)	—	—	436 (27)
11-13	161 (29)	306 (28)	.54	1.11 (0.79-1.55)	467 (29)
14-16	111 (20)	229 (21)	.33	1.21 (0.83-1.77)	340 (21)
17-19	69 (12)	149 (14)	.96	0.99 (0.63-1.55)	218 (13)
≥20	44 (8)	132 (12)	.11	1.56 (0.91-2.68)	176 (11)
Number of medication-related problems			.58		
0	69 (12)	172 (16)	.10	1.46 (0.93-2.31)	241 (15)
1	111 (20)	210 (19)	.68	1.09 (0.72-1.66)	321 (20)
2	111 (20)	212 (20)	.21	1.29 (0.87-1.94)	323 (20)
3	72 (13)	122 (11)	.79	1.06 (0.67-1.68)	194 (12)
4	63 (11)	103 (10)	.77	1.07 (0.67-1.72)	166 (10)
≥5 (reference)	129 (23)	263 (24)	—	—	392 (24)
Number of prescribers			.61		
1-5 (reference)	321 (58)	541 (50)	—	—	862 (53)
6-10	193 (35)	428 (40)	.60	1.08 (0.81-1.44)	621 (38)
11-15	38 (7)	92 (9)	.80	1.07 (0.63-1.84)	130 (8)
≥16	3 (1)	21 (2)	.19	2.71 (0.60-12.20)	24 (2)
Number of pharmacies			.21		
1 (reference)	171 (31)	304 (28)	—	—	475 (29)
2	146 (26)	312 (29)	.04	1.42 (1.01-1.99)	458 (28)
3	107 (19)	221 (20)	.34	1.20 (0.83-1.73)	328 (20)
≥4	131 (24)	245 (23)	.67	1.08 (0.75-1.56)	376 (23)
Diagnosis of depression					
Yes	101 (18)	228 (21)	.84	1.04 (0.73-1.47)	329 (20)
No (reference)	454 (82)	854 (79)	—	—	1308 (80)
Diagnosis of moderate or severe asthma					
Yes	161 (29)	463 (43)	.68	0.94 (0.71-1.25)	624 (38)
No (reference)	394 (71)	619 (57)	—	—	1013 (72)
Number of controller medication classes for asthma			<.001		
0-1 (reference)	359 (65)	190 (18)	—	—	549 (34)
2	137 (25)	322 (30)	<.001	4.50 (3.36-6.04)	459 (28)
3	56 (10)	468 (43)	<.001	12.05 (8.45-17.18)	524 (32)
≥4	3 (1)	102 (9)	<.001	47.08 (14.30-155.03)	105 (6)
Number of albuterol inhalers					
<3 (reference)	311 (56)	346 (32)	—	—	657 (40)
≥3	244 (44)	736 (68)	<.001	1.95 (1.51-2.53)	980 (60)
Number of oral corticosteroid fills			.52		
0 (reference)	410 (74)	736 (68)	—	—	1146 (70)
1	74 (13)	178 (17)	.80	0.95 (0.66-1.38)	252 (15)
2	37 (7)	65 (6)	.15	0.67 (0.40-1.15)	102 (6)
≥3	34 (6)	103 (10)	.58	0.87 (0.52-1.45)	137 (8)
Having a 90-d supply for controller medications					
No (reference)	411 (74)	482 (45)	—	—	893 (55)
Yes	144 (26)	600 (56)	<.001	3.06 (2.34-4.00)	744 (45)
High adherence to any controller medication class in 2019					
No (reference)	193 (35)	175 (16)	—	—	555
Yes	362 (65)	907 (84)	<.001	1.99 (1.48-2.66)	1082

NOTE. High adherence: with proportion of days covered for any controller medication for asthma ≥ 80%.
Bonferroni-adjusted *P* value = .0038.

model that describes a patient's greater perception of illness to be associated with higher adherence.[17] Another study found that changes in medication adherence during the COVID-19 pandemic varied across different medication classes.[18] It is important for providers to identify barriers to medication adherence and to emphasize the importance of controller medications given their role in preventing avoidable health care utilization among patients with asthma. Furthermore, a recent study found that use of medications to treat asthma was associated with better outcomes among patients with asthma and COVID-19, reinforcing the importance of adherence in this vulnerable population.[19] Notably, patients with high adherence in 2019 were more likely to be highly adherent in 2020 suggesting once patients are adherent to their therapies, this behavior is more likely to be sustained among patients with asthma.

It is also important to highlight this study found 67% of patients in 2019 and 60% of patients in 2020 were with 3 or more albuterol fills in the first 7 months of each year. This suggested that regardless of rates of adherence to controller medications, patients were perhaps overutilizing albuterol to ameliorate symptoms associated with asthma, placing them at risk for potentially avoidable health care

utilization, including emergency department visits and hospitalizations, and resulting in higher cost of care.[20-23] Overuse of short-acting β_2-agonist (SABA) medications can lead to β-receptor down-regulation, causing decreased response to SABA treatment and rebound bronchoconstriction.[24] In turn, SABA overuse causes a patient to consume even more reliever treatment as it becomes less effective. Although a recent study found that asthma-related emergency department visits and hospitalizations decreased overall among all patients with asthma during the COVID-19 pandemic, potentially attributable to social distancing and face mask wearing,[25] the targeted identification of patients with potential overutilization of SABA inhalers can improve medication utilization and quality of life and reduce potentially avoidable health care utilization in this cohort.

Patients with more MRPs in this study were less likely to be adherent to their medications in 2019. Patients participating in programs that identify and address MRPs may experience improved compliance to the overall medication regimen. These patients may benefit from programs that utilize a combination of education and inhaler coaching from an asthma educator and regular, long-term follow-up with pharmacists; this intervention demonstrated reduced emergency department utilization, hospitalization, and direct cost savings.[26] In addition, a pharmacist-led intervention dedicated to improving asthma medication use was associated with reductions in exacerbations, improved asthma symptom control and quality of life, and improved adherence to prescribed treatment.[27] Although surrogate markers for disease severity such as number of controller medication classes and albuterol fills were consistently associated with medication adherence in 2019 and 2020, corticosteroids were not. This relationship may not have been consistently detected because oral corticosteroids may have been utilized for other diseases. It is important for prescribers and providers to highlight the preventative benefits of asthma controller medications to reduce avoidable health care utilization.

Limitations

The population of this study was limited to Medicare-enrolled, MTM-eligible beneficiaries from 1 insurance plan provider, and thus may not be representative of an entire Medicare population nor represent a geographically diverse population. Adherence during the COVID-19 pandemic may have been underestimated because of the study period examining the first 7 months of 2020. Investigators were unable to assess whether adherence was influenced by shortages affecting the supply of available medications in dispensing pharmacies. We were unable to determine whether rescue inhalers claims were the result of patient stockpiling or early refills related to travel. Adherence measurements were based on prescription claims data; investigators were unable to assess whether patients used the medications as prescribed. Investigators were unable to assess the influence of patient co-pay on adherence outcomes or the effect of using mail-order pharmacies on adherence. The MRPs included in this study were those determined by electronic review of prescription claims, which may differ from MRPs identified by other approaches. Investigators were unable to assess for the effects of a COVID-19 infection on adherence.

Conclusion

Older adults with asthma represent an understudied patient population. In 2019, among Medicare-enrolled older adults, mean adherence ranged from 75% to 90% depending on the controller medication. Results from our data suggested that medication adherence may have been negatively impacted by the COVID-19 pandemic. Despite the considerable decrease in adherence to asthma controller medications, patients continued filling SABA inhalers at a similar rate, suggesting older adults may be over-reliant on SABA reliever inhalers for treatment of asthma. Patients with more controller medications, more albuterol fills, and a 90-day supply were more likely to be highly adherent to their controller medications. Health care providers should consistently assess barriers to medication adherence and albuterol use to ensure optimal control of asthma. Patients may benefit from 90-day supply of controller medications to reduce disruptions in access, especially during epidemics or pandemics.

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Supplementary Data

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.anai.2022.02.010.

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Supplementary Data

eTable 1
International Statistical Classification of Diseases and Related Health Problems Tenth (ICD-10) Revision Codes

Category	Condition	Diagnosis code(s)
COPD	COPD	ICD-10: J44, J44.8, J44.9, J41, J41.0, J41.1, J41.8
	Bronchitis	ICD-10: J40, J42
	Emphysema	ICD-10: J43, J43.0, J43.1, J43.2, J43.8, J43.9
	Bronchiectasis	ICD10: J47.0, J47.1, J47.9
	COPD (acute exacerbation)	ICD-10: J44.1, J44.0
Asthma	Asthma	ICD-10: J45, J45.1, J45.8, J45.9
	Predominantly allergic asthma	ICD-10: J45.0
	Pulmonary eosinophilia	ICD-10: J82
	Mild intermittent asthma	ICD-10: J45.20-J45.22
	Mild persistent asthma	ICD-10: J45.30-J45.32
	Moderate persistent asthma	ICD-10: J45.40-J45.42
	Severe persistent asthma	ICD-10: J45.50-J45.52
	Asthma (acute exacerbation or status asthmaticus)	ICD-10: J46
Cystic fibrosis		ICD-10: E84.0, E84.19
Depression		ICD-10: F31.30, F31.31, F31.32, F31.4, F31.5, F31.60, F31.61, F31.62, F31.63, F31.64, F31.75, F31.76, F31.77, F31.78, F31.81, F32.0, F32.1, F32.2, F32.3, F32.4, F32.5, F32.9, F33.0, F33.1, F33.2, F33.3, F33.40, F33.41, F33.42, F33.8, F33.9, F34.1, F43.21, F43.23

Abbreviations: COPD, chronic obstructive pulmonary disease; ICD-10, International Classification of Diseases, Tenth Revision.

eTable 2
Medications Included in Each Medication Class

Medication category	Names of medications
Inhaled corticosteroid	Beclomethasone, budesonide, ciclesonide, fluticasone, mometasone
Long-acting β-agonist	Arformoterol, formoterol, indacaterol. olodaterol, salmeterol, vilanterol
Long-acting muscarinic antagonist	Aclidinium, glycopyrrolate, revefenacin, tiotropium, umeclidinium
Leukotriene receptor antagonist	Montelukast, zarfilukast
Theophylline	Theophylline
Oral corticosteroids	Hydrocortisone, prednisone, prednisolone, methylprednisolone, dexamethasone