The Association Between the Supply of Nonpharmacologic Providers, Use of Nonpharmacologic Pain Treatments and High-risk Opioid Prescription Patterns Among Medicare Beneficiaries With Persistent Musculoskeletal Pain

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Background: Opioids are prescribed more frequently than nonpharmacologic treatments for persistent musculoskeletal pain (MSP). We estimate the association between the supply of physical therapy (PT) and mental health (MH) providers and early nonpharmacologic service use with high-risk opioid prescriptions among Medicare beneficiaries with persistent MSP.

Research Design: We retrospectively studied Medicare beneficiaries (>65 y) enrolled in Fee-for-Service and Part D (2007–2014) with a new persistent MSP episode and no opioid prescription during the prior 6 months. Independent variables were nonpharmacologic provider supply per capita and early nonpharmacologic service use (any use during first 3 mo). One year outcomes were long-term opioid use (LTOU) (≥90 days' supply) and high daily dose (HDD) (≥50 mg morphine equivalent). We used multinomial regression and generalized estimating equations and present adjusted odds ratios (aORs).

Results: About 2.4% of beneficiaries had LTOU; 11.9% had HDD. The supply of MH providers was not associated with LTOU and HDD. Each additional PT/10,000 people/county was associated with greater odds of LTOU [aOR: 1.06; 95% confidence interval (CI), 1.01–1.11). Early MH use was associated with lower odds of a low-risk opioid use (aOR: 0.81; 95% CI, 0.68–0.96), but greater odds of LTOU (aOR: 1.93; 95% CI, 1.28–2.90). Among beneficiaries with an opioid prescription, early PT was associated with lower odds of LTOU (aOR: 0.75; 95% CI, 0.64–0.89), but greater odds of HDD (aOR: 1.25; 95% CI, 1.15–1.36).

Conclusions: The benefits of nonpharmacologic services on opioid use may be limited. Research on effective delivery of nonpharmacologic services to reduce high-risk opioid use for older adults with MSP is needed.

Key Words: persistent musculoskeletal pain, older adults, opioid prescribing, access to care, physical therapy, mental health services

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Nearly 60% of adults over age 65 experience musculoskeletal pain (MSP).[1] Persistent (>3 mo) MSP can lead to inactivity, falls, mood disorders, and disability for older adults.[2,3] Clinical guidelines for long-term pain management recommend nonpharmacologic treatments before prescribing opioids.[4–6] If opioids are necessary to manage pain, guidelines recommend using nonpharmacologic treatments with opioids, prescribing opioids at the lowest effective dose and shortest duration, and assessing the benefits and risks of opioid use as treatment progresses.[4–6] Many nonpharmacologic services (eg, chiropractic care and occupational therapy) may be used to treat pain, but physical therapy (PT) and mental health (MH) services have some of the strongest evidence.[5] The benefits of MH (eg, cognitive behavioral therapy) and PT services include improvements in pain symptoms and functioning, and reductions in opioid use.[7–11]

Opioids may be effective for acute pain; however, high-risk opioid use (eg, long-term use or high dose) is not supported by evidence.[12,13] The proportion of older adults with ≥90 days' supply of opioids almost doubled (4%–7%) between 2007 and 2012.[14] About 3% of older adults are prescribed daily doses exceeding 120 mg morphine equivalent (MME)—more than twice the maximum dose recommended by the Centers for Disease Control and Prevention (CDC).[5,15] Nearly 25% of Medicare

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beneficiaries concurrently have ≥90 consecutive days of opioid use and daily doses ≥100 MME.[16] High-risk opioid use can lead to tolerance, overdose, and death.[5,17–19]

Understanding the drivers of high-risk opioid use can inform efforts to prevent or reduce opioid use. Older adults are prescribed opioids more frequently than nonpharmacologic services[20] which may, in part, be due to problems accessing nonpharmacologic services.[21] Early use of nonpharmacologic services for pain is recommended, but whether these services limit high-risk opioid use among older adults with persistent pain is unknown.[5]

Among Medicare beneficiaries >65 years with a new episode of persistent MSP, we estimated the association of the supply of nonpharmacologic providers (PT and MH) and early nonpharmacologic service use, with high-risk opioid use. We hypothesized that (1) a greater supply of PT and MH providers is associated with lower odds of high-risk opioid use; and (2) early PT and MH service use is associated with lower odds of high-risk opioid use.

MATERIALS AND METHODS

Data Sources

Data came from Medicare Fee-for-Service (FFS) claims and the Area Health Resource File.[22] We used a 5% sample of beneficiaries enrolled in Medicare FFS and Part D between January 1, 2008 and December 31, 2013, and earlier Medicare claims data from 2007 to ensure a 1-year look-back period. The Master Beneficiary Summary file contains demographic, enrollment, and death data. Data about diagnoses, service utilization, and service dates came from claims filed for services covered by Medicare Parts A (inpatient services) and Part B (outpatient services, including home health, hospice, and skilled nursing facilities). The Part D Drug Event file contains information on claims for filled prescriptions (amount of medication dispensed, days' supply, fill dates). The Area Health Resource File was used to assign annual county characteristics to beneficiaries based on the county of residence and index year.[22,23]

Study Population

We identified beneficiaries with a new episode of what will become persistent MSP using International Disease Classification Codes, 9th edition (ICD-9) in any diagnostic position from claims of inpatient, institutional and non-institutional outpatient, home health, and skilled nursing facility services.[24] Beneficiaries with 2 claims with diagnoses of MSP >90 but <365 days apart were included.[25] We identified a new persistent MSP episode with the first claim of a pain diagnosis (index date) following a year without any claims with a pain diagnosis. Pain diagnoses did not have to be the same to identify an episode.

To ensure that beneficiaries had a pain episode and no history of opioid use and nonpharmacologic service use, we required continuous enrollment in Medicare FFS for 1 year and Part D for 6 months before the index date, and no opioid prescription, PT or MH service use in the prior 6 months. Although beneficiaries could have multiple pain episodes during the study period, we selected the first episode to ensure that utilization rates were independent of the history of pain care. To focus on MSP, we excluded beneficiaries with a trauma diagnosis or invasive surgery defined by Current Procedural Codes (CPT) and ICD-9 codes in the year before the index date.[24,26] Beneficiaries with hospice or long-term care services at any time were excluded because clinical guidelines differ for these beneficiaries.[5] Beneficiaries who were 65 years or younger at index were excluded. After the index date, beneficiaries were followed for 1 year or until they were censored due to death, enrollment in Medicare Advantage, or disenrollment from Part D.

Outcomes

We identified beneficiaries with long-term opioid use (LTOU) and high daily doses (HDD) during the year after the index date using Part D claims. Oral and transdermal formulations of opioids were included to reflect Food and Drug Administration-approved indication to treat pain. Opioids were identified by CDC National Drug Codes.[27]

We defined LTOU as a total days' supply during the follow-up period exceeding 90.[14] The total days' supply is the sum of days' supply for each prescription filled during follow-up. The outcome was censored if the follow-up period was ≤1 year.

To identify beneficiaries with HDD, we calculated the daily dose for each prescription by dividing the product of the quantity prescribed, the drug strength, and the MME conversion factor by the days' supplied.[27,28] The total daily dose is an "as prescribed measure" that sums the daily MME for all prescriptions on a given day, and accounts for overlapping prescriptions.[29] To examine periods of high-intensity opioid use, HDD was ≥50 MME (per CDC guidelines) on any day during the follow-up period.[5,29]

We created a 5-category beneficiary-level outcome for high-risk use during the year follow-up: no opioid use, low-risk use (≥1 opioid prescription but no LTOU or HDD), LTOU only, HDD only, and both LTOU and HDD.

Primary Independent Variables

The primary independent variables were supply of selected nonpharmacologic providers [MH (psychiatrists and psychologists) and PTs] and early use of nonpharmacologic services. County supply of nonpharmacologic providers is a proxy for local availability. Scaled annual per capita per county measures were the ratios between number of providers in a county and the annual county population multiplied by 10,000 (noted as number of providers/10,000 people/county).[22] We used all available years for the supply counts (psychiatrists: 2008, 2010–2013; psychologists: 2009, PTs: 2009).[22] We imputed missing data for the annual psychiatrist supply using linear interpolation where the existing annual supply variable was a function of the year. The interpolation was conducted separately for each county. Since only 1 year was available for the psychologists and PT supply, data from 2009 were carried forward for the study years. Using CPT and Healthcare Common Procedural Coding System (Supplementary Table 1, Supplemental Digital Content 1, http://links.lww.com/MLR/B967), we created 2 separate binary indicators for early use of PT and MH services defined as ≥1 visit within 3 months of the index date.[30,31]

Covariates

Individual characteristics were measured 1 year before the index date and included age, race, sex, Medicaid dual eligibility, and Part D low-income subsidy (proxy for income).[32] Comorbidities were measured using the Deyo-Charlson comorbidity score.[33] We identified nonmutually exclusive categories for the underlying

MSP pain conditions: arthritis, back pain, chronic pain, neck pain, psychogenic pain, sprain or strain, fibromyalgia, or other. We identified depression and anxiety at baseline using the ICD-9 codes from the Centers for Medicare and Medicaid's Chronic Conditions Warehouse and the Healthcare Cost and Utilization Project.[24,34,35] CPT and ICD-9 codes identified trauma diagnoses and surgery during the follow-up period.[24,26] A censor variable identified the loss to follow-up reason. Length of follow-up time was the number of days from index date to end of the study period. An early opioid prescription was defined as an opioid prescription claim during 3 months after the index date. CPT codes identified early occupational therapy and chiropractor visits 3 months after the index date.[36,37] The number of prescribers and pharmacies was calculated by summing the number of unique prescribers and pharmacies visited by the beneficiary during the follow-up period. Centers for Medicare and Medicaid's changed the encryption method to identify unique prescribers and pharmacies in 2014.[38] To obtain the totals for beneficiaries with a 2013 index date, we counted each prescriber or pharmacy as unique, which may lead to double counting. Time trends in the model adjust for this change.

To account for "prescribing culture," we include county-level covariates such as the annual supply of primary care providers (PCP), that is, internal medicine, general practice, geriatrics specialists (2008, 2010–2013), surgeons (2008, 2010–2013), pain specialists (physical medicine or rehabilitation specialists: 2008, 2010–2013), midlevel practitioners (nurse practitioners: 2009; physician assistants: 2009), and pharmacists (2009).[22,39] The total supply of PCPs, surgeons, and pain specialists, included providers with an MD or DO training in office-based settings, hospital staff, hospital residents, and clinical fellows.[22] We imputed the missing data and calculated per capita provider supply measures as described above for the per capita nonpharmacologic provider supply measure. County demographics included proportion of the county population below the Federal Poverty Level and the proportion of the county population over 65. Rural-Urban Commuting Area codes were used to assign counties to metropolitan and rural designations.[22,23]

Statistical Analysis

T tests and χ^2 tests were used to compare characteristics of beneficiaries with an opioid prescription, LTOU, and HDD to those without those outcomes, separately.

We used a multinomial logistic regression to estimate the association between the supply and use of nonpharmacologic services with the 5-category outcome measure for high-risk opioid use. We chose a multinomial model because it accounted for the unobserved correlation in the error between beneficiaries with and without opioid use by using a single variance-covariance matrix.[40] It used data from the entire cohort in a single model to assess population-level risk of high-risk opioid use.[40] For the 5-category outcome measure, low-risk opioid use during the follow-up period is the reference category. Because opioids may be indicated for MSP, the low-risk reference category highlights the contrast between clinically appropriate and risky opioid use, and enables comparisons of estimates from the main and subgroup models (described below).[5] In the multivariable model, we included MH provider supply, PT provider supply, early MH service use, and early PT use, individual characteristics (demographics, comorbidities, trauma, surgery, censoring reason, follow-up days), county characteristics (provider supply and demographics), and state and time fixed effects.

To address potential selection bias from differences in unobserved characteristics (eg, pain severity, functional status) between beneficiaries with and without opioid prescriptions, we conducted subgroup analyses of beneficiaries with at least 1 opioid prescription in the follow-up period. The binary outcomes for the subgroup analyses were LTOU and HDD. The independent variables were the supply of nonpharmacologic providers and early use of nonpharmacologic services. The models controlled for the same characteristics as the multinomial model, the number of prescribers and pharmacies, and early opioid prescriptions. We used generalized estimating equations and selected the model with the lowest quasi-likelihood under the independence model criterion. We present adjusted odds ratios (aORs) and 95% confidence intervals (CIs).

Analyses were conducted in SAS Version 9.4 (SAS Institute Inc., Cary, NC). The Institutional Review Boards at Duke University School of Medicine and University of North Carolina- Chapel Hill approved this study.

RESULTS

We identified 197,827 beneficiaries with a new episode of persistent MSP without an opioid prescription in the 6 months before the index date. We excluded 80,386 beneficiaries with surgery and 1497 with a trauma diagnosis before the index date, 5943 with hospice use within the study window, and 2802 beneficiaries with MH and PT 6 months before the index date. The final cohort included 65,101 beneficiaries (Fig. 1).

Among beneficiaries with persistent MSP, 2.4% had LTOU, and 11.9% had HDD (Table 1). The median supply of nonpharmacologic providers was 3.3 MH (interquartile range: 1.6–5.7) and 5.9 PT (interquartile range: 4.0–7.6) per 10,000 people/county. During the first 3 months of the persistent pain episode, 11.2% of beneficiaries used PT, 1.6% used MH services, and 13.2% filled an opioid prescription. For the 31.3% of the beneficiaries who filled at least 1 opioid prescription during the follow-up period, the average daily dose was 43.6 MME and the average days' supply was 28.2 days. Beneficiaries with 1 or more opioid prescriptions during the follow-up year were more likely to be younger, male, white, have Medicaid, and use PT early compared with beneficiaries without an opioid prescription.

Among beneficiaries with an opioid prescription during the follow-up year, 7.6% had LTOU, 38.3% had HDD, and 3.4% had concurrent LTOU and HDD (Table 2). Compared with beneficiaries without LTOU, beneficiaries with LTOU were less likely to use PT early and more likely to use MH early. Beneficiaries with LTOU lived in counties with fewer MH providers and PTs compared with beneficiaries without LTOU. Early MH service use was similar for beneficiaries with and without HDD. Beneficiaries with HDD were more likely to have an early PT visit and live in counties with fewer MH providers.

Supply of Nonpharmacologic Providers and Opioid Use

The supply of MH and PT providers were not associated with the odds of low-risk opioid use relative to no

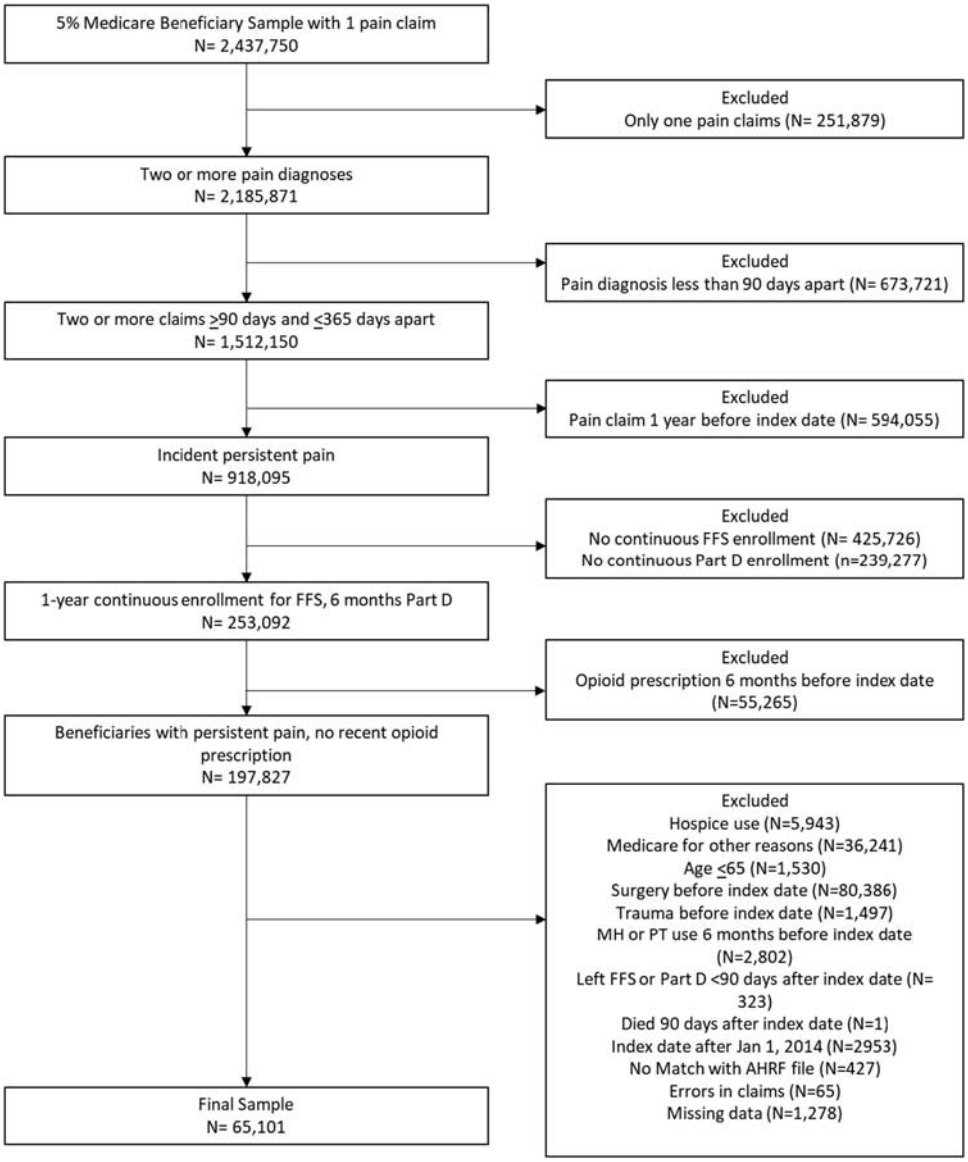

FIGURE 1. Cohort selection process of Medicare beneficiaries with a new episode of persistent musculoskeletal pain. FFS indicates Fee-for-Service.

opioid use during follow-up (Table 3). The MH supply was not significantly associated with LTOU, HDD, or concurrent HDD and LTOU (Table 3). Each additional PT/10,000 people/county was associated with greater odds of LTOU (aOR: 1.06; 95% CI, 1.01–1.11) relative to low-risk opioid use (Table 3). In subgroup analysis of beneficiaries with opioid use, each additional MH/10,000 people/county was significantly associated with lower odds of LTOU (aOR: 0.97; 95% CI, 0.94–1.00) (Table 4).

Early Use of Nonpharmacologic Services and Opioid Use

Early use of MH was associated with lower odds of a low-risk opioid use relative to no opioid use during follow-up (aOR: 0.81; 95% CI, 0.68–0.96) (Table 3). Early use of MH was associated with greater odds of LTOU relative to a low-risk opioid use (aOR: 1.93; 95% CI, 1.28–2.90) (Table 3). In the subgroup analysis of beneficiaries with opioid use, early use of MH services was associated with greater odds of LTOU (aOR: 1.76; 95% CI, 1.24–2.51), but not significantly associated with the odds of HDD (Table 4).

Early PT use was associated with greater odds of a low-risk opioid use relative to no opioid use during follow-up (aOR: 1.49; 95% CI, 1.39–1.59) (Table 3). Early PT use was associated with greater odds of HDD (aOR: 1.33; 95% CI, 1.22–1.45) relative to low-risk opioid use (Table 3). In the subgroup analysis of beneficiaries with opioid use, early PT use was associated with lower odds of LTOU (aOR: 0.75; 95% CI, 0.64–0.89) but greater odds of HDD (aOR: 1.25; 95% CI, 1.15–1.36) (Table 4).

TABLE 1. Characteristics of Medicare Beneficiaries With a New Episode of Persistent Musculoskeletal Pain by Receipt of At Least 1 Opioid Prescription During 1-Year Follow-up

	Entire Cohort (N = 65,101), Mean (SD)/N (%)	No Opioid Prescription (N = 44,692), Mean (SD)/N (%)	Opioid Prescription (N = 20,409) Mean (SD)/N (%)	*P*
Outcomes				
Opioid prescription during follow-up	—	—	20,409 (100.0)	
Days' supply ≥ 90 d	—	—	1553 (7.6)	
Prescription dose ≥ 50 MME	—	—	7816 (38.3)	
Prescription dose ≥ 90 MME	—	—	3864 (18.9)	
Opioid prescription characteristics				
Early opioid prescription	—	—	8565 (42.0)	
Average daily MME	—	—	43.6 (36.5)	
Total days' supply	—	—	28.2 (49.8)	
Demographics				
Age (categories) (y)				
66–69	18,242 (28.0)	12,145 (27.2)	6097 (29.9)	< 0.001
70–74	15,546 (23.9)	10,467 (23.4)	5079 (24.9)	< 0.001
75–79	12,025 (18.5)	8302 (18.6)	3723 (18.2)	0.31
80–84	9474 (14.6)	6729 (15.1)	2745 (13.4)	< 0.001
≥ 85	9814 (15.1)	7049 (15.8)	2765 (13.5)	< 0.001
Age, continuous	75.6 (7.7)	75.8 (7.8)	75.1 (7.6)	< 0.001
Sex				
Female	42,986 (66.0)	29,715 (66.5)	13,271 (65.0)	< 0.001
Male	22,115 (34.0)	14,977 (33.5)	7138 (35.0)	< 0.001
Race				
White	55,182 (84.8)	37,744 (84.5)	17,438 (85.4)	0.001
Black	4499 (6.9)	3064 (6.9)	1435 (7.0)	0.41
Other race	5420 (8.3)	3884 (8.7)	1536 (7.5)	< 0.001
Medicaid dual eligible	12,889 (19.8)	8643 (19.3)	4246 (20.8)	< 0.001
Part-D low-income subsidy	570 (0.9)	417 (0.9)	153 (0.7)	0.02
Metropolitan county	52,870 (81.2)	36,469 (81.6)	16,401 (80.4)	< 0.001
Total days of follow-up	357.9 (33.7)	358.2 (33.2)	357.3 (34.7)	< 0.001
Comorbidities				
Deyo-Charlson Comorbidity score (mean)	1.1 (1.4)	1.1 (1.4)	1.1 (1.5)	0.52
0	30,635 (47.1)	21,006 (47.0)	9629 (47.2)	0.67
1	16,801 (25.8)	11,510 (25.8)	5291 (25.9)	0.64
2	8573 (13.2)	5889 (13.2)	2684 (13.2)	0.93
≥ 3	9092 (14.0)	6287 (14.1)	2805 (13.7)	0.27
Anxiety	1347 (2.1)	920 (2.1)	427 (2.1)	0.78
Depression	3685 (5.7)	2484 (5.6)	1201 (5.9)	0.09
Trauma during follow-up	4129 (6.3)	2262 (5.1)	1867 (9.1)	< 0.001
Surgery during follow-up	16,609 (25.5)	9206 (20.6)	7403 (36.3)	< 0.001
Trauma or surgery during follow-up	18,676 (28.7)	10,478 (23.4)	8198 (40.2)	< 0.001
Pain type				
Arthritis	64,030 (98.4)	43,956 (98.4)	20,074 (98.4)	0.96
Back pain	43,164 (66.3)	28,320 (63.4)	14,844 (72.7)	< 0.001
Chronic pain	10,280 (15.8)	5434 (12.2)	4846 (23.7)	< 0.001
Neck pain	7783 (12.0)	4871 (10.9)	2912 (14.3)	< 0.001
Psychogenic pain	814 (1.3)	530 (1.2)	284 (1.4)	0.03
Sprain or strain	18,729 (28.8)	11,949 (26.7)	6780 (33.2)	< 0.001
Fibromyalgia	45,074 (69.2)	30,457 (68.1)	14,617 (71.6)	< 0.001
Other pain type	20,366 (31.3)	12,830 (28.7)	7536 (36.9)	< 0.001
Utilization during follow-up				
Use mental health services	1979 (3.0)	1311 (2.9)	668 (3.3)	0.02
Used physical therapy	15,773 (24.2)	8658 (19.4)	7115 (34.9)	< 0.001
No. Pharmacists	—	—	1.2 (0.4)	
No. Prescribers	—	—	1.4 (0.8)	
Early use of physical therapy	7309 (11.2)	4170 (9.3)	3139 (15.4)	< 0.001
Early use of mental health services	1014 (1.6)	697 (1.6)	317 (1.6)	0.95
Early use of occupational therapy	1993 (3.1)	1029 (2.3)	964 (4.7)	< 0.001
Early use of chiropractic services	4606 (7.1)	3448 (7.7)	1158 (5.7)	< 0.001

(*Continued*)

TABLE 1. Characteristics of Medicare Beneficiaries With a New Episode of Persistent Musculoskeletal Pain by Receipt of At Least 1 Opioid Prescription During 1-Year Follow-up (*continued*)

	Entire Cohort (N = 65,101), Mean (SD)/N (%)	No Opioid Prescription (N = 44,692), Mean (SD)/N (%)	Opioid Prescription (N = 20,409) Mean (SD)/N (%)	*P*
County characteristics (median, interquartile range)				
Mental health provider supply*	3.3 (1.6–5.7)	3.4 (1.6–6.0)	3.0 (1.4–5.5)	< 0.001
Physical therapist supply*	5.9 (4.0–7.6)	6.0 (4.1–7.7)	5.7 (3.8–7.4)	< 0.001
Primary care providers supply*	6.8 (5.0–8.9)	6.9 (5.1–9.0)	6.6 (4.9–8.5)	< 0.001
Surgeons supply*	5.7 (3.5–8.0)	5.7 (3.6–8.1)	5.5 (3.3–7.9)	< 0.001
Pain specialists supply*	0.3 (0.1–0.4)	0.3 (0.1–0.5)	0.2 (0.1–0.4)	< 0.001
Pharmacists supply*	8.9 (7.2–11.2)	8.9 (7.2–11.3)	8.7 (7.1–11.1)	< 0.001
Midlevel providers supply*	4.8 (3.3–7.1)	4.8 (3.3–7.1)	4.8 (3.2–7.1)	< 0.001
Occupational medicine provider supply*	0.0 (0.0–0.1)	0.0 (0.0–0.1)	0.0 (0.0–0.1)	< 0.001
Chiropractors supply*	2.4 (1.6–3.3)	2.4 (1.6–3.4)	2.3 (1.5–3.3)	< 0.001
Proportion of population over 65	0.1 (0.1–0.2)	0.1 (0.1–0.2)	0.1 (0.1–0.2)	< 0.001
Proportion of population in poverty	0.1 (0.1–0.2)	0.1 (0.1–0.2)	0.1 (0.1–0.2)	< 0.001

Average daily dose: total MME/total days' supply accounting censoring.
*Per 10,000 people.
MME indicates milligram morphine equivalent.

DISCUSSION

For beneficiaries over 65 years old with persistent MSP, opioid use during a pain episode was common (~30%), with an average daily dose of 43.7 MME and an average days' supply of 28.2. Compared with all Medicare beneficiaries,[16] the study cohort had similar average daily dose but used opioids longer—unsurprising given the presence of persistent MSP in this cohort. The LTOU prevalence for beneficiaries with persistent MSP was similar to the prevalence for older adult Medicare beneficiaries broadly, whereas the prevalence of daily dose ≥ 50 MME was over 10% points higher.[14,29] About 3% of beneficiaries with MSP and opioid prescription had LTOU and HDD. The prevalence of HDD is potentially concerning given many beneficiaries had doses that exceed CDC thresholds.[5] HDD, which may be prescribed in response to more severe and/or persistent pain conditions, also increase the risk of adverse events.[17,19] LTOU or HDD may be clinically appropriate, but requires careful monitoring and clear understanding of associated risks.[5]

In general, the nonpharmacologic provider supply was not significantly associated with the odds of low-risk opioid use compared with no opioid use. Notably, the PT supply was associated with greater odds of LTOU compared with low-risk opioid use, perhaps an indicator that higher supply of PT providers may occur in conjunction with providers that prescribe opioids. Subgroup analyses of beneficiaries with opioid use showed that the supply of nonpharmacologic providers was not associated with HDD; however, MH provider supply was associated with lower odds of LTOU. The lack of association between the supply of nonpharmacologic providers and most high-risk opioid use outcomes suggests that geographic availability of nonpharmacologic services may not impact opioid use. Although this study did not explore the association between the nonpharmacologic provider supply and early use of nonpharmacologic services, geographic availability, insufficient insurance coverage, patient or provider knowledge, beliefs, treatment preferences, and transportation may contribute to low rates of early nonpharmacologic service use.[41–43]

In contrast to provider supply, benefits of early use of nonpharmacologic services differed for MH and PT services. Early MH use was associated with lower odds of no opioid use compared with low-risk opioid use and greater odds of LTOU. Early PT use was associated with greater odds of low-risk opioid use and HDD and lower odds of LTOU (for beneficiaries with opioid use). The findings for early PT use were consistent with another study on patients with new onset back pain.[44] Although timing of MH and PT services in the context of a persistent pain episode may be one important component of service delivery, treatment efficacy may depend on the number of visits.[9,10]

The opposing directions of the associations between early use of nonpharmacologic services with LTOU and HDD make it difficult to conclude if early use of nonpharmacologic services leads to high-risk opioid use or if it indicates a greater need for pharmacologic and nonpharmacologic pain treatments as pain persists. Unlike our findings, previous research shows that among patients with acute MSP, early PT use is associated with greater odds of low-risk opioid use, but these differences may be attributed to the difference in treatment needs for acute and persistent MSP patients.[45–47] Beneficiaries may be indicated for pharmacologic and nonpharmacologic care when pain persists, which complicates effective pain management in real world settings.[5] MH services address the psychological, emotional, and behavioral needs that develop during a pain episode, whereas PT address the physical impairment and functional limitations.[48] However, currently systems lack the way to efficiently coordinate both of these forms of nonpharmacologic care with pharmacologic options.

Collectively these findings suggest 2 benefits of nonpharmacologic services: (1) early MH services may prevent opioid prescriptions; and (2) early PT may prevent LTOU for those already using opioids. Current reforms to reduce opioid prescriptions have not addressed ways to provide alternatives to opioids and encourage nonpharmacologic service use.[49,50] Little is known about whether policies result in harms

TABLE 2. Characteristics of Medicare Beneficiaries With a New Episode of Persistent Musculoskeletal Pain and Opioid Prescription During 1-Year Follow-up by High-risk Opioid Prescription Patterns

	LTOU			HDD		
	No Long-Term Opioid Use (N = 18,856), Mean (SD)/N (%)	**Long-Term Opioid Use (N = 1553), Mean (SD)/N (%)**	***P***	**No High Daily Dose (N = 12,938), Mean (SD)/N (%)**	**HDD (N = 7816), Mean (SD)/N (%)**	***P***
Outcomes						
Dose ≥ 50 MME	7131 (37.8)	685 (44.1)	< 0.001		7816 (100.0)	
Days' supply ≥ 90 d	—	1553 (100.0)	< 0.001	868 (6.9)	685 (8.8)	< 0.001
Opioid prescription characteristics						
Average daily MME	44.5 (36.9)	32.8 (30.2)	< 0.001	25.4 (10.6)	73.1 (43.6)	< 0.001
Total days' supply	16.5 (17.2)	170.0 (85.0)	< 0.001	26.2 (45.9)	31.2 (55.4)	< 0.001
Demographics						
Age (categories) (y)						
66–69	5678 (30.1)	419 (27.0)	0.01	3677 (29.2)	2420 (31.0)	0.007
70–74	4757 (25.2)	322 (20.7)	< 0.001	3034 (24.1)	2045 (26.2)	< 0.001
75–79	3425 (18.2)	298 (19.2)	0.31	2320 (18.4)	1403 (18.0)	0.40
80–84	2513 (13.3)	232 (14.9)	0.07	1754 (13.9)	991 (12.7)	0.01
≥ 85	2483 (13.2)	282 (18.2)	< 0.001	1808 (14.4)	957 (12.2)	< 0.001
Age, continuous	75.0 (7.5)	76.3 (8.1)	< 0.001	75.3 (7.7)	74.7 (7.4)	< 0.001
Sex						
Female	12,242 (64.9)	1029 (66.3)	0.29	8274 (65.7)	4997 (63.9)	0.01
Male	6614 (35.1)	524 (33.7)	0.29	4319 (34.3)	2819 (36.1)	0.01
Race						
White	16,159 (85.7)	1279 (82.4)	< 0.001	10,471 (83.1)	6967 (89.1)	< 0.001
Black	1292 (6.9)	143 (9.2)	< 0.001	972 (7.7)	463 (5.9)	< 0.001
Other race	1405 (7.5)	131 (8.4)	0.16	1150 (9.1)	386 (4.9)	< 0.001
Medicaid dual eligible	3712 (19.7)	534 (34.4)	< 0.001	2959 (23.5)	1287 (16.5)	< 0.001
Part-D low-income subsidy	130 (0.7)	23 (1.5)	< 0.001	104 (0.8)	49 (0.6)	0.11
Metropolitan county	15,179 (80.5)	1222 (78.7)	0.08	10,166 (80.7)	6235 (79.8)	0.09
Total days of follow-up	357.6 (34.1)	353.4 (41.4)	< 0.001	358.0 (33.2)	356.3 (37.0)	< 0.001
Comorbidities						
Deyo-Charlson Comorbidity score (mean)	1.1 (1.5)	1.2 (1.6)	0.005	1.1 (1.5)	1.0 (1.5)	< 0.001
0	8953 (47.5)	676 (43.5)	0.003	5793 (46.0)	3836 (49.1)	< 0.001
1	4855 (25.7)	436 (28.1)	0.04	3332 (26.5)	1959 (25.1)	0.03
2	2476 (13.1)	208 (13.4)	0.77	1691 (13.4)	993 (12.7)	0.14
≥ 3	2572 (13.6)	233 (15.0)	0.13	1777 (14.1)	1028 (13.2)	0.05
Anxiety	379 (2.0)	48 (3.1)	0.004	279 (2.2)	148 (1.9)	0.12
Depression	1076 (5.7)	125 (8.0)	< 0.001	743 (5.9)	458 (5.9)	0.91
Trauma in year after index date	1697 (9.0)	170 (10.9)	0.01	1020 (8.1)	847 (10.8)	< 0.001
Surgery in year after index date	6621 (35.1)	782 (50.4)	< 0.001	4225 (33.6)	3178 (40.7)	< 0.001
Trauma or surgery during follow-up	7371 (39.1)	827 (53.3)	< 0.001	4687 (37.2)	3511 (44.9)	< 0.001
Pain type						
Arthritis	18,546 (98.4)	1528 (98.4)	0.92	12,347 (98.0)	7727 (98.9)	< 0.001
Back pain	13,589 (72.1)	1255 (80.8)	< 0.001	9214 (73.2)	5630 (72.0)	0.08
Chronic pain	4256 (22.6)	590 (38.0)	< 0.001	2580 (20.5)	2266 (29.0)	< 0.001
Neck pain	2656 (14.1)	256 (16.5)	0.009	1744 (13.8)	1168 (14.9)	0.03
Psychogenic pain	264 (1.4)	20 (1.3)	0.72	170 (1.3)	114 (1.5)	0.52
Sprain or strain	6328 (33.6)	452 (29.1)	< 0.001	4006 (31.8)	2774 (35.5)	< 0.001
Fibromyalgia	13,434 (71.2)	1183 (76.2)	< 0.001	8906 (70.7)	5711 (73.1)	< 0.001
Other pain type	6930 (36.8)	606 (39.0)	0.07	4462 (35.4)	3074 (39.3)	< 0.001
Utilization during follow-up						
Any use of mental health services	576 (3.1)	92 (5.9)	< 0.001	428 (3.4)	240 (3.1)	0.20
Any use of physical therapy	6599 (35.0)	516 (33.2)	0.16	3858 (30.6)	3257 (41.7)	< 0.001
No. pharmacists	1.1 (0.4)	1.5 (0.8)	< 0.001	1.1 (0.4)	1.2 (0.5)	< 0.001
No. prescribers	1.4 (0.7)	2.3 (1.5)	< 0.001	1.3 (0.6)	1.7 (1.0)	< 0.001
Early use of physical therapy	2924 (15.5)	215 (13.8)	0.08	1738 (13.8)	1401 (17.9)	< 0.001
Early use of mental health services	269 (1.4)	48 (3.1)	< 0.001	204 (1.6)	113 (1.4)	0.33
Early opioid prescription	7544 (40.0)	1021 (65.7)	< 0.001	4908 (39.0)	3657 (46.8)	< 0.001

(*Continued*)

TABLE 2. Characteristics of Medicare Beneficiaries With a New Episode of Persistent Musculoskeletal Pain and Opioid Prescription During 1-Year Follow-up by High-risk Opioid Prescription Patterns (*continued*)

	LTOU			HDD		
	No Long-Term Opioid Use (N = 18,856), Mean (SD)/N (%)	Long-Term Opioid Use (N = 1553), Mean (SD)/N (%)	*P*	No High Daily Dose (N = 12,938), Mean (SD)/N (%)	HDD (N = 7816), Mean (SD)/N (%)	*P*
Early use of occupational therapy	860 (4.6)	104 (6.7)	< 0.001	530 (4.2)	434 (5.6)	< 0.001
Early use of chiropractic services	1081 (5.7)	77 (5.0)	0.20	759 (6.0)	399 (5.1)	0.006
County characteristics						
Mental health providers*	3.0 (1.4–5.5)	2.7 (1.2–4.9)	< 0.001	3.1 (1.4–5.5)	2.8 (1.3–5.1)	< 0.001
Physical therapists*	5.7 (3.9–7.5)	5.3 (3.5–7.3)	< 0.001	5.7 (3.8–7.4)	5.7 (3.9–7.6)	0.03
Primary care providers*	6.6 (4.9–8.6)	6.4 (4.7–8.4)	0.001	6.6 (4.9–8.6)	6.6 (4.8–8.5)	0.03
Surgeons*	5.5 (3.3–7.9)	5.2 (3.1–7.7)	< 0.001	5.5 (3.3–7.9)	5.4 (3.3–7.9)	0.95
Pain specialist*	0.2 (0.1–0.4)	0.2 (0.0–0.4)	< 0.001	0.2 (0.1–0.4)	0.2 (0.1–0.4)	< 0.001
Pharmacists*	8.8 (7.2–11.1)	8.5 (6.8–10.9)	< 0.001	8.7 (7.1–11.0)	8.9 (7.2–11.2)	< 0.001
Midlevel providers*	4.8 (3.2–7.1)	4.6 (3.2–6.9)	0.047	4.7 (3.2–7.1)	4.8 (3.2–7.0)	0.31
Occupational medicine provider supply*	0.0 (0.0–0.1)	0.0 (0.0–0.1)	0.12	0.0 (0.0–0.1)	0.0 (0.0–0.1)	0.80
Chiropractors supply*	2.3 (1.6–3.3)	2.2 (1.5–3.1)	< 0.001	2.3 (1.5–3.3)	2.3 (1.5–3.3)	0.31
Proportion of population over 65	0.1 (0.1–0.2)	0.1 (0.1–0.2)	0.89	0.1 (0.1–0.2)	0.1 (0.1–0.2)	0.18
Proportion of population in poverty	0.1 (0.1–0.2)	0.1 (0.1–0.2)	< 0.001	0.1 (0.1–0.2)	0.1 (0.1–0.2)	< 0.001

Average daily dose: total MME/total days' supply accounting censoring.
*Per 10,000 people.
HDD indicates high daily dose; LTOU, long term opioid use; MME, milligram morphine equivalent.

(eg, undertreated pain) or safer care (eg, nonpharmacologic treatments), but clinical guidelines support policies that increase the uptake of nonpharmacologic services.[4–6] Educating patients and providers about the benefits of nonpharmacologic treatments may increase service utilization. Integrating MH and PT providers in primary care settings may provide organizational and practice-level support for PCPs who care for patients with persistent pain.[51–53] With greater demand for services and predicted provider shortages, policies that strengthen the nonpharmacologic provider workforce, such as increasing the number of training programs, telemedicine, and financial incentives, may be needed.[54,55]

Opioids may treat pain from surgery or trauma, and patients undergoing major surgery and an opioid dose ≥ 100 MME were more likely to have LTOU.[56] Interestingly, even after controlling for surgery or trauma, we found significant but differing associations between early nonpharmacologic service use and high-risk opioid use which suggests that nonpharmacologic services may have a broader role for persistent MSP management. Short-term opioid use, often indicated for surgery and trauma patients, can lead to LTOU in some individuals.[5,57] Future research should explore how use of nonpharmacologic services alters opioid use for surgery and trauma patients.

Our study has several limitations. As an observational study, associations are not causal. Unobserved variables (eg, pain severity, function, utilization of other medical services, supply of substance use providers, use of nursing home care or long-term services, and county opioid prescribing rates) may bias the results. Although state fixed effects account for some unobserved differences by state, the associations for the supply variables may be biased to the null because variation in the outcomes may be small in states with few beneficiaries. Our findings should be interpreted with caution because few beneficiaries used MH services. We lack data on whether prescribed opioids were taken as indicated. Administrative claims data only include services that were paid for by Medicare, which may exclude data on some pain treatments (eg, over the counter medications, yoga, and massage). When this study was conducted, claims with substance use disorder diagnoses were redacted,[58] which could affect the estimates for MH use if those claims had substance use diagnoses. Measurement error in the measure for the nonpharmacologic provider supply may bias MH and PT supply estimates toward the null. Findings may not generalize to younger adults and adults with surgery or trauma.

CONCLUSIONS

Our findings shed light on the role of select nonpharmacologic services and high-risk opioid use for older adults with persistent pain. Although there may be some benefits of early nonpharmacologic service use on opioid use, future research should examine optimal timing and dosing of nonpharmacologic services for patients with persistent MSP, and account for pain severity, function, and psychosocial characteristics. Future research should also better understand the interaction between contextual and individual characteristics at work in the complex system around pain management.

TABLE 3. Association Between the Supply of Nonpharmacologic Providers, Early Use of Nonpharmacologic Services and Opioid Prescribing Patterns Among Medicare Beneficiaries With Persistent Musculoskeletal Pain Using a Multinomial Model

	No Opioid Prescription During 1 y Follow-up		LTOU		HDD		LTOU and HDD	
	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI
Mental health provider supply†	1.01	1.00–1.02	0.97	0.93–1.01	1.00	0.98–1.01	0.98	0.94–1.02
Physical therapist supply†	1.00	0.99–1.02	1.06	1.01–1.11*	1.02	1.00–1.04**	0.99	0.94–1.05
Early use of mental health	1.24	1.04–1.48*	1.93	1.28–2.90***	0.89	0.69–1.16	1.14	0.67–1.93
Early use of physical therapy	0.67	0.63–0.72***	0.99	0.79–1.23	1.33	1.22–1.45***	1.21	0.97–1.52**
Metropolitan county	1.02	0.95–1.10	0.89	0.71–1.12	0.99	0.90–1.10	1.11	0.86–1.43
Age (categories) (y)								
70–74	1.03	0.97–1.09	0.87	0.70–1.07	0.95	0.87–1.03	0.84	0.68–1.06
75–79	1.12	1.05–1.20***	1.10	0.89–1.36	0.82	0.75–0.90***	0.88	0.69–1.11
80–84	1.25	1.17–1.34***	1.23	0.98–1.55**	0.76	0.68–0.84***	0.72	0.55–0.94*
≥85	1.34	1.24–1.44***	1.29	1.03–1.62*	0.64	0.58–0.72***	0.87	0.68–1.13
66–69	Reference		Reference		Reference		Reference	
Sex								
Female	0.97	0.93–1.01	1.09	0.93–1.27	0.95	0.90–1.02	0.89	0.75–1.05
Male	Reference		Reference		Reference		Reference	
Race								
Unknown	0.89	0.62–1.27	0.57	0.14–2.38	0.67	0.37–1.24	0.46	0.06–3.40
Black	0.91	0.83–0.99*	1.17	0.91–1.50	0.82	0.72–0.93***	0.86	0.62–1.18
Other	1.02	0.93–1.11	0.85	0.65–1.12	0.68	0.59–0.79***	0.81	0.57–1.13
White	Reference		Reference		Reference		Reference	
Medicaid dual eligible	0.85	0.81–0.90***	2.01	1.70–2.37***	0.72	0.66–0.79***	1.40	1.15–1.70***
Charlson score	0.98	0.96–0.99***	1.00	0.95–1.05	0.98	0.95–1.00*	1.03	0.98–1.08
Depression	1.03	0.94–1.13	1.28	0.99–1.67**	0.99	0.87–1.13	1.05	0.76–1.43
Anxiety	0.94	0.81–1.09	1.32	0.89–1.97	0.90	0.72–1.12	1.26	0.76–2.09
Early use of occupational therapy	0.73	0.65–0.83***	1.25	0.92–1.70	1.15	0.99–1.33**	1.17	0.85–1.62
Early use of chiropractor visit	1.38	1.26–1.51***	0.73	0.51–1.05**	0.74	0.65–0.85***	1.12	0.81–1.57
Trauma	0.70	0.64–0.76***	0.85	0.66–1.11	1.26	1.13–1.40***	1.39	1.10–1.76***
Surgery	0.57	0.54–0.60***	1.31	1.13–1.52***	1.30	1.21–1.38***	2.54	2.15–3.01***
Censor reason								
Complete follow-up	1.19	0.90–1.57	1.73	0.67–4.45	0.63	0.44–0.90*	0.30	0.16–0.56***
Less than 365 d of follow-up	1.10	0.88–1.39	1.83	0.82–4.07	0.77	0.57–1.04**	0.78	0.47–1.30
Died	Reference		Reference		Reference		Reference	
Total days follow-up	1.00	1.00–1.00	1.00	1.00–1.00	1.00	1.00–1.00	1.00	1.00–1.00
Arthritis	1.09	0.93–1.27	1.23	0.70–2.17	1.57	1.20–2.04***	0.96	0.50–1.84
Back pain	0.66	0.63–0.70***	1.48	1.23–1.77***	0.80	0.75–0.86***	1.53	1.23–1.90***
Chronic pain	0.66	0.62–0.69***	1.83	1.57–2.14***	1.43	1.33–1.54***	2.88	2.44–3.39***
Neck pain	0.93	0.87–0.99*	0.95	0.78–1.17	0.98	0.90–1.07	1.20	0.98–1.47**
Psychogenic pain	1.02	0.85–1.22	0.72	0.37–1.37	1.03	0.80–1.33	0.86	0.45–1.65
Sprain or strain	0.82	0.79–0.86***	0.84	0.72–0.99*	1.07	1.01–1.15*	0.86	0.72–1.03**
Fibromyalgia	0.98	0.93–1.03	1.01	0.86–1.20	0.97	0.90–1.04	1.27	1.04–1.56*
Other	0.83	0.79–0.87***	0.82	0.71–0.96*	1.07	1.00–1.14**	0.96	0.81–1.14
Part D low-income subsidy	1.13	0.89–1.43	1.24	0.69–2.23	0.90	0.61–1.32	1.14	0.55–2.36
Primary care providers supply†	1.00	0.99–1.02	1.00	0.95–1.05	0.99	0.97–1.01	1.00	0.95–1.06
Surgeons supply†	1.01	1.00–1.02	1.02	0.98–1.07	1.02	1.00–1.04**	1.02	0.97–1.07
Pain specialists supply†	0.93	0.82–1.06	0.60	0.36–1.00*	0.81	0.67–0.98*	0.80	0.47–1.36
Pharmacists supply†	1.01	1.00–1.02***	0.98	0.95–1.01	1.01	0.99–1.02	1.00	0.97–1.03
Midlevel providers supply†	0.99	0.98–1.00*	1.00	0.97–1.04	1.00	0.99–1.02	1.01	0.97–1.04
Occupational medicine provider supply†	1.09	0.72–1.65	0.25	0.05–1.18**	1.01	0.56–1.81	5.51	1.72–17.67***
Chiropractors supply†	1.00	0.98–1.02	0.98	0.92–1.05	0.99	0.96–1.01	0.97	0.90–1.05
Proportion of population over 65	1.29	0.64–2.62	3.48	0.34–36.07	2.09	0.79–5.54	1.10	0.09–14.17
Proportion of population in poverty	1.48	0.80–2.74	2.00	0.29–13.57	0.32	0.13–0.79*	1.77	0.19–16.76

For all columns, the reference group is a low-risk opioid prescription pattern during follow-up.
Adjusted for state and time fixed effects.
†Per 10,000 people.
aOR indicates adjusted odds ratio; CI, confidence interval; HDD, high daily dose; LTOU, long term opioid use.
*$P < 0.05$.
**$P < 0.1$.
***$P < 0.01$.

TABLE 4. Association Between the Supply of Nonpharmacologic Providers, Early Use of Nonpharmacologic Services and High-risk Prescriptions Among Beneficiaries With At Least 1 Opioid Prescription During the Year of a Persistent Pain Episode

	LTOU		HDD	
	aOR	95% CI	aOR	95% CI
Mental health providers per 10k people	0.97	0.94–1.00*	1.00	0.98–1.02
Physical therapists per 10k people	1.03	1.00–1.07**	1.02	1.00–1.04**
Early use of mental health services	1.76	1.24–2.51***	0.85	0.66–1.10
Early use of physical therapy	0.75	0.64–0.89***	1.25	1.15–1.36***
Metropolitan county	0.97	0.82–1.14	0.95	0.85–1.05
Age category (y)				
70–74	0.92	0.78–1.08	0.95	0.88–1.03
75–79	1.16	0.98–1.38**	0.83	0.76–0.91***
80–84	1.32	1.10–1.59***	0.77	0.69–0.85***
≥85	1.64	1.37–1.98***	0.70	0.63–0.78***
66–69	Reference		Reference	
Female	0.99	0.87–1.12	0.93	0.87–0.99*
Race				
Black	1.03	0.83–1.28	0.79	0.69–0.90***
Other	0.95	0.75–1.19	0.70	0.61–0.81***
Unknown	0.58	0.16–2.07	0.66	0.35–1.25
White	Reference		Reference	
Medicaid buy-in	1.83	1.60–2.10***	0.67	0.62–0.73***
Deyo-Charlson comorbidity score	1.02	0.98–1.06	0.98	0.96–1.00*
Depression	1.29	1.04–1.61*	0.97	0.85–1.11
Anxiety	1.41	1.00–1.98**	0.92	0.74–1.15
Early opioid prescription	2.13	1.89–2.40***	1.09	1.03–1.17***
Early occupational therapy	1.00	0.79–1.28	1.10	0.95–1.27
Early chiropractor visit	0.92	0.70–1.20	0.75	0.65–0.85***
Trauma after index date	0.80	0.66–0.97*	1.20	1.08–1.33***
Surgery after index date	1.19	1.06–1.35***	1.17	1.10–1.25***
No. pharmacies	1.80	1.63–1.99***	1.15	1.06–1.25***
No. prescribers	1.85	1.75–1.96***	1.89	1.80–1.98***
Censor				
1 y follow-up	0.72	0.49–1.04**	0.74	0.59–0.94*
Died	0.99	0.62–1.59	1.54	1.15–2.07***
Left FFS or Part D	Reference		Reference	
Total days	1.00	1.00–1.00	1.00	1.00–1.00
Arthritis	1.03	0.66–1.64	1.53	1.17–1.99***
Back pain	1.46	1.26–1.69***	0.77	0.72–0.83***
Chronic pain	1.57	1.39–1.77***	1.33	1.23–1.42***
Neck pain	1.04	0.89–1.22	0.98	0.89–1.07
Psychogenic pain	0.76	0.46–1.25	1.02	0.79–1.32
Sprain or strain	0.76	0.67–0.86***	1.07	1.00–1.14*
Fibromyalgia	1.04	0.91–1.19	0.96	0.89–1.03
Other pain type	0.81	0.72–0.91***	1.05	0.98–1.12
Part D low-income subsidy in any month in the 6 mo before index date	1.53	0.93–2.51**	1.02	0.70–1.46
Primary care providers per 10k people	1.00	0.97–1.04	0.98	0.96–1.00*
Surgeons per 10k people	1.02	0.99–1.05	1.03	1.01–1.05*
Pain specialist per 10k people	0.75	0.53–1.06	0.78	0.64–0.95*
Pharmacists per 10k people	0.98	0.96–1.00**	1.01	0.99–1.02
Midlevel providers per 10k people	0.99	0.97–1.01	1.00	0.99–1.02
Occupational therapists per 10k people	1.22	0.43–3.45	1.27	0.71–2.30
Chiropractors per 10k people	1.00	0.95–1.04	0.98	0.95–1.01
Proportion of population over 65	1.09	0.24–4.96	1.73	0.65–4.59
Proportion of population in poverty	4.05	0.97–16.95**	0.27	0.11–0.68***

The LTOU model used an exchangeable correlation and included time fixed effects. State fixed effects were omitted from the LTOU model due to unstable estimates.
The HDD model used unstructured correlation and included time and state fixed effects.
Each column contains estimates from a separate model.
Reference group for long-term prescription: no long-term use.
Reference group for HDD: daily dose <50 MME.
†Per 10,000 people.
aOR indicates adjusted odds ratio; CI, confidence interval; HDD, high daily dose; LTOU, long term opioid use; MME, milligram morphine equivalent.
*$P < 0.1$.
**$P < 0.05$.
***$P < 0.01$.

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