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Association between chiropractic spinal manipulative therapy and benzodiazepine prescription in patients with radicular low back pain: a retrospective cohort study using real-world data from the USA

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ABSTRACT

Objectives Although chiropractic spinal manipulative therapy (CSMT) and prescription benzodiazepines are common treatments for radicular low back pain (rLBP), no research has examined the relationship between these interventions. We hypothesise that utilisation of CSMT for newly diagnosed rLBP is associated with reduced odds of benzodiazepine prescription through 12 months' follow-up.

Design Retrospective cohort study.

Setting National, multicentre 73-million-patient electronic health records-based network (TriNetX) in the USA, queried on 30 July 2021, yielding data from 2003 to the date of query.

Participants Adults aged 18–49 with an index diagnosis of rLBP were included. Serious aetiologies of low back pain, structural deformities, alternative neurological lesions and absolute benzodiazepine contraindications were excluded. Patients were assigned to cohorts according to CSMT receipt or absence. Propensity score matching was used to control for covariates that could influence the likelihood of benzodiazepine utilisation.

Outcome measures The number, percentage and OR of patients receiving a benzodiazepine prescription over 3, 6 and 12 months' follow-up prematching and postmatching.

Results After matching, there were 9206 patients (mean (SD) age, 37.6 (8.3) years, 54% male) per cohort. Odds of receiving a benzodiazepine prescription were significantly lower in the CSMT cohort over all follow-up windows prematching and postmatching (p<0.0001). After matching, the OR (95% CI) of benzodiazepine prescription at 3 months was 0.56 (0.50 to 0.64), at 6 months 0.61 (0.55 to 0.68) and 12 months 0.67 (0.62 to 0.74). Sensitivity analysis suggested a patient preference to avoid prescription medications did not explain the study findings.

Conclusions These findings suggest that receiving CSMT for newly diagnosed rLBP is associated with reduced odds of receiving a benzodiazepine prescription during follow-up. These results provide real-world evidence of practice guideline-concordance among patients entering this care pathway. Benzodiazepine prescription for rLBP should be further examined in a randomised trial including patients receiving chiropractic or usual medical care, to reduce residual confounding.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study used an a priori protocol to examine a large, national, multicentre population; however, smaller private practice healthcare settings were not included.
⇒ A new-user, active-comparator design was used to reduce bias and improve the comparability of cohorts.
⇒ Considering patients with comorbidities or characteristics unrelated to radicular low back pain could be more likely to receive a benzodiazepine prescription, extensive propensity score matching was used to control for these confounding variables.
⇒ As chiropractors cannot prescribe benzodiazepines, we performed a sensitivity analysis to examine the influence of a patient preference to avoid prescription medications.
⇒ Given the possibility of residual confounding, these findings should be further investigated using a randomised controlled trial.

INTRODUCTION

Benzodiazepines (BZDs) are a class of psychoactive medication increasingly prescribed for patients with low back pain (LBP),[1–3] and commonly used in patients with radicular LBP (rLBP),[4] a subcategory of back pain with nerve root involvement.[5] Insufficient evidence supporting the efficacy of BZDs for LBP[6] and the risk of serious adverse events[7] has led clinical practice guidelines (CPGs) to discourage their use for this condition.[8–11] Although chiropractors frequently use non-pharmacological treatments for patients with rLBP,[12] no research has examined the association between chiropractic care and receipt of BZDs prescribed by other providers.

Previous research identified that patients receiving care with a chiropractor for incident LBP had reduced odds of receiving an opioid prescription compared with other provider types.[13–15] Like BZDs, opioids are prescribed for rLBP[4] despite CPGs recommending their limited use.[8–11] Given these parallels, the phenomenon of reduced prescription in patients receiving chiropractic care may extend to BZDs. Considering the practice guidance to limit opioid and BZD prescribing for LBP, research to identify care pathways associated with decreased prescription of these medications could inform patients' and clinicians' choice of initial treatment strategy.

Although chiropractors cannot prescribe opioids or BZDs within their scope of practice,[16] prescription of these medications may reflect the quality of patient care. Prescription of BZDs has been proposed as a surrogate marker for greater pain severity[17] and could serve as an indicator of provider concordance with LBP CPGs.[8–11]

Limited research has examined the association between other allied health interventions (eg, acupuncture, physical therapy) and BZD prescription. In one study, military personnel receiving at least four acupuncture treatments for back pain or other conditions over 1 year had a 14% reduction of BZD utilisation during a 60-day follow-up window.[18] A pharmacist-led opioid stewardship programme was associated with reduced opioid and BZD coprescription.[19] One study observed an increase in BZD prescription among patients receiving a physical therapy evaluation alongside an emergency department visit for back or neck pain.[20]

BZDs are sedative-hypnotic medications that act as central nervous system (CNS) depressants, and have anticonvulsant, anxiolytic and muscle relaxant properties.[21] Their primary mechanism is to potentiate the effect of γ-aminobutyric acid, the main inhibitory CNS neurotransmitter.[21 22]

Interest in prescribing BZDs for LBP developed during the second half of the 20th century,[23–25] with a significant increase in the early 21st Century.[1–3] The number of physician visits during which BZDs was prescribed for back pain and chronic pain in the USA more than tripled from 2003 to 2015.[1] From 2008 to 2015, 11.5% of opioid-naïve adults were prescribed a BZD over a 12-month window after index LBP diagnosis.[4] In a 2018 survey, 27.0% of LBP patients reported being recommended BZDs by a medical doctor in the previous 12 months.[26]

As adjuvant analgesics,[22 27] BZDs have been used to treat LBP-related muscle spasms[23 28] and neuropathic pain.[24 28] Although early research suggested BZDs had a direct analgesic effect related to central or peripheral receptor-mediated interactions,[24 29] there has not been conclusive evidence that BZDs produce an overall analgesic effect.[22] Accordingly, researchers have proposed that benefits related to pain management could result from BZDs alleviating pain-related anxiety and/or depression.[27]

Adverse effects of BZDs include sedation, addiction[7] and increased risk of suicide.[30] Dependence occurs in 20%–100% of those taking BZDs for at least 1 month.[22] There is an increased risk of fatal, accidental overdose with concurrent use of BZDs and opioids.[7] BZDs are also a risk factor for motor vehicle collisions, falls and associated injuries, which may be explained by BZD-related psychomotor, balance and cognitive impairment.[7]

Although BZDs are increasingly prescribed for LBP, there is no strong evidence supporting their use for this condition. Recent CPGs from the National Institute for Health and Care Excellence (2020),[10] Veterans Affairs and Department of Defense (2019),[8] Global Spine Care Initiative (2018)[9] and Belgian Health Care Knowledge Centre (2017)[11] recommended against prescribing BZDs for LBP while those of the American College of Physicians (2017) concluded there was insufficient evidence for their effectiveness in acute or subacute LBP.[6]

Chiropractors are portal-of-entry providers that treat a variety of musculoskeletal conditions, the most common of which is LBP.[31] In a 2019 survey, US chiropractors reported managing radiculopathy at least once per week, and being the first provider to diagnose radiculopathy in 74% of patients.[12] The most common treatment chiropractors employ is spinal manipulative therapy (SMT), also called chiropractic SMT (CSMT). Systematic reviews have found evidence supporting this treatment for acute,[32] chronic[33] and radicular LBP,[34] while documenting its safety.[32 33]

SMTs include hands-on and instrumented-assisted therapies applied to the spine, excluding soft tissue treatments such as massage.[35] These include high-velocity, low-amplitude manipulation involving a thrust,[36] and low-force, non-thrust or mobilisation techniques. Although other practitioners including physical therapists and osteopaths may perform SMT, chiropractors administer the majority of this therapy in the USA.[35 37]

SMT may alleviate rLBP through several mechanisms. Specifically, SMT may relax hypertonic (abnormally tight) muscles,[38 39] or release adhesions surrounding the lumbar disc or facet joints,[38 40] leading to improved range of motion in those with rLBP.[41] In general, SMT has a hypoalgesic (pain-reducing) effect which may depend on patient expectations.[42] Accordingly, it is possible that rLBP relief provided by CSMT may offer an alternative option for patients who could otherwise be prescribed BZDs.

Objectives

We hypothesise that adults receiving care for new diagnosis of rLBP with CSMT will have reduced odds of receiving a BZD prescription compared with those initiating care with a non-chiropractic provider (ie, non-CSMT) over a follow-up windows of 3, 6 and 12 months, which will be maintained after controlling for confounding variables.

METHODS

Study design

This study followed an a priori protocol,[43] which was modified to standardise the exclusion assessment window from

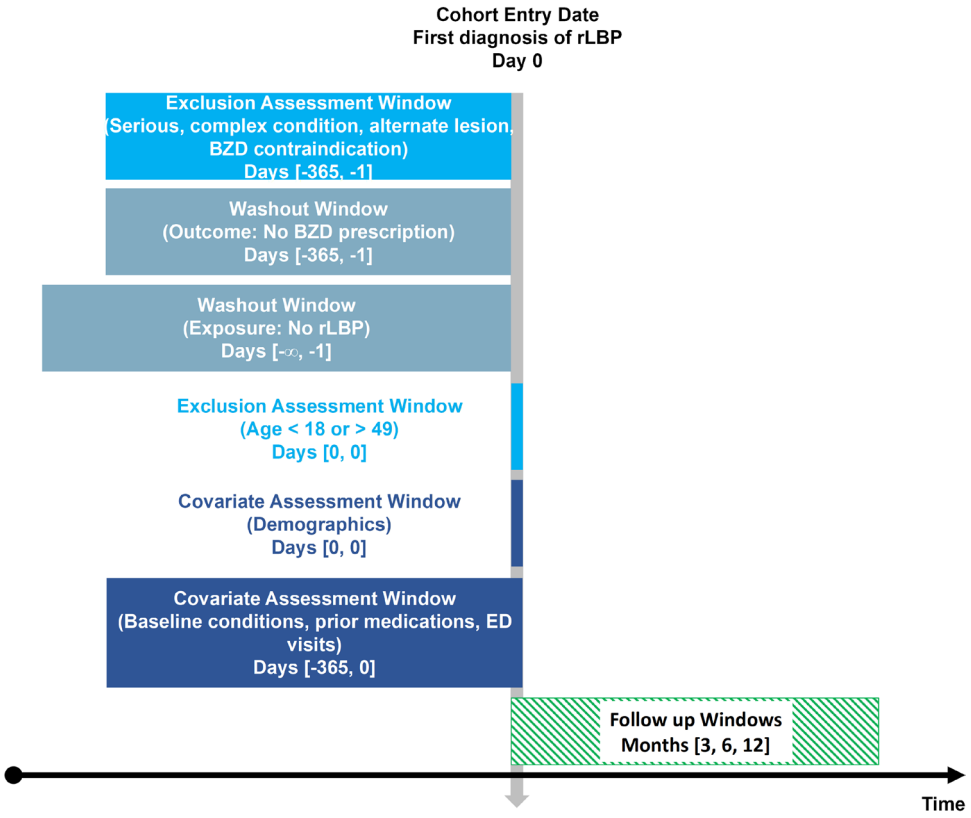

Figure 1 Graphical depiction of study design the vertical grey arrow represents the index date when each individual patient was diagnosed with radicular low back pain (rLBP). Text to the left of this arrow describes study selection criteria which were assessed during time windows ((#, #)) of days preceding and the index date. Rectangles overlapping with the vertical grey arrow also overlap with the index diagnosis date (day 0). The wash-out period for rLBP was infinite (∞). The follow-up windows are described in terms of months. Image created using creative commons template from Schneeweiss *et al*.[78] BZD, benzodiazepines; ED, emergency department.

days −365 to −1 (figure 1). Having exclusion windows of different durations was not possible using TriNetX. This retrospective cohort study follows the Strengthening the Reporting of Observational Studies in Epidemiology guideline,[44] uses aggregated real-world data, and includes an active comparator, new-user design, which is recommended to reduce bias in real-world data studies.[45]

Setting and data source

This study used the TriNetX (TriNetX, Cambridge, Massachusetts, USA) national research network.[46] This network includes deidentified, aggregated electronic heath records data, from 73 million patients and 52 healthcare organisations (HCOs) at the time of sampling. Although geographical and institutional information of participating HCOs is anonymised, these are typically academically affiliated medical centres that provide outpatient, inpatient and specialty care. This data source includes patients' treatments, problems list and diagnoses.[47]

TriNetX deidentifies data to safeguard protected health information by restricting the population to less than age 90, and rounding patient counts less than 10–10. Queries are possible using Current Procedural Terminology (CPT), Veterans Health Administration National Drug File (VANDF) and International Classification of Disease (ICD) codes. At University Hospitals of Cleveland, access to TriNetX is managed by the Clinical Research Centre. A TriNetX query on 30 July 2021 yielded data ranging from 2003 to 2021.

Participants

Eligibility criteria

Inclusions

Adults aged 18–49 with incident rLBP were included, while serious pathology, structural deformity, prior surgery and alternate neurological lesions causing LBP were excluded. Radicular LBP is distinct from referred and axial forms of LBP, having a greater likelihood of pain radiating distal to the knee, neurologic deficits, neural tension and greater activity limitation.[48 49] This study examined the LBP subcategory of rLBP to create uniformity between cohorts with regard to clinical features and odds of receiving a BZD prescription.

The infinite washout window for rLBP establishes new-users with a follow-up beginning at index rLBP diagnosis. The rLBP phenotype (see online supplemental table 1) included ICD-10 codes describing 'lumbosacral radiculopathy' or 'nerve root disorder' and 'sciatica,' a synonym for rLBP.[5]

The age range of 18–49 was chosen to narrow the population to patients with rLBP resulting from lumbar disc herniation (LDH) rather than lumbar spinal stenosis

(LSS) thereby improving equipoise with respect to clinical presentation and treatment patterns. The most common cause of rLBP in patients less than 50 is LDH.[48 50] Conversely, the prevalence of LSS increases around age 60.[51]

Lumbar intervertebral disc displacement or LDH codes were not used as inclusions, in preference for more clinically relevant rLBP codes. An LDH increases the odds of rLBP only by a small degree, as LDH can be asymptomatic,[52] or cause localised LBP,[53] which is treated differently than rLBP.[54 55] Disc degeneration, disc bulging or spondylosis codes were not included, which do not necessarily cause radiculopathy.[53]

Patients were divided into two cohorts according to receipt of CSMT, resulting in CSMT and non-CSMT cohorts (see online supplemental table 2). This was done using the CPT codes 98940, 98941 and 98 942. These codes are relatively specific to the chiropractic profession in the USA.[37] The non-CSMT cohort was considered an active-comparator as these patients were actively engaged in the healthcare system for evaluation and/or treatment of rLBP.[56]

Exclusions

Exclusions were assessed within 365 days preceding index diagnosis (see online supplemental table 3). Serious pathology causing LBP was excluded via ICD-10 codes used by previous studies for this reason: cauda equina syndrome, infection, fracture or malignancy.[13 14 57]

Previous lumbar surgery (postlaminectomy syndrome and arthrodesis status) was excluded which can represent a relative contraindication to CSMT,[58] while structural deformities (spondylolisthesis and scoliosis) were excluded which can increase the odds of lumbar surgery.[59]

Absolute contraindications to BZDs were excluded, which could reduce the odds of BZD prescription: closed-angle glaucoma,[21] chronic obstructive pulmonary disease,[21] myasthenia gravis,[21 28] Parkinson's disease,[21] porphyria[21] and pregnant or breastfeeding women[21] (ICD-10: O00-O9A).

Stenosis of any spinal region (ICD-10: M48.0), together with LSS, were excluded. Cervical and thoracic stenosis could cause alternate neurological lesions, while the clinical features and management of LSS differs from rLBP related to LDH.[60] Patients with LSS are also older and have higher rates of comorbidities[61] and polypharmacy.[62] Lumbosacral plexopathy and myelopathy were excluded given these alternative neurological lesions are potentially more complex, prompting different care pathways.

Variables

Benzodiazepines

The VANDF code CN302 (benzodiazepine derivative sedatives/hypnotics) was used to identify BZD prescriptions.[63] This category includes medications containing alprazolam, chlordiazepoxide, clonazepam, clorazepate, diazepam, estazolam, flurazepam, lorazepam, midazolam, oxazepam, remimazolam, temazepam and triazolam.

Our 12-month BZD wash-out window adhered to a standard for defining BZD naïve patients,[64] while a 12-month follow-up window enabled comparison with previous data regarding BZD utilisation.[2 4 26] Additional 3-month and 6 month follow-up windows allowed examination of temporal trends in BZD prescription.

Potential confounders

Confounders present within 365 days preceding and including the index date of rLBP diagnosis were controlled for via propensity score matching (PSM) (see online supplemental table 4). These were specified a priori[43] based on evidence of an association with BZD utilisation (positive or negative):

- Age, sex, race and ethnicity (positive or negative).[65 66]
- Tobacco use,[65 66] and prescription of opioids or stimulants (positive).[66]
- Prior emergency department visits (positive).[65]
- Mental, behavioural and neurodevelopmental disorders including anxiety, depression[28 67] and substance use disorders including alcohol related disorders (positive).[65 66]
- Diseases of the nervous system including movement disorders,[28] multiple sclerosis,[22] epilepsy,[28] new daily persistent headache,[22] insomnia,[21 28] trigeminal neuralgia[28] and various pain syndromes (positive)[22 68]; and sleep apnoea, in which BZDs are used with caution (negative).[21 28]
- Liver and renal disorders: BZDs used with caution (negative).[21]
- Non-BZDs: Concurrent prescription with BZDs discouraged[69] due to risk of side effects (negative).[69 70]

Sample size

A total sample size of 357 was calculated using opioid utilisation data, given the lack of data regarding BZDs in CSMT recipients, and because opioids are also prescribed for rLBP. Calculations were made using G*Power (Universität Düsseldorf), using z-tests for logistic regression, α error of 0.05, power of 0.95, R^2 of 0.9 and OR of 0.23 from a prior study,[14] assuming a normal distribution. The probability for the alternative hypothesis was 0.35, the incidence of opioid utilisation for LBP in a prior study.[4]

Statistical methods

Propensity scores for patients in each cohort were calculated using TriNetX via logistic regression. A greedy nearest-neighbour matching algorithm was used,[71] with a 1:1 ratio and calliper of 0.01 pooled SD. Baseline characteristics were compared using a Pearson χ^2 test or independent-samples t-test.

Sensitivity analysis was conducted using the E-value, the minimum strength of association that unmeasured confounders would need to explain away an observational association, as measured using risk ratio (RR).[72] Variables associated with both the exposure (CSMT) and outcome (BZDs) may be considered for E-value analysis.[72] A literature search revealed that patients 'against taking

Table 1 Baseline characteristics before and after propensity score matching

Characteristic	Before matching			After matching		
	CSMT	Non-CSMT	P value	CSMT	Non-CSMT	P value
No.	9206	491 187		9206	9206	
Age	37.6±8.31	37.4±8.25	0.0052	37.6±8.31	37.6±8.28	0.9476
Sex						
Female	4998 (54.29%)	267 089 (54.37%)	0.8703	4998 (54.29%)	5012 (54.44%)	0.8359
Male	4207 (45.69%)	222 373 (45.27%)	0.416	4207 (45.69%)	4191 (45.52%)	0.8129
Race						
Black	427 (4.63%)	85 622 (17.43%)	<0.001	427 (4.63%)	438 (4.75%)	0.7016
White	6879 (74.72%)	315 701 (64.27%)	<0.001	6879 (74.72%)	6923 (75.20%)	0.4542
Asian	104 (1.13%)	10 661 (2.17%)	<0.001	104 (1.13%)	101 (1.09%)	0.8331
Ethnicity						
Hispanic/Latino	206 (2.23%)	50 519 (10.28%)	<0.001	206 (2.23%)	200 (2.17%)	0.7633
Not Hispanic/Latino	7458 (81.01%)	300 924 (61.26%)	<0.001	7458 (81.01%)	7501 (81.47%)	0.4169
Conditions (ICD-10)						
Diseases of the nervous system (G00–G99)	5736 (62.30%)	141 485 (28.80%)	<0.001	5736 (62.30%)	5749 (62.44%)	0.8432
Mental, behavioural and neurodevelopmental disorders (F01–F99)	4825 (52.41%)	132 980 (27.07%)	<0.001	4825 (52.41%)	4807 (52.21%)	0.7906
Other diseases of liver (K76)	304 (3.30%)	10 014 (2.03%)	<0.001	304 (3.30%)	260 (2.82%)	0.0599
Tobacco use (Z72.0)	53 (0.57%)	9255 (1.88%)	<0.001	53 (0.57%)	49 (0.53%)	0.6912
Chronic kidney disease (N18)	52 (0.56%)	3078 (0.62%)	0.4562	52 (0.56%)	40 (0.43%)	0.2098
Medications (VANDF)						
Opioid analgesics (CN101)	5924 (64.34%)	145 258 (29.57%)	<0.001	5924 (64.34%)	5973 (64.88%)	0.4501
CNS stimulants (CN800)	2610 (28.35%)	21 786 (4.43%)	<0.001	2610 (28.35%)	2574 (27.96%)	0.5553
Sedatives/hypnotics, other (CN309)	899 (9.76%)	20 030 (4.07%)	<0.001	899 (9.76%)	899 (9.76%)	1
Emergency department services	4276 (46.44%)	114 319 (23.27%)	<0.001	4276 (46.44%)	4273 (46.41%)	0.9646

CNS, central nervous system; CSMT, chiropractic spinal manipulative therapy; ICD, International Classification of Diseases; VANDF, Veterans Health Administration National Drug File.

prescription drugs' had an OR of 1.57 for self-referring to a chiropractor compared with a medical physician.[73] This was converted to an RR via square transformation,[74] to yield a value of 1.25. The current study E-values were determined by entering point estimates and confidence intervals (CIs) into an E-value calculator.[75]

Patient and public involvement

No patient or public involvement.

RESULTS

Participants

A large population was identified for each cohort (table 1). Before PSM, there were 9206 patients in the CSMT cohort and 491 187 patients in the non-SMT cohort. After PSM, there were 9206 patients in each cohort (mean (SD) age, 37.6 (8.3) years, 54% male). Before PSM, the CSMT cohort had a higher percentage of white patients (74.7% vs 64.3%) and lower percentage of other races and individuals not Hispanic/Latino. Before matching, the CSMT cohort had a greater frequency, relative to the non-CSMT cohort, of ICD-10 categories 'Diseases of the nervous system' and 'Mental, behavioural and neurodevelopmental disorders,' as well as liver disease, prior emergency department visits, prescription of opioid analgesics, CNS stimulants and sedatives/hypnotics. Tobacco use was less frequent in the CSMT cohort. These variables were not significantly different post-PSM (p>0.05).

Descriptive data

Each cohort had a high number of average facts per patient (CSMT 2443 vs non-CSMT 905) suggesting a minimal effect of missing data. A visual diagnostic revealed that propensity scores were well matched (see online supplemental figure 1).

Key results

The odds of receiving a BZD prescription were lower in the CSMT cohort over all follow-up windows, with statistical

Table 2 Key results

	Before PSM		After PSM	
	CSMT n=9206	Non-CSMT n=491 187	CSMT n=9206	Non-CSMT n=9206
3 months				
BZD No. (%)	409 (4.4)	33 932 (6.9)	409 (4.4)	701 (7.6)
OR (CI)	0.63 (0.57 to 0.70)	(reference)	0.56 (0.50 to 0.64)	(reference)
6 months				
BZD No. (%)	577 (6.3)	41 807 (8.5)	577 (6.3)	908 (9.9)
OR (CI)	0.72 (0.66–0.78)	(reference)	0.61 (0.55–0.68)	(reference)
12 months				
BZD No. (%)	862 (9.4)	53 294 (10.9)	862 (9.4)	1223 (13.3)
OR (CI)	0.85 (0.79–0.91)	(reference)	0.67 (0.62–0.74)	(reference)

BZP, benzodiazepine prescription; CSMT, chiropractic spinal manipulative therapy; No, number; PSM, propensity score matching.

significance (p<0.0001) for each window (table 2). After PSM, the OR (95% CI) was 0.56 (0.50 to 0.64) over 3 months, 0.61 (0.55 to 0.68) over 6 months and 0.67 (0.62 to 0.74) over 12 months.

Sensitivity analysis

Each of the post-PSM ORs yielded E-values (lower CI) of 2.94 (2.5) for the 3-month follow-up window, 2.66 (2.3) for 6 months and 1.64 (1.43) for 12 months. The RR for patients 'against taking prescription drugs' (1.25) was less than each of these E-values and lower CIs, indicating this unmeasured confounder did not account for the reduced ORs in the CSMT relative to the non-CSMT cohorts.

DISCUSSION

To our knowledge, this is the first study to examine the association between CSMT and subsequent BZD prescription which was achieved through the use of a large, real-world database. Before PSM, recipients of CSMT had significantly reduced odds of BZD prescription for each 3-month, 6-month and 12-month follow-up window. After PSM, the magnitude of these associations was increased and maintained statistical significance. Sensitivity analysis demonstrated that a chiropractic patient preference to avoid 'prescription drugs' could not explain away these results.

The frequency of BZD prescription for rLBP occurring over 12 months in the non-CSMT cohort (13.3% post-PSM) is within the range of BZD utilisation in prior studies of LBP (11.5%–27.0%).[2 4 26] A disproportionately large percentage of BZD prescriptions occurred during the initial 3-month window (CSMT 47.5%, non-CSMT 57.3%, post-PSM), suggesting a short-term window is needed when examining BZD prescription.

The identified post-PSM ORs had a diminishing magnitude from 3 to 12 months follow-up, indicating that the negative association between CSMT and BZD prescription is strongest in the short term. It is unclear when or if this association would diminish to the null, and a longer follow-up window would be needed to examine this question.

Reduced odds of receiving a BZD prescription among patients using CSMT for newly diagnosed rLBP is a marker of greater guideline-concordance in patients entering this treatment pathway. These results reinforce the use of CSMT as a first-line non-pharmacological option for adults with rLBP.

Although our results are consistent with prior studies identifying a reduced odds of opioid prescription in recipients of CSMT,[15] the association between CSMT and prescription opioids or BZDs should be explored further with a randomised controlled trial. Retrospective studies could be conducted to replicate these findings in other LBP populations or settings, while prospective studies could reduce confounding.

Limitations

First, as an observational study, we cannot infer causality between CSMT and BZD prescriptions. In addition, prescription of BZDs is only one indicator of care and may not correspond with other markers such as patient-reported outcomes, pain severity, ability to work and avoidance of surgery.

Second, residual confounding could be present as variables associated with BZD utilisation, including education level,[65 66] income,[67] alcohol intake (not meeting criteria for alcohol related disorders),[65] marital status, employment status and self-rated health[65] were not available in TriNetX. These were also not applicable to E-value analysis given the lack of association with CSMT. Pain severity was likewise unavailable in the dataset for propensity matching, and thus could have differed between cohorts. It is possible that patients with milder pain could be more likely to trial treatments such as CSMT before moving on to BZDs. Contextual effects, such as patients' expectations that CSMT, would have a beneficial effect could have affected our results, yet this variable was not possible to control for. Further, patient functional status and

lumbar imaging findings were unavailable for propensity matching and these variables could have differed between cohorts.

Third, this study does not incorporate non-clinical variables related to the provider–patient interaction. Physician time constraints could result in pressure to prescribe BZDs.[76] Conversely, chiropractors cannot yield to such pressure given they cannot prescribe BZDs.

Fourth, although we narrowed the study population and controlled for several confounders, BZDs could have been differentially prescribed for comorbid conditions. Although we controlled for substance use disorders, we were unable to directly examine illicit use of BZDs. The strength and duration of BZD prescriptions was unavailable, which would allow comparisons and risk stratification using enhanced levels of measurement such as diazepam equivalents.

Fifth, diagnoses of rLBP could be misclassified as new if patients were previously treated at a non-TriNetX facility or had incorrect data in their chart. This could not be prevented using ICD-10 codes, which lack acute/chronic designations for LBP. Misclassification could also occur if patients developed an excluded condition (eg, cauda equina syndrome) during follow-up, given exclusions were retrospective. Although we attempted to control for symptom duration with patients required to have newly diagnosed rLBP, it is possible that the mean interval between symptom onset and diagnosis varied between cohorts. We were unable to validate the rLBP phenotype accuracy as the study used multicentre, deidentified data.

Sixth, although our sensitivity analysis provides insight into whether the patients' desire not to take prescription drugs was a factor, this question may not be specific enough. Some patients may hold attitudes and beliefs to not take potentially sedating medications such as BZDs, which may not hold true for other medication classes. Further, those patients may be more inclined to self-select to chiropractic treatment.

Finally, roughly 5.4%[12] of US chiropractors are employed by HCOs in the TriNetX network. Chiropractic care pathways in these HCOs may differ from smaller private practices. Results could also be influenced by the overall care provided by chiropractors, rather than an isolated effect of CSMT. Chiropractors also educate patients, perform soft tissue therapies, exercise therapies and refer for other services when needed.[12 77] Provision of such interventions could not be quantified or isolated using TriNetX. The percentage of patients receiving SMT from non-chiropractic providers (eg, osteopaths, physical therapists) could not be quantified, however, this would be a small contributor to overall SMT received.[35]

CONCLUSIONS

This study identified a significant reduction in odds of BZD prescription over 3-month, 6-month and 12-month follow-up windows in adults initiating care for rLBP with CSMT. These results suggest that CSMT, influences BZD utilisation, and patients entering this pathway for rLBP are more likely to receive guideline-concordant care with respect to BZD prescription. As these results derive from academically affiliated HCOs, results may not be generalisable to the broader healthcare landscape. These findings should be validated in other LBP populations and settings and examined using a randomised controlled trial.

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