The Prevalence of Low Back Pain in the Emergency Department: A Systematic Review and Primary Study in the Charles V. Keating Emergency and Trauma Centre.

by

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I dedicate this work to Victoria and my parents, who guided and supported me even when I was wrong.

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ABSTRACT

Introduction: Low back pain may be having a significant impact on emergency departments around the world. Research suggests low back pain is one of the leading causes of emergency department visits. However, in the peer-reviewed literature, there has been limited focus on the prevalence and management of back pain in the emergency department setting. Furthermore, the applicability of the available research to our local emergency department setting is unclear.

Methods: This project includes two studies to investigate the prevalence of low back pain in emergency settings: 1. a **systematic review** of the published literature to gather a comprehensive and global perspective about the prevalence of low back pain in emergency settings, and 2. a **cross sectional analysis** using six years of data from our local emergency setting the Charles V. Keating Emergency and Trauma Centre, Halifax Nova Scotia, Canada.

Results: The systematic review included 21 studies, reported between 2000 and 2016, presenting prevalence data from 12 countries. The pooled prevalence estimate from included standard emergency settings was 4.39% (95% CI: 3.67-5.18). Prevalence estimates of the included studies ranged from 0.9% to 17.1%. Results indicated there are many gaps in the literature, for example research in Canada.

The prevalence of patients presenting to our local emergency department with a complaint of back pain was 3.17%. Individuals diagnosed with non-specific low back pain made up 60.8% of all back pain presentations (prevalence 1.93%). Peak hours of presentation for a complaint of back pain were 1000 and 1100 and there was little fluctuation in prevalence over the six years; there was, however, an increase in the number of presentations for low back pain over the study period.

Conclusion: This project included the first systematic review; comprehensive search strategy to examine the prevalence of low back pain in the emergency department. Our primary study is the first multi-year analysis assessing the prevalence of low back pain in a Canadian emergency department. Results from this thesis will inform healthcare providers, as well as administrative and policy decision-makers, of the global and local impact of low back pain in emergency settings, and will help identify opportunities for further research to enhance care pathways of patients suffering from low back pain.

LIST OF ABBREVIATIONS USED

ED	Emergency Department
LBP	Low Back Pain
EDIS	Emergency Department Information System
ROB	Risk of Bias
QEII ED	Queen Elizabeth Charles V. Keating Emergency and Trauma Centre
CIHI	Canadian Institute of Health Information
NSHA	Nova Scotia Health Authority
KT	Knowledge Translation
US	United States
CTAS	Canadian Triage and Acuity Scale
ICD	International Classification of Disease

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CHAPTER 1: INTRODUCTION

1.1 Epidemiology of Low Back Pain

1.1.1 Cost/Societal Burden of Back Pain Globally

Low back pain is defined as pain and discomfort localized below the costal margin and above the inferior gluteal folds, with or without leg pain [11]. It is one of the most prevalent forms of musculoskeletal pain [1,2]; it has a major effect on patients' quality of life and has a significant economic impact [4,5,6]. In 2012, an analysis by Vos et al., concluded that low back pain is the leading cause of years lived with disability in all developed countries [7].

Low back pain has a large global economic burden [4]. A systematic review conducted by Dagenais et al., 2008, aimed to analyze the total costs of low back pain to society; they estimated that in the US the total costs, direct (medical and nonmedical), indirect costs and intangible costs of low back pain, are between 84.1 billion and 624.8 billion US dollars annually. The majority of these costs come from patients with chronic low back pain or back pain lasting more than 12 weeks [4].

1.1.2 Cost/Societal Burden of Back Pain in Nova Scotia

In Canada, an analysis using the Canadian Community Health Survey (CCHS) indicated that approximately 9% of Canadians aged 12 and older currently suffer from chronic low back pain [13]. Cycle 1.1 of the CCHS performed in 2002 found that Nova Scotians (20 to 44 years) report back problems more than any other condition [12]. Results from an earlier

analysis conducted by Health Canada in 1999 determined that 14% of all Nova Scotians have chronic back problems [14]. This same report found that musculoskeletal disorders, for example back problems and arthritis, are the most prevalent of all chronic conditions in the province, and account for the highest disability costs [14]. Additionally, musculoskeletal disorders are the third highest costs of any diseases in the province, following circulatory disease and cancers.

1.1.3 Course of Low Back Pain

The majority of low back pain (non-specific) is measured on a spectrum from acute to chronic. Along this spectrum patients may encounter recurring and or relapsing acute episodes of low back pain. Acute low back pain is defined as pain lasting less than 3 months and chronic low back pain is pain lasting more than 3 months [18, 20]. The majority of patients who present with an episode of low back pain at a discrete point have a favorable prognosis [16, 17]. For example, 50% of patients seeking care for acute non-specific low back pain can expect to resume normal activity within 4 to 6 weeks [18]. Low back pain develops into persistent disabling chronic pain in between 10-20% of patients with an acute episode of low back pain [19].

1.1.4 Treatment Settings for Low Back Pain

The use of healthcare services for low back pain has increased over the past 20 years [8]. In 2002, low back pain was the fifth most common reason for all office based physician visits in the US [21]. Low back pain is treated in a number of settings including the primary care setting and emergency department settings. It is currently widely accepted

that the management of low back pain should begin in the primary care setting [22]. Over half of visits for low back pain are to primary care physicians [23]. However, recent research has indicated that large numbers of patients are presenting to emergency departments with low back pain [22, 24]. A recent analysis of Canadian emergency department visits, performed by the Canadian Institute of Health Information (CIHI), indicated that low back pain is one of the leading causes of emergency department visits [9]. In this analysis of presenting complaints, "Back Pain" was the sixth most common reason for an emergency department visit [9]. Though this research is not peer reviewed, and no clear definition of back pain was reported, it suggests back pain plays an important role in the emergency department.

1.1.5 Cost of Low Back Pain in the Emergency Department

Currently, there is limited research on the economic burden of low back pain in the emergency department. An analysis by Jorgenssen in the US found that patients presenting to the emergency department with back pain cost between $399 to $1943 per visit [25]. Additionally, they identified that approximately 3% of patients presented to the emergency department three or more times, and that these patients with back pain accounted for 12.4 % of the total charges in the emergency department [25]. Another analysis, performed by Martin and colleagues analyzed the expenditures of adults with back and neck problems in the emergency department using national US estimates [26]. Results indicated that there has been a substantial increase in expenditures between 1997 (1.8 billion annually) and 2005 (2.6 billion annually) [26].

1.1.6 Defining Low Back Pain in the Emergency Department

There are currently many approaches to categorize low back pain. In 2007, Chou and colleagues revised a clinical guideline from the American College of Physicians for the diagnosis and treatment of low back pain in the primary care setting [21]. This guideline categorizes low back pain into three categories (non-specific low back pain, back pain potentially associated with radiculopathy or spinal stenosis, or back pain potentially associated with another specific spinal cause). In a more recently published report of the recommended treatments for evaluating and treating low back pain in the emergency department, Borczuk and colleagues used a similar three-category approach to define low back pain [15]. Table 1.1 summarizes the approaches used to categorize low back pain in the emergency department management report [15]. Both the clinical guideline and emergency department management report will guide our work and the definitions we use to define low back pain.

Table 1.1: An approach used to categorize low back pain presented by Borczuk et al. [15].

Categories of Lower Back Pain Used in Patient Management	
Category	Management
Patients with red flag symptoms	Red flags: age > 50 y or < 20 y, history of cancer, history of unexplained weight loss, persistent fevers and/or night sweats, immuno-compromise (HIV), prolonged steroid use, intravenous drug use, recent bacterial infection (bacteremia), known aortic aneurysm, motor neurologic deficit and urinary retention, bowel incontinence, saddle anesthesia, hypotension, pulsatile abdominal mass, pulse deficit, recent instrumentation. Management: address immediate threats to patients with extensive and emergent evaluation of patients including appropriate imaging.
Patients with lumbar radiculopathy	Management: examined for significant neurological deficits that require emergent imaging and spinal consultation. Most of these patients will require pain management, education and outpatient referral to their primary care physician.
Patients presenting with nonspecific back pain	Management: These patients make up 85% of patients with back pain [41]. They may receive pain management, education and referral to their primary care physician [22].

1.2 Prevalence

Studying accurate prevalence rates in health research is an essential step in understanding an illness and its burden on individuals and the health care system [27]. Prevalence studies are cost-effective and useful, informing health care providers, as well as administrative and policy decision makers, of the potential impact of low back pain in the emergency department setting [28]. Additionally, prevalence snapshots over time may give temporal information showing whether low back pain is increasingly being represented in the emergency department [8].

1.3 Need for Research

Research on the prevalence of low back pain in the emergency department will inform healthcare providers, as well as policy and decision makers, of the potential and local impact of low back pain in the emergency department, and will help identify opportunities for further research to enhance care pathways of patients suffering from low back pain.

1.4 Thesis Objective

The overall objective of this thesis is to provide global and local estimates of the prevalence of low back pain in the emergency department. To fulfill this objective, this thesis is divided into two separate studies. We conducted a (1) systematic review and a (2) primary study in our local emergency department using six years of administrative data. 1: The review provides comprehensive background research for the primary study, and context for the results of our primary study. It provides needed prevalence estimates

for researchers, health care providers and administrative and policy decision makers around the world [8]. Our review additionally provides a comparison of estimates between emergency department settings and across study methodologies. 2: The primary study offered estimates of low back pain using different definitions of low back pain and described characteristics of individuals diagnosed in these distinct definitions of low back pain. The study additionally assessed trends in low back pain prevalence in our emergency department over time.

1.5 Thesis Layout

This thesis document is divided into four chapters:

- Chapter 1, this chapter, includes literature review and overall thesis objective.
- Chapter 2 contains the manuscript of our systematic review of low back pain in emergency settings.
- Chapter 3 includes the manuscript of our primary study of low back pain in our local emergency department
- Chapter 4 contains our conclusions, implications for future research and for policy makers.

CHAPTER 2: THE PREVALENCE OF LOW BACK PAIN IN EMERGENCY SETTINGS: A SYSTEMATIC REVIEW (MANUSCRIPT ONE)

2.1 Abstract

Objectives: To perform a systematic review of evidence about the prevalence of low back pain in emergency settings and explore the impact of study characteristics including type of emergency setting and how the study defined low back pain.

Methods: Studies were identified from PubMed and EMBASE, grey literature search, and other sources. We selected studies that presented prevalence data for adults presenting to an emergency setting with low back pain. Critical appraisal was conducted using a modified tool developed to assess prevalence studies. Meta-analyses and a meta-regression explored the influence of study-level characteristics on prevalence.

Results: We screened 1187 citations and included 21 studies, reported between 2000 and 2016 presenting prevalence data from 12 countries. The pooled prevalence estimate from studies of standard emergency settings was 4.39% (95% CI: 3.67-5.18). Prevalence estimates of the included studies ranged from 0.9% to 17.1% and varied with study definition of low back pain and the type of emergency setting. The overall quality of the evidence was judged to be moderate as there was limited generalizability and high heterogeneity in the results.

Conclusion: This is the first systematic review to examine the prevalence of low back pain in emergency settings. Our results indicate that low back pain is consistently a common presenting complaint and that the prevalence of low back pain varies with definition of low back pain and emergency setting. Clinicians and policy decisions makers should be aware of the potential impact of low back pain in their emergency settings.

2.2 Introduction

Low back pain is one of the most common and costly forms of musculoskeletal pain [1]. The individual lifetime prevalence of low back pain is approximately 49-90% [61] and approximately 25% of patients presenting for care with low back pain will have another episode within one year [3]. Over the past quarter century there has been an increasing interest in researching the prevalence of low back pain [8]. These estimates are important, as they can serve as a basis for etiologic studies and healthcare evaluation [8].

The majority of patients, who seek care for low back pain, are initially evaluated by a primary care physician [29]. Nevertheless, a governmental report from Canada [9] and research conducted in the US [30] suggest that low back pain is a top five presenting complaint in the emergency department. A comprehensive scoping review of the literature [31] revealed no systematic review on the prevalence of low back pain in the emergency department, though several international studies on the topic were identified [32, 33, 34, 35, 36]. There is currently a need to synthesize the available literature and provide prevalence estimates for researchers, health care providers and administrative and policy decision makers around the world [8].

Our objectives in this study were to systematically identify and synthesize available studies of prevalence of low back pain in the emergency department. We explored heterogeneity by comparing prevalence estimates for types of emergency department settings and for different definitions of low back pain used in included studies.

2.3 Materials and Methods

2.3.1 Search Strategy

We searched electronic databases PubMed and EMBASE (to November 2015) using controlled vocabulary and keyword variations of the concepts: emergency department, low back pain and prevalence (see Appendix One and Two). We conducted citation searches of seminal studies [33-39]. For studies with greater than 500 citations, we searched within citations for "emergency department" using Google Scholar. We reviewed reference lists of included studies to identify other potentially relevant studies. Additionally, our literature search incorporated all relevant literature that was identified in a broad scoping review mapping published research studies about back pain in the emergency department [31]. We searched for relevant subsequent publications for any abstracts identified.

We searched the grey literature guided by the 'Grey Matters' checklist [52]; we searched all websites listed in the checklist under the headings of health economics [e.g. Public Health Agency of Canada] or health statistics [e.g. Canadian Institute for Health Information and the CDC National Centre for Health Statistics], excluding pharmacological based websites (see Appendix Three). Websites that we reviewed collected data from Canada, the United States, Australia, Ireland, England, Scotland and five international databases (e.g. World Health Organization). We searched these websites 10 pages deep using the following search criteria, "low back pain" and "prevalence" and "emergency department". We did not restrict searches by language or date. The grey literature search was conducted in May 2015.

2.3.2 Selection Criteria

We included studies that investigated patients presenting to emergency settings. We defined 'emergency setting' as all pre-hospital, emergency, ambulatory, outpatient, accident, trauma, triage and urgent care services. Standard emergency settings provide initial treatment to patients with a broad spectrum of illnesses and injuries, some of which may be life-threatening and require immediate action. For completeness, we included non-standard emergency settings, which provide care for a limited population and/or limited spectrum of illness and injuries (for example, orthopedic emergency settings).

We classified emergency settings by size. Emergency department settings with less than 10,000 annual visits were categorized as 'rural', those with more than 10,000 annual visits were categorized as 'metropolitan' and we separately considered studies that used nationally representative samples of emergency settings.

We categorized emergency settings by country level health care system funding. Studies were classified as being either using primarily a public funding system or a private funding system. If information was not provided in the publication, this data was collected from governmental websites and online encyclopedias identified using the search engine Google. We defined publicly funded healthcare systems as systems with no out of pocket costs associated with care in an emergency setting. We defined private funded healthcare systems as systems that require out of pocket payments for most visits to emergency settings and many procedures.

We included studies that measured adults presenting with low back pain. We defined adults as individuals over the age of 14, as this is an age where patients are likely to be diagnosed and treated as an adult [53]. If study selection criteria were mixed or unclear, we defined studies with an adequately 'adult' population as those with a minimum mean age of 30 years.

We included studies that used any definition of back pain. We used subgroups to explore the impact of study definitions of low back pain. We categorized studies that identified patients from presenting complaint codes and studies that captured their study population from diagnostic codes. We also collected information on the specific coding system, for example: International Classification of Disease (ICD) diagnostic codes and Emergency Department Information System (EDIS) presenting complaint codes.

We categorized low back pain definitions as 'broad' or 'narrow'. Studies were defined as 'broad' if they used a general definition of 'back pain' to define their prevalence estimate. These studies may have included some individuals with back pain in regions other than the low back (for example, thoracic spine). Studies were defined as 'narrow' if they used the definition of 'low back pain' or 'non-specific low back pain', or were limited to pain complaints in the lumbar region.

We included studies that presented data about the prevalence, including presentation of a prevalence rate (total number of adults presenting to an emergency setting with low back pain/total number of individuals presenting to the emergency setting over a specified period

of time), or raw data to allow prevalence calculation.

2.3.3 Study Selection and Data Collection

Two independent reviewers screened the titles and abstracts from the electronic database searches for studies meeting our selection criteria. In the case of disagreement, resolution was achieved by discussion with a third reviewer. The primary author screened the titles from the grey literature searches, reference lists (from included studies), results of the scoping review [31], and citation searches. Full articles were obtained for potentially relevant studies, or where relevance was unclear; two authors independently assessed the full text to determine eligibility prior to data extraction.

Two independent reviewers performed data extraction. In the case of disagreement, resolution was achieved by including a third reviewer. We used a data extraction form (see Appendix Six), to record information about the methods and results of each included study, including study objectives, location and type of emergency setting, study period, sample size, the definition of low back pain used by the study authors to calculate prevalence, population characteristics including age and sex, and the prevalence estimate. In studies using the same datasets, we extracted the prevalence data of the study that was conducted over the longest period of time and rated as having the lowest risk of bias. Finally, one reviewer collected information from an independent Google search to characterize each study's country-level healthcare system funding system.

2.3.4 Critical Appraisal

Two independent reviewers critically appraised each included study using a modified a tool developed to assess prevalence studies (See Appendix Four) [3]. In the case of disagreement or uncertainty, discussion was used to reach consensus with a third reviewer. The modified tool assesses each study according to nine domains: three external validity domains, and six internal validity domains, plus one item assessing overall risk of bias. The external validity domains assess the target population; sampling and non-response bias, while the internal risk of bias domains assess data collection, case definitions, assessment tools, prevalence period and an assessment of the numerator and denominator. We modified the original tool by omitting an additional domain that assesses whether the study population represents the national population, which was not relevant to our review. The reviewers rated each of the nine domains as either high or low risk of bias; the overall risk of bias was rated as low, moderate or high risk of bias. We judged an overall low risk of bias if a study scored 'low risk of bias' on all domains. A moderate risk of bias study had one to two domains rated as a high risk of bias, and an overall high risk of bias study had three or more domains rated as a high risk of bias.

2.3.5 Analysis

Descriptive analyses were used to report study characteristics. We reported prevalence ranges, information on emergency settings, study methodology, and study populations.

Meta-Analyses: We used meta-analyses to pool prevalence estimates for sufficiently homogeneous groups of studies conducted in standard emergency settings. Subgroup

analyses explored the impact of study level characteristics: back pain definition, coding system used for definitions of low back pain, health care system and emergency setting on prevalence estimates.

For all meta-analyses, we used a random-effects model to calculate mean prevalence rates and 95% confidence intervals. We normalized the distribution of the prevalence rates by transforming the prevalence estimates reported in the publications (or calculated using reported data) using a double arcsine transformation. This transformation stabilizes the variance when pooling prevalence estimates and eliminates the bias when combining prevalence estimates close to 0 or 100 [54]. The rates were restored for presentation of results. We assessed statistical heterogeneity using the Q statistic and I^2 index [55]. We used forest plots to graphically present prevalence estimates and 95% CIs. We tested subgroups for inter-group heterogeneity using the Q statistic [56].

Meta-Regression: We performed a random effects meta-regression analysis to explore the independent association of three clinically relevant characteristics with prevalence: the coding system used for definitions of low back pain, health care system funding, and study risk of bias [57]. Results of the analysis were used to determine the variance explained by the covariates and their contribution to the total variance in the prevalence estimates. For our analysis we used the Knapp-Hartung variance estimator and associated t-test to calculate p-values and confidence intervals [58]. This estimator was used, as it lowers the amount of unjustified significant results [58]. All analyses were performed using STATA 13.1

Sensitivity Analyses: We performed sensitivity analyses in our subgroup analyses by excluding studies judged to have a high risk of bias. We included studies with duplicate data in the systematic review. However, no duplicate data was used in our statistical analyses.

Assessing the Quality of Evidence (GRADE): We adapted components of the GRADE [59] framework to assess the overall quality of the available evidence on the prevalence of low back pain in the emergency setting, judged as high, moderate, low or very low quality evidence based on: study limitations (overall risk of bias of the evidence identified), imprecision (study sample sizes), indirectness (generalizability of included studies) and inconsistency (unexplained heterogeneity) [59,60]. Appendix Five provides additional detail about our assessment of the overall quality of the evidence.

2.4 Results

Our search of electronic databases identified 1187 citations; we screened 68 full texts and included nine studies from the electronic search. We included an additional twelve studies from alternative search strategies (8 scoping review, 2 citation and reference searches and 2 grey literature search) for a total of 21 included studies, 3 of which used overlapping data (Figure 2.1).

Study Characteristics: The 21 included studies were reported between 2000 and 2016 from 12 countries using a variety of data sources, including administrative databases, surveys and patient charts [32-51, 71] (Table 2.1). Nineteen studies collected data from standard emergency settings, one study was conducted in an orthopaedic emergency department [39], one study

was conducted in medical presidiums following an earthquake [41], and one study collected data from emergency ambulance calls [48]. Reported prevalence estimates ranged from 0.9% to 17%.

Four included studies were judged to have high risk of bias, 12 with moderate risk of bias, and five with low risk of bias (Table 2.4). Studies with high overall risk of bias inconsistently defined low back pain, didn't use coding systems for their definitions of low back pain, and had prevalence data that was collected over less than one year

Meta-Analyses: The pooled prevalence estimate for standard emergency settings was 4.39% (3.67%-5.18%). There is significant heterogeneity in the results of this analysis, as assessed by the Q statistic (5.9e+05, p=0.00) and the I^2 index (100.0%) (Figure 2.2).

Subgroup analysis results are presented in Table 2.2. Figure 2.3 presents a forest plot of subgroups (coding system, healthcare system funding and definition of low back pain). We found that studies using presenting complaints to measure prevalence had a higher pooled prevalence estimate 5.5% (3.5%-7.8%) than studies using diagnosis coding 3.4% (3.1%-3.8%), with significant inter-group heterogeneity (p=0.046).

Meta-Regression Analyses: None of the covariates investigated were significantly associated with prevalence estimates (Table 2.3).

Sensitivity Analyses: When studies with a high risk of bias were eliminated from our

analysis of standard emergency settings, the pooled prevalence estimate was 4% (3.2%-4.9%). Additionally, there was no longer significant inter-group heterogeneity in studies using presenting complaints and studies using diagnosis codes (p=0.229). Other results from our sensitivity analysis can be found in Table 2.2.

Quality of the Evidence – GRADE: We judged the overall quality of the evidence available to be moderate and judged that further research could modify our estimate of low back pain in emergency settings. Our judgment was downgraded as we included four studies with high risk of bias and additionally 12 studies with moderate risk of bias. There was a large amount of variability in the prevalence estimates of included studies, and there was a lack of prevalence estimates from some important settings, including rural areas and developing nations.

2.5 Discussion

This review provides the first comprehensive search and synthesis of the international literature on the prevalence of low back pain in emergency settings. The result of our synthesis of all prevalence estimates for adults presenting with low back pain to standard emergency settings was 4.3% (3.6%-5.1%). Our pooled estimate indicates that low back pain is a common presenting complaint in emergency settings in our analysis. To provide this perspective, a national trends analysis performed in the US showed that presenting complaints with prevalence of 3.7% (or higher) made up the top 10 presenting complaints in the average American emergency department. Our result is similar to the prevalence of "shortness of breath" (4%) and "fever and chills" (4.4%). For comparison, the highest most

common presenting complaint, “any injury”, had a prevalence of 18.2% and the second highest estimate, “cough, upper respiratory or ears/nose/throat symptoms”, had a prevalence of 9.2% [30].

Significant heterogeneity was found in prevalence estimates of the included studies. Prevalence estimates of included studies ranged from 0.9% to 17.1%. Although variation in estimates from different emergency settings were expected, it is important to explore potential sources of heterogeneity, including the types of emergency settings. Though the majority of included studies were conducted in standard emergency settings, there were three studies from non-standard settings, which contributed to the large range of prevalence estimates. For example, the study with the highest prevalence estimate (17%) gathered data from an orthopedic emergency department, where one might expect to find a higher prevalence of low back pain patients [39].

We explored potential sources of heterogeneity by conducting subgroup and meta-regression analyses. Subgroup analyses exploring the impact of study-level characteristics on prevalence estimates found that studies using ‘presenting complaints’ to define low back pain cases were associated with a higher prevalence estimate 5.5% (3.5%-7.8%) than studies that used diagnostic coding 3.4% (3.1%-3.8%). This may be due to the fact that prevalence estimates from studies using presenting complaints reflect the symptom of back pain as a chief complaint, which may or may not be caused by the underlying etiology associated with a diagnosis of back pain. Conversely, diagnostic codes represent a specific category of low back pain (for example, non-specific low back pain). We did not find any meaningful results

from our meta-regression analysis. This may due to the small number of studies and many sources of heterogeneity.

2.5.1 Strengths and Limitations of our Review

A strength of the review was our approach to analysis, which included a meta-analysis, meta-regression, subgroup analysis and sensitivity analyses. These analyses allowed us to explore the effects of study level characteristics on prevalence estimates and test the robustness of our analysis.

Another strength of the study was our use of alternative search strategies, such as the results from a scoping review of back pain in emergency settings. This was important as only 43% of included studies came from our electronic search. We believe future research would benefit if studies were properly indexed with "prevalence" in electronic databases PubMed and EMBASE.

Our study should be considered in the context of the limitations of the evidence available. There are limitations in the generalizability of our results. In our search, we found no studies analyzing the prevalence of low back pain primarily in rural emergency settings. Also, we found no results from developing nations, though these and rural settings may represent unique populations and distinct prevalence rates.

Our exploratory analyses require cautious interpretation. Our pooled estimates are useful to provide context and compare study level characteristics, however, they must be carefully interpreted. Decision makers and clinicians should consider individually relevant emergency

settings and applicable study methodologies.

Researchers in the field should concentrate on improving the quality of prevalence estimates for low back pain in emergency settings. This could be achieved by conducting studies that use well defined, transparent definitions of low back pain, e.g., studies using specific triage codes or specific diagnosis codes. Also, there should be an increase in prevalence estimates from rural emergency settings and estimates from developing nations as they may represent unique populations with various low back pain needs.

2.5.2 Conclusion

This is the first systematic review to explore the prevalence of low back pain in emergency settings. Determining the prevalence is a crucial step in understanding the impact of low back pain in various emergency settings. Our results not only indicate that low back pain is consistently a common presenting complaint, they also reveal that the prevalence of low back pain varies with definition of low back pain and emergency setting. Clinicians and policy decisions makers should be aware of the potential impact of low back pain in their emergency settings. This review will facilitate this discussion and provide context. This review may additionally be used to inform future research, which will allow for more meaningful comparisons between and within emergency settings.

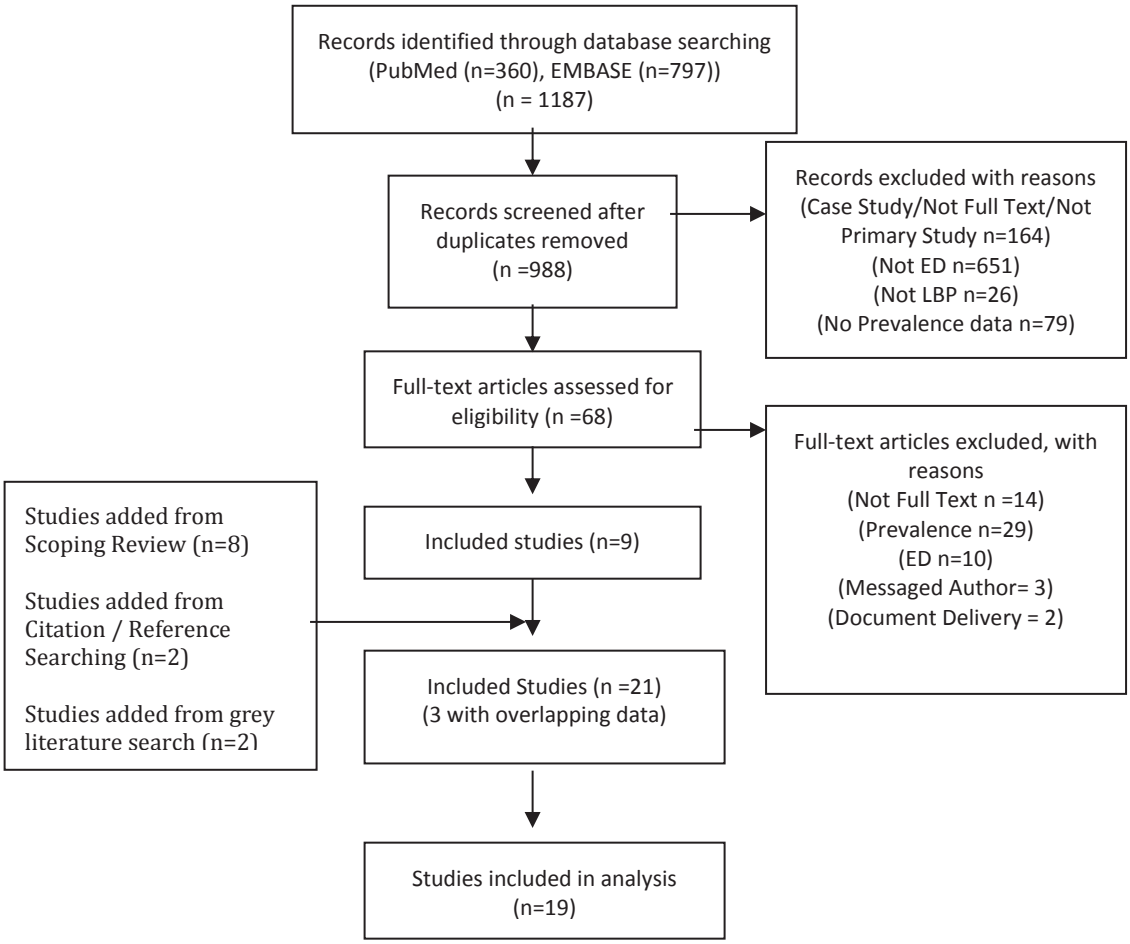

Figure 2.1: Flow chart of the selection of studies to be included in our systematic review.

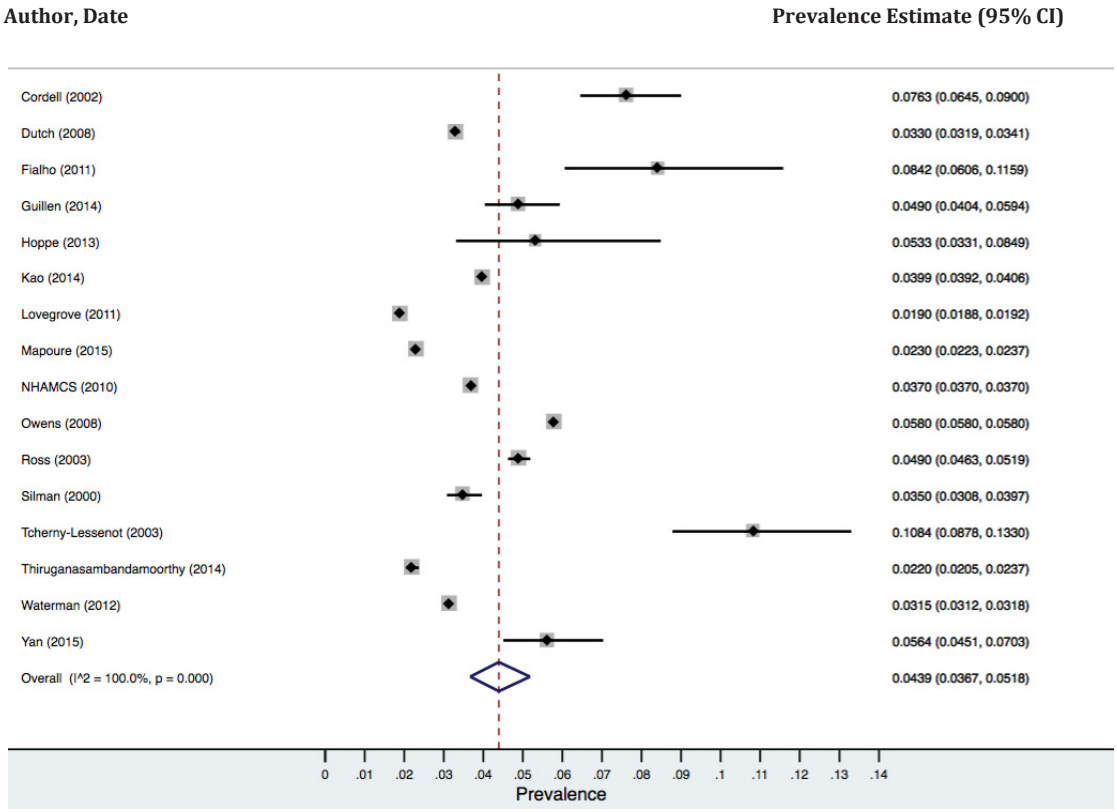

Figure 2.2: Random effects meta-analyses of prevalence estimates from included studies with standard emergency settings (n=16).

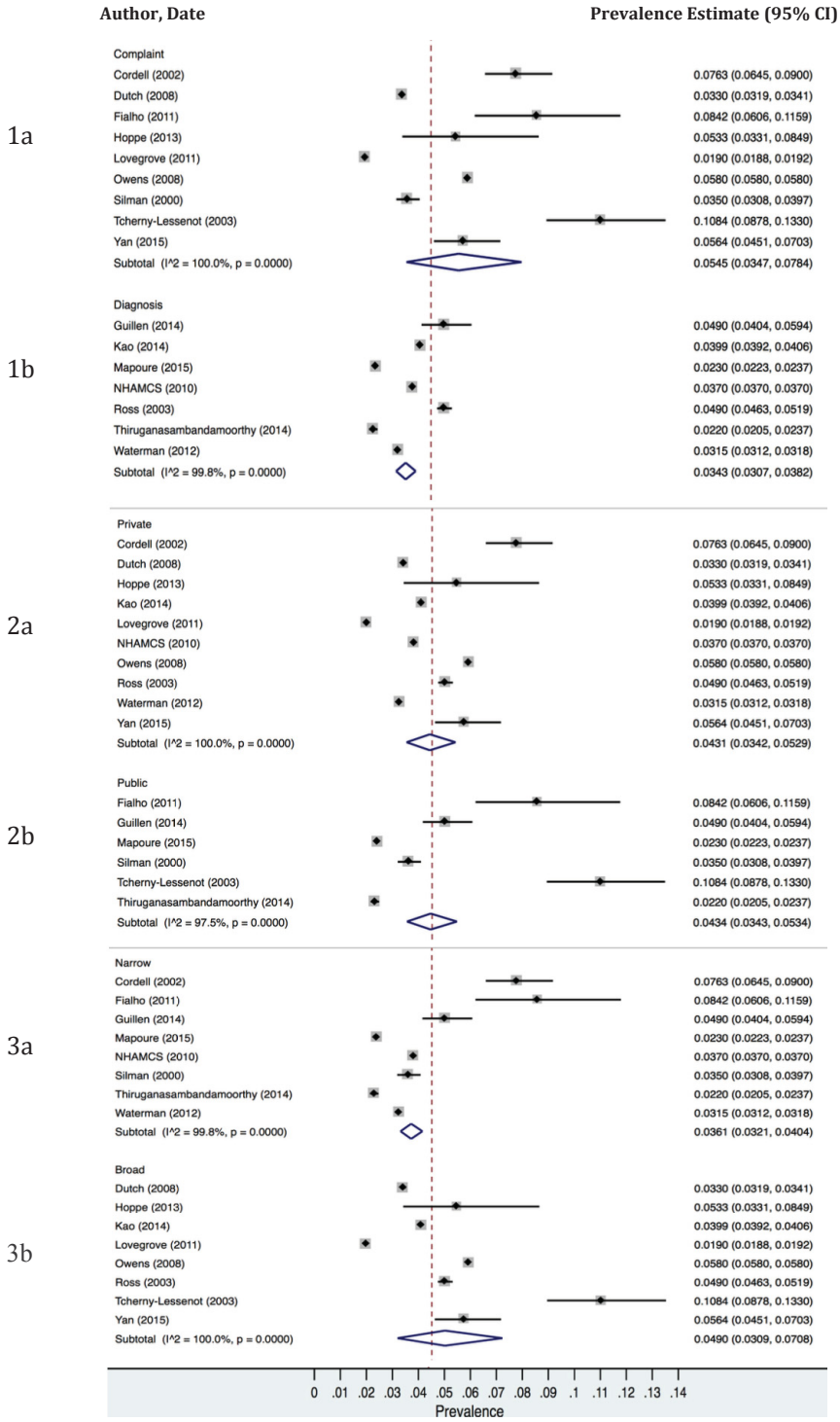

Figure 2.3: Random effects meta-analyses of prevalence estimates from included studies with standard emergency settings (n=16). Studies are grouped by the approach used to define the definition of low back pain: **Meta-analysis 1** – Studies grouped by coding system used for the definition of low back pain, **1a** "Complaint" indicates studies using presenting complaints for their definitions of low back pain, 1b "Diagnosis" indicates studies using diagnosis codes for their definition. **Meta analysis 2**- Studies are grouped by healthcare system funding, **2a** "Private" indicates studies conducted in regions with private healthcare funding. **2b** "Public" indicates studies conducted in regions with public healthcare funding. **Meta analysis 3**- Studies are grouped by definition of low back pain, **3a** "Narrow" indicates studies using narrow definitions of low back pain. They used a definition of 'low back pain' or 'non-specific low back pain', or were limited to pain complaints in the lumbar region. **3b** "Broad" indicates studies using broad definitions of low back pain. They used a general definition of 'back pain' to define their prevalence estimate, which may have included some individuals with back pain in regions other than the low back pain.

Table 2.1: Methods and results of included studies.

Study	Location of study	Duration of data collection	ED Setting	Health Care System Funding	Age (Mean/ Median)	Sex (%Fem)	Definition of LBP**	Coding System**	Sample Size	Prevalence Estimate
Angeletti, 2013	Italy	1-12 months	**Non-Standard ED**: Presidium (Post Seismic Period)	Private	53‡	36§	Narrow	**Diagnosis-** Patient Charts	958	4.9%
Astete, 2014**	Spain	1-5 Years	**Standard ED:** Metropolitan	Public	57	61	Narrow	**Diagnosis**	2000**	2.9%
Cordell, 2002	USA	<Month	**Standard ED:** Metropolitan	Private	30	55	Narrow	**Complaint**	1665	7.6%
Dutch, 2008	Australia	1-5 Years	**3 Standard EDs:** Metropolitan	Private	>18	-	Broad	**Complaint**	104 705**	3.3%
Fialho, 2011	Brazil	<Month	**Standard ED:** Metropolitan	Public	41‡	58§	Narrow	**Complaint-** Patient Charts	392	8.4%
Hoppe, 2013**	USA	1-12 Months	**Standard ED:** Metropolitan	Private	38	49	Broad	**Complaint-** EDIS	300**	5.4%
Kao, 2014*	USA	≥5 Years	**Standard ED:** National Representation	Private	44	45	Broad	**Diagnosis-** ICD-9||	323 186- 1.1 Billion	3.99%
Friedman, 2010*	USA	≥5 Years	**Standard ED:** National Representation	Private	40	51	Narrow¶	**Diagnosis-** ICD-9||	183 64 3 -114 million	2.3%
Niska, 2010*	USA	1-5 Years	**Standard ED:** National Representation	Private	>18	47	Narrow	**Diagnosis-** ICD-9||	39 393 000	1.9%
Lovegrove, 2011	Australia	1-5 Years	**Standard ED:** Metropolitan (All EDs in Perth)	Private	46‡	51§	Broad	**Complaint-** EDIS	1 171 731	1.9%
Mapoure, 2015	Cameroon	≥5 Years	**Standard ED:** Metropolitan	Public	40	51	Narrow¶	**Diagnosis-** ICD-9||	183 633	2.3%
Marinos, 2008	Greece	1-5 Years	**Non-Standard ED:** Orthopedic	Private	>18	47	Narrow	**Diagnosis-** ICD-9	39 172	17.1%
NHAMCS, 2010	USA	1-5 Years	**Standard ED:** National Representation	Private	37†	57	Narrow	**Diagnosis-** ICD-9	84 886 000	3.7%
Owens, 2008	USA	1-5 Years	**Standard ED:** National Representation	Private	47	57	Broad	**Complaint-** ICD-9||	128 350 000	5.8%
Philips 2012	Barbados	1-12 Months	**Non-Standard ED:** Emergency Calls	Private	-	-	Broad	**Complaint**	8875	0.9%
Ross, 2003	USA	≥5 Years	**Standard ED:** Metropolitan Observation Unit	Private	53	59	Broad	**Diagnosis**	22530	4.9%

Silman, 2000	UK	1-12 months	**2 Standard EDs:** Metropolitan	Public	>18	-	Narrow	**Complaint-** Survey	A: 5147 B: 1459	A: 3.2% B: 4.7% (Pooled 3.5)
Tcherny-Lessenot, 2003**	France	<Month	**Standard ED:** Metropolitan	Public	37	50	Broad	**Complaint-** Survey	729**	10.8%
Thiruganasamban-damoorthy, 2014**	Canada	1-12 months	**2 Standard EDs:** Metropolitan	Public	49‡	51§	Narrow	**Diagnosis-** ICD-10\\	31705	2.2%
Waterman, 2012	USA	≥5 Years	**Standard ED:** National Representation	Private	39‡	49§	Narrow	**Diagnosis-** ICD-9\\	1 820 000	3.15%
Yan, 2015	Cambodia	1-12 months	**2 Standard EDs:** Metropolitan	Private	42	64	Broad	**Complaint**	1295	5.6%

***:** Indicates that studies used the same database.
†: Had to calculate age using age ranges.
‡: indicates that the age calculation was derived from the back pain population, not the entire presenting population, *(>18)* indicates that the study collected data from an adult population 18+,
§: indicates that the % female calculation was derived from the back pain population, as opposed to the entire presenting population to the ED.
¶: Indicates that studies used a definition of non-specific low back pain.
\\: indicates that the study used and presented specific codes for their definitions of LBP.
****:** *Astete:* random sample chosen from all patients presenting to the ED, *Dutch:* excluded younger than 18, left before being seen by a physician, dead on arrival and trauma patients. *Tcherny-Lessenot:* Survey data, missing some individuals who could not fill out survey or too many presenting to the ED at one time, *Hoppe:* Individuals were receiving opioid in the population they used to explore back pain, *Thirun:* Used age and sex for patients with serious pathology. "*Definition of LBP*"**,** "Narrow" indicates studies using narrow definitions of low back pain. They used a definition of 'low back pain' or 'non-specific low back pain', or were limited to pain complaints in the lumbar region**,** while "Broad" indicates studies using broad definitions of low back pain. They used a general definition of 'back pain' to define their prevalence estimate, which may have included some individuals with back pain in regions other than the low back pain. "*Coding System***".** "Complaint" indicates studies using presenting complaints for their definitions of low back pain while "Diagnosis" indicates studies using diagnosis codes for their definition.

Table 2.2: Subgroup analyses presenting pooled prevalence estimates for various subgroups for all studies and for sensitivity analyses excluding high risk of bias studies.

Subgroup	Category	Prevalence, all studies (95% CI)	Inter-group Heterogeneity	Prevalence, low ROB studies (95% CI)	Inter-group Heterogeneity
Back Pain Definition*	Broad	**4.9%** (3.1-7.1)	**p=0.1850**	**3.9%** (1.9-6.4)	**p=0.8574**
	Narrow	**3.6%** (3.2-4.0)		**3.6%** (3.2-4.1)	
Coding System†	Complaint	**5.5%** (3.5-7.8)	**p=0.0459**	**5.0%** (2.6-8.2)	**p=0.2289**
	Diagnosis	**3.4%** (3.1-3.8)		**3.4%** (3.1-3.8)	
Health System‡	Private	**4.3%** (3.4-5.3)	**p=0.9464**	**4.1%** (3.2-5.2)	**p=0.2106**
	Public	**4.4%** (3.4-5.3)		**3.3%** (2.6-4.1)	
Emergency Setting§	Standard	**4.4%** (3.7-5.2)	**p=0.7734**	**4.0%** (3.2-4.9)	**p=0.7149**
	Non-Standard	**6.1%** (0.0-2.3)		**6.1%** (0.00-23.2)	

***:** "Narrow" indicates studies using narrow definitions of low back pain. They used a definition of 'low back pain' or 'non-specific low back pain', or were limited to pain complaints in the lumbar region**,** while "Broad" indicates studies using broad definitions of low back pain. They used a general definition of 'back pain' to define their prevalence estimate, which may have included some individuals with back pain in regions other than the low back pain (for example, thoracic spine).
†: "Complaint" indicates studies using presenting complaints for their definitions of low back pain while "Diagnosis" indicates studies using diagnosis codes for their definition.
‡: "Private" indicates studies conducted in regions with private healthcare funding and "Public" indicates studies conducted in regions with public healthcare funding.
§: "Standard" indicates studies provide initial treatment to patients with a broad spectrum of illness and injuries, while "Non-Standard" indicates settings, which provide care for a limited population and/or limited spectrum of illness and injuries.

Table 2.3: Meta Regression analysis exploring included studies conducted in standard emergency settings.

Covariate	Coefficient	95% Confidence Interval		P-Value
Coding System*	-0.01989	-0.04472	0.00493	0.106
ROB†	0.01032	-0.02085	0.04149	0.485
Health System‡	0.00309	-0.02580	0.03199	0.819

***:** includes studies grouped by coding system used for the definition of low back pain. In our analysis 1 was given to studies using diagnosis codes for their definition, while 0 was given to studies using presenting complaints for their definition.
†: includes studies grouped by risk of bias. In our analysis 1 was given to studies judged to have a moderate to high risk of bias and 0 was given to studies judged to have a low risk of bias.
‡: includes studies grouped by healthcare system funding. In our analysis 1 was given to studies conducted in regions with private healthcare funding and 0 was given to studies conducted in regions with public healthcare funding.

Table 2.4: Risk of bias analysis for all studies included in the review. Hoy et al., 2012, developed this risk of bias tool.

Authors	Sampling frame represent target population?	Random selection for sample or census?	Likelihood of nonresponse bias minimal?	Data collected directly from subjects?	Acceptable case definition?	Study Instrument has validity and reliability?	Same mode of data collection for all subjects?	Length of prevalence period appropriate?	Appropriate numerator and denominator ?	Overall Risk Assessment
Angeletti	L	L	L	L	L	H	L	H	L	Mod
Astete	L	L	L	L	L	H	L	L	L	Mod
Cordell	L	L	L	L	L	H	L	H	L	Mod
Dutch	L	L	L	L	H	H	L	L	L	Mod
Fialho	L	L	L	L	L	H	L	H	L	Mod
Hoppe	L	L	L	L	H	H	L	H	L	High
Kao*	L	L	L	L	L	L	L	L	L	Low
Friedman*	L	L	L	L	L	L	L	L	L	Low
Niska*	L	L	L	L	L	H	L	L	L	Mod
Lovegrove	L	L	L	L	L	L	L	L	L	Low
Mapoure	L	L	L	L	L	H	L	H	L	Mod
Marinos	L	L	L	L	H	H	L	L	L	Mod
NHAMCS	L	L	L	L	L	H	L	L	L	Mod
Owens	L	L	L	L	L	L	L	L	L	Low
Philips	L	L	L	L	H	H	L	L	L	Mod
Ross	L	L	L	L	H	H	L	L	L	Mod
Silman	L	H	H	L	L	H	L	H	L	High
Tcherny-Lessenot	H	H	H	L	H	H	L	H	L	High
Thiruga-nasamban-damoorthy	L	L	L	L	L	L	L	H	L	Mod
Waterman	L	L	L	L	L	L	L	L	L	Low
Yan	L	L	L	L	H	H	L	H	L	High

*: indicates studies using the same database

CHAPTER 3: THE PREVALENCE OF LOW BACK PAIN IN THE EMERGENCY DEPARTMENT: A PRIMARY STUDY IN THE CHARLES V. KEATING EMERGENCY AND TRAUMA CENTRE, HALIFAX, NOVA SCOTIA, CANADA. (MANUSCRIPT TWO)

3.1 Abstract

Objectives: To estimate prevalence rates of low back pain in a large Nova Scotian emergency department using various definitions of low back pain, and to describe characteristics of individuals included in these groups. An additional objective is to assess trends in low back pain prevalence in our emergency department over time.

Methods: We conducted a cross sectional analysis using six years of administrative data from our local emergency setting. We first calculated the prevalence and patient characteristics for individuals presenting with any complaint of back pain, and for groups diagnosed with different types of low back pain. We explored prevalence over time by analyzing prevalence and presentation trends by month, day of the week and hour of the day.

Results: The prevalence of patients presenting to our local emergency department with a complaint of back pain was 3.17%. Individuals diagnosed with non-specific low back pain made up 60.8% of all back pain presentations (prevalence 1.93%). Individuals receiving a diagnostic code compatible with low back pain with nerve root irritation made up 6.7% of all back pain presentations (prevalence 0.22%); the serious low back pain group accounted for 9.9% of all back pain presentations (prevalence 0.32%). There was little fluctuation in prevalence over the six years of data; however, there was a linear increase in presentations for low back pain over the study period.

Conclusion: This is the first multi-year analysis assessing the prevalence of low back pain in a Canadian emergency department. Back pain is a common presenting complaint in our local emergency department. Most individuals presenting with back pain are diagnosed with non-specific low back pain. Future research should concentrate on understanding the management of low back pain in this setting, to ensure this is the proper setting and approach to manage this common condition.

3.2 Introduction

Low back pain is one of the most common forms of musculoskeletal pain, prompting individuals to seek medical care [1, 8]. In 2002, low back pain was the fifth most common reason for all office based physician visits in the US [21]. A systematic review conducted by Dagenais et al., 2008 analyzed the total costs of low back pain to society and estimated that in the US the total costs - direct (medical and nonmedical), indirect costs, and intangible costs of low back pain - are between 84.1 billion and 624.8 billion US dollars annually [4].

Most individuals will develop low back pain at some point in their life, as the lifetime prevalence is between 49-90% [61]. It is currently accepted that the management of low back pain should begin in the primary care setting [22], and over half of visits for low back pain are to primary care physicians [29]. Nevertheless, a recent systematic review on the prevalence of low back pain in emergency settings [5] suggests that low back pain is a common presenting complaint to this setting (pooled prevalence estimate 4.3%). Results from the same systematic review [62] indicated that there are a number of gaps in the literature, particularly a lack of clear and detailed definitions of low back pain. Additionally, the review identified a need for studies comparing prevalence results from multiple definitions of low back pain and research conducted in Canada [62].

In this study, we addressed these gaps in the literature by conducting a cross sectional analysis, involving secondary use of data from a large emergency department in Nova Scotia, Canada. Our objectives were to estimate the prevalence of low back pain among patients presenting to the emergency department, using different definitions of low back

pain, and to describe the characteristics of patients diagnosed with these distinct definitions of low back pain. Our secondary objective was to assess trends in low back pain prevalence in this emergency department over time.

3.3 Methods

3.3.1 Design and Data Sources

We conducted a cross-sectional analysis of emergency department administrative data collected between the 15th of July 2009 and the 15th of July 2015. All patients presenting to the emergency department were captured in the database.

3.3.2 Emergency Department Setting

This study was conducted at the Charles V. Keating Emergency and Trauma Centre (QEII emergency department) in Halifax, Nova Scotia, Canada. It is a tertiary care teaching hospital and the largest emergency department in Atlantic Canada with approximately 71,000 patient presentations each year [(63)].

3.3.3 Data Collection

We collected data from the administrative database EDIS (Emergency Department Information System), which is the central information database used in the QEII emergency department. The database contains over one million patient records and offers access to these records in real time. The database is constantly updated with information

about patients as they progress through the emergency department. EDIS is currently endorsed by the Canadian Association of Emergency Physicians, L'Association des Médecins d'Urgence du Quebec, the National Emergency Nurses Affiliation, the Canadian Paediatric Society and the Society of Rural Physicians of Canada [64].

We collected data on individuals as they passed through the emergency department. We collected data on patients' presenting complaint codes, presenting level of pain, Canadian Triage and Acuity Scale (CTAS) scores and individuals' time of arrival. Presenting complaints were captured using the EDIS presenting complaint list. Description of the CTAS scores can be found online in Appendix Seven.

We gathered data on patient characteristics age, sex and whether patients currently had a primary care provider. Information on primary care providers was captured as a check box when individuals present to the emergency department. We also captured patients emergency department diagnosis using both ICD-9 and ICD-10 codes, as the QEII emergency department switched from the use of ICD-9 codes to ICD-10 codes between July 2012 and Feb 2013.

We collected data on patients' length of stay in the emergency department, whether patients were admitted to hospital following the visit and the details of the type of emergency department visit (e.g. referred to the emergency department or transferred from another health facility). We also captured whether patients had repeat visits to the emergency department, who was responsible for payment in the emergency department (e.g. department of health or workers' compensation) and whether the patient received any imaging services (x-ray, CT, MRI). A list of the characteristics captured can be found

in Appendix Eight.

3.3.4 Study Population

We defined our eligible population as all adults presenting to the emergency department, excluding patients' deceased on arrival. Adults were defined as individuals over the age of 16 (the minimum age of intake in our emergency setting). We included patients who arrived to the emergency department independently or by emergency health services (ambulance or helicopter). The eligible population made up the denominator in our prevalence estimate. This included the total number of emergency department visits [40, 36] and the total number of individual patients presenting to the emergency department [35] over the study period.

Low back pain definitions: We first calculated the overall prevalence, patient presentations and patient characteristics for individuals presenting with a complaint of "back pain" or "traumatic back/spine injury". These codes were used to capture individuals potentially diagnosed with serious or non-serious low back pain. From this population, we defined three clinically relevant low back pain patient groups based on patient's diagnostic ICD codes: 1. non-specific low back pain, 2. low back pain with nerve root irritation and 3. serious low back pain (see Table 3.1). ICD diagnoses included in each group was determined by consultation of previous studies [10, 21, 80] and consensus with three independent researchers, which included an emergency physician and a back pain content expert. In the case of disagreement, discussion between the three reviewers was used to reach consensus.

1) *Non-specific low back pain* was defined as low back pain not attributed to an identifiable specific pathology [8]. Non-specific low back pain is described as pain, muscle tension, or stiffness localized below the lower edge of the chest and above the upper thigh [19]. For example, we included patients assigned ICD codes 724.5 "back pain" and 847.2 "low back strain" in this group (Table 3.1, Section A). A more specific definition of non-specific low back pain, excluding ambiguous codes (e.g. 729.9 "other msk"), was used for sensitivity analysis (Table 3.2).

2) *Low back pain with nerve root irritation* was defined as low back pain that included neurological signs and symptoms. This included patients with low back pain including irritation/compression of a lumbar nerve root). For example, we included patients assigned ICD codes 724.3 "sciatica" and 729.2 "radiculopathy" in this group (Table 3.1, Section B).

3) *Serious low back pain* defined patients presenting with low back pain who are diagnosed with another etiology, for which low back pain may be a symptom, and often requiring different and sometimes urgent care. For example, we included patients assigned ICD codes of 441.9 "aortic aneurysm" and 577.0 "pancreatitis" in this group (Table 3.1, Section C).

Individuals presenting with a low back pain complaint, but not meeting the above definitions, were classified as 'other' and further classified for completeness based on independent researcher judgment. These groups were defined as *Likely non-specific low back pain with comorbidity* (patients presenting with low back pain, but ultimately diagnosed with an etiology unlikely to have back pain as a symptom; consensus

judgement that diagnosis was likely to be a co-morbid condition), or *Non-lumbar back pain* (thoracic or cervical non-specific pain syndromes). Remaining patients with other diagnostic codes were classified as 'unsure'.

3.3.5 Analysis

We calculated the crude prevalence rates for all patients presenting with a complaint of low back pain, and for each of our defined low back pain groups.

We described patient characteristics for each of our defined categories of low back pain. Frequencies and percentages were used to describe categorical variables. Continuous variables were described as means and standard deviations, or medians and inter-quartile ranges. Data was tested for normal distribution using the Shapiro-Wilk test. Means were used for variables with results that were normally distributed and medians were used for non-normally distributed data. Krustal-Wallis analysis of non-parametric data was used with a Bonferroni adjustment to test for significant differences between patient characteristics for separate definitions of low back pain.

Trends in low back pain prevalence over time were assessed using the available six-years of data grouped by month of presentation. The analysis of trend examines the low frequency variation in the data along with non-stationary changes in prevalence [(65)]. We fitted our data with a random walk model looking for seasonality by month. We used this model as we expect random presentations for back pain month to month [(66)]. The trend fitting our data was smoothed and tested for linearity using a linear regression. We

performed these analyses for both prevalence estimates by month and presentations for low back pain per month. This allowed us to determine the trend in prevalence of low back pain with and without the influence of total presentations to the emergency setting. Due to partial data in the months of July 2009 and July 2015, we excluded these two months from the time series analysis.

We analyzed presentations by hour of the day and day of the week. We used density plots to explore presentations during separate hours of the day and days of the week and unpaired t-tests to test for significant differences between individuals presenting during work hours (Mon-Fri, 9AM-5PM) and non-work hours.

Significance was set at p=0.05 level for all comparative analyses. Analyses were conducted using STATA IC 13.1.

3.4 Results

There were a total of 406,918 presentations to the QEII emergency department during our six-year study period, of which 12,914 or 3.17% of individuals presented with a primary complaint of back pain, including "Back Pain" (12,706 presentations) and "Traumatic Back/Spine Injury" (208 presentations). The majority of patients (60.8%) presenting with back pain received a diagnostic code compatible with non-specific low back pain (prevalence of 1.93%). Individuals receiving a diagnostic code compatible with low back pain with nerve root irritation made up 6.7% of all back pain presentations (prevalence 0.22%); the serious low back pain group accounted for 9.9% of all back pain presentations (prevalence 0.32%) (see Figure 3.1).

Characteristics of patients presenting to the emergency department with a complaint of back pain are described in Table 3.3. The median age of individuals was 45 (IQR: 30-60), and females made up 53.4% of the population. Patients spent a median length of 3.13 hours (IQR: 1.93-5.1) in the emergency department and 34.7% of individuals presenting with back pain received x-rays.

We compared patient characteristics between the three definitions of low back pain: non-specific, nerve root and serious low back pain (Table 3.4). We found that individuals with non-specific low back pain had significantly higher CTAS scores (i.e. "less urgent"). We also found that the non-specific low back pain group had significantly lower age (median 43), compared to both the low back pain with nerve root irritation (median 46) and serious low back pain (median 58) groups. Furthermore, individuals with non-specific low back pain were significantly less likely to be admitted to the hospital. Results of our Krustal-Wallis analysis are presented in Table 3.5.

Our sensitivity analysis, which was used to test the robustness of our definition of non-specific low back pain (eliminating ambiguous codes), resulted in an insignificant difference in prevalence (1.89%) compared to our non-specific low back pain estimate of (1.93%). Furthermore, we found no significant difference in age, sex or CTAS scores between both groups.

In our analysis of prevalence estimates over time, we found that peak hours for presentations for back pain were between 9AM and 11AM (Figure 3.2). Our results indicate that significantly more individuals presented during non-work hours, 61.8%, compared to work hours (Figure 3.3). Also, significantly more individuals presented on

Mondays (16.6%) compared to all other days of the week (Figure 3.4).

Our time series analysis showed that trends in the prevalence of low back pain in the emergency department remained stable over the six years of our study. The monthly prevalence of back pain ranged from 2.73% to 4.09%. There was no linear trend identified in the data; the linear regression resulted in a slope of -0.001 and an R^2 value of 0.06 (Figure 3.5A).

Trend analysis for patient presentations for low back pain revealed a steady increase in patient presentations over the six years of data. The trend in presentations per month ranged from 135 to 230. The linear regression resulted in a slope of 0.42 with a R^2 value of 0.78 (Figure 3.5B).

3.5 Discussion

Our multi-year study provides evidence that a substantial number of individuals, just over three percent, present to the QEII emergency department with a complaint of low back pain. We found large variation in prevalence estimates for different definitions of low back pain. Most individuals presenting with back pain were diagnosed with non-specific low back pain (prevalence 1.93%), while individuals with low back pain with nerve root irritation had a prevalence of 0.22% and individuals with serious low back pain had a prevalence of 0.32%. These estimates are useful as they allow for comparison with other research in the field and they provide context for future prevalence estimates.

Our prevalence estimate for individuals presenting with back pain, 3.17%, is lower than

what was observed in a meta-analysis of 16 prevalence studies of low back pain in the emergency department (4.3%) [62]. This difference may be due to the fact that the review included a broad spectrum of emergency settings, which may have different healthcare funding structures and access, and which may serve different patient populations.

Our results are comparable to other studies conducted in similar settings using similar back pain definitions of non-specific low back pain and low back pain with nerve root irritation. For example, a study conducted in Canada [51], and one conducted in the US [34] reported prevalence estimates of 2.2%, and 2.3%, respectively, compared to our prevalence estimate of 2.15% (1.93% non specific low back pain and 0.32% low back pain with nerve root irritation).

To provide perspective, a study conducted in the US [30], which analyzed top presenting complaints, found that back pain (including neck pain), ranked as being the fifth most common presenting complaint in the emergency department [30]. Another recent analysis of Canadian emergency department visits, performed by the Canadian Institute of Health Information (CIHI), indicated that back pain is the sixth most common reason for an emergency department visit [9].

Studies using only ICD codes to quantify low back pain may be underrepresenting the burden of low back pain in emergency settings. Most studies in this field define prevalence for non-specific low back pain and for low back pain with nerve root irritation; however, other studies have not described prevalence of the serious low back pain group [62]. Including this group in prevalence estimates is important as it captures a clinically relevant population requiring serious intervention and significant resources.

Future research should capture this population to increase the homogeneity of the literature and our understanding of the impact of the serious low back pain group in various emergency settings.

This is one of the first studies to describe the prevalence and patient characteristics for groups of low back pain patients defined using discharge diagnostic codes. Results indicate that the severity of patients increases as our definitions progress from non-specific low back pain to low back pain with nerve root irritation to serious low back pain. CTAS scores become more severe (i.e. "decrease"); length of stay increases, hospital admissions increase and so does median age of patients. We found that 27.4% of individuals diagnosed with non-specific low back pain received x-rays. This result is similar to an analysis performed in the US [10], which found 30.5% of individuals received x-rays for back-related presentations to the emergency department. Our result may be a sign of x-ray overuse. Further analysis is required to determine which x-rays were truly warranted. This could be done by examining the prevalence of individuals presenting with a complaint of back pain along with red flag symptoms.

Our exploration of trends in low back pain presentations to the emergency department over time found that the prevalence of low back pain has remained relatively stable over the six years of the study period. However, there has been a steady increase in the number of presentations for low back pain over the past six years. This indicates that the emergency department has had a relative increase in total patient presentations, including back pain, over the past six years. The increase in emergency department and back pain patients may be due to changes in primary care availability, an increase in population or a decrease in population health. Further research is needed to understand this result.

3.5.1 Strengths and Limitations

A strength of this study was the use of a sensitivity analysis to explore the robustness of our definition of non-specific low back pain. As we found insignificant differences between the two definitions (prevalence, patient characteristics), we can be confident in the robustness of our definition of non-specific low back pain.

Our use of specific definitions of low back pain will benefit future research exploring the economic impact of back pain. As our separate definitions represent various levels of severity and intervention, they additionally represent different levels of economic impact. Our use of these definitions will provide a better picture of the economic burden of back pain in the emergency department.

We may be underestimating our prevalence estimate of low back pain, as we limited our study population to patients presenting with back pain. Because we used EDIS presenting complaint data to define our study population, our study does not include individuals who did not present with a complaint of back pain, however, left the emergency department with a diagnosis compatible with low back pain.

The accuracy of the presenting and diagnostic codes used in the emergency department administrative data (EDIS) is currently unknown. There may be differences between patient charts and what is recorded in the administrative dataset. The confidence in our results could be improved by performing a validity and reliability study on the EDIS database by comparing results from the database to patient charts [22].

Finally, the results of our study may not be generalizable to other parts of Canada, due to provincial differences in the population of patients seeking care for low back pain in the emergency department; for example socioeconomic status and the availability of emergency health services, as well as the structure of the health care system in Nova Scotia. We recommend that future research address this issue by analyzing prevalence in other emergency settings in Canada, including rural settings.

3.5.2 Conclusions

Back pain is a common presenting complaint to emergency departments. Most individuals presenting with back pain are diagnosed with non-specific low back pain; however, we found that some individuals who present with back pain are discharged with other diagnoses. Moving forward, grouping patients using specific diagnostic codes would help us to better understand the prevalence of low back pain and its economic impact on the emergency department. Canadian research on the topic should include rural settings, where back pain is unexplored. In our local setting, future research should examine the increasing trend in presentations of low back pain and the impact of primary care service access on the prevalence of low back pain in the emergency department. We should also concentrate on understanding the management of low back pain in this setting, to ensure this is the proper setting and approach to manage this common condition.

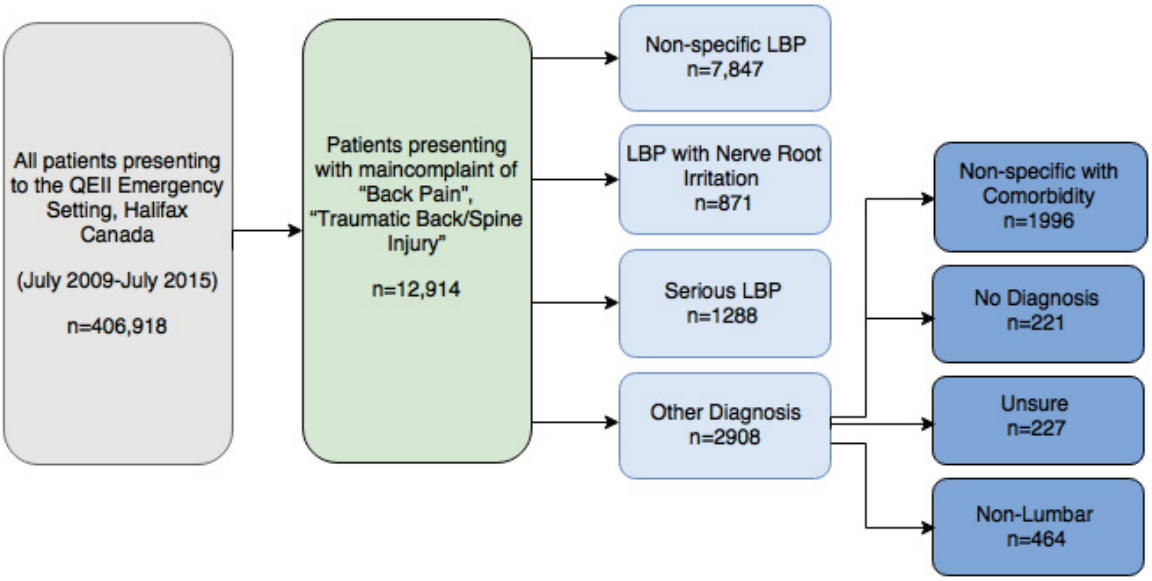

Figure 3.1: Flow diagram of the complete study population.

Table 3.1: ICD-9/10 coding for definitions of low back pain; "non-specific low back pain", "low back pain with nerve root irritation" and "serious low back pain" based on results from the EDIS database.

Non Specific Low Back Pain		Low Back Pain with Nerve Root Irritation		Serious Low Back Pain			
ICD 9/10	Diagnosis	ICD 9/10	Diagnosis	ICD 9/10	Diagnosis	ICD 9/10	Diagnosis
715.90 osteoarthritis 719.45 pain - hip nyd 719.49 polyarthralgia 720.2 sacroiliitis 721.3 spondylosis lumbar spine 721.3 sacroiliac arthritis 721.90 arthritis back 721.90 osteoarthritis back 724.2 mechanical low back pain 724.2 recurrent low back pain 724.5 pain - back nyd 724.5 back pain 724.5 chronic back pain 724.6 pain buttock 724.6 pain sacrum 724.79 pain coccyx 724.8 muscle spasm back 724.8 facet joint syndrome 728.85 muscle spasm 729.1 musculoskeletal pain 729.1 fibromyalgia 729.1 myalgia 729.1 myofascial syndrome 729.9 other msk 780.9 chronic pain (misc) 843.8 strain gluteal muscle 843.9 sprain hip 844.8 strain hamstring 846.0 lumbosacral strain 846.1 sprain sacroiliac jnt/ligament 847.2 low back strain 848.8 other sprain/strain trunk 998.1 bruising (po) M13.9 arthritis, unspecified M25.5 joint pain M54.5 back pain M62.6 muscle strain M79.1 myalgia M81.9 osteoporosis S30.80 superficial inj low back / pelvis S31.0 ow lower back / pelvis, uncomplicated V71.8 normal exam Z71.9 counselling / medical advice		722.10 herniated lumbar disc 722.2 herniated disc (neuro)) 722.6 degenerative disc disease 724.3 sciatica 728.9 weakness leg 729.2 neuralgia 729.2 radiculopathy 729.2 radiculopathy leg 782.0 paresthesia, nyd M48.0 spinal stenosis R20.8 paresthesias - numbness		041.9 other bacterial 052.9 chickenpox 053.9 herpes zoster 053.9 shingles 153.9 colon ca 183.0 ovary ca 199.1 metastatic cancer 199.1 all other ca's 203.0 multiple myeloma 208.0 acute leukemia 300.81 somatoform disorder 324.1 abscess, spinal 336.9 cord compression (neuro) 336.9 cord compression 344.60 cauda equina syndrome 410.70 nstemi 411.1 angina unstable 411.1 acute coronary syndrome 413.9 angina-stable 415.1 pulmonary embolus 423.9 pericarditis 441.0 dissection aorta 441.9 aortic aneurysm 482.9 bacterial pneumonia 483 atypical pneumonia 485 bronchopneumonia 511.89 hemopneumothorax 535.00 acute gastritis 540.1 diverticular abscess 540.9 acute appendicitis 541 possible appendicitis 555.9 crohn's disease 558.9 gastroenteritis 560.1 ileus 560.9 small bowel obstruction 560.9 large bowel obstruction 562.10 diverticulosis 562.11 diverticulitis 564.0 constipation 566 perirectal abscess 567.9 peritonitis 569.49 other anorectal 569.9 other gi condition 574.20 biliary colic 574.20 cholelithiasis 575.0 acute cholecystitis 576.1 ascending cholangitis 577.0 pancreatitis 577.8 gallstone pancreatitis 584.9 renal failure acute 590.8 pyelonephritis 591 hydronephrosis 592.1 ureteral calculus 593.9 mass kidney 595.9 cystitis 599.0 urinary tract infection 599.33 urosepsis 599.7 hematuria 601.9 prostatitis 604.90 orchitis 805.2 compression fracture thoracic spine		614.9 pelvic inflammatory disease 620.2 ovarian cyst 625.3 dysmenorrhea 625.8 pelvic pain nyd 626.2 menorrhagia 629.9 other pelvic organ problem 632 missed abortion 644.10 labour 682.2 abscess back 682.2 abscess perineum 682.5abscess buttock 685.0pilonidal abscess 686.9 other cellulitis/abscess 720.0 ankylosing spondylitis 726.5 bursitis hip 728.88 rhabdomyolysis 730.20 osteomyelitis 788.0 renal colic 805.2 fracture thoracic spine 805.4 compression fracture lumbar sp 805.4 fracture lumbar spine 805.6 fracture coccyx 805.6 fracture sacrum 807.00 fracture rib 807.00 fracture ribs 808.0 fracture acetabulum 808.2 fracture pubic rami 808.43 multiple pelvic fractures 809.0 other fracture spine/trunk 820.8 fracture hip 827.0 other fracture pelvis/leg 861.21 contusion lung 876.0 stab wound back 969.9 o.d. drugs of abuse - other A09.9 gastroenteritis B00.9 herpes C90.0 multiple myeloma G06.1 intraspinal abscess and granuloma I20.0 unstable angina I21.9 acute myocardial infarction I26.9 pulmonary embolism I71.9 aortic aneurysm K56.6 sbo/lbo bowel obstruction K62.9 anal and rectal disorder K63.9 intestinal disease, other K80.8 biliary colic / cholelithiasis K85.9 pancreatitis, acute L05.0 pilonidal cyst with abscess M45 ankylosing spondylitis M46.4 discitis N10 pyelonephritis N17.9 acute renal failure N23 renal colic N39.0 urinary tract infection N41.0 prostatitis, acute S22.90 fx thoracic vertebra, closed S27.30 contusion lung, no ow S32.0 fx lumbar vert, closed S32.20 fx coccyx, closed S33.1 Dislocated lumbar vertebra	

Table 3.2: ICD-9/10 coding for a definition of low back pain that is representative of the literature.

Description	ICD-9 Code
Myalgia	729.1
Muscle spasm	728.85
Mechanical Low Back Pain	724.2
Recurrent Low Back Pain	724.2
Back Pain	724.5
Chronic Back Pain	724.5
Pain-Back nyd	724.5
Muscle Spasm Back	724.8
Musculoskeletal Pain	729.1
Other msk	729.9
Chronic Pain (misc)	780.9
Pain nyd (Misc)	780.9
Lumbosacral Strain	846.0
Sprain Sacroiliac Int/Ligament	846.1
Low Back Strain	847.2
Other Sprain/ Strain Trunk	848.8

Description	ICD-10 Code
Myalgia	M79.1
Back Pain	M54.5
Muscle Strain	M62.6
Superficial inj Low Back / Pelvis uncomplicated	S30.80
Ow lower back / pelvis, uncomplicated	S31.0

Table 3.3: Patient characteristics of individuals presenting with a complaint of low back pain.

Characteristic	**Presenting complaint of LBP** n=12,914
Age, years (Median, IQR)	45 (30,60)
Female sex (#,%)	6897 (53.4)
CTAS (median, IQR))	4 (3-4)
Primary Care Provider (#,%)	12211 (94.5)
Type of ED visit (#,%) Direct to Consult Referral from GP Return Visit Missing Other (Emergency presentation)	 310 (2.4) 30 (0.2) 36 (0.3) 2247 (17.4) 10 291 (79.7)
X ray (#,%) **CT** (#,%) **MRI** (#,%)	4478 (34.7) 968 (7.5) 15 (0.12)
Hospital admission [#(%)]	878 (6.8)
Length of stay, hrs (Median, IQR)	3.13 (1.93-5.1)
Responsibility for payment (#,%) Department of Health, NS Worker's Compensation Board, NS Other Missing	 10680 (82.7) 852 (6.6) 1078 (8.3) 304 (2.4)

Table 3.4: Patient characteristics of individuals presenting with a complaint of low back pain and diagnosed with various definitions of low back pain.

Characteristic	**Non-Specific LBP** n=7,847	**LBP with Nerve Root Irritation** *n=871*	**Serious LBP** *n=1,288*
Age, years (Median, IQR)	43 (29,57)	46 (36,57)	58 (38,76)
Female sex (#,%)	4135 (52.7)	476 (54.6)	735 (57.1)
CTAS (median, IQR))	4 (3-4)	4 (3-4)	3 (3-3)
Primary Care Provider (#,%)	7413 (94.5)	825 (94.7)	1231 (95.6)
Type of ED visit (#,%)			
Direct to Consult	54 (0.7)	19 (2.2)	142 (11.0)
Referral from GP	12 (0.2)	2 (0.2)	5 (0.4)
Return Visit	19 (0.2)	6 (0.7)	5 (0.4)
Missing	1315 (16.8)	149 (17.1)	227 (17.6)
Other (Emergency presentation)	6447 (82.1)	695 (79.8)	909 (70.6)
Hospital admission [#(%)]	118 (1.5)	39 (4.5)	412 (32)
Length of stay, hrs (Median, IQR)	2.83 (1.8-4.43)	2.88 (1.7-4.9)	5.53 (3.5-9.2)
Responsibility for payment (#,%)			
Department of Health, NS	6366 (81.1)	751 (86.2)	1122 (87.1)
Worker's Compensation Board, NS	31 (0.4)	47 (5.4)	28 (2.2)
Other	1292 (16.5)	55 (6.3)	95 (7.4)
Missing	158 (2.0)	18 (2.1)	43 (3.3)

Table 3.5: Results of Krustal-Wallis analysis used to test for significant differences between patient characteristics for separate definitions of low back pain ("non-specific low back pain", "low back pain with nerve root irritation" and "serious low back pain".)

Characteristics	Nonspecific - Nerve	Nonspecific - Serious	Nerve - Serious
Age	< p=0.0000	< p=0.0000	< p=0.0001
Sex (More Females)	No Difference p=0.2786	< p=0.0000	No Difference p=0.4157
Length of Stay	No Difference p=0.5140	< p=0.0000	< p=0.0000
CTAS (Higher = less severe)	> p=0.0047	> p=0.0000	> p=0.0000
Hospital Admissions	< p=0.0003	< p=0.0000	< p=0.0000

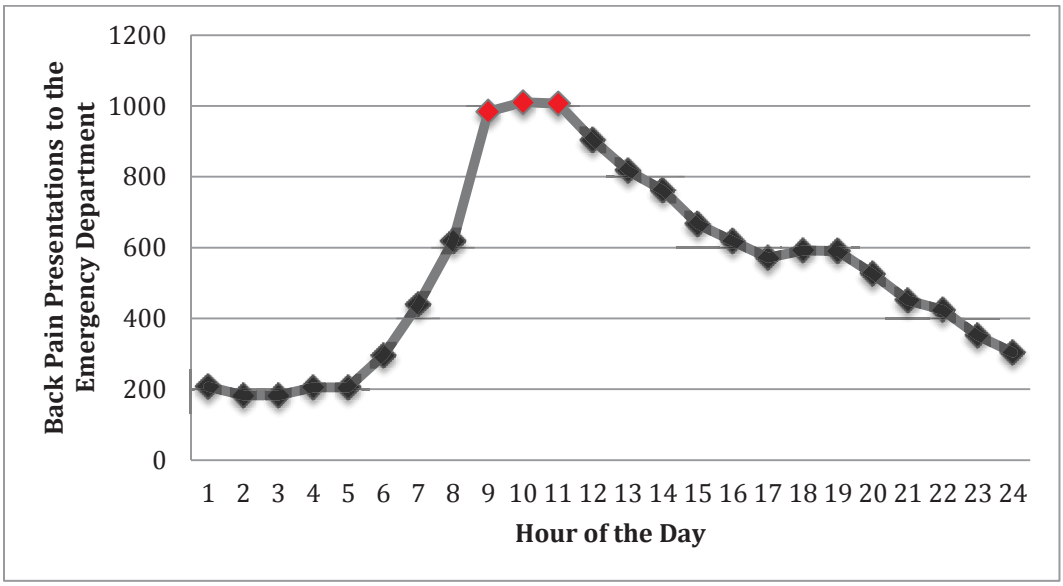

Figure 3.2: Patient presentations for back pain by the hour of the day. The analysis includes data from all days of the week. Peak hours of presentation were between 9 and 11 AM.

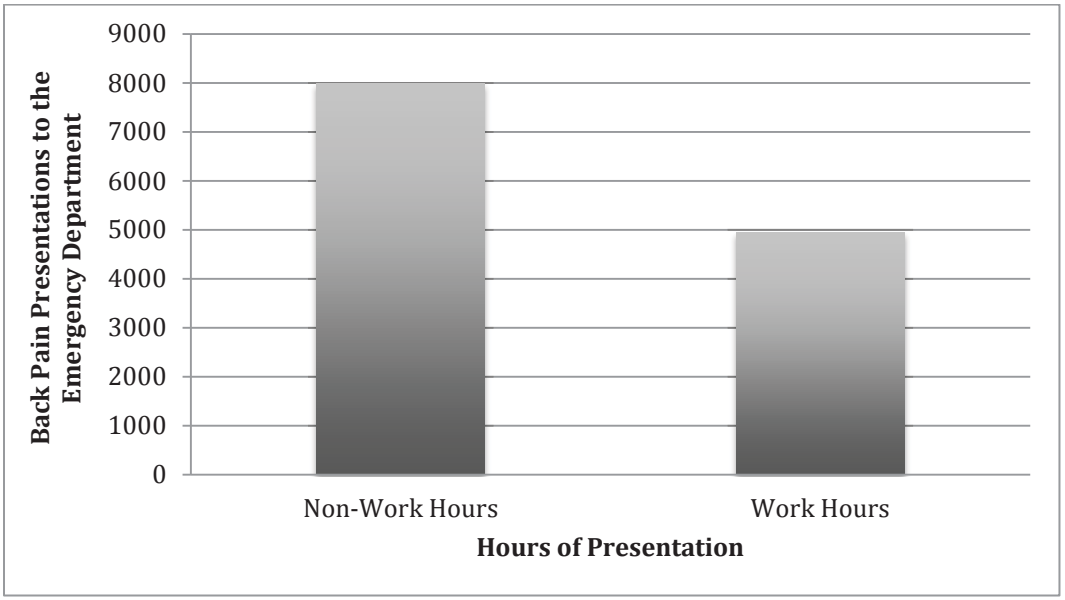

Figure 3.3: Patients presenting with low back pain during typical work hours, defined as 9am to 5pm Monday to Friday (38.2%) and non-work hours (61.8%) ($p<0.05$).

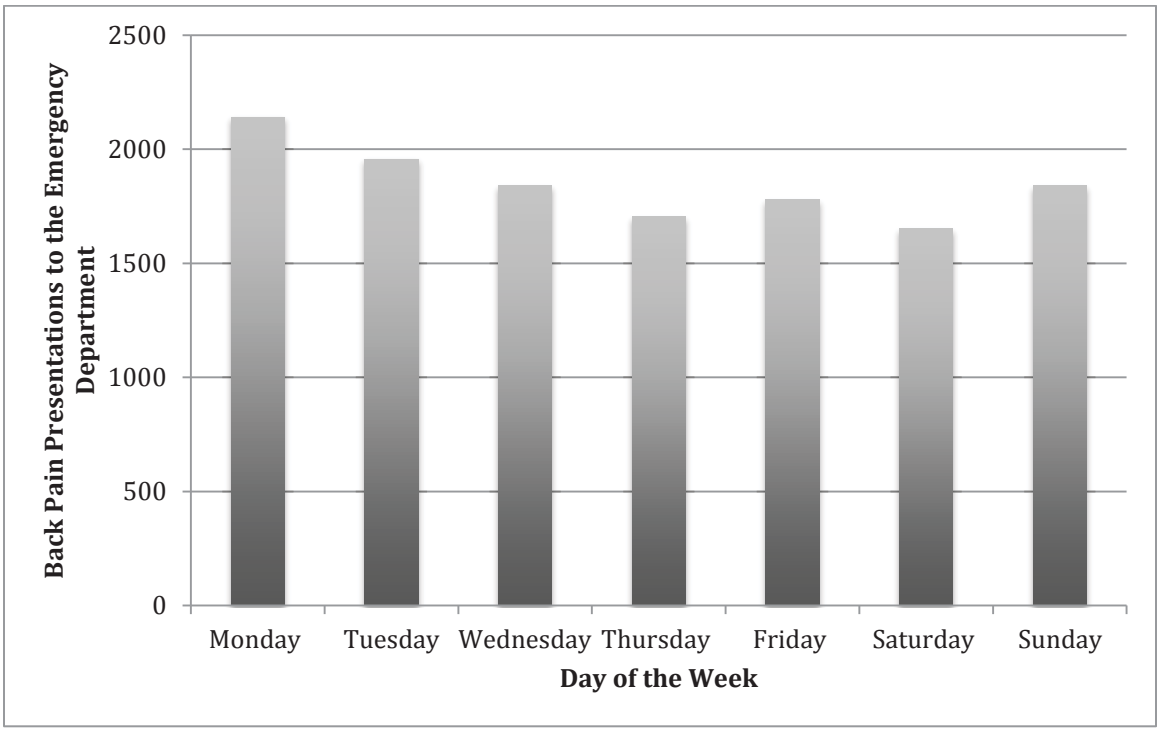

Figure 3.4: Presentations for back pain by day of the week.

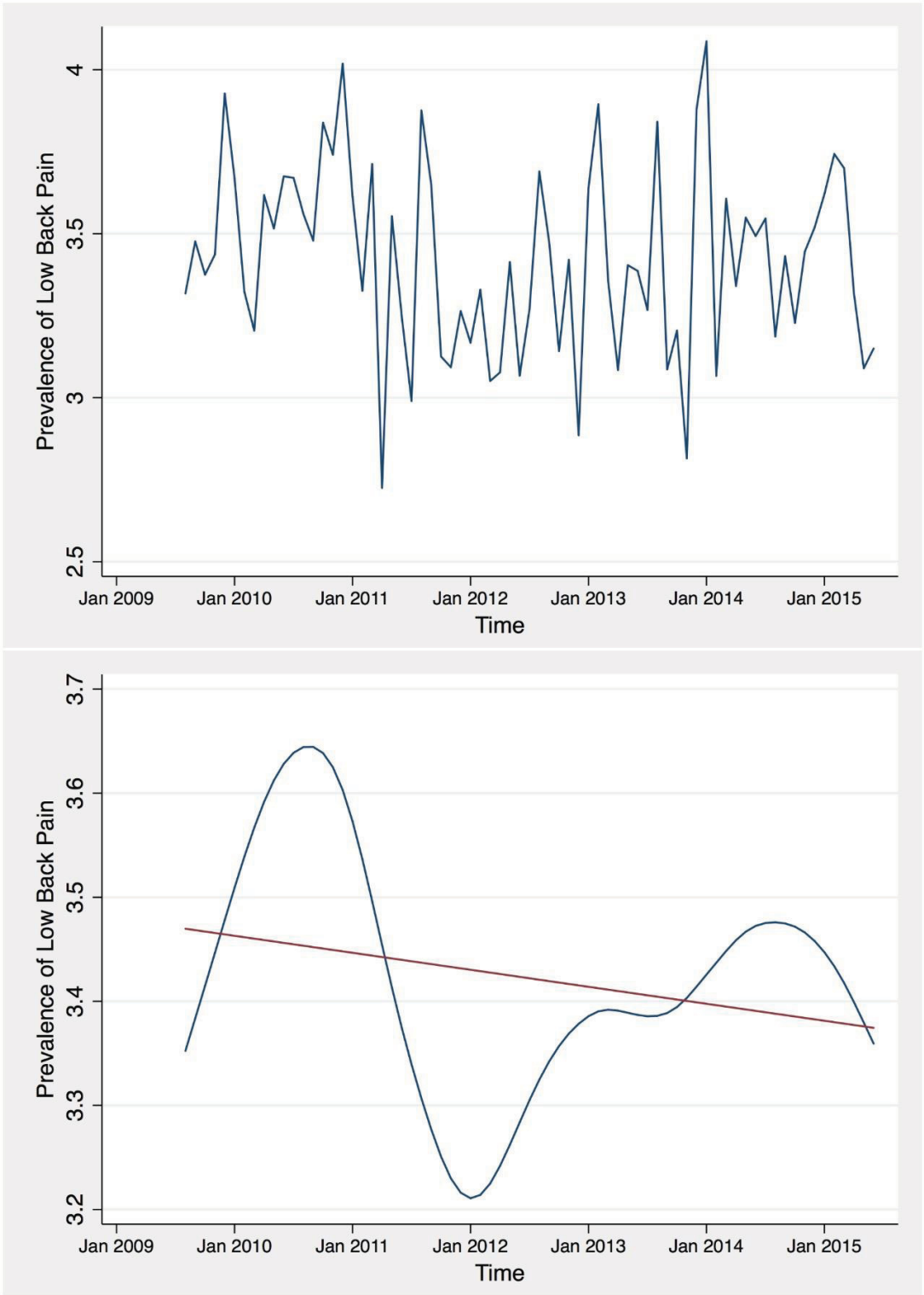

Figure 3.5 A: Prevalence of low back pain between July 2009 and July 2015 grouped by month. The top panel displays raw data and the bottom panel reports the smoothed trend analysis with a linear regression. The linear regression resulted in a slope of -0.001 and an R^2 value of 0.06.

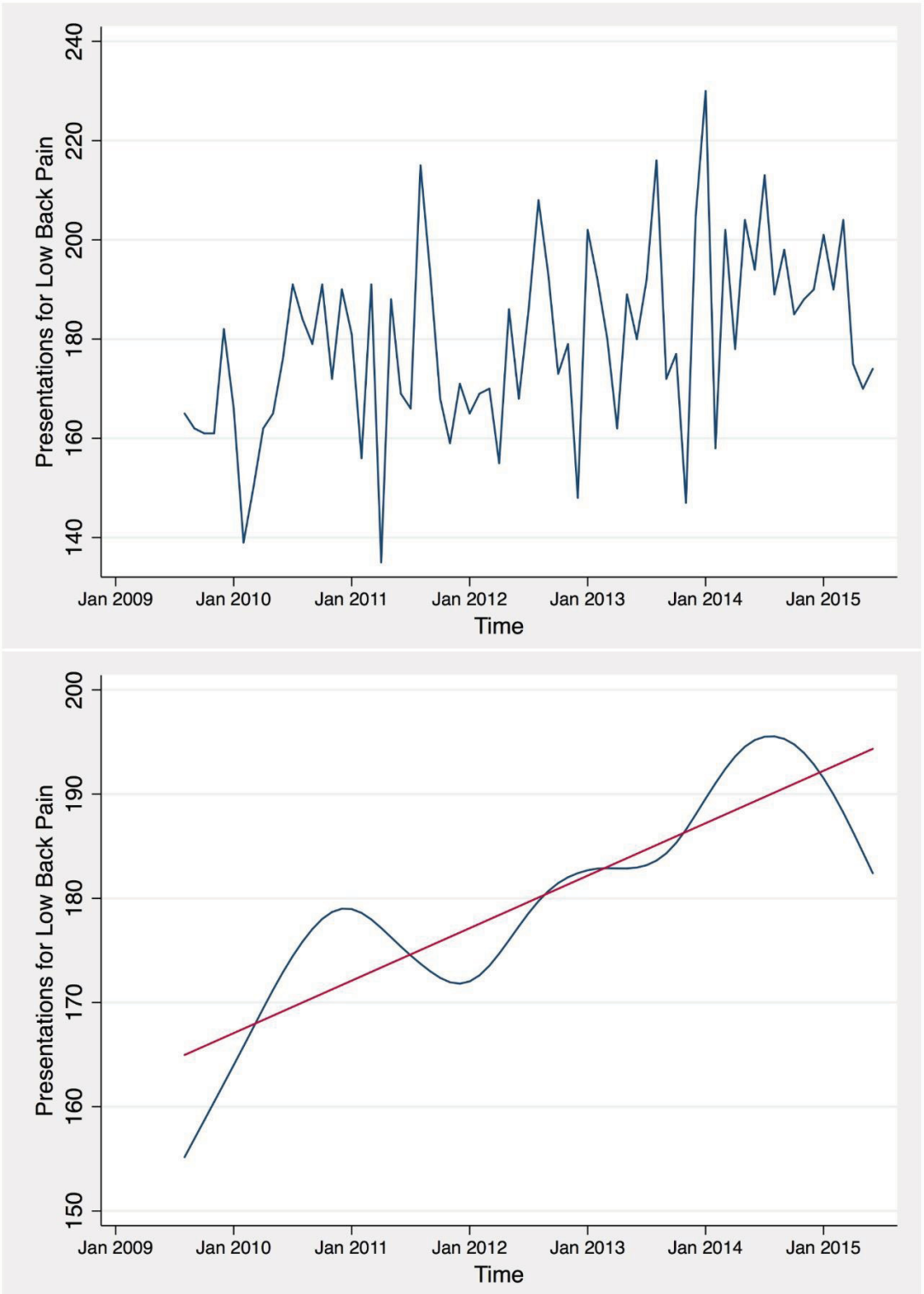

Figure 3.5 B: Presentations of individuals with a complaint of "back pain" or "traumatic back/spine injury" between July 2009 and July 2015 grouped by month. Panel one displays raw data and panel two reports the smoothed trend analysis with a linear regression. The linear regression resulted in a slope of 0.419 and an R^2 value of 0.787.

CHAPTER 4: CONCLUSIONS

4.1 Discussion

Low back pain is consistently a common presenting complaint in both local and international emergency settings. To provide context for these results, we believe we must take a step back to explore low back pain as a whole and its role in healthcare. To facilitate this, we compare low back pain in both emergency and primary care settings.

4.1.1 Prevalence

Research indicates that only 25% of individuals with low back pain seek care from a health care provider for their pain [67]. Individuals presenting for care typically have higher rates of comorbidities, lower education and more severe pain [67]. It is currently accepted that the management of low back pain should begin in the primary care setting [22]. As such, it is not surprising to find that the majority of patients, who seek care for low back pain, are initially evaluated by a primary care physician [29].

Low back pain is one of the most common reasons for presentation to primary healthcare providers [68]. An analysis conducted in Australia found that low back pain was the eighth most common condition managed by primary health care clinicians with a prevalence of 1.8% [22]. These results compare quite closely with the results we identified in our local emergency department. We found a slightly higher prevalence of 3.17%; an analysis in Canada, performed by CIHI, reported that back pain is the sixth most common presenting complaint in the emergency department, similar to the primary care setting [9].

4.1.2 Patient Characteristics

What influences patients' decisions to seek care in either setting? To answer this, we can first explore potential differences in patient populations by investigating patient characteristics in both settings. A study conducted in Australia of low back pain in a primary care setting found that patients had a mean age of 44 and that 53.4% of patients were males. Another analysis in the US [69], found that the mean age of individuals presenting with acute back pain in urban primary care facilities was 41 and that 44% of patients were males. The patient characteristics in these studies appear similar to characteristics of our study population in our local emergency setting. Compared to patients in our study receiving a diagnosis compatible with non-specific low back pain group (since the majority of individuals presenting to a primary care setting are assessed as having non-specific low back pain [68]), we identified a median age of 43 and that 47.3% of patients were males. Further research is needed to understand why certain individuals present to the emergency department for low back pain. This work could include a qualitative analysis of patient perspectives along with a quantitative analysis comparing additional patient characteristics of individuals presenting with back pain to both settings.

4.1.3 Management

An analysis conducted in the US [69], found that patient outcomes of acute low back pain are similar whether patients receive care from primary care physicians, chiropractors or orthopedic surgeons. There is currently limited research on the management of low back pain in emergency department settings. We were able to describe limited characteristics

about management collected in the administrative data, however one relevant finding is that 27.4% of individuals receiving a diagnosis compatible with non-specific low back pain received radiographic imaging. Research suggests this result may be mirrored in primary care settings, as the use of spinal imaging has become routine [21]. An analysis in the US, found that the average rate of x-ray use in a primary care setting for individuals with back pain was 16% [70]. These results are concerning, as the use of spinal imaging may lead to worse patient outcomes due to over diagnosis of asymptomatic etiologies [23]. Plain x-ray results are poorly associated with symptoms and cannot be used to determine key causes of nerve root irritation, including spinal stenosis or herniated invertebral disk [23]. As we found a higher use of imaging services in the emergency department compared to the primary care setting, patient outcomes may be worse in the emergency setting. A prognostic study of patient outcomes in the emergency department is needed to explore this further.

4.1.4 Cost

The increasing economic burden of low back pain is a concern for both the primary care and emergency settings [21]. In the US, between the years of 1997 and 2005, there was a 65% increase in the average total health expenditure for patients with back and neck problems [21]. The cost increased from $4795 to $6096 per year [21]. In primary care settings, an analysis in the US found that the average cost per visit was $478 [69]. In comparison, an analysis also conducted in the US, found that patients presenting to the emergency department with back pain cost between $399 and $1943 per visit [25]. Simple economical comparison between both settings is difficult. Nevertheless, the high costs

associated with patients presenting to the emergency department may be a concern in our local setting, as there has been an increase in the number of presentations for back pain over the past six years. Additionally, costs may be elevated in our local setting due to the high rate of x-ray use for individuals presenting with back pain (34.7%). A formal analysis of cost in our local setting is needed to facilitate further discussion.

4.2 Implications for Future Research

The results of this work will help inform research on this topic. From our search of the literature, we have identified many gaps in the field, including research conducted in Canada and research using transparent definitions of low back pain. We addressed these gaps by performing our primary study, however, there still remain many opportunities to improve our understanding of low back pain in emergency settings.

There is also a need to increase the generalizability of the results from our systematic review and primary study. There is currently a lack of research from rural emergency settings and emergency settings in developing nations, though these settings may represent unique populations and distinct prevalence rates.

We have identified a need to understand why individuals present to the emergency department for back pain, how patients fare in the emergency department (prognosis), and the cost of back pain in the emergency department. This research can be used to inform clinicians and policy decision makers of the impact of low back pain and future steps to improve patient outcomes, patient flow and the economic impact of back pain. This research

will help facilitate discussion on whether the emergency department is the proper setting to treat back pain. This could help inform initiatives to improve care and health outcomes.

Regardless of whether the emergency department is the proper setting to treat low back pain, initiatives can be undertaken to improve care and health outcomes. For example, if the emergency department is not the proper setting to manage back pain, then public/patient education is essential. This could be accomplished by using public education and patient instructions following their visit to the emergency department. If the emergency department is a proper setting to treat back pain, than changes can be made in the emergency department to facilitate care for patients. An example might include employing additional staff (e.g., paramedics or other allied healthcare providers) during times when patients typically present with back pain.

4.3 Implications for Policy Makers

Clinicians and policy decisions makers should be aware of the impact of low back pain in their emergency settings. In our local setting, we are currently working with clinicians and administrators to disseminate our results and begin discussion.

This research will be used to help inform a number of local research initiatives, which will further our understanding of low back pain in emergency settings. Our ultimate goal must be to enhance care pathways and treatment of patients suffering from low back pain and improve patient outcomes in our local emergency department.

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Appendix One: PubMed search strategy. Left column presents the MESH terms searched. Right column presents the number of studies returned from each search.

emergency medical services[Mesh]	98220
emergency medicine[Mesh]	10124
emergency medicine*[tw]	15880
emergency centre*[tw]	116
emergency clinic*[tw]	480
emergency service*[tw]	49709
emergency department*[tw]	52517
emergency room*[tw]	13229
emergency ward*[tw]	856
emergency unit*[tw]	1581
emergency treatment*[tw]	11753
emergency care*[tw]	5907
emergency patient*[tw]	1231
emergency physician*[tw]	6423
ambulatory care[Mesh]	45710
ambulatory care facilities[Mesh]	44180
ambulatory medicine*[tw]	181
ambulatory centre*[tw]	18
ambulatory clinic*[tw]	611
ambulatory service*[tw]	465
ambulatory department*[tw]	34
ambulatory room*[tw]	2519
ambulatory ward*[tw]	3
ambulatory unit*[tw]	88
ambulatory treatment*[tw]	1431
ambulatory care*[tw]	52285
ambulatory patient*[tw]	3957
ambulatory physician*[tw]	85
outpatients[Mesh]	9291
outpatient medicine*[tw]	55
outpatient centre*[tw]	92
outpatient clinic*[tw]	32540
outpatient service*[tw]	2923
outpatient department*[tw]	4746
outpatient room*[tw]	13
outpatient ward*[tw]	95
outpatient unit*[tw]	659
outpatient treatment*[tw]	4433
outpatient care*[tw]	3342
outpatient physician*[tw]	205
accident medicine*[tw]	33
accident centre* [tw]	15
accident clinic* [tw]	6
accident service*[tw]	90
accident department*[tw]	106
accident room*[tw]	7
accident ward*[tw]	11
accident unit*[tw]	34
accident treatment*[tw]	21
accident care*[tw]	12
accident patient*[tw]	146
accident physician*[tw]	7045
trauma medicine*[tw]	29
trauma centre*[tw]	1375
trauma clinic* [tw]	184
trauma service*[tw]	771
trauma department*[tw]	129
trauma room*[tw]	155
trauma ward*[tw]	63
trauma unit*[tw]	548
trauma treatment*[tw]	212
trauma care*[tw]	2700

trauma patient*[tw]	12384
trauma physician*[tw]	28
triage medicine[tw]	0*
triage centre*[tw]	12
triage clinic*[tw]	35
triage service*[tw]	79
triage department*[tw]	4
triage room*[tw]	12
triage ward*[tw]	233
triage unit*[tw]	33
triage treatment*[tw]	3607
triage care*[tw]	10
triage patient*[tw]	281
triage physician*[tw]	10
urgent care[tw]	1089
urgent care medicine*[tw]	35
urgent care centre*[tw]	25
urgent care clinic*[tw]	120
urgent care service*[tw]	51
urgent care department*[tw]	13
urgent care room*[tw]	1
urgent care unit*[tw]	6
urgent care treatment*[tw]	23
urgent care patient*[tw]	8
urgent care physician*[tw]	8
(OR/1-87)	**291775**
prevalence[Mesh]	197000
incidence[Mesh]	180216
prevalence*[tw]	477728
incidence*[tw]	632904
occurrence*[tw]	260129
commonness*[tw]	182
frequency*[tw]	652873
(OR/89-95)	**1622686**
back pain[Mesh]	29440
low back pain[Mesh]	14613
sciatic neuropathy[Mesh]	5775
dorsalgia[tw]	64
back pain[tw]	43975
backach*[tw]	3398
back ach*[tw]	80
lumbar pain*[tw]	191
coccyx[tw]	1229
coccydynia[tw]	84
sciatica[tw]	5773
spondylosis[tw]	3292
lumbago[tw]	1164
back disorder*[tw]	513
(OR/97-110)	**55738**
(88 AND 96 AND 111)	**263**

Appendix Two: EMBASE search strategy. Describes search terms and final number of studies returned by the final search.

1.	'emergency health service'/exp
2.	'emergency ward'/exp
3.	'emergency treatment'/exp
4.	'emergency care'/exp
5.	'evidence based emergency medicine'/exp
6.	'ambulatory care'/exp
7.	'outpatient'/exp
8.	'outpatient department'/exp
9.	'outpatient care'/exp
10.	urgicenter:ab,ti
11.	emergicenter:ab,ti
12.	((emergenc* OR ambulatory OR outpatient* OR accident* OR urgent* OR trauma*) NEAR/2 (medicine* OR centre* OR center* OR clinic* OR service* OR department* OR room* OR ward* OR unit* OR treatment* OR care* OR patient* OR physician* OR doctor*)):ab,ti
13.	1-7 OR
14.	'prevalence'/exp
15.	'incidence'/exp
16.	prevalence*:ab,ti OR incidence*:ab,ti OR occurrence*:ab,ti OR commonness:ab,ti OR frequency*:ab,ti
17.	9-11 OR
18.	'low back pain'/exp
19.	'backache'/exp
20.	'sciatic neuropathy'/exp
21.	dorsalgia:ab,ti
22.	backache:ab,ti
23.	coccyx:ab,ti
24.	coccydynia:ab,ti
25.	sciatica:ab,ti
26.	spondylosis:ab,ti
27.	lumbago:ab,ti
28.	((back OR lumbar) NEAR/2 pain*):ab,ti
29.	(back NEAR/2 disorder*):ab,ti
30.	13-24 OR
31.	8 AND 12 AND 25 **683**

Appendix Three: Search strategy for our search of the grey literature. Describes websites and the number of titles we searched.

Included Websites from Grey Matters	**Titles Searched**
Health Economics	
Health Agency of Canada (PHAC)	100
Agency for Healthcare Research and Quality National Quality Measured Clearinghouse.	200
Health Statistics	
Canadian Institute for Health Information (CIHI)	100
Health Canada	100
Institute for Clinical Evaluation Sciences	250
Institute of Health Economics	2
PHAC Reports and Publications and Surveillance	100
Stats Canada	-
CDC National Center for Health Statistics	250
WHO	100

Appendix Four: Risk of bias tool developed by Hoy et al., 2012 [3]. We used this tool to explore the risk of bias of studies included in our systematic review.

External Validity
1.Was the sampling frame a true or close representation of the target population?
2. Was some form of random selection used to select the sample, OR was a census undertaken?
3. Was the likelihood of nonresponse bias minimal?
Internal Validity
4. Were data collected directly from the subjects (as opposed to a proxy)?
5. Was an acceptable case definition used in the study?
6. Was the study instrument that measured the parameter of interest shown to have validity and reliability?
7. Was the same mode of data collection used for all subjects?
8. Was the length of the shortest prevalence period for the parameter of interest appropriate?
9. Were the numerator(s) and denominator(s) for the parameter of interest appropriate?
10. Summary item on the overall risk of study bias (?).

Appendix Five: GRADE concepts developed by Guyatt et al., 2011 [59]. The GRADE components were adapted to assess the overall quality of the available evidence on the prevalence of low back pain in the emergency setting.

Evidence about Prevalence
Study Limitations: Serious limitations when most evidence is from studies with moderate or unclear risk of bias for most bias domains. Very Serious limitations when most evidence is from studies with high risk of bias for almost all bias domains.
Inconsistency: Unexplained heterogeneity or variability in results across studies with differences of results not clinically meaningful. For narrative summary: variations in prevalence estimates across studies.
Indirectness: The study sample, and the outcome or prevalence estimate in the primary studies do not accurately reflect the review question. Generalizability of the study population (is the study population a subset of the population of interest?).
Imprecision: For narrative summary: within-study imprecision: sample size justification is not provided for prevalence estimates. Across study imprecision: there are few studies and small number of participants across studies.
Publication Bias: Published evidence is restricted to only a portion of the studies conducted on the topic.

Appendix Six: Data extraction form for (manuscript one). In our systematic review, we extracted the following data from included studies to describe study and patient characteristics.

Study Title
Primary Author
Publication Year
Country /Region
Study Objectives
Study Design
Data Source *(Description)*
Data Source *(Category)*
Study Duration (Timeline)
Setting Service *(Description)*
Setting Service *(Category) (*Admin data, Survey Data, Patient Charts, Other)
Setting Health Care System *(Description)*
Setting Health Care System *(Category) (EMS, ED, Hospital, EMS and ED, EMS and Hospital, ED and Hospital, EMS and ED and Hospital, Community ED Centre.*
Population *(Description)*
Population *(Category) (Metropolitan, Rural, Both, Other)*
Case Definition (Overall, Anatomy, Duration, Signs/Symptoms, Activity Limits, Anything Non-Medical)
Inclusion Criteria
Exclusion Criteria
Age (Range)
Age (Mean)
Sex
Workers Compensation
Week Days Presenting
Classification of LBP *(Description)*
Classification of LBP *(Category) (Non-specific, Muscular, Non-Muscular, All Back Pain, Other)*
LBP Coding System *(Descriptive)*
LBP Coding System *(Category) (EDIS Triage Coding, ICD-9, ICD-10, Clinical classification software, Canadian Emergency Department Diagnosis Shortlist, Other)*
Assignment of LBP Code *(Descriptive)*
Assignment of LBP Code *(Category) (Paramedic, Triage Nurse, Nurse, Physician, Other)*
LBP Code Limits (Codes Used to Define Back Pain)
Stratification / Standardization *(Descriptive)*
Stratification *(Category) (Age, Sex, Location, Income, Workers Compensation, None, Other)*
Sample Size
Prevalence (%)
Authors Conclusions / Outcome
Limitations: data entered by the people, Muscular and non-muscular

Appendix Seven: CTAS coding list (manuscript two). Describes how patients are classified based on the severity of their etiology upon arrival at our local ED.

Triage Level	Acuity Level	Time to Physician	Usual Presentation	Sentinel Diagnoses
I	Resuscitation	Immediate	• Code arrest • Major shock • Shock states • Near-fatal asthma • Severe respiratory distress • Altered mental state (unconscious or delirious)	• Traumatic shock • Pneumothorax (traumatic or tension) • Facial burns with airway compromise Severe burns > 30% body surface area • Overdose with hypotension or unconsciousness AMI with complications (CHF or hypotension) • Status asthmaticus • Head injury (major or unconscious) Status epilepticus
II	Emergent	≤ 15 min	• Head injury (risk features with or without altered mental state) • Severe trauma • Altered mental state (lethargic, drowsy, agitated) • Signs of serious infection (purpuric rash, toxic) Allergic reaction (severe) • Chemical exposure (eyes) • Nontraumatic, visceral chest pain (with or without associated symptoms) • Vomiting or diarrhea, suspicion of dehydration • Overdose (but conscious) or drug withdrawal • Abdominal pain (age > 50 yr) with visceral symptoms • Sexual assault • GI bleeding with abnormal vital signs • CVA with major deficit • Severe asthma (peak expiratory flow rate <40%) Moderate or severe dyspnea • Acute vaginal bleeding (pain scale > 5 with or without abnormal vital signs) • Neonate (age <7 days) • Fever (age <3 mo), with rectal temp > 38.0□C • Acute psychotic episode or extreme agitation • Diabetic hypoglycemia or hyperglycemia • Headache, with pain scale 8–10/10 • Chemotherapy or immunocompromise • **Pain scale 8–10/10 (abdominal, costovertebral angle, back, eye)***	• Head injury • Trauma involving multiple sites • Multiple rib fractures • Neck or spinal cord injury • Anaphylaxis • Alkaline or caustic ocular burns • AMI, unstable angina or CHF • Chest pain NOS • Gastroesophageal reflux • Unspecified drug or medicinal overdose • Abdominal aortic aneurysm Appendicitis, cholecystitis • GI bleeding with hypotension • CVA • Severe asthma or COPD • Croup • Spontaneous abortion • Ectopic pregnancy or rupture Epiglottitis, meningitis, sepsis • Acute psychotic episode, agitation or DTs • Diabetic ketoacidosis • Hypoglycemia, hyperglycemia or migraine Renal colic Keratitis
III	Urgent	≤ 30 min	• Head injury: alert with vomiting • Moderate trauma • Abuse, neglect or assault • Signs of infection • Mild or moderate asthma (peak expiratory flow rate >40%) • Mild or moderate dyspnea • Cheat pain with no visceral symptoms (sharp or MSK, no previous heart disease) • GI bleeding with normal vital signs • Acute vaginal bleeding with normal vital signs • Seizure (alert on arrival) • Acute psychosis with or without suicidal ideation • Pain scale 8–10/10 with minor injuries • **Pain scale 4–7/10 with headache, costovertebral angle or back pain*** • Vomiting and diarrhea (age < 2 yr) without dehydration • Dialysis problems	• Head injury • Anterior shoulder dislocation • Tibia or fibula fracture • Bimalleolar or trimalleolar ankle fracture • Pyelonephritis or sepsis • Asthma without status or COPD Bronchiolitis or croup • Pneumonia Unspecified chest pain NOS (MSK, GI, respiratory) • Uncomplicated GI bleeding • Spontaneous abortion • Seizure Acute psychosis with or without suicidal ideation Low back pain, strain (disk) Migraine
IV	Less Urgent	≤ 1 h	• Head injury: alert with no vomiting • Minor Trauma • Acute abdominal pain • Vomiting and diarrhea (age > 2yr) without Dehydration • Headache: not migraine, not sudden • Earache • Chest pain, minor trauma or MSK injury: no distress • Suicidal ideation or depression • Corneal foreign body • Minor allergic reaction • **Chronic back pain*** • URI symptoms • Pain scale 4-7/10	-Head injury: alert with no vomiting -Colles' fracture -Ankle sprain -Appendicitis -Cholecystitis -URI -Otitis media or otitis externa -Chest pain NOS (MSK, GI, Respiratory) -Gastroesophageal reflux -Suicidal ideation or depression -Urticaria -Corneal foreign body **-Low back pain or strain***
V	Non-Urgent	≤ 2 h	• Minor trauma: not necessarily acute • Sore throat without respiratory symptoms • Diarrhea alone, without dehydration • Vomiting alone, with normal mental status and no dehydration • Menses • Minor symptoms • Chronic abdominal pain • Psychiatric complaints • Pain scale < 4/10	• **Low back pain or strain*** • URI • Gastroenteritis • Vomiting • Disorders of menstruation • Dressing changes or cast changes • Constipation • Neurotic, personality and nonpsychotic mental disorders • superficial laceration(s)

Appendix Eight: Data dictionary (manuscript two). In our primary study, we collected the following information to describe the patient and health system characteristics from the EDIS database.

Variable	Measurement	Source
Age	Measured in years. (Presented as mean age and age ranges (16-25, 26-35, 36-45, 46-55, 56-65, 66-75, 76+)).	EDIS
Sex	Measured as a nominal variable, where 0=female, 1=male.	EDIS
Responsibility for Payment	Measured as a categorical variable, where 1=OHIP, 2=WCB/WCB Hospital Staff, 3=Other Province, 4=Non-resident of Canada, 5=DVA/Federal Government/DIA/RCMP, 6=Uninsured Resident/Unknown	EDIS
Primary Care Provider	Present/Absent: Measured as a dichotomous variable, where 0=Does NOT have a Primary Care Provider, 1=Does have a Primary Care Provider	EDIS
Referral Source	Yes/No: Measured as a dichotomous variable, where 0=NOT Referred to ED by Physician or Health Professional, 1=Referred to ED by Physician or Health Professional.	EDIS
Method of Arrival (MOA)	Measured as a nominal variable, where 0= Independently, 1= Ambulance, 2= Helicopter.	EDIS
Time of presentation	Date, hour and minute of a patient's arrival. We will analyze as a nominal variable in two ways. The first 0= not presenting during work hours and 1= presenting during work hours (8 AM to 5PM). The second 0= presenting on a weekend and 1= presenting on a weekday.	EDIS
Chief Complaint / Reason for visit	EDIS presenting complaint list (# 551 Back Pain, #552 Traumatic Back/ Spine Injury).	EDIS
CTAS Score	Measured on a CTAS 5-point scale of severity: Resuscitation, Emergent, Urgent, Less Urgent, Non-Urgent.	EDIS
Type of ED Visit	Measured as a categorical variable, where 1=Emergency Presentation, 2=Direct to Consult, 3=Return Visit-PLANNED, 4=Return Visit-UNPLANNED, 5=811 Referral, 6=Trauma Team, 7=Referral from GP/Clinic	EDIS
Presenting Level of Pain (Pain Scale)	Measured as a categorical variable, where 0=No Pain, 1=Mild Pain, 2=Moderate Pain, 3=Severe Pain. To describe the pain intensity of patients presenting to the ED with LBP. Consistent with the NRS-11 scale (Numeric Rating Scale), where 0=No pain, 1-3=Mild Pain, 4-6=Moderate Pain, and 7-10=Severe Pain	EDIS
ED Diagnosis (Main Problem)	ICD-9/ 10 Codes	EDIS
Leave against medical advice (AMA)	Measured as a nominal variable, where 0= Patients left without being seen by a physician, 1= Patients were seen by a physician.	EDIS
Departure Time (Disposition Time)	Hour and minute of a patient's disposition time.	EDIS
Admission	Measured as a nominal variable, where 0= Patient is sent home from the ED and 1= Patient is admitted into the hospital.	EDIS
Length of Stay (LOS)	Measured in (Hours / Minutes) from triage coding to diagnosis coding.	EDIS