



Contents lists available at ScienceDirect

## Exploratory Research in Clinical and Social Pharmacy

journal homepage: [www.elsevier.com/locate/rcsop](http://www.elsevier.com/locate/rcsop)

## Racial and ethnic disparities in Medicare Part D medication therapy management services utilization



Xiaobei Dong<sup>a</sup>, Chi Chun Steve Tsang<sup>b</sup>, Jamie A. Browning<sup>c</sup>, Joseph Garuccio<sup>c</sup>, Jim Y. Wan<sup>d</sup>, Ya Chen Tina Shih<sup>e</sup>, Marie A. Chisholm-Burns<sup>f</sup>, Samuel Dagogo-Jack<sup>g</sup>, William C. Cushman<sup>h</sup>, Junling Wang<sup>i</sup>, Junling Wang<sup>i,\*</sup>

<sup>a</sup> Joseph J. Zilber School of Public Health, University of Wisconsin-Milwaukee, 1240 N. 10th St., Milwaukee, WI 53205, United States of America

<sup>b</sup> Health Outcomes and Policy Research, Department of Clinical Pharmacy and Translational Science, University of Tennessee Health Science Center College of Pharmacy, 881 Madison Avenue, Room 212, Memphis, TN 38163, United States of America

<sup>c</sup> Health Outcomes and Policy Research, Department of Clinical Pharmacy and Translational Science, University of Tennessee Health Science Center College of Pharmacy, 881 Madison Avenue, Memphis, TN 38163, United States of America

<sup>d</sup> Department of Preventive Medicine, University of Tennessee Health Science Center College of Medicine, 66 N. Pauline, Suite 633, Memphis, TN 38163, United States of America

<sup>e</sup> Department of Health Services Research, University of Texas MD Anderson Cancer Center, Section of Cancer Economics and Policy, 1515 Holcombe Blvd., Unit 1444, Houston, TX 77030, United States of America

<sup>f</sup> School of Medicine, Oregon Health & Science University, 3181 Sam Jackson Park Road, Portland, OR 97236, United States of America

<sup>g</sup> Division of Endocrinology, Diabetes & Metabolism, Clinical Research Center, University of Tennessee Health Science Center, Memphis, TN 38163, United States of America

<sup>h</sup> Department of Preventive Medicine, University of Tennessee Health Science Center College of Medicine, 66 North Pauline Street, Suite 651, Memphis, TN 38163, United States of America

<sup>i</sup> Department of Clinical Pharmacy & Translational Science, University of Tennessee Health Science Center College of Pharmacy, 881 Madison Avenue, Room 221, Memphis, TN 38163, United States of America

## ARTICLE INFO

## Keywords:

Medicare Part D Medication Therapy Management  
Racial and ethnic disparities  
Service utilization  
Pharmacist  
Comprehensive medication review  
Targeted medication review

## ABSTRACT

**Background:** The Medicare Part D medication therapy management (MTM) program has positive effects on medication and health service utilization. However, little is known about its utilization, much less so about the use among racial and ethnic minorities.

**Objective:** To examine MTM service utilization among older Medicare beneficiaries and to identify any racial and ethnic disparity patterns.

**Methods:** A retrospective cross-sectional analysis of 2017 Medicare administrative data, linked to the Area Health Resources Files. Fourteen outcomes related to MTM service nature, initiation, quantity, and delivery were examined using logistic, negative binomial, and Cox proportional hazards regression models.

**Results:** Racial and ethnic disparities were found with varying patterns across outcomes. For example, compared with White patients, the odds of opting out of MTM were 8% higher for Black patients (odds ratio [OR] = 1.08, 95% confidence interval [CI] = 1.03–1.14), 57% higher for Hispanic patients (OR = 1.57, 95% CI = 1.42–1.72), and 57% higher for Asian patients (OR = 1.57, 95% CI = 1.33–1.85). The odds of continuing MTM from the previous years were 12% lower for Black patients (OR = 0.88, 95% CI = 0.86–0.90) and 3% lower for other patients (OR = 0.97, 95% CI = 0.95–0.99). In addition, the probability of being offered a comprehensive medication review (CMR) after MTM enrollment was 9% lower for Hispanic patients (hazard ratio [HR] = 0.91, 95% CI = 0.85–0.97), 9% lower for Asian patients (HR = 0.91, 95% CI = 0.87–0.94), and 3% lower for other patients (HR = 0.97, 95% CI = 0.95–0.99). Hispanic and Asian patients were more likely to have someone other than themselves receive a CMR.

**Conclusions:** Racial and ethnic disparities in MTM service utilization were identified. Although the disparities in specific utilization outcomes vary across racial/ethnic groups, it is evident that these disparities exist and may result in vulnerable communities not fully benefiting from the MTM services. Causes of the disparities should be explored to inform future reform of the Medicare Part D MTM program.

\* Corresponding author.

E-mail addresses: [dong7@uwm.edu](mailto:dong7@uwm.edu) (X. Dong), [ctsang@uthsc.edu](mailto:ctsang@uthsc.edu) (C.C.S. Tsang), [j.browning.pharmd@gmail.com](mailto:j.browning.pharmd@gmail.com) (J.A. Browning), [joseph.garuccio@gmail.com](mailto:joseph.garuccio@gmail.com) (J. Garuccio), [jwan@uthsc.edu](mailto:jwan@uthsc.edu) (J.Y. Wan), [yashih@mdanderson.org](mailto:yashih@mdanderson.org) (Y.C.T. Shih), [chishmar@ohsu.edu](mailto:chishmar@ohsu.edu) (M.A. Chisholm-Burns), [sdj@uthsc.edu](mailto:sdj@uthsc.edu) (S. Dagogo-Jack), [wcushman@uthsc.edu](mailto:wcushman@uthsc.edu) (W.C. Cushman), [jwang26@uthsc.edu](mailto:jwang26@uthsc.edu) (J. Wang), [jwang26@uthsc.edu](mailto:jwang26@uthsc.edu) (J. Wang).

<http://dx.doi.org/10.1016/j.rcsop.2023.100222>

Received 13 June 2022; Received in revised form 5 November 2022; Accepted 6 January 2023

Available online xxx

2667-2766/© 2023 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

Every year, the United States is burdened with over \$500 billion in health care costs attributable to suboptimal medication therapy.<sup>1</sup> The resulting medication therapy problems are particularly common among older adults who experience issues ranging from inappropriate medications to adverse health outcomes.<sup>2,3</sup> Medication therapy management (MTM) emerged in the 1990s as an approach to mitigate medication-related problems and promote health care coordination. MTM typically includes services such as reviewing a patient's medication records and developing a medication-related intervention plan.<sup>4,5</sup> The significance of MTM was officially recognized in 2006, when the Centers for Medicare & Medicaid Services (CMS) required Medicare Part D plan sponsors to provide MTM services to eligible beneficiaries.<sup>6</sup> While Medicare MTM eligibility criteria are plan-specific, they must comply with CMS guidelines to target beneficiaries having multiple chronic conditions, taking multiple Part D prescription medications, and crossing a predetermined annual cost threshold.<sup>7</sup> Similarly, although plan sponsors have some freedom in determining the type and frequency of MTM services, each MTM program must include comprehensive medication reviews (CMR) and targeted medication reviews (TMR) per CMS requirements.<sup>7</sup>

A limited number of studies have examined the Medicare Part D MTM effects on medication and health service utilization. Findings from these studies are generally equivocal. On the one hand, Perloth and colleagues analyzed data on 2010 Medicare beneficiaries who were newly enrolled in MTM and found improved medication adherence among those with diabetes, chronic obstructive pulmonary disease, and congestive heart failure. MTM also had some initial effect on improved drug safety and the program reduced hospital utilization and costs for beneficiaries with diabetes and congestive heart failure who received CMRs.<sup>8</sup> A more recent study found that CMR reduced nonadherence to medications for diabetes, hypertension, and hyperlipidemia among older beneficiaries having Alzheimer's disease.<sup>9</sup> On the other hand, substantial performance variation among prescription drug plans (PDP) was also reported.<sup>8</sup> Furthermore, one study suggested that MTM may improve medication-related problems but not necessarily patient-centered and health care utilization outcomes.<sup>10</sup> This prompted the CMS to launch a five-year Enhanced MTM model to test whether consistent improvement in health care outcomes can be attained with additional incentives.

The above evidence suggests the value of the MTM program; less is known about MTM utilization among racial and ethnic minorities. Based on a 20% random sample of the 2013–2014 Medicare population, a study examined the pattern of CMR receipt and observed that all minorities except Black patients had lower odds of receiving a CMR.<sup>3</sup> Another study of a 20% random sample of the 2014 population reported disparity in CMR receipt for beneficiaries with mental health conditions relative to those without.<sup>11</sup> A recent study by Pestka et al. examined the utilization of a comprehensive list of MTM services without a focus on racial and ethnic disparities.<sup>12</sup>

In this study, a categorization of MTM service utilization based on the nature of the variables for the utilization measures was piloted (Appendix A). Specifically, MTM utilization was analyzed in four dimensions including service nature, initiation, quantity, and delivery. The first dimension, the nature of MTM services, captures information such as opting out of MTM and receiving a CMR from a local pharmacist. Since 2010, eligible beneficiaries are automatically enrolled in MTM unless they request to opt out.<sup>13</sup> Racial and ethnic minorities might be more likely to opt out because historically they have lower uptake rates for health care programs.<sup>14,15</sup> Receiving a CMR from a local pharmacist may be analyzed as a study outcome because personal relationships between MTM enrollees and providers were associated with MTM effectiveness.<sup>8</sup> This outcome thereby depicts the nature of a service that may be distinct from other types of MTM services. The second and third dimensions, service initiation and quantity, respectively represent the efficiency and intensity of the MTM program. Due to historical disparities in health care access and use, racial and ethnic minorities might experience delays in receiving MTM services

and their received services might be less intensive compared with their White counterparts.<sup>14,15</sup> The fourth dimension encompasses both the mode and recipient types of CMR delivery. The objective of this study was to examine the four dimensions of Medicare Part D MTM services and to identify any racial and ethnic disparity patterns.

## 2. Methods

### 2.1. Data source

A retrospective cross-sectional study was conducted utilizing 2017 Medicare administrative data linked to the Area Health Resources Files (AHRF; Appendix B). Medicare data analyzed were Master Beneficiary Summary File (MBSF), Part A and B claims, and the Part D MTM Data file. MBSF provides demographic and plan enrollment information while Part A and B claims supply diagnosis records and dates of service. MTM Data file contains MTM-related information, such as enrollment, service receipt dates, and service provider characteristics.<sup>16</sup> To supplement patient-level characteristics in MBSF, this study obtained from AHRF county-level information on population socioeconomic characteristics and community health care resources of the beneficiaries' county of residence.<sup>17</sup> The AHRF data were linked to Medicare claims based on the county of the Medicare beneficiaries' county of residence.

### 2.2. Study sample

The study sample included beneficiaries who met the following criteria in the study year: (1) aged 65 years or older; (2) were alive at the end of the study year; (3) had continuous Part A, B, and D coverage; and (4) enrolled in an MTM program. Therefore, the study sample included only fee-for-service Medicare population and did not include Medicare Advantage beneficiaries. Race and ethnicity were examined in five categories: non-Hispanic White (White), Black, Hispanic, Asian and Pacific Islander (Asian), and other patients. Race and ethnicity were identified using the Research Triangle Institute race code. The other patient category included American Indian, Alaska Native, unknown, and other races/ethnicities. Because the code has a lower sensitivity in identifying American Indian and Alaska Native patients,<sup>18</sup> these racial groups were combined with individuals with "unknown" and "other" races/ethnicities.

### 2.3. Outcome measures

Four groups of outcomes were examined in this study (Appendix A). The first group, related to the nature of MTM services, included five outcomes: (1) opting out of MTM after being enrolled; (2) MTM was continued from the previous year; (3) receiving a CMR with a written summary in the CMS Standardized Format; (4) CMR provider was a pharmacist; and (5) CMR provider was a local pharmacist. Specifically, a CMR is an interactive consultation conducted once a year by a pharmacist or other qualified providers with a beneficiary either in person, over the phone, or via telehealth methods.<sup>7</sup> A written summary in a CMS standardized format is required to be delivered to the beneficiary following each CMR.<sup>7</sup> Outcome (2) measures whether a current MTM enrollee was also enrolled in an MTM program in the previous year. While outcomes (4) and (5) were not independent of one another, they were analyzed separately to better understand potential racial/ethnic disparity patterns when different types of pharmacists were considered. A binary variable was created for each of the outcomes with the value of one representing "yes" for the corresponding outcome.

The second group of outcomes represented the initiation of MTM services and included four outcomes: (1) days before opting out after being determined eligible for MTM; (2) days before opting out after MTM enrollment; (3) days before being offered CMR after MTM enrollment; and (4) days before the first CMR receipt after MTM enrollment. A distinction is made between outcomes (1) and (2) because plan sponsors may offer MTM enrollment to an expanded population who do not meet the eligibility

criteria.<sup>7</sup> These enrollment cases are infrequent, and the expanded population usually include beneficiaries deemed at risk of misusing frequently abused drugs by a plan sponsor.<sup>7</sup> For each of the outcomes in this group, the number of days was obtained by calculating the difference between the corresponding service dates in the Part D MTM Data file.

The third group of outcomes entailed the quantity of MTM services received, including: (1) the number of drug therapy problem resolutions; (2) the number of drug therapy problem recommendations made to the beneficiary's prescriber; and (3) the number of TMRs conducted. The number of drug therapy problem resolutions indicates the number of resolutions stemming from recommendations made to and implemented by a beneficiary's prescribers as a result of MTM services. The TMR measured in outcome (3) in this group differs from a CMR in several ways: it is focused on addressing specific medication-related problems, must be provided at least quarterly, and does not have to be interactive as the reviews can be delivered via mail.<sup>7</sup>

Lastly, the fourth group of outcomes was related to MTM delivery methods and recipient types, including: (1) CMR delivery methods. A binary variable was created with the value of one representing telephone and zero representing face to face. Telehealth consultations and other methods of delivery were not included in the analysis due to small sample size. (2) CMR recipient types. A variable was constructed with four mutually exclusive categories including beneficiary, beneficiary's prescriber, caregiver, and other authorized individual.

#### 2.4. Covariates

Covariate selection was guided by Gelberg-Andersen's Behavioral Model for Vulnerable Populations (Appendix B). This is because the study outcomes were related to utilization of health services across racial and ethnic groups and the model was devised to identify factors affecting health service utilization among vulnerable patients. Specifically, this model delineates patterns of health care utilization as the consequence of interplay between predisposing, enabling, and need factors.<sup>19</sup> Predisposing factors predict the likelihood of seeking health services. Enabling factors facilitate access to such services. Need factors refer to perceived or evaluated health conditions that affect health service needs. In this study, the predisposing variables included age, sex, race/ethnicity, the proportion of married-couple families, and the proportion of people with at least high school education. The enabling variables included per capita income, the proportion of people without health insurance, metropolitan statistical area, health professional shortage area, and census regions. Metropolitan statistical areas and census regions respectively represent the level of community-level and region-level resources that may promote or hinder the provision of health care services. While there was a concern about possible collinearity between metropolitan statistical areas, Health Professional Shortage Areas, and census regions, a collinearity test indicated that the three variables were not collinear. The need variable was a risk adjustment summary score used as a proxy for health status. The score was calculated using the CMS hierarchical condition category (HCC) methodology mainly based on patient diagnoses records, with higher scores suggesting poorer health status and higher expected health care utilization.<sup>20</sup>

#### 2.5. Statistical analysis

Descriptive analyses were first conducted across racial/ethnic groups to obtain means and standard deviations for continuous characteristics and numbers and proportions for categorical characteristics. To compare the characteristics of White patients with each minority group, *t*-tests and Chi-square tests were conducted for continuous (except per capita income) and categorical variables, respectively. A signed rank test was performed to test the racial/ethnic differences in median per capita income. The same tests were next performed to compare the frequency distributions of outcomes between White patients and each minority group.

Multivariable analyses were then conducted to examine differences in outcomes across racial/ethnic groups, with White patients serving as the

reference group. Different regression models were employed based on the types of outcome variables. Binomial and multinomial logistic regression models were used for the binary and multiple-category outcomes related to the nature and delivery of MTM services. For outcomes pertaining to the initiation of MTM services, Cox proportional hazards models were used because each outcome represented a duration between two events. For outcomes related to the quantity of MTM services, negative binomial models were utilized for the count outcome variables. Because some of the covariates were county-level factors, the study clustered standard errors at the county level in all multivariable analyses to account for potential within-county correlation among observations. All analyses were conducted with SAS Enterprise 7.1 (Cary, NC) at the CMS Virtual Research Data Center. The Institutional Review Board at the corresponding author's institution approved this study (approval number #17-05326-XM).

### 3. Results

Patient characteristics across racial/ethnic groups are reported in Table 1. After inclusion criteria were applied, 31.79% of the total MTM population were omitted. The analytic sample size was 2,508,437, which included 71.93% White patients, 11.39% Black patients, 10.78% Hispanic patients, 3.76% Asian patients, and 2.14% other patients. Among predisposing factors, White patients were older than Black, Hispanic, and other patients, and had a higher proportion of males than Black and Hispanic patients. Compared with all racial/ethnic minority groups, White patients lived in counties with higher proportions of married-couple families and individuals with at least high school education. In contrast, Asian and other patients resided in counties with higher per capita incomes than White patients. Black and Hispanic patients lived in counties with higher uninsured rates than White patients. Among enabling factors, White patients were less likely to live in metropolitan statistical areas and Health Professional Shortage Areas than their minority counterparts. Concerning the need factor, White patients had higher risk adjustment summary scores than Hispanic, Asian, and other patients. All aforementioned differences were statistically significant ( $p < .05$ ). It should be noted that, while statistically significant differences in characteristics were detected between racial/ethnic groups, some of the differences, such as age, may be clinically irrelevant.

Table 2 presents the unadjusted comparison for study outcomes between White patients and each minority group. The following results suggested potential disparities in relation to White patients ( $p < .05$ ). Among outcomes that represent the nature of MTM services, Black, Hispanic, and Asian patients had a higher portion of beneficiaries opting out of MTM. Black and other patients were less likely to continue MTM from the previous year. Asian and other patients were less likely to receive CMRs with a written summary in the CMS standardized format. Hispanic, Asian, and other patients were less likely to receive CMRs from a pharmacist. Moreover, Black and Hispanic patients were less likely to receive CMRs from a local pharmacist. In terms of outcomes related to MTM service initiation, it took longer for Black patients to be offered CMRs after MTM enrollment. Regarding the quantity of MTM services received, Asian and other patients on average received fewer TMRs. It should be noted that the mean numbers of TMRs conducted were considerably higher compared with other MTM services because a TMR can be provided at any time of the year and may be a follow-up intervention of the same medication-related problem for assessing medication use on an on-going basis. Concerning MTM recipient types, CMRs were less likely to be received by beneficiaries but more likely by caregivers among Hispanic and Asian patients. In addition, CMRs were more likely to be received by beneficiaries' prescribers among Black, Hispanic, and Asian patients.

Tables 3 through 5 present results from multivariable analyses. Only findings that suggest significant disparities experienced by racial/ethnic minority groups in relation to White patients are included in the tables. Table 3 reports the logistic regression results on disparity patterns in outcomes pertaining to the nature of MTM services. Compared with White patients, the odds of opting out of MTM were 8% higher for Black patients (odds ratio [OR] = 1.08, 95% confidence interval [CI] = 1.03–1.14),

**Table 1**  
Characteristics of Study Population across Racial/Ethnic Groups in 2017.

Characteristics	Total Population, n = 2,508,437	Non-Hispanic White Patients, n = 1,804,308	Black Patients, n = 285,719	Hispanic Patients, n = 270,316	Asian/Pacific Islander Patients, n = 94,418	Other Patients, n = 53,676
<b>Predisposing Factors</b>						
Age, mean (SD)	75.82 (7.00)	76.06 (7.03)	74.82* (6.76)	75.44* (6.83)	76.94* (7.22)	73.08* (6.17)
Male, n (%)	1,033,608 (41.21)	768,521 (42.59)	91,787* (32.12)	102,017* (37.74)	42,154* (44.65)	29,129* (54.27)
Pr Married-couple Families, mean (SD) <sup>a</sup>	0.72 (0.07)	0.74 (0.06)	0.67* (0.08)	0.68* (0.08)	0.71* (0.07)	0.72* (0.07)
Pr Ind Education ≥ High School, mean (SD) <sup>a</sup>	0.87 (0.06)	0.88 (0.05)	0.86* (0.05)	0.82* (0.08)	0.85* (0.05)	0.87 (0.05)
<b>Enabling Factors</b>						
Per Capita Income (in \$1000), median (IR) <sup>a</sup>	46.51 (16.30)	45.85 (15.14)	47.53 (15.45)	46.05 (18.68)	58.42* (16.64)	48.76* (16.71)
Pr Ind No Health Insurance, mean (SD) <sup>a</sup>	0.10 (0.05)	0.10 (0.04)	0.11* (0.05)	0.13* (0.07)	0.09 (0.04)	0.10 (0.05)
MSA, n (%) <sup>a</sup>	2,082,521 (83.02)	1,434,386 (79.50)	253,790* (88.83)	256,353* (94.83)	92,916* (98.41)	45,076* (83.98)
HPSA, n (%) <sup>a</sup>	2,318,226 (92.42)	1,638,882 (90.83)	273,751* (95.81)	264,314* (97.78)	90,891* (96.26)	50,388* (93.87)
<b>Census Regions, n (%)</b>						
Northeast	560,804 (22.36)	399,202 (22.12)	54,767* (19.17)	67,248* (24.88)	25,217* (26.71)	14,370* (26.77)
Midwest	586,060 (23.36)	495,823 (27.48)	57,187* (20.02)	15,309* (5.66)	6625* (7.02)	11,116* (20.71)
South	921,095 (36.72)	630,755 (34.96)	154,689* (54.14)	106,362* (39.35)	14,963* (15.85)	14,326* (26.69)
West	440,478 (17.56)	278,528 (15.44)	19,076* (6.68)	81,397* (30.11)	47,613* (50.43)	13,864* (25.83)
<b>Need Factor</b>						
Risk Adjustment Summary Score, mean (SD)	1.63 (1.53)	1.66 (1.54)	1.70 (1.62)	1.42* (1.40)	1.49* (1.31)	1.55* (1.47)

MTM = medication therapy management; SD = standard deviation; IR = interquartile range; Pr = proportion of; Ind = individuals with; Pr Ind Education ≥ High School, refers to the proportion of individuals aged 25 years or older with at least a high school education; MSA = metropolitan statistical area; HPSA = health professional shortage area.

<sup>a</sup> Indicates a county-level characteristic.

\* Indicates characteristic was statistically different from non-Hispanic White patients by pairwise comparison ( $P < .05$ ).

57% higher for Hispanic patients (OR = 1.57, 95% CI = 1.42–1.72), and 57% higher for Asian patients (OR = 1.57, 95% CI = 1.33–1.85). The odds of continuing MTM from the previous years were 12% lower for Black patients (OR = 0.88, 95% CI = 0.86–0.90) and 3% lower for other

patients (OR = 0.97, 95% CI = 0.95–0.99). Asian patients (OR = 0.75, 95% CI = 0.68–0.83) and other patients (OR = 0.87, 95% CI = 0.83–0.92) were less likely to receive CMRs in the CMS standardized format. In addition, Black (OR = 0.80, 95% CI = 0.69–0.93) and Hispanic

**Table 2**  
Unadjusted Comparison of Study Outcomes across Racial/Ethnic Groups.

Outcome	Non-Hispanic White Patients n (%)	Black Patients n (%)	Hispanic Patients n (%)	Asian/Pacific Islander Patients n (%)	Other Patients n (%)
<b>Nature of Services</b>					
Opting Out of MTM	83,431 (4.62)	15,678* (5.49)	22,050* (8.16)	7407* (7.84)	2537 (4.73)
MTM Continued from Previous Year	1,080,260 (59.87)	159,953* (55.98)	162,281 (60.03)	57,568* (60.97)	30,566* (56.95)
CMR Received with Written Summary in Standardized Format	745,484 (41.32)	139,420* (48.80)	129,586* (47.94)	34,769* (36.82)	21,032* (39.18)
CMR Received from a Pharmacist	599,684 (80.44)	110,440 (79.21)	90,934* (70.17)	26,113* (75.10)	16,325* (77.62)
CMR Received from a Local Pharmacist	168,552 (22.61)	25,417* (18.23)	24,621* (19.00)	9797* (28.18)	4802 (22.83)
<b>Initiation of Services</b>					
Days Before Opting Out After Determined Eligible (mean, SD)	106.62 (85.82)	133.23* (88.93)	139.00* (92.92)	127.55* (95.24)	115.77* (87.82)
Days Before Opting out After MTM enrollment (mean, SD)	106.71 (85.88)	133.33* (88.99)	138.46* (93.18)	127.59* (95.24)	115.94* (87.90)
Days Before Being Offered CMR After MTM Enrollment (mean, SD)	13.14 (14.07)	13.83* (16.01)	14.22 (15.30)	13.19 (14.72)	13.16 (14.08)
Days Before 1st CMR Receipt After MTM Enrollment (mean, SD)	98.59 (83.35)	97.15* (81.27)	107.53* (90.51)	106.10* (90.32)	99.32 (85.21)
<b>Quantity of Services Received</b>					
Number of Drug Therapy Problem Resolutions Received (mean, SD)	0.75 (1.74)	0.81* (1.82)	0.80 (1.74)	0.83 (1.78)	0.78 (1.79)
Number of Drug Therapy Problem Recommendations Made to Prescriber (mean, SD)	2.35 (4.21)	2.50* (4.36)	2.45 (4.16)	2.51 (4.25)	2.41 (4.37)
Number of Targeted Medication Reviews Conducted (mean, SD)	36.76 (76.23)	45.61* (93.42)	42.44 (89.32)	29.57* (61.67)	34.82* (70.65)
<b>Delivery Methods and Recipient Types</b>					
CMR Delivered by Telephone	687,926 (92.28)	127,054* (91.14)	119,092 (91.91)	30,264* (87.05)	19,335 (91.93)
<b>Beneficiary</b>					
Beneficiary	615,091 (82.51)	118,845* (85.24)	100,764* (77.76)	26,290* (75.61)	17,624* (83.80)
Beneficiary's Prescriber	13,995 (1.88)	3159* (2.27)	3223* (2.49)	996* (2.86)	342* (1.63)
Caregiver	98,271 (13.18)	14,932* (10.71)	21,204* (16.36)	6139* (17.66)	2553* (12.14)
Other Authorized Individual	18,127 (2.43)	2484* (1.78)	4395* (3.39)	1344* (3.87)	513* (2.44)

MTM = medication therapy management; CMR = comprehensive medication review; SD = standard deviation.

\* Indicates frequency distribution was statistically different from non-Hispanic White patients by pairwise comparison ( $P < .05$ ).



**Table 3**  
Racial/Ethnic Disparity Patterns in Nature of MTM Services: Logistic Regression Results.

Characteristics	Opting Out of MTM		MTM Continued from Previous Year		CMR Received in Standardized Format		CMR Received from a Pharmacist		CMR Received from a Local Pharmacist	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
<b>Predisposing Factors</b>										
<b>Race/Ethnicity</b>										
Black Patients	1.08	1.03–1.14	0.88	0.86–0.90	1.35	1.30–1.41	0.80	0.69–0.93	0.77	0.69–0.86
Hispanic Patients	1.57	1.42–1.72	1.06	1.02–1.10	1.21	1.07–1.37	0.67	0.46–0.98	0.96	0.83–1.12
Asian/Pacific Islander Patients	1.57	1.33–1.85	1.01	0.98–1.05	0.75	0.68–0.83	1.23	1.02–1.48	1.81	1.50–2.18
Other Patients	0.94	0.87–1.01	0.97	0.95–0.99	0.87	0.83–0.92	0.99	0.90–1.09	1.15	1.06–1.25
Age	0.99	0.988–0.991	1.03	1.028–1.030	1.00	1.001–1.004	0.99	0.985–0.991	0.99	0.991–0.998
Male	0.90	0.88–0.92	1.00	0.988–1.004	0.98	0.97–0.99	0.99	0.96–1.02	0.91	0.89–0.92
Pr Married-couple Families*	0.23	0.12–0.41	0.99	0.77–1.27	0.55	0.33–0.92	3.37	0.38–30.07	2.65	0.81–8.63
Pr Ind Education ≥ High School*	5.22	1.80–15.16	0.51	0.38–0.69	2.09	1.06–4.12	0.08	0.01–0.96	0.59	0.13–2.78
<b>Enabling Factors</b>										
Per Capita Income (in \$1000)*	1.00	0.997–1.003	1.00	0.999–1.002	1.00	0.9951–0.9996	1.00	0.99–1.01	1.00	0.9939–1.0002
Pr Ind No Health Insurance*	23.10	5.93–89.98	0.23	0.17–0.32	0.47	0.17–1.31	0.31	0.005–19.036	0.52	0.12–2.13
Metropolitan Statistical Area*	1.17	1.10–1.25	1.05	1.03–1.08	1.07	1.02–1.13	0.81	0.69–0.96	0.87	0.756–0.997
Health Professional Shortage Area*	1.00	0.92–1.09	0.99	0.96–1.02	1.14	1.07–1.22	1.09	0.86–1.38	1.18	0.98–1.42
<b>Census Regions</b>										
Midwest	0.98	0.88–1.09	1.04	0.99–1.08	0.90	0.82–0.99	1.02	0.75–1.40	1.51	1.16–1.97
South	0.82	0.72–0.93	1.01	0.97–1.05	1.03	0.96–1.11	1.08	0.77–1.51	1.54	1.27–1.88
West	1.22	1.03–1.45	0.96	0.919–1.001	1.13	1.05–1.22	0.25	0.18–0.34	1.00	0.80–1.26
<b>Need Factor</b>										
Risk Adjustment Summary Score	1.00	0.98–1.01	1.06	1.05–1.07	0.70	0.69–0.71	1.36	1.29–1.44	1.23	1.18–1.27

MTM = medication therapy management; CMR = comprehensive medication review; OR = odds ratio; CI = confidence interval; Pr = proportion of; Ind = individuals with; Pr Ind Education ≥ High School, refers to the proportion of individuals aged 25 years or older with at least a high school education.

Reference groups: non-Hispanic White patients, female, non-metropolitan statistical area, non-health professional shortage area, and Northeast census region.

\* Indicates a county-level characteristic.

patients (OR = 0.67, 95% CI = 0.46–0.98) had lower odds of receiving CMRs from a pharmacist. Black patients also had 23% lower odds of receiving CMRs from a local pharmacist (OR = 0.77, 95% CI = 0.69–0.86).

Table 4 reports the Cox proportional hazard analysis results on disparity patterns in outcomes pertaining to MTM service initiation and quantity. Compared with White patients, the risk, or probability, of being offered a CMR after MTM enrollment was 3% lower for Black patients (hazard ratio [HR] = 0.97, 95% CI = 0.943–0.995), 6% lower for Hispanic patients (HR = 0.94, 95% CI = 0.90–0.99), and 5% lower for Asian patients (HR = 0.95, 95% CI = 0.91–0.99). The probability of receiving the first CMR after MTM enrollment was 8% lower for Hispanic patients (HR = 0.92, 95% CI = 0.86–0.98) and 7% lower for Asian patients (HR = 0.93, 95% CI = 0.87–0.99).

Disparity patterns in MTM service receiver types are presented in Table 5. Both Hispanic and Asian patients were more likely than White patients to have someone else receive a CMR than to receive it by themselves. Specifically, compared with White patients, the relative risk ratios (RRR) for Hispanic patients having their prescribers, caregivers, or other authorized individuals receive a CMR rather than receiving it by themselves were 1.53 (95% CI = 1.29–1.81), 1.69 (95% CI = 1.53–1.87), and 1.88 (95% CI = 1.58–2.25), respectively. Likewise, the RRRs for Asian patients were 1.76 (95% CI = 1.08–2.85), 1.63 (95% CI = 1.44–1.85), and 1.64 (95% CI = 1.41–1.89), respectively.

#### 4. Discussion

This study analyzed Medicare data from 2017 to examine racial/ethnic disparities related to Part D MTM service nature, initiation, quantity, and delivery. Racial/ethnic disparities were found for each group of outcomes with the disparity patterns varying across specific outcomes.

Previous studies have examined the characteristics of Medicare beneficiaries being offered and receiving a CMR. For example, Coe et al. discovered that Black and Hispanic patients had lower odds than White patients of being offered CMRs and that Black patients had higher, but Hispanic, Asian, and other patients had lower, odds of receiving a CMR than White patients.<sup>3</sup> The current study discovered similar racial/ethnic disparities in

the duration between MTM enrollment and CMR offer or receipt. Specifically, Black, Hispanic, and Asian patients were more likely than White patients to have a longer duration between MTM enrollment and CMR offer,

**Table 4**  
Racial/Ethnic Disparity Patterns in MTM Service Initiation: Cox Proportional Hazard Analysis Results.

Characteristics	Days Before Being Offered CMR After MTM Enrollment		Days Before 1st CMR Receipt After MTM Enrollment	
	HR	95% CI	HR	95% CI
<b>Predisposing Factors</b>				
<b>Race/Ethnicity</b>				
Black Patients	0.97	0.943–0.995	1.03	1.01–1.05
Hispanic Patients	0.94	0.90–0.99	0.92	0.86–0.98
Asian/Pacific Islander Patients	0.95	0.91–0.99	0.93	0.87–0.99
Other Patients	1.00	0.98–1.02	0.99	0.97–1.01
Age	1.00	1.001–1.003	1.00	0.998–0.999
Male	0.97	0.968–0.979	0.98	0.978–0.987
Pr Married-couple Families*	0.87	0.57–1.35	1.42	1.10–1.83
Pr Ind Education ≥ High School*	0.68	0.48–0.97	1.11	0.79–1.57
<b>Enabling Factors</b>				
Per Capita Income (in \$1000)*	1.00	0.999–1.002	1.00	0.9980–1.0001
Pr Ind No Health Insurance*	0.35	0.21–0.57	1.28	0.84–1.95
Metropolitan Statistical Area*	0.96	0.935–0.995	1.00	0.98–1.03
Health Professional Shortage Area*	0.96	0.92–1.01	1.03	1.00–1.05
<b>Census Regions</b>				
Midwest	0.90	0.83–0.97	0.98	0.94–1.02
South	0.92	0.87–0.98	1.04	1.01–1.08
West	0.96	0.90–1.02	1.03	0.99–1.08
<b>Need Factor</b>				
Risk Adjustment Summary Score	1.00	0.996–1.012	1.01	1.0096–1.0189

MTM = medication therapy management; CMR = comprehensive medication review; HR = hazard ratio; CI = confidence interval; Pr = proportion of; Ind = individuals with; Pr Ind Education ≥ High School, refers to the proportion of individuals aged 25 years or older with at least a high school education.

Reference groups: non-Hispanic White patients, female, non-metropolitan statistical area, non-health professional shortage area, and Northeast census region.

\* Indicates a county-level characteristic.

**Table 5**  
Racial/Ethnic Disparity Patterns in MTM Recipient Types: Multinomial Logistic Regression Results.

Characteristics	Beneficiary's Prescriber		Caregiver		Other Authorized Individual	
	RRR	95% CI	RRR	95% CI	RRR	95% CI
<b>Predisposing Factors</b>						
Race/Ethnicity						
Black Patients	1.07	0.94–1.21	0.98	0.93–1.04	1.02	0.94–1.11
Hispanic Patients	1.53	1.29–1.81	1.69	1.53–1.87	1.88	1.58–2.25
Asian/Pacific Islander Patients	1.76	1.08–2.85	1.63	1.44–1.85	1.64	1.41–1.89
Other Patients	0.99	0.83–1.17	1.23	1.15–1.31	1.30	1.14–1.48
Age	1.06	1.053–1.063	1.09	1.093–1.096	1.10	1.094–1.101
Male	1.05	0.996–1.102	1.78	1.71–1.84	1.64	1.55–1.73
Pr Married-couple Families*	0.07	0.02–0.34	2.36	1.52–3.66	15.08	4.97–45.77
Pr Ind Education $\geq$ High School*	10.23	1.02–102.20	0.11	0.06–0.20	0.15	0.05–0.52
<b>Enabling Factors</b>						
Per Capita Income (in \$1000)*	1.00	0.999–1.004	1.00	0.993–1.001	1.00	0.99–1.01
Pr Ind No Health Insurance*	0.49	0.02–11.73	0.08	0.04–0.17	0.19	0.02–1.97
Metropolitan Statistical Area*	1.61	1.32–1.97	0.90	0.85–0.96	0.98	0.87–1.10
Health Professional Shortage Area*	1.06	0.84–1.33	0.97	0.91–1.03	0.97	0.83–1.13
<b>Census Regions</b>						
Midwest	0.96	0.71–1.29	1.05	0.95–1.16	0.70	0.57–0.85
South	0.64	0.49–0.83	1.10	1.01–1.19	0.81	0.68–0.96
West	0.42	0.30–0.59	0.86	0.78–0.94	0.93	0.76–1.15
<b>Need Factor</b>						
Risk Adjustment Summary Score	1.11	1.06–1.15	1.23	1.22–1.25	1.17	1.14–1.20

MTM = medication therapy management; RRR = relative risk ratio; CI = confidence interval; Pr = proportion of; Ind = individuals with; Pr Ind Education  $\geq$  High School, refers to the proportion of individuals aged 25 years or older with at least a high school education.

Reference groups: non-Hispanic White patients, female, non-metropolitan statistical area, non-Health Professional Shortage Area, and Northeast census region.

\* Indicates a county-level characteristic.

while Hispanic and Asian patients were more likely than White patients to have a longer duration between MTM enrollment and CMR receipt.

Additionally, another previous study revealed that a smaller proportion of Black patients received CMRs from community pharmacists than plan pharmacists,<sup>21</sup> which is similar to the results of this study demonstrating that Black patients are less likely to receive a CMR from a local pharmacist. This has important implications as past studies have demonstrated that local/community pharmacists are generally more familiar with their patients' health conditions, thereby leading to higher quality of care.<sup>8</sup> These previous studies primarily examined the offer and receipt of CMRs. The current study expanded on the existing knowledge of disparities in MTM services by investigating multiple dimensions of MTM services, many of which have not been reported in the literature.

Several previous studies have demonstrated the value of MTM services in improving the use of medications and reducing disparities. For example, one study revealed that MTM services over the telephone resolved 62% of the identified medication- and health-related problems.<sup>22</sup> Additionally, MTM services that resolve medication-related problems increase medication adherence and reduce inpatient admission and emergency department visits.<sup>23</sup> Regarding the disparity-reducing benefits of MTM services, Medicare beneficiaries receiving a CMR reduces racial/ethnic disparities in medication adherence for diabetes, hypertension, and hyperlipidemia.<sup>24</sup> Even among complex Alzheimer's patients, receiving a CMR reduces ethnic disparities in medication adherence to statin medications between Hispanic and White patients.<sup>25</sup> The current study's findings reveal that racial/ethnic minorities are not receiving all MTM services as equally as White patients, suggesting disparities in receiving the associated benefits. This could worsen the already existing and well-documented racial/ethnic disparities in health care.

Racial/ethnic disparities found in this study could potentially be the result of lower quality health care, a perpetuating issue for minorities despite other improvements in health care. Minorities have reported concerns with the quality of care received from physicians, which may affect their inclination to adopt new interventions, such as MTM services. For example, Hispanic, Black, and Asian patients, compared with White patients, reported more often that their physicians do not have their medical records or other pertinent health care information and that they have more difficulties scheduling quick follow-up appointments.<sup>26</sup> Further,

Black and Hispanic patients reported more frequently than White patients that help to manage their care was not provided, and Asian patients reported less than White patients that physicians talk over their medications with them.<sup>26</sup> Additionally, a focus group revealed that the public does not generally understand the meaning of MTM and the services offered with MTM,<sup>27</sup> and a survey found that 92.5% of a Medicare enrollee cohort did not know about MTM.<sup>28</sup> Thus, the combined fact that minorities tend to experience lower quality health care and that MTM is little known to the patient community may have contributed to minorities' indifference towards MTM services, resulting in opting out of MTM or not continuing MTM from a previous year.

Another major issue that may affect the quality of care that individuals from certain racial/ethnic groups receive in the U.S. is the lack of access to local providers who speak the patient's native language. A previous study revealed that non-English speaking Hispanic and Asian individuals have lower odds of receiving some health care services than those that speak English.<sup>29</sup> Additionally, Hispanic patients that only speak Spanish have reported less satisfaction with communication from providers.<sup>30</sup> The current study found that Asian and other patients had lower odds of receiving a standardized written CMR summary and that Hispanic, Asian, and other patients were more likely to have someone else receive the CMR for themselves. While language information was not available in the data used in this study, these findings may stem from lacking access to MTM providers who speak the patients' native languages. Similarly, another problem that may be causing some of the discovered MTM disparities is the lack of access to pharmacies for some minority communities. It has been confirmed that there are fewer pharmacies in Black and Hispanic communities than in White communities.<sup>31</sup> Such pharmacy deserts may be a reason why this study found that Black and Hispanic patients had lower odds of receiving a CMR from a pharmacist than White patients. The disparities associated with local pharmacist provision of MTM and in pharmacy deserts may be modest given that most MTM services were still provided by non-local pharmacists. Nonetheless, to ensure equitable access to pharmacies, governments should consider utilizing financial incentives, such as tax benefits and grants, to increase the number of pharmacies in pharmacy deserts. Furthermore, to prevent pharmacy closure in minority neighborhoods, federal agencies should consider increasing or subsidizing reimbursement rates for pharmacies most at risk for closure.

Previous literature has pointed out that MTM services, delivery, and outcomes vary considerably by PDP.<sup>8</sup> In addition, different PDPs serve different geographical regions, where the racial/ethnic composition may differ considerably. Consequently, intervention focus and tactics used to engage beneficiaries may be different across PDPs serving different demographic populations. Therefore, it should be acknowledged that the racial/ethnic disparities observed in this study may be partly attributable to the heterogeneity of MTM services provided by the PDPs.

While eliminating racial/ethnic disparities in MTM services may be a complex task, a solution is needed to ensure that racial/ethnic minorities are benefiting from MTM services. A simple start would be to increase Medicare beneficiaries' understanding of the purpose and benefits of MTM services. Miguel et al. discovered that clearly explaining the process and benefits of a CMR improved individuals' willingness to participate.<sup>32</sup> Since communication between a patient and a pharmacist is influenced by the patient's knowledge, beliefs, and past experiences,<sup>33</sup> it is essential that MTM services are clearly explained to a patient and any uncertainties with the services are clarified prior to offering the services. Furthermore, it is important that access to pharmacies is increased among minority communities and that local pharmacists build relationships with their patients, including improving access to pharmacists or translators who speak the language of those in the community.

This study should be interpreted with a few limitations in mind. One limitation stems from the use of Medicare administrative claims, which restricts the researchers' ability to account for some individual-level characteristics. County-level data were utilized as substitutes in this study, but this may result in individual characteristics not being accurately represented. In addition, individuals who did not have continuous Medicare coverage for the year were excluded, which may potentially result in an underestimation of disparities if the reason for not having Medicare coverage was associated with socioeconomic factors. Additionally, since only the fee-for-service Medicare population was analyzed for this study, the findings may not be generalizable to Medicare Advantage beneficiaries. Lastly, due to data limitation, the type of medication-related problems (e.g., medication non-adherence, medication safety, etc.) identified during the MTM encounter could not be analyzed in this study. Racial/ethnic disparities in health outcomes may potentially exist partially because both the type of clinical services provided and demographic groups served may vary across different MTM programs.<sup>22,23,34</sup> Despite these limitations, this study is among the first to utilize the MTM data to examine disparities in MTM services among Medicare beneficiaries.

In conclusion, racial/ethnic disparities in Medicare MTM services were confirmed with this study. Although the disparities in specific MTM services and delivery methods vary across each racial/ethnic group, it is evident that these disparities exist and may result in minorities not receiving the positive effects that MTM services provide. Potential causes of the disparities in the Medicare MTM program should be further explored to discover the best resolution in the future. The cause for disparities patterns reported in this study may be multifaceted and warrant a complex solution. Future research should also examine if racial/ethnic disparities exist among specific Medicare populations, such as specific chronic conditions.

## Funding

Research reported in this publication was supported by the National Institute on Aging of the National Institutes of Health under Award Number R01AG040146. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The sponsor of the research does not have any role in any aspects of the research, including study design, the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

## CRedit authorship contribution statement

**Xiaobei Dong:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Chi Chun Steve Tsang:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Jamie A. Browning:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Joseph Garuccio:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Jim Y. Wan:** Funding acquisition, Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Ya Chen Tina Shih:** Funding acquisition, Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Marie A. Chisholm-Burns:** Funding acquisition, Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Samuel Dagogo-Jack:** Funding acquisition, Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **William C. Cushman:** Funding acquisition, Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Junling Wang:** Funding acquisition, Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Junling Wang:** Funding acquisition, Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision, Project administration.

## Declaration of Competing Interest

Xiaobei Dong: None. Chi Chun Steve Tsang: None. Jamie A. Browning: None. Joseph Garuccio: None. Jim Y. Wan: None. Ya Chen Tina Shih: None. Marie A. Chisholm-Burns: Received funding from Carlos and Marguerite Mason Trust. Samuel Dagogo-Jack: Led clinical trials for AstraZeneca, Boehringer Ingelheim, and Novo Nordisk, Inc., received consulting fees from AstraZeneca, Boehringer Ingelheim, Janssen, Merck & Co. Inc., and Sanofi, and has equity interests in Jana Care, Inc. and Aerami Therapeutics. William C. Cushman: Received grant funding from Eli Lilly. Junling Wang: Received funding from AbbVie, Curo, Bristol Myers Squibb, Pfizer, and Pharmaceutical Research and Manufacturers of America (PhRMA), and serves on Health Outcomes Research Advisor Committee of the PhRMA Foundation.

## Acknowledgement

The authors would like to acknowledge the assistance from Oluwasefunmi Agbanigo, a PharmD student in the College of Pharmacy at the University of Tennessee Health Science Center.

## Appendix A. Measures of Medication Therapy Management (MTM) Services Utilization

Dimension of Measures	Data Type	Study Outcomes	Type of Regression
Nature of MTM Services	Binary	Whether: (1) beneficiary opted out of MTM after being enrolled; (2) MTM was continued from the previous year; (3) a comprehensive medication review (CMR) with a written summary in CMS standardized format was received; (4) CMR provider was a pharmacist; and (5) CMR provider was a local pharmacist.	Logistic model
Initiation of MTM Services	Duration (time) between events	(1) Days before opting out after being determined eligible for MTM; (2) Days before opting out after MTM enrollment; (3) Days before being offered CMR after MTM enrollment; and (4) Days before the first CMR receipt after MTM enrollment.	Cox proportional hazards model
Quantity of MTM Services Received	Discrete	(1) Number of drug therapy problem resolutions; (2) Number of drug therapy problem recommendations made to the beneficiary's prescriber; and (3) Number of targeted medication reviews conducted.	Negative binomial model
Delivery Method and Recipient Types	Categorical	(1) CMR delivery methods. A binary outcome with value of one representing telephone and zero representing face to face. Telehealth consultations and other methods of delivery were not included in the analysis due to small sample size; (2) CMR recipient types. An outcome with four mutually exclusive categories including beneficiary (reference group), beneficiary's prescriber, caregiver, and other authorized individual.	Logistic model/ Multinomial logistic model

All study outcomes were derived from Medicare Part D MTM Data File.

## Appendix B. Data Type, Operationalization, and Data Sources for Independent Variables

Variables	Data Type	Operationalization in Regression Models	Sources of Data
Predisposing Factors			
Race and ethnicity	Categorical	Dummy variables for non-Hispanic Black patients, Hispanic patients, Asian/Pacific Islander patients, and Other patients, with non-Hispanic White patients as the reference group.	Master Beneficiary Summary File (MBSF)
Age	Continuous	Age in years.	MBSF
Gender	Binary	Dummy variable for male; female as the reference group	MBSF
County-level predisposing	Continuous	(1) Proportion of married-couple families; (2) Proportion of individuals aged 25 years or older with at least a high school education.	Area Health Resource File (AHRF)
Enabling Factors			
County-level enabling	Continuous/Binary	(1) Per capita income; (2) Proportion of individuals without health insurance; (3) Dummy variable for metropolitan statistical area (MSA); non-MSA as the reference group; (4) Dummy variable for Health Professional Shortage Area (HPSA) concerning primary care; non-HPSA as the reference group	AHRF
Census regions	Categorical	Dummy variables for Midwest, South, and West; Northeast as the reference group.	AHRF
Need Factor			
Risk adjustment summary score	Continuous	A score developed based on the Centers for Medicare and Medicaid Services Diagnostic Cost Group/Hierarchical Condition Category model.	Medicare Parts A and B claims

## References

- Watanabe JH, McInnis T, Hirsch JD. Cost of prescription drug-related morbidity and mortality. *Ann Pharmacother* 2018;52:829–837.
- Petrone K, Katz P. Approaches to appropriate drug prescribing for the older adult. *Prim Care* 2005;32:755–775.
- Coe AB, Adeoye-Olatunde OA, Pestka DL, et al. Patterns and predictors of older adult Medicare Part D beneficiaries' receipt of medication therapy management. *Res Social Adm Pharm* 2020;16:1208–1214. <https://doi.org/10.1016/j.sapharm.2019.12.007>.
- Ai AL, Carretta H, Beitsch LM, Watson L, Munn J, Mehriary S. Medication therapy management programs: promises and pitfalls. *J Manag Care Spec Pharm* 2014;20:1162–1182. <https://doi.org/10.18553/jmcp.2014.20.12.1162>.
- American Pharmacists Association, National Association of Chain Drug Stores Foundation. Medication therapy management in pharmacy practice: core elements of an MTM service model (version 2.0). *J Am Pharm Assoc* 2008;48:341–353.
- Centers for Medicare & Medicaid Services. Medicare program; Contract year 2015 policy and technical changes to the Medicare Advantage and the Medicare prescription drug benefit programs; Proposed rule. *Federal Register* 2014;79:1917–2073.
- Centers for Medicare & Medicaid Services. CY 2017 medication therapy management program guidance and submission instructions. <https://www.cms.gov/Medicare/Prescription-Drug-Coverage/PrescriptionDrugCovContra/Downloads/Memo-Contract-Year-2017-Medication-Therapy-Management-MTM-Program-Submission-v-040816.pdf>; 2016. (Accessed 22.04.22).
- Perloth D, Marrufo G, Montesinos A, et al. Medication Therapy Management in Chronically Ill Populations: Final Report. [https://innovation.cms.gov/files/reports/mtm\\_final\\_report.pdf](https://innovation.cms.gov/files/reports/mtm_final_report.pdf); 2013.
- Dong X, Tsang CCS, Zhao S, et al. Effects of the Medicare Part D comprehensive medication review on medication adherence among patients with Alzheimer's disease. *Curr Med Res Opin* 2021;37:1581–1588. <https://doi.org/10.1080/03007995.2021.1935224>.
- Viswanathan M, Kahwati LC, Golin CE, et al. Medication therapy management interventions in outpatient settings: a systematic review and meta-analysis. *JAMA Intern Med* 2015;175(1):76–87.
- Murugappan MN, Seifert RD, Farley JF. Examining Medicare Part D Medication Therapy Management program in the context of mental health. *J Am Pharm Assoc* 2020;60:571–579.
- Pestka DL, Zillich AJ, Coe AB, et al. Nationwide estimates of medication therapy management delivery under the Medicare prescription drug benefit. *J Am Pharm Assoc* 2020;60(3):456–461.
- Centers for Medicare & Medicaid Services. Part C and D Performance Data. <https://www.cms.gov/Medicare/Prescription-Drug-Coverage/PrescriptionDrugCovGenIn/Performanc eData>. (Accessed 22.04.22).
- Skarupski KA, de Leon CF, Barnes LL, et al. Medicare Part D enrollment in a biracial community-based population of older adults. *Gerontologist* 2009;49:828–838.
- Levy H, Weir DR. Take-up of Medicare Part D: results from the Health and Retirement Study. *J Gerontol B Psychol Sci Soc Sci* 2010;65B:492–501.
- Research Data Assistance Center. Find, Request, and Use CMS Data. <https://www.resdac.org/>; 2022. (Accessed 22.04.22).
- Health Resources & Services Administration. Area Health Resources Files. <https://data.hrsa.gov/topics/health-workforce/ahr/>; 2022. (Accessed 22.04.22).
- Jarrin OF, Nyandege AN, Grafova IB, Dong X, Lin H. Validity of race and ethnicity codes in Medicare administrative data compared with gold-standard self-reported race collected during routine home health care visits. *Med Care* 2020;58:e1–e8. <https://doi.org/10.1097/MLR.0000000000001216>.
- Gelberg L, Andersen RM, Leake BD. The Behavioral Model for Vulnerable Populations: application to medical care use and outcomes for homeless people. *Health Serv Res* 2000;34:1273–1302.
- Centers for Medicare & Medicaid Services. Medicare managed care manual: chapter 7-risk adjustment. <https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/Downloads/mc86c07.pdf>; 2014. (Accessed 22.09.12).
- Adeoye OA, Farley JF, Coe AB, et al. Medication therapy management delivery by community pharmacists: insights from a national sample of Medicare Part D beneficiaries. *J Am Coll Clin Pharm* 2019;2:373–382. <https://doi.org/10.1002/jac5.1160>.
- Moczygemba LR, Barner JC, Gabrillo ER. Outcomes of a Medicare Part D telephone medication therapy management program [published correction appears in *J Am Pharm Assoc* (2003). 2013;53:12. Brannier, Jamie C [corrected to Barner, Jamie C]]. *J Am Pharm Assoc* (2003) 2012;52. <https://doi.org/10.1331/JAPhA.2012.11258.e144-e152>.
- Ferries E, Dye JT, Hall B, Ndehi L, Schwab P, Vaccaro J. Comparison of medication therapy management services and their effects on health care utilization and medication adherence. *J Manag Care Spec Pharm* 2019;25:688–695. <https://doi.org/10.18553/jmcp.2019.25.6.688>.
- Dong X, Tsang CCS, Zhao S, et al. Effects of the Medicare Part D comprehensive medication review on racial and ethnic disparities in medication adherence. *Am Health Drug Benefits* 2021;14:101–109.
- Browning JA, Tsang CCS, Dong X, et al. Effects of Medicare comprehensive medication review on racial/ethnic disparities in nonadherence to statin medications among patients with Alzheimer's Disease: an observational analysis. *BMC Health Serv Res* 2022;22:159. Published 2022 Feb 7: <https://doi.org/10.1186/s12913-022-07483-8>.



26. Martino SC, Elliott MN, Hambarsoomian K, et al. Racial/ethnic disparities in Medicare beneficiaries' care coordination experiences. *Med Care* 2016;54:765–771. <https://doi.org/10.1097/MLR.0000000000000556>.
27. Taylor AM, Axon DR, Campbell P, et al. What patients know about services to help manage chronic diseases and medications: findings from focus groups on medication therapy management. *J Manag Care Spec Pharm* 2018;24:904–910. <https://doi.org/10.18553/jmcp.2018.24.9.904>.
28. Law AV, Okamoto MP, Brock K. Perceptions of Medicare Part D enrollees about pharmacists and their role as providers of medication therapy management. *J Am Pharm Assoc* (2003) 2008;48:648–653. <https://doi.org/10.1331/JAPhA.2008.07084>.
29. Sentell T, Shumway M, Snowden L. Access to mental health treatment by English language proficiency and race/ethnicity. *J Gen Intern Med* 2007;22(suppl 2):289–293. <https://doi.org/10.1007/s11606-007-0345-7>.
30. Weech-Maldonado R, Fongwa MN, Gutierrez P, Hays RD. Language and regional differences in evaluations of Medicare managed care by Hispanics. *Health Serv Res* 2008;43:552–568. <https://doi.org/10.1111/j.1475-6773.2007.00796.x>.
31. Guadamuz JS, Wilder JR, Mouslim MC, Zenk SN, Alexander GC, Qato DM. Fewer pharmacies in Black and Hispanic/Latino neighborhoods compared with White or diverse neighborhoods, 2007–15. *Health Aff (Millwood)* 2021;40:802–811. <https://doi.org/10.1377/hlthaff.2020.01699>.
32. Miguel A, Hall A, Liu W, et al. Improving comprehensive medication review acceptance by using a standardized recruitment script: a randomized control trial. *J Manag Care Spec Pharm* 2017;23:13–21. <https://doi.org/10.18553/jmcp.2017.23.1.13>.
33. Qudah B, Thakur T, Chewning B. Factors influencing patient participation in medication counseling at the community pharmacy: a systematic review. *Res Social Adm Pharm* 2021;17:1863–1876. <https://doi.org/10.1016/j.sapharm.2021.03.005>.
34. Bankes D, Pizzolato K, Finnel S, et al. Medication-related problems identified by pharmacists in an enhanced medication therapy management model. *Am J Manag Care* 2021;27(16 Suppl):S292–S299.