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Price elasticity of demand for buprenorphine/naloxone prescriptions☆

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A B S T R A C T

Although there have been supply-side efforts in response to the opioid crisis (e.g., prescription drug monitoring programs), little information exists on demand-side approaches related to patient cost sharing that may affect utilization of and adherence to pharmacotherapy by individuals with opioid use disorder. Among individuals who had initiated pharmacotherapy, we estimated the price elasticity of demand of prescription fills of buprenorphine/naloxone, a common pharmacotherapy drug, overall and by patient characteristics. Using the IBM MarketScan® Commercial Claims and Encounters Database for individuals with employer-sponsored private health insurance coverage, we examined the relationship between cost sharing and the number of buprenorphine/naloxone prescription fills using enrollee-level longitudinal fixed effects models. Cost sharing was expressed as a price index for each employer-plan. By including enrollee-level fixed effects, the identification of the effect of interest comes from longitudinal variation in prices across multiple time points for each enrollee. Overall, the demand for buprenorphine/naloxone was price inelastic ($p = 0.191$). However, some subgroups were responsive to price. A doubling of price was associated with a decrease in fills by 3.0% for enrollees aged 45–64 years ($p = 0.029$); 5.7% for those in rural areas ($p = 0.033$); 5.8% for residents of the South ($p \leq 0.001$); and 3.0% for those enrolled in an HMO ($p = 0.004$). Insurers should consider the effects on these groups before increasing beneficiary out-of-pocket costs for pharmacotherapy and efforts to increase adherence should consider that price may be a barrier for some subgroups with OUD.

1. Introduction

Opioid dependence has risen to crisis proportions in the United States. In 2017, over 2 million Americans abused or were dependent on prescription opioids or heroin (Substance Abuse and Mental Health Services Administration, 2017). As the incidence and prevalence of opioid use disorders (OUD) have grown, so has the use of pharmacotherapy (Alderks, 2013). Medication-assisted treatment refers to the use of Food and Drug Administration (FDA)-approved prescription drugs, in conjunction with psychosocial services and supports, for the treatment of addiction. Prescription drugs commonly used in pharmacotherapy include buprenorphine/naloxone and methadone (Schuckit, 2016). Like other chronic diseases, treatment of OUD over the course of many months and even years may be necessary (American Society of Addiction Medicine, 2015; Buchberger, 2017) and recent research suggests long-term maintenance therapy is more effective at decreasing risk of relapse than short-term stabilization, after which doses of buprenorphine/naloxone are tapered and eventually stopped (Fiellin, Schottenfeld, & Cutter, 2014; Woody et al., 2008).

Unfortunately, there are barriers to accessing treatment. The supply of certified physicians who can dispense pharmacotherapy drugs is insufficient (Volkow, Frieden, Hyde, & Cha, 2014). Historically, the restriction of methadone to specialized outpatient clinics contributed toward a need for a long-acting oral pharmacotherapy that could be prescribed in office-based settings (Schuckit, 2016). In 2002, Congress approved the prescription of buprenorphine/naloxone in office-based practices by qualified physicians who receive special approval. Originally the number of patients to which a doctor could prescribe this medication was capped at 30, but that number increased to 100 patients in January 2007 and increased again to 275 patients in July 2016 (Leinwand-Leger, 2015; Schuckit, 2016). Between 2003 and 2013, the number of ambulatory visits involving buprenorphine/naloxone prescriptions climbed from 0.16 to 2.1 million visits among a nationally representative sample of office-based physicians (Turner, Kruszewski, &

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Alexander, 2015). Still, there are only enough authorized physicians to treat an estimated 49% of opioid dependent individuals, and that number may be even lower in certain areas of the country (Jones, Campopiano, Baldwin, & McCance-Katz, 2015; Vestal, 2016). Even among physicians licensed to prescribe treatment, many never do so (Vestal, 2016).

Although there have been supply-side efforts to address the opioid crisis, including prescription drug monitoring programs (PDMPs), pill mill laws, OxyContin reformulation, hydrocodone rescheduling, and naloxone access laws and programs (Ali, Dowd, Classen, Mutter, & Scott, 2017), little information exists on demand-side reforms—such as those related to the out-of-pocket price of pharmacotherapy—that may influence patient utilization and adherence. Buprenorphinenaloxone is often placed in the highest cost sharing tiers by health insurance plans or excluded from coverage completely (Horgan, Reif, Hodgkin, Garnick, & Merrick, 2008; Peters & Wengle, 2016).

To our knowledge, the relationship between price and use of pharmacotherapy has yet to be examined. In this study, among a group of individuals with employer-sponsored insurance coverage who initiated buprenorphine/naloxone treatment, we estimate the price elasticity of demand of buprenorphine/naloxone prescription fills overall and by patient characteristics to identify populations that may be more or less sensitive to price. These patient characteristics included age, which has been associated with adherence to treatment (Morgan, Schackman, Leff, Linas, & Walley, 2017; Weinstein et al., 2017); location, because patterns of opioid use vary widely across the United States (Weiss et al., 2017); and plan type, because we hypothesize the baseline price of buprenorphine/naloxone and changes in price over time may vary by type of coverage.

2. Methods

2.1. Study population

We examined the IBM MarketScan® Commercial Claims and Encounters Database, which contains the healthcare experience of millions of individuals employed by over 100 medium and large-sized firms and their dependents in the United States. We excluded plans for which enrollees were required to pay toward a deductible on prescription drug claims. We limited the study population to enrollees aged 12–64 years with prescription drug coverage with no evidence of cancer or palliative care. Our rolling panel design included an observation for the enrollee in the quarter if the employer contributed to the data set during the past year and for the next six months. From Q1 2011 through Q2 2015, employees contributed at least 1 and up to 18 quarters of data. On average, enrollees contributed 7 quarters of data.

We used a patient cohort approach that included only patients who filled a buprenorphine/naloxone outpatient prescription, either as a sublingual tablet or sublingual or buccal film. Between Q1 2011 and Q2 2015, we selected the quarter in which the enrollee first filled a prescription for buprenorphine/naloxone and tracked buprenorphine/naloxone fills and fills for other non-pharmacotherapy opioids in every quarter thereafter (see Appendix A for a list of non-pharmacotherapy medications). We used data from Q4 2010 to weight our price index (described below).

We focus on buprenorphine/naloxone as opposed to other prescription pharmacotherapy drugs because it is indicated for the treatment of OUD and generally does not involve off-label use. Buprenorphine hydrochloride for instance, although indicated for the treatment of OUD, may be prescribed for pain management (Heit & Douglas, 2008). Naltrexone is indicated for the treatment of both OUD and alcohol dependence. Additionally, prescriptions for buprenorphine/naloxone are far more common than those for other forms of buprenorphine and naltrexone (Morgan et al., 2017), increasing the stability of our price elasticity estimates.

2.2. Primary dependent variable

The primary dependent variable of interest was a continuous measure of the number of fills in the quarter, which was based on the 'days supplied' field on each paid claim. Consistent with past research and because fills with a supply of 30 days or less typically are charged one copayment regardless of the days supplied (Gatwood et al., 2014), fills with less than a 30-day supply were considered one fill; fills with greater than a 30-day supply were standardized to 30 days. Since this outcome represents the quantity of items purchased, our results reflect the price elasticity of demand.

2.3. Primary independent variable

Cost sharing was the primary explanatory variable. Ideally, health plans' formularies determining copayments and coinsurance of buprenorphine/naloxone would be used to measure cost sharing. This plan-level measure reduces selection bias related to consumer choices that may affect an enrollee's actual, individual level of cost sharing (i.e., the out-of-pocket price paid by each individual) (Gatwood et al., 2014). Instead, because MarketScan does not contain information on plan design by medication, to approximate the plan formulary, we created a price index for each employer-plan per quarter, weighted for utilization of brand and generic medication in the past quarter. Past research suggests such indices are highly correlated (exceeding 0.95) with formularies extracted from plan booklets (Chernew et al., 2008). First, we summed the generic and brand cost-sharing amounts (copayment plus coinsurance) across enrollees in the plan and divided those values by the sum of generic and brand prescription fills (standardized) to obtain the mean cost per fill. Next, we calculated generic and brand weights, which equaled the percentage of buprenorphine/naloxone fills that were generic or brand across all employer-plans in the past quarter. We used data from the past quarter to ensure the weights were unrelated to our outcome (fills). The sum of the weighted mean cost per generic and brand fill equaled the price index of buprenorphine/naloxone.

2.4. Descriptive analysis

In our descriptive analysis, first we examined characteristics of the study population. We created an approximate measure of the proportion of time the cohort was covered by buprenorphine/naloxone fills. This measure, examined overall and within patient subgroups, was expressed as the number of 30-day buprenorphine/naloxone fills out of total eligible person-months, where one quarter equaled three months. We also calculated the number of 30-day fills for non-pharmacotherapy long- and short-acting opioids out of total person-months, which may suggest relapse. Second, we examined trends in filling behavior, price, and generic use and changes in the distribution in price over time across employer-plans.

2.5. Regression analysis

We employed longitudinal Poisson regression models with fixed effects to examine the relationship between the price index and fills, where individuals were the cross-sectional unit and calendar quarters were the unit of time. The model included fixed effects for the individual enrollee, which control for time invariant characteristics associated with the enrollee. By including enrollee-level fixed effects, we identified the effect of interest from the longitudinal variation in the price imposed on each enrollee across multiple time points. We also included fixed effects for calendar quarter, which control for time-variant characteristics that might affect cost sharing over time equally across enrollees. The models included the natural log of the price index, the parameter estimate (coefficient) for which can be interpreted as the percentage change in fills that is associated with a 1% change in price, which is the definition of price elasticity.

We also included the following time variant covariates in the models: region, rural location, income quartile of the location of the patient's residence, plan type, the Charlson Comorbidity Index measured each quarter from diagnostic information in the medical claims (Deyo, Cherkin, & Ciol, 1992), and the price index of other non-pharmacotherapy opioid prescription fills that may affect adherence to buprenorphine/naloxone treatment or discontinuation of pharmacotherapy and use of a non-pharmacotherapy opioid. The price index of non-pharmacotherapy opioids was calculated separately for long- and short-acting medications using the same methods as described above for the price index of buprenorphine/naloxone.

Our models included robust standard errors clustered by enrollee. We did not cluster standard errors by plan, the unit for which the price index was calculated. As a sensitivity analysis, we re-estimated our models using fixed effects based on an identifier for the enrollee-plan and clustering standard errors at this level. This approach limits the identification of the effect of interest to variation in price within enrollees who had the same plan over time, and clusters standard errors by plan (Abowd, Kramarz, & Margolis, 1999; Andrews, Schank, & Upward, 2006). These findings were generally similar to those discussed below (see Appendix A).

3. Results

Our analysis includes 25,901 enrollees who filled a buprenorphine/naloxone prescription from 2011 through Q2 2015 (Table 1). The largest proportion of the study population was 25–44 years of age (44.4%), male (64.8%), located in an urban area (87.8%), resided in the South (37.1%), and had moderate to high incomes (33.4% lived in a ZIP Code where the median household income ranked in the third quartile based on the national distribution). The majority of individuals were enrolled in an HMO (56.2%).

Overall, across all enrollees, the proportion of total person-months the enrollees contributed to the cohort that was covered by 30-day buprenorphine/naloxone fills was 72.5% (Table 1). At the same time, 30-day fills of non-pharmacotherapy opioids constituted 21.3% of total person-months. These distributions varied by patient characteristics. For instance, compared with other subgroups, 30-day buprenorphine/naloxone fills constituted a greater proportion of person-months for enrollees who were 25–44 years of age (81.6%), males (73.6%), located in rural areas (78.7%), resided in the Northeast (80.3%), from lower-income areas (79.8%, quartile 1), enrolled in an HMO or POS (73%), and who had no comorbidities on the Charlson Comorbidity Index (73.1%). Compared with other subgroups, 30-day fills of non-pharmacotherapy opioids constituted a greater proportion of time in the cohort for enrollees who were older (45–64 years; 34.3%), female (29.5%), located in a region other than the Northeast (23% or greater), resided in the wealthiest areas (24.0%), the employees' spouses (34.2%), and reached almost half among those with two or more comorbidities (49.1%).

On average across employer-plans (Fig. 1), the price index increased from Q1 2011 through Q1 2013, from $43.12 to $47.62 per fill. The price decreased after that until Q2 2014, after which it remained approximately stable at around $32. Meanwhile, the average number of

Table 1
Baseline characteristics of enrollees who filled a buprenorphine/naloxone prescription and filling behavior over the study period.
Data Source: IBM Market Scan® Commercial Claims and Encounters Database, Q1 2011–Q2 2015.

Characteristic	Total		Number of person-months in cohort	30-day fills of buprenorphine/naloxone		30-day fills of non-pharmacotherapy opioid	
	Number	Percent		Number	Proportion of person-months	Number	Proportion of person-months
Total	25,901	100.0%	564,942	409,503	72.5%	120,263	21.3%
Age, years							
12–17	250	1.0%	2184	1402	64.2%	166	7.6%
18–24	8027	31.0%	154,182	93,110	60.4%	11,651	7.6%
25–44	11,505	44.4%	240,075	195,990	81.6%	50,614	21.1%
45–64	6119	23.6%	168,501	119,002	70.6%	57,833	34.3%
Sex							
Male	16,778	64.8%	365,931	269,454	73.6%	61,592	16.8%
Female	9123	35.2%	199,011	140,049	70.4%	58,671	29.5%
Location							
Rural	3156	12.2%	65,028	51,148	78.7%	12,493	19.2%
Urban	22,745	87.8%	499,914	358,355	71.7%	107,770	21.6%
Region							
Northeast	6070	23.4%	128,259	103,010	80.3%	18,136	14.1%
North central	5888	22.7%	136,578	96,694	70.8%	31,160	22.8%
South	9607	37.1%	206,133	148,995	72.3%	47,495	23.0%
West	4268	16.5%	92,172	59,552	64.6%	22,998	25.0%
Community-level income quartile							
1 (poorest)	1667	6.4%	35,520	28,342	79.8%	6351	17.9%
2	8623	33.3%	185,400	142,834	77.0%	35,778	19.3%
3	8638	33.4%	186,222	133,323	71.6%	40,309	21.6%
4 (wealthiest)	6973	26.9%	157,800	105,004	66.5%	37,826	24.0%
Relationship to employee							
Self	10,934	42.2%	245,394	195,936	79.8%	52,917	21.6%
Spouse	6822	26.3%	160,203	118,889	74.2%	54,721	34.2%
Other	8145	31.5%	159,345	94,678	59.4%	12,625	7.9%
Plan type							
HMO	14,553	56.2%	314,982	229,907	73.0%	69,449	22.0%
PPO	4141	16.0%	90,591	65,651	72.5%	17,825	19.7%
POS	3237	12.5%	67,506	49,469	73.3%	13,656	20.2%
Other	3970	15.3%	91,863	64,477	70.2%	19,333	21.0%
Charlson Comorbidity Index							
0	24,051	92.9%	517,734	378,444	73.1%	100,471	19.4%
1	1553	6.0%	39,336	26,338	67.0%	15,924	40.5%
2+	297	1.2%	7872	4721	60.0%	3868	49.1%

Abbreviations: HMO, health maintenance organization; PPO, preferred provider organization; POS, point of service.

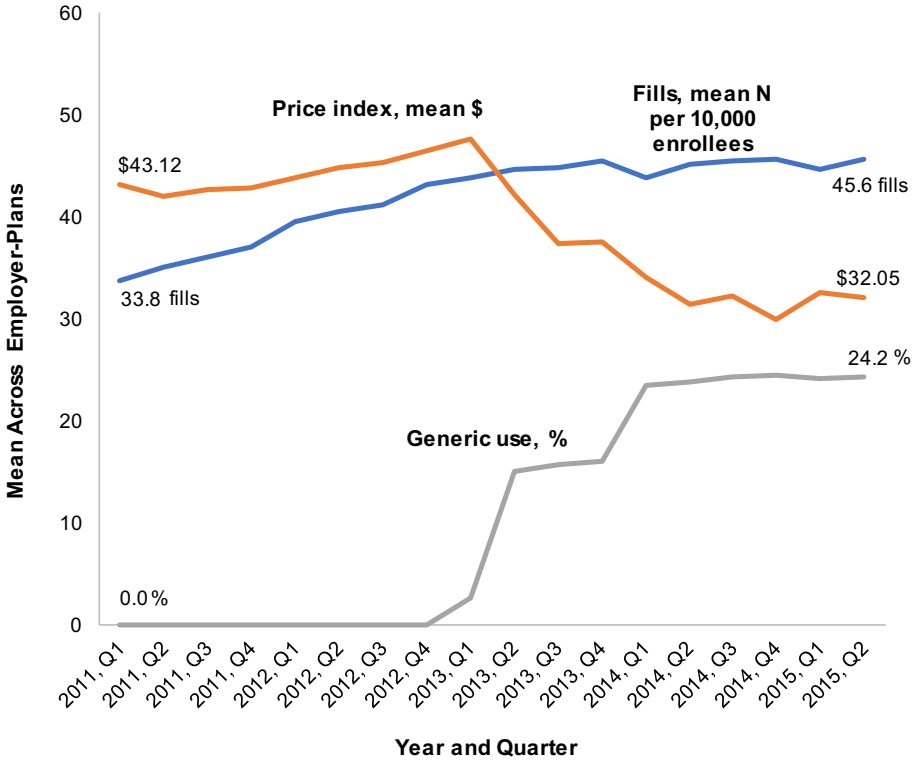

Fig. 1. Trends in price, filling behavior, and generic use of buprenorphine/naloxone prescriptions across employer-plans.
Data Source: IBM Market Scan® Commercial Claims and Encounters Database, Q1 2011–Q2 2015. The price index for Q1 2011 was weighted by generic and brand utilization patterns in Q4 2010.

fills per 10,000 enrollees increased from 33.8 to 45.6 from Q1 2011 to Q2 2015. By Q2 2015, 24.2% of fills were for generic medication. Although on average, the price of buprenorphine/naloxone was $32 in 2015, there was variation in the price across employer-plans (Fig. 2). In Q2 2015, the price was set at over $43.39 per fill for 25% of employer-plans. Excluding outliers, the price ranged from $0 to $83.11.

Overall, the demand of buprenorphine/naloxone was price inelastic (Fig. 3). A doubling of price was associated with a 1.0% decrease in fills ($p = 0.191$). However, some subgroups of enrollees were more responsive to price. A doubling of price was associated with a 3.0% decrease in fills for enrollees aged 45–64 years ($p = 0.029$); a 5.7% decrease in fills for those in rural areas ($p = 0.033$); a 5.8% decrease in fills for residents of the South ($p \leq 0.001$); and a 3.0% decrease in fills for those enrolled in an HMO ($p = 0.004$). Although the results were not statistically significant, a doubling of price was also associated with a 3.4% increase in fills for those enrolled in PPOs ($p = 0.058$) and 4.4% decrease in fills for individuals from the lowest income communities (quartile 1) ($p = 0.080$).

4. Discussion

Among this group of individuals with employer-sponsored private insurance coverage, we did not find evidence that the demand of buprenorphine/naloxone prescriptions was price elastic overall. We limited our sample to enrollees who filled a buprenorphine/naloxone prescription and followed them over time. The fact that they, as a whole, were not responsive to price may suggest that these individuals who already initiated treatment had already overcome barriers related to price. Our results are also suggestive of a high rate of relapse—on average, approximately one-fifth of the person-months that our sample contributed to the study period overlapped with fills of non-pharmacotherapy opioids, with higher rates in some subgroups.

That said, our results suggest that lowering the price of buprenorphine/naloxone could result in greater adherence to treatment for some subgroups—those aged 45–64 years, those who resided in rural areas, those from the South, those enrolled in HMOs, and those from lower income communities; although the latter did not reach statistical significance. These subgroups represent a considerable portion of our sample—60%, for instance, were enrolled in an HMO. Among these subgroups, a doubling of price was associated with a 3.0% to a 5.8% decrease in fills, magnitudes which are consistent with past research on the price elasticity of demand of other prescription medications (Gatwood et al., 2014). The fact that some subgroups were responsive to price and others were not also is consistent with other research, which has shown that some groups are more likely to discontinue treatment than other groups. For instance, Weinstein et al. (2017) found that older age was associated with greater odds of retention in office-based treatment with buprenorphine lasting one year or longer. Another recent study, among a sample of commercially insured individuals similar to our own study population, also found that older age was associated with continuing treatment 30 days after initiation (Morgan et al., 2017). Our study contributes to this literature by providing a potential reason why making pharmacotherapy cheaper to the patient could contribute to the retention of older adults in office-based treatment.

Our findings also suggest that socioeconomically disadvantaged individuals may be more likely to forgo OUD treatment due to price, resonating with literature showing people navigating other types of chronic disease often self-restrict medication due to lack of coverage (Steinman, Sands, & Covinsky, 2001). This is particularly troubling as individuals in poverty are more likely to be heroin users, thus the individuals being left out of treatment are those most in need (Martins et al., 2017).

In general, price elasticities are negative. However, we found that for individuals enrolled in PPOs an increase in the price of buprenorphine/naloxone was associated with an increase in fills. Over the study period, use of the brand name drug Suboxone became less common as generic forms of buprenorphine/naloxone became available. If brand

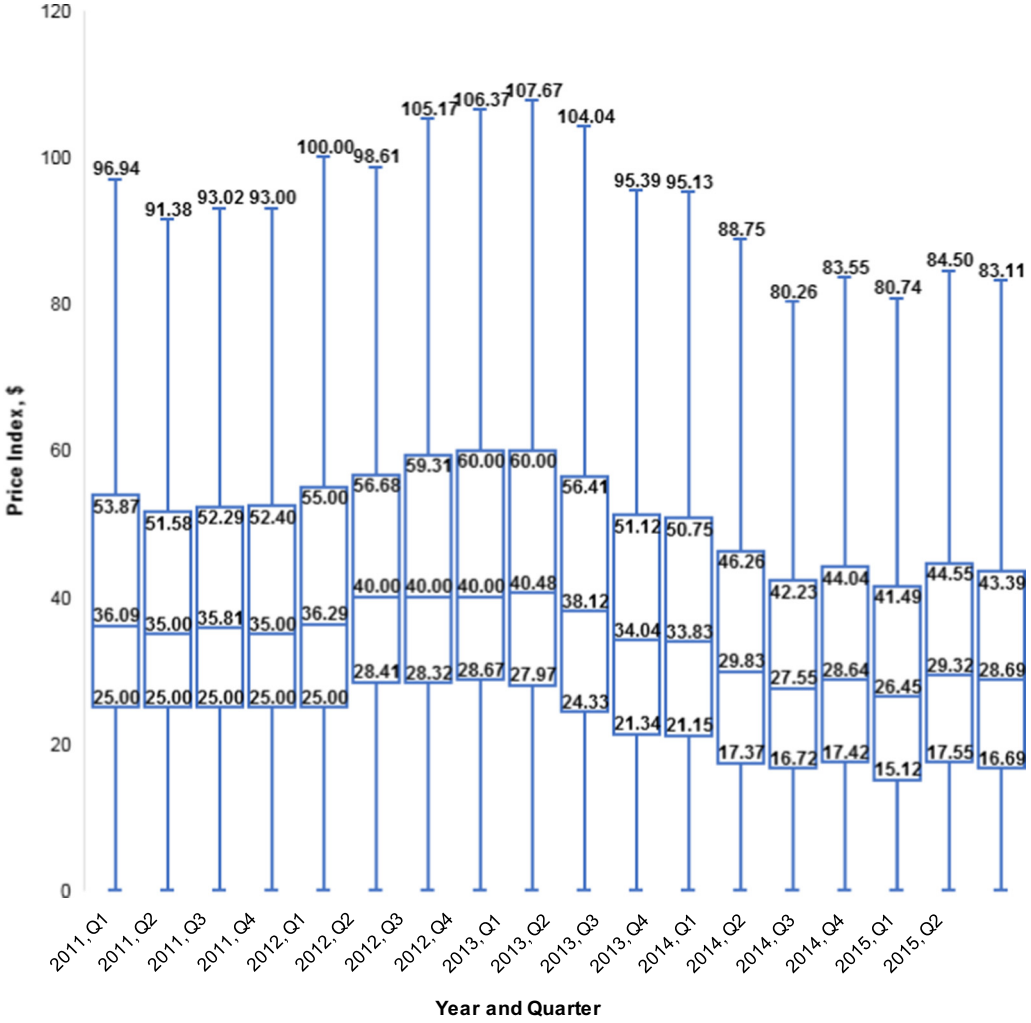

Fig. 2. Distribution of the price index of buprenorphine/naloxone prescriptions across employer-plans.
Notes: The bottom, middle, and top of the box represent the first quartile, median, and third quartile, respectively. The lower and upper whiskers represent the local minimum and local maximum, excluding outliers, and can be used to interpret the range of the data.
Data Source: IBM Market Scan® Commercial Claims and Encounters Database, Q1 2011–Q2 2015. The price index for Q1 2011 was weighted by generic and brand utilization patterns in Q4 2010.

name medication is important to certain populations, this may explain why as the price decreased for some insurance plans, the rate of treatment discontinuation increased. At the same time, the manufacturer of Suboxone introduced a film form of buprenorphine/naloxone, to which they will continue to hold the patent. This was viewed as an effort to encourage customers to switch to the film before the generic tablet was introduced to the market (O'Neil, 2013). Thus, if the film form improved adherence and continuation in treatment, for some plans the price and use of buprenorphine/naloxone may have increased, both of which may have been driven by an increase in the demand for buprenorphine/naloxone film.

Several other patterns in our descriptive data warrant comment. The percentage of person-months in our cohort that were covered by 30-day buprenorphine/naloxone fills was approximately 75%, and the percentage covered by non-pharmacotherapy opioids was approximately 20%. This suggests that some individuals in our sample are relapsing, as they stop treatment with buprenorphine/naloxone and start using other opioids. For certain subgroups—for instance, enrollees < 24 years of age—the sum of the percentage of time covered by buprenorphine/naloxone and that covered by non-pharmacotherapy opioids was < 100%. While this could suggest that individuals in these groups are stopping treatment and not using other prescription opioids, we are unable to determine all substances that individuals may substitute for buprenorphine/naloxone treatment, such as heroin, and are unable to determine if they are still using narcotics or maintaining sobriety. Our results also suggest the rate of relapse may be higher for some groups. Although on average approximately 20% of the person-time enrollees spent in our cohort overlapped with fills of non-pharmacotherapy opioids, this number approached 50% among individuals with two or more comorbidities.

This study has several limitations. Because we examined individuals who were already using buprenorphine/naloxone, we are only able to comment on the intensive margin and not the extensive margin associated with initiating treatment, which will be an important area of focus for future research given there are other barriers to starting treatment, such as finding an available physician (Volkow et al., 2014). Additionally, we excluded plans for which it appeared that enrollees were paying toward a deductible on prescription drug claims. This was necessary because our market basket approach for measuring cost sharing assumes a linear price structure, but it decreases the generalizability of our results. We also did not examine other pharmacotherapies, including office-based prescriptions for naltrexone and buprenorphine hydrochloride or buprenorphine or methadone administration in outpatient facilities. Nor did we examine the effect of out-of-

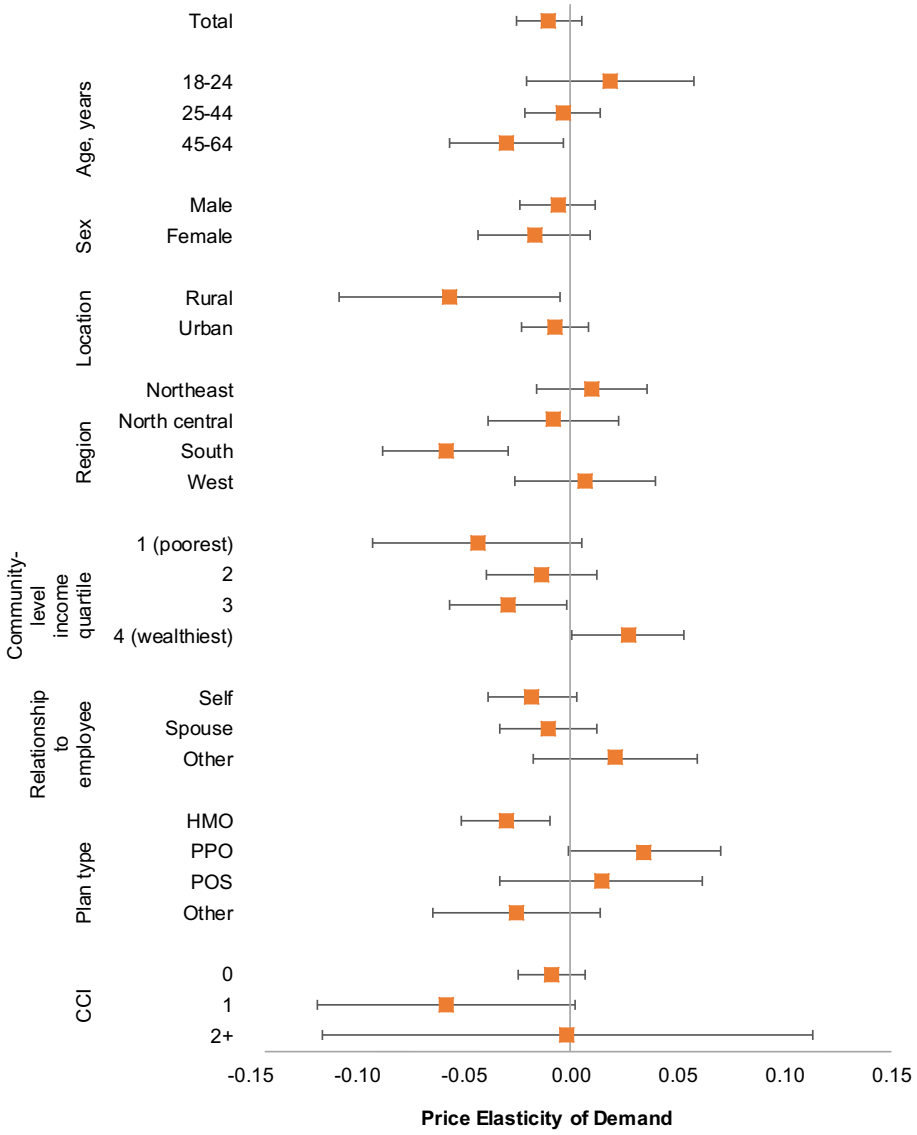

Fig. 3. Price elasticity of demand of buprenorphine/naloxone prescriptions.
Abbreviations: HMO, health maintenance organization; PPO, preferred provider organization; POS, point of service; CCI, Charlson Comorbidity Index.
Note: The estimate for enrollees individuals aged 12–17 years is not shown because of small sample size and wide confidence intervals. Models adjusted for region, rural location, income quartile of the location of the patient's residence, plan type, the CCI (unless stratified on that variable), and the price of non-pharmacotherapy opioids. Models included fixed effects for the enrollee and time (calendar quarter).
Data Source: IBM Market Scan® Commercial Claims and Encounters Database, Q1 2011–Q2 2015. The price index for Q1 2011 was weighted by generic and brand utilization patterns in Q4 2010.

pocket costs, or time costs, associated with office visits or social support services, which may be considerably more expensive than the cost of prescription medication (All About Suboxone, 2017) and which may not be covered by insurance (Parran et al., 2017), for which the physician may only accept cash. Our descriptive statistics show that the population included in this study has a higher average socioeconomic status than the population receiving treatment in specialty settings that receive public funding, potentially limiting the generalizability of our findings (Mutter, Ali, Smith, & Strashny, 2015). Although our research may not seem immediately generalizable to the Medicaid population where cost sharing has historically not been an issue, several states have begun piloting various approaches to cost sharing in the Medicaid population (Medicaid, 2019). Thus, our study may inform future research on coverage of pharmacotherapies for OUD among the Medicaid population (Kaiser Family Foundation, 2018).

In conclusion, our study is an important first step in research on substance treatment that assesses the role of price on the continued use of pharmacotherapy drugs. Our paper suggests that among individuals who have initiated treatment with buprenorphine, out-of-pocket costs, in general, are not a barrier to continuing to fill prescriptions. With that said, we did see evidence of greater sensitivity to price in certain subgroups, and we observed that a non-trivial percentage of the patients in our study who were filling prescriptions for pharmacotherapy drugs also filled prescriptions for non-pharmacotherapy opioids. Insurers, employers, and policymakers should consider the effects on these groups before increasing beneficiary out-of-pocket costs for pharmacotherapy drugs and efforts to increase adherence should consider that price may be a barrier.

Appendix A

Exclusion of plans with deductibles: We excluded plans for which it appeared that enrollees were paying toward a deductible on prescription drug claims. This was necessary because our market basket approach for measuring cost sharing assumes a linear price structure, but it decreases the generalizability of our results. For each plan, we obtained the percentage of enrollees that paid toward their deductible on prescription claims for any type of medication (not only opioids). We then excluded plans in a given year where $> 1\%$ of enrollees paid toward their deductible on a prescription drug claim in that year. We included plans with a very small percentage ($\leq 1\%$) of enrollees paying toward a deductible on a prescription drug claims because, after review, we found that many of these claims were most likely invalid data (e.g., invalid National Drug Codes [NDC]). The plans

included in our study with ≤1% of enrollees paying toward a deductible on prescription drug claims covered 68% of enrollees in MarketScan in 2011 and 54% in 2015.

Long-acting opioids included the following drugs listed as their generic name: acetaminophen/oxycodone hydrochloride sold under the brand name Xartemis XR, buprenorphine sold under the brand names Butrans and Belbuca, fentanyl in the form of the extended release patch, hydrocodone bitartrate, hydromorphone hydrochloride in the form of extended release capsules or tablets, levorphanol tartrate, methadone hydrochloride, morphine sulfate in the form of extended release capsules or tablets, morphine sulfate/naltrexone hydrochloride, oxycodone, oxycodone hydrochloride in the form of the extended release tablet, oxymorphone hydrochloride in the form of the extended release tablet, tapentadol hydrochloride in the form of the extended release tablet, and tramadol hydrochloride in the form of extended release capsules or tablets.

Short-acting opioids included the following drugs listed as their generic name, excluding those with specific brand names or forms that fell into the long-acting categories described above: A.P.C. w/codeine, acetaminophen/butalbital/codeine phosphate, acetaminophen/caffeine/dihydrocodeine bitartrate, acetaminophen/codeine phosphate, acetaminophen/hydrocodone bitartrate, acetaminophen/meperidine hydrochloride, acetaminophen/oxycodone hydrochloride, acetaminophen/pentazocine hydrochloride, acetaminophen/propoxyphene hydrochloride, acetaminophen/propoxyphene napsylate, acetaminophen/tramadol hydrochloride, apap/butabarbital na/codeine phos, apap/butalbital/caff/codeine phos, asa/oxycodone hcl/oxycodone terephthalate, aspirin (buffered)/codeine phosphate, aspirin/butalbital/caffeine/codeine phosphate, aspirin/caffeine/dihydrocodeine bitartrate, aspirin/caffeine/propoxyphene hydrochloride, aspirin/carisoprodol/codeine phosphate, aspirin/codeine phosphate, aspirin/hydrocodone bitartrate, aspirin/oxycodone hydrochloride, aspirin/pentazocine hydrochloride, belladonna alkaloids/opium alkaloids, butorphanol tartrate, codeine phosphate, codeine sulfate, dihydrocodeine/apap/caffeine, fentanyl, fentanyl citrate, hydrocodone bitartrate/ibuprofen, hydromorphone hydrochloride, ibuprofen/oxycodone hydrochloride, meperidine hydrochloride, morphine sulfate, naloxone hydrochloride/pentazocine hydrochloride, oxycodone hydrochloride, oxymorphone hydrochloride, propoxyphene hydrochloride, propoxyphene napsylate, tapentadol hydrochloride, tramadol hydrochloride.

Appendix T1

Regression results based on the same models as Fig. 3, but including a fixed effect for the enrollee-plan versus only the enrollee.
Data Source: Truven Health MarketScan® Commercial Claims and Encounters Database, Q1 2011–Q2 2015. The price index for Q1 2011 was weighted by generic and brand utilization patterns in Q4 2010.

Subgroup	Price elasticity of demand of buprenorphine/naloxone			
	Beta	Low CI	High CI	p-Value
Total	−0.0070	−0.0232	0.0092	0.3953
Age, years				
12–17	−0.1361	−0.4215	0.1493	0.3498
18–24	0.0200	−0.0238	0.0639	0.3708
25–44	−0.0060	−0.0254	0.0134	0.5455
45–64	−0.0246	−0.0510	0.0019	0.0685
Sex				
Male	0.0020	−0.0169	0.0208	0.8387
Female	−0.0229	−0.0523	0.0065	0.1267
Location				
Rural	−0.0431	−0.0949	0.0087	0.1031
Urban	−0.0059	−0.0228	0.0111	0.4978
Census region				
Northeast	0.0207	−0.0075	0.0490	0.1499
North central	0.0048	−0.0297	0.0393	0.7847
South	−0.0739	−0.1080	−0.0398	0.0000
West	0.0103	−0.0225	0.0431	0.5400
Median household income				
Quartile 1 (poorest)	−0.0454	−0.0964	0.0056	0.0812
Quartile 2	−0.0104	−0.0378	0.0170	0.4562
Quartile 3	−0.0283	−0.0587	0.0020	0.0676
Quartile 4 (wealthiest)	0.0289	0.0014	0.0565	0.0393
Relationship to employee				
Self	−0.0139	−0.0355	0.0076	0.2054
Spouse	−0.0164	−0.0406	0.0077	0.1827
Dependent/other/unknown	0.0287	−0.0149	0.0723	0.1975
Plan type				
HMO	−0.0315	−0.0535	−0.0095	0.0050
PPO	0.0386	0.0039	0.0732	0.0290
POS	0.0359	−0.0129	0.0848	0.1494
Other	−0.0252	−0.0670	0.0165	0.2366
Charlson Comorbidity Index				
0	−0.0058	−0.0231	0.0114	0.5090
1	−0.0545	−0.1159	0.0070	0.0823
2+	0.0272	−0.0811	0.1355	0.6222

Abbreviations: HMO, health maintenance organization; PPO, preferred provider organization; POS, point of service. Note: The estimate for enrollees individuals aged 12–17 years is not shown because of small sample size and wide confidence intervals. Models adjusted for region, rural location, income quartile of the location of the patient's residence, plan type, the Charlson Comorbidity Index (unless stratified on that variable), and the price of non-pharmacotherapy opioids. Models included fixed effects for the enrollee-plan and time (calendar quarter).

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