Effect of High-Deductible Insurance on Health Care Use in Bipolar Disorder

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ABSTRACT

OBJECTIVES: To determine the impact of high-deductible health plans (HDHPs) on health care use among individuals with bipolar disorder.

STUDY DESIGN: Interrupted time series with propensity score–matched control group design, using a national health insurer's claims data set with medical, pharmacy, and enrollment data.

METHODS: The intervention group was composed of 2862 members with bipolar disorder who were enrolled for 1 year in a low-deductible (≤$500) plan and then 1 year in an HDHP (≥$1000) after an employer-mandated switch. HDHP members were propensity score matched 1:3 to contemporaneous controls in low-deductible plans. The main outcomes included out-of-pocket spending per health care service, mental health–related outpatient visits (subclassified as visits to nonpsychiatrist mental health providers and to psychiatrists), emergency department (ED) visits, and hospitalizations.

RESULTS: Mean pre– to post–index date out-of-pocket spending per visit on all mental health office visits, nonpsychiatrist mental health provider visits, and psychiatrist visits increased by 21.9% (95% CI, 15.1%-28.6%), 33.8% (95% CI, 2.0%-65.5%), and 17.8% (95% CI, 12.2%-23.4%), respectively, among HDHP vs control members. The HDHP group experienced a –4.6% (95% CI, –11.7% to 2.5%) pre- to post change in mental health outpatient visits relative to controls, a –10.9% (95% CI, –20.6% to –1.3%) reduction in nonpsychiatrist mental health provider visits, and unchanged psychiatrist visits. ED visits and hospitalizations were also unchanged.

CONCLUSIONS: After a mandated switch to HDHPs, members with bipolar disorder experienced an 11% decline in visits to nonpsychiatrist mental health providers but unchanged psychiatrist visits, ED visits, and hospitalizations. HDHPs do not appear to have a "blunt instrument" effect on health care use in bipolar disorder; rather, patients might make trade-offs to preserve important care.

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Bipolar disorder is a serious mental illness characterized by acute episodes of mania, hypomania, and depression. Bipolar spectrum disorders include subtypes bipolar I, bipolar II, and cyclothymia. These often have an early age of onset, high risk of suicide, and high rates of co-occurring psychiatric conditions such as substance use disorders.[1,2] In the United States, the 12-month prevalence of bipolar disorder is 2.8% and the lifetime prevalence is 4.4%.[3] Although persons with bipolar disorder can have asymptomatic periods, episodes of clinical instability and impairment are common.[2] In addition to managing acute mood episodes, guideline-recommended care for bipolar disorder requires a chronic care model of evidence-based medications, ongoing follow-up, and often evidence-based psychotherapies during nonmanic phases of care, such as individual and group psychoeducation, cognitive behavior therapy, interpersonal social rhythm therapy, and family-focused therapy, to reduce depressive symptoms or prevent future manic or depressive episodes.[4,5]

In an effort to control rising health care costs, payers and employers are increasingly adopting high-deductible health plans (HDHPs)[6] that require high out-of-pocket payments.[6,7] HDHP advocates believe that providing patients with information about the quality of medical services while exposing them to greater costs will create "activated healthcare consumers"[8] who will seek higher-value health care, adopt healthy behaviors, and reduce future costs.

HDHPs have proliferated over the past decade. In 2018, 58% of covered workers had deductibles of $1000 or more and 26% had deductibles of $2000 or more.[9] Based on findings going back to the RAND Health Insurance Experiment (HIE)[10] of the 1970s and 1980s, high cost sharing is generally considered a "blunt instrument" that reduces all health care utilization among all types of patients. However, more recent studies have found that such reductions do not occur in all clinical situations[11-14] or for all subgroups.[13,14] HDHP effects on patients with serious mental illness including bipolar disorder are unknown.

We chose to study patients with bipolar disorder because it is a serious mental illness that is common enough among commercially insured persons to study robustly. Bipolar disorder is also a chronic

condition and requires consistent access to medications and expensive specialist care. This population could be "tipped over the edge" by even small reductions in access given that suboptimal adherence to bipolar medications can result in debilitating episodes of mania or depression. We hypothesized that the higher out-of-pocket spending for specialist care under HDHPs would reduce mental health outpatient visits to both psychiatrists and nonpsychiatrist mental health providers and that reduced psychiatrist visits would reduce bipolar medication fills. The expected direction of emergency department (ED) visits and hospitalizations was uncertain.

TAKEAWAY POINTS

- High-deductible health plan (HDHP) members with bipolar disorder experienced a moderate decrease in nonpsychiatrist mental health outpatient visits, but rates of psychiatrist visits, medication use, emergency department visits, and hospitalizations did not change.
- HDHP members with bipolar disorder might elect to pay more out of pocket to maintain psychiatrist care and associated medication use but not nonpsychiatrist mental health provider care.
- HDHPs do not appear to have a "blunt instrument" effect on health care use in bipolar disorder; rather, patients might make trade-offs to preserve important care.
- Policy makers, employers, and health plans could use these findings to construct highly efficient value-based or tailored health insurance designs that optimize health care use and spending; for example, plans might reduce out-of-pocket costs for nonpsychiatrist mental health provider visits to enhance use.

METHODS

Data Source and Population Setting

We drew our commercially insured study population from a large national claims database with members enrolled between January 2003 and December 2012. Data included medical, pharmacy, and outpatient claims from members of a large national health plan.

Research Design and Study Groups

We used an interrupted time series with propensity-matched comparison series research design.[15-17] We included individuals with bipolar disorder who were enrolled in low-deductible plans during a baseline year. Some experienced an employer-mandated switch to HDHPs and were followed for a subsequent year. Others continued in low-deductible plans because their employers offered only these arrangements, and we followed these members as the control group. Thus, our study groups were not offered a choice of deductible level, minimizing self-selection.

Employer selection and study group identification. Our process for identifying study groups involved first identifying eligible employers and then eligible patients with bipolar disorder at those employers. In a given benefit year (the 12 months when an employer provides certain health insurance benefits), we classified employers as offering low- or high-deductible coverage based on offering exclusively annual deductibles of $0 to $500 or at least $1000, respectively (**eAppendix** section I[A] and **eAppendix Table 1** [eAppendix available at **ajmc.com**]). We then defined the pool of potential HDHP group employers as those with at least 1 year of low-deductible coverage followed by at least 1 year of mandated HDHP coverage.

We defined the index date for employers that switched to HDHPs as the first day of the month when the switch occurred. We defined the index date for employers that did not switch plans as the first day of the month when their yearly account was renewed. Members had index dates as early as January 1, 2004, and as late as January 1, 2012. For each person, we defined the beginning of the baseline period as 12 months before the employer's index date.

Bipolar cohort selection. Study cohort selection began with 53 million overall members up to age 64 years enrolled during 2000-2012 (**eAppendix Figure 1**). Similar to prior research,[18-21] we used a hierarchical algorithm and evidence of outpatient and inpatient bipolar disorder diagnoses captured in *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes to classify patients as having bipolar I, bipolar II, or uncertain type (eAppendix section I[B]).

After applying this algorithm, the bipolar cohort included 333,780 members. After restricting to members who were continuously enrolled for at least 2 years in the previously defined employers, who were aged 12 to 64 years during the calendar year of the index date, who had a most recent bipolar diagnosis that occurred from 5 years to 4 months prior to the index date, and whose employers did not carve out mental health benefits, we had a prematch pool of 2950 HDHP members and 26,911 controls with bipolar disorder.

Outcome Measures

Primary measures included mental health outpatient visits, overall and subclassified into (1) visits to psychiatrists and (2) visits to nonpsychiatrist mental health providers (eg, psychologists, counselors, mental health social workers). We chose this categorization because among mental health specialists, psychiatrists typically prescribe medications for bipolar disorder, whereas nonpsychiatrist mental health specialists commonly provide psychotherapy. In secondary analyses, we also examined the remaining small subset of mental health visits to (3) non–mental health specialist clinicians such as primary care providers. To better understand changes in use of health care that was not specifically related to mental health, we also measured non–mental health–related office visits, overall ED visits, and overall hospitalizations. Non–mental health–related visits comprised all office visits (including hospital outpatient visits) not classified as mental health related using the approach described earlier. That is, they included visits to non–mental health specialists that had evaluation and management codes for office visits (except those that were mental health specific) and a primary or secondary diagnosis that was not related to mental health.

TABLE 1. Baseline Characteristics of the HDHP and Control Groups, Before and After Propensity Score Match

	Before 1:3 propensity score match			After 1:3 propensity score match		
Sample size	HDHP group (n = 2950)	Control group (n = 26,911)	Standardized difference[a]	HDHP group (n = 2862)	Control group (n = 7705)	Standardized difference[a]
Aged >40 years on index date, n (%)	1443 (48.9)	12,996 (48.3)	0.013	1401 (49.0)	3676 (47.7)	0.025
Age in years on index date, mean (SD)	37.5 (13.7)	37.6 (14.0)	−0.005	37.5 (13.7)	37.6 (13.9)	−0.003
Female, n (%)	1858 (63.0)	16,489 (61.3)	0.035	1805 (63.1)	4834 (62.7)	0.007
Individuals by below-poverty level of neighborhood,[b] n (%)						
<5%	1361 (46.1)	12,935 (48.1)	0.149	1323 (46.2)	3580 (46.5)	0.041
5%-9.9%	805 (27.3)	7163 (26.6)		784 (27.4)	2096 (27.2)	
10%-19.9%	539 (18.3)	4833 (18.0)		525 (18.3)	1428 (18.5)	
≥20%	239 (8.1)	1926 (7.2)		230 (8.0)	601 (7.8)	
Missing poverty	6 (0.2)	54 (0.2)				
Individuals by below-high-school education level of neighborhood,[b] n (%)						
<15%	1792 (60.7)	16,964 (63.0)	0.157	1751 (61.2)	4751 (61.7)	0.031
15%-24.9%	681 (23.1)	5987 (22.2)		662 (23.1)	1790 (23.2)	
25%-39.9%	383 (13.0)	3093 (11.5)		366 (12.8)	945 (12.3)	
≥40%	88 (3.0)	813 (3.0)		83 (2.9)	219 (2.8)	
Missing education	6 (0.2)	54 (0.2)				
Race/ethnicity,[b] n (%)						
Hispanic	133 (4.5)	1501 (5.6)	0.055	130 (4.5)	359 (4.7)	0.000
Asian	41 (1.4)	365 (1.4)		33 (1.2)	80 (1.0)	
Black neighborhood	34 (1.2)	278 (1.0)		33 (1.2)	101 (1.3)	
Mixed neighborhood	375 (12.7)	3886 (14.5)		371 (13.0)	1002 (13.0)	
White neighborhood	2360 (80.2)	20,800 (77.5)		2295 (80.2)	6163 (80.0)	
Missing race	7 (0.0)	81 (0.0)				
ACG score,[c] mean (SD)	2.2 (3.0)	2.2 (3.1)	−0.030	2.1 (3.0)	2.1 (3.0)	−0.001
United States region, n (%)			0.201			0.022
West	382 (12.9)	3692 (13.7)		370 (12.9)	965 (12.5)	
Midwest	1046 (35.5)	8659 (32.2)		1018 (35.6)	2826 (36.7)	
South	1309 (44.4)	10,688 (39.7)		1264 (44.2)	3302 (42.9)	
Northeast	212 (7.2)	3849 (14.3)		210 (7.3)	612 (7.9)	
Missing region	1 (0.0)	23 (0.1)				
Outpatient co-payment in $, mean (SD)	18.3 (6.5)	16.1 (6.4)	0.342	18.3 (6.5)	17.9 (6.1)	0.067

(continued)

As a secondary measure, we assessed bipolar medication use to determine whether this key component of outpatient bipolar disorder therapy was affected. Our measure was the number of days per study year that the member had at least 1 medication that is recommended for the treatment of bipolar disorder (lithium, atypical antipsychotics, and select anticonvulsants) on hand. We also assessed out-of-pocket spending on these health services per member and per visit, event, or prescription. Details about measure construction are included in the eAppendix.

Covariates

Using 2000 US Census block group data and validated methods,[22,23] we classified members according to the income and education levels of their neighborhood (**Table 1**).[22-24] We applied the Johns Hopkins ACG algorithm, a validated measure that predicts mortality,[25,26] to members' baseline year to estimate general morbidity, including both mental and physical conditions. We matched study groups on morbidity level because patients with differing levels of morbidity will have differing cost exposure and contact with the health system. We first used geocoding to classify patients as being from white, black, Hispanic, or mixed neighborhoods and then, when available, overwrote a participant's classification as Hispanic or Asian using the E-Tech (Ethnic Technologies) system,[27] which analyzes full names and geographic locations of individuals. This validated approach of combining surname analysis and Census data has positive and negative predictive values of approximately

TABLE 1. *(Continued)* Baseline Characteristics of the HDHP and Control Groups, Before and After Propensity Score Match

	Before 1:3 propensity score match			After 1:3 propensity score match		
Sample size	HDHP group (n = 2950)	Control group (n = 26,911)	Standardized difference[a]	HDHP group (n = 2862)	Control group (n = 7705)	Standardized difference[a]
Employer size by enrollees, n (%)						
0-99	1292 (43.8)	4108 (15.3)	1.082	1240 (43.3)	3071 (39.9)	0.064
100-999	1335 (45.3)	8460 (31.4)		1300 (45.4)	3695 (48.0)	
≥1000	323 (10.9)	14,343 (53.3)		322 (11.3)	939 (12.2)	
Substance use disorder, n (%)	486 (16.5)	4164 (15.5)	0.028	462 (16.1)	1206 (15.7)	0.000
Bipolar type, n (%)						
Type I	2135 (72.4)	19,598 (72.8)	0.029	2070 (72.3)	5595 (72.6)	0.031
Type II	367 (12.4)	3414 (12.7)		358 (12.5)	950 (12.3)	
Uncertain	448 (15.2)	3899 (14.5)		434 (15.2)	1160 (15.1)	
Rural/urban residence, n (%)[d]						
Rural	267 (9.1)	1867 (6.9)	0.074	256 (8.9)	626 (8.1)	0.036
Urban	2618 (88.7)	24,488 (91.0)		2545 (88.9)	6910 (89.7)	
Unknown	65 (2.2)	556 (2.1)		61 (2.1)	169 (2.2)	

HDHP, high-deductible health plan.

[a]Indicates the difference in means between the intervention and control groups divided by the SD of the difference in means. Lower values indicate greater similarity, and values less than 0.2 indicate minimal differences between groups.

[b]For complete descriptions of how we constructed baseline variables, please refer to the Methods section.

[c]An ACG score of 1.0 represents the mean score of the reference population.

[d]Based on the Rural Urban Continuum Codes data.

Source: Authors' analysis of national commercial health insurer claims data source, 2003-2012.

80% and 90%, respectively.[28] Other covariates included age category (12-18, 19-29, and 30-64 years) and US region of residence (West, Midwest, South, Northeast).

Member-level clinical covariates included bipolar disorder type (type I, type II, or uncertain type) (eAppendix section I[B]), number of baseline outpatient psychiatrist and nonpsychiatrist mental health provider visits per quarter, substance use disorder diagnosis (*ICD-9-CM* codes 291.x-292.x, 303.xx-305.xx), number of mental health ED visits per quarter, number of baseline mental illness (bipolar disorder or depression) inpatient days per quarter, number of baseline 30-day equivalent bipolar medication fills per quarter, and number of months from first observed bipolar diagnosis to the index date.

Derived employer-level characteristics included employer size (1-49, 50-99, 100-249, 250-499, 500-999, or ≥1000 enrollees); index month/year; percentage of women; percentage of enrollees in each of 4 US regions and in income, education, age, and race/ethnicity categories; employer baseline cost level and trend derived from a standardized cost variable; and mean employer ACG score.

Matching

To further minimize potential selection effects, we used a 2-level (employer- and member- level) propensity score matching approach[29,30] and estimated propensity scores predicting the likelihood of a mandated HDHP switch based on the employer-level covariates defined above. Within these quartiles, we performed the member-level match between contemporaneous HDHP and control group members in the match pool with index dates between January 1, 2004, and January 1, 2012 (matching details in eAppendix section I[D]). After propensity score matching, the final study sample included 2862 HDHP members with bipolar disorder and 7705 matched controls.

Analyses

We compared baseline characteristics of our study groups using a standardized differences approach.[31] To determine whether HDHP members might be dropping out of their employers' health plans at different rates compared with control members, we compared characteristics of the groups that had at least 12, 13, 18, and 24 months of enrollment, counting from the beginning of the baseline period.

After analyzing interrupted time series data (eAppendix section I[E]) and finding that all primary outcome measures had parallel baseline trends (data not shown), we used generalized estimating equations in a difference-in-differences analytic framework to compare changes in outcomes among members in the year before and after the mandated HDHP switch vs controls. Regression models for outpatient visits and corresponding out-of-pocket spending used a negative binomial distribution and were adjusted for employer size, calendar year of index date, gender, age category, race, ethnicity, and neighborhood income level and education level. The term of interest was the 2-way interaction between an indicator of HDHP vs control group and an indicator of the year before vs after the index date. Using terms from the regression model, we then used

TABLE 2. Mental Health Outpatient Visits, Bipolar Medication Use, and Corresponding Out-of-Pocket Spending 1 Year Before and After Members With Bipolar Disorder Experienced a Mandated Switch to HDHPs, Compared With Contemporaneous Members With Bipolar Disorder Remaining in Low-Deductible Plans[a]

	HDHP		Control		Absolute change (95% CI), HDHP vs control	Relative change in % (95% CI), HDHP vs control
	Baseline year	Follow-up year	Baseline year	Follow-up year		
All mental health visits						
Out-of-pocket spending per visit, $	34.3	42.3	31.8	32.1	**7.6 (5.5-9.7)**	**21.9% (15.1%-28.6%)**
Visit rate per member, n	5.2	4.3	5.4	4.7	−0.2 (−0.5 to 0.1)	−4.6% (−11.7% to 2.5%)
Out-of-pocket spending per member, $	237.4	234.3	207.4	181.0	**27.2 (9.3-45.1)**	**13.1% (4.1%-22.2%)**
Nonpsychiatrist mental health provider visits						
Out-of-pocket spending per visit, $	35.2	47.3	31.2	31.3	**12.0 (1.1-22.8)**	**33.8% (2.0%-65.5%)**
Visit rate per member, n	2.5	1.9	2.6	2.2	**−0.2 (−0.5 to 0.0)**	**−10.9% (−20.6% to −1.3%)**
Out-of-pocket spending per member, $	112.2	104.7	94.9	84.4	4.9 (−8.7 to 18.5)	4.9% (−9.0% to 18.9%)
Psychiatrist visits						
Out-of-pocket spending per visit, $	34.8	41.1	32.0	32.1	**6.2 (4.4-8.0)**	**17.8% (12.2%-23.4%)**
Visit rate per member, n	2.3	2.1	2.4	2.1	0.0 (−0.2 to 0.2)	0.6% (−9.3% to 10.6%)
Out-of-pocket spending per member, $	108.6	110.6	98.6	86.9	**14.9 (5.0-24.8)**	**15.5% (4.7%-26.4%)**
Non–mental health visits[b]						
Visit rate per member, n	0.22	0.18	0.25	0.22	−0.02 (−0.05 to 0.01)	−9.0% (−23.5% to 5.5%)
Use of any bipolar medication						
Out-of-pocket spending per 30-day fill, $	39.3	46.0	35.9	36.0	**6.6 (4.2-9.0)**	**16.8% (10.3%-23.3%)**
Days of any use per member, n	128.9	127.5	118.9	116.6	1.2 (−1.8 to 4.1)	0.9% (−1.4% to 3.3%)
Out-of-pocket spending per member, $	179.6	199.4	167.8	156.8	**31.6 (19.4-43.8)**	**18.8% (11.0%-26.7%)**

HDHP, high-deductible health plan.

[a]Regression models used a negative binomial distribution and were adjusted for employer size, calendar year of index date, gender, age category, race, ethnicity, and neighborhood income level and education level. Bolded results indicate statistically significant (P <.05) estimates.

[b]Non–mental health visits included visits to non–mental health specialists that had evaluation and management codes for office visits (except those that were mental health specific) and a primary or secondary diagnosis that was not mental health related.

marginal effects methods to calculate mean adjusted baseline and follow-up outpatient visit rates and out-of-pocket spending, as well as absolute and relative changes.[32] We used a similar approach to model ED visits, hospitalizations, and corresponding out-of-pocket spending, but we used a zero-inflated negative binomial distribution to account for patients with zero utilization and spending in these areas.

RESULTS

After matching, all standardized differences between HDHP and control group characteristics were well below 0.2, indicating minimal differences (Table 1).[31] The average age of HDHP and control members was approximately 37 years, and 62% in each group were women. Approximately 26% lived in low-income neighborhoods, 16% lived in low-education neighborhoods, 4% were Hispanic, and the mean (SD) ACG morbidity score was 2.1 (3.0). About half of members (HDHP, 45.4%; control, 48.0%) were enrolled through midsize employers with 100 to 999 enrollees. Differential dropout was minimal and thus should not bias our results (**eAppendix Tables 4** and **5**).

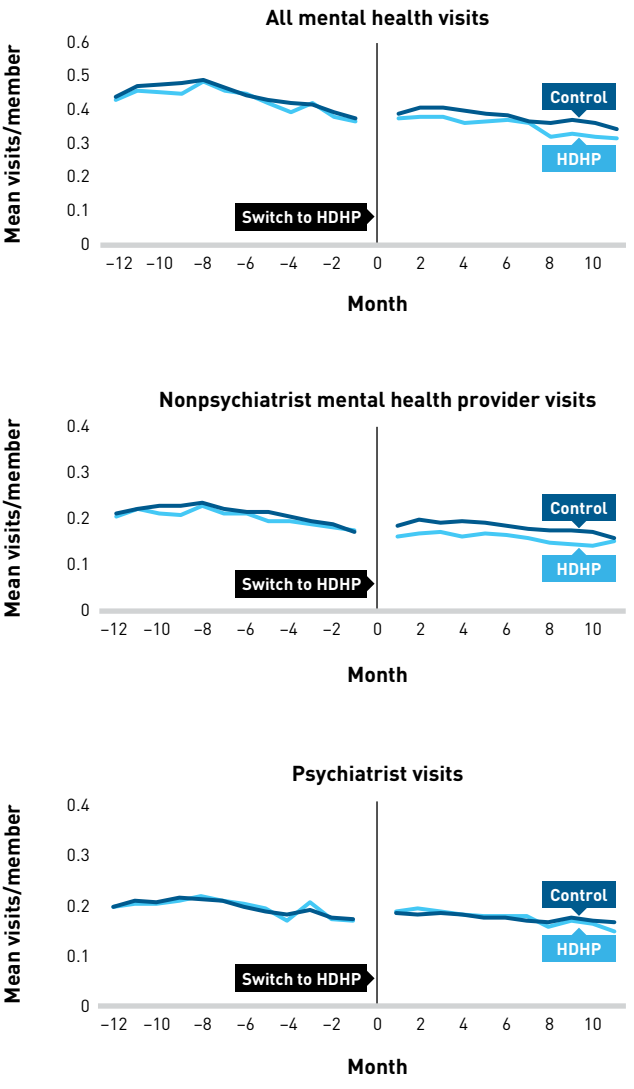
In adjusted difference-in-differences analyses, out-of-pocket spending from before to after the index date for all medical services increased by 20.9% (95% CI, 15.7%-26-3%) among HDHP members relative to controls (**eAppendix Table 6** and **eAppendix Figure 2**). HDHP members experienced a 21.9% (95% CI, 15.1%-28.6%) increase in mental health visit prices (spending per visit) in the follow-up year compared with baseline relative to control group members (**Table 2**) but no detectable changes in overall mental health outpatient visits (relative change, −4.6% [95% CI, −11.7% to 2.5%]) (**Figure**). The HDHP group experienced a 13.1% (95% CI, 4.1%-22.2%) relative pre- to post increase in out-of-pocket spending per member for outpatient mental health visits (**eAppendix Figure 3**).

Analyses by visit type revealed that, in the context of a 33.8% (95% CI, 4.3%-63.3%) relative increase in visit price, HDHP members reduced nonpsychiatrist mental health provider visits by 10.9% (95% CI, −20.6% to −1.3%) (Table 2 and Figure). In contrast, psychiatrist visits were unchanged (0.6% [95% CI, −9.3% to 10.6%]) despite a 17.8% (95% CI, 12.2%-23.4%) increase in visit price. Per-member out-of-pocket spending changes were 4.9% (95% CI, −9.0% to 18.9%) for nonpsychiatrist mental health provider visits and 15.5% (95% CI, 4.7%-26.4%) for psychiatrist visits (eAppendix Figure 3). Non–mental health provider visits for mental health reasons and corresponding out-of-pocket spending were unchanged (**eAppendix Table 7**). HDHP members experienced a −9.0% (95% CI, −23.5%

to 5.5%) nonsignificant relative change in non–mental health visits (Table 2).

HDHP members experienced no detectable changes in the proportion of days with any bipolar medication on hand after the HDHP switch relative to controls (Table 2 and **eAppendix Figure 4**) despite an increase in 30-day fill price of 16.8% (95% CI, 10.3%-23.3%) at follow-up vs baseline. Similarly, ED visits and hospitalizations were unchanged (**Table 3**), whereas per-event prices increased by 40.1% (95% CI, 20.5%-59.8%) and 38.7% (95% CI, 3.7%-73.8%), respectively.

FIGURE. Monthly Rates of Overall Mental Health Visits and Subtypes Among HDHP and Control Members With Bipolar Disorder[a]



HDHP, high-deductible health plan.

[a]Vertical black lines are centered at the index month when HDHP group members were switched into HDHPs.

DISCUSSION

After an employer-mandated transition to HDHPs, commercially insured members with bipolar disorder maintained stable overall mental health outpatient visit rates relative to similar patients who remained in low-deductible health plans. However, nonpsychiatrist mental health provider visits declined by 11% among HDHP members, whereas psychiatrist visits were unchanged despite increased prices per visit. We did not find statistically significant changes in use of bipolar medications, ED visits, or hospitalizations.

A potential interpretation is that HDHP members with bipolar disorder elected to pay more out of pocket to maintain psychiatrist care and associated medication use but not nonpsychiatrist mental health provider care. HDHP members with bipolar disorder might be trying to preserve visits that they needed for medication refills, changes, or dose adjustments. Or, given that visits to nonpsychiatrist mental health providers generally occur more frequently, patients might view reducing the frequency of such visits as a necessary trade-off to manage their out-of-pocket expenses. It is difficult to interpret the lack of ED visit changes, in part because visits could simultaneously decrease because of HDHP financial barriers and increase because of inappropriately deferred care, leaving overall rates unchanged. In addition, HDHP members might not be able to reduce this key source of care given that research has demonstrated that individuals with bipolar disorder use the ED to obtain urgent mental health care.[33]

Previous research has not addressed effects of HDHPs on outpatient care among patients with mental health conditions. Earlier studies examined the broad impact of cost sharing on mental health care utilization. For example, the RAND HIE of the 1970s and 1980s found that higher cost sharing led to lower mental health care utilization compared with the demand for general medical services.[10,34] In contrast, a more recent study found that patients' price sensitivity for mental health and general medical care was comparable.[35] Similar to our results, that study found significant variation in price sensitivity within types of mental health care (eg, visits, medications). However, these older studies did not examine populations with serious mental illness and were unable to distinguish cost-sharing effects on patient visits to different provider types. We are also not aware of research regarding the association between HDHP enrollment and changes in nonpsychiatrist mental health care visits, emergency care, and hospitalizations. In a context of reduced nonpsychiatrist mental health care visits, we found that rates of ED visits and hospitalizations did not change for HDHP members.

Substantially more is known about the impact of cost sharing on non–mental health care use and outcomes. The RAND HIE[10] found that high out-of-pocket costs reduced almost all utilization to a similar degree. However, similar to our results among individuals with bipolar disorder, more recent studies have found that such reductions do not occur consistently in all clinical situations[12-14] or for all demographic subgroups.[13,14,36] Recent research has generally found that when services are subject to the deductible, utilization

TABLE 3. ED Visits, Hospitalizations, and Corresponding Out-of-Pocket Spending 1 Year Before and After Members With Bipolar Disorder Experienced a Mandated Switch to HDHPs, Compared With Contemporaneous Members With Bipolar Disorder Remaining in Low-Deductible Plans[a]

	HDHP		Control		Absolute change (95% CI), HDHP vs control	Relative change in % (95% CI), HDHP vs control
	Baseline	Follow-up	Baseline	Follow-up		
ED visits						
Out-of-pocket spending per visit, $	136.3	199.8	127.2	133.1	**57.2 (33.7-80.7)**	**40.1% (20.5%-59.8%)**
Visit rate per member, n	0.53	0.54	0.57	0.56	0.0 (0.0-0.1)	1.4% (–9.0% to 11.9%)
Out-of-pocket spending per member, $	68.1	106.6	63.3	67.8	**33.5 (18.5-48.6)**	**46.0% (22.1%-69.8%)**
Hospitalizations						
Out-of-pocket spending per hospitalization, $	1012.0	1351.8	954.6	919.1	**377.4 (102.5-652.4)**	**38.7% (3.7%-73.8%)**
Hospitalization rate per member, n	0.18	0.16	0.18	0.16	0.0 (0.0-0.0)	–3.0% (–19.2% to 13.2%)
Out-of-pocket spending per member, $	177.2	214.6	145.4	138.9	**45.3 (3.1-87.5)**	26.8% (–1.7% to 55.2%)

ED, emergency department; HDHP, high-deductible health plan.

[a]Regression models used a zero-inflated negative binomial distribution and were adjusted for employer size, calendar year of index date, gender, age category, race, ethnicity, and neighborhood income level and education level. Bolded results indicate statistically significant (P <.05) estimates.

decreases more among vulnerable members (eg, low-income, high-morbidity members) than less vulnerable members.[13,14,37,38]

The RAND study also predicted that utilization decreases would not worsen health outcomes except among vulnerable members. Few modern studies have assessed health outcomes, but 2 detected evidence of increased adverse outcomes among low-income and high-morbidity members with diabetes.[13,14]

Our study thus adds the novel insight that commercially insured patients with a serious mental illness might not experience cost sharing in HDHPs as a "blunt instrument" but rather make trade-offs to preserve certain types of mental health care. Policy makers, employers, and health plans could therefore use our findings to construct highly efficient value-based[39] or tailored[40] health insurance designs that optimize health care use and spending; for example, plans might reduce out-of-pocket costs for nonpsychiatrist mental health provider visits to enhance use while maintaining cost sharing for psychiatrist visits. Findings could also help clinicians recognize high-deductible insurance as a risk factor for patients with serious mental illness to reduce their use of certain mental health–related services.

Further research should investigate whether the reduced visits to nonpsychiatrist mental health providers that we detected cause adverse mental health or clinical events and should examine detailed medication adherence measures. Future studies should also address effects of HDHP transitions on patients with bipolar disorder who have lower incomes, higher morbidity, and higher levels of cost sharing under HDHPs with health savings accounts.

Limitations

Our study has several limitations. We studied enrollees with employer-sponsored health insurance enrolled through a single national claims database. In addition, this study did not focus on the most vulnerable subset of members with bipolar disorder who might have public insurance or be uninsured. Nevertheless, given that HDHPs are almost exclusively a feature of commercial health insurance, our results should be generalizable to many individuals with bipolar disorder in employer-sponsored plans. Although we measured changes in ED visits and hospitalizations, these are imperfect health outcomes measures and our study was unable to assess important outcomes such as mania, depression,[41] or suicide attempts. Our data did not allow us to classify members as the beneficiary, spouse, or dependent. Observational studies are subject to bias from unmeasured confounders. However, the controlled interrupted time series design that we used guards against most threats to validity.[15] Finally, the patients included in our study were in different phases of their condition with regard to duration of recognized disease and disease control but unlikely to be imbalanced by study group.

CONCLUSIONS

HDHP members with bipolar disorder who faced substantial increases in cost sharing preserved psychiatrist visits while reducing nonpsychiatrist mental health provider visits. Further research should determine how such reduced care affects mental health and clinical outcomes such as suicide, mania, and depression. ■

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eAppendix

Contents

I. Methods

A. Study Group Construction and Deductible Imputation Algorithm

To determine employer deductible levels, we used a benefits type variable that we had for most smaller employers (with approximately 100 or fewer employees). For larger employers, we took advantage of the fact that health insurance claims data are the most accurate source for assessing out-of-pocket obligations among patients who utilize health services. Our claims data contained an in-network/out-of-network deductible payment field. For patients who use expensive or frequent services, the sum of their yearly deductible payments add up to clearly identifiable exact amounts such as $500.00, $1000.00, $2000.00, etc. When even several members have these same amounts, it provides strong evidence that the employer offered such an annual deductible level. It is also possible to detect employers that offer choices of deductible levels when multiple employees have deductibles at two or more levels, such as 20 employees with an exact annual amount of $1000.00 and 12 employees with $500.00.

For employers with at least 10 workers, we therefore summed each member's in-network deductible payments and number of claims over the enrollment year and assessed other key characteristics such as percentage with Health Savings Accounts. We randomly selected half of the employer data set that contained both our calculated employer characteristics (independent variables, below) and actual annual deductible levels from the benefits table (dependent variable, after categorization; below).

We then used a logistic model that predicted the 3-level outcome of deductible <=$500/$500-$999/>$1000 (again, dependent variable) based on multiple aggregate employer characteristics (independent variables) such as the first and second most common whole number deductible value, the percentage with Health Savings Accounts or Health Reimbursement Arrangements, the median deductible payment, the percentage of employees using services, the employer size, the percentage of employees with summed annual deductible amounts (from claims data) between $100 to ≤$500/ >$500 to <$1000/ ≥$1000 to ≤$2500/ >$2500, etc. This predictive model output the probability that employers had deductibles in the three categories (summing to 1) and we assigned the employer to the level that had the highest probability. If we detected employers that had 10 or more employees with whole number deductible levels both above and below $500 (e.g. $250.00 and $1500.00), we assigned the employers' category as "choice." If 100% of employees had Health Savings Accounts, we also overwrote any previous assignment to classify the employer as a high-deductible employer. We tested the predictive model on the other half of the sample for which we had actual deductible levels from the benefits table (eAppendix Table 1). At employers with 75-100 enrollees, we found sensitivity and a specificity of over 96%. The sensitivity and specificity would be expected to be even higher at employers with more than 100 enrollees (because more claims data would be available to provide evidence of deductible levels).

Rationale for low- and high-deductible cutoff values: when Health Savings Account-eligible HDHPs came to market in 2006, the Internal Revenue Service set the minimum deductible level for qualifying HDHPs at $1050 (which could be adjusted upward for inflation annually). The range of this minimum deductible during our study period was $1050-$1200. For these reasons, we defined HDHPs as annual individual deductibles of at least $1000 (otherwise health savings account plans would be excluded). In addition, choosing this cutoff (as opposed to e.g. $2000) also improves the sensitivity and specificity of the imputation because this is common deductible level and more enrollees per employer meet this threshold. This cutoff is also a "real-world" deductible minimum that allows the most generalizable results. We did not create a separate imputation algorithm for deductible levels of e.g. >=$2000 due to concerns that a less sensitive and specific algorithm would lead to biased effect estimates and a smaller HDHP sample size. It is important to note that $1000 was the **minimum** annual deductible level and not the mean deductible level. We cannot calculate the mean deductible level of the HDHP group directly but would expect it to be in the range of approximately $1500 to $2000. We defined traditional plans as having deductible levels of ≤$500 after determining that a threshold of ≤$250 would lead to an inadequate sample size for the control group. Again, the mean deductible level of the control group members would be lower than $500.

After assigning deductible levels at the employer plan year level, we began with 1,830,665 employer plan years. We excluded 201,230 plan years (11%) that included deductible levels other than only low or only high.

Among the remaining 1,629,435 plan years, we excluded 191,519 (12%) that did not have 2 years of continuous enrollment. Finally, from the remaining 1,437,916 employer plan years, we excluded 549,638 (38%) that were not transitions of low deductible to low deductible or low deductible to high deductible. Most of these exclusions were due to employers having high deductibles at their initial appearance in our dataset and remaining in high deductible plans.

Our HDHP group therefore comprised the enrollment years of employers that had a year-on-year transition from low- to high-deductible coverage (from $500 or less to $1000 or more). Some employers had multiple eligible index dates (e.g., multiple low-to-low deductible years or both low-to-low and low-to-high deductible years). In these cases, we randomly assigned employers to the HDHP or control pool then randomly selected one of their index dates (and their corresponding before-after enrollment years).

B. Bipolar Cohort and Bipolar Type Identification Algorithm

Similar to prior research,[10-13] we defined the bipolar cohort as members who had 1 or more inpatient diagnoses with a first position diagnosis of bipolar disorder, or 2 or more outpatient visit claims with a first or second position diagnosis of bipolar disorder on different days no more than 23 months apart. We used a hierarchy to further classify members as having bipolar I, bipolar II, or uncertain bipolar type. We first classified patients as having bipolar I if they had at least 1 inpatient or 2 outpatient bipolar I diagnoses (International Classification of Diseases, 9th revision [ICD-9-CM] codes: 296.0-296.1, 296.4- 296.7). Among those not qualifying as having bipolar I, we classified patients as having bipolar II disorder if they had at least 1 inpatient or 2 outpatient bipolar II diagnoses (ICD-9-CM code: 296.89). Among those not classified as having bipolar I or II, we classified members as having uncertain bipolar type if they had either at least 1 inpatient diagnosis with a non-specific bipolar type code (ICD-9-CM 296.80-296.82, 301.11, 301.13) or at least 2 outpatient visits with any bipolar diagnoses but not reaching the above thresholds of at least 2 bipolar I diagnoses or at least 2 bipolar II diagnoses. We then excluded members with schizophrenia or schizoaffective disorder diagnoses (ICD-9-CM: 295.xx).

C. Covariates

To estimate comorbidity, we applied the Johns Hopkins ACG algorithm to members' baseline period. The ACG algorithm uses age, sex, and ICD-9-CM codes to calculate a morbidity score relative to a reference population average of 1.0.[8,9] Researchers have validated the index against premature mortality.[8,9] We defined four validated neighborhood income levels using the 2000 U.S. Census Bureau and defined members as high- and low-income based on living in neighborhoods with below-poverty-levels of <10% and ≥10%, respectively.[10] Similarly, we created validated education level categories. We used geocoding to classify patients as from white, black, Hispanic, or mixed neighborhoods, and we classified participants as Hispanic or Asian using the E-Tech system (Ethnic Technologies), which analyzes full names and geographic locations of individuals.[1,2] Census-based measures of socioeconomic status have been validated and used in multiple studies to examine the impact of policy changes on disadvantaged populations. We combined both techniques because geocoding is not sensitive in detecting ethnicity and surname analysis is non-informative regarding race. This validated approach has a high positive predictive value.[13,14]

D. Propensity Score Matching Approach

Propensity score matching assists in generating a control group with a similar likelihood of being exposed to a given "intervention" (in this case, shifting to HDHP coverage) based on measured characteristics when individuals have not been randomly allocated into study groups. To perform propensity score matching, we assigned each employer to a propensity score quartile then performed the member-level match among pre-match pool members with bipolar disorder who transitioned to a HDHP between January 2004 and January 2012 (allowing a 1-year follow-up ending in December 2012 at the latest) to contemporaneous control members using 1:3 caliper matching without replacement.

After classifying every employer's index date, we used an employer-level model to generate annual employer propensity score quartiles. This logistic model predicted the likelihood of an employer joining a HDHP in a given calendar period based on employer size (1-99, 100-999, and 1000+ enrollees); index month/year;

percentage of women; percentage of enrollees in region, income, education, age, and race/ethnicity categories; employer baseline cost level and trend derived from a standardized cost variable; mean employer ACG score; and a proxy for actuarial value of health plan offerings (total out-of-pocket expenditures for all enrollees at an employer divided by their total standardized costs in a given benefit year). The member-level logistic regression in our propensity score model included age category, bipolar type, gender, race/ethnicity, neighborhood poverty and education, US region, ACG morbidity score, substance use disorder diagnosis, index month, employer size, out-of-pocket to standardized cost ratio, and number of calendar months from first observed bipolar diagnosis to the index date. Based on evidence that matching on the functional form of the baseline outcome trend generates less biased effect estimates,[3,4] we also matched on quarterly number of baseline outpatient psychiatrist and non-psychiatrist mental health provider mental health visits, quarterly number of mental health emergency department visits, quarterly number of baseline mental illness inpatient visits, and quarterly number of baseline 30-day equivalent bipolar medication fills. After propensity-score matching, the final study sample included 2862 HDHP members with bipolar disorder and 7705 matched controls. Compared with the unmatched sample, our propensity score matching approach increased the similarity of the HDHP and control groups with respect to almost all covariates as measured by standardized differences.

E. Measure Construction

To define our outpatient measures, we used billing codes on office visit claims then defined mental health visits as those that included: (1) Current Procedural Terminology (CPT-4) or Healthcare Common Procedure Coding System (HCPCS) codes specific to mental health (initial evaluations, medication management, psychotherapy, psychometric testing, case management, intensive outpatient/partial hospital/residential services, skills training, crisis services; codes available upon request), (2) a primary or secondary mental health-related ICD-9 diagnosis code for the visit (codes 291-314), or (3) mental health provider type codes. Among these overall mental health visits, we then flagged psychiatrist visits as any office visit that had “psychiatrist” as the provider category. We similarly flagged non-psychiatrist mental health providers based on approximately thirty provider types listed in eAppendix Table 2. Finally, we defined non-mental health specialist mental health visits as any office visit where the provider was not a mental health specialist and that also included either a mental health ICD-9 diagnosis or a mental health- specific CPT-4 or HCPCS evaluation and management code.

We used established health insurance claims-based algorithms to capture overall emergency department visits and hospitalizations. We used National Drug Classification codes to identify medications that are recommended for the treatment of bipolar disorder (eAppendix Table 3). Fills were spread across the days covered (i.e. a 30-day fill claim on December 16th would be spread as one drug per day from December 16th through January 14th).

To assess overall cost sharing increases among HDHP members relative to controls, we defined mean overall annual out-of-pocket spending per member as the sum of copayment, deductible, and coinsurance amounts for all health services used in a study period divided by the number of patients in a given study group. We calculated out-of-pocket spending per study group member for outpatient mental health visits, emergency department visits, hospitalizations, and bipolar medication use in the same manner. We also assessed out-of-pocket spending per service (in contrast to per patient) as a proxy for the price subjects faced for measured services (henceforth, “visit price,” “30-day fill price,” or “hospitalization price”).To define our outpatient measures, we used billing codes on office visit claims then defined mental health visits as those that included: (1) Current Procedural Terminology (CPT-4) or Healthcare Common Procedure Coding System (HCPCS) codes specific to mental health (initial evaluations, medication management, psychotherapy, psychometric testing, case management, intensive outpatient/partial hospital/residential services, skills training, crisis services; codes available upon request), (2) a primary or secondary mental health-related ICD-9 diagnosis code for the visit (codes 291-314), or (3) mental health provider type codes. Among these overall mental health visits, we then flagged psychiatrist visits as any office visit that had “psychiatrist” as the provider category. We similarly flagged non-psychiatrist mental health providers based on approximately thirty provider types listed in eAppendix Table 2. Finally, we defined non-mental health specialist mental health visits as any office visit where the provider was not a mental health specialist and that also included either a mental health ICD-9 diagnosis or a mental health- specific CPT-4 or HCPCS evaluation and management code.

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F. Analysis

We used two analytic approaches to estimate the association between HDHP enrollment and outpatient care measures (online supplement Section I.E):

Segmented regression analysis on interrupted-time-series data. We aligned relative time for all cohort members at their index dates. After constructing the controlled interrupted-time-series plots with monthly points adjusted for the above demographic and socioeconomic covariates using marginal effects methods,[5] we differenced the monthly HDHP and control group points to display changes in the HDHP group relative to the control group. We then applied aggregate-level segmented linear regression[6] to model this differenced trend, adjusting standard errors for autocorrelations between sequential monthly measurements. The regression models had intercept, baseline trend, level change, and trend change terms, and these terms were included in final models using backwards elimination with a threshold of $p<0.05$. We used the baseline trend term to determine if the parallel trends assumption[7] of difference-in-differences analysis was met across outcome measures.

Difference-in-differences analysis. After finding that all primary outcome measures had parallel baseline trends (data not shown), we used generalized estimating equations in a difference-in-differences analytic framework to compare changes in outcomes among members in the year before and after the mandated HDHP switch versus controls. Regression models for outpatient visits and corresponding out-of-pocket spending used a negative binomial distribution and were adjusted for employer size, calendar year of index date, gender, age category, race, ethnicity, and neighborhood income level and education level. The term of interest was the two-way interaction between an indicator of HDHP versus control group and of the year before versus after the index date. Using terms from the regression model, we then used marginal effects methods to calculate mean adjusted baseline and follow-up outpatient visit rates and out-of-pocket spending as well as absolute and relative changes.[8] We used a similar approach to model emergency department visits, hospitalizations, and corresponding out-of-pocket spending, but with a zero-inflated negative binomial distribution to account for patients with zero utilization and spending in these areas.

II. Results

eAppendix Table 1. Validation of deductible imputation algorithm.

	Gold Standard[a]=high-deductible (n)	**Gold Standard=low-deductible (n)**
We imputed high-deductible	611,541	14,335
We imputed low-deductible	24,017	465,120
	High-deductible	**Low-deductible**
Sensitivity	96.2%	97.0%
Specificity	97.0%	96.2%
Positive Predictive Value	97.7%	95.1%

[a]Gold standard was a benefits variable specific to each employer derived from a benefits table and obtained from the health insurer via the data vendor.

eAppendix Table 2. Non-psychiatrist mental health provider types use in mental health visit classification algorithm.

Psychologist; nurse practitioner (clinical specialist in mental health); psychiatric nurse specialist; employee assistance program (EAP) counselor; addiction medicine specialist; other mental health professional (addiction medicine specialist, alcohol and drug abuse counselor, clinical social worker, clinical social worker/mental health counselor, custodial care, empowerment coach, licensed professional counselor, marriage and family social worker, marriage and family therapist, master of social work, mental health counselor, mental health service provider, mental health/substance abuse, other mental health professional, psychoanalyst, psychosomatic medicine professional, registered social worker, substance abuse services); other non-mental health professional (doctor of education, empowerment coach, hypnotist, pastoral counselor); and mental health facility

eAppendix Table 3. Codes used to identify and classify bipolar medications.

Drug Class	Hierarchical Ingredient Code List Number	Generic Names
Guideline-concordant Anti-Convulsants	11735, 1893, 1884, 7378, 1883, 1882	Oxcarbazepine, Carbamazepine, Divalproex Sodium, Lamotrigine, Valproic Acid, Valproate Sodium
D2 Antagonist Antipsychotics	1621, 1624, 1625, 1626, 1662, 1660, 1661, 1663, 1664, 1635, 1666, 1627, 13819, 1637, 1622, 1631, 1668, 1667, 1630, 1623	Chlorpromazine HCl, Fluphenazine Decanoate, Fluphenazine Enanthate, Fluphenazine HCl, Haloperidol, Haloperidol Decanoate, Haloperidol Lactate, Loxapine HCl, Loxapine Succinate, Mesoridazine Besylate, Molindone HCl, Perphenazine, Perphenazine/Amitriptyline HCl, Pimozide, Promazine HCl, Thioridazine HCl, Thiothixene, Thiothixene HCl, Trifluoperazine HCl, Triflupromazine HCl
Second-Generation Antipsychotics	24551, 42595, 36576, 42283, 4834, 36778, 37321, 11814, 36716, 25800, 34343, 36479, 14015, 8721, 25509, 21974, 23379	Aripiprazole, Aripiprazole Lauroxil, Asenapine Maleate, Brexpiprazole, Clozapine, Iloperidone, Lurasidone HCl, Olanzapine, Olanzapine Pamoate, Olanzapine/Fluoxetine HCl, Paliperidone, Paliperidone Palmitate, Quetiapine Fumarate, Risperidone, Risperidone Microspheres, Ziprasidone HCl, Ziprasidone Mesylate
Lithium	35133, 1669, 1670, 37605	Lithium Aspartate, Lithium Carbonate, Lithium Citrate, Lithium Citrate Tetrahydrate

eAppendix Table 4. Comparison of Dropout between those with 12 Months of Baseline Continuous Enrollment and those with 13 Months (Baseline + 1 Month) of Continuous Enrollment

	Cohort with at least 12 Months of continuous baseline enrollment			Cohort with 12 months of continuous baseline enrollment plus at least 1 month of continuous follow-up enrollment		
	HDHP Group (N=3,560)	Control Group (N=32,577)	Standardized Difference*	HDHP Group (N=3,409)	Control Group (N=30,416)	Standardized Difference*
Age > 40 on index date, No. (%)	1,685 (47.3)	15,340 (47.1)	0.005	1,627 (47.7)	14,418 (47.4)	0.007
Age on index date, Mean (SD)	37.3 (13.6)	37.3 (13.9)	-0.006	37.4 (13.6)	37.4 (13.9)	-0.005
Female, No. (%)	2,253 (63.3)	19,958 (61.3)	0.041	2,154 (63.2)	18,647 (61.3)	0.038
No. (%) living in neighborhoods with below- poverty levels of						
<5%[1]	1,620 (45.5)	15,503 (47.6)	0.051	1,558 (45.7)	14,514 (47.7)	0.149
5%-9.9%[1]	980 (27.5)	8,698 (26.7)		929 (27.3)	8,117 (26.7)	
10%-19.9%[2]	658 (18.5)	5,913 (18.2)		628 (18.4)	5,486 (18.0)	
>=20%[2]	295 (8.3)	2,399 (7.4)		287 (8.4)	2,238 (7.4)	
Missing Poverty	7 (0.2)	64 (0.2)		7 (0.2)	61 (0.2)	
No. (%) living in neighborhoods with below-high-school education levels of						
<15%[3]	2,156 (60.6)	20,421 (62.7)	*	2,061 (60.5)	19,139 (62.9)	0.072
15%-24.9%[3]	822 (23.1)	7,331 (22.5)		790 (23.2)	6,802 (22.4)	
25%-39.9%[4]	460 (12.9)	3,782 (11.6)		440 (12.9)	3,492 (11.5)	
>=40%[4]	115 (3.2)	979 (3.0)		111 (3.3)	922 (3.0)	
Missing Education	7 (0.2)	64 (0.2)		7 (0.2)	61 (0.2)	
Race/ethnicity, No. (%)[5]						
Hispanic	174 (4.9)	1,772 (5.4)	0.058	163 (4.8)	1,679 (5.5)	0.076
Asian	52 (1.5)	439 (1.3)		49 (1.4)	419 (1.4)	
Black neighborhood	41 (1.2)	343 (1.1)		39 (1.1)	302 (1.0)	
Mixed neighborhood	453 (12.7)	4,767 (14.6)		441 (12.9)	4,439 (14.6)	
White neighborhood	2832 (79.6)	25164 (77.2)		2709 (79.5)	23489 (77.2)	
Missing Race	8 (0.2)	92 (0.3)		8 (0.2)	88 (0.3)	
ACG score, Mean (SD) **	2.2 (3.0)	2.2 (3.1)	-0.030	2.2 (3.0)	2.2 (3.1)	-0.030
United States Region, No. (%)						
West	474 (13.3)	4,526 (13.9)	0.202	444 (13.0)	4,233 (13.9)	0.238
Midwest	1,222 (34.3)	10,545 (32.4)		1,189 (34.9)	9,750 (32.1)	
South	1,612 (45.3)	12,977 (39.8)		1,531 (44.9)	12,126 (39.9)	

Northeast	250	(7.0)	4,501	(13.8)		243	(7.1)	4,281	(14.1)	
Missing Region	2	(0.1)	28	(0.1)		2	(0.1)	26	(0.1)	
Outpatient Copayment, Mean $ (SD)	18.4	(6.5)	16.2	(6.3)	0.348	18.4	(6.5)	16.2	(6.3)	0.347
Mean Employer Size (SD)	505.2	(1127.4)	4103.8	(8312.1)	-0.607	504.8	(1134.4)	4154.7	(8362.1)	-0.612
Employer Size, No. (%)										
0-99	1,633	(45.9)	7,499	(23.0)	0.911	1,554	(45.6)	5,934	(19.5)	0.973
100-999	1,572	(44.2)	9,763	(30.0)		1,511	(44.3)	9,450	(31.1)	
1000+	355	(10.0)	15,315	(47.0)		344	(10.1)	15,032	(49.4)	
No. (%) with Substance Abuse Disorder	486	(13.7)	4,164	(12.8)	0.022	486	(14.3)	4,164	(13.7)	0.013
Mean Bipolar 30-day Equivalent	1.5	(1.7)	1.6	(1.7)	-0.022	1.5	(1.7)	1.6	(1.7)	-0.030
Mean Quarterly Emergency Room Visits, per 100 patients	0.0	(0.1)	0.0	(0.1)	-0.054	0.0	(0.1)	0.0	(0.1)	-0.045
Mean Quarterly Outpatient MH Non-Psych Visits	0.7	(1.7)	0.9	(2.1)	-0.117	0.6	(1.7)	0.9	(2.1)	-0.119
Mean Quarterly Outpatient MH Psychiatrist Visits	0.6	(1.0)	0.8	(1.4)	-0.135	0.6	(1.0)	0.8	(1.4)	-0.128
Bipolar Type, No. (%)										
Type 1	2,548	(71.6)	23,662	(72.6)	0.028	2,448	(71.8)	22,104	(72.7)	0.031
Type 2	453	(12.7)	4,162	(12.8)		433	(12.7)	3,883	(12.8)	
Other	559	(15.7)	4,753	(14.6)		528	(15.5)	4,429	(14.6)	
Mean Quarterly Outpatient MH Visits	1.1	(1.9)	1.3	(2.3)	-0.134	1.0	(1.9)	1.3	(2.3)	-0.129
Months between 1st Qualifying Bipolar Diagnosis and Index Date, Mean (SD)	-25.6	(19.8)	-24.1	(17.4)	-0.078	-25.7	(19.8)	-24.4	(17.6)	-0.070
Rural/Urban Residence, No. (%)										
Rural	267	(7.5)	1,867	(5.7)	0.080	267	(7.8)	1,867	(6.1)	0.103
Urban	2,618	(73.5)	24,488	(75.2)		2,618	(76.8)	24,488	(80.5)	
Unknown	675	(19.0)	6,222	(19.1)		524	(15.4)	4,061	(13.4)	

Abbreviations: MH, mental health; ACG, Adjusted Clinical Group; HDHP, high-deductible health plan. [1]Defined as high-income. [2]Defined as low-income. [3]Defined as high-education. [4]Defined as low-education. [5]See manuscript for definition of race/ethnicity categories. *Lower standardized differences indicate greater similarity. **An ACG Scores of 1.0 represents the mean score of the reference population. *Standardized difference not able to be calculated.

eAppendix Table 5. Comparison of Dropout between those with 18 Months of Continuous Enrollment (Baseline + 6 Months) and those with the full 24 Months (Baseline + 12 Months)

	Cohort with 12 months of continuous baseline enrollment plus at least 6 months of continuous follow-up enrollment			Cohort with 12 months of continuous baseline enrollment plus at least 12 months of continuous follow-up enrollment		
	HDHP Group (N=3,162)	Control Group (N=28,719)	Standardized Difference*	HDHP Group (N=2950)	Control Group (N=26911)	Standardized Difference*
Age > 40 on index date, No. (%)	1,537 (48.6)	13,724 (47.8)	0.016	1,443 (48.9)	12,996 (48.3)	0.013
Age on index date, Mean (SD)	37.5 (13.7)	37.5 (14.0)	0.000	37.5 (13.7)	37.6 (14.0)	-0.005
Female, No. (%)	1,990 (62.9)	17,616 (61.4)	0.032	1,858 (63.0)	16,489 (61.3)	0.035
No. (%) living in neighborhoods with below- poverty levels of						
<5%[1]	1,451 (45.9)	13,725 (47.8)	0.149	1,361 (46.1)	12,935 (48.1)	0.149
5%-9.9%[1]	863 (27.3)	7,663 (26.7)		805 (27.3)	7,163 (26.6)	
10%-19.9%[2]	576 (18.2)	5,176 (18.0)		539 (18.3)	4,833 (18.0)	
>=20%[2]	266 (8.4)	2,097 (7.3)		239 (8.1)	1,926 (7.2)	
Missing Poverty	6 (0.2)	58 (0.2)		6 (0.2)	54 (0.2)	
No. (%) living in neighborhoods with below-high-school education levels of						
<15%[3]	1,914 (60.5)	18,087 (63.0)	0.044	1,792 (60.7)	16,964 (63.0)	0.157
15%-24.9%[3]	732 (23.1)	6,393 (22.3)		681 (23.1)	5,987 (22.2)	
25%-39.9%[4]	408 (12.9)	3,308 (11.5)		383 (13.0)	3,093 (11.5)	
>=40%[4]	102 (3.2)	873 (3.0)		88 (3.0)	813 (3.0)	
Missing Education	6 (0.2)	58 (0.2)		6 (0.2)	54 (0.2)	
Race/ethnicity, No. (%)[5]						
Hispanic	148 (4.7)	1,581 (5.5)	0.109	133 (4.5)	1,501 (5.6)	0.055
Asian	48 (1.5)	398 (1.4)		41 (1.4)	365 (1.4)	
Black neighborhood	36 (1.1)	295 (1.0)		34 (1.2)	278 (1.0)	
Mixed neighborhood	401 (12.7)	4,175 (14.5)		375 (12.7)	3,886 (14.4)	
White neighborhood	2,522 (79.8)	22,185 (77.2)		2,360 (80.0)	20,800 (77.3)	
Missing Race	7 (0.2)	85 (0.3)		7 (0.2)	81 (0.3)	
ACG score, Mean (SD) **	2.2 (3.0)	2.2 (3.1)	-0.030	2.2 (3.0)	2.2 (3.1)	-0.030
United States Region, No. (%)						
West	415 (13.1)	3,974 (13.8)	0.238	382 (12.9)	3,692 (13.7)	0.201
Midwest	1,114 (35.2)	9,211 (32.1)		1,046 (35.5)	8,659 (32.2)	
South	1,408 (44.5)	11,445 (39.9)		1,309 (44.4)	10,688 (39.7)	
Northeast	224 (7.1)	4,065 (14.2)		212 (7.2)	3,849 (14.3)	
Missing Region	1 (0.0)	24 (0.1)		1 (0.0)	23 (0.1)	
Outpatient Copayment, Mean $ (SD)	18.4 (6.5)	16.2 (6.3)	0.342	18.3 (6.5)	16.1 (6.4)	0.342
Mean Employer Size (SD)	517.5 (1152.4)	4263.5 (8477.9)	-0.619	530.7 (1175.2)	4393.9 (8619.5)	-0.628
Employer Size, No. (%)						

0-99	1,411	(44.6)	5,064	(17.6)	1.027	1,292	(43.8)	4,108	(15.3)	1.082
100-999	1,415	(44.8)	8,950	(31.2)		1,335	(45.3)	8,460	(31.4)	
1000+	336	(10.6)	14,705	(51.2)		323	(10.9)	14,343	(53.3)	
No. (%) with Substance Abuse Disorder	486	(15.4)	4,164	(14.5)	0.021	486	(16.5)	4,164	(15.5)	0.023
Mean Bipolar 30-day Equivalent	1.6	(1.7)	1.6	(1.8)	-0.026	1.6	(1.7)	1.6	(1.8)	-0.021
Mean Quarterly Emergency Room Visits, per 100 patients	0.0	(0.1)	0.0	(0.1)	-0.042	0.0	(0.1)	0.0	(0.1)	-0.035
Mean Quarterly Outpatient MH Non-Psych Visits	0.6	(1.7)	0.8	(2.1)	-0.117	0.6	(1.6)	0.8	(2.1)	-0.122
Mean Quarterly Outpatient MH Psychiatrist Visits	0.6	(1.0)	0.8	(1.4)	-0.142	0.6	(1.0)	0.8	(1.4)	-0.142
Bipolar Type, No. (%)										
Type 1	2280	(72.1)	20884	(72.7)	0.031	2,135	(72.4)	19,598	(72.8)	0.029
Type 2	392	(12.4)	3,655	(12.7)		367	(12.4)	3,414	(12.7)	
Other	490	(15.5)	4,180	(14.6)		448	(15.2)	3,899	(14.5)	
Mean Quarterly Outpatient MH Visits	1.0	(1.9)	1.3	(2.3)	-0.136	1.0	(1.9)	1.3	(2.3)	-0.138
Months between 1st Qualifying Bipolar Diagnosis and Index Date, Mean (SD)	-26.2	(20.0)	-24.7	(17.7)	-0.082	-26.8	(20.2)	-25.1	(17.9)	-0.090
Rural/Urban Residence, No. (%)										
Rural	267	(8.4)	1,867	(6.5)	0.055	267	(9.1)	1,867	(6.9)	
Urban	2,618	(82.8)	24,488	(85.3)		2,618	(88.7)	24,488	(91.0)	0.074
Unknown	277	(8.8)	2,364	(8.2)		65	(2.2)	556	(2.1)	

Abbreviations: MH, mental health; ACG, Adjusted Clinical Group; HDHP, high-deductible health plan. [1]Defined as high-income. [2]Defined as low-income. [3]Defined as high-education. [4]Defined as low-education. [5]See manuscript for definition of race/ethnicity categories. *Lower standardized differences indicate greater similarity. **An ACG Scores of 1.0 represents the mean score of the reference population

eAppendix Table 6. Total out-of-pocket spending per member 1 year before and after members with bipolar disorder experienced a mandated switch to HDHPs, compared with contemporaneous members with bipolar disorder remaining in low-deductible plans

	HDHP		Control		Absolute Change, HDHP vs. Control, (95% CI)			Relative Change, HDHP vs. Control, % (95% CI)		
	Baseline	Follow-Up	Baseline	Follow-Up						
Total Out-of-Pocket Spending, $	1756.8	2185.6	1563.8	1608.1	379.0	(291.5,	466.5)	21.0	(15.7,	26.3)

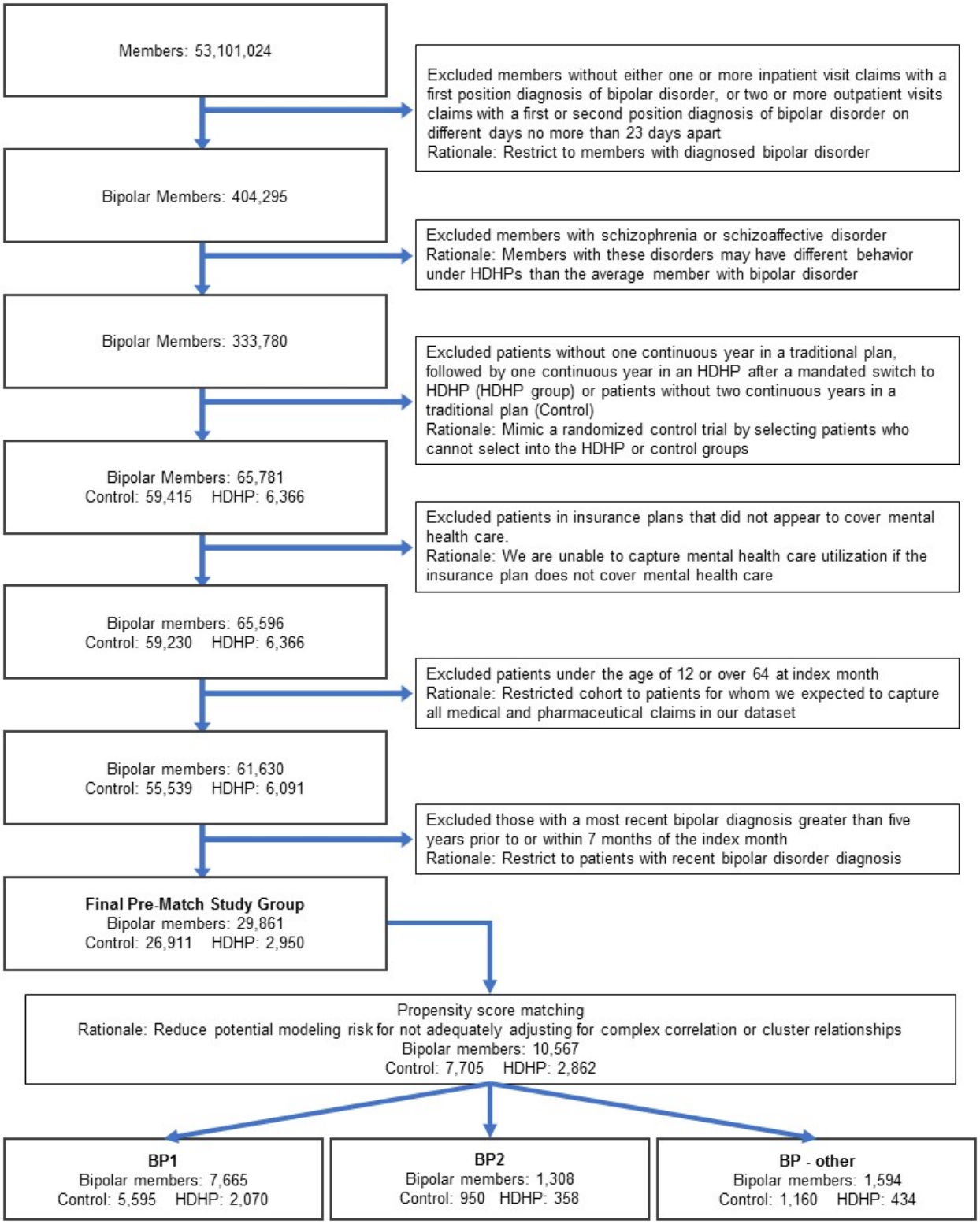
Abbreviations: HDHP, high-deductible health plan. **Note**: Regression model used a zero-inflated negative binomial distribution and was adjusted for employer size, calendar year of index date, gender, age category, race, ethnicity, and neighborhood income level and education level

eAppendix Table 7. Annual mental health outpatient visits to non-mental health providers for mental health conditions 1 year before and after members with bipolar disorder experienced a mandated switch to HDHPs, compared with contemporaneous members with bipolar disorder remaining in low-deductible plans

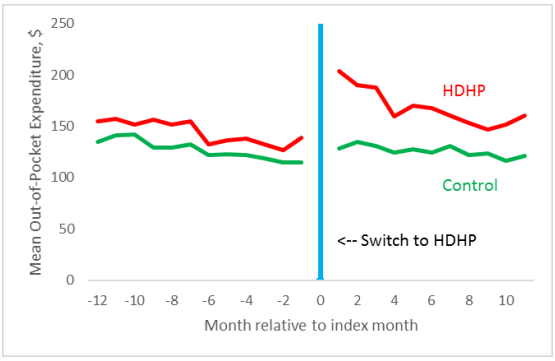
	HDHP		Control		Absolute Change, HDHP vs. Control, (95% CI)			Relative Change, HDHP vs. Control, % (95% CI)		
	Baseline	Follow-Up	Baseline	Follow-Up						
Rate (mean visits/member/year)	0.4	0.2	0.4	0.3	0.0	(-0.1,	0.1)	-2.7%	(-28.5%,	23.1%)

Abbreviations: HDHP, high-deductible health plan. **Note**: Regression model used a negative binomial distribution and was adjusted for employer size, calendar year of index date, gender, age category, race, ethnicity, and neighborhood income level and education level

eAppendix Figure 1. CONSORT cohort selection diagram with reasons for excluding members from sample.

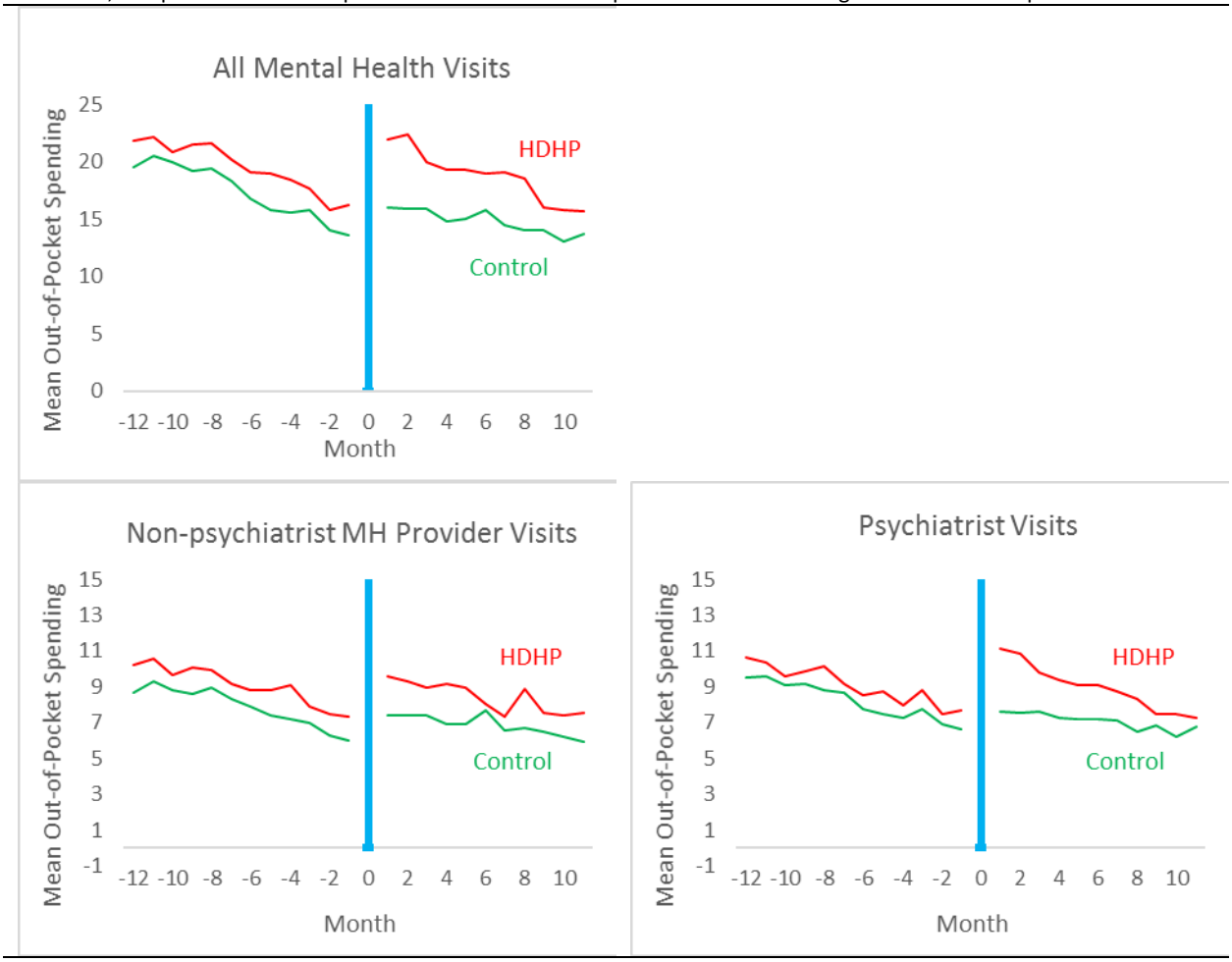


eAppendix Figure 2. Monthly total out-of-pocket spending per member 1 year before and after members with bipolar disorder experienced a mandated switch to HDHPs, compared with contemporaneous members with bipolar disorder remaining in low-deductible plans.



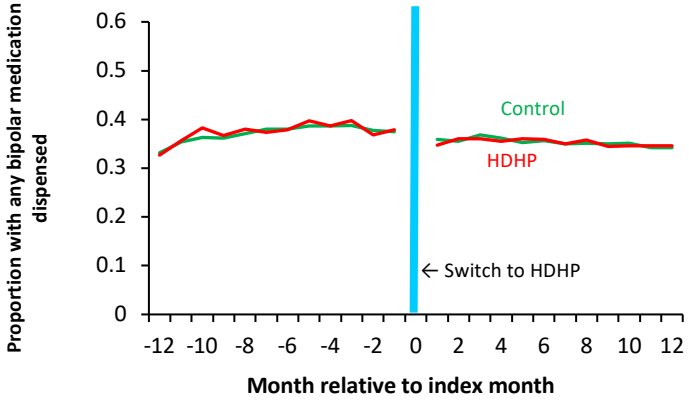
Abbreviations: HDHP, high-deductible health plan.

eAppendix Figure 3. Monthly out-of-pocket spending for overall mental health visits, non-psychiatrist mental health provider visits, and psychiatrist visits 1 year before and after members with bipolar disorder experienced a mandated switch to HDHPs, compared with contemporaneous members with bipolar disorder remaining in low-deductible plans.



Abbreviations: HDHP, high-deductible health plan; MH, mental health. Vertical blue lines are centered at the index month when HDHP group members were switched into HDHPs.

eAppendix Figure 4. Monthly fills of any bipolar medication 1 year before and after members with bipolar disorder experienced a mandated switch to HDHPs, compared with contemporaneous members with bipolar disorder remaining in low-deductible plans.



Abbreviations: HDHP, high-deductible health plan. Vertical blue lines are centered at the index month when HDHP group members were switched into HDHPs.

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