The Effects of Preoperative Analgesic Medications on Postoperative Pain and Disability Following Spinal Surgery for Degenerative Cervical Spine Conditions

by

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ABSTRACT

Background: Neurological pain is a leading public health challenge. Two common cervical neurological conditions are myelopathy and radiculopathy, caused by compression and inflammation of the spinal cord, or a cervical nerve root, respectively. Patients are often treated with nonoperative and operative interventions; however, some patients do not experience satisfactory clinical outcomes. **Aim:** To investigate the association of preoperative analgesic medications (Muscle Relaxants, Neuroleptics, Narcotics, Over-the-Counter medications, and NSAIDs) with postoperative neck/arm pain and disability. **Study Design:** Longitudinal and retrospective analysis of 539 patients with cervical radiculopathy and 609 patients with cervical myelopathy. **Data Analysis:** Propensity score models using inverse probability weighting and regression adjustments were performed to determine the effects of preoperative analgesics on postoperative clinical outcomes. **Results:** Preoperative analgesics had no clinically relevant effects on postoperative pain or disability. However, decision-making around analgesic use is complex and the long-term effects on patients' overall health should be considered.

DEDICATION

This thesis is dedicated to patients living with cervical radiculopathy and myelopathy.

I would also like to thank each and every one who has helped me achieve this milestone, including my family for always believing in my abilities and supporting me throughout my pursuit for education. I have also been privileged to have wonderful mentors along the way who have guided and encouraged me to achieve my goals. Thank you!

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Chapter 1: Introduction

Neurological pain is a leading public health challenge, affecting the quality of life and socioeconomic well-being of 6.9-10% of the adult population. Two common cervical neurological conditions are myelopathy and radiculopathy, caused by compression and inflammation of the spinal cord, or a cervical nerve root, respectively.

Etiologically, cervical radiculopathy originates from mechanical or chemical injury to the spinal nerve root by a herniated or degenerated disc or spondylosis, in the cervical spine (Eubanks, 2010; Magnus et al., 2021; Rothman & Winkelstein, 2007). Symptomatically, patients often complain of experiencing sensory and/or motor weakness, decreased reflexes, and pain radiating from neck to their arms, chest, upper back, and shoulders (Iyer & Kim, 2016; Magnus et al., 2021). On the other hand, patients with cervical myelopathy suffer from compression of their spinal cord, due to narrowing of the spinal canal, as a result of herniated disc, spondylosis, or stenosis (McCartney et al., 2018). Symptomatically, cervical myelopathy patients often complain of bilateral neurological deficits like numbness, tingling, decrease in strength in hands/feet, clonus, unbalanced gait, bowel/bladder issues; however, they may or may not present with neck pain (McCartney et al., 2018).

Patients with radiculopathy and myelopathy are often treated with non-operative therapies such as physical therapy, pharmaceuticals, as well as surgical interventions (Galbraith et al., 2011). Pharmaceutical drugs include oral analgesics, non-steroidal anti-inflammatory drugs (NSAIDs), opioids, antidepressants, muscle relaxants, and

neuroleptics (Childress & Becker, 2016; Eubanks, 2010; Iyer & Kim, 2016; Todd, 2011). According to the North American Spine Society (NASS), guidelines on pharmacological treatment for management of cervical radiculopathy is inadequate (Onks & Billy, 2013). Significant side-effects can occur as a result of these medication, including weight gain, osteoporosis, ulcers, sedation, depression and abuse of the prescribed medication (Todd, 2011).

We have previously found associations between preoperative medication use and postoperative outcomes for patients undergoing surgery for lumbar spinal stenosis (Hébert et al., 2020) and lumbar radiculopathy (submission in preparation). In the proposed study, we are looking to advance these findings by evaluating these relationships in a wider sample of patients with nerve-mediated pain and disability (i.e., radiculopathy and myelopathy) arising from all sources of spinal degeneration.

This study aims to understand the impact of preoperative analgesics use on postoperative clinical outcomes for patients with cervical myelopathy and radiculopathy. Our main objective is to estimate the effects of preoperative analgesic(s) use (i.e., over the counter medications, non-steroidal anti-inflammatory drugs (NSAIDs), muscle relaxants, neuroleptics, and opioids), on postoperative clinical outcomes (i.e., pain and disability) at 3 and 12 months, for patients undergoing surgery for cervical radiculopathy and myelopathy.

This study could be valuable in helping patients and their healthcare providers better understand the relationship between different analgesics used and its impact on postoperative clinical outcomes of pain and disability, in patients with cervical radiculopathy and myelopathy.

Literature Review

Impact of Neurological pain

Neurological pain is a leading public health challenge, affecting the quality of life and socioeconomic well-being of 6.9-10% of the adult population (van Hecke et al., 2014). Neck pain is the second most frequent musculoskeletal condition after back pain (Binder, 2007). In Canada, chiropractors receive about 30% of cases related to neck pain (Binder, 2007). Individuals with neck pain and its associated disorders (NAPD) usually experience headaches, arm/back pain, and temporomandibular pain (Cassidy & Côté, 2008). It can be burdensome for the patient as it would impact not only their physical health but also their psychological, social, and financial health.

Neck pain can be a source of problems not just for the patient but also for their employers and the health care system. A study done in Netherlands in 1996 estimated that the total cost of neck pain to be US $686 million, with US $160 million used for direct care cost and a substantial proportion for indirect cost. For example, the indirect cost of workplace absenteeism resulted in 185.4 million and disability cost the most at US$341 in 1996 Netherlands (Borghouts et al., 1999).

Additionally, neck pain and mental health are common comorbidities that impact the quality of life (Côté et al., 2003; Xu et al., 2020). A large-scale national survey from China (n=28,140) by Xu et al., (2020), reported that 23.9% of the respondents suffered from mental disorders such as mood and anxiety disorder and substance abuse/dependence, along with chronic back and neck pain (Xu et al., 2020).
Apart from economic and mental health impacts, psychosocial aspects can also be associated with the development and coping of neck pain (Hurwitz et al., 2006). Although further knowledge is needed on how patients cope with neck pain, patients with better support systems had a better clinical reduction in pain and disability (Côté et al., 2003; Hurwitz et al., 2006).

Cervical myelopathy and radiculopathy

Etiology

Two common cervical neurological conditions are myelopathy and radiculopathy, caused by compression and inflammation of the spinal cord, or a cervical nerve root, respectively.

Cervical radiculopathy is caused by pinching of cervical nerve root, with C-7 nerve root most commonly impacted (Álvarez Pinzón & Krill, 2018). Cervical radiculopathy originates from mechanical or chemical injury to the spinal nerve root by a herniated or degenerated disc or spondylosis in the cervical spine (Eubanks, 2010; Magnus et al., 2021; Rothman & Winkelstein, 2007). Symptomatically, patients often complain of experiencing sensory and/or motor weakness, decreased reflexes, and pain radiating from

neck to their arms, chest, upper back, and shoulders (Iyer & Kim, 2016; Magnus et al., 2021).

On the other hand, patients with cervical myelopathy suffer from compression of their spinal cord, due to narrowing of the spinal canal, as a result of herniated disc, cervical degeneration, degenerative cervical spine, spondylosis, or stenosis (Baptiste & Fehlings, 2006; McCartney et al., 2018). Symptomatically, patients with cervical myelopathy often complain of bilateral neurological deficits like numbness, tingling, decrease in strength in hands/feet, clonus, unbalanced gait, bowel/bladder issues; however, they may or may not present with neck pain (McCartney et al., 2018).

Along with aging and degeneration (wear and tear), there are several conditions that can lead to the development of cervical myelopathy and radiculopathy, such as disc herniation, spondylosis, and spinal stenosis.

Cervical Disc Herniation

Disc herniation, also referred to as “slipped disk” or “ruptured disk”, occurs when the annulus fibrosus (a dense ring containing nucleus pulposus) is damaged and displaced from its normal intervertebral space (Adams et al., 1986; Dydyk et al., 2022; Wheeler, 2021). There are four stages to disc herniation: disc protrusion, subannular extrusion, transannular extrusion, and sequestration (Weiner & Patel, 2008).

The herniated disc can compress on the spinal cord and nerves resulting in burning or stinging pain sensations and functional decline (Dydyk et al., 2022). The most common cause of cervical disc herniation is aging followed by trauma. As one ages, the nucleus pulposus becomes progressively dehydrated and weak, resulting in a herniated disc (Dydyk et al., 2022). A prolapse or herniation could be indicative of an annulus rupture with nucleus material in the spinal canal, leading to inflammation and radiating pain (Weiner & Patel, 2008). Lumbar and cervical spine (C6-C7) regions are at higher risk of herniated disc than thoracic spine (Dydyk et al., 2022).

Cervical Spondylosis

Cervical spondylosis is becoming more prevalent, especially in societies with a growing aging population (Yonenobu, 2000). Over 85% of adults aged 60 or older are affected by cervical spondylosis, though it can also be triggered by trauma to the cervical spine (*Cervical Spondylosis - Symptoms and Causes*, 2022; Ferrara, 2012). As one ages, the spine progressively degenerates, including the intervertebral discs and facet joints, which connect the vertebrates (Shedid & Benzel, 2007). This results in loss of height of the ventral cervical spine and compression of the nerves and blood vessels (Ferrara, 2012). These events compromise the structural integrity of supportive soft tissues, leading to the bulging of discs and ligaments around the spinal segment. This further leads to more load placed on the facet joints and eventually results in osteophytes formation (i.e., bone spurs) to counter the extra load. Patients with cervical spondylosis can experience neck pain and stiffness (*Cervical Spondylosis - Symptoms and Causes*, 2022). The loss of disc height and development of osteophytes can result in numbness, pain, and chronic motor

and/or sensory deficits in arms and legs and even loss of bladder or bowel control (*Cervical Spondylosis - Symptoms and Causes*, 2022; Ferrara, 2012).

Cervical Stenosis

Cervical Stenosis is the narrowing of the of the spinal canal which effectively compresses the spinal cord. Bone spurs can compress the nerve roots, contributing to the narrowing of the spinal canal. As we age, the spinal discs dry out, creating space between the vertebrae, and the bones and ligaments lose their elasticity (*Cervical Spine – Anatomy, Diseases and Treatments*, 2021). Apart from the normal process of aging and congenital causes of stenosis, other factors such as poor posture, injury, infectious diseases, systemic conditions (i.e., inflammatory diseases, calcium metabolic disorders, etc.) can also trigger degeneration of the spine, leading to cervical stenosis (*Cervical Spine – Anatomy, Diseases and Treatments*, 2021; Stafira et al., 2003). Patients with cervical stenosis often complain of neck or arm pain, numbness, weakness, loss of muscle tone and coordination in arms, as well as loss of steadiness in legs. Cervical stenosis is the most common cause of cervical myelopathy in patients over 50 years (Melancia et al., 2014).

Prevalence

Cervical pain is a common condition that one could experience in their lifetime, affecting up to two-thirds of the population. Cervical pain is also more common in educated individuals with headaches, low back pain, and previous traumatic injury to the head (Todd, 2011). Cervical spondylotic myelopathy (CSM) is the leading cause of non-traumatic cervical injury in older adults aged 55 or older (W. F. Young, 2000). Incidence of CSM is estimated to be 4 per 100,000 person-years (Nouri et al., 2015). Whereas,

incidence of cervical radiculopathy is estimated to be at 83 per 100,000 people being affected annually (Todd, 2011). Cervical radiculopathy is more common in urban populations of high-income countries, especially in office and computer workers (Hoy et al., 2010). Manual labor, such as heavy lifting or operating vibrating machines can also increase the risk of cervical radiculopathy (Magnus et al., 2021). Additionally, women, age 35-49 years, are more susceptible to cervical radiculopathy than men (Hoy et al., 2010). Risk factors include previous diagnosis of lumbar radiculopathy, cigarette smoking, Caucasian heritage, diving from a board, and playing golf (Iyer & Kim, 2016).

Treatment/Therapy

In order to restore function and alleviate pain, non-operative therapies such as physical therapy and oral analgesics are the considered as the standard treatments for patients with cervical radiculopathy (Galbraith et al., 2011; Todd, 2011). Although cervical myelopathy is an emergent condition prompting surgical intervention, patients may be prescribed analgesic at some point before the surgery. Pharmaceutical drugs include oral analgesics, non-steroidal anti-inflammatory drugs (NSAIDs), opioids, muscle relaxants, and neuroleptics (Childress & Becker, 2016; Eubanks, 2010; Iyer & Kim, 2016; Todd, 2011). According to the North American Spine Society (NASS), guidelines on pharmacological treatment for management of cervical radiculopathy is inadequate (Onks & Billy, 2013). Significant side-effects can occur as a result of these medication, including weight gain, osteoporosis, ulcers, sedation, depression and abuse of the prescribed medication (Todd, 2011).

If symptoms are not relieved by non-operative methods, surgical measures may be needed. Cervical anterior and posterior decompression and fusion surgeries could be helpful; however, they could lead to adjacent segment degeneration – an increased degeneration at adjacent to the fusion (Seo & Choi, 2008; Todd, 2011). Some studies report that there might be no significant difference between surgical and non-surgical treatments (Todd, 2011). Since the majority of patients improve with non-operative management of cervical radiculopathy, early surgical intervention should be considered if patient shows concerning signs or symptoms during the observation period, such as 'progressive neurological deficits, myelopathy, and fractures' to name a few (Iyer & Kim, 2016). Other studies recommend an earlier surgical intervention for better patient post-surgical outcomes. Patients with cervical myelopathy who went underwent surgery earlier had better outcomes compared to patients who waited longer (Galbraith et al., 2011). Patients who had a surgical intervention within 6 months had significantly reduced arm pain scores compared to patients who waited longer (Burneikiene et al., 2015). Another study supported better patient outcomes if a surgical intervention was performed before 8 weeks from the onset of cervical radiculopathy signs and symptoms (Alentado et al., 2014).

Clinical Outcome Measures

Several tools can be used to assess the physical and mental effects associated with cervical radiculopathy and myelopathy. Along with imaging of the cervical spine, a physician evaluates their patient with neck pain through a detailed physical exam and the area, quality, duration of pain along with worsening and alleviating factors are considered

along with other factors (Todd, 2011). Questionnaires are helpful in quantifying the pain intensity, disability, and overall impact on health (Todd, 2011).

Neck Disability Index (NDI)

The Neck Disability Index questionnaire is a patient-reported outcome measure to assess cervical disability (Joseph & Palappallil, 2017; MacDermid et al., 2009; Vernon & Mior, 1991). It consists of 10-items, where patient rate the difficulty of 10 functional status (i.e., driving, reading, lifting, headaches, pain, etc.). Each question is scored from 0-5, with a total score from 0 to 100 and higher values indicating greater disability (MacDermid et al., 2009; Vernon & Mior, 1991). NDI was administered preoperatively at baseline, and postoperatively at 3 months and 12 months.

NDI has a high reliability, validity and responsiveness in patients with chronic pain, including cervical radiculopathy (MacDermid et al., 2009). The NDI has a minimal detectable change (MDC) of 13.4 points and a minimal clinically important difference (MCID) of 8.5 points in patients with cervical radiculopathy (Pool et al., 2007; Vernon & Mior, 1991; I. A. Young et al., 2010).

Numeric Pain Rating Scale (NPRS)

Numeric Pain Rating Scale is a patient-reported outcome measure. It consists of an 11-point numeric pain rating scale to measure neck pain intensity (Pool et al., 2007). NPRS assessed the overall neck and arm pain intensity in the preceding 24 hours. NPRS was measured preoperatively at baseline, and postoperatively at 3 and 12 months. The NPRS

represented a Likert scale ranging from 0 (‘no pain) to 10 (‘unbearable pain’) for neck and arm pain intensity level.

In a systematic review to assess the psychometric properties of NPRS for neck pain, NPRS had good-to-excellent test-retest reliability (correlation coefficient of 0.58 to 0.93) when retested within 4 weeks (Modarresi et al., 2022). They also reported clinically important difference (CID) of 1.5-2.5 points and minimum detectable change (MDC) of 2.6 to 4.1 points for NPRS in patients with cervical pain (Modarresi et al., 2022; Pool et al., 2007; I. A. Young et al., 2010). A minimum of 35% reduction on the NPRS is needed for patients with chronic spinal cord injury to experience a change in their pain intensity (Hanley et al., 2006). NPRS is practical to implement and shows suitable responsiveness as an outcome measure (Modarresi et al., 2022; I. A. Young et al., 2010). NPRS has also been shown to moderately associate with NDI, with r = 0.48 to 0.54 (Modarresi et al., 2022).

Potential Outcome Predictors

Patients with cervical radiculopathy and myelopathy are exposed to pharmaceutical drugs such as over-the-counter medications, muscle relaxants, non-steroidal anti-inflammatory drugs (NSAIDSs), opioids, and neuroleptics (Childress & Becker, 2016; Eubanks, 2010; Iyer & Kim, 2016; Todd, 2011).

Neuroleptics (such as Gabapentin and Pregabalin) are commonly used, especially with patients with radiculopathy to treat neuropathic pain (Todd, 2011). We have previously

found associations between preoperative medication use and postoperative outcomes for patients undergoing surgery for lumbar spinal stenosis (Hébert et al., 2020) and lumbar radiculopathy (submission in preparation). In the aforementioned longitudinal analysis of prospective data with Lumbar Spinal Stenosis patients (N=529), patients using anti-convulsant medications (i.e., neuroleptics) before surgery were more likely to experience poor leg pain outcome after surgery. A systemic review on the use of anticonvulsants for low back and radicular pain found moderate to high-quality evidence that it is ineffective in managing chronic back/leg pain and disability; and high-level evidence that gabapentinoids (i.e., gabapentin and pregabalin) have more adverse events such as drowsiness, dizziness, and nausea (Enke et al., 2018). In a double-blind, randomized controlled trial, pregabalin and active placebo faired similar results in patients with neurogenic claudication (Markman et al., 2015). Even though neuroleptics are not useful in treating all neuropathic pain, they are often prescribed for chronic low back pain (Markman et al., 2015). Therefore, it is important to understand the use of neuroleptics before surgery and its potential influence on postoperative clinical outcomes (pain, disability, and satisfaction) in patients with cervical radiculopathy and myelopathy.

According to the Canadian Community Health Survey (CCHS) of 2018, 3.7 million Canadians reported using opioid pain relievers in the past year (Government of Canada, 2019). Opioids are Narcotics or opioids when used for a short duration can alleviate pain. However, they don't work as well in the long-term, even at increased dosages (Todd, 2011). Chronic use of opioids can lead to dependency/substance abuse and depression along with sedation, constipation, hypoventilation (Jain et al., 2018; Todd, 2011).

Chronic opioid therapy (COT) can also result in tolerance of opioids, where the patient needs more opioids to alleviate pain. Another paradoxical side-effect of COT is the development of opioid-induced hyperalgesia (OIH), where the patient becomes more sensitive to pain. The precise mechanism for this phenomenon is not well understood, however, neuronal plastic changes in the spinal cord may play a role in OIH (M. Lee et al., 2011; Mao et al., 1995). A prospective cohort study with 583 patients undergoing spine surgery found that increased preoperative opioid use was significantly linked with increased opioid dependence 1 year after surgery (Armaghani et al., 2014). Increase use of preoperative opioid use is a significant predictor of increase Neck Disability Index score; decreased patient-reported EuroQol-5D score and 12-Item Short-Form Health Survey, for both physical and mental component, when assessed 1 year after surgery (Jain et al., 2018; D. Lee et al., 2014). Patients with pre-existing mental illness such as depression and anxiety are significantly linked with increased narcotic use before surgery (Armaghani et al., 2013). Substance use in patients with mood and anxiety disorders could be a form of self-medication to alleviate the symptoms of the mental illness (Manning, 2015; National Institute of Health, 2008). Hence, a psychological and substance use evaluation, and counselling on minimizing opioid use is suggested in patients prescribed opioid prior to spine surgery (Armaghani et al., 2013, 2014). Due to disturbance in pain perception and threshold associated with opioids, preoperative opioid use could influence postoperative clinical outcomes (of pain, disability, and patient satisfaction).

Muscle relaxants are also commonly used, however, similar to narcotics, it can lead to dependency/substance abuse or depression (Todd, 2011). NSAIDS and over the counter drugs such as aspirin and ibuprofen are other common and cost-effective choices to alleviate neck pain in cervical patients. However, a subset of patients suffering from increased cardiac risk cannot use NSAIDS and other who do may experience side-effects such as nausea, gastric ulcers and even kidney disorders (Todd, 2011).

Knowledge Gap

There is a lack of literature on the effects of different medications used before surgery, especially in patient populations with cervical myelopathy and radiculopathy. Based on previous associations between preoperative medication use and postoperative outcomes for patients undergoing surgery for lumbar spinal stenosis (Hébert et al., 2020) and lumbar radiculopathy (submission in preparation), we are looking to advance these findings by evaluating these relationships in a wider sample of patients with nerve-mediated pain and disability (i.e., radiculopathy and myelopathy) arising from all sources of spinal degeneration.

Due to the disturbance in pain perception and threshold observed in patients using opioid and neuroleptic before surgery, we are exploring other medication (such as muscle relaxants, NSAIDS, and over the counter drugs), and their possible association with postoperative clinical outcomes of pain and disability.

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Chapter 2

Associations Of Preoperative Analgesic Medication Use With Postoperative Pain And Disability Outcomes Following Spinal Surgery For Degenerative Cervical Spine Conditions

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Key Words: Cervical radiculopathy; Cervical myelopathy; neck pain; arm pain; disability; muscle relaxants; neuroleptics; narcotics; over-the-Counter; NSAIDs; analgesics; Numeric Pain Rating Scale (NPRS); Neck Disability Index (NDI);

Contributions: L.B. took a leading role in the following research tasks: identification and design, practical research aspects, data analysis, and manuscript preparation.

Mini Abstract/Précis

We estimated the effect of preoperative analgesics on postoperative pain/disability outcomes in patients with cervical myelopathy and radiculopathy. Preoperative analgesics had no clinically relevant effects on postoperative pain or disability. Even though a statistically significant reduction in arm pain was seen at 3 months post-surgery for patients with cervical radiculopathy and myelopathy, who consumed narcotics and muscle relaxants, respectively, these effects were clinically insignificant.

ABSTRACT

Study Design: Retrospective cohort study

Objective: To estimate the effect of preoperative analgesic use on postoperative pain and disability outcomes in patients with cervical myelopathy and radiculopathy.

Summary of Background Data: There is limited knowledge about the effects of preoperative analgesics on postoperative arm/neck pain and disability outcomes.

Methods: We included data from patients enrolled in the Canadian Spine Outcomes and Research Network (CSORN), who had undergone surgery for degenerative cervical myelopathy and radiculopathy. Patients reported if they used preoperative analgesics over the last 6 months. The study outcomes were neck pain-related disability, neck pain, and arm pain, measured pre-surgery and 3- and 12- months post-surgery. Disability was measured using the 0 – 100 Neck Disability Index (NDI), and neck/arm pain intensity were measured using 0 – 10 numeric pain rating scales. We applied propensity score models using inverse probability weighting and regression adjustment to account for potential confounding due to age, sex, education level, smoking, depression risk, and baseline pain or disability.

Results: We included data from 539 patients with cervical radiculopathy (44.16% female; mean age 51.11[SD 9.64] years) and 609 patients with cervical myelopathy (38.92% female mean age 59.24[SD 12.04] years). Preoperative analgesic use did not affect neck pain and disability measured at 3-months for both population groups. However, compared to non-users, patients with cervical radiculopathy who consumed narcotics reported less arm pain (mean difference[95%CI] = -0.54 [-0.97 to -0.11]) 3-months post-surgery. Similarly, patients with cervical myelopathy who consumed muscle

relaxants (-0.61[-1.09 to -0.13]) reported reduced arm pain, 3-months post-surgery. There were no effects of preoperative analgesics on 12-month outcomes of neck pain, arm pain, and disability for both population groups.

Conclusion: Preoperative analgesics had no clinically relevant effects on postoperative pain or disability. However, decision-making around analgesic use is complex and the long-term effects on patients' overall health should be considered.

Key Points

- When controlling for demographic and clinical factors, preoperative analgesics did not have clinically relevant effects on postoperative neck pain, arm pain, or disability.
- While there were small reductions in arm pain at 3 months post-surgery for patients who consumed narcotics in the cervical radiculopathy cohort and with muscle relaxant use in the cervical myelopathy cohort, these effects were not clinically significant.
- Decision-making around analgesic use is complex and requires the patient and physician to consider the long-term effect on patients' overall health. However, our study indicates that analgesics do not have a negative impact on postoperative pain or disability.

Introduction

Cervical myelopathy and cervical radiculopathy are common neurological conditions caused by the compression and inflammation of the spinal cord or a cervical nerve root, respectively. Etiologically, cervical radiculopathy originates from mechanical or chemical injury to the spinal nerve root by a herniated or degenerated disc or spondylosis in the cervical spine region (Eubanks, 2010; Magnus et al., 2021; Rothman & Winkelstein, 2007). Symptomatically, patients often complain of experiencing sensory and/or motor weakness, decreased reflexes, and pain radiating from the neck to their arms, chest, upper back, and shoulders (Iyer & Kim, 2016; Magnus et al., 2021). On the other hand, patients with cervical myelopathy suffer from spinal cord compression, due to spinal canal narrowing, as a result of disc herniation, spondylosis, or stenosis (McCartney et al., 2018). Symptomatically, patients with cervical myelopathy often complain of bilateral neurological deficits like numbness, tingling, decrease in strength in hands/feet, clonus, unbalanced gait, and bowel/bladder issues; however, they may or may not present with neck pain (McCartney et al., 2018).

Patients with radiculopathy and myelopathy are often exposed to nonoperative therapies including pharmaceuticals before surgical interventions (Galbraith et al., 2011). Patients may be prescribed pharmaceutical drugs, including over-the-counter medications, non-steroidal anti-inflammatory drugs (NSAIDs), opioids, muscle relaxants, and neuroleptics (Childress & Becker, 2016; Eubanks, 2010; Iyer & Kim, 2016; Todd, 2011). However, according to the North American Spine Society (NASS), guidelines on pharmacological treatment for managing patients with cervical radiculopathy are inadequate (Onks &

Billy, 2013). Additionally, significant side effects can occur as a result of these medications, including weight gain, osteoporosis, ulcers, sedation, depression and abuse of the prescribed medication (Todd, 2011).

Several studies have found a negative association between preoperative analgesic use and postoperative clinical outcomes. Patients undergoing cervical fusion who consumed narcotics before surgery experienced worse functional outcomes than patients not taking narcotics (Lawrence et al., 2008). Another longitudinal study of patients undergoing lumbar spinal stenosis surgery indicated that patients who consumed anticonvulsants had more leg pain post-surgery (Hébert et al., 2020). Additionally, opioid use in patients undergoing anterior cervical discectomy and fusion (ACDF) was predictive of poor disability outcome 2 years post-surgery (Hébert et al., 2022).

This study aimed to understand the impact of preoperative analgesic medications on postoperative clinical outcomes for patients with cervical myelopathy and radiculopathy. Specifically, our objective was to estimate the effects of preoperative analgesics (over-the-counter medications, non-steroidal anti-inflammatory drugs (NSAIDs), muscle relaxants, neuroleptics, and opioids) on pain and disability, 3 and 12 months after surgery, for patients with cervical radiculopathy and myelopathy.

Methods

Study design and participants

We employed a retrospective cohort study design using de-identified data from patients enrolled in the Canadian Spine Outcomes and Research Network (CSORN) registry. The

CSORN is a multicenter research network consisting of Canadian spine surgeons and rehabilitation specialists advancing care for patients with spinal disorders. The CSORN registry collects longitudinal data from patients undergoing spine surgery. Clinical outcome data were collected before the surgery and 3 and 12 months after surgery.

We included male or female patients aged ≥ 18 years (or the provincial age of majority – depending on local REB guidelines) who underwent cervical spine surgery for degenerative pathology resulting in either cervical radiculopathy or cervical myelopathy with or without radiculopathy. We excluded patients diagnosed with tumors, infections, fractures, or inflammatory diseases.

The surgeon evaluated and diagnosed patients with cervical myelopathy or radiculopathy as their primary or secondary diagnosis. Cervical myelopathy and radiculopathy were constructed as two separate pathology groups for this study. Cervical myelopathy cohort included all patients with a primary or secondary diagnosis of myelopathy. Whereas cervical radiculopathy cohort included all patients with a primary or secondary diagnosis of radiculopathy without a primary or secondary diagnosis of myelopathy.

Ethics approval

This study protocol was approved by the Horizon Health Network Research Ethics Board (REB #2022-3092) and the University of New Brunswick Research Ethics Board (REB #2022-041).

All individual CSORN sites also received ethical approval from their local Research Ethics Boards.

Exposure variables

Patients reported their use of analgesics in the past 6 months and the frequency with which they took the medication (daily, as needed, or not taken). Exposure variables of interest are collected by the CSORN registry before cervical surgery (i.e., during the initial surgical consult) and post-surgery at 3- and 12-months.

Outcome measures

The outcome measures of interest were the Neck Disability Index (NDI) and Numeric Pain Rating Scale (NPRS) for neck and arm intensity. All outcomes were collected before surgery, and 3- and 12-months after surgery.

Neck Disability Index (NDI)

The NDI is a patient-reported outcome measure to assess neck pain-related disability (Joseph & Palappallil, 2017; MacDermid et al., 2009; Vernon & Mior, 1991). It consists of 10 items, where patient rate the difficulty of 10 functional activities (e.g., driving, reading, lifting, headaches, pain, etc.). Each question is scored from 0-5, with a total score from 0 to 100 and higher values indicating greater disability (MacDermid et al., 2009; Vernon & Mior, 1991).

NDI has a high level of reliability, validity, and responsiveness in patients with chronic neck pain, including those with cervical radiculopathy (MacDermid et al., 2009). The NDI has a minimal detectable change (MDC) of 13.4 points and a minimal clinically important difference (MCID) of 8.5 points in patients with cervical radiculopathy (Pool et al., 2007; Vernon & Mior, 1991; I. A. Young et al., 2010).

Numeric Pain Rating Scales (NPRS)

The NPRS is a patient-reported measure of pain intensity, comprising an 11-point scale with scores ranging from 0 (‘no pain) to 10 (‘unbearable pain’) (Pool et al., 2007). Patients completed separate NPRS for neck pain and arm pain intensity in the preceding 24 hours.

The NPRS has good-to-excellent test-retest reliability (correlation coefficient of 0.58 to 0.93) when retested within 4 weeks (Modarresi et al., 2022). The NPRS shows a minimal clinically important difference (MCID) of 1.5-2.5 points in patients with cervical spine disorders and a minimum of 35% reduction in NPRS is needed for patients with chronic spinal cord injury to experience a change in their pain intensity (Hanley et al., 2006; Modarresi et al., 2022; Pool et al., 2007; I. A. Young et al., 2010).

Data analysis

All data were analyzed using Stata software (V.16.1; StataCorp, College Station, TX, USA). The effects of preoperative analgesics on postoperative pain and disability were estimated separately with doubly robust models in patients with cervical radiculopathy and myelopathy using propensity scores with regression adjustment. In particular, we

used the inverse probability of treatment weighting (IPTW) at 3 months and 12 months post-surgery. Propensity scores was defined as the probability of a patient receiving treatment or not, depending on measured baseline confounding variables. The propensity score values were estimated using logistic regression and was regressed on measured baseline confounding variables. Measured baseline confounding variables included patient's age, sex, occupation level, smoking habit, risk of depression, and baseline arm/neck pain or neck disability. These variables were selected as they are potential common causes of both exposure/treatment (medication use) and outcome (postoperative pain and disability).

Diagnostic checks help identify if the propensity score models are adequately specified by making sure that the measured baseline confounding variables are similar between "treated" and "control" groups (Austin, 2009). Diagnostic checks were performed for balance (of standardized differences and variance ratio) and overlap of weighted groups. We compared our standardized difference with external diagnostic criterion of 10% or (0.10) (Austin et al., 2021), because this magnitude of difference represents negligible imbalance between "treated" and "untreated" groups. We further evaluated the weighted variance ratio by applying a variance ratio between 0.5 and 2.0 (Austin, 2009, 2011). Checking for variance ratio allows for better understanding of standard deviation distribution of continuous confounding variables between the "treated" and "control" groups.

We visually evaluated for overlap in propensity scores to see the distributions between treated and untreated patients. A substantial overlap was expected between the propensity scores and these graphs also yield information regarding the positivity assumption. Positivity assumption states that a patient should not have any contraindications to being either in the "treated" or "control" groups (Austin, 2009; Imbens et al., 2009).

Propensity scores were converted to inverse probability of treatment weights using the following formulas:

$$weight\ for\ treated\ group = \frac{1}{propensity\ score};$$

$$weight\ for\ control\ group = \frac{1}{1-propensity\ score}.$$

The weights were then applied to linear regression models along with all confounding variables to estimate the average treatment effects of each medication on the outcomes of interest.

Results

We included data from 539 patients with cervical radiculopathy (44.16% female; mean age 51.11[SD 9.64] years) and 609 patients with cervical myelopathy (38.92% female mean age 59.24[SD 12.04] years). These data were collected nationally from 14 different hospital sites for cervical myelopathy and 15 different hospital sites for cervical radiculopathy. Demographic and preoperative characteristics of each patient group are reported in Table 1. Evolution of sample sizes for both population groups are shown in Figure 1 and 2. Our models met all prespecified model criteria except for patients with

cervical myelopathy who consumed NSAIDs and neuroleptic medications at 12-months post-surgery, in which the standardized difference for sex was 0.10 (Appendix A).

Pain-related disability

After adjusting for potential confounding due to age, sex, education level, smoking status, depression risk, and baseline arm pain, there were no significant effects of preoperative analgesic use on neck pain-related disability outcomes measured at 3-months and 12-months, postoperatively, for both population groups (Figures 3 and 4).

Neck pain intensity

After adjusting for potential confounding variables, there were no significant effects of preoperative analgesic use on neck pain measured at 3-months and 12-months, postoperatively, for both population groups (Figures 3 and 4).

Arm pain intensity

Compared to non-consumers, patients with cervical myelopathy who consumed muscle relaxants reported less arm pain (mean difference[95%CI] = -0.61[-1.09 to -0.13]) 3 months after their surgery (Figure 3). There were no significant effects of muscle relaxants use on 12-month outcomes of arm pain for patients with cervical myelopathy.

Compared to non-consumers, patients with cervical radiculopathy who consumed narcotics experienced less arm pain (mean difference[95%CI] = -0.54 [-0.97 to -0.11]) 3

months after surgery (Figure 4). There were no significant effects of narcotic use on 12-month outcomes of arm pain for patients with cervical radiculopathy.

There were no significant effects of other preoperative analgesic use on arm pain measured at 3-months and 12-months, postoperatively (Figures 3 and 4).

Discussion

This study aimed to estimate the effect of preoperative analgesic use on postoperative clinical outcomes of neck pain, arm pain, and neck pain-related disability in patients with degenerative cervical myelopathy and cervical radiculopathy. We found no effects of preoperative analgesics on postoperative pain and disability outcomes, except for two medication patients with lower arm pain at 3 months; however, they are likely to be clinically irrelevant.

After adjusting for potential confounding due to age, sex, education level, smoking status, depression risk, and baseline arm/neck pain and disability, most preoperative analgesics did not have significant effects on arm pain, neck pain, or disability 3 months and 12-months after surgery. However, we found that compared to non-consumers, preoperative consumers of narcotics, either taken daily or as needed, significantly reduced arm pain 3-months after surgery for patients with cervical radiculopathy. Compared to non-consumers, daily or intermittent use of muscle relaxants significantly reduced arm pain 3-months after surgery, for patients with cervical myelopathy. Our significant outcome finding may be a spurious outcome based on the number of models tested for five

different medications, at two time points, for the two clinically different population groups.

In a longitudinal study of 352 patients who underwent surgery for Anterior cervical discectomy and fusion (ACDF) and consumed opioids daily, patients were more likely to experience poor disability post-surgery (Hébert et al., 2022). Extrapolating from another longitudinal analysis of 529 patients who underwent surgery for degenerative lumbar spinal stenosis, found that preoperative anticonvulsant use (i.e., neuroleptics) was predictive of poor leg pain outcome post-surgery (Hebert et al., 2019). Deducing from a prognostic study of 91 patients who underwent cervical arthrodesis surgery, patients who used chronic narcotic pain medication pre-surgery continued to experience a decline in functional outcomes and continued using narcotics 2-years post-surgery, compared to non-chronic consumers (Lawrence et al., 2008). Our findings sway away from these results as we found no clinically significant results of analgesics on post-surgical neck/arm pain and disability experienced by patients. However, we included a larger sample size and a more comprehensive method to factor in known confounding variables.

Clinical Implications

For both, cervical myelopathy and radiculopathy groups, the use of preoperative analgesics did not show a clinically important impact on patient's pain and disability outcomes. The patient and their circle of care can consider this finding in their decision-making of analgesic use along with other long-term effects of analgesics such as dependency, minor and major side effects, and cost (Borghouts et al., 1999; Todd, 2011).

Research Implications

This study can help build future studies to support and advance knowledge on analgesic use on postoperative clinical outcomes using propensity scores. Other populations that undergo spinal surgery can be used to replicated and validate this study. To our knowledge, this study is first to use propensity score weighting to investigate the effects of analgesics on post-operative pain and disability in patients with cervical myelopathy and radiculopathy. PS weighting can be helpful tool in identifying causal inference using observational data (Shiba & Kawahara, 2021), given that confounding variables are balanced between treatment and control groups (Austin, 2009). Even though a randomized controlled trial can address unknown confounding variables, using propensity score weighting is a more feasible approach, combined with a large sample size and controlling of known confounders to help estimate the average treatment effect of pain medications on post-surgical outcomes of pain and disability.

Strengths/Limitations

Strengths of this study include the large sample size of patients from 15 spine centers across Canada, the use of standardized patient-centered outcomes, and robust methods to account for the impact of confounding.

Since this study was a retrospective cohort study, we were limited to only use the data that was collected by the registry. There may be additional sources of confounding that were not accounted for in our models. The study data were collected through self-reported patient questionnaires, performed either through mail or by phone. This could

potentially lead to recall bias as patients were asked to remember their medication history in the last 6 months. There may also be a component of social desirability bias when reporting medication use rather than obtaining this information through pharmacy reports.

We also excluded patients from the model if they failed to report key variables of interests. We made an assumption that our data were missing completely at random and therefore we proceeded with complete case analysis. If our data was missing for any other reason than randomness, then our results would be biased.

An additional limitation was our pain-related outcome measures. Patients with cervical myelopathy commonly experience pain-*less* disability due to compression of their spinal cord and tend to have a more functional impact on their ability to do daily activities. Therefore, our pain and disability measures may have missed some aspects of these patients' disability.

Conclusion

Preoperative analgesics did not have a clinically significant impact on patient's pain and disability, postoperatively, at 3 and 12 months. Preoperative use of narcotics and muscle relaxants led to very small reductions in arm pain intensity 3-months after surgery for patients with cervical radiculopathy and myelopathy, respectively. However, the magnitude of these effects would not be considered to be clinically important. Other analgesics (i.e., NSAIDs, Over-the-counter medications, and neuroleptics) had no

statistically significant or clinically important effects on pain and disability measured 3 and 12 months post-surgery, for both patient groups.

Clinical decision-making around preoperative analgesic use for patients with cervical radiculopathy or myelopathy is complex and requires the patient and physician to consider the long-term effect on patients' overall health. However, our study indicates that these analgesics do not negatively impact postsurgical pain and disability.

Further research is needed to help understand the effects of preoperative analgesics on postoperative clinical outcomes. For example, it may be beneficial to explore the effects of different analgesic dosages and assess if they have an impact on clinical outcomes for patients with cervical myelopathy and radiculopathy.

Figures

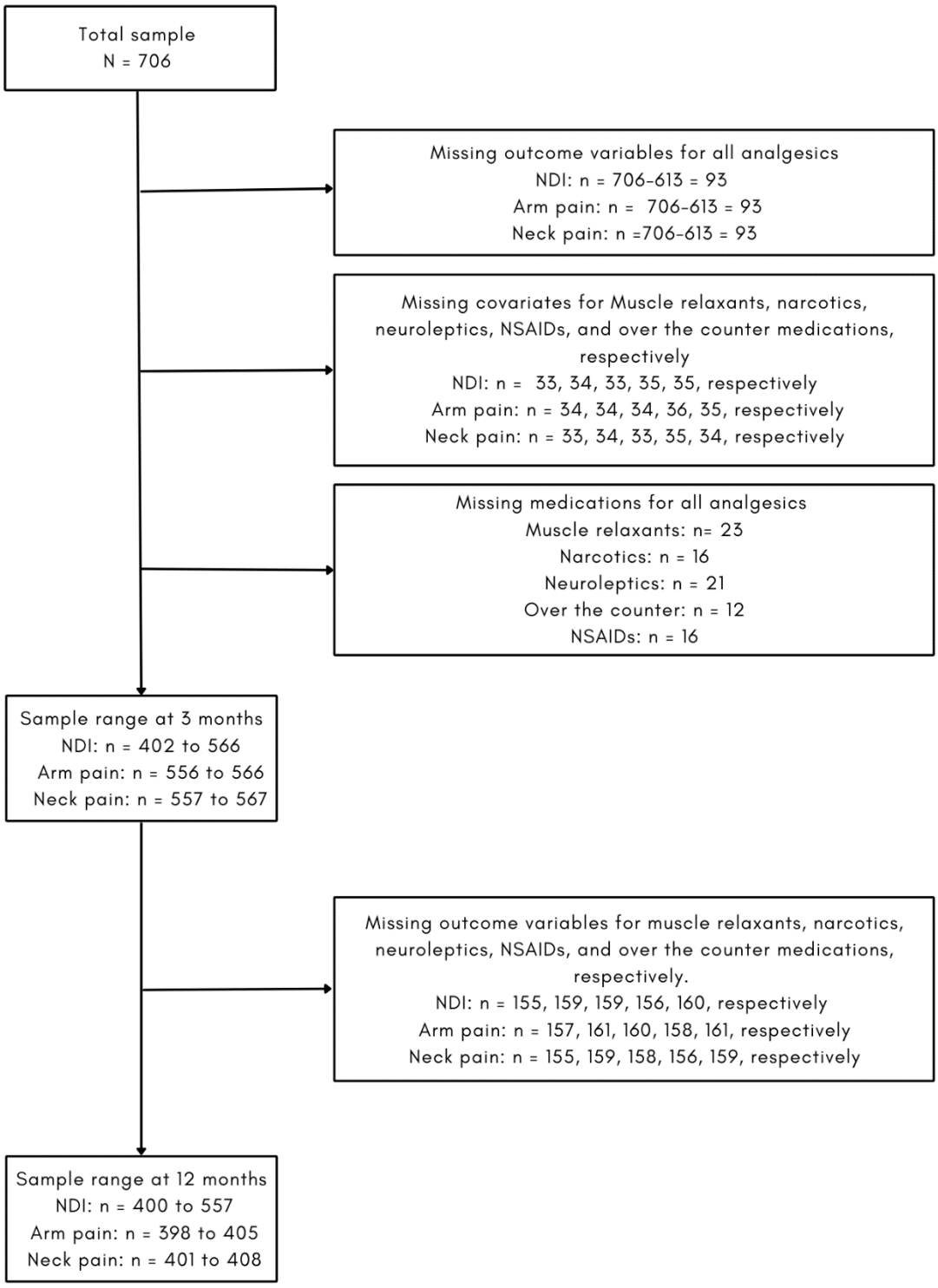

Figure 1. Study flow diagram for patients with cervical myelopathy.

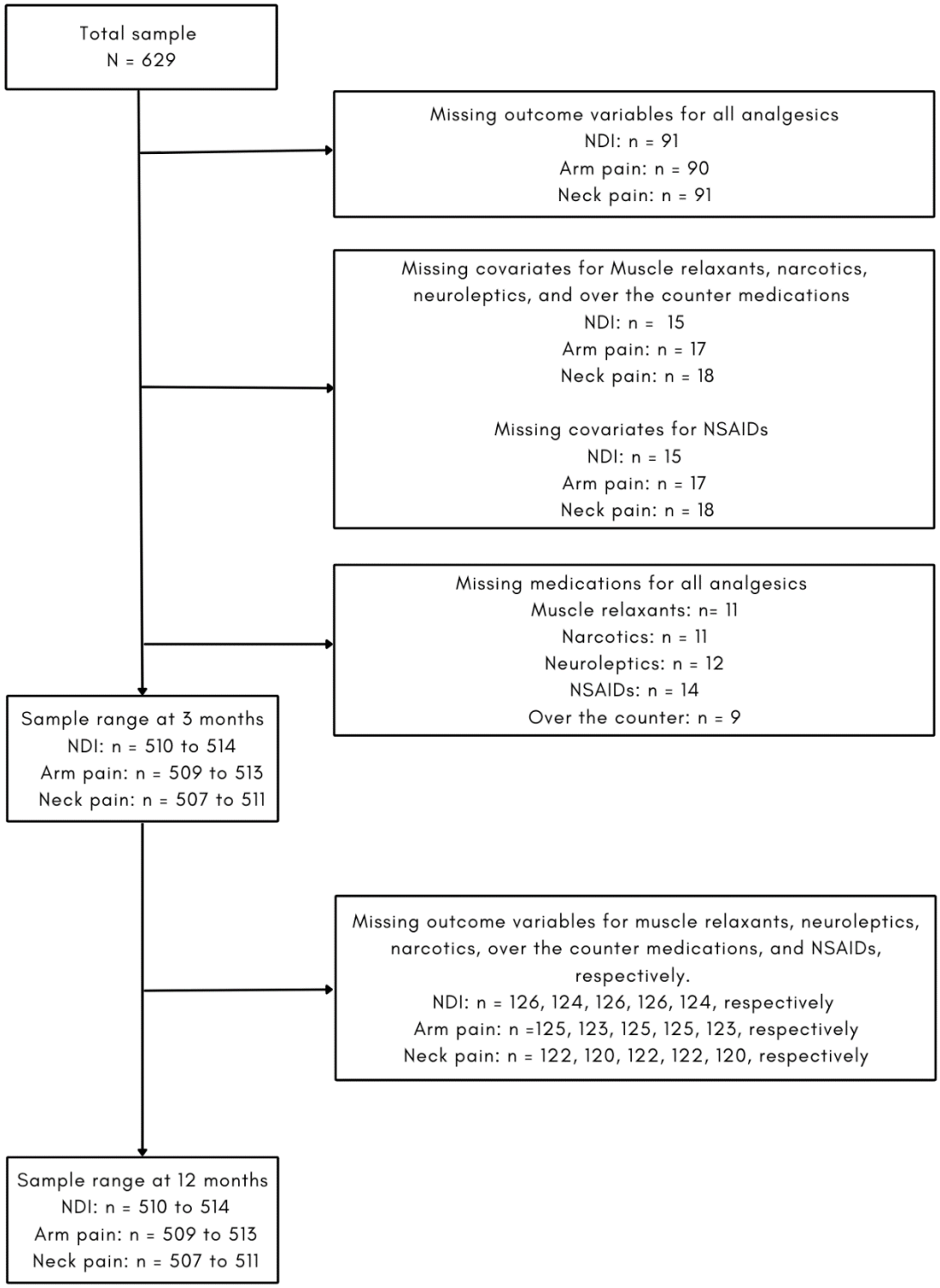

Figure 2. Study flow diagram for patients with cervical radiculopathy.

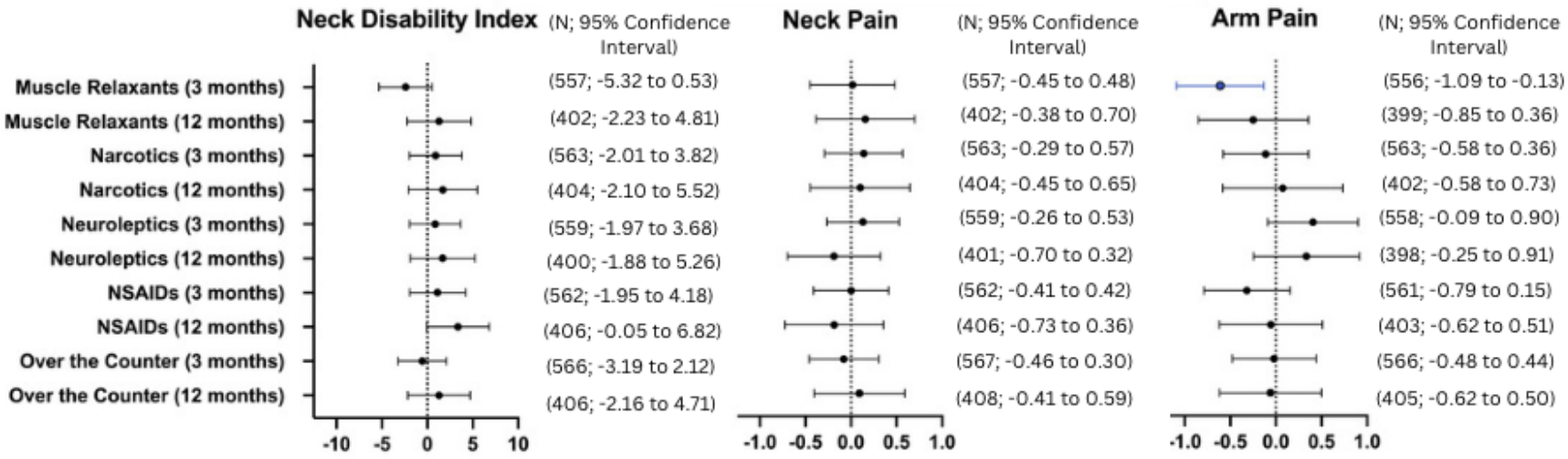

Figure 3. Effects of analgesic use at 3- and 12-months, post-surgery, on neck pain-related disability, neck pain, and arm pain, for patients with cervical myelopathy. Values reported are average treatment effects and 95% confidence intervals. Blue color indicates a significant affect. Models adjusted for age, sex, education level, smoking status, depression risk, and baseline pain and disability.

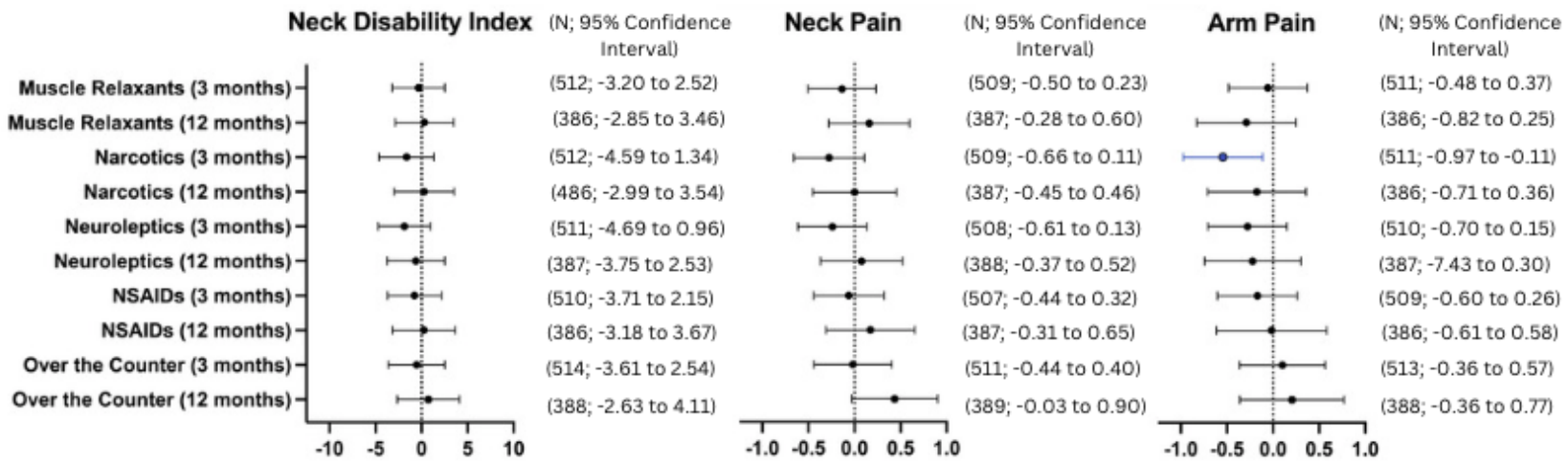

Figure 4. Effects of analgesic use at 3- and 12-months, post-surgery, on neck pain-related disability, neck pain, and arm pain, for patients with cervical radiculopathy. Values reported are average treatment effects and 95% confidence intervals. Blue color indicates a significant affect. Models adjusted for age, sex, education level, smoking status, depression risk, and baseline pain and disability.

Tables

Table 1. Demographic and preoperative characteristics of patients with cervical radiculopathy and cervical myelopathy.

Variable	Cervical Radiculopathy		Cervical Myelopathy	
	Sample Size	**Value**	**Sample Size**	**Value**
Age (years)	539	51.11 ± 9.64	609	59.23 ± 12.04
Female sex	529	238 (44.16%)	609	237 (38.92%)
Education status				
Less than high school	539	48 (8.91%)	609	97 (15.93%)
High school diploma		134 (24.86%)		171 (28.08%)
Technical school/Associate degree		128 (23.75%)		117 (19.21%)
College/University degree/Undergraduate degree		180 (33.40%)		168 (27.59%)
Post-Graduate or Professional degree		49 (9.09%)		56 (9.20%)
Smoking status				
Non – smoker	539	388 (71.99%)	609	407 (66.83%)
Past – smoker		44 (8.16%)		45 (7.39%)
Present – smoker		107 (19.85%)		157 (25.78%)
Baseline Body Mass Index (BMI)	538	28.39 ± 7.32	608	28.51 ± 7.32
Baseline Arm Pain (NPRS)	537	6.88 ± 2.18	603	5.47 ± 3.02
Baseline Neck Pain (NPRS)	537	6.61 ± 2.24	603	5.20 ± 3.02
Baseline neck-pain related disability score (NDI)	539	44.61 ± 16.13	606	41.01 ± 19.28
Fusion surgery	537	400 (74.49%)	608	524 (86.18%)
Medications, users				
Muscle relaxants	531	199 (37.48%)	589	130 (22.07%)
Narcotics	532	253 (47.56%)	594	186 (31.31%)
Neuroleptics	529	275 (51.98%)	589	178 (30.22%)
NSAIDs	529	186 (35.16%)	595	158 (26.55%)
Over the counter	534	375 (70.22%)	598	332 (55.52%)

NPRS = Numeric Pain Rating Scale; NDI = Neck Disability Index; NSAID = Non-steroidal anti-inflammatory drugs; Values are reported as Mean ± Standard Deviation (SD) or as Number of patients (percentage of total patients).

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Appendix A

Balance statistics and overlap plots

All data was analyzed using STATA V.16.1; StataCorp, College Station, TX, USA

In our propensity score models, we balanced matched treated and control participants by setting the standardized difference at a suggested threshold of 10% or (0.10) (Austin et al., 2021; Mamdani et al., 2005). While all the matched weighted patient groups reported a standardized difference of well below 10%, patients with cervical myelopathy using NSAIDs and neuroleptics, 12-months post-surgery, reported a standardized difference above or at the threshold of 10% (0.10).

We modified the propensity score model to better balance the matched control and treatment groups by allowing for quadratic relations between confounding variables in patients with cervical myelopathy, using neuroleptics, 12 months post-surgery. We acknowledge that patients with cervical myelopathy using NSAIDs, 12-months post-surgery, had a standardized difference at the recommended threshold at 0.100 for sex of the cohort. This could indicate that sex as a confounding variable could impact the "treated" or "control" groups. However, since it is sitting right at the threshold of 0.1, we deem that there is negligible difference in between groups due to sex.

Cervical Myelopathy

Neck Disability Index (NDI)

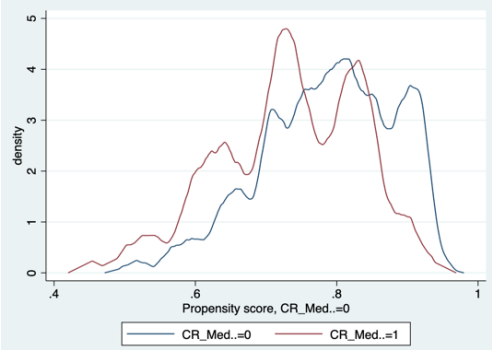
Muscle Relaxants

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.3483894	-.0380923	1.018021	.9539729
X_AgeCalc# X_AgeCalc	-.3464999	-.0430377	.9206024	.9323912
sex	-.1453515	-.0232846	1.054444	1.00905
CR_Education_~s	.1454632	.043392	.931316	.9602312
smoke	-.0656723	.0401121	.9525708	1.052968
CR_PHQ9_new	.3400639	.0167968	.9503891	1.003465
CR_PHQ9_new# CR_PHQ9_new	.2888004	.0155585	1.12642	1.015302
NDIScore_bl	.4064202	.0247817	.8511787	.8903034

(ii) Overlap plot

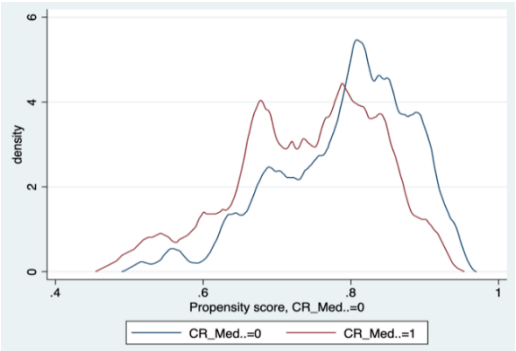


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.3115187	-.0297381	.9173243	.9603702
X_AgeCalc# X_AgeCalc	-.3186569	-.0336779	.8251216	.9291035
sex	-.1597334	-.0448759	1.065701	1.017751
CR_Education_~s	.0980336	.0178538	.9492098	.9542725
smoke	-.0821978	.0383833	.9033451	1.013833
CR_PHQ9_new	.2572246	.0078054	1.061937	.9865028
CR_PHQ9_new# CR_PHQ9_new	.2460528	.0029702	1.27242	1.05116
NDIScore_bl	.4198003	.0142076	1.041095	1.011777

(ii) Overlap plot



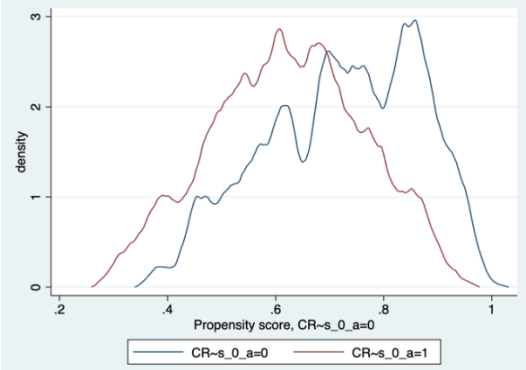
Neuroleptics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1223816	.0048066	.608092	.9498488
X_AgeCalc# X_AgeCalc	-.1703976	-.000358	.6173552	.9524735
sex	-.1249775	-.0221906	1.052988	1.008923
CR_Education_~s	.0935306	-.0274121	.928406	.9648389
smoke	.0067661	.0094802	.9693683	.9664488
CR_PHQ9_new	.3329804	.0111329	.9537339	.9768592
CR_PHQ9_new# CR_PHQ9_new	.2812142	.0030233	1.097158	.9834109
NDIScore_bl	.5911844	.0592381	.7977059	.7926936

(ii) Overlap plot

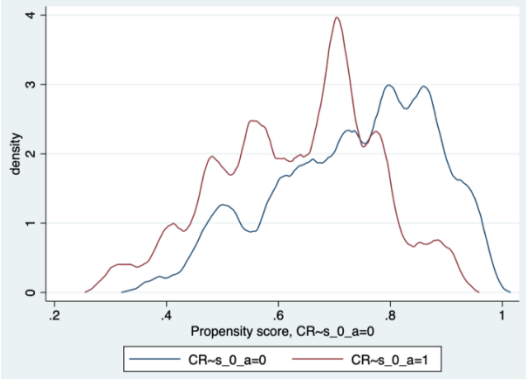


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1531973	.0370767	.6112973	.8961542
X_AgeCalc# X_AgeCalc	-.1975406	.0264944	.6177539	.942007
sex	-.2028282	-.0902893	1.085079	1.03093
CR_Education_~s	.1645179	-.0159485	.9160067	.8942002
smoke	-.1075834	-.0085256	.8879589	.9703213
CR_PHQ9_new	.3676523	.0102421	.9730584	1.000811
CR_PHQ9_new# CR_PHQ9_new	.3228777	.0091058	1.183045	1.031002
NDIScore_bl	.5503789	.0786027	.845475	.8184771

(ii) Overlap plot



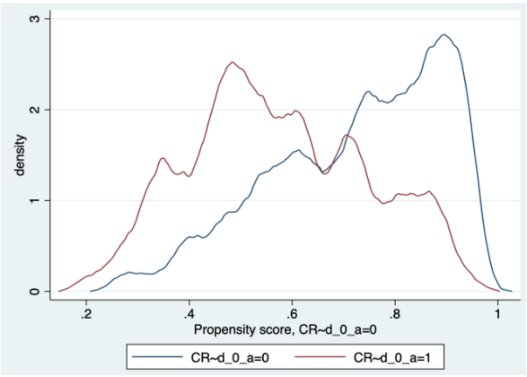
Narcotics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0743572	-.02055	.838749	.9292955
X_AgeCalc# X_AgeCalc	-.0926786	-.0280242	.8089788	.884006
sex	-.1474755	.0180683	1.055994	.9923537
CR_Education_~s	-.0677784	-.020019	1.108336	1.160371
smoke	.1513966	.097189	1.100946	1.059492
CR_PHQ9_new	.6974372	-.0109991	.971106	1.026494
CR_PHQ9_new# CR_PHQ9_new	.6208103	-.002029	1.248428	.907127
NDIScore_bl	.8550898	.0138375	.8563887	.9797043

(ii) Overlap plot

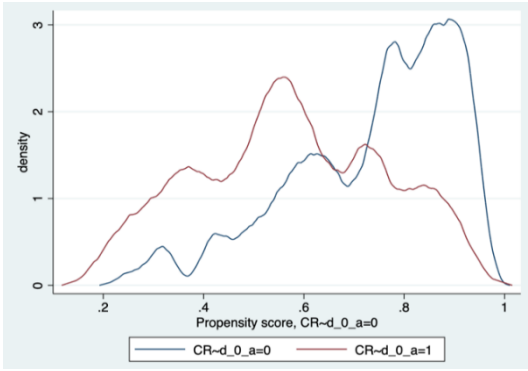


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.10824	-.037616	.8515289	.9729566
X_AgeCalc# X_AgeCalc	-.1235083	-.0402984	.8275234	.9275933
sex	-.1013654	.0093067	1.046771	.9955253
CR_Education_~s	-.0923091	-.0069561	1.072196	1.118079
smoke	.0744133	.116858	1.020298	1.06594
CR_PHQ9_new	.7293081	-.0191212	1.081611	1.056752
CR_PHQ9_new# CR_PHQ9_new	.6928182	-.0006718	1.497197	.9442983
NDIScore_bl	.8910634	-.0286181	.8999437	1.051018

(ii) Overlap plot



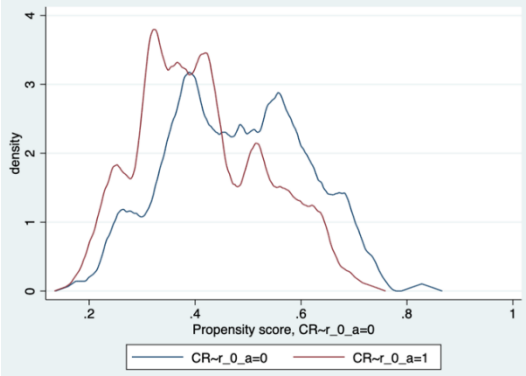
Over-the-Counter Medications

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0965456	-.0092982	.8232976	.99001
X_AgeCalc# X_AgeCalc	-.1169978	-.0103633	.8249487	.9975564
sex	-.2354424	-.0085985	1.11328	1.003891
CR_Education_~s	.0587503	-.0118017	.9274681	.929168
smoke	-.0202072	-.0007831	.9681378	.9817108
CR_PHQ9_new	.3771549	-.0081815	1.075148	.9910478
CR_PHQ9_new# CR_PHQ9_new	.3443903	-.0097003	1.457907	1.091571
NDIScore_bl	.4446252	-.0060904	.7919729	.7993174

(ii) Overlap plot

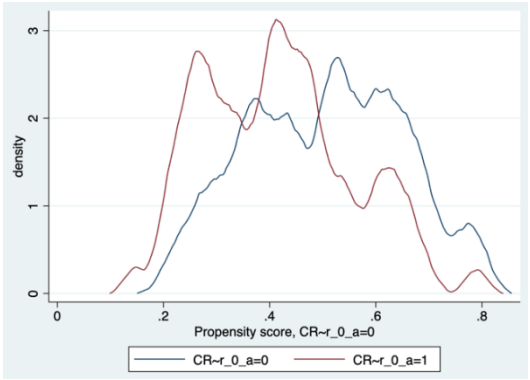


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.05194	-.0150765	.8160248	.9861515
X_AgeCalc# X_AgeCalc	-.0717922	-.0164162	.8293737	1.00521
sex	-.2881402	-.0073302	1.150081	1.003712
CR_Education_~s	.0185756	.0011234	.8943118	.8714022
smoke	-.1781459	.0083458	.8167186	.9781971
CR_PHQ9_new	.3175921	-.0082754	1.006473	.9965979
CR_PHQ9_new# CR_PHQ9_new	.2793924	-.0082726	1.305239	1.077541
NDIScore_bl	.4950335	.0072414	.8622324	.9086572

(ii) Overlap plot



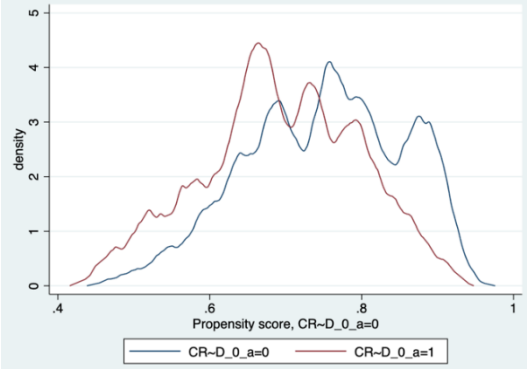
NSAIDs

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2053859	.025819	.8778907	1.031955
X_AgeCalc# X_AgeCalc	-.2186665	.0291718	.8487836	1.048704
sex	-.1832322	-.0141681	1.067869	1.005846
CR_Education_~s	.1223306	.0096748	.8275101	.8314501
smoke	-.1438681	-.0634865	.8194995	.8752974
CR_PHQ9_new	.3488625	.0176387	.9191168	.9657693
CR_PHQ9_new# CR_PHQ9_new	.2856203	.0054931	1.105642	.999787
NDIScore_bl	.4158607	.0114384	.8760604	.9298103

(ii) Overlap plot

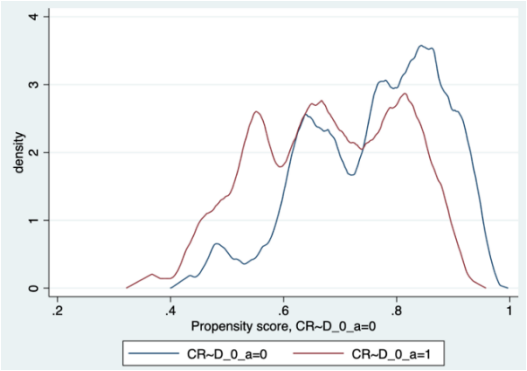


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0987052	.0101762	.8344086	1.006785
X_AgeCalc# X_AgeCalc	-.1158622	.010788	.8386959	1.02864
sex	-.2127191	-.0546052	1.08423	1.021634
CR_Education_~s	.1758955	.0287342	.9906902	.9872155
smoke	-.3849896	-.0837224	.6033122	.8779827
CR_PHQ9_new	.3672584	.0043973	.9771829	.9448
CR_PHQ9_new# CR_PHQ9_new	.3238699	-.0121606	1.204444	.9838438
NDIScore_bl	.4014865	-.0062641	.9847268	.9978225

(ii) Overlap plot



Neck Pain Scale

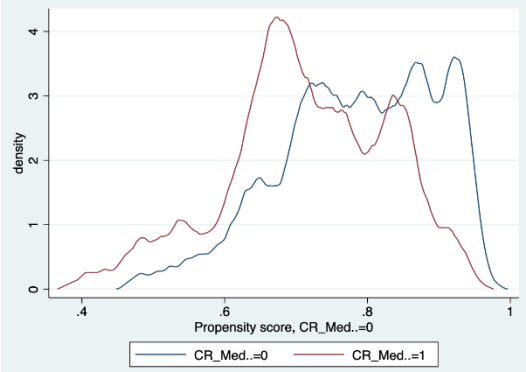
Muscle Relaxants

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.340174	-.0176224	1.01364	.9562618
X_AgeCalc# X_AgeCalc	-.3384201	-.0223146	.9195405	.9317254
sex	-.1690126	-.0318973	1.063071	1.01239
CR_Education_~s	.1244129	.0397838	.9399224	.9884922
smoke	-.0837338	.0214061	.9301466	1.054174
CR_PHQ9_new	.3156529	.0037321	.9433877	.976555
CR_PHQ9_new# CR_PHQ9_new	.2635363	-.0034371	1.115012	1.007348
PainScaleNeck~l	.5304446	.0547791	.707508	.8162647

(ii) Overlap plot

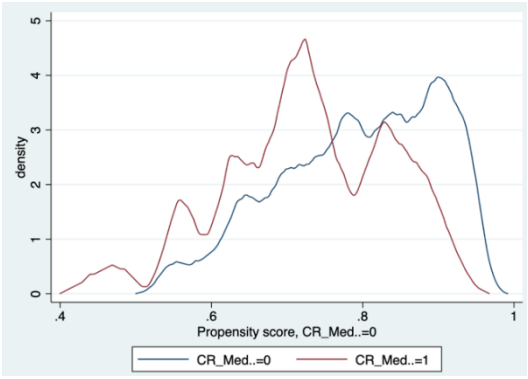


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2772841	.0071295	.9359764	.9798292
X_AgeCalc# X_AgeCalc	-.2830977	.005152	.8437841	.9510989
sex	-.1597334	-.0100057	1.065701	1.004389
CR_Education_~s	.099335	.0450886	.9612752	.9496769
smoke	-.1281268	-.010357	.8609487	.9923825
CR_PHQ9_new	.2265393	-.0386959	1.062807	.9722572
CR_PHQ9_new# CR_PHQ9_new	.2172293	-.0409594	1.256697	1.049414
PainScaleNeck~l	.5717273	.0894722	.6926692	.7705767

(ii) Overlap plot



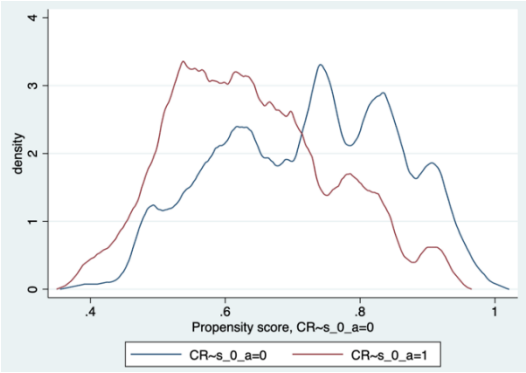
Neuroleptics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1237691	.0531656	.6123591	.9484139
X_AgeCalc# X_AgeCalc	-.1709142	.0480846	.6215765	.9863748
sex	-.1327734	-.0771843	1.05784	1.027759
CR_Education_~s	.106415	-.0493895	.9207085	1.001682
smoke	-.0138118	.0024611	.9542668	.9712579
CR_PHQ9_new	.345032	-.0122507	.9515058	1.021574
CR_PHQ9_new# CR_PHQ9_new	.2913461	-.0045008	1.099331	.9809795
PainScaleNeck~l	.5017735	.0069032	.7868188	1.029318

(ii) Overlap plot

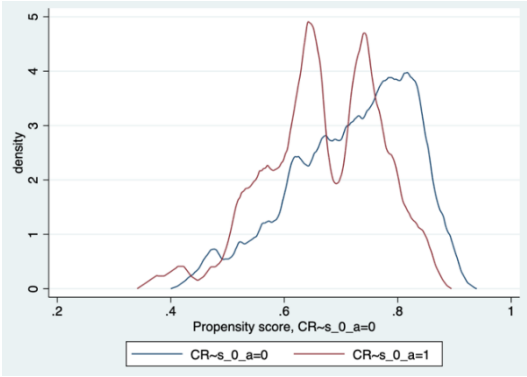


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1400938	-.0290016	.6058888	.6295303
sex	-.2300713	-.0574053	1.09451	1.0223
CR_Education_~s	.1424583	.0018675	.9234198	.9276414
smoke	-.1221124	-.0055888	.8540184	.9618892
CR_PHQ9_new	.3602975	.0601565	.9919617	.9498369
PainScaleNeck~l	.3580795	.0279435	.9173635	.9930836
PainScaleNeck~l# PainScaleNeck~l	.348969	.0266709	1.066979	.980182

(i) Overlap plot



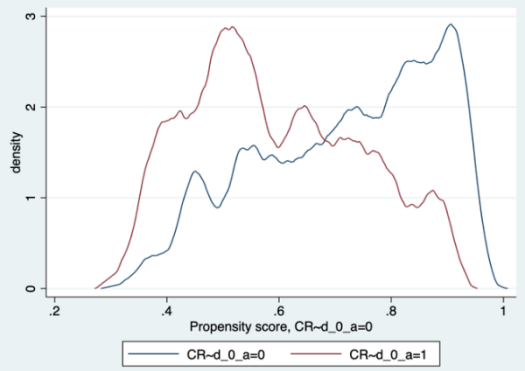
Narcotics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0725936	-.0238522	.8498129	.9248959
X_AgeCalc# X_AgeCalc	-.0895198	-.0317175	.8199216	.8951999
sex	-.1558634	.0135755	1.060986	.9940136
CR_Education_~s	-.0566033	-.0457959	1.126835	1.194437
smoke	.1508547	.060888	1.079544	.9978191
CR_PHQ9_new	.698591	.0296689	.9733494	.9986944
CR_PHQ9_new# CR_PHQ9_new	.6222118	.0254746	1.259108	.9127226
PainScaleNeck~l	.6623346	.0914638	.6686309	.780173

(ii) Overlap plot

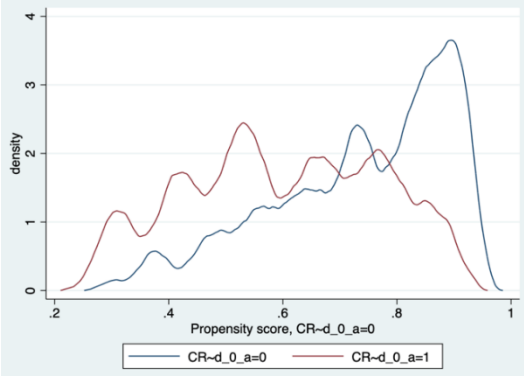


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1019237	-.0236592	.8668268	.920863
X_AgeCalc# X_AgeCalc	-.1154681	-.0313704	.8439873	.9118036
sex	-.116562	.0160669	1.052619	.9921786
CR_Education_~s	-.0856278	-.0499285	1.094697	1.156468
smoke	.0661675	.0792394	1.010879	1.022936
CR_PHQ9_new	.7300354	.041864	1.077626	.9976623
CR_PHQ9_new# CR_PHQ9_new	.6907721	.036538	1.508947	.9392884
PainScaleNeck~l	.7067695	.0876597	.6995157	.7875476

(ii) Overlap plot



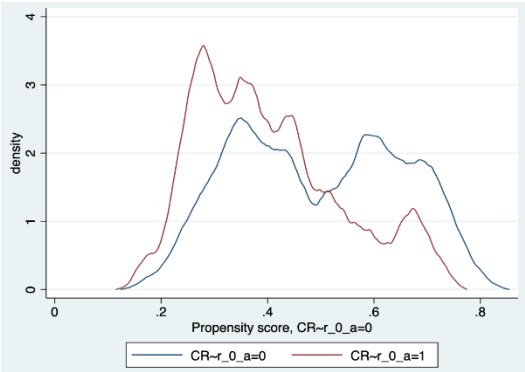
Over-the-Counter Medications

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1070469	-.0096856	.8286762	.9991988
X_AgeCalc# X_AgeCalc	-.1267301	-.0097827	.8321457	1.02163
sex	-.2468613	-.0141167	1.122465	1.00694
CR_Education_~s	.0575512	-.000787	.9350069	.9251091
smoke	-.0276144	-.0013278	.9623087	.9880692
CR_PHQ9_new	.3906223	-.0083419	1.062757	.9783948
CR_PHQ9_new# CR_PHQ9_new	.3522933	-.0134866	1.457253	1.076913
PainScaleNeck~l	.5736	.0046559	.7284006	.866724

(ii) Overlap plot

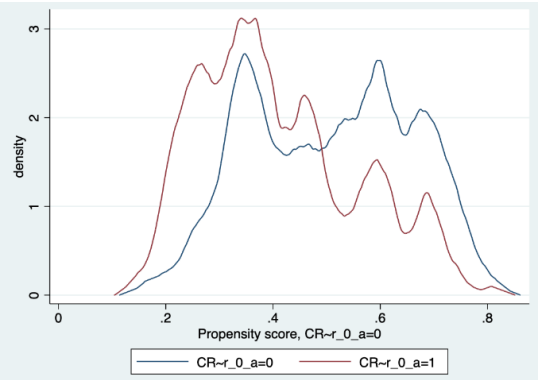


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0384017	-.0168812	.8244792	1.01332
X_AgeCalc# X_AgeCalc	-.0571241	-.0155357	.8378012	1.043038
sex	-.2890142	-.0173953	1.150221	1.009219
CR_Education_~s	.0071709	.0122519	.8967525	.8628485
smoke	-.1850602	.0038407	.8046431	.9722469
CR_PHQ9_new	.3249264	-.0128783	1.034168	.978413
CR_PHQ9_new# CR_PHQ9_new	.2932826	-.0176548	1.353365	1.050301
PainScaleNeck~l	.5474712	.0059199	.7665252	.8774562

(ii) Overlap plot



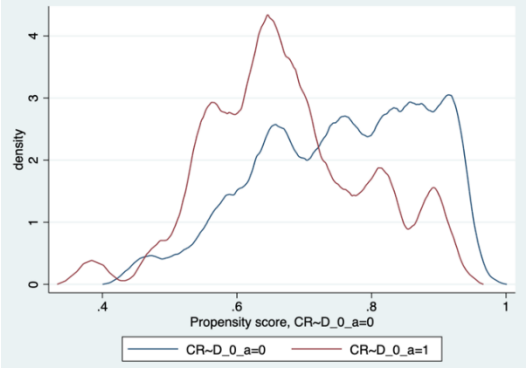
NSAIDs

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2110503	.0611088	.8767399	1.099581
X_AgeCalc# X_AgeCalc	-.2241142	.0711371	.8488144	1.143824
sex	-.1933198	-.0237236	1.073629	1.009782
CR_Education_~s	.1315945	.0094309	.8180118	.815943
smoke	-.1443379	-.0558806	.8163367	.8831331
CR_PHQ9_new	.3463556	.0410469	.9274088	.9356032
CR_PHQ9_new# CR_PHQ9_new	.2857538	.0173382	1.1053	.9728262
PainScaleNeck~l	.5894923	.0192398	.7149892	.9283271

(ii) Overlap plot

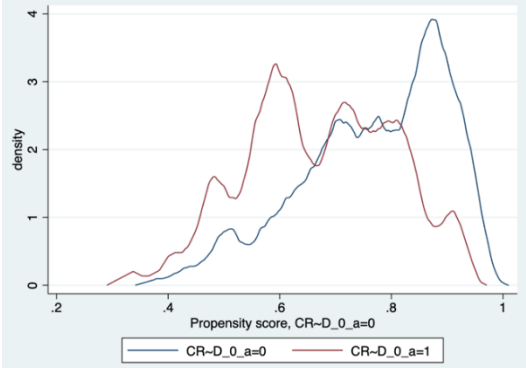


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0879646	.0412325	.8352086	1.030994
X_AgeCalc# X_AgeCalc	-.1050422	.0438886	.8409935	1.082226
sex	-.2507222	-.1004368	1.093556	1.03423
CR_Education_~s	.1531721	.0368423	1.009297	.980383
smoke	-.4085661	-.0463122	.5739514	.9229404
CR_PHQ9_new	.3481698	.0396027	.9915964	.9060518
CR_PHQ9_new# CR_PHQ9_new	.3095863	.0076599	1.200649	.9587445
PainScaleNeck~l	.5226049	.0100827	.7345691	.927756

(ii) Overlap plot



Arm Pain Scale

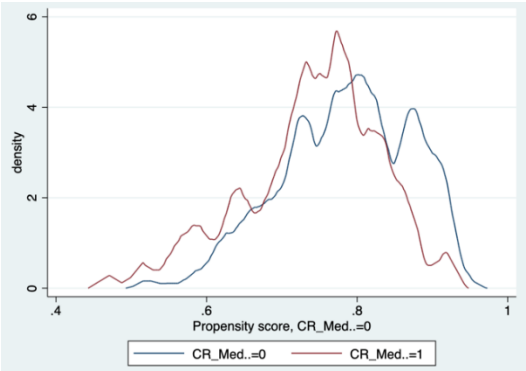
Muscle Relaxants

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.3455952	-.0429073	1.026718	.9561818
X_AgeCalc# X_AgeCalc	-.342655	-.0476153	.9307036	.9389187
sex	-.1788087	-.0006462	1.066227	1.000305
CR_Education_~s	.1384238	.0260229	.9354445	.9477335
smoke	-.0659273	.0276097	.9464187	1.040761
CR_PHQ9_new	.2934859	.0239544	.9331319	1.010032
CR_PHQ9_new# CR_PHQ9_new	.2387582	.0233579	1.108346	1.067034
PainScaleArm_bl	.2066478	.0250427	.8524082	.9305299

(ii) Overlap plot

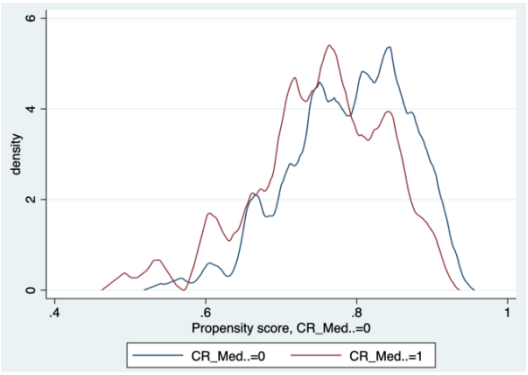


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.273013	-.0264614	.9533707	.9540787
X_AgeCalc# X_AgeCalc	-.2775388	-.0309874	.8593412	.9264599
sex	-.1852071	-.0095216	1.076195	1.004279
CR_Education_~s	.1111654	.0187337	.9676795	.9403383
smoke	-.1219563	.0312197	.8637905	1.012108
CR_PHQ9_new	.2211215	.0092904	1.049377	.9754171
CR_PHQ9_new# CR_PHQ9_new	.2079867	.0010628	1.252139	1.063271
PainScaleArm_bl	.297678	.0101731	.8148297	.8985729

(ii) Overlap plot



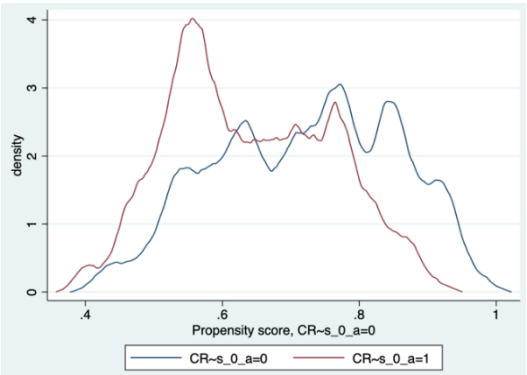
Neuroleptics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1130783	.0095519	.6146909	.9021373
X_AgeCalc# X_AgeCalc	-.1601129	-.0006559	.6234938	.9226412
sex	-.1433178	-.0576968	1.062355	1.021846
CR_Education_~s	.097202	-.0312216	.9267779	.959097
smoke	-.0099562	.0189307	.9574735	.9872568
CR_PHQ9_new	.3450548	.0087727	.9413126	.9686522
CR_PHQ9_new# CR_PHQ9_new	.2870625	-.0013967	1.091342	.9549256
PainScaleArm_bl	.4866459	.0804939	.757662	.9372522

(ii) Overlap plot

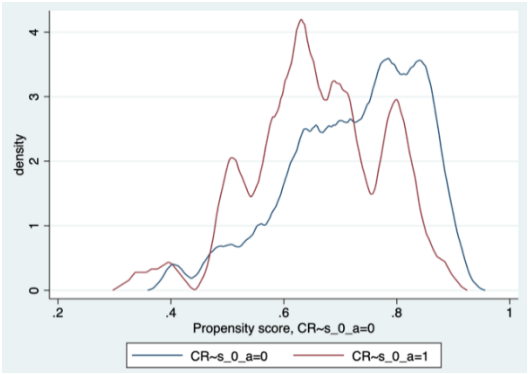


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1371777	-.0477235	.6128885	.6005672
sex	-.2554374	-.0637403	1.107606	1.024884
CR_Education_~s	.1530473	-.0029207	.9282332	.9109805
smoke	-.1176675	.0069241	.854687	.9655409
CR_PHQ9_new	.3604107	.0560002	.9822054	.9156409
PainScaleArm_bl	.4303541	.0055507	.8286526	1.009095
PainScaleArm_bl# PainScaleArm_bl	.4276872	.0088841	1.025983	.9966202

(ii) Overlap plot



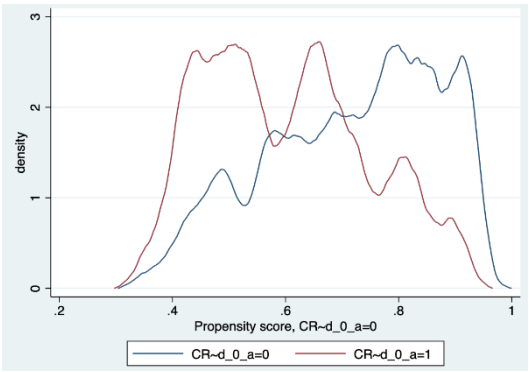
Narcotics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0651067	-.0161931	.8549045	.8985361
X_AgeCalc# X_AgeCalc	-.081487	-.026864	.8244556	.8626825
sex	-.1612857	.0328868	1.064024	.9846204
CR_Education_~s	-.056805	-.0215453	1.111758	1.127891
smoke	.1508547	.0312231	1.079544	.9707442
CR_PHQ9_new	.6803387	.0043982	.9820313	1.008946
CR_PHQ9_new# CR_PHQ9_new	.606143	.0063534	1.259974	.9008343
PainScaleArm_bl	.5202324	.0605555	.7496284	.8810335

(ii) Overlap plot

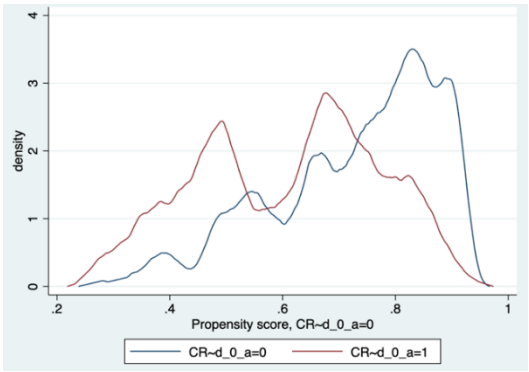


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0950478	-.0277378	.8807909	.8930839
X_AgeCalc# X_AgeCalc	-.1071586	-.0382594	.8582281	.8700436
sex	-.1235412	.0160949	1.058325	.991777
CR_Education_~s	-.0794121	-.0057366	1.083548	1.099192
smoke	.0578728	.040369	.9996698	.9907427
CR_PHQ9_new	.7178864	.0225372	1.099956	1.01166
CR_PHQ9_new# CR_PHQ9_new	.6847593	.0233297	1.533257	.9308381
PainScaleArm_bl	.5269938	.0721125	.7442668	.8625758

(ii) Overlap plot



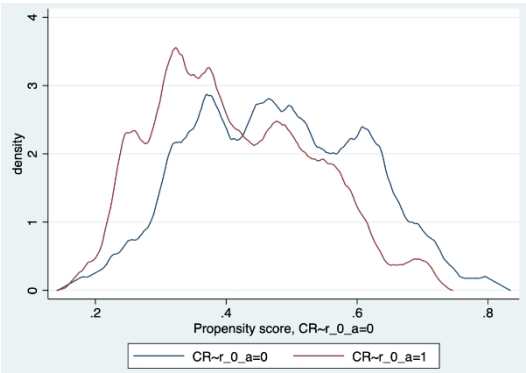
Over-the-Counter Medications

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0984945	-.0052601	.8209797	.991124
X_AgeCalc# X_AgeCalc	-.1191988	-.0061768	.8234171	1.00544
sex	-.2621228	-.0023257	1.133064	1.001078
CR_Education_~s	.0558525	-.0005816	.9355991	.9241184
smoke	-.0351429	.0018953	.9564365	.9841907
CR_PHQ9_new	.3999714	.0014705	1.067453	.999998
CR_PHQ9_new# CR_PHQ9_new	.3598195	.0012721	1.464697	1.100697
PainScaleArm_bl	.3295314	.0010829	.8492771	.962982

(ii) Overlap plot

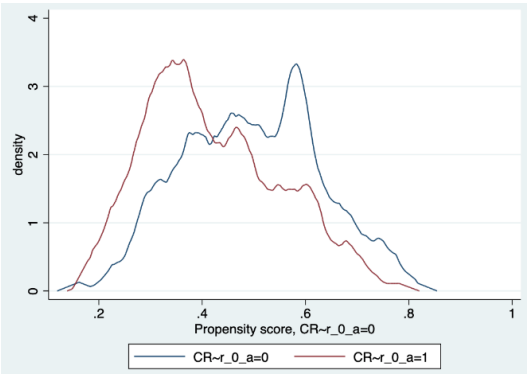


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0331577	-.0133167	.7892794	.999443
X_AgeCalc# X_AgeCalc	-.0560797	-.0133289	.7986346	1.014343
sex	-.3083105	-.0056565	1.169072	1.002872
CR_Education_~s	.0145445	.0097298	.8970317	.8658619
smoke	-.1772723	.0057723	.8055665	.961021
CR_PHQ9_new	.3106751	-.0098628	1.02149	.9968953
CR_PHQ9_new# CR_PHQ9_new	.2769012	-.0095528	1.331291	1.07328
PainScaleArm_bl	.3600155	.0029999	.8562044	.9819887

(ii) Overlap plot



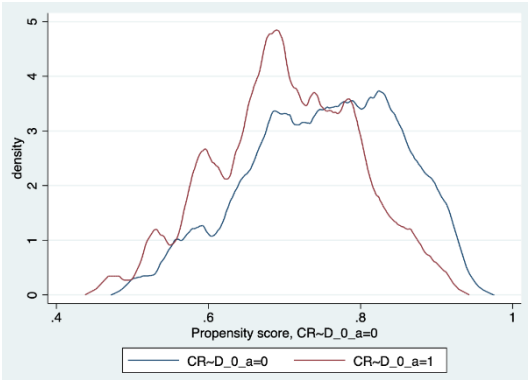
NSAIDs

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2149846	.0212642	.8856335	1.02491
X_AgeCalc# X_AgeCalc	-.2271769	.0238184	.8569399	1.053154
sex	-.2024023	-.0229348	1.076792	1.00957
CR_Education_~s	.1441614	.0276528	.8127862	.7968652
smoke	-.1288676	-.0334905	.8291218	.889065
CR_PHQ9_new	.3279967	.0281728	.9181961	.9677768
CR_PHQ9_new# CR_PHQ9_new	.2647889	.015104	1.09961	1.008226
PainScaleArm_bl	.3037343	.0448711	.7038292	.8300031

(ii) Overlap plot

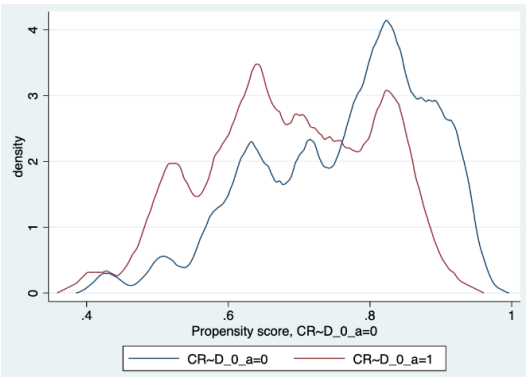


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0830797	-.0085739	.8467156	.9956018
X_AgeCalc# X_AgeCalc	-.098964	-.0089753	.8537484	1.017878
sex	-.2763162	-.069266	1.105037	1.027194
CR_Education_~s	.1643181	.0538185	1.015034	.9934936
smoke	-.4048001	-.0604868	.575786	.8866848
CR_PHQ9_new	.3462099	.0217079	.9814501	.9409579
CR_PHQ9_new# CR_PHQ9_new	.3038667	.0018205	1.199241	.9893735
PainScaleArm_bl	.2586893	.0173987	.7093694	.8673161

(ii) Overlap plot



Balance statistics and overlap plots

Cervical Radiculopathy

Neck Disability Index (NDI)

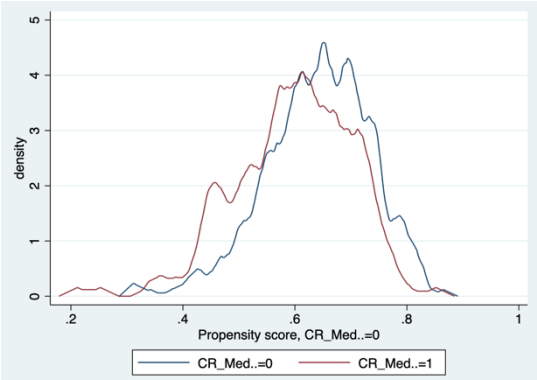
Muscle Relaxants

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2621489	-.0088022	1.147023	.9751695
X_AgeCalc# X_AgeCalc	-.2427106	-.010849	1.026497	.9406284
sex	-.1300577	.0071791	1.033322	.9979505
CR_Education_~s	.2138024	.0082943	.7688281	.7979815
smoke	-.1161762	.0104682	.8389165	.9791012
CR_PHQ9_new	.1172351	-.0035238	.8926237	.9906901
CR_PHQ9_new# CR_PHQ9_new	.0724844	-.0055552	.864465	.9178793
NDIScore_bl	.1249803	-.0014068	.8108587	.8696276

(ii) Overlap plot

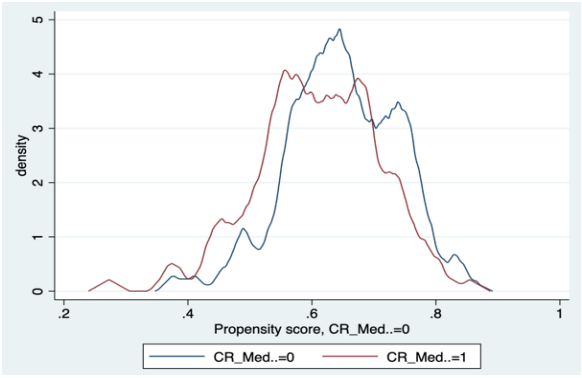


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1763035	.0025215	1.238092	.9855573
X_AgeCalc# X_AgeCalc	-.1520965	.0011502	1.182297	.9700829
sex	-.0815852	.0113857	1.022846	.9967096
CR_Education_~s	.1557873	.0083516	.7971545	.7969354
smoke	-.2046301	.0123333	.7681537	1.012535
CR_PHQ9_new	.1665489	-.0094472	.9327339	1.005524
CR_PHQ9_new# CR_PHQ9_new	.1297443	-.0068631	.896543	.9019849
NDIScore_bl	.1451209	.0007127	.9141883	.9624899

(ii) Overlap plot



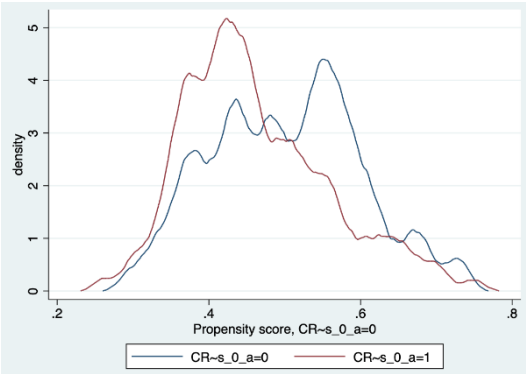
Neuroleptics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1673713	.0073952	.9192471	.9829134
X_AgeCalc# X_AgeCalc	-.1704346	.0056677	.8458824	.9735558
sex	-.1556032	.0011951	1.040277	.9996893
CR_Education_~s	.030742	-.0086988	.958937	.9562445
smoke	-.0041759	.004307	.9552441	.9838218
CR_PHQ9_new	.2386171	-.0078062	.948156	1.011311
CR_PHQ9_new# CR_PHQ9_new	.1920847	-.0037502	1.095385	1.044671
NDIScore_bl	.3438096	-.0084562	.9239378	1.014932

(ii) Overlap plot

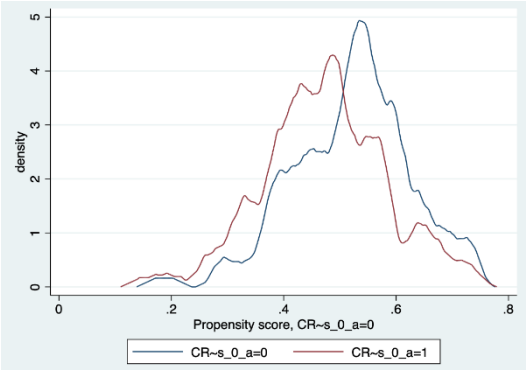


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2409084	.0142832	1.232166	.9903146
X_AgeCalc# X_AgeCalc	-.2158102	.0130709	1.117721	.9582562
sex	-.1949886	.0002898	1.049481	.9999295
CR_Education_~s	-.0151764	-.0162626	1.048892	1.044761
smoke	.0481088	-.0091838	1.074213	1.004201
CR_PHQ9_new	.2346575	-.0122912	.9521224	1.01504
CR_PHQ9_new# CR_PHQ9_new	.1926668	-.0068016	1.038536	.9893663
NDIScore_bl	.2785356	-.0144417	.8019716	.841964

(ii) Overlap plot



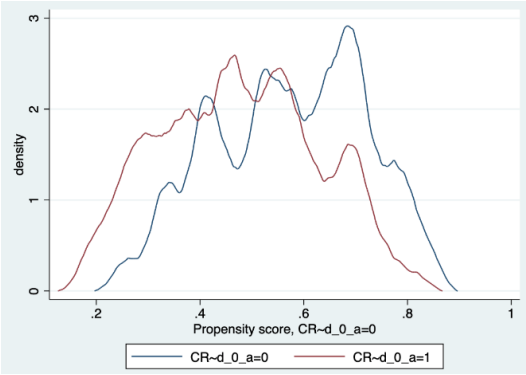
Narcotics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0685018	-.0234112	.7617844	.9731829
X_AgeCalc# X_AgeCalc	-.0912401	-.0254178	.7090541	.9428311
sex	-.1200014	-.0154133	1.031428	1.003594
CR_Education_~s	.0719747	-.0053089	.8978025	.8921549
smoke	.1924463	.016765	1.170533	.9621305
CR_PHQ9_new	.5707129	.0244921	1.174589	1.020971
CR_PHQ9_new# CR_PHQ9_new	.5338681	.0266071	1.72173	1.131259
NDIScore_bl	.5372708	.0308807	.9955292	1.031462

(ii) Overlap plot

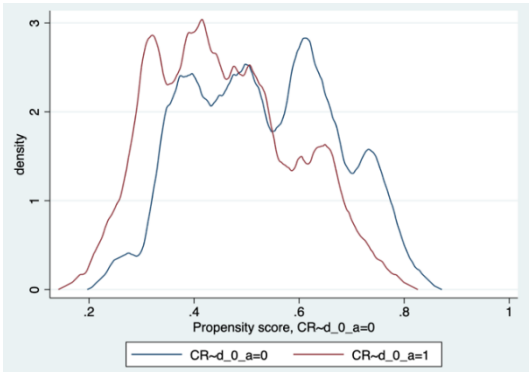


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1356667	-.0135	.8157575	.9765395
X_AgeCalc# X_AgeCalc	-.1508643	-.0153891	.7534064	.9576819
sex	-.1173983	-.0152019	1.030036	1.003336
CR_Education_~s	.0161757	-.0026431	.9918889	.9769866
smoke	.0710418	.0088991	1.023717	.9551187
CR_PHQ9_new	.5043139	.014169	1.085997	1.003251
CR_PHQ9_new# CR_PHQ9_new	.4617615	.0132433	1.473213	1.047307
NDIScore_bl	.4953157	.0178094	1.04405	1.067058

(ii) Overlap plot



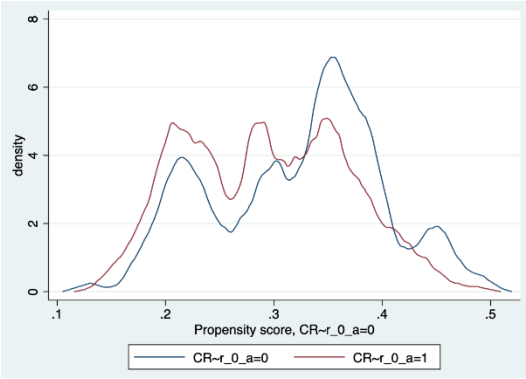
Over-the-Counter Medications

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0583687	.0129119	.956002	1.010689
X_AgeCalc# X_AgeCalc	-.0604305	.0135269	.9044026	.9836296
sex	-.2923087	.0076403	1.10591	.9983014
CR_Education_~s	.1237685	-.0148073	.9508252	.9415787
smoke	-.0766722	.0092698	.9881004	1.115834
CR_PHQ9_new	.046453	-.0172508	.9988559	.9915021
CR_PHQ9_new# CR_PHQ9_new	.040592	-.0170978	1.033892	.9743935
NDIScore_bl	.1923789	-.0237568	.8025546	.8224112

(ii) Overlap plot

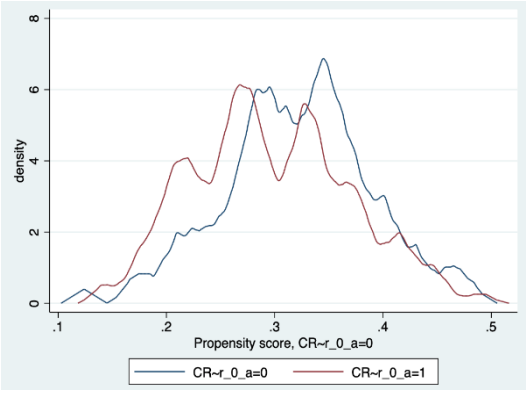


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	.107779	.0150873	1.024313	1.008602
X_AgeCalc# X_AgeCalc	.1078313	.0155111	1.053271	.9944638
sex	-.2052599	-.0049283	1.061123	1.001178
CR_Education_~s	.1375829	-.0285371	1.021139	.9676251
smoke	-.0653183	.0176963	.9820525	1.090812
CR_PHQ9_new	.0444276	-.0219781	1.145689	1.004716
CR_PHQ9_new# CR_PHQ9_new	.0766681	-.0181268	1.318661	1.069929
NDIScore_bl	.1468586	-.0162728	.8292777	.7678943

(ii) Overlap plot



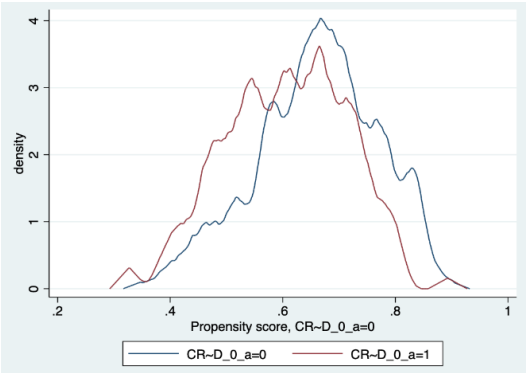
NSAIDs

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0382428	.0072111	1.024728	.9986727
X_AgeCalc# X_AgeCalc	-.03508	.0069101	1.074882	1.06669
sex	-.0915661	.0016896	1.024268	.9995881
CR_Education_~s	.33377	.0196469	.8258283	.8547885
smoke	-.1937476	-.002337	.7795713	1.011776
CR_PHQ9_new	.2712859	-.0020417	1.01414	1.024224
CR_PHQ9_new# CR_PHQ9_new	.2422446	.0046233	1.073605	.9644333
NDIScore_bl	.2333076	.0091975	.7329149	.7479827

(ii) Overlap plot

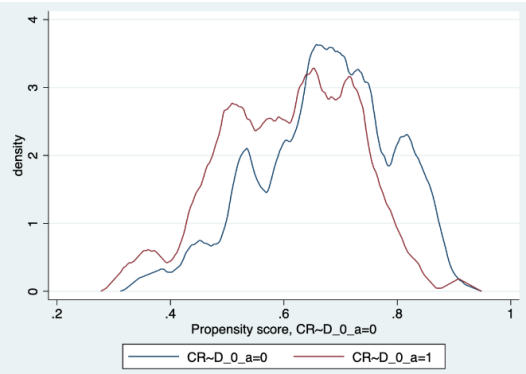


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.08389	-.0012631	1.04891	.978699
X_AgeCalc# X_AgeCalc	-.0773655	-.0031947	1.091553	1.033281
sex	-.089097	.0090957	1.023704	.9977343
CR_Education_~s	.3955263	.0167214	.8529521	.8727089
smoke	-.1863532	.0045057	.8093263	1.03507
CR_PHQ9_new	.3088526	-.0058793	.9960688	1.025422
CR_PHQ9_new# CR_PHQ9_new	.2746672	.0016321	1.083221	.9648668
NDIScore_bl	.2297987	.014558	.758191	.776752

(ii) Overlap plot



Neck Pain Scale

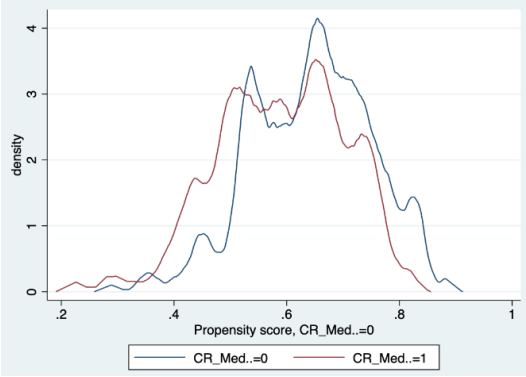
Muscle Relaxants

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2631905	-.0178434	1.140602	.9776662
X_AgeCalc# X_AgeCalc	-.2442204	-.0194488	1.020563	.9382139
sex	-.1350216	.0024189	1.035206	.9993327
CR_Education_~s	.213367	.0117415	.7649769	.7978682
smoke	-.1143187	.0087869	.8417346	.9827585
CR_PHQ9_new	.1202036	.0018528	.8917167	.9913916
CR_PHQ9_new# CR_PHQ9_new	.0747693	-.0006708	.8655006	.9157513
PainScaleNeck~l	.2275759	.024066	.6281575	.7480699

(ii) Overlap plot

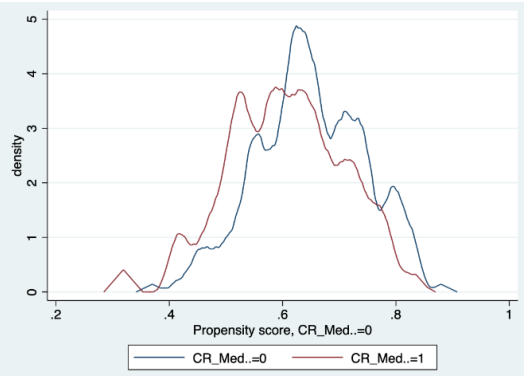


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1652694	.0004343	1.235294	.9954451
X_AgeCalc# X_AgeCalc	-.1414046	.0000128	1.180753	.9740841
sex	-.09746	.006608	1.026762	.9981088
CR_Education_~s	.1509875	.012384	.7872742	.7888232
smoke	-.1985275	.0138726	.7723136	1.018407
CR_PHQ9_new	.1585084	-.0085417	.9220568	1.006527
CR_PHQ9_new# CR_PHQ9_new	.119733	-.0058104	.8706437	.8885298
PainScaleNeck~l	.1844515	.0157562	.6865413	.784575

(ii) Overlap plot



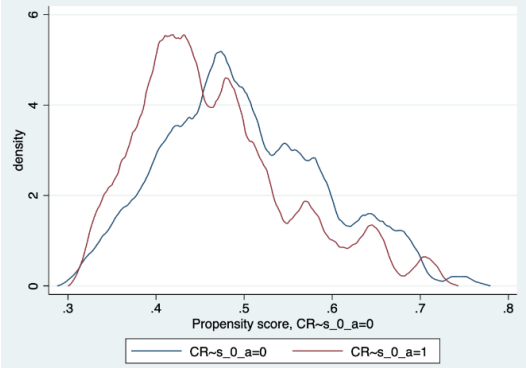
Neuroleptics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1684187	.005141	.9186826	.9807484
X_AgeCalc# X_AgeCalc	-.171531	.0032554	.8455812	.9654601
sex	-.1602653	-.0007749	1.042448	1.00018
CR_Education_~s	.0381071	-.0044376	.961094	.9700159
smoke	-.0116969	.0077916	.9448284	.9804351
CR_PHQ9_new	.2492234	-.0046744	.9601914	1.008099
CR_PHQ9_new# CR_PHQ9_new	.2044787	-.0019018	1.111279	1.037588
PainScaleNeck~l	.2100392	-.0002291	.8957822	1.068097

(ii) Overlap plot

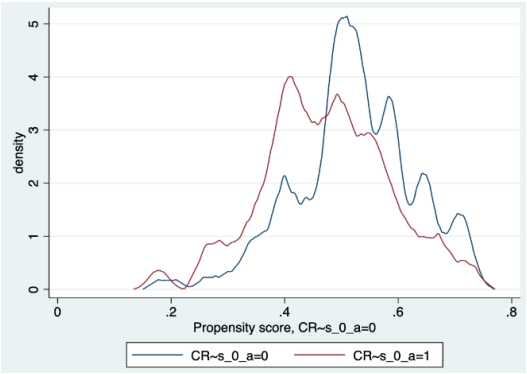


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2507512	.0168347	1.218868	.988659
X_AgeCalc# X_AgeCalc	-.2260241	.0154126	1.104412	.9586341
sex	-.1991685	-.0005951	1.051484	1.000152
CR_Education_~s	.0125976	-.0178193	1.039708	1.047352
smoke	.0385978	-.0023657	1.061495	1.0079
CR_PHQ9_new	.2691316	-.0091653	.9764527	1.014225
CR_PHQ9_new# CR_PHQ9_new	.22976	-.0043057	1.095994	.9984355
PainScaleNeck~l	.1630232	-.0074241	.9019409	1.020632

(ii) Overlap plot



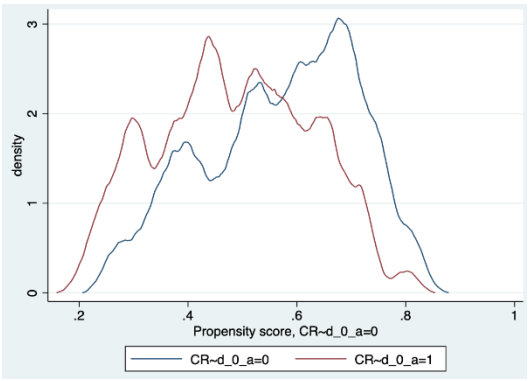
Narcotics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0682053	-.0245772	.7673659	.9830357
X_AgeCalc# X_AgeCalc	-.0903515	-.0256525	.7142436	.9482637
sex	-.1149668	-.0148481	1.030769	1.00323
CR_Education_~s	.0735154	-.0136302	.902784	.904234
smoke	.1907436	.0162544	1.165692	.9456995
CR_PHQ9_new	.5705924	.0146873	1.177205	1.007395
CR_PHQ9_new# CR_PHQ9_new	.5345583	.0147095	1.723004	1.109069
PainScaleNeck~l	.2149316	.0226312	.8733858	.9105117

(ii) Overlap plot

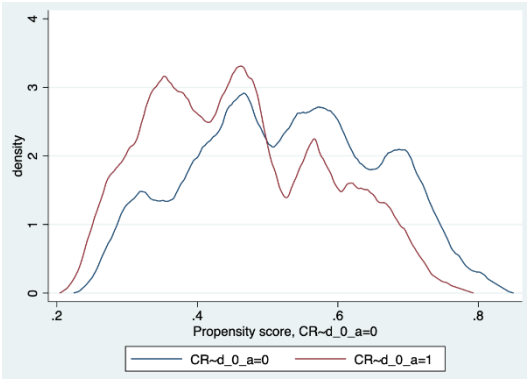


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1388693	-.010357	.8128818	.9761845
X_AgeCalc# X_AgeCalc	-.1540224	-.0123269	.7515417	.9563195
sex	-.1035227	-.0066284	1.026899	1.001317
CR_Education_~s	.0056185	-.0057636	1.002122	.9968361
smoke	.0495462	.0144703	.9975692	.9562958
CR_PHQ9_new	.5067627	.0080913	1.097611	.9984284
CR_PHQ9_new# CR_PHQ9_new	.4668121	.0067064	1.495988	1.047731
PainScaleNeck~l	.2324931	.0070649	.9629024	1.049307

(ii) Overlap plot



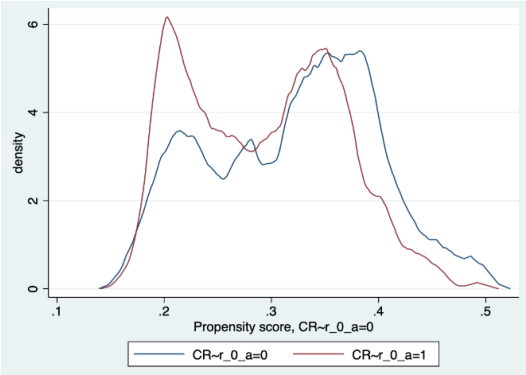
Over-the-Counter Medications

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0651016	-.0023464	.9574088	1.006771
X_AgeCalc# X_AgeCalc	-.066858	-.0016737	.9059405	.972139
sex	-.3013156	.0135392	1.112639	.997043
CR_Education_~s	.1162025	-.0115005	.9530041	.9477763
smoke	-.0847313	.0072785	.9784216	1.104755
CR_PHQ9_new	.0425169	-.009663	.9908004	.9936544
CR_PHQ9_new# CR_PHQ9_new	.0350793	-.0099925	1.024697	.9838342
PainScaleNeck~l	.1658133	-.0204753	.7891383	.943408

(ii) Overlap plot

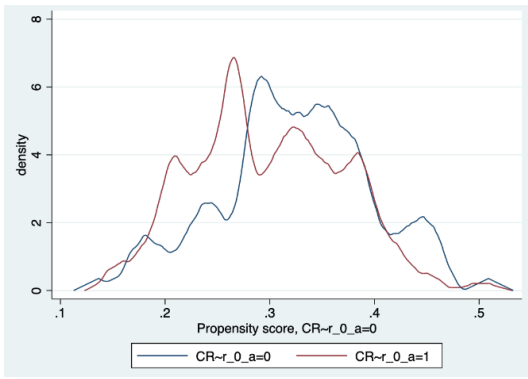


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	.1020673	.0019527	1.024528	1.003073
X_AgeCalc# X_AgeCalc	.1021134	.0021813	1.052623	.9826922
sex	-.2117967	.0013225	1.064872	.9997134
CR_Education_~s	.1515516	-.0316034	1.00876	.960554
smoke	-.0694948	.0201781	.9748092	1.090463
CR_PHQ9_new	.0665583	-.0228501	1.157414	.9987358
CR_PHQ9_new# CR_PHQ9_new	.0986579	-.0205731	1.34765	1.069711
PainScaleNeck~l	.1213765	-.0194024	.8510757	.9296466

(ii) Overlap plot



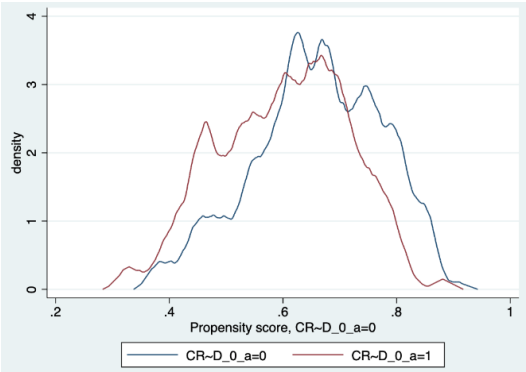
NSAIDs

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0387359	.000461	1.018728	1.012967
X_AgeCalc# X_AgeCalc	-.0360886	.0016237	1.068576	1.078661
sex	-.0962159	-.0039382	1.025828	1.001022
CR_Education_~s	.3336163	.0215612	.8219321	.8529889
smoke	-.1921346	-.0045001	.7820456	1.007448
CR_PHQ9_new	.2746413	-.000942	1.013858	1.021745
CR_PHQ9_new# CR_PHQ9_new	.2450431	.0049327	1.075983	.9586933
PainScaleNeck~l	.2001061	.0245772	.7240498	.779085

(ii) Overlap plot

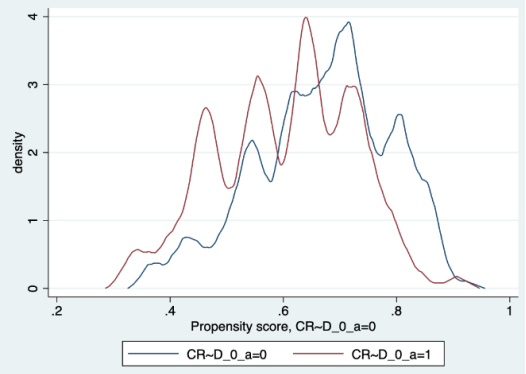


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0695893	-.006498	1.036483	.9912826
X_AgeCalc# X_AgeCalc	-.0645025	-.0071394	1.079001	1.040811
sex	-.0947501	.0029997	1.02524	.9992669
CR_Education_~s	.3960356	.0194771	.8401526	.8594105
smoke	-.1867773	.0043254	.8072725	1.034967
CR_PHQ9_new	.3118569	-.0101995	.9821819	1.025752
CR_PHQ9_new# CR_PHQ9_new	.2741958	-.0020897	1.046502	.941924
PainScaleNeck~l	.1149015	.0202254	.8811597	.8822049

(ii) Overlap plot



Arm Pain Scale

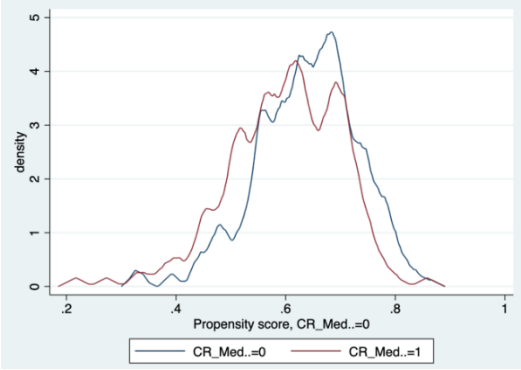
Muscle Relaxants

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2598014	-.0066623	1.145445	.9817038
X_AgeCalc# X_AgeCalc	-.2404723	-.008158	1.024801	.9466218
sex	-.1274432	.0052434	1.032326	.9985304
CR_Education_~s	.2109103	.0090169	.7681729	.8007565
smoke	-.118112	.0121657	.837271	.9764803
CR_PHQ9_new	.1132504	-.0057977	.8942429	.9905143
CR_PHQ9_new# CR_PHQ9_new	.0695585	-.0075922	.8639444	.9150244
PainScaleArm_bl	.0179593	.0104873	.8397776	.8452931

(ii) Overlap plot

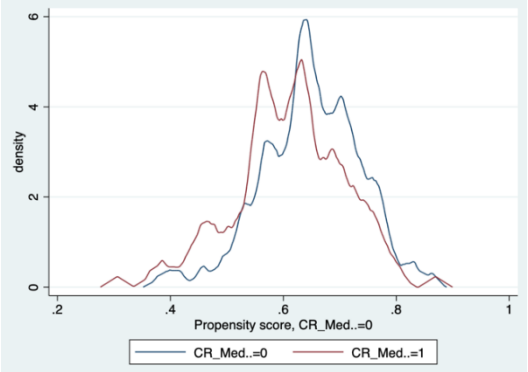


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1641876	.0076667	1.24695	.9883996
X_AgeCalc# X_AgeCalc	-.1393354	.0064243	1.192107	.9696532
sex	-.0957933	.0115422	1.024916	.9967403
CR_Education_~s	.152636	.0045105	.8019955	.8122093
smoke	-.2046301	.0200931	.7681537	1.014782
CR_PHQ9_new	.1422145	-.0130354	.9179259	1.007332
CR_PHQ9_new# CR_PHQ9_new	.1038221	-.0095805	.8622603	.8890673
PainScaleArm_bl	-.0788137	.0059911	.8952593	.8267664

(ii) Overlap plot



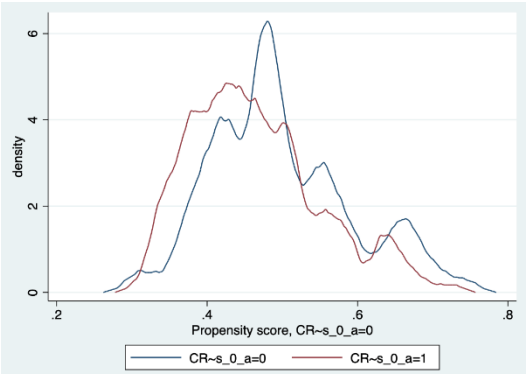
Neuroleptics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1642723	.0000184	.9174651	.970491
X_AgeCalc# X_AgeCalc	-.1675319	-.0027223	.8439296	.9550863
sex	-.1522699	-.0065941	1.038839	1.001613
CR_Education_~s	.0268442	-.0029839	.9585266	.9594464
smoke	-.006565	.008308	.9526579	.9811128
CR_PHQ9_new	.2338068	-.0001602	.9497791	1.008763
CR_PHQ9_new# CR_PHQ9_new	.1885662	.0021793	1.094319	1.048172
PainScaleArm_bl	.2318392	.0075672	.973996	1.157853

(ii) Overlap plot

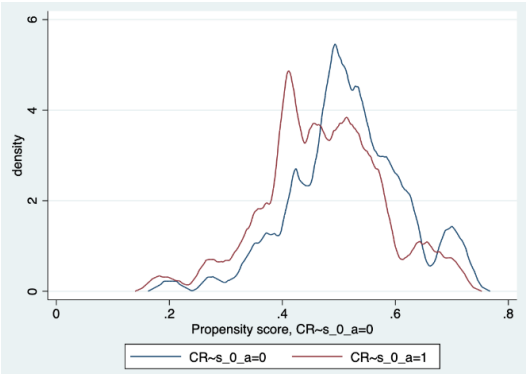


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.2354818	.0114092	1.212864	.9893384
X_AgeCalc# X_AgeCalc	-.2114151	.0101563	1.097029	.952477
sex	-.1750023	-.0037428	1.042389	1.000919
CR_Education_~s	.011221	-.0173815	1.040717	1.047168
smoke	.042034	-.0018275	1.066932	1.00902
CR_PHQ9_new	.2576658	-.00653	.9642243	1.013307
CR_PHQ9_new# CR_PHQ9_new	.216238	-.0022205	1.073643	1.003575
PainScaleArm_bl	.1172237	.0081037	.9478792	1.02677

(ii) Overlap plot



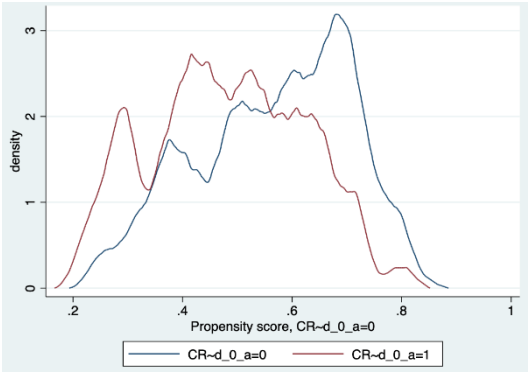
Narcotics

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0655318	-.0209104	.7605149	.9835757
X_AgeCalc# X_AgeCalc	-.0884767	-.0219941	.707618	.9505832
sex	-.1169151	-.0132954	1.030227	1.002848
CR_Education_~s	.0684869	-.0151187	.8972433	.8987174
smoke	.1904888	.010711	1.167336	.939372
CR_PHQ9_new	.5667877	.0128413	1.175962	1.008516
CR_PHQ9_new# CR_PHQ9_new	.5310911	.0134077	1.719832	1.111761
PainScaleArm_bl	.1527017	.0185863	.7898587	.8128504

(ii) Overlap plot

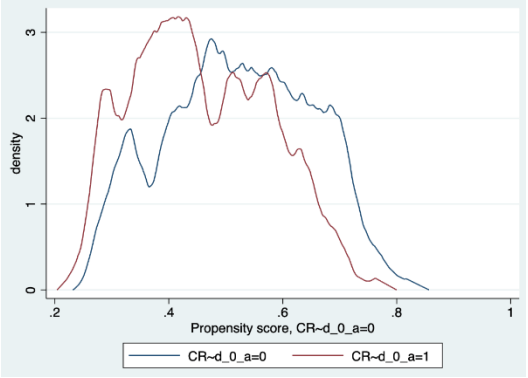


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.1385823	-.0098318	.8080364	.9797586
X_AgeCalc# X_AgeCalc	-.1541425	-.0114668	.7468286	.9623854
sex	-.1092876	-.0051011	1.026732	1.001004
CR_Education_~s	-.0039643	-.0064815	.9909181	.9828469
smoke	.0589154	.0064279	1.009781	.9433761
CR_PHQ9_new	.4991759	.0082663	1.108406	1.000983
CR_PHQ9_new# CR_PHQ9_new	.4626291	.0075508	1.509331	1.057945
PainScaleArm_bl	.1182818	.0079994	.8218736	.8676866

(ii) Overlap plot



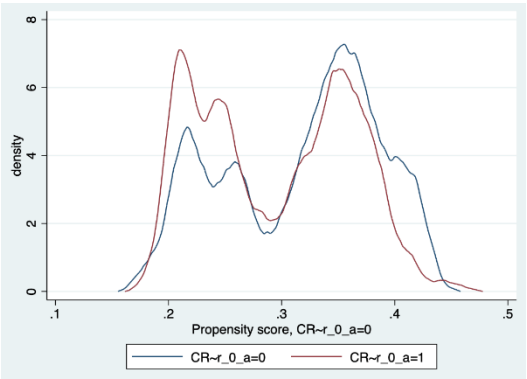
Over-the-Counter Medications

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0606802	.0022669	.9567789	.9994077
X_AgeCalc# X_AgeCalc	-.0625874	.0021457	.9053189	.9649349
sex	-.2950681	.0061387	1.106094	.9986427
CR_Education_~s	.1265495	-.0039695	.9507761	.9476646
smoke	-.0750675	.0109142	.9899871	1.103006
CR_PHQ9_new	.0501791	-.0055889	.9967298	.9954588
CR_PHQ9_new# CR_PHQ9_new	.043252	-.0060063	1.034192	.9919666
PainScaleArm_bl	.0986667	-.0167928	1.044765	1.137299

(ii) Overlap plot

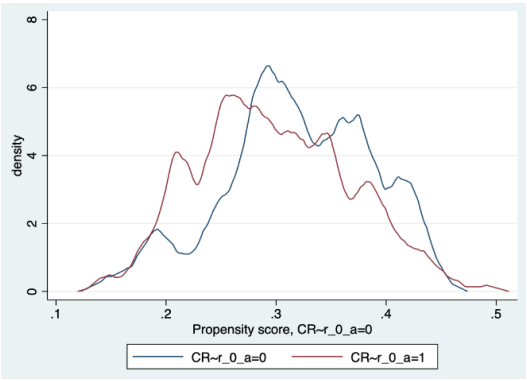


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	.1017673	.0023404	1.014323	.9959354
X_AgeCalc# X_AgeCalc	.1008194	.0019051	1.041861	.9757662
sex	-.2127333	-.0043384	1.061882	1.000991
CR_Education_~s	.1517902	-.0280194	.9887648	.9393272
smoke	-.0653183	.0187544	.9820525	1.083585
CR_PHQ9_new	.0844931	-.0163811	1.164649	1.000502
CR_PHQ9_new# CR_PHQ9_new	.1158853	-.0143505	1.362483	1.076883
PainScaleArm_bl	.0772658	-.0146526	.9566966	.9923365

(ii) Overlap plot



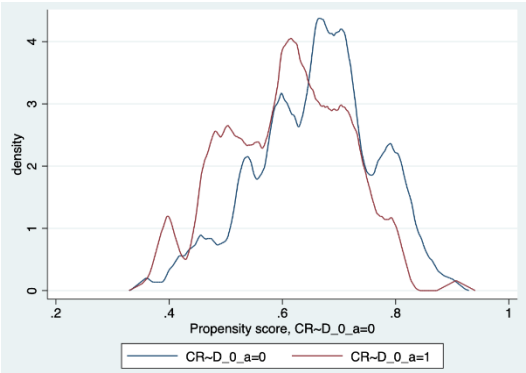
NSAIDs

- 3 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0357493	.0138807	1.023676	1.008211
X_AgeCalc# X_AgeCalc	-.0327448	.0142631	1.073554	1.07603
sex	-.0889621	.0115442	1.02339	.9969166
CR_Education_~s	.3310261	.0146871	.8250332	.8704901
smoke	-.1956833	-.002031	.7781205	1.005293
CR_PHQ9_new	.267624	-.0173344	1.015782	1.022701
CR_PHQ9_new# CR_PHQ9_new	.2395656	-.0089945	1.072843	.9531267
PainScaleArm_bl	-.0021288	.0141359	1.105443	1.034154

(ii) Overlap plot

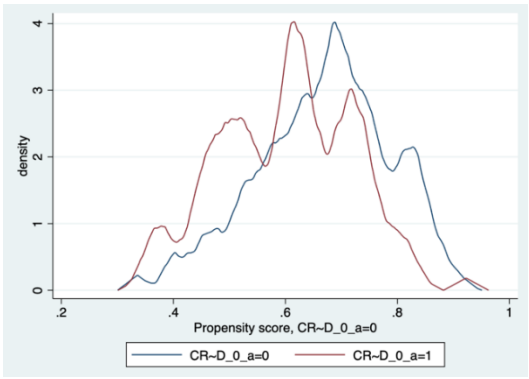


- 12 months

(i) Balance diagnostic

	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
X_AgeCalc	-.0634388	.0056219	1.037103	.9818154
X_AgeCalc# X_AgeCalc	-.0584416	.0038241	1.079082	1.031689
sex	-.0832163	.0216122	1.021533	.9944593
CR_Education_~s	.3970947	.0102222	.8469801	.8857872
smoke	-.1988315	.0116013	.7965268	1.041161
CR_PHQ9_new	.3072628	-.0253805	.9782748	1.034354
CR_PHQ9_new# CR_PHQ9_new	.2689168	-.013122	1.034988	.9390357
PainScaleArm_bl	-.0310413	.010634	1.12919	.9924679

(ii) Overlap plot



Curriculum Vitae

Candidate's full name: Lalita Bharadwaj

Universities attended (with dates and degrees obtained):

University of Calgary, Bachelor of Science in Biological Science, 2016

University of Calgary, Bachelor of Science in Psychology, 2016

Publications: N/A

Conference Presentations:

Virtual Poster presented at the Canadian Association on Gerontology 2021 (CAG2021): Bharadwaj L., Nissen K., Henry, J. L., Sheehy, L., Achieving vitality with virtual reality: Breaking the barriers to rehabilitation exercise in seniors using virtual reality.

Speaker and booth at the Canadian Frailty Network & New Brunswick Health Research Foundation (CFN & NBHRF): Bharadwaj L., Nissen K., Henry, J.L., Sheehy, L., Home and Facility-based Virtual Reality to Increase Rehabilitative Exercise in Older Adults.

Poster at the Canadian Association on Gerontology 2022 (CAG2022): Bharadwaj L., Nissen K., Henry, J. L., Sheehy, L., Challenges to executing an exercise-based rehabilitation research project with seniors in long-term care facilities and in the community throughout the COVID-19 pandemic.

Speaker at the Canadian Frailty Network & New Brunswick Health Research Foundation (CFN & NBHRF): Bharadwaj L., Trajectories of Postoperative Disability Following Neck Surgery For Cervical Myelopathy.

Awarded speaker at the Annual IMPARTy Research Conference 2022: Bharadwaj L., Trajectories of Postoperative Disability Following Neck Surgery For Cervical Myelopathy.

Poster at the Canadian Spine Society 2023 (CSS2023): Bharadwaj L., El-Mughayyar D., Bigney E., Manson N., Abraham E. E., Small C., Attabib N., Richardson E. E., Kearney J., Kundap U., CSORN Associations of Preoperative Analgesic Use with Postoperative Pain and Disability Following Spinal Surgery for Cervical Myelopathy and Radiculopathy.