Milestone 1: Executive Summary, Project Plan, and Environmental Scan

Cortex Crew

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Interdisciplinary Medical Sciences
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Assignment Acknowledgement

To maintain transparency and uphold academic integrity, we acknowledge that we used generative artificial intelligence tools, specifically ChatGPT and Grammarly, to assist with editing and reviewing of our work for grammar and clarity. **Author Contributions**

Student Name	Student Number	Contributions
Navreet Dhillon	251534314	Equal
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Project Plan

Dates	Task	To-Do
August 18, 2025	Literature Scan and Group meeting	Allocate environmental scan sections among group members.
August 23, 2025	Group meeting (Zoom)	Progress checks on environmental scan.
August 25–29, 2025	Capstone Intensive Week	Focused work sessions; preparation for Milestone 1.
August 28, 2025	Group meeting	Finalizing environmental scan for Milestone 1.
August 29, 2025 (5:00 pm)	Milestone 1 submission	Final edits and submission deadline.
September 11, 2025 (and ongoing, Tuesdays & Thursdays, 3:00 pm)	Weekly group meetings	Regular biweekly check-ins to ensure steady progress
October 21–23, 2025	Capstone Check in meetings	Formal progress review with Dr. Wood; feedback for next phase.
November 4–6, 2025	Capstone Intensive Period	Dedicated time for writing, data integration, and analysis.
November 7, 2025	Systemic Review Submission	Final edits and submission deadline.

Capstone Project Executive Summary

Names of group members (full): Navreet Dhillon, Damian French, Olayori Olasode, Thibicka Thevan,
Date: August 29th, 2025
Topic area: Neuroscience - Chronic Pain and Adverse Childhood Experiences

Statement of the problem: Despite strong evidence that early childhood trauma produces lasting neurological changes that increase the risk of chronic pain in adulthood, Canadian pain care systems continue to overlook this connection. Trauma-informed, neuroscience-based approaches that account for adverse childhood experiences (ACEs) are rarely integrated into clinical practice, leaving a critical gap between scientific knowledge and patient care.

Tentative research question: Why do Canadian chronic pain care systems fail to integrate trauma-informed, neuroscience-based approaches that address the role of ACEs, despite substantial evidence of their importance?

Current progress to date: We have conducted an initial environmental scan on chronic pain in Canada, summarizing prevalence, costs, and patterns of inequity. We reviewed evidence that ACEs are linked to chronic pain through biological, psychological, and social mechanisms, including HPA axis dysregulations, neuroinflammation, and maladaptive neuroplasticity. In addition, we identified key social and environmental contributors, including poverty, intergenerational trauma, and stigma, which are linked to higher exposure to ACEs. Therefore, these social and environmental conditions lead to an increased likelihood of experiencing an ACE, which then increases the risk of developing chronic pain and contributes to unequal access to effective care and poorer patient outcomes. Finally, we compared Canadian frameworks to international guidelines.

Challenges & barriers: Some challenges and barriers we faced as a group included narrowing down our wicked problem due to the lack of direct primary literature, the need to synthesize information from multiple domains, and the limited reporting on current practices and their progress. We also faced difficulties in wording sentences clearly and ensuring that each section flowed smoothly, as there were many interconnected topics. Conducting the environmental scan required extra attention to detail to make sure we identified relevant and credible sources. Additionally, we had to be careful in selecting and verifying the correct evidence to support our claims and maintain accuracy throughout the report.

The next steps for us is to focus on more concrete and specific literature on the current approaches and how chronic pain is assessed in Ontario. This will involve identifying best practices, evaluating the effectiveness of existing assessment tools, and comparing provincial strategies to ensure a comprehensive understanding of how chronic pain is addressed. By doing so, we aim to identify gaps in the current system and provide evidence-based recommendations for improving assessment and care practices.

Environmental Scan

Background and Context

Chronic Pain in Canada

Chronic pain, defined as persistent or recurring pain lasting beyond three months, is among the most common health condition in Canada, affecting nearly one in five people across the country (Health Canada, 2021; Nicolson et al., 2023). . Women, and seniors, report higher rates than the general population. Nationally, chronic pain incurs billions of dollars in annual healthcare costs and lost productivity (Health Canada, 2021). Despite its prevalence and impact, treatment remains inconsistent and fragmented. Although chronic pain is commonly approached as a purely biomedical problem, research increasingly shows that it arises from a combination of physical, psychological, and social factors (Pianese & Bordoni, 2025). Psychological stress and social environments influence how pain is processed and maintained. Among these influences, adverse childhood experiences (ACEs) are strong predictors of pain, shaping brain development and increasing vulnerability to chronic pain in adulthood (Bussières et al., 2023).

Adverse Childhood Experiences (ACEs)

ACEs are traumatic events that occur during childhood, such as exposure to abuse, neglect, or household instability (Tidmarsh et al., 2022) Globally, nearly half of all children experience at least one ACE, which can have lasting effects beyond emotional distress. ACEs can alter the trajectory of physical and mental health across the lifespan, influencing outcomes such as cardiovascular disease, mood and anxiety disorders, substance use, and social functioning (Werthman et al., 2022). In relation to pain, individuals with early-life adversity are almost twice as likely to develop chronic pain compared to those who have not (Tidmarsh et al., 2022)

Jointly, ACEs encompass a broad range of early-life stressors that significantly influence the development and persistence of chronic pain. Common ACEs include parental separation or substance abuse, exposure to physical, emotional, or sexual abuse, and chronic stress arising from neglect or unstable home environments (Tidmarsh et al., 2022; Bussières et al., 2023). Children exposed to four or more ACEs have been shown to have an 18.4% prevalence of chronic pain in adulthood, compared to 4.8% of those with no ACEs, emphasizing the cumulative impact of multiple stressors (Craner et al., 2022; Nelson et al., 2021). Experiences as such often disrupt neurodevelopment which exacerbates chronic pain within patients (Burke et al., 2017; Smith & Pollak, 2020; Tidmarsh et al., 2022). Understanding the specific types and combinations of ACEs is essential for implementing trauma-informed, patient-centered approaches in chronic pain management that address both the neurobiological and psychosocial consequences of early adversity (Werthman et al., 2022; Pianese & Bordoni, 2025).

Intersection of ACEs and Chronic Pain

More than three-quarters of adults with chronic pain report at least one ACE, and nearly half report multiple exposures (Craner et al., 2022). Beyond prevalence, ACE exposure is linked to increased pain severity, duration, and greater disability, indicating that early trauma also shapes the severity and persistence of pain. Individuals with a history of ACEs are more likely to present with comorbid mental health concerns such as anxiety, depression, and post-traumatic stress, which further exacerbate pain and complicate treatment (Bussières et al., 2023). Many patients cycle through health systems without receiving adequate or integrated care, emphasizing gaps in current service delivery (Hargreaves et al., 2019). Taken together, chronic pain reflects an interplay between biological, psychological, and social factors, rather than physical factors alone.

The Wicked Problem

Canada’s chronic pain care system faces a systemic failure: it does not adequately integrate trauma-informed and neuroscience-based approaches, despite strong evidence linking adverse childhood experience (ACEs) and chronic pain outcomes. This failure results in care that treats symptoms rather that root causes, perpetuating cycles of suffering for millions of Canadians.

Although chronic pain affects one in five Canadians, access to comprehensive, interprofessional treatment remains severely limited (Health Canada, 2021). Most pain clinics operate within a fragmented model that overlooks the psychosocial and trauma-related dimensions of pain. Only 25% of multidisciplinary pain treatment centers accept patients with co-occurring mental health or substance use disorders (Bosma et al., 2024), leaving those most in need excluded from care. This exclusion emphasizes a systemic inequity in how pain services are structured and delivered.

The problem is compounded by a shortage of clinicians trained in pain neurobiology and trauma-informed care, long wait times, and geographic disparities that leave rural and marginalized populations with little to no access. As a result, patients frequently cycle through medical and emergency systems without lasting relief, receiving pharmacological or procedural interventions that fail to address the biopsychosocial mechanisms underpinning chronic pain (King & Fraser, 2013).

This crisis exemplifies a wicked problem which is complex, multidimensional, and resistant to single-sector solutions. Chronic pain arises from biological, psychological, and social factors that interact across the lifespan (Bosma et al., 2024). Yet current policies and care models remain reserved, ignoring how trauma, stress, and social determinants of health perpetuate pain across generations. The consequence is not only persistent patient suffering, but also declining trust in the healthcare system, reinforcing stigma and disengagement from care.

Key Findings

Interest-Holder Groups

Chronic pain management involves a complex network of interest-holder groups, each with unique roles and perspectives. Patients are central, with lived experiences emphasizing gaps in care. Patients report more severe pain, comorbid mental health concerns, and repeated health system interactions when ACEs are part of their history (Craner et al., 2022; Nelson et al., 2021; Hargreaves et al., 2019). Primary care physicians are typically the first point of contact for individuals with chronic pain. However, many report uncertainty in differentiating chronic pain from acute or psychosomatic causes and often lack adequate training in trauma-informed approaches. This disconnect commonly occurs during the initial assessment and referral process, where biomedical models tend to dominate and psychosocial contributors receive less attention (Health Canada, 2021; Busse at al., 2017). Healthcare providers, including primary care physicians, pain specialists, and mental health professionals, must balance pharmacological and non-pharmacological approaches; however, they often lack training in trauma-informed care (Busse et al., 2017; Burke et al., 2017; Pianese & Bordoni, 2025). Health Canada and the Canadian Pain Task Force provide national strategies, reports, and advisory guidance emphasizing patient-centered, interdisciplinary, and trauma-informed approaches, though their recommendations lack regulatory authority (Health Canada, 2021). Advocacy groups, such as Pain Canada, raise public awareness, support policy change, and support policy reform (Bussières et al., 2023). International frameworks, including Australia's National Strategic Action Plan and the UK's National Institute for Health and Care Excellence (NICE) guidelines, serve as reference points for interest-holder collaboration, demonstrating how coordinated, evidence-based policies can improve access and outcomes (Australian Government, 2021; NICE, 2021). Together, these groups influence the development, implementation, and evaluation of chronic pain care systems in Canada.

Regulatory and Legal Frameworks

A combination of national strategies, clinical guidelines, and provincial health delivery systems guide the framework for chronic pain care in Canada. At the federal level, Health Canada established the Canadian Pain Task Force in 2019, which has produced three reports emphasizing the importance of trauma-informed, patient-centered, and interdisciplinary models of care (Health Canada, 2021). However, because the Task Force functions only in an advisory capacity without regulatory authority, implementation has been inconsistent across provinces. Clinical regulation has also influenced practice. The 2017 Canadian Guidelines for Opioid Therapy and Chronic Non-Cancer Pain introduced new restrictions on opioid prescribing, shifting the focus toward non-pharmacological approaches (Busse et al., 2017). These include cognitive-behavioural therapy, exercise-based rehabilitation, mindfulness programs, and other mind-body practices that target both physical and psychological contributors to pain (Wang et al., 2025). However, there has not been a parallel shift towards trauma-informed models that integrate early-life adversity into chronic pain.

Internationally, other countries have advanced, more coordinated frameworks that explicitly integrate psychosocial and trauma-informed approaches. Australia’s National Strategic Action Plan for Pain Management is a coordinated national framework that embeds psychosocial care and includes perspectives of people with lived experiences in service design and evaluation (Australia Government, 2021). The United Kingdom has taken a different approach through its NICE guidelines for chronic pain, which provide binding national clinical standards that discourage routine opioid prescribing and emphasize integrated non-pharmacological methods, such as psychological therapies, physical activity, and self-management (NICE, 2021). Compared to these models, Canada remains reliant on non-binding reports and provincial variation, which contributes to gaps in access and inconsistent integration of trauma-informed approaches in pain care.

Social and Environmental Factors

Social and environmental factors significantly shape the experience and outcomes of chronic pain, particularly for individuals with ACEs. Poverty, intergenerational trauma, and systemic inequities exacerbate vulnerability to chronic pain, limiting access to comprehensive care and psychosocial supports (Hargreaves et al., 2019; Bussières et al., 2023). Exposure to household dysfunction, abuse, or chronic stress during childhood can alter neurodevelopment, including dysregulation of the HPA axis, neuroinflammation, and maladaptive pain-processing pathways, creating long-term susceptibility to heightened pain sensitivity (Burke et al., 2017; Smith & Pollak, 2020; Tidmarsh et al., 2022). Stigma surrounding trauma and pain discourages disclosure and engagement with healthcare services, entrenching disparities in treatment outcomes (Nelson et al., 2021; Craner et al., 2022). Environmental determinants, such as limited access to trauma-informed services and fragmented care delivery, compound these physiological effects, contributing to persistent and disabling pain, co-occurring with anxiety, depression, and post-traumatic stress (Dalechek et al., 2024; Werthman et al., 2022). Addressing these social and environmental contributors is crucial for implementing effective, equitable, and trauma-informed chronic pain care in Canada, demonstrating the need for integrated interventions at the individual, community, and policy levels (Health Canada, 2021; Pianese & Bordoni, 2025).

Stigma Around Trauma and Pain

Patients with chronic pain who have experienced ACEs face stigma that complicates both diagnosis and treatment. Patients reporting trauma-linked pain frequently encounter skepticism from healthcare providers, leading to underassessment, undertreatment, and delayed access to appropriate care (Bosma et al., 2024; Hargreaves et al., 2019). This stigma is compounded when pain co-occurs with mental health conditions such as anxiety, depression, or post-traumatic stress, as providers may dismiss symptoms as psychosomatic rather than recognizing their neurobiological and psychosocial underpinnings (Dalechek et al., 2024; Bussières et al., 2023). Research indicates that stigma can increase psychological distress, perpetuate pain severity, and reduce engagement with both pharmacological and non-pharmacological interventions (Tidmarsh et al., 2022; Werthman et al., 2022). Despite the evidence supporting trauma-informed and patient-centered care, current Canadian chronic pain systems fail to address stigma, leaving patients caught in cycles of suffering and healthcare disengagement (Health Canada, 2021; Pianese & Bordoni, 2025). Addressing stigma is therefore essential to improving both access to care and overall outcomes for those with trauma-associated chronic pain.

Social Determinants

Social determinants such as poverty, intergenerational trauma, and socioeconomic status influence both the development of ACEs and the persistence of chronic pain. Individuals especially from marginalized communities, face compounded risks due to systemic inequities, which can exacerbate physiological and psychological vulnerabilities(Dalechek et al., 2024; Nelson et al., 2021). Among these determinants, family structure, particularly single-parent households, has emerged as an important context for understanding heightened exposure to ACEs. In 2018, The Ontario Incidence Study of Reported Child Abuse and Neglect gathered information onprimary caregiving relationships to children in relation to maltreatment investigations. It was reported that ninety-five percent of the substantiated investigations involved children whose primary caregiver was a biological parent (Fallon et al., 2020). This illustrates the risks of children in single parent households for ACEs as it is not just a contextual factor.

Additionally, national data further emphasizes this concern, showing that in 2021, 16.4% of families in Canada were led by a single parent, and nearly one in five children under the age of 15 lived in these family structures, emphasizing the overall vulnerability of large populations of children to early adversity events (Battams & Mathieu, 2024). Evidence shows that children in single-parent households are at increased risk of neglect, which is recognized as a core ACE. The Canadian Incidence Study of Reported Child Abuse and Neglect found that nearly one-third (31.9%) of child maltreatment investigations involved single-parent families, under conditions of economic instability (Fallon et al., 2013). Together, these findings indicate that structural stressors such as poverty and reduced caregiver capacity intersect with family structure to heighten the risk of ACEs.

Physiology: Neurobiological Mechanisms Linking ACEs and Chronic Pain

Early adversity has been shown to leave lasting marks on how the brain and body respond to stress (Burke et al., 2017). ACEs impact neurobiology through dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, increased neuroinflammation, and maladaptive neuroplasticity. Repeated exposure to stressful experiences during childhood can disrupt the HPA axis, which plays a crucial role in regulating stress hormones and immune responses. These changes alter brain development, affect stress responses, and heighten pain sensitivity (Tidmarsh et al., 2022). Additionally, repeated stress promotes chronic neuroinflammation, resulting in irregular cortisol levels and increased expression of inflammatory mediators , such as IL-6 and TNF-α (Hakamata et al., 2022). These changes work together as lower cortisol reactivity reduces the body’s ability to suppress inflammation, while IL-6 and TNF-α promote neuroinflammatory processes.

Additionally, neuroimaging studies suggest that ACEs are associated with structural and functional changes in the prefrontal cortex, amygdala, hippocampus, and anterior cingulate cortex, regions that regulate emotion, cognition, and pain processing (Bick & Nelson, 2016). These disruptions interfere with normal brain maturation and synaptic pruning, contributing to maladaptive patterns of neuroplasticity (Smith & Pollak, 2020). As a result, individuals exposed to ACEs are more susceptible to central sensitization, a condition in which the nervous system becomes hyper-responsive to sensory input. Individuals who experienced adversity early in life are more likely to develop heightened pain sensitivity and persistent pain even in the absence of injury (Tidmarsh et al., 2022; Song et al., 2024). Taken together, these findings show that the connection between ACEs and chronic pain is not simply psychological. Trauma experienced in childhood influences biological systems in a way that increases vulnerability to pain throughout adulthood.

Epidemiology of ACEs and Chronic Pain

In Canada, approximately 45% of adults report experiencing at least one ACE (Bussières et al., 2023). Among those exposed to four or more ACEs, nearly 18% developchronic pain, compared to 4.8% among individuals with no ACE exposure (Craner et al., 2022; Nelson et al., 2021). Globally, similar patterns are observed. Cross-national analyses indicate that early-life adversity consistently predicts increased pain susceptibility and severity. Using data from more than 200,000 participants across 22 countries, Macchia et al. (2025) reported that childhood experiences such as abuse, family financial hardship, and parental loss were each independently associated with higher likelihood of pain in adulthood, even after controlling for demographic and cultural variation. Individuals with a history of ACEs are more likely to experience widespread pain, occuring in multiple regions of the body, often on both sides and above and below the waist, along with increased functional impairment, and comorbid mental health conditions, which further exacerbate pain outcomes (Dalechek et al., 2024; Tidmarsh et al., 2022; Werthman et al., 2022). Evidence shows that pain outcomes are influenced by social inequities. People facing socioeconomic barriers, and many Indigenous communities in Canada experience higher exposure to adversity and greater prevalence of chronic pain, partly due to unequal access to care and social resources (Hargreaves et al., 2019; Health Canada, 2021). National data indicates that Indigenous adults have among the highest rates of frequent and activity limiting pain, and that pain-related disability remains more common among Metis and First Nation peoples (DeSouza et al., 2025) These findings emphasize the need for trauma-informed and equity focused approaches to chronic pain care.

Pharmacological Approaches and Their Limitations

Pharmacological interventions remain the dominant treatment modality for chronic pain, with opioids and nonsteroidal anti-inflammatory drugs (NSAIDs) commonly used, and condition-specific agents such as antidepressants and anticonvulsants for neuropathic pain (Busse et al., 2017; Pianese & Bordoni, 2025). Although the 2017 Canadian Guidelines for Opioid Therapy and Chronic Non-Cancer Pain recommend caution in opioid prescribing and promote non-pharmacological therapies, they do not integrate core trauma-informed care principles, such as recognizing patient trauma histories, prioritizing psychological safety, or emphasizing patient empowerment (Busse et al., 2017). Trauma-informed care frameworks emphasize these elements as essential for effective chronic pain management (Yamin et al., 2024). The discrepancy is significant, as patients with chronic pain often have histories of ACEs that alter neurobiological stress and pain-processing pathways, complicating treatment (Burke et al., 2017; Smith & Pollak, 2020; Tidmarsh et al., 2022). Neglecting trauma-informed approaches may therefore limit treatment effectiveness and safety. International guidelines and initiatives also support integrating psychosocial interventions alongside pharmacological approaches, as they recognize that reliance solely on medications can overlook biopsychosocial determinants and exacerbate disparities in outcomes (Australian Government, 2021; NICE, 2021; Health Canada, 2021). These limitations emphasize the need for multidisciplinary, trauma-informed approaches to complement pharmacological care.

Patient Experience

Patients living with chronic pain report complex experiences shaped by both biological and psychosocial factors, with ACEs playing a significant role in pain perception and management (Bussières et al., 2023; Craner et al., 2022; Nelson et al., 2021). These ACE studies focus on objective early-life circumstances, such as abuse, neglect, or household dysfunction, rather than patients' subjective feelings. Individuals with chronic pain frequently describe feelings of invalidation and stigma from healthcare providers, particularly when their pain has no clear biomedical cause or is influenced by past trauma (Tidmarsh et al., 2022; Werthman et al., 2022). These findings reflect patients' self-reported experiences rather than objective events.

In its 2021 report, Health Canada documented patients' frustrations with fragmented care, long wait times, and limited access to interdisciplinary and trauma-informed services, which collectively contribute to icreased psychological distress and pain outcomes (Health Canada, 2021). While wait times are objective, the reported frustrations are largely subjective experiences. Moreover, studies show that comorbid mental health conditions among treatment-seeking patients is increasing over time, with higher prevalence of anxiety, depression, and post-traumatic stress complicating pain management (Bosma et al., 2024; Dalechek et al., 2024). These studies combine mental health diagnoses with patient-reported symptom severity. International guidelines emphasize the importance of incorporating patient perspectives into care planning, as demonstrated in Australia's National Strategic Action Plan and the UK's NICE guidelines, which integrate lived experiences into service design to improve adherence, satisfaction, and overall outcomes (Australian Government, 2021; NICE, 2021). These findings demonstrate that patient-centered approaches, including trauma-informed and psychosocially integrated care, are critical for improving chronic pain experiences and outcomes.

Case Studies

A recent case study by Reaume (2023) illustrates how integrating psychosocial and contextual factors into pain assessment can improve chronic pain management in primary care. The study followed a patient in a rural clinical setting whose pain was influenced by psychological distress, social stressors, and limited access to services. Using a biopsychosocial framework, the care team identified and addressed multiple drivers of pain rather than focusing solely on physical symptoms. Their approach led to improved treatment engagement, enhanced coping strategies, and reduction in pain-related distress. The case demonstrates the importance of individualized, patient-centered care models that recognize the broader determinants of pain and support a shift toward trauma-informed and interdisciplinary approaches in chronic pain management.

Summary and Next Steps

Chronic pain in Canada is a pervasive and complex health challenge, affecting nearly one in five Canadians and generating substantial economic, social, and personal burdens (Health Canada, 2021; Bussières et al., 2023). ACEs have significant effects on chronic pain through biological, psychological, and social pathways, including lasting neurobiological changes such as HPA axis dysregulation, neuroinflammation, and altered pain-processing, alongside social determinants such as poverty, intergenerational trauma, and systemic inequities that exacerbate outcomes (Burke et al., 2017; Smith & Pollak, 2020; Tidmarsh et al., 2022; Hargreaves et al., 2019). Despite growing recognition of trauma-informed approaches, Canadian chronic pain care continues to rely heavily on pharmacological management with limited and uneven integration of interdisciplinary, and trauma-informed models (Busse et al., 2017; Pianese & Bordoni, 2025; Health Canada, 2021). There are exemplary models in other nations, such as Australia's National Strategic Action Plan and the UK's NICE guidelines, that demonstrate the benefits of coordinated, evidence-based, and psychosocially integrated care (Australian Government, 2021; NICE, 2021).

Future directions should prioritize implementing trauma-informed, patient-centered frameworks that integrate psychosocial interventions alongside pharmacological treatment. Improvement can be made if efforts are focused on expanding provider training in trauma-informed care, improving access to interdisciplinary services, and systematically incorporating patient perspectives into care design and evaluation (Tidmarsh et al., 2022; Bussières et al., 2023). Further research should focus on examining large-scale interventions, developing standardized protocols for psychosocial integration, and assessing long-term outcomes of ACE-informed approaches. Policy efforts should reduce systemic barriers, address social determinants of health, and create binding frameworks to ensure equitable, accessible, and effective chronic pain care across Canada, ultimately reducing the burden of chronic pain and mitigating intergenerational trauma impacts.

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