

A retrospective analysis of pain changes and opioid use patterns temporally associated with a course of chiropractic care at a publicly funded inner-city facility

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Background: Non-pharmacologic treatment, including chiropractic care, is now recommended instead of opioid prescriptions as the initial management of chronic spine pain by clinical practice guidelines. Chiropractic care, commonly including spinal manipulation, has been temporally associated with reduced opioid prescription in veterans with spine pain.

Purpose: To determine if chiropractic management including spinal manipulation was associated

Analyse rétrospective de l'évolution de la douleur et des habitudes de consommation des opioïdes temporairement associées à des soins chiropratiques au sein d'un établissement du centre-ville financé par l'État
Contexte : Conformément aux directives de pratique clinique, un traitement non pharmacologique, notamment des soins chiropratiques, à la place de prescriptions d'opioïdes est désormais recommandé dans le traitement initial de la douleur chronique à la colonne vertébrale. Les soins chiropratiques, qui comprennent habituellement la manipulation vertébrale, ont été liés de manière provisoire à une consommation

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with decreased pain or opioid usage in financially disadvantaged individuals utilizing opioid medications and diagnosed with musculoskeletal conditions.

Methods: A retrospective analysis of quality assurance data from a publicly funded healthcare facility was conducted. Measures included numeric pain scores of spine and extremity regions across three time points, opioid utilization, demographics, and care modalities.

Results: Pain and opioid use significantly decreased concomitant with a course of chiropractic care.

Conclusions: A publicly funded course of chiropractic care temporally coincided with statistically and clinically significant decreases in pain and opioid usage in a financially disadvantaged inner-city population.

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KEY WORDS: analgesics, back pain, chiropractic, chronic pain, low-income population, musculoskeletal manipulations, musculoskeletal pain, opioid, single-payer system, spine

Introduction

Since 1994, there has been a 4-fold increase in opioid prescription in the United States and long-term opioid use has become a major public health concern.^{1,2} In recent years there has been a decrease in opioid prescription for chronic pain;³ however, opioid prescription for back pain remains high⁴⁻⁶, and prescription rates in the US and Canada are two or three times higher than in most European countries⁴. This is problematic because of the high incidence of addiction and overdose related deaths associated

réduite d'opioïdes sur ordonnance chez les vétérans souffrant de douleurs à la colonne vertébrale.

Objectif : Déterminer si un traitement chiropratique, y compris la manipulation vertébrale, était lié à une diminution de la douleur ou de la consommation d'opioïdes chez les personnes défavorisées sur le plan financier utilisant des médicaments à base d'opioïdes et souffrant de problèmes musculosquelettiques.

Méthodologie : Une analyse rétrospective des données sur l'assurance de la qualité provenant d'un établissement de soins de santé financé par l'État a été menée. Les mesures portaient sur des résultats numériques de la douleur à la colonne vertébrale et des extrémités des membres à trois moments différents, la consommation d'opioïdes, des données démographiques et les modes de soins.

Résultats : La douleur et la consommation d'opioïdes ont sensiblement diminué dans le cadre de soins chiropratiques.

Conclusions : Une diminution importante de la douleur et de la consommation d'opioïdes observée de façon statistique et clinique a coïncidé de manière provisoire avec des soins chiropratiques financés par l'État dans un groupe de personnes défavorisées sur le plan financier vivant au centre-ville.

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MOTS CLÉS : analgésiques, chiropratique, colonne vertébrale, douleur chronique, douleur dorsale, douleur musculosquelettique, manipulations musculosquelettiques, opioïde, population à faible revenu, système à payeur unique

with opioid use and the paucity of evidence that opioids actually aid those suffering from chronic musculoskeletal conditions, such as back pain.⁷⁻⁹ Opioid medications impair the ability to engage in activities of daily living⁵ and are no more effective than alternative treatments for pain-related dysfunction¹⁰, creating financial and quality of life challenges. While there may be situations where opioid medication prescription is clinically necessary; for those patients with chronic, non-cancer conditions such as those suffering from musculoskeletal conditions includ-

ing back and neck pain; there are other options that are recommended by clinical practice guidelines (CPGs).¹¹⁻¹⁴

Back pain has been cited as the leading cause of activity limitation and work disability worldwide and has become one of the most common reasons for seeking care.^{6,15-17} Most adults will experience back pain at some point in their life¹⁸ and total costs associated with back pain are estimated as high as \$100 billion per year in the United States^{11,19} and \$6-\$12 billion per year in Canada¹³. People afflicted with back pain tend to have significantly higher health care utilization and costs.^{6,20} Additionally, studies have provided evidence that more expensive therapies and diagnosis techniques do not result in better patient outcomes.²⁰⁻²² Given the ballooning costs of healthcare systems around the world, health policy stakeholders, such as governmental policy makers, clinicians, governing bodies of healthcare professions, insurance companies, workers' compensation groups, and the general public, should consider more affordable, cost-efficient, and effective approaches for the management back pain that are congruent with CPGs.

According to recent CPGs, a trial of non-pharmacologic care should be considered as a first line treatment for those suffering back pain. Spinal manipulative therapy (SMT) is one such recommended treatment option.^{11-14,23,24} Spinal manipulative therapy has been demonstrated to be a cost-effective treatment option for the management of back pain²⁵⁻²⁸ and results in high reported levels of patient satisfaction²⁹⁻³¹. Chiropractic care, which involves spinal manipulation and adjunctive therapies, is consistent with recent CPGs¹¹⁻¹⁴ and is a viable first line treatment option prior to the use of opioid prescription medication. Additionally, many individuals with chronic non-cancer pain (46%) seek chiropractic as a treatment option.³² Chiropractic care is congruent with recommendations from both the American College of Physicians¹¹ and Canadian Chiropractic Guideline Initiative¹³ because it has demonstrated positive outcomes for spinal pain and has been associated with safety, cost effectiveness, and reductions in opioid use^{12-14,33-35}. Unfortunately, low-income individuals may not have equitable access to chiropractic care as a treatment option. In the Canadian healthcare system, individuals with incomes below a certain point are compensated for any prescription drugs they purchase by provincial pharmaceutical programs, while full reimbursement for chiropractic care is not currently covered. While more

affluent individuals may access chiropractic care through third party insurance or out-of-pocket payments, low-income individuals may be unable to access such CPG recommended treatment options. Low-income individuals are therefore unable to access chiropractic care due to financial barriers even though it is a less expensive and less harmful form of treatment than prescription opioids. An investigation of whether a low-income demographic benefits from a course of chiropractic care would help to demonstrate if extending equitable access to this form of therapy is warranted. With the present opioid crisis, SMT should be considered as a possible treatment option for patients to transition from opioid prescriptions or illicit use towards more effective and less harmful pain management options such as chiropractic. The purpose of this study was to investigate opioid utilization and musculoskeletal pain rating among low-income patients receiving chiropractic care in a publicly funded healthcare system. It was our hypothesis that such individuals would decrease their opioid use concomitant with decreased pain intensity ratings associated with a course of chiropractic care.

Methods

Ethics approval for this study was granted by the University of Manitoba Health Research Ethics Board.

Study design

The study was a retrospective review of prospectively collected quality assurance data obtained from the chiropractic program database of a publicly funded clinic.

Setting

All information collected for this study was obtained from a publicly funded clinic in Winnipeg, Manitoba with integrated on-site chiropractic services. The data used for this study is securely maintained at the publicly funded clinic by the treating clinicians on site. Patient data was completely de-identified upon entry to an anonymized database prior to analysis and interpretation.

Patients and variables

The data was collected between January 2011 to December 2017. Inclusion criteria for database review included patients identified/indicated as having: (a) experienced pain >3 months duration, (b) a history of opioid utiliz-

Table 1.
Patient Characteristics

Characteristic	N (%), or mean (SD) [range]
Total Patients	62 (100%)
Age (years)	48.6 (13.6) [19-83]
BMI^a (kg/m ²)	31.6 (8.46) [18.24-49.75]
Gender^b	
Men	24 (38.7%)
Women	38 (61.3%)
Ethnicity^b	
Caucasian	30 (48.4%)
Metis	15 (24.2%)
First Nations	15 (24.2%)
African	1 (1.61%)
Latino	1 (1.61%)
Chronic Pain Region at Baseline	
Cervical	23 (37.1%)
Thoracic	40 (64.5%)
Lumbar	50 (80.6%)
Sacral	41 (66.1%)
Extremity	34 (54.8%)
Referrals	
Referred by PCP ^c	42 (67.7%)
Referred back to PCP post-treatment	5 (8.1%)
No further referral needed post-treatment	57 (91.9%)

^aBody Mass Index. ^bSelf-identified by patients. ^cPrimary Care Provider.

ation at admission or during their care, and (c) received a course of chiropractic care. Eligibility for chiropractic treatment included: (a) residence in a pre-identified low-income neighbourhood, and (b) lack healthcare insurance coverage for chiropractic care. Immigrants and refugees to Canada living in pre-determined geographic locales for less than three years and individuals who did not have a standing claim involving an automobile injury claim or Workers Compensation Board funding who were referred by partner programs/organizations also received care and were included in this analysis. The eligibility for chiropractic treatment, and therefore the focus on low-income individuals, was determined by the treatment and data collection site, which is dedicated to providing healthcare services to economically disadvantaged individuals in Winnipeg, Manitoba. Sociodemographic infor-

mation derived from the eligible patient database entries is provided in Table 1. Independent variables included the pain site and time point. Pain sites were indicated according to their anatomical site as follows: cervical spine (CS), thoracic spine (TS), lumbar spine (LS), sacroiliac region (SI), and extremity (EXT). Time points included: baseline (BL) which was the time of first treatment, visit 5 (V5), and discharge (DIS). Dependent variables included pain level, opioid use at baseline/discharge, and the number of Tylenol 3 (T3) pills used per day. Pain level experienced at each symptomatic site was assessed by a numeric rating scale (NRS), an 11-point Likert scale with 0 representing “no pain” and 10 representing “worst pain imaginable.”³⁶ The minimally clinically important difference (MCID) was determined to be 2-points on the pain rating Likert scale.¹¹ The number of patients using opioids at BL, DIS, or neither was reported (Table 4). If the opioid being used at BL or DIS was T3, the number of T3 tablets utilized per day was reported (Figure 2).

Bias

This study was funded by the Canadian Chiropractic Association (CCA). However, the CCA had no influence over the reported results, data reduction, analysis, or statistical modelling. Statistical tests were performed by an individual who had no contact with the granting organization directly or indirectly throughout the process. Another source of bias may have occurred from patients refusing to disclose or misreporting their own opioid use.

Chiropractic treatment methods and frequency

Patients receiving chiropractic treatment underwent a history and physical examination followed by a course of pragmatic care as determined by the attending chiropractors. Follow up visits during a course of care consisted of; diversified spinal or extremity joint manipulation and/or mobilization, soft tissue therapy, acupuncture, and/or other modalities, including but not limited to ultrasound, electrical stimulation, thermal treatment, exercise, home advice, and Kinesiotaping, when clinically indicated. All aforementioned treatments were delivered by a licensed chiropractor. Re-evaluation visits were scheduled after every four to six treatment visits to assess response to care. New patient assessments were scheduled for 30 to 60 minutes, while treatment visits and re-evaluation visits were 15 to 30 minutes in duration.

Statistical analyses

Descriptive analyses included demographic and treatment modality means and standard deviations, as well as the number of patients and their percentage change in T3 tablets taken per day for the subset of patients with T3 prescriptions over the course of chiropractic care.

Analyses were conducted using jamovi (The jamovi project, v. 0.9). All analyzed outcomes were calculated as p-values and the level of significance was set to $\alpha=0.05$. One-way repeated measures analysis of variance (ANOVA) models (3 timepoints – baseline, visit 5, discharge) were used to establish main effects for time under care at each pain site, after which Tukey's honestly significant differences was used to determine the location of main effects. McNemar's test was used to analyze the difference in opioid utilization rates at baseline and discharge.

Results

Patients

Out of the 482 patients treated by the chiropractic program in the analyzed timeframe (January 2011 to December 2017) at the publicly funded clinic, 62 individuals met the inclusion criteria. Out of the eligible patients, 67.7% were referred by their Primary Care Provider (PCP) to the on-site chiropractic program. The majority of study participants were woman (61.3%), who self-identified as Caucasian (48.4%), with a mean age of 48.6, SD=13.6 years old, and a BMI of 31.6, SD=8.5 kg/m² (obese). The most commonly reported painful spinal complaints were in the lumbar (80.6%), sacral (66.1%) and thoracic (64.5%) regions. The overwhelming majority of patients had pain in multiple regions, specifically: 14 out of 62 patients had pain in two regions, 17 had pain in three regions, 14 had pain in four regions and 16 had pain in five regions. At the end of their course of chiropractic care, 8.1% of patients were referred back to their PCP for alternate treatment consideration. As a result, 91.9% of chiropractic patients using opioids were able to be discharged without further referral for their musculoskeletal spine pain following a course of chiropractic care (Table 1). Thirty-three of the opioid using patients utilized a singled course of chiropractic care, which allowed us to confirm specific start and end dates of the course of care. The average duration of that course of care was M=15.77 weeks, SD=17.40

weeks; with M =16.38 treatment visits, SD=16.70 treatment visits over that period of time. A limitation of the dataset is that the number of weeks in a course of care is not possible to determine when multiple courses of care are engaged in by a single patient. For all patients with opioid medication prescriptions, dosage, onset, and offset of medication was guided by the prescribing physician. A breakdown of care modalities employed is shown in Table 2.

Pain by region and time point

We observed a statistically and clinically significant decrease in pain level over a course of care from baseline compared to visit 5 and baseline compared to time of discharge for patients using opioid medications. Pain was reduced by amounts exceeding minimally clinically important differences (MCID) in all anatomical regions. The MCID was determined to be 2-points on the pain rating Likert scale.¹¹ Mean reported pain between BL and V5 pain changed by -2.50 (CS), -3.15 (TS), -2.72 (LS), -2.97 (SI), and -3.48 (EXT); between BL and DIS, pain changed by -2.63 (CS), -3.11 (TS), -3.56 (LS), -3.72 (SI), and -3.78 (EXT). Between V5 and DIS, further pain changes were no longer statistically significant, though trends toward further reductions were seen, with the exception of the thoracic region: -0.125 (CS), 0.037 (TS), -0.844

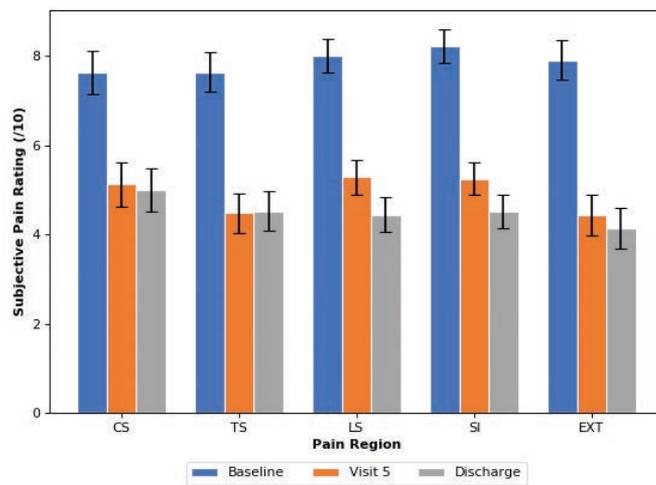


Figure 1.

Self-reported spine pain across a course of chiropractic care (error bars represent standard error).

Table 2.
Treatment modalities utilized

Treatment	N (% total patients)	Treatment	N (% total patients)
Total Patients	62 (100%)	Electrical Stimulation^b	13 (21.0%)
Spinal/Extremity Manipulative Therapy	62 (100%)	Cervical	2 (3.23%)
Cervical	28 (45.2%)	Thoracic	5 (8.06%)
Thoracic	52 (83.9%)	Lumbar	8 (12.9%)
Lumbar	54 (87.1%)	Sacral	7 (11.3%)
Sacral	49 (79.0%)	Extremity	2 (3.23%)
Extremity	30 (48.4%)	Thermal Treatment^c	49 (79.0%)
Spinal/Extremity Manipulative Therapy Method	62 (100%)	Cervical	11 (17.7%)
Manual adjustment with cavitation	44 (71.0%)	Thoracic	27 (43.5%)
Side posture with cavitation	23 (37.1%)	Lumbar	33 (53.2%)
Drop table	46 (74.2%)	Sacral	34 (54.8%)
Activator instrument 41 (66.1%)		Extremity	19 (30.6%)
Mobilization	62 (100%)	Exercises	43 (69.4%)
Cervical	30 (48.4%)	Cervical	19 (30.6%)
Thoracic	53 (85.5%)	Thoracic	32 (51.6%)
Lumbar	58 (93.5%)	Lumbar	36 (58.1%)
Sacral	50 (80.6%)	Sacral	29 (46.8%)
Extremity	36 (58.1%)	Extremity	25 (40.3%)
Soft Tissue Therapy^a	62 (100%)	Kinesiotaping	7 (11.3%)
Cervical	31 (50%)	Cervical	1 (1.61%)
Thoracic	54 (87.1%)	Thoracic	2 (3.23%)
Lumbar	58 (93.5%)	Lumbar	3 (4.84%)
Sacral	50 (80.6%)	Sacral	1 (1.61%)
Extremity	36 (58.1%)	Extremity	4 (6.45%)
Acupuncture	31 (50%)	Other Modalities^d	35 (56.5%)
Cervical	10 (16.1%)	Cervical	7 (11.3%)
Thoracic	5 (8.06%)	Thoracic	9 (14.5%)
Lumbar	10 (16.1%)	Lumbar	15 (24.2%)
Sacral	14 (22.6%)	Sacral	17 (27.4%)
Extremity	26 (41.9%)	Extremity	19 (30.6%)
Ultrasound	1 (1.61%)	Reinforcement of other provider recommendations	24 (38.7%)
Cervical	0 (0%)	Prescriptions	12 (19.4%)
Thoracic	0 (0%)	Labwork ^e	8 (12.9%)
Lumbar	0 (0%)	Special Studies ^f	16 (25.8%)
Sacral	0 (0%)	Compliance ^g	20 (32.3%)
Extremity	1 (1.61%)	Other	18 (29.0%)
		Supportive Nutritional Encouragement	22 (35.5%)
		Supportive Emotional/Social Encouragement	37 (60.0%)

^aMechanical percussive therapy using a Thumper, Effleurage, Deep Tissue, Trigger Point Therapy, Transverse Friction Therapy, Soft Tissue Mobilization.

^bInterferential Current, Transcutaneous Electrical Nerve Stimulation (TENS), Russian Stim. ^cCryotherapy or heat application. ^dLinament application. ^eProviding labwork results to the patient in lieu of another provider. ^fExplanation and encouragement to go through with a procedure/imaging recommended by another provider. ^gEncouragement to adhere to a prescription from another provider.

Table 3.
ANOVAs for pain across a course of chiropractic care at different anatomical locations

Descriptives				ANOVA					Post-Hoc		
Pain Region	Time	Mean (/10)	SE (/10)	F _{ANOVA}	df _B ^a	df _W ^b	p _{ANOVA}	η^2_p	BL ^c -V5 ^d (/10)	BL-DIS ^e (/10)	V5-DIS (/10)
Cervical	Baseline	7.63	0.488	9.47	2	30	<0.001*	0.387	2.51*	-2.63*	-0.120
	Visit 5	5.12									
	Discharge	5.00									
Thoracic	Baseline	7.63	0.445	33.0	2	52	<0.001*	0.559	-3.15*	-3.11*	0.040
	Visit 5	4.48									
	Discharge	4.52									
Lumbar	Baseline	8.00	0.384	36.4	2	62	<0.001*	0.540	-2.72*	-3.56*	-0.840
	Visit 5	5.28									
	Discharge	4.44									
Sacroiliac	Baseline	8.22	0.375	40.9	2	62	<0.001*	0.569	-2.97*	-3.72*	-0.750
	Visit 5	5.25									
	Discharge	4.50									
Extremities	Baseline	7.91	0.455	44.9	2	44	<0.001*	0.671	-3.48*	-3.78*	-0.300
	Visit 5	4.43									
	Discharge	4.13									

^aDegrees of freedom between groups. ^bDegrees of freedom within groups. ^cBaseline. ^dVisit 5. ^eDischarge. *Significant difference ($\alpha=0.05$)

(LS), -0.750 (SI), and -0.304 (EXT), respectively (Figure 1; Table 2).

Main effects for time were found in the ANOVA for each anatomical region. Post-hoc analysis revealed that the BL timepoint was different from V5 and DIS, while there were no significant differences between V5 and DIS in any comparison (Table 3).

Opioid usage by time point

A significant number of people who utilized opioids at BL no longer did at DIS (n=15). Although some people who did not use opioids at BL did at DIS (n=4), McNemar's test revealed that the number of people who stopped using opioids during the study period was significantly greater than those who began (p=0.012) (Table 4). Therefore, there was a significant decrease in the number of people who used opioids at DIS compared to BL. This translated into a 59.0% reduction in the number of patients using

Table 4.
Results of McNemar's test for differences between opioid utilization at baseline and discharge

	Discharge		Total
	No Utilization	Utilization	
Baseline			
No Utilization	19*	4	23
Utilization	15	24	39
Total	34	28	62
McNemar's Test			
	Value	df	p
χ^2	6.37	1	0.012
N	62		

*Used opioids at some point during the course of care but did not at baseline or discharge.

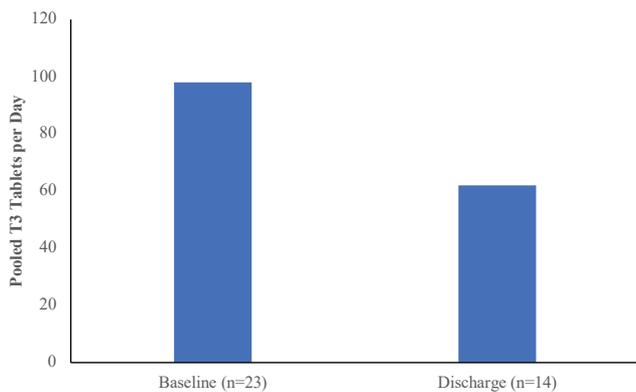


Figure 2.
Difference between baseline and discharge pooled Tylenol 3 usage per day

opioids after progressing through a course of chiropractic care (Table 4).

Tylenol 3 tablet usage per 24-hour period

Tylenol 3 tablets (T3 – 30mg of codeine phosphate) were the most commonly prescribed opioid for the chiropractic clinic patients between BL and DIS. At BL the pooled daily usage of T3 tablets was 98 tablets per day based on a sample size of 23 patients. At DIS the pooled daily usage of T3 tablets reduced to 62 tablets per day. There was a 36.7% reduction in usage (number of tablets per 24-hour period, excluding PRN [pro re nata, or “at will”] prescriptions) following a course of chiropractic care. Upon closer examination, the relationship is linked to the number of patients continuing to be on a T3 prescription. Individuals taking T3 were consuming about the same amount on average per person at the start and the end of care (98 tablets/23 people=4.26 tablets per person, 62 tablets/14 people=4.43 tablets per person), but overall fewer people 14/23 =60.9% (a 39.1% reduction) remained on T3 by the end of a course of care.

Discussion

The hypothesis of this study; that low-income individuals would experience decreased pain and a reduced rate of opioid utilization after a course of chiropractic care; is supported by the present results. Pain decreased over a course of care, with statistically and clinically significant

differences being observed after five visits for every anatomical pain region examined and treated. The sample considered in this study was more likely to have ceased their opioid usage at discharge than to have commenced opioid utilization over that course of care. Nearly 40% fewer individuals used Tylenol 3 at the end of their course of care compared to their baseline.

A population frequently exposed to opioid medications are those with spinal pain, specifically low back pain. Usual medical care for low back pain patients is not consistent with CPG recommendations. Studies report up to 30% of patients who see their family physician with low back pain receive opioid prescriptions and 60% of patients reporting to the Emergency Department with low back pain do as well.³⁷ This indicates the overuse of opioid prescription in these settings. The low-income population is a group that is inordinately at risk of opioid addiction and mortality following exposure through prescription.³⁸ A potential solution to consider for patients with chronic spinal pain is a course of chiropractic care, a non-pharmacological healthcare intervention. A recent review by Corcoran suggested that those utilizing chiropractic services had 64% lower odds of being prescribed opioid medications compared to people not utilizing chiropractic services.³⁵ The results of the present study and those referenced above suggest that enabling economically disenfranchised people to have access to chiropractic services may reduce pain and may reduce opioid use.

The present study was conducted in an environment that alleviated the financial barrier for access to chiropractic care through public funding from a provincial government in Canada. The results observed were that a course of chiropractic treatment for those who utilized opioids occurred concomitantly with a statistically and clinically significant decrease in patient reported chronic pain. Most cases (91.9%) did not require further referral to another healthcare provider upon discharge from chiropractic care, providing evidence that most musculoskeletal pain issues were resolved to a point where the patients no longer sought additional healthcare services for their musculoskeletal pain at the end of the course of care. A low rate of further referral to other healthcare disciplines following a course of chiropractic care is in agreement with previously published studies.³⁹ Chiropractic management has been shown to be a relatively cost-effective non-pharmacological treatment for back pain.^{26,28} Not requiring fur-

ther referral in most cases and a decrease in chronic pain intensity after a brief course of care provide evidence that chiropractic management is potentially a cost-efficient and effective treatment option to consider for integration into publicly funded health systems.³⁹

There are limitations to the current study. As this is a retrospective analysis and patients were not randomized to a chiropractic care or control group, causation is not possible to determine using this design. The lack of control over additional comorbidity and life circumstances of the sample population mean that unpredicted factors may have impacted patient outcomes. The population is somewhat heterogenous, in that while all patients utilized opioid medications, some patients were prescribed opioid medications, while others admitted self-medicating with opioids that were not attained through prescription or legal sources. A limitation of the dataset is that the number of weeks in a course of care is not possible to determine when multiple courses of care are engaged in by a single patient. Additionally, the use of a design that does not require a control group means that the effects of time or other interventions were not controlled for. This also includes not being able to control for the updated opioid prescribing guidelines for chronic pain in Canada that were introduced in 2011, and were updated in 2017.^{40,41} Given that chronic pain may fluctuate over time, but is not likely to spontaneously resolve, and the treatments offered were congruent with CPG recommendations,¹¹ the improvements observed are promising and should not be discounted; they can be a catalyst for further prospective study.

Conclusions

The results of the present study found a statistically and clinically significant pain reduction concomitant with publicly funded chiropractic management in a low-income population who utilized opioids. Additionally, a reduction in opioid use, compared to baseline, was found following a course chiropractic management at a multidisciplinary healthcare facility where the majority of patient referrals came from primary care physicians, and resulted in an endpoint of musculoskeletal care for the majority of individuals treated by the onsite chiropractors.

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Availability of data and materials

The data underlying this article were provided by the Mount Carmel Clinic with permission. Data will be shared on request by the corresponding author with the permission of the Mount Carmel Clinic.

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