Standardization of Predictive Factors for Chronic Low Back Pain: A Pilot Study

by

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ABSTRACT

Chronic low back pain (CLBP) is a challenging problem in Nova Scotia and is a leading cause of disability and a contributor to high health related costs to the system.

The primary objective of this thesis is to develop and test a methodology for the creation of an electronic standardized assessment tool for chronic conditions such as CLBP using a triangulation method. The methodology involves evidence-based, expert and explicit clinical knowledge in the development of the tool.

The outcome of this research is the development of a methodology model for the generation of electronic standardized assessment form for CLBP with 30 predictive factors. Experts evaluated the form for its use and usefulness, usability, and standardized terminologies. Intra-Class Correlation (ICC) and Cronbach's alpha were used to measure inter-rater reliabilities among experts. The results were in the fair and moderate levels of agreement due to the limitation in sample size and the variation of disciplines among participants.

List of Abbreviations Used

BIA	Business Impact Analysis
BPAQ	Baeck Physical Activity Questionnarie
CCM	Chronic Care Model
CLBP	Chronic Low Bak Pain
FABQ	Fear Avoidance Beliefs Questionnaire
ICC	Intra-class Correlation
ICD	International Classification of Diseases
iEHR	interoperable Electronic Health Record
LBP	Low Back Pain
MeSH	Medical Subject Headings
MMICS	Multinational Musculoskeletal Inception Cohort Study
MRMQ	Modified Roland-Morris Disability Questionnaire
OMPSQ	Orebro Musculoskeletal Pain Screening Questionnaire
PCPs	Primary Care Providers
PCS	Pain Catastropising Scale
PMU	Pain Management Unit
RMDQ	Roland and Morris Disability Questionnaire
SBT	STarT Back Tool
TSK	Tempa Scale of Kinesiophobia
SNOMED CT	Systematized Nomenclature of Medicine - Clinical Terms
WHO	World Health Organization

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Chapter 1 Introduction

Globally, chronic pain is the most costly and prevalent condition for which treatment is sought. Persistent pain that lasts more than three months is considered to be chronic. According to Fishman et. al. [1], the estimation of the cost of treating chronic pain among the U.S population is higher than the cost of all other chronic conditions including conditions such as heart disease, cancer, and hypertension. The high cost of treatment for chronic pain is possibly due to its complexity of being a biopsychosocial disorder. It could also be due to lack of timely and effective treatment strategies [1, 2].

Evidence shows that costs due to disability and prevalence of chronic low back pain (CLBP) are rising [1]. Even though, it occurs in only 2-7% of low back patients, it is a highly expensive and debilitating condition [3]. It is difficult for physicians to assess and manage CLBP because it is a heterogeneous conditions that need to be categorized into clinically relevant treatmetnt group [4]. Currently there are no standardized assessment tool that include comprehensive predictive factors to identify those individuals at risk of developing CLBP [5]. This thesis work focused on developing an electronic standardized assessment form for CLBP through the application of a triangulation methodology to retrieve the relevant predictive factors across heterogeneous sources (literature, chronic pain database, patient charts, and experts' opinions). Expert opinions were generated through review of the predictive factors at key phases of research, and evaluation through feedback questionnaires that asked questions about the use and usefulness, usability, and acceptability for individuals with CLBP.

1.1 Problem Statement

In this thesis, the main problem identified is the lack of predictive factors that can identify low back pain (LBP) patients who are at risk of developing CLBP. Being able to identify patients at risk of developing CLBP can help in early management and traeatment, and improve the quality of health care provided along with a reduction in the associated healthcare costs [6].

1.2 Research Objectives

The primary objective of this research is to use a triangulation methodology to develop an electronic standardized assessment form that includes the relevant set of predictive factors for CLBP. The predictive factors in the assessment form are derived from heterogeneous sources of knowledge such as reference data set from evidence-based literature, a chronic pain database, patient charts, and expert feedback.

1.3 Research Questions

Towards this research objective, the following research questions are addressed

1- Can we triangulate from heterogeneous sources a relevant set of predictive factors for CLBP?

2- Can we represent the set of predictive factors for CLBP using a standardized assessment form ?

1.4 Key Considerations for this Research

1.4.1Challenges in Timely and Accurate Referrals for CLBP and their Implications for Healthcare

Most LBP problems can be assessed and managed in primary care clinics by family physicians and other healthcare providers [7, 8] who encourage patients to resume their normal activity and avoid bed rest, and educate them about posture and lifting strategies [9]. In addition, they give them information about different therapies such as physical therapy, manipulation therapy, and exercise programmes [10]. Although most of these cases can be treated and followed in the primary care unit, specialist referrals are necessary some times in order to get access to certain services and prevent the transition from acute LBP to CLBP. A specialist has more experience that can be beneficial for patients' management and care plans. Moreover, they can decide the requirements for surgical or advanced interventions for treating patients [11]. As noted in the National Institute for Clinical Excellence's referral guide, the need for critical and urgent referrals of patients' with LBP to specialist depends on certain signs and symptoms [12].

In addition to professional knowledge and attitudinal skills, communication skill is an important competent referral. Each referral letter must contain specific information about the patient in order to get the maximum benefits from it and save time. Incomplete patient information in the referral letters can delay the referring process which leads to delay in patient assessment and treatment. Therefore, having certain guidelines to follow in the referral process is essential, with consideration being given to making these guidelines easy to access and follow [13].

The best way to have an easy access to such information and to ensure complete patient data is through electronic referral forms for each department or specialist; these forms

have to be user-friendly, and integrated with other healthcare systems that include patients' and doctors' data. According to Fernando et. al. [14], there are many benefits behind electronic referrals especially in the department of Orthopedics. The e-referral system proved to be cost effective, reducing the waiting times for patients by reducing the congestion at specialized centers, and it provided the specific patient care for those who required it the most in a short period of time [14].

1.4.2 Standardization and its Implications in Healthcare and Management of Complex Conditions

A number of experts, consultants, and organizations point out that following certain rules and procedures is both essential and beneficial. These rules are considered standards that can help organizations in the process of organizing, managing, choosing policies, and designing certain products and services. This standardization will facilitate coordination and cooperation among organizations and workers around the world [15].

In this research study, explaining the managing of standardization in three parts is helpful. The first part outlines the standardization of clinical practice, followed by the standardization of documentation, then standardization of vocabulary.

One important aspect of standardization is the process of developing or creating clinical practice guidelines. There are acknowledged and desirable attributes for clinical practice guidelines; these attributes include: validity, reliability and reproducibility, clinical applicability, clinical flexibility, clarity, documentation, development by a multidisciplinary process, and plans for review [16, 17]. In 2002, the Conference on Guidelines Standardization (COGS) convened to address the absence of these attributes from published guidelines. As a result of COGS, a checklist was created which helped in the evaluation of the validity and usability of the guidelines [16].

Patients' medical records are an essential source of data about a patient's health and disease. They provide evidence of treatment which demonstrates the accountability of health care providers. These records can be retrieved if needed for legal issues in a court. Also, it is a valuable source of information for researchers as it can assist in research regarding quality improvement through the evaluation of practice. Another important aspect of these medical records is as a basic communication method between healthcare professionals; it also has an impact on funding and resource allocation [18, 19].

Standardization has a partial, though significant, role in providing complete, clear, concise, correct, and confidential documentation, as indicated by Ungan [20], in his research study on a step-by-step framework for documenting a process. The framework development required knowledge management, an essential step in transferring tacit knowledge into explicit knowledge. It also deals with semantic interoperability when codifying and verifying knowledge, and also with metadata schema when combining and placing the knowledge in a standardized form [20, 19].

Standardization in medical terminology is vital to ensure clear communication between health care professionals, which is essential in order to provide the best quality of care to patients. The lack of standardization in medical terminology might lead to miscommunication, and improper interpretation of data [21]. Semantic interoperability can only be achieved when there is standardization in medical terminology.

1.4.3 Developing Standardized Process for Complex and Chronic Conditions such as CLBP

Complex and chronic conditions affect people's lives dramatically and maybe considered to be a significant life changing process. The early understanding of chronic conditions is

essential to help with the prevention, acceptance, management, and adaptation process; this requires collaboration within a multidisciplinary team of healthcare professionals.

According to a research study done by Carmel Martin and Joachim Stumerg [22], the Chronic Care model (CCM), initially developed by Wagner, was proposed as a conceptual framework to help with the idea of system redesigning. This model is intended to assist policy makers, healthcare providers, and health care users in a way that explains and tries to prevent chronicity. As a result of this study, the implementation of chronic disease registries and protocol-based chronic disease management has been proven to have an impact on the primary care delivery process. It shows improvement in patient self–management and some cost effectiveness [22].

1.5 Overview of Solutions

In order to address these questions, this research aims to apply a triangulation methodology to develop an electronic standardized assessment form that includes a relevant set of CLBP predictive factors. This assessment form can be used by a primary care provider (PCP) in the assessment of LBP patients in initial phases of treatment to enable early detection, timely referral to specialist for accurate and appropriate early treatment strategies. It can also be helpful in assisting the PCP generating relevant care plans and risk management strategies.

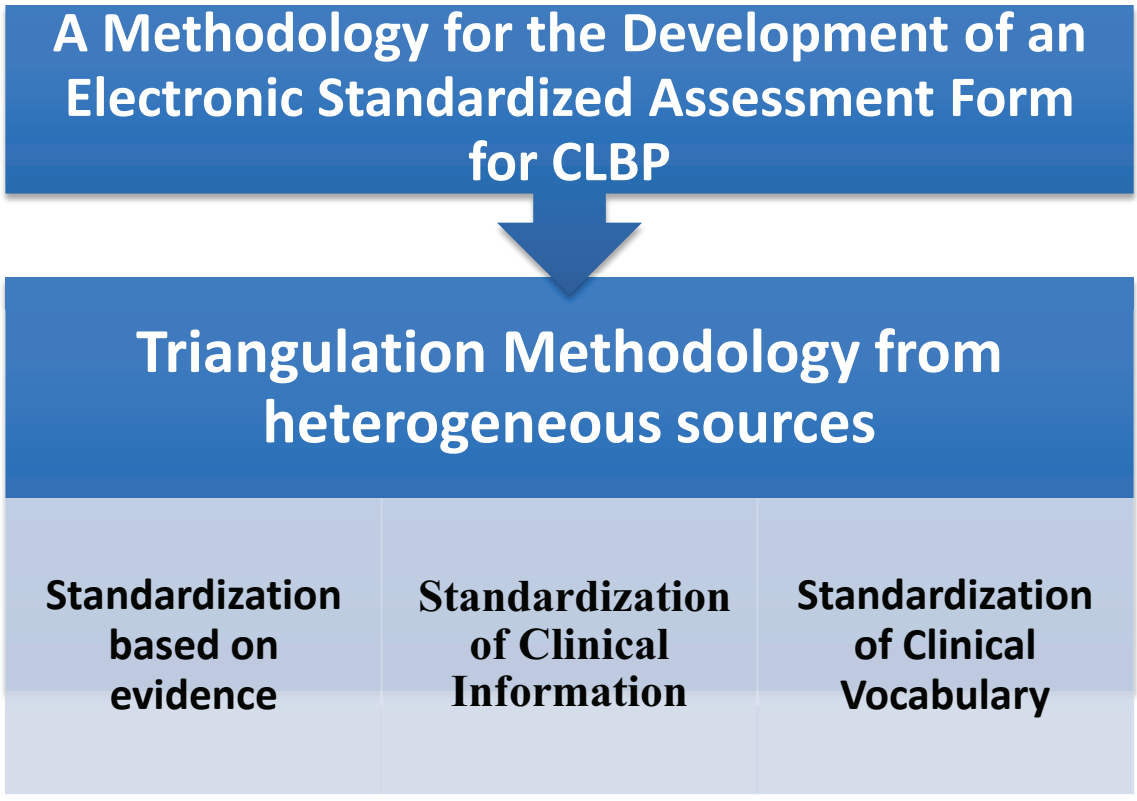

Figure 1: Methodology Used in this Research

The triangulation methodology involved the retrieval of relevant knowledge from heterogeneous sources to assist with the development of the standardized assessment form [23]. (See Figure1). In the first phase of the research, a reference set of predictive factors that included all the relevant factors for CLBP were selected following a review of literature. Predictive factors were retrieved from patient charts using a retrospective chart audit process and from a chronic pain database. Predictive factors generated from clinical knowledge were compared against the reference data set and reviewed by experts for relevance and usefulness for use in standardized assessment form. The standardized assessment form was generated using this comprehensive and validated set of predictive factors. The predictive factors in the standardized assessment form were then standardized for clinical vocabulary using a widely recognized reference terminology

SNOMED CT. The standardized vocabulary was also reviewed and evaluated for completeness and accuracy by experts.

1.6 Contribution of the Dissertation

The lack of standardized assessment tools that can help health care providers in the process of assessing and managing CLBP patients has a huge impact on the development of this thesis research.The study aims to develop and evaluate an electronic standardized assessment form for CLBP in order to assess LBP patients and provide early detection for the transition from acute to chronic stage of LBP.

The assessment form created includes predictive factors that were collected from heterogeneous sources and were evaluated by multidisciplinary medical experts.

Regarding future expectations, this pilot study may be completed and extended to measure the effectiveness of the form on a larger sample size or even on clinical trial sample. However, it might also be helpful in education as an educational tool for physicians or it might be implemented as a part of a CLBP assessment policy that can help primary care physicians in the decision making process regarding referring patients to specialists

The key contributions of this dissertation can be summarized as follows:

1- Development and validation of a methodology for the creation of an electronic standardized assessment form for CLBP.
2- Standardization of clinical vocabulary in the electronic assessment form using SNOMED CT.
3- Involvement of experts in key phases of development and validation of the standardized assessment form for CLBP.

1.7 Thesis Organization

The thesis is organized as follows:

- Chapter 2 presents an overview of the challenges and problems in the management of CLBP.
- Chapter 3 presents the background information of relevance to this thesis. It also contains a detailed description of standardization of clinical practice, clinical documentation, and standardization of vocabularies.
- Chapter 4 presents a comprehensive literature review conducted to support the methodology developed in this thesis research. Begining with a discussion of the strategic search consideration and the inclusion / exclusion criteria for selecting a reference dataset from different research studies. Followed by the use of predictive factors for CLBP and comparison between different back pain clinical assessment tools. Finally, this chapter identify gaps in the literature in the areas of relevance to this research.
- Chapter 5 outlines the triangulation methodology used in the development of the electronic standardized assessment form for CLBP.
- Chapter 6 presents the results of the research in the domain of mapping data from clinical information with data from evidence. It also present the results from medical experts' opinions regarding selection of predictive factors, feedback of the electronic standardized assessment form for its use and usability, and also for the use of SNOMED CT in standardizing vocabularies in the form.
- Finally, in chapter 7 discussion, limitations, future directions for research and conclusions were represented.

Chapter 2 Challenges and Problems Definition

Chapter 2 discusses the challenges and problems addressed by this thesis, namely the challenges and problems of CLBP assessment and management. The chapter begins with a definition of key terms and concepts of relevance to this research work. This followed by the challenges and problems of assessing and managing CLBP. The final section describes the definition of this thesis problem.

2.1 Terminology as Defined in this Thesis

Primary Care Provider (PCP) is a physician chosen by or assigned to a patient, who both provides primary care and acts as a gatekeeper to control access to other medical services [24].

Predictive Factors refers to a clinical or biologic characteristic that provides information on the likely benefit from treatment [25].

Heterogeneous is different in kind, composed of parts of different kinds, and having widely dissimilar elements or constituents [26]

Interoperability is the ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces, and to use the services so exchanged to enable them to operate effectively together [27].

2.2 Challenges and Problems in the Assessment and Management of CLBP

The assessment and management of CLBP contains many challenges that include limitation in the use of predictive factors that identify patients at risk, and limitation of access to assessment tools that can provide timely and relevant referrals. There is also a

lack of standardized and consistent capture of relevant clinical data, and communication gaps between PCPs and specialists.

All of these problems lead to inappropriate referrals, increased wait times, poor patient care experiences, and high healthcare costs (See Figure 2). These challenges and problems are noted in different literature reviews. It is important to overcome these challenges and problems in order to impove the quality of healthcare.

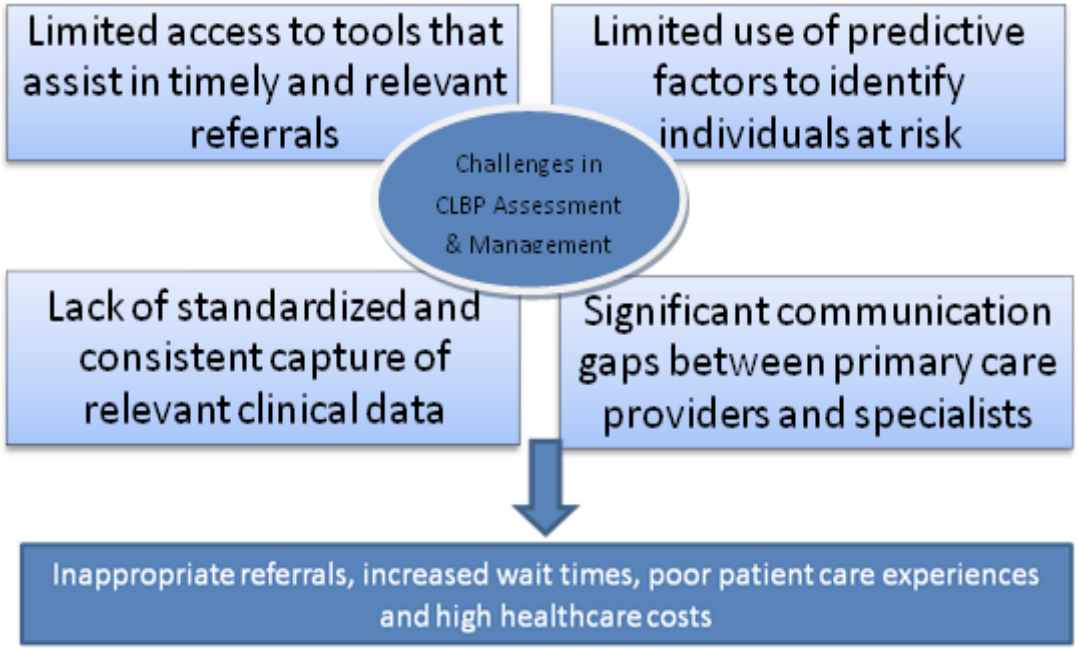

Figure 2: Problems and Challenges in CLBP Assessment and Management

2.2.1 Limited Use of Predictive Factors to Identify Individuals at Risk

Predictive factors are helpful in early identification of patients at risk of developing CLBP; this early identification leads to early management and decision making regarding care plans.

According to Pincus et. al. [6], one approach for preventing the transition from acute to chronic LBP is to identify patients at risk of developing CLBP [6]. Several predictive factors associated with the development of CLBP were found in literature reviews about

LBP in primary care. These predictive factors are from diverse categories (clinical, psychosocial, financial, demographic, and work related) [28, 29, 30, 31, 32].

Predictive factors for CLBP can help in identifying the need for patients' referrals to either a pain specialist or a surgeon in a timely manner. Knowing to whom exactly the patient need to be referred, supports the multidisciplinary treatment plan for the patient. Even if the patients does not require referrals to a specialist, prediction of CLBP can help PCP in creating a suitable management plan for care, and support the communication and collaboration among multidisciplinary care team (e.g. physiotherapists, psychologist, healthcare educator) [33]. Early identification of CLBP by PCP can help in the appropriate decision making regarding a care plan for the patient. Knowing the exact treatment and management plan for patients may strengthen the patient-physician relationship, which is significant for the treatment adherence. It has been proven that there is a significant association between patient-physician relationship and outcomes. Some of the patient-physician aspects (e.g. satisfaction of care, trust, and patient participation) have a significant association with outcomes (e.g. pain, disability, quality of life, and pain-related psychological impairment) [34].

Although, there are many predictive factors for CLBP that have been proven to help in assessing and managing patients with LBP, the use of these predictive factors is still limited due to the unavailability of a standardized assessment tool containing predictive factors for CLBP that can be used by PCPs [35, 10, 6].

2.2.2 Limited Access to Tools that Assist in Timely and Relevant Referrals

Clinical practice guidelines are developed in order to assist practitioners in the decision making process during the preparation of patients' care plans for specific clinical circumstances [36].

Clinical guidelines for assessment and management of LBP are available for PCPs and have proven to be effective for improving the quality of healthcare. Following these guidelines can improve the efficiency of patient care by assisting PCPs in timely referrals to specialists (either pain specialists or surgeons) [9, 37].

According to Chou et. al. [38], there are specific guidelines for PCPs that can help them in the assessment and management of CLBP. These guidelines contains number of recommendations that indicate when to advise patietns about self-care, discuss noninvasive treatments options, or consulting and referring to specialist.This guideline paper followed the American Colleger of Physicians (ACP) and the American Pain Society (APS). Mainly, it assist PCPs in the decision making process regarding management and treatment of CLBP patients [38].

Although, these guidelines are important and helpful for PCPs, there are some barriers that limit or restrict complete physician adherence to practice and use guidelines. Some of these barriers are: lack of awareness or familiarity, lack of agreement, lack of confidence in the use of these guidelines, limited availability of time at the point of care, and lack of outcomes expectancy. These barriers affect physicians' knowledge, attitudes, and behaviour [36]. The existence of such barriers indicates limitation in using clinical guidelines that assist in timely and relevant referrals to a specialist.

2.2.3 Lack of Standardized and Consistent Capture of Relevant Clinical Data

There is lack of standardized procedures followed by clinicians in capturing clinical data. This may be due to the complexity of medical care and limited human performance. These shortcomings can lead to increased medical errors, miscommunication with other healthcare providers, and a reduction in the quality of healthcare [39, 40]. The

development of a standardized tool to capture clinical data is important in assisting PCPs in the assessment and management of CLBP [39].

According to Safran et. al. [41], the use of an electronic patient record is a standardized method of capturing clinical data. It is also a helpful tool in improving communication among healthcare providers. This research study also notes that using the electronic methods may overload users with unwanted or unnecessary communications and it consider this as a negative point [41]. The need for healthcare communication standards (HCS) to ensure accurate, concise, complete, clear, and useful patient information is crucial, especially in the use of electronic medical records [42]. Although, electronic medical records are important and beneficial in improving the quality of healthcare, they are still not used everywhere due to the need for interoperability and integration with other systems.

2.2.4 Significant Communication Gaps between PCPs and Specialists

There are numerous literature reviews about collaboration and communication in healthcare settings, explaining its importance and its challenges in a heterogeneous environment that contains a variety of healthcare providers [43, 44]. Collaboration and communication among healthcare providers is essential for improving the quality of healthcare provided to patients. It also plays an important role in patient safety because it reduces the medical errors that can happen due to miscommunication among members of the healthcare team [39].

One of the important communication tools that can reduce the significant communication gaps between PCPs and specialists are referral letters. Successful referrals ensure that the right person is doing the right thing at the right time for the right patient. The PCP and specialist need to communicate clearly and trust each other in order to determine the best

care plan given to their patients. These referral letters are supposed to be effective and standardized by being based on clear information regarding roles and boundaries of each healthcare professional [45].

According to Yeuen et.al. [46], the use of electronic referrals letters among PCPs can improve communication and collaboration with specialists with regard to patient safety. This will lead to improvement of the overall clinical care. In this research study, PCPs were surveyed to assess the impact of electronic referrals on work flow and clinical care. These PCPs, indicated that electronic referrals do improve healthcare access and quality; while its impact on workflow should be considered [46].

However, there is still lack of standardized referral letters that contain complete and effective information; such standardization can improve the communication gaps among healthcare providers [47].

According to Stille et al, [48] there are some barriers that prevent proper collaboration and communication among healthcare specialists in assessing and managing children with chronic conditions. The most important barriers are inefficiency in the telephone contacts, transcription delay, and failure to share patient information with other healthcare providers [48]. Moreover, limited time available for healthcare providers, lack of understanding the role and tasks of other healthcare providers, insufficient support in the organization, and the differences in priorities and values among professionals are considered barriers to appropriate collaboration in the healthcare settings [43, 49].

The lack of professional communication in healthcare settings between inter-professional teams can cause serious sequences for patients. It can lead to medical errors, delay in the patients' care plan, reduce the quality of care which can lead to reduced patient' satisfaction and safety, and increase the mortality rates [40, 50].

For complex and chronic health conditions, the problems associated with lack of collaboration and communication should be solved in order to improve the quality of healthcare and patient outcomes.

Many research studies have indicated the importance of having collaboration among multidisciplinary healthcare providers in the assessment and treatment of CLBP [51, 52]. According to a study by Guzman J. et al, [53] the multidisciplinary team that showed effectiveness in assessing and treating CLBP patients included physical, psychological, and social/occupational teams.

2.3Problem Definition

In this chapter, the need for a standardized assessment form has been identified as a plausible method to improve interoperability among healthcare providers and facilitate timely care for patients with CLBP. This standardized assessment form need to be easily filled by physicians at the point of care in the clinical settings.

In this thesis, a triangulation methodology was applied for the creation of an electronic standardized assessment form for CLBP. This triangulation methodology has three levels of standardizations: standardizations based on evidence, standardization of clinical information, and the standardization of vocabulary. Expert opinion and feedback were obtained at key phases of research to validate the knowledge applied in the standardized assessment form. One of the novelties of the research is the harmonization of knowledge from heterogeneous sources in the standardized assessment form through the application of multiple levels of standardization.

Chapter 3 Background

This chapter presents the background information of relevance to this thesis. The subsequent sections will present a definition of the three categories of low back pain (acute, sub-acute, and chronic low back pain) depending on its duration. After that, background information regarding CLBP is explored. It concludes with a detailed description of standardization at three levels: standardization of clinical practice, standardization of clinical documentation, and standardization of vocabulary.

3.1 Definition of Acute, Sub-acute, and Chronic Low Back Pain

According to Robertson [54], due to the lack of specific pathology that explains the sensation of LBP, the most common assessment in primary care is non-specific LBP- almost 90 % of the time. LBP is divided into three specific naming groups depending on its duration: if the pain persists up to six weeks then it is considered to be acute; if it lasts between six and twelve weeks it is sub acute; and if it exists longer than twelve weeks is termed chronic [54, 55].The description of CLBP usually includes certain pain characteristics such as, deep, aching, burning, or dull pain which of course affects the lower back area or even can radiate to the leg sometimes. There are some functional limitations associated with CLBP that include: moderate pain, discomfort, some fatigue, and difficulty lifting objects. It also has some effects on emotional status and social relationships [56].

Similarly, the National Institute of Neurological Disorders and Stroke defined chronic pain as the pain that continues for more than three months; otherwise it is acute pain [57]. Although each type of pain has been defined, researchers could not identify a specific time for the transition from acute to chronic pain [54].

3.2 CLBP: Prevalence, Impact, and Treatment Strategies in Nova Scotia

3.2.1 CLBP Prevalence in Nova Scotia

A 2004 report by the Nova Scotia Department of Health states that people between the ages of 20 and 44 experience back pain problems more than any other chronic condition [58]. There is an effect of activity level on the prevalence of back pain: 20.9 % of physically inactive Nova Scotians complain about back pain versus 15.8 % of physically active.

3.2.2 Magnitude of problems in terms of disability and associated costs

Direct and indirect financial, workforce and social costs as a consequence of CLBP are a significant burden to individuals, to society and to the healthcare system. Most patients with a new episode of LBP have a favorable prognosis, with 75-90% recovering in terms of pain and disability or returning to work within 3-4 weeks [59, 60]. Patients with continuous LBP for more than three months progress to CLBP and often continue to experience longstanding pain [57].

According to the World Health Organization, almost 37% of back pain problems are due to occupational risk factors, and it has a huge effect on the economy because it is a major cause of absence from work [61]. The estimated cost of managing LBP is $6billion to $ 12 billion annually in Canada [62] .

3.2.3 Treatment Strategies for CLBP

The main goals of treating CLBP are to reduce or eliminate the pain, improve the quality of life, improve the functional capacity, and the ability to regain independence. CLBP is affected by multiple factors (clinical, psychological, social, demographic, and work related issues) which makes it hard to be managed by one person. Therefore, there is a need for a multidisciplinary care team that consists of family physician, surgeon, and

pain specialist. The treatment regimen includes non-pharmacologic and pharmacologic approaches that can be used alone or combined. The non-pharmacological treatment includes complementary and alternative medicine approache such as acupuncture, chiropractic medicine, herbal and dietary supplements, biofeedback cognitive therapy, psychotherapy, and physical therapy [63]. Almost 80 % of CLBP patients are using prescribed medication in addition to the complementary and alternative medicine approaches. The most commonly prescribed medications for CLBP include: non-steroidal anti-inflammatory drugs (NSAIDs), tramadol, skeletal muscle relaxants, and systematic corticosteroids [63].

According to the Institute for Clinical Systems Improvement (ICSI) [64], there are specific algorithms for assessing and managing patients with chronic conditions including CLBP. Their healthcare guideline is designed to assist clinicians in treating their patients and in the decision making regarding referring patients to specialist or for consultation [64].

3.3 Standardization

A number of experts, consultants, and organizations point out that following certain rules and procedures is both essential and beneficial. These rules are considered standards that can help organizations in the process of organizing, managing, choosing policies, and designing products and services. This standardization will facilitate coordination and cooperation between organizations and workers around the world [15]. In this research study three areas of standardization are explored: the first one outlined is the standardization of clinical practice, after that standardization of documentation is explained, and finally standardization of vocabulary.

3.3.1 Standardization of Clinical Practice

Standardization in clinical practice requires following specific clinical guidelines. Standardization has affected the medical care provided to patients, prevented the variations in the outcomes and has had some impact on the measurement of quality of care. Therefore, having standardized clinical practice is essential for healthcare workers.

Clinical guidelines are available to help practitioners in the process of assessment, management, treatment, and referrals either to surgeons or to pain specialists. In order to improve the quality of healthcare provided to patients, clinical guidelines should be followed [16]. There are committees and organizations for each country that provide and prepare the clinical guidelines such as The National Collaborating Centre for Primary Care, American College of Physicians, and American Pain Society [55, 35].

Evidence-based guidelines for back pain have been published in response to the increased economic and social cost of back pain to the National Health Service (NHS) [9, 37]. In the NHS guideline, a specific diagnostic triage is presented for health professional to follow; this triage indicates the different diagnoses for back pain and when to refer to a specialist. There are also some guidelines regarding treatment plans and advice regarding activity and back exercises [37].

Standardization is considered as a powerful process that can affect medical care in both directions; either improvement or deterioration depending on the way it is used [18]. If used properly it can improve the health accessibility and can be cost effective, but if used wrongly it can reduce the creativity and healthcare delivery process [18]. Therefore, standardization was defined as providing the best possible care to patients in the hospital through the best medical knowledge and skills available [18].

Having standardization when performing a certain procedure, according to the best medical knowledge and skills available, is important to prevent variations in the outcomes. According to Ungan [20], different people perform the same work or task differently which causes variation in outputs. Therefore, having standardized methods to follow in doing certain procedures and tasks is essential.

In a study done by Donabedian [65], the quality of medical care can be measured by many approaches, such as measuring the outcomes, examining the process of care itself, and studying the settings and organizational structure where care is provided. When evaluating the quality of medical care, values, and standards are required to be used in assessment when examining the process of care itself [65].

3.3.2 Standardization of Clinical Documentation

At the present time, there are many uses for medical records. It is used as a source of information regarding patients' conditions and evidence of treatment which facilitates holding practitioners accountable in the event of legal procedings. Moreover, they are a valuable source for researchers, where it can help in clinical trials or patients' data retrieval for certain research studies. It is also a basic communication method among healthcare professionals and it can be used in quality improvement through the evaluation of practice. In addition, standardized documentation may have an impact on funding and resource allocation [18, 66].

Standardization has a pivotal role in providing complete, clear, concise, correct, and confidential documentation, as indicated by Ungan [20]. Standardized clinical documents include referral letters that need to contain clear information in order to be effective. These effective referral letters facilitate the communication process between PCPs and specialist and improve the quality of healthcare [45].

A study done by Gulati et. al. [67], stated that most of the referral letters are insufficient due to a lack of some basic information. This may lead to increased waiting time for proper examination and treatment by specialists. Their study assessed the quality of referral letters for patients with back pain from PCPs to a multidisciplinary outpatient clinic in Norway. It is important for the referral letters to include all the essential information that can help in improving patient care by specialists [67].

In a study done by Donabedian [65], standards and values are an essential part in evaluating the quality of medical care; especially when examining the process of care itself. The most important thing is to have the appropriate and complete medical care provided to patients with minimum redundancy of information from history, physical examination, and diagnostic tests. All of these will reduce the cost and improve the quality of healthcare. Therefore, having standards when assessing patients is a necessary condition [65].

A study done by Richard et al [68], proposed the use of standardization in outcome measures for LBP. This study explores the process of choosing standardized outcome measures by proposing a core set of six questions from different domains that concern clinical practice, quality improvement, and that can be used as a component of more formal research; adding another core set of instruments for clinical research. The paper then pointed out the attention some factors that need to be considered when choosing these standardized outcome measures. Moreover, the study concluded that some of the advantages of having a standardized set of outcome measures were the improvement of comparability among clinical studies, the facilitation of meta-analysis and cost-effectiveness analysis and the encouragement of complete reports of outcomes [68].

3.3.3 Standardization of vocabularies

Standardization of medical terminology is important to ensure clear communication among healthcare professionals, which is essential in providing the best quality of care to patients. The lack of standardization in medical terminology might lead to miscommunication, and improper interpretation of data [21].

Healthcare computing systems have been useful and practical with the expansion of health care around the world. The use of these systems is very important to provide direct patient care, to facilitate communication and information sharing among healthcare providers, to provide easier accessibility, and to help in cost saving [69, 70].

It is crucial for healthcare systems to have standardized vocabularies in order to provide an accurate and efficient flow of data; this will facilitate the sharing of information and interoperability among various systems used across the country. In the long run, standardization will improve the quality of health care and make the health care system more efficient [69, 70, 71].

Moreover, a study done by Sunyaev et. al. [72], supports the requirement of IT-standards and standardization especially with the current evolution in technology and healthcare. It is extremely important in exchanging medical information, communicating among different systems, reduction of errors and making healthcare services safer, and it allows for the needed interoperability of systems and data needed [72].

Standardized vocabularies are vital in directing the patients' information and matching it with the appropriate knowledge; this is helpful for retrieving basic information such as, demographics, references, and educational material, also for assisting experts in decision making [69].

The recognition of the necessity of standardizing medical vocabulary has led, during the past forty years, to global efforts in this area. According to World Health Organization [73], the standard medical vocabulary and diagnostic tool for epidemiology, health management, and clinical purposes used is International Classification of Diseases (ICD). It is considered as the main coding system used to classify diseases and health problems. It is also used for recoding mortality and morbidity statistics by WHO member states. The use of ICD-10 was begun in 1994 by WHO member states after their endorsing it in 1990 [73]. Another medical vocabulary coding system that is mainly used for the purpose of medical literature is MeSH (Medical Subject Headings), which was developed by the National Library of Medicine. This coding system covers many subjects such as anatomy, diseases, procedures, and chemicals. The Systematized Nomenclature of Medicine (SNOMED) was released over 40 years ago and aimed to cover and code all the electronic medical record contents [70].

According to Business Impact Analysis Report (BIA) for Alberta Health and Wellness report [71], the Systematized Nomenclature of Medicine - Clinical Terms (SNOMED CT) was selected by Canada Health Infoway Electronic Health Record Steering Committee. The SNOMED CT was selected as the Canadian standard for the reference terminology of the pan-Canadian interoperable Electronic Health Record (iEHR) [71].

The benefits behind having standardized clinical vocabularies were explained in this BIA report, specifically for Alberta health care system. Although there were other vocabularies that were considered in this BIA report the only one that was comprehensive to support all health care setting was SNOMED CT. Therefore, it was considered as the core standardized clinical vocabulary for the Alberta health care system [71].

Another study done by Sampalli, Shepherd, and Duffy [74], standardized the clinical terms by using SNOMED CT as a reference terminology. In this study, SNOMED CT browser was used to manually search for "identical matches" of clinical terms in order to standardize it. If "identical matches" for the clinical terms were not found "Synonyms" were searched for; there is also identification of "no match" terms if not found. Multidisciplinary experts' opinions were gathered regarding the standardization of clinical terms with SNOMED CT. As a result of this study, 82% of the clinical terms were standardized using SNOMED CT [74].

SNOMED CT can be used to compose a term. When a concept can be represented with a single SNOMED CT identifier, it is pre-coordinated; when multiple SNOMED CT identifiers are needed to represent a concept, it is post-coordinated. For example, "computed tomography guidance for needle biopsy" is represented with a pre-coordinated term, as it is represented by a single SNOMED CT ID, which is 14211004 [75, 76]. A study by De Silva, MacDonald, Paterson et.al. [76], investigated sensitivity, specificity, positive and negative predictive values of SNOMED CT for representing a set of computed tomography dictionaries from multiple hospitals in Newfoundland and Labrador. For their study, SNOMED CT had a sensitivity of 56% for pre-coordinated, and a sensitivity of 98% for post-coordinated, so was considered to offer valid coverage of the computed tomography domain [76].

In conclusion, this chapter discussed the differences between acute, sub-acute and chronic low back pain. Furthermore, the prevalence, impact and treatment strategies for CLBP were reviewed. In addition, the importance of standardization along many levels of relevance and their benefits in improving care were discussed.

Chapter 4 Literature Review

This chapter presents a detailed literature review conducted to support the methodology developed in this thesis work. The chapter begins with a discussion of the strategic search consideration and the inclusion/exclusion criteria for selecting the evidence reference set for this research. This is followed by a description of the use of predictive factors in the management of chronic problems such as CLBP. There are also research studies that compare various back pain clinical tools used for assessing and managing CLBP. Finally, the chapter summarizes gaps in literature that support this research study.

4.1 Strategic Search Consideration

According to Williamson et.al. [77], there are many strategic search considerations for choosing and conducting reference studies. One of these strategies is called mini-synthesis and starts with already prepared information syntheses, such as systematic review articles. Such articles provide the best evidence available in literature [77]. The task of producing an information synthesis requires a systematic approach that includes a plan, a database of articles, validation of individual studies, and the preparation and evaluation of the synthesis manuscript [77]. Each study in the database is assigned a relevance code to determine whether or not it will be included in the systematic review.

Another type of information synthesis is a consensus statement, which depends on a panel of leaders following a formal protocol to evaluate the information available [77]. According to Pincus et. al. [6], there was a lack of systematic reviews for many of the factors deemed by the consensus panel to be associated with CLBP [6].

According to the Cochrane Collaboration [78], there is another strategic search consideration that considers the prognosis methodology, targeting four key questions:

1. What is the course of the condition/disease? (Descriptive)

2. What prognostic factors are associated with outcome? (Explanatory)

3. What groups of prognostic factors best predict outcome? (Outcome prediction)

4. What are the interactions between intervention and prognostic factors?

The answers for the first 3 questions was essential for my search strategy for a reference dataset. The course of condition or disease is low back pain, where the prognostic factores are the predictive or risk factors for CLBP under different categories, the predicted outcome is CLBP according to my research. Howeve, the final question wasn't answered because it is out my research scope; this research is only concerned with prediction of the outcomes and did not go furthere to include the intervention. From the answers provided for the first three questions and according to the inclusion/exclusion criteria for my search, the best available studies based on evidence and theory were provided.

4.2 The Inclusion and Exclusion Criteria for Selecting the Reference Set for this Thesis Research

Validity should be considered when chosing a literature as a reference set through identifying the focus of the review. Then information must be collected and synthesised from the relevant studies to draw a conclusion [79]. There are several inclusion criteria for this research that assist in selecting the literature reference set. These inclusion criteria were for the search strategy that aims to retrieve clinically relevant prognostic studies, including studies that have the word "cohort" in the title, abstract or MeSH heading, or the word "prognosis" or "predictor" in the title or abstract was done [80]. The patient population is adults with back pain or low back pain. The course of the condition

is progression from LBP to CLBP. Therefore, the exclusion criteria were studies that were not clinically relevant, studies that were not about chronic low back pain, studies about children and non-English studies.

Answering the relevant prognosis methodology questions, suggestion from the members of the back pain community about convenience sample of literature, and considering the inclusion/exclusion criteria for my search, helped in providing reference set of studies based on evidence and theory.

4.3 Predictive Factors for CLBP

For several years, the efforts to identify high risk patients for developing CLBP have been of research interest [28, 32]. Although only small group of acute low back pain patients will have persistent or recurrent symptoms of LBP that can lead to disability, it is essential to be able to identify these predictive factors. The early prediction of transition from LBP to CLBP can make a huge saving in medical cost and reduce human suffering [32]. It has been proven by research that most of the cost of treating back pain is in this small proportion of people who developed CLBP [28, 81].

Most of CLBP predictive factors research studies focused on only a specific category of factors, such as psychological or psychosocial; it is even more specific some time with only 2 to 3 factors being considered. The research study by Pincus et. al. [6], focused on a comprehensive set of predictive factors identified by a consensus panel. The panel identified the clinical, psychological, financial, life style, social, demographics, and work-related factors associated with transition from LBP to CLBP [6].

A study done by Gatchel et al, [32], focused on the psychosocial characteristics as predictive factors for the development of CLBP in patients with acute low back pain. That study evaluated 421 patients within six weeks of acute back pain onset for one year

after the initial evaluation to document return to work status. The evaluation was done systematically for various standard assessment forms that include demographic and medical history, Million Visual Analog Scale, Assessment of Psychopathology and Personality Disorders, Minnesota Multiphasic Personality Inventory, and One-year Follow-up Assessment. As a result of this study, the psychosocial factors were found to be significant predictor variables for developing CLBP. The general psychiatric syndromes and psychological measures are vital primary or tertiary risk factors. Another factor which has a huge effect on the prediction of CLBP development was gender. As a result of the statistical algorithms, prediction of acute low back pain patients at risk to develop CLBP is detectable and can help in preventing disability [32]. That research focused only on psychosocial predictive factors for CLBP; unlike the aim of this research that includes CLBP predictive factors under various categories.

A prospective study in the primary care done by Thomas et al, [28], concentrated on following 180 LBP patients at 1 week, three months and 12 months after consultation. The results of the study suggest that predictive factors for CLBP are: increased age, history of LBP, and female gender. In addition, pre-morbid factors such as high level of psychological distress, poor self rated health, low level of physical activity, smoking, and dissatisfaction with employment are considered predictive factors for CLBP. Other factors related to the episode of LBP are indicated as CLBP predictive factors; these include: duration of symptoms, pain radiating to the leg, widespread pain, and restriction in spinal mobility [28]. This study, as the previous one, focused only on certain predictive factors but still not all the categories were included. To overcome this gap, the thesis research collected predictive factors from heterogeneous sources that cover most of the categories.

Another research paper indicates that early detection of patients at risk of developing CLBP is significant because the socioeconomic costs associated with CLBP patients are much higher than the costs for acute LBP patients. As a result of this study, depression and maladaptive cognitions are considered necessary predictive factors that should be included in the screening tools for predicting CLBP because these factors can be addressed in primary and secondary prevention. There is also a correlation between the psychological factors at baseline and progression to persistent LBP up to six months [82]. None of these research studies applied any standardization of vocabularies, through the use of a standardized terminology reference such as SNOMED CT. That is one reason why these research studies have gaps that can be addressed in this thesis research through the development of a standardized assessment form that includes predictive factors under various categories, and standardizes vocabulary by using SNOMED CT.

4.4 Back Pain Clinical Assessment Tools

There are many clinical tools that aid in the assessment and management process of patients complaining of back pain. These tools usually contain a number of questions regarding the pain and its effect on patients daily living activities. These questions are answered by patients in a short time; then they are scored by healthcare professionals to identify who is at risk of developing chronicity, or to make appropriate decisions regarding treatment plans. However, there is a lack of brief and practical tools containing predictive factors for CLBP that can be easily used by the PCPs at the point of care [83, 84].

In a study by Hill et. al. [83], two sub-grouping tools were compared in order to determine which was a better fit for use. The compared tools were STarT Back Tool (SBT) and the Orebro Musculoskeletal Pain Screening Questionnaire (OMPSQ). The

SBT has 9 items selected as predictive factors with dichotomised response format (‘agree’ or ‘disagree’), while the OMPSQ consists of 24 self-reported items that provides a point score ranging from two to 210. This study compared the two tools for correlation scores and level of agreement about patients’ allocation to low, medium, and high risk subgroups. The study shows both similarities and differences between these two tools. They are similar in the subgroup patient characteristics and in the abilities to differentiate according to validated reference standards measures. On the other hand, the SBT is faster in completion by patients and easier to score by physicians. The allocation of patients to high risk group is higher in the OMPSQ than in the SBT (38% vs. 25%). In addition to the items these tools contain, there are more scoring tools that need to be considered such as RMDQ (Ronland and Morris Disability Questionnaire), PCS (Pain Catastrophising Scale), and TSK (Tampa Scale of Kinesiophobia)for fear [83].

Another research study [85] focused on measuring the reliability and inter-consistency of a set of LBP measurement tools to find out whether they are appropriate to use in a community-based sample in Israel. The design was a test re-test reliability study in physiotherapy clinics that included 151 patients with LBP. There were seven tools related to LBP measured in this paper, four of them are directly related to LBP, while the other 3 tools are potentially associated to LBP. These tools are: The Modified Roland-Morris Disability Questionnaire (MRMQ), a simple verbal pain severity scale, modified pain symptoms frequency, bothersomeness indices, Fear-Avoidance Beliefs Questionnaire (FABQ), work satisfaction scale, and the Baecke Physical Activity Questionnaire (BPAQ). As a conclusion, most of these measurement tools were found to be reliable and suitable for use in a community-based system in Israel [85].

Although these various tools are considered to be useful and easy to use, they still need to be completed by the patients then scored by the clinicians, which is time consuming, unlike the intended electronic standardized assessment tool that can be filled in easily by clinicians at the point of care.

4.5 Gaps in Literature

The objective of this thesis research is to provide an essential electronic standardized assessment tool that helps in assessing and managing CLBP patients. It is also intended to facilitate communication among healthcare providers and improve the quality of healthcare.

In summary, we know that predictive factors are important and there is a lack of an easy, quick, tool to assess patients in primary care clinics at the point of care.

Chapter 5 Methodology

The chapter begins with research objectives followed by the triangulation methodology used to generate standardization along three levels: standardization based on evidence, standardization of clinical information, and standardization of clinical vocabulary. Discussion of each level under the triangulation methodology is presented in detail.

5.1 Research Objective

The main objective of this research is to develop an electronic standardized assessment form for CLBP. The development of the form is done by applying a triangulation methodology that facilitates the harmonization of heterogeneous sources [23]. The heterogeneous sources include standardization based on evidence, standardization of clinical information and standardization of clinical vocabulary. Figure 3 shows a schematic of the methodology used in the thesis research.

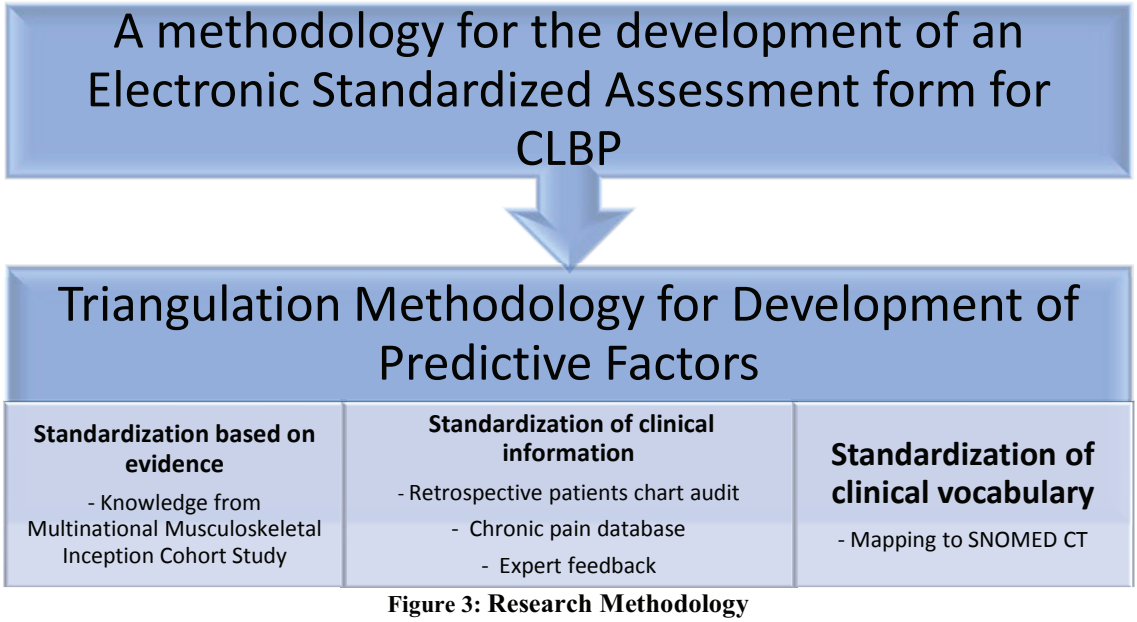

Figure 3: Research Methodology

5.2 Triangulation Methodology

The triangulation metaphor is derived from navigation and military strategy and denotes the use of multiple reference points to locate the exact position of an object [86, 87]. The triangulation methodology facilitates the use of multiple methods to study a single problem such as interviews, observations, questionnaires and documents [88].The crux of this methodology is that by applying multiple data collection techniques, a greater level of accuracy and confidence can achieved in the interpretation of a phenomenon versus a single viewpoint [89, 90]. In this research, the triangulation methodology was applied to combine knowledge from various types of sources namely, location, knowledge and methods. (Figure 4).

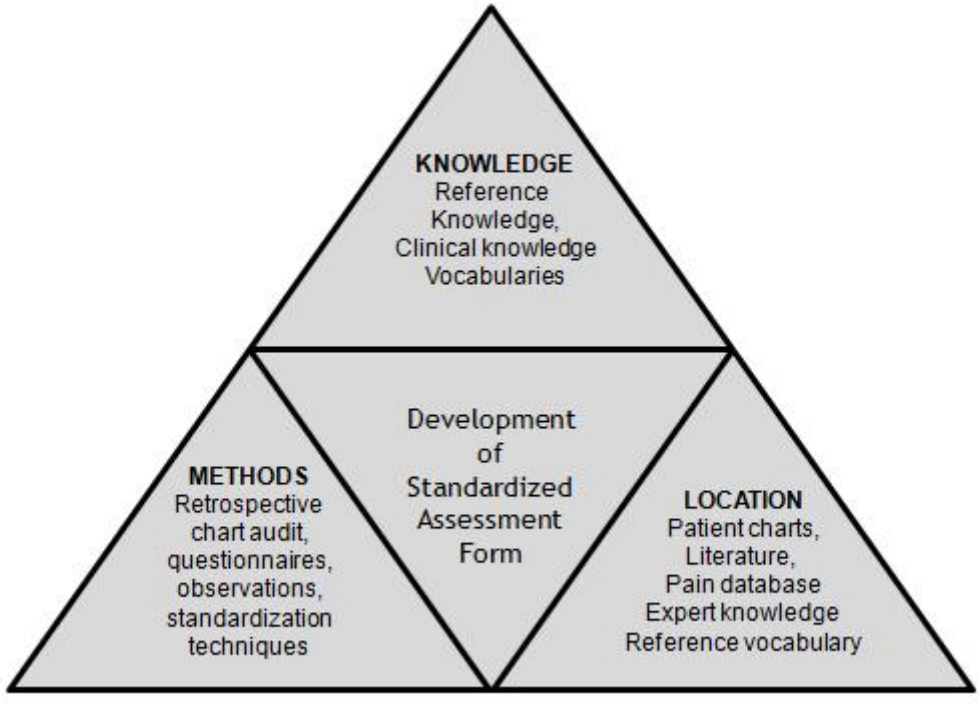

Figure 4: Triangulation Methodology

Location of sources included patient charts, pain database, reference dataset, experts and standardized vocabularies. Methods included retrospective chart audit, observations and questionnaires. Finally, different types of knowledge included clinical knowledge, expert knowledge, evidence and reference vocabularies. The multiple dataset are harmonized using the triangulation of these to improve the level of accuracy and confidence in the end product, namely, standardized predictive factors for CLBP as shown in Figure 4.

Figure 5 shows the various phases and research steps involved in this thesis research along with detailed description of each phase of research.

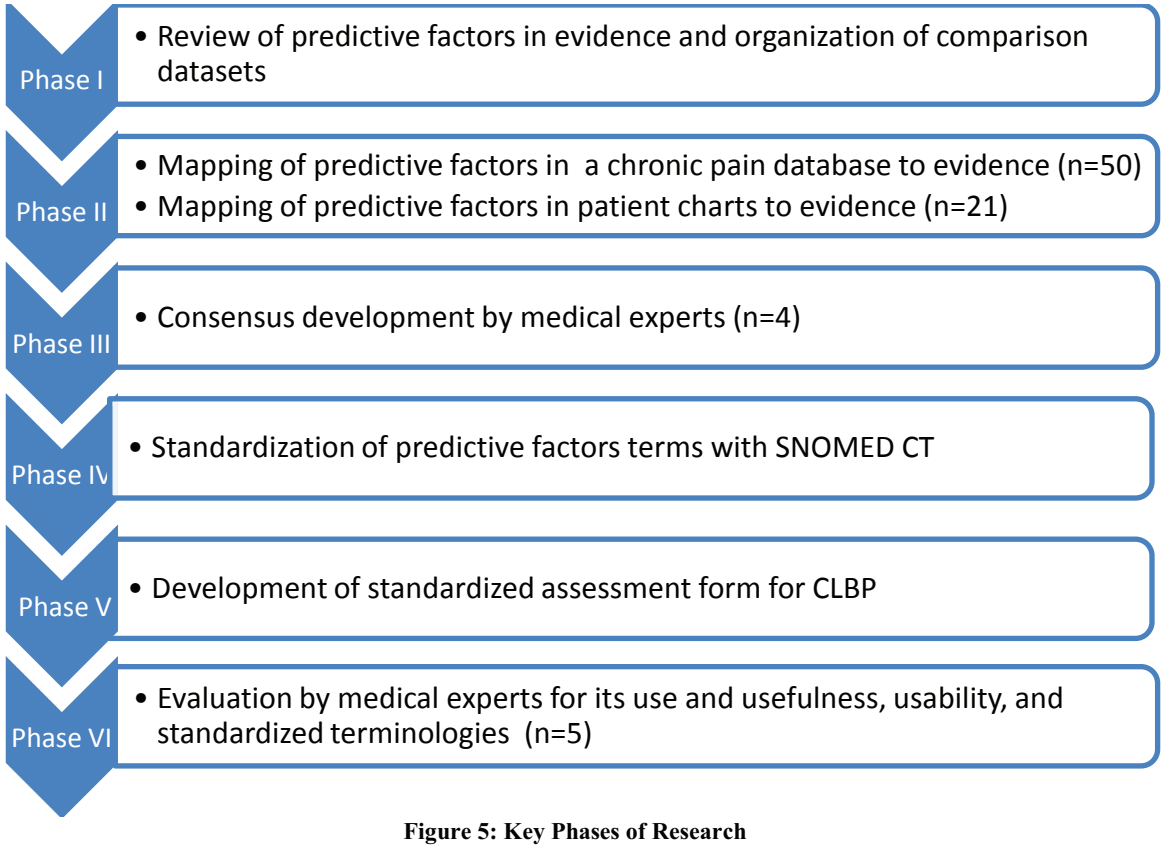

Figure 5: Key Phases of Research

5.2.1 Standardization Based on Evidence

The first phase of research involved gathering the knowledge based on evidence from the literature sources. There are two strategic search considerations followed when searching research studies to ensure choosing the right and suitable reference set for this research. These two strategic search considerations consist of the prognosis methodology from the Cochrane Collaboration that includes four key questions [78], (See Figure 6) and the inclusion and exclusion criteria (See Figure 7). The prognostic methodology are information about the long-term healthcare and well-being regarding a specific conditions. Which are provided by the one of the Cochrane Method Group, the Prognosis Methods Group) [91]. From these two strategic search consideration, and from a convenience sample of literature that was informed by members of the back pain research community. Ten research studies were reviewed in order to select the predictive factors dataset. After reviewing these studies, the Multinational Musculoskeletal Inception Cohort Study (MMICS) was chosen to be the reference dataset for use in this research study. The MMICS study was chosen because it is a concise statement based on evidence, theory, and practicality.

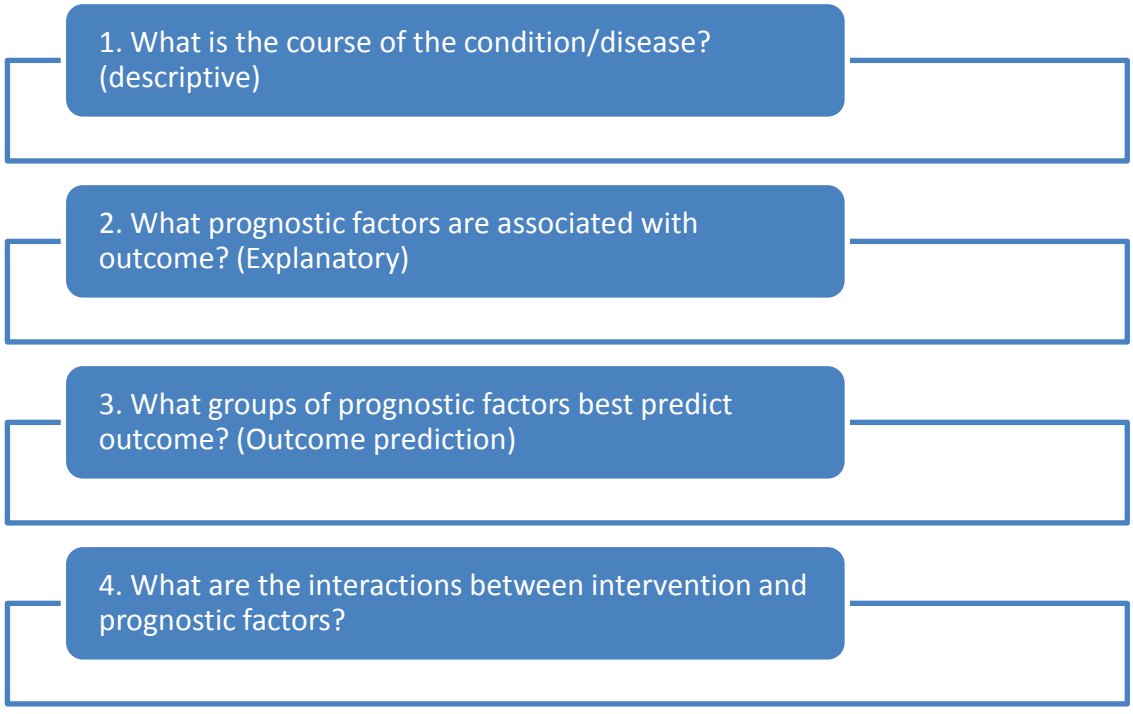

Figure 6: The 4 Key Questions in Prognosis Methodology

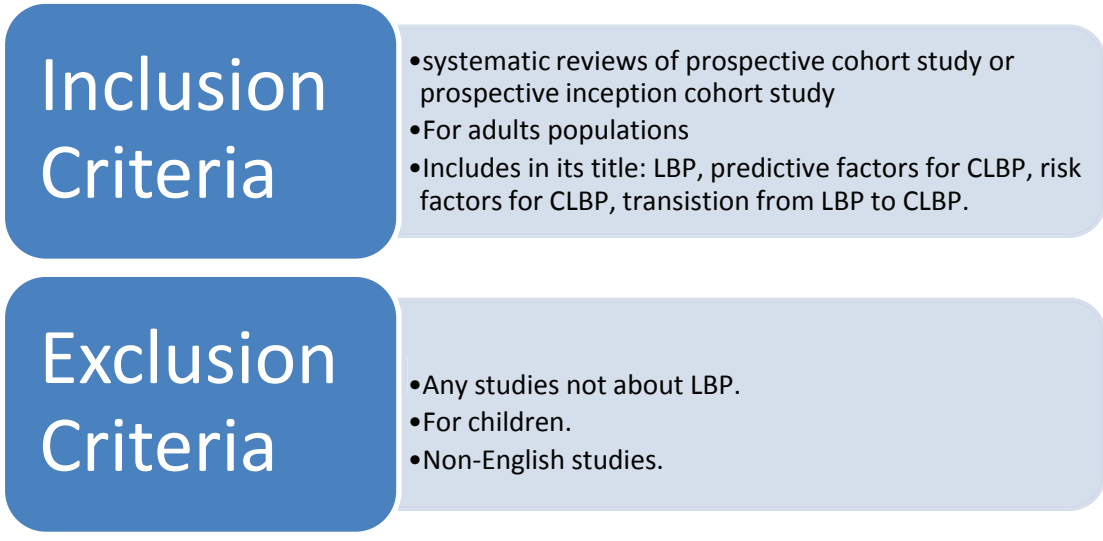

Figure 7: Inclusion and Exclusion Criteria for Articles Choosing Strategies

According to Pincus et. al. [6], the method of selecting the predictive factors in the MMICS goes through a four stage process that contains: generating factors for consideration, consensus for inclusion and exclusion criteria, selection of measurements, and finally approval of the selected list from the team leaders for the predictive factors

that had relevant measurements. As a result of the predictive factors selecting process about 45 predictive factors under different categories (clinical, financial, life style, psychological, social, demographic, and work) were selected for use in assessing patients with CLBP from MMICS

The MMICS[1] Statement [6], is a consensus statement aimed at improving the quality of prospective investigations into the transition from early stages of LBP to persistent problems. The MMICS Statement is primarily aimed at researchers who want to investigate prognoses in LBP from different cohort studies and different healthcare systems. One of the mandates of the MMICS Statement was to develop a minimal but comprehensive number of predictive factors based on current evidence and theory. This set of predictive factors is the reference set for this research study [6]. (See Appendix A). This data set from literature was used as a reference point for the collected data from the other heterogeneous sources (patients' charts and chronic pain database).

5.2.2 Standardization of Clinical Information

The next phase of research involved retrieving clinical knowledge from different sources, namely, a chronic pain database, patient charts, and medical experts' opinions and feedback. The knowledge is gathered through a variety of methods including retrospective chart audit, questionnaires, and observations. The details are provided in the following sub-sections.

5.2.2.1 Data Retrieval from a Chronic Pain Database

From a previously existing chronic pain database platform, patient profiles were analyzed to collect multidisciplinary profiles of patients with chronic pain. From this chronic pain database, profiles of patients with a diagnosis of CLBP were selected and clinical data

[1] Multinational Musculoskeletal Inception Cohort Study

that were considered to be predictive factors were retrieved and compared with the MMICS[2] dataset. These collected predictive factors were compared in a patient matrix spreadsheet with the ones from the MMICS[3]. The level of compatibility was measured between these two sources, with given a score of '1' if there is a match and a score of '0' for no match terms.

5.2.2.2 Data Retrieval from Patient Charts

After reviewing the predictive factors collected from the literature review paper, which were considered as a reference set, a retrospective chart audit review of patient charts was conducted from patients with a diagnosis of CLBP, selected from the Pain Management Unit (PMU) of the Capital Health District in Nova Scotia. PMU is a treatment facility for individuals with chronic pain. Ethical approval to conduct the retrospective chart audit of patient charts was obtained from Capital Health Ethics Committee (See Appendix H) . Data was stored in password protected electronic file on a secured computer in the office of one of the investigators in Capital Health, Nova Scotia. Personal identifiers were removed from patient files before storing them in the computer. The charts were reviewed to retrieve any terms that were considered as predictive factors or related to predictive factors for CLBP and compared with the ones gathered from the literature review in a patients' matrix spreadsheet. A score of '1' was given when there was a match with the term found in literature and a score of '0' when there was no match. These selected terms were compiled with the ones from the MMICS[4] and from the

[2, 4] Multinational Musculoskeletal Inception Cohort Study

[4] Multinational Musculoskeletal Inception Cohort Study

chronic pain database in order to develop one standardized assessment form that can be used by healthcare professionals.

The percentages of some selected items were calculated and compared with percentages of the same items from the chronic pain database and experts' opinion. This comparison shows the differences between actual captured data and what experts mentioned is captured in the second level of feedback questionnaire. Some of these selected items were divided into two categories (Psychosocial predictive factors and pain with commonly found demographic predictive factors) and analysed for the comparison between patients' charts captured data and experts' opinion. This was done because most of the predictive items from the chronic pain database were not so consistent with the two other sources; so comparing only actual captured data from patients' charts and experts' opinion showed more consistency. From these selected items, three were grouped into subcategories according to the available data (Employment Status, Age, and Gender); then the percentages of each group were calculated. This dividing was done just to recognize the highest and lowest percentages from the sub groupings. The collected data from a chronic pain database and patient charts were combined to obtain the percentages for only the three items that have sub groupings. Employment status was divided into seven subgroups that include: employed, self-employed, not working due to pain, not working by choice, unemployed, retired, and unknown employment status for data that were not captured. Age was divided into 5 subgroups 1 (under 30 years old), 2 (30-40), 3 (40-50), 4 (50-60), and 5 (over 60). Gender is divided as expected to female and male. The results of these percentages are explained in the next chapter.

5.2.2.3 Feedback from Medical Experts

Experts' opinions regarding the compiled list of predictive factors for CLBP are essential to the methodology of this research study. The methods followed to gather their opinion was through web-based survey questionnaires that were sent out to different medical experts. There were experts from the PMU[5], neurosurgery department, orthopaedic surgery department, and primary care unit. The primary care unit includes a family physician and a nurse practitioner who agreed to participate in this research study. All participants received consent forms that explained the study and their participation role, and they were asked to sign and return it (See Appendix H.3). Three different questionnaires were developed accordingly; these were sent in different periods of time and to different participants.

The first questionnaire (Interview Questionnaire) involved obtaining feedback from pain experts in the PMU[6]. This questionnaire contains six questions, with yes/no answers for most of them. The purpose of this questionnaire was to ascertain if pain specialists are using predictive factors in their clinical practice at the current time, and also to discover their usage of practice guidelines at the point of care. We also wanted to obtain their opinion on the importance of using these even if they weren't currently using them in practice. The interview questionnaire was specifically developed for use in this study. (See Appendix.B).

The second level of feedback "experts' opinion survey" was conducted to ascertain the level of agreement on the predictive factors compiled in this research from literature, the chronic pain database, patient charts, and the pain specialists' feedback from the first

[5, 5] Pain Management Unit

level of questionnaire. This questionnaire was sent to the pain specialists and to the surgeons due to their experience with CLBP patients. Therefore, their opinion regarding each predictive factor is valuable in this research to help in the development of the standardized assessment form. The total number of participants receiving this questionnaire was six but only four completed and returned it. This questionnaire contains 81 selected items from the previous heterogeneous sources (literature, chronic pain database, patient charts, and the pain specialists' opinion from the first level of feedback). In this level of feedback medical experts were asked to review the items and indicate their level of agreement for each item as a predictive factor for CLBP. The questionnaire contains all the predictive factors in a table with 5 point Likert scale beside each item (1= strongly disagree, 2=Disagree, 3= Neutral, 4=Agree, and 5= strongly agree) (See Appendix C). The feedback from this form was used in developing the standardized assessment form for CLBP. Some statistical analysis (Intra-class Correlation (ICC) and Cronbach's Alpha) regarding these collected data were done to measure inter-rater reliability and inter-consistency among participants. The interpretation for ICC and Cronbach's alpha are almost the same and it indicate fair agreement (0.2-0.4), moderate (0.41-0.6), excellent (0.61-0.8), and almost perfect (0.81-1). The results from these statistical analyses are explained in the next chapter.

As part of this second level of the feedback process, the medical experts were also asked to choose if the presented item is captured or not in their practice (See Appendix C). This scoring process is binary (captured=1, not captured =0), and the feedback data from this part was used, as mentioned previously, to get percentages of some selected items. We

also conducted inter-rater reliability by using ICC[7] and inter-consistency by using Cronbach's Alpha calculation.

5.2.2.4 Development of an Electronic Standardized Assessment Form

From the experts' opinion survey, the final electronic standardized assessment form was developed according to the results gathered from the participating experts. The selection of items was done according to the mean of medical experts' level of agreement for each item. Items with mean equal 4 or higher were selected for inclusion in the electronic standardized assessment form. The electronic standardized assessment form was developed in a readily available website that is considered one of the best form/survey builders available in the internet. This website helped in making drop down menus and multiple choice questions; it also eases the process of adding different types of questions and sharing it with experts electronically [92]. (See Appendix D).

5.2.2.5 Evaluation of the Use, Usefulness, and Usability of the Electronic Standardized Assessment Form

The third level of feedback contains the developed electronic standardized assessment form for CLBP. There were supposed to be eight participants in this level (2 pain specialists, 4 surgeons, 1 family physician, and 1 nurse practitioner), but only five participants completed this phase (1 pain specialist, 2 surgeon, 1 family physician, and 1 nurse practitioner). However, all participants were asked to complete this form on a mock patient and after submitting it, they were given another form with questions regarding use, usefulness, and usability of this form. (See Appendix E). Statistical measurements

[7] Intra-class correlation

for inter-rater reliability and inter-consistency are done using ICC[8] and Cronbach's Alpha analysis.

5.2.3 Standardization of Clinical Vocabularies

Finally, the triangulation method included developing standardized knowledge from a reference vocabulary, SNOMED CT using mapping of concepts methods. This phase also included the evaluation of standardized terminology by medical experts.

5.2.3.1 Mapping of Predictive Factors in the Electronic Standardized Assessment Form with SNOMED CT

Following the standardized assessment form feedback questionnaire, another form was given to the medical experts to review. This form included mapping of the charts terms with SNOMED CT terminology and its concept ID. The mapping process was done by searching the SNOMED CT browser for each term match to map it with either a pre-coordinated terms or a post-coordination. The pre-coordinated terms were considered to be matching with a single concept ID from SNOMED CT; while the post-coordination consists of a multiple simpler concepts from SNOMED CT [75]. From my dataset of predictive factors terms, there are only 11/110 terms that needed post-coordination mapping. For example, the predictive factor term used is (not working due to pain = giving up work + due to+ pain = 276059007 + 42752001 + 22253000). While the rest of the predictive factors were pre-cordinated with SNOMED CT 99/110.

5.2.3.2 Evaluation of Standardized Terminology

After mapping these terms with SNOMED CT, the form was sent to the same five medical experts (1 pain specialist, 2 surgeons, 1 family physician, and 1 nurse practitioner), and they were asked to give their feedback on the usefulness of these

[8] Intra-class correlation

SNOMED CT terms. This feedback questionnaire contained only two general questions that determine their level of agreement about the usefulness of SNOMED CT. (See Appendix F).

In conclusion, all the methodologies used were employed to calculate results needed to support this research.

Chapter 6 Results

In this chapter, I present the results and statistical analysis conducted in this thesis. The heterogeneous sources under the triangulation methodology contain three levels of standardization: standardization based on evidence, standardization of clinical information, and standardization of clinical vocabulary derived from various locations and research methods. Triangulation methodology helped in developing an electronic standardized assessment form for CLBP with higher confidence in the accuracy of results. In addition, an evaluation of experts' view point regarding the use, usefulness, and usability of the final standardized assessment form for CLBP is also presented adding to the credibility of the results. Finally, representation of the predictive factors using standardized vocabulary is also presented.

6.1 Triangulation Methodology

Predictive factors for CLBP were collected from heterogeneous sources to help in the development of the standardized assessment form for CLBP. The results of frequency analysis for data collected from heterogeneous sources are explored in this chapter.

6.1.1 Standardization Based on Evidence

A review of the literature for a predictive factors dataset for CLBP was done to find a reference set of predictive factors based on evidence, theory, and practicality. Prognosis methodology, convenient sample from members of the back pain community, and inclusion/exclusion criteria were used to search the literature for the best reference set. From answering the four key prognosis methodology questions, considering the convenience sample, and according to the inclusion/exclusion criteria; 41 articles were looked at (See Figure 8). From these 41 articles, only ten were considered most

appropriate to choose from. The article chosen as an evidence reference set is the MMICS[9]. This article contains 45 predictive factors under different categories (clinical, financial, life style, psychological, social, demographic, and work) that were selected to be used in assessing patients with CLBP [6].

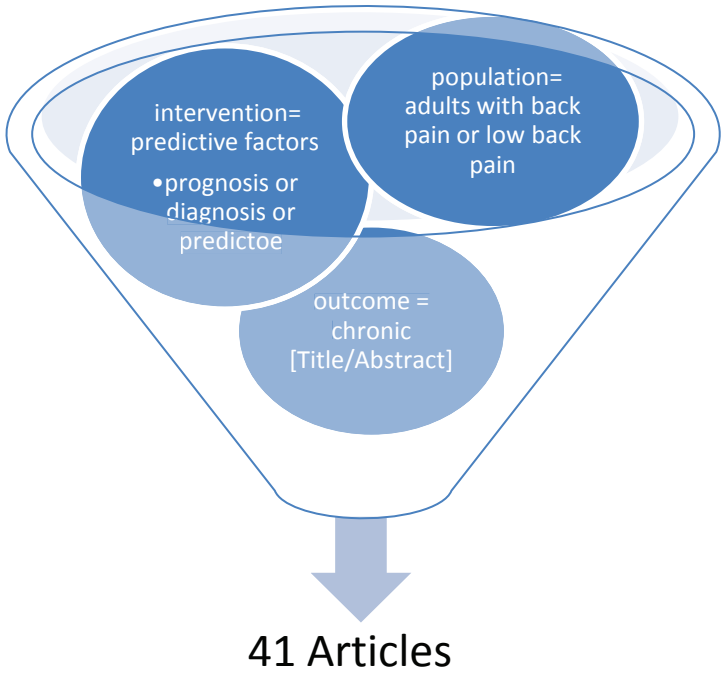

Figure 8: Prognostic Methodology for Choosing Reference Evidence

6.1.2 Standardization of Clinical Information

Data retrieval of clinical information came from three heterogeneous sources: a chronic pain database, patient charts, and medical experts' opinions and feedback. Collected predictive factors from a chronic pain database and patient charts were mapped and compared with the reference set from evidence. From each source, frequency analysis for some of the collected data was summarized using Microsoft Excel. Finally, the analyzed data was compared with what experts said is captured in their practice to see the

[9] Multinational Musculoskeletal Inception Cohort Study

difference between what is actually captured and what experts think is important to capture.

6.1.2.1 Frequency Analysis of Data Collection Practice from a Chronic Pain Database

The collected predictive factors from 50 patient profiles from a chronic pain database were mapped and compared with the reference data set by assigning a score of '1' whenever there was a match and a score of '0' when there is no match. Figure 9, shows the highest percentages of matched predictive factors when comparing it to the reference dataset.

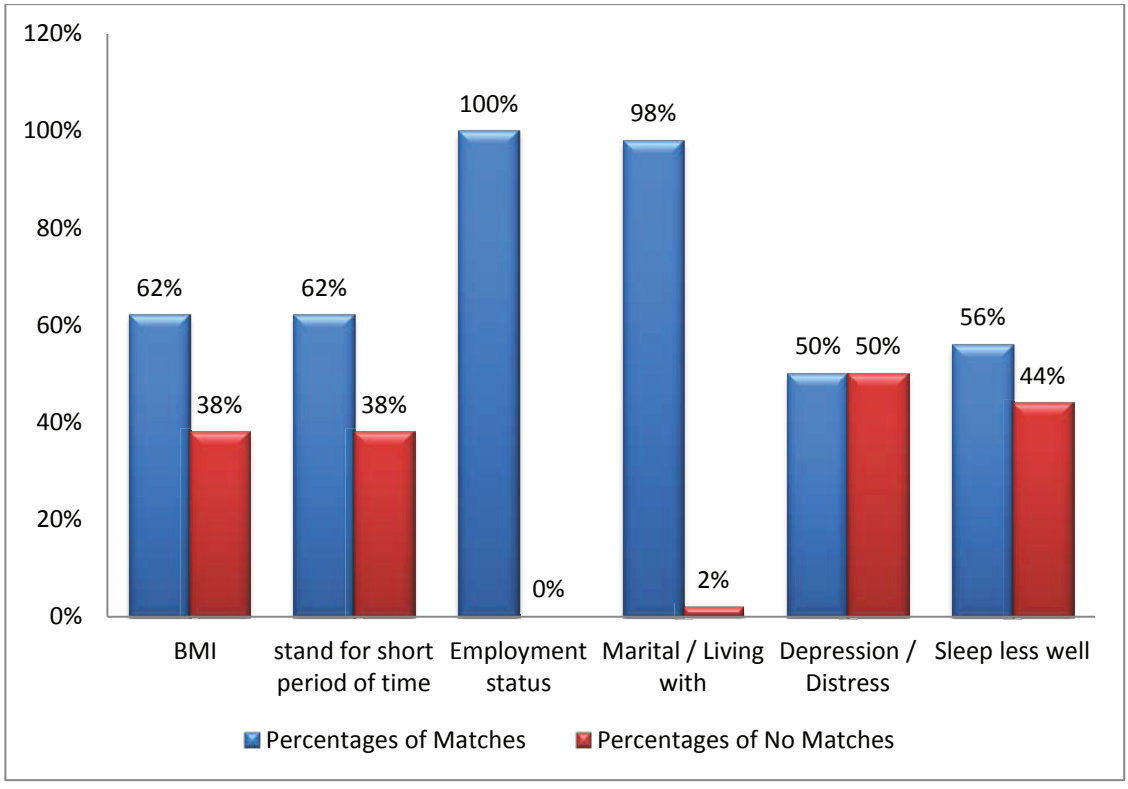

Figure 9: Highest Percentages of Matched Predictive Factors from a Chronic Pain Database with Reference Set

On the other hand, figure 10 shows some of the lowest percentages of matched predictive factors from a chronic pain database with the reference set.

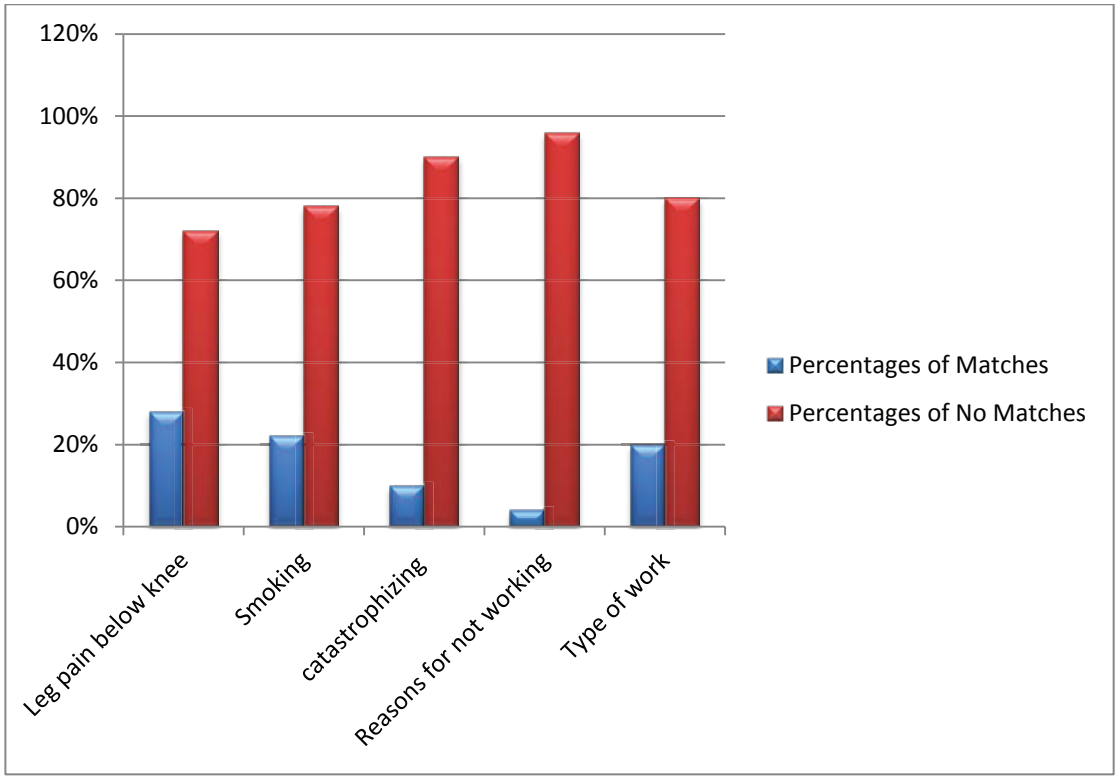

Figure 10: Lowest Percentages of Matched Predictive Factors from a Chronic Pain Database with Reference Set

Frequency analysis of a total of 23 items was done through calculating the percentages of actual captured data from the chronic pain database and compared with the percentages of captured data found in patients' charts from PMU[10], and with percentage of these data captured by experts. The differences among these three sources show the actual captured data and what experts think are important items to be captured. The predictive factors and their percentages were summarized in table 1.

6.1.2.2 Frequency Analysis of Data Collection Practice from Patients' Charts

Similar to the previous section, the collected predictive factors from patient charts were mapped and compared with the reference data set by assigning a score of '1' whenever

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there was a match and a score of '0' when there is no match. Figure 11, shows the highest percentages of matched predictive factors when comparing it to the reference dataset.

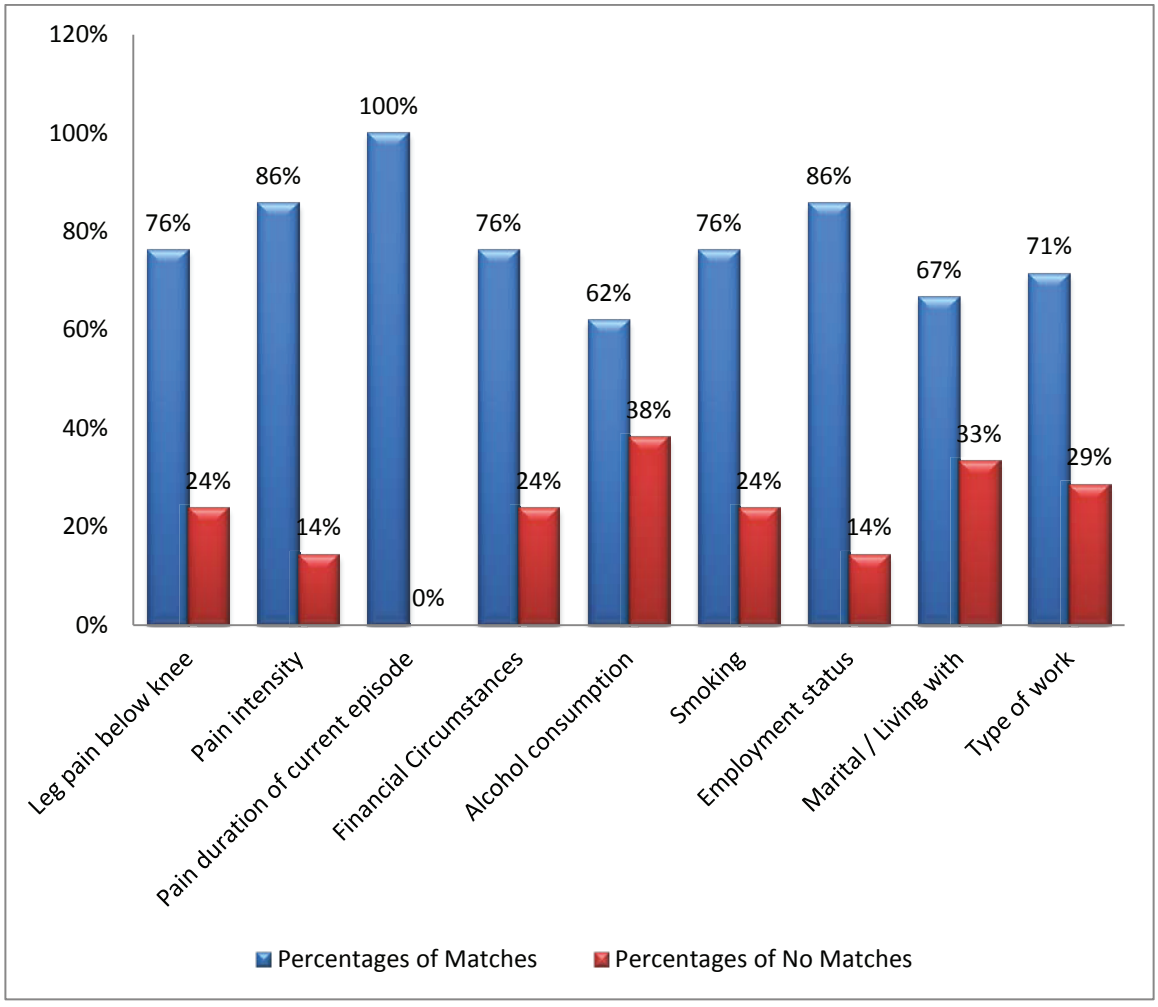

Figure 11: Highest Percentages of Matched Predictive Factors from a Patient Charts with Reference Set

On the other hand, figure 12 shows some of the lowest percentages of matched predictive factors from patient charts with the reference set.

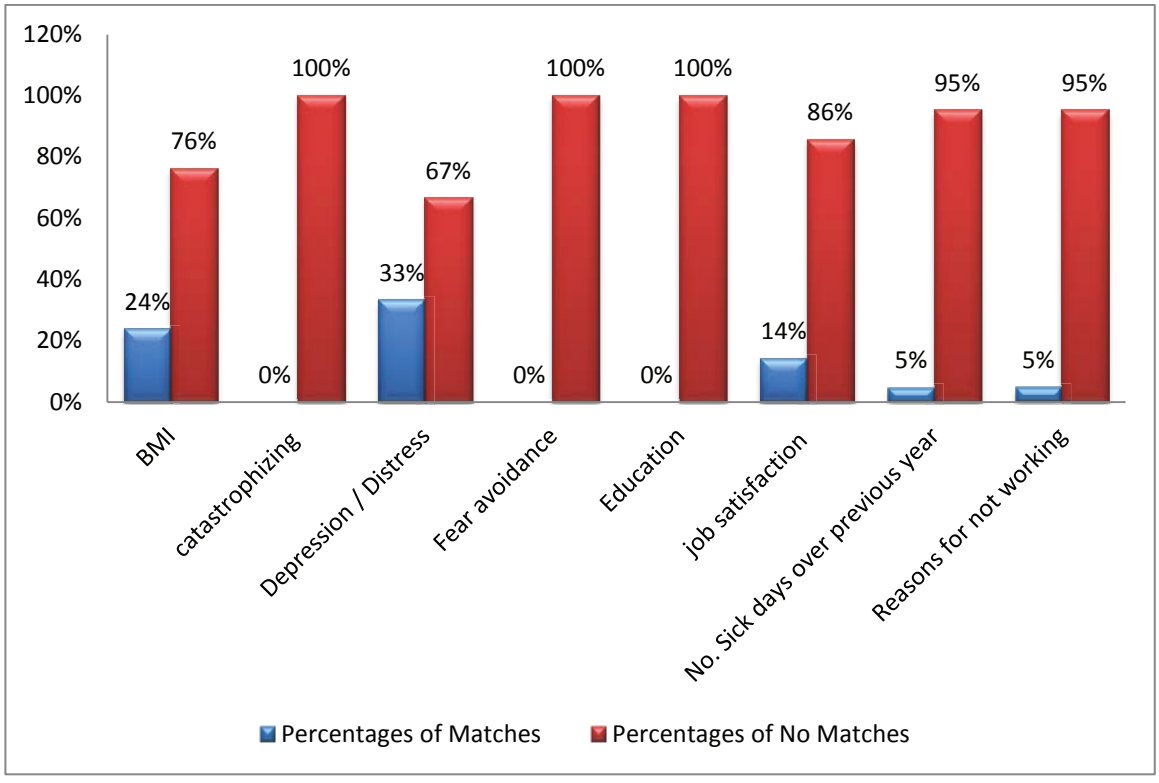

Figure 12: Lowest Percentages of Matched Predictive Factors from Patient Charts with Reference Set

The total of 23 predictive factors were gathered, but this time from 21 patients' charts from the PMU[11]. These percentages were compared with the percentages found on the chronic pain database and with experts' percentage of capturing these data. These predictive factors and their percentages are summarized in table 1.

6.1.2.3 Frequency Analysis of Data Collection Practice from Experts' Opinion

A survey questionnaire that included a list of predictive factors was sent to six experts to get their assessment of the degree to which items were currently being captured in

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medical practice. Of those six experts only four responded by filling out and returning the survey. The percentages of 23 items were calculated and compared with the percentages from the patients' charts and patients' profiles mentioned in the previous two sections. These items and percentages are found in table 1.

Predictive Factors for CLBP	**Actual Captured Data**		**Experts' Thoughts**
	From 21 pain management unit patients' charts	**From 50 chronic pain database patient profiles**	**From experts opinions (4 experts)**
1- BMI	24 %	62 %	75 %
2- Pain Intensity	86 %	0 %	100 %
3- Pain Duration of Current Episode	100 %	0 %	100 %
4- Pain Location: Leg pain below the Knee	76 %	28 %	100 %
5- Alcohol Consumption	62 %	0 %	100 %
6- Exercise	52 %	0 %	100 %
7- Smoking	76 %	22 %	100 %
8- Occupation Type	71 %	20 %	75 %
9- Reason for not working	5 %	4 %	75 %
10- Catastrophyzing	0 %	10 %	50 %
11- Depression / Distress	33 %	50 %	75 %

Predictive Factors for CLBP	Actual Captured Data		Experts' Thoughts
	From 21 pain management unit patients' charts	From 50 chronic pain database patient profiles	From experts opinions (4 experts)
12- Difficulty falling/Staying asleep	62 %	42 %	87.5 %
13- Financial Circumstances	76 %	44 %	50 %
15- Sickness Benefits	24 %	30 %	50 %
16- Aggravating/ Alleviating Factors: Prolonged Standing	33 %	62 %	100 %
17- Work / house work	100 %	60 %	100 %
18- Relieved by lying down	33 %	18 %	100 %
19- Relieved by changing position	10 %	0 %	100 %
20- Worsened by bending or kneeling down	62 %	76 %	75 %
21- Employment Status	86 %	100 %	100 %
- **Employed (1)**	38%	48 %	
- **Self-employed (2)**	0 %	0 %	
- **Not working due to pain (3)**	14 %	0%	
- **Not working by choice (4)**	0 %	0 %	
- **Unemployed (5)**	14 %	48 %	
- **Retired (6)**	19 %	4 %	
- **Unknown employment status (0)**	14 %	0 %	

Predictive Factors for CLBP	Actual Captured Data		Experts' Thoughts
	From 21 pain management unit patients' charts	From 50 chronic pain database patient profiles	From experts opinions (4 experts)
22- Age	100 %	100 %	100 %
- **1 (under 30 years old)**	5 %	8 %	
- **2 (30 – 40 years old)**	10 %	24 %	
- **3 (40 – 50 years old)**	19 %	26 %	
- **4 (50 – 60 years old)**	52 %	28 %	
- **5 (over 60 years old)**	14 %	14 %	
23- Gender	100%	100 %	100%
- Female	57 %	54 %	
- **Male**	43 %	46 %	

Table 1: Comparison between Predictive Factors Percentages from Different Sources.

A comparison of 23 predictive factors from heterogeneous sources is revealed in table 1; the visual representation of table 1 is shown in the figure below figure 13. It shows the difference between the data actually captured in practice and the data experts' think is important to capture.

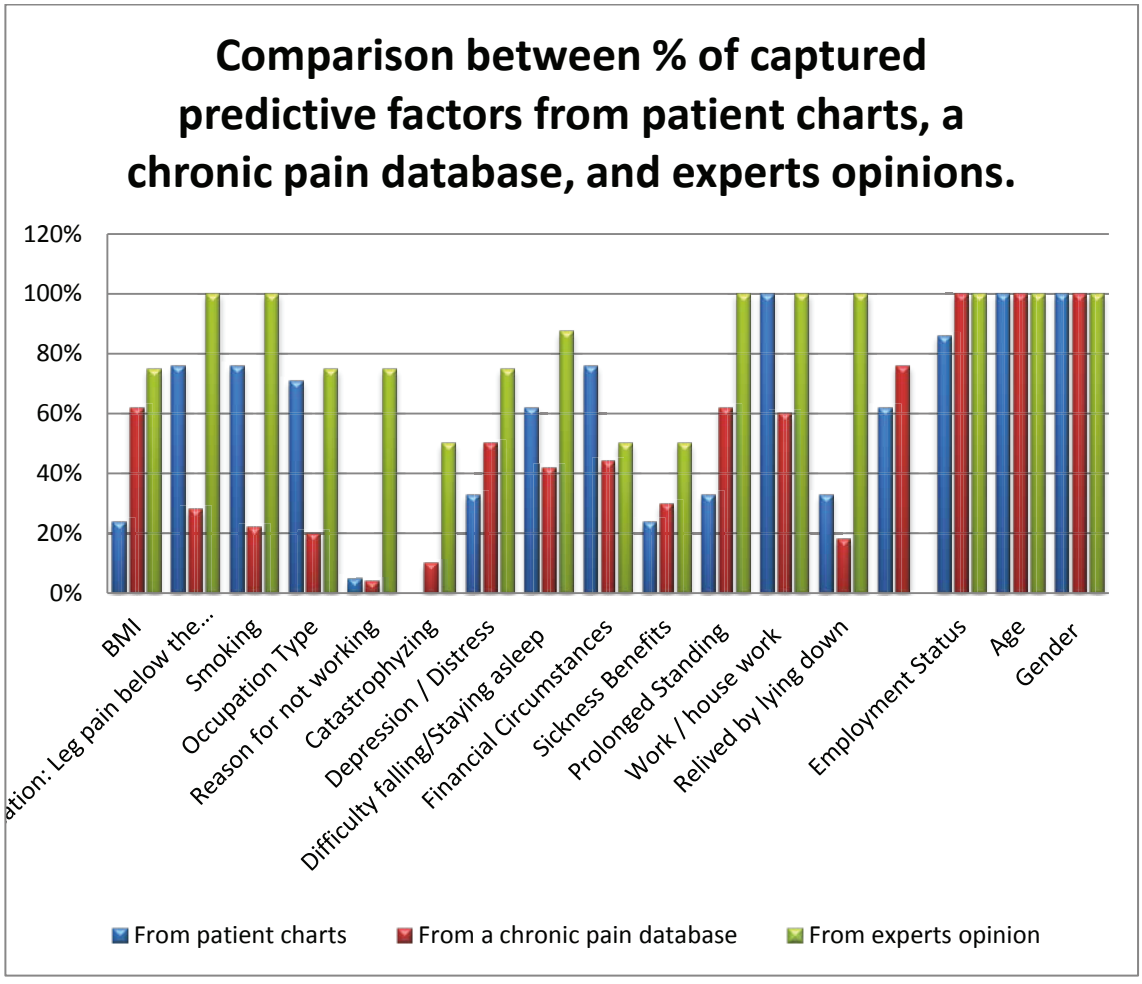

Figure 13: Comparison between Captured Data from Patient Charts, a Chronic Pain Database, and Experts' Opinion

From figure 13, capturing data from a chronic pain database is not always showing consistency with the two other sources. Therefor, we divided these 23 items into two subcategories; the first one includes psychosocial predictive factors as in and the second one includes pain and commonly found demographic predictive factors.

Figure 14 shows the psychosocial predictive factor comparison between captured data from patient charts and experts' opinions.

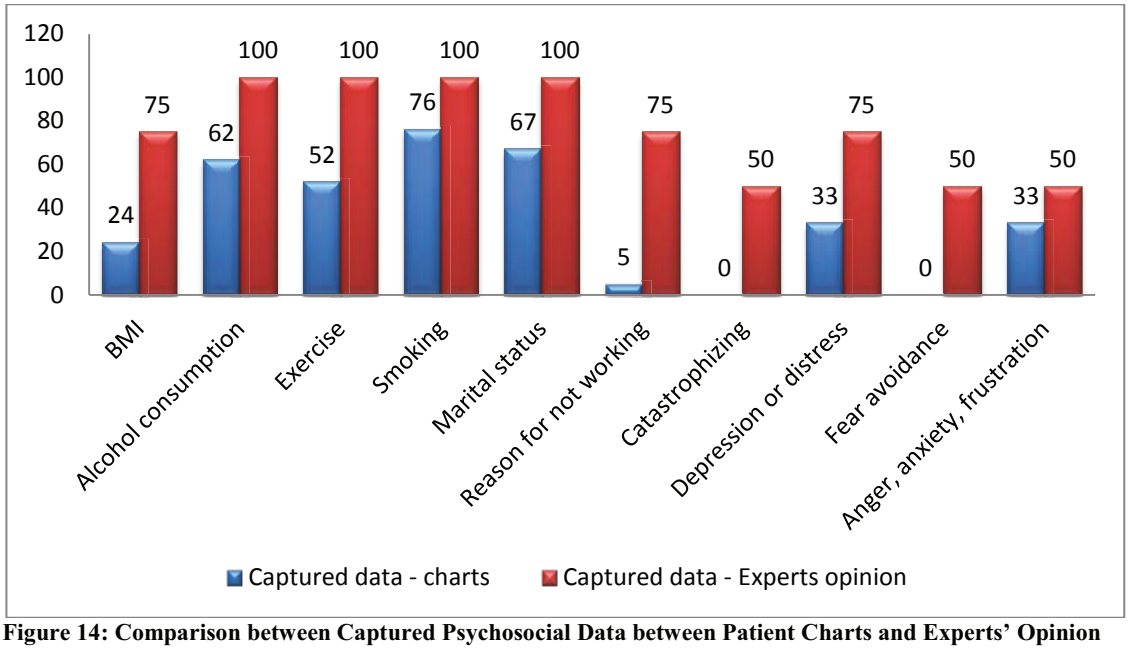

Figure 14: Comparison between Captured Psychosocial Data between Patient Charts and Experts' Opinion

Figure 15 shows the captured data from patient charts and experts' opinion regarding pain and common demographics predictive factors.

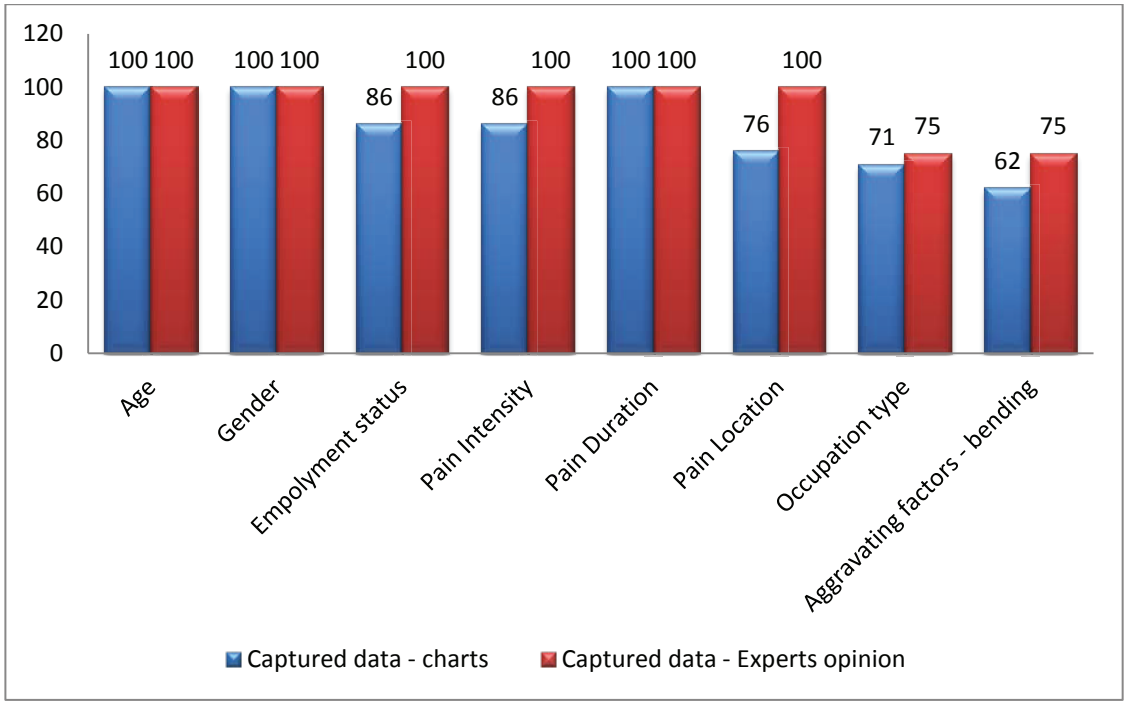

Figure 15: Comparison between Captured Pain and Demographic Data from Patient Charts and Experts' Opinion

Figure 14, shows inconsistency between actual captured data in patient charts and experts' opinion for the psychosocial predictive factors, unlike the pain and commonly demographic predictive factors that shows more consistency between captured data in patient charts and from experts' opinion.

Some of the data, such as age and gender, were 100 % captured both in practice and experts' opinion. Other predictive factors are captured in high percentages in patients' charts but not captured at all, or captured with low percentages in the chronic pain database, and vice versa. For example, "pain intensity" is captured 86 % in patients' charts and not captured at all in the chronic pain database. Another example is "pain duration of current episode" with 100% captured in patients' charts and not captured at all in chronic pain database. An example of higher percentages captured predictive factors in the chronic pain database is the BMI with 62%, where its capturing percentage is 24% from patients' charts.

For some of the sub-groups of predictive factors, such as Gender, Age, and employment status, the percentages of combined patient data from patients' charts and the chronic pain database was shown to provide significant information regarding higher percentages for some categories within the groups. For example, the gender percentages indicate a slightly higher incidence in females than in males (See table 2).

Gender	Percentages
Female	55 %
Male	45 %

Table 2: Gender Percentages

Regarding a patient's age, I used 5 groupings, and the percentage in each age group is shown below in table 3.

Age Groups	Percentage
1 (under 30 years old)	5 %
2 (30 – 40 years old)	19.7 %
3 (40 – 50 years old)	23.9 %
4 (50 – 60 years old)	35.2 %
5 (over 60 years old)	14 %

Table 3: Percentages of Age Groups

The employment status was divided into six categories and the percentage in each employment group is summarized in table 4.

Employment Status	Percentages
1- employed	45 %
2- self-employed	0 %
3- not working due to pain	4.2 %
4- not working by choice	0 %
5- unemployed	38 %
6- retired	8.4 %
0- Unknown employment status	4.2 %

Table 4: Employment Status Percentages

An analysis of this data shows that the percentage of female patients is somewhat higher than males. In addition, the highest percentages for age groups are those between 40-50 and between 50-60 years old. 45% of patients are employed, followed by unemployed patients with 38%. These are all frequency analyses for the data gathered regarding

predictive factors for CLBP patients. A visual presentation of the gender grouping shows in Figure 16.

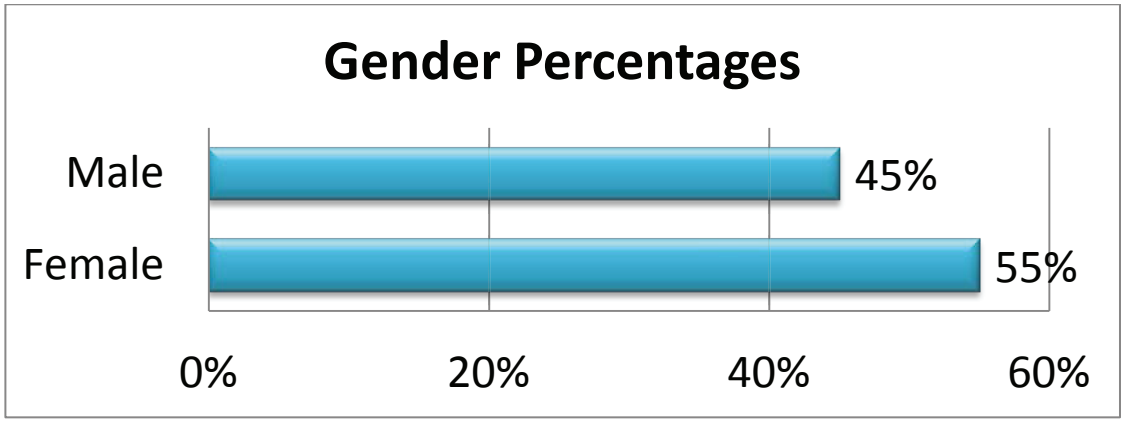

Figure 16: Gender Percentages

The age group percentages is shown in Figure 17 below.

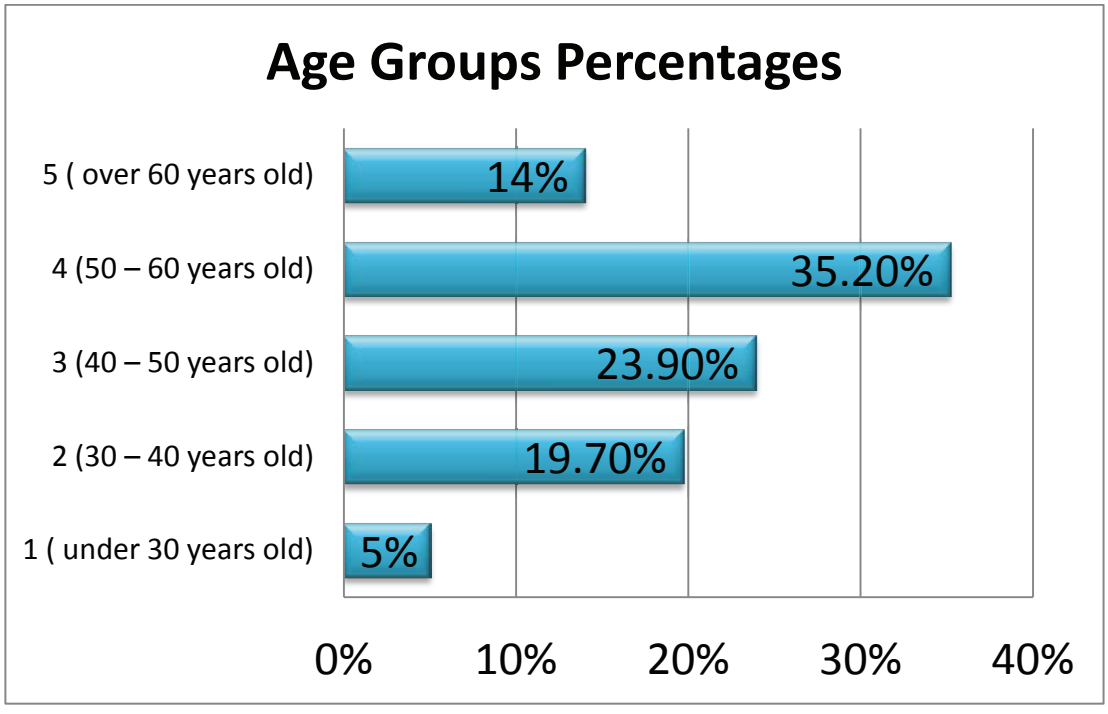

Figure 17:Age Groups Percentages

Figure 18 shows the percentages of the employment status groups from the patient charts and chronic pain database.

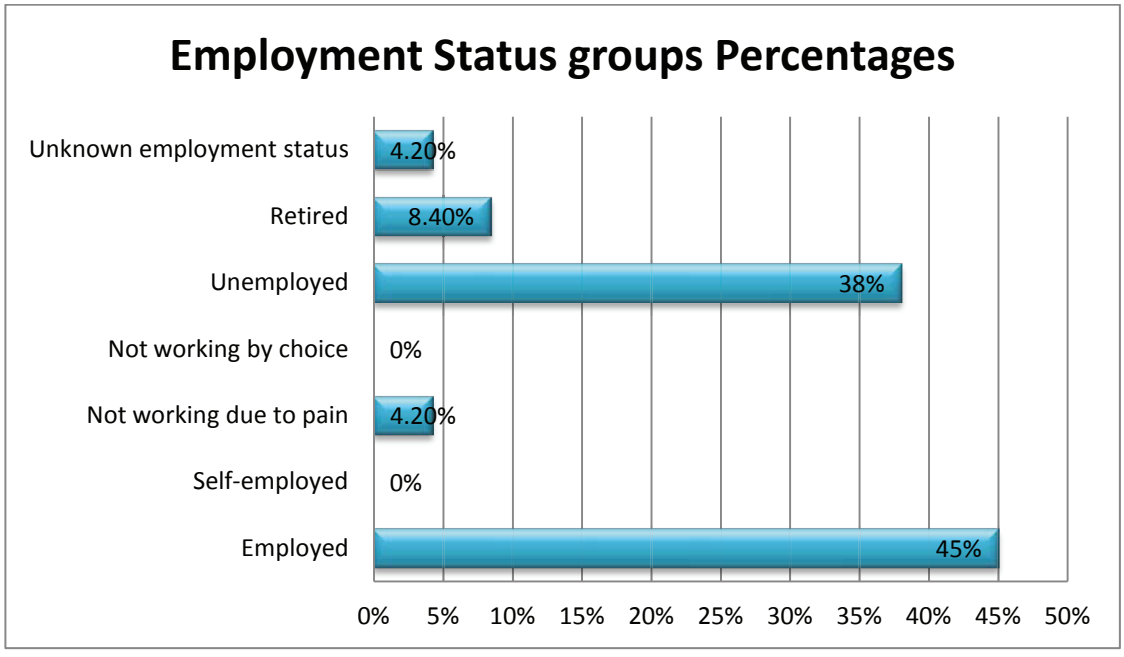

Figure 18: Employment Status Groups Percentages

6.1.2.4 Feedback from Experts' Opinion on the Interview Questionnaire

The first level of questionnaire was reviewed by the two pain specialists in PMU[12]. The purpose of this questionnaire was to ascertain if pain specialists are using predictive factors in their clinical practice. It also asked about their use of practice guidelines at the point of care (See Appendix B). As a result of this questionnaire two predictive factors, thought to be important for inclusion in the assessment form, were added. These two predictive factors were a woman's obstetrical history and number of children.

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6.1.2.5 Rating the Quality of the Experts' Opinion Survey

Experts' feedback was used to select the predictive factors that would become the final standardized assessment form for CLBP. All analysis was conducted with SPSS version 21 [93].

Four participants rated the list of predictive factors (items) for its use and usefulness for the standardized assessment form for CLBP. The scoring was ordinal (Likert scale) ranging from 1 (strongly disagree) to 5 (strongly agree). Inter-rater reliability was assessed for the collection of 81 items with no missing data.

Because the data is ordinal, several methods of analyses are possible. The most appropriate statistical measurement is intra-class correlation (ICC) [94]. Specifically, it is the ICC using the two-way random model. The ICC is "basically" an extension of the simple bivariate correlation to the case of more than two raters. It is applicable to ordinal data when it can be assumed that the data from each rater is more or less normal (this is likely reasonable here). The ICC is also related to the effect size measure of a two-way mixed ANOVA. For the current data, the ICC = 0.275 ($F(80,240) = 1.803$, $P < .001$). According to Ovsenik, Farcnik, and Verdenik [95], the interpretation scale of ICC is: fair (0.2- 0.4), moderate (0.41 – 0.60), excellent (0.61 – 0.80), and almost perfect (0.81 – 1). Therefore, the ICC value is considered "fair" agreement between raters [95, 94]. However, when the data has more range, there is more room for disagreement. Therefore, lower levels of agreement was expected from this dataset [94].

The 81 predictive factors were divided into five smaller categories according to their content in order to measure the agreement level between raters and to see if there is a certain group that might have higher agreement level than the whole dataset.

The statistical measurement of these five different categories is summarized in table 5.

Category Name	Number of Items	ICC	Interpretation of ICC
Top Categories	39	0.292	fair agreement
Pain Location Category	5	0.560	Moderate agreement
Aggravating / Alleviating Factors Category	16	0.540	Moderate agreement
Previous Treatment Category	5	0.276	fair agreement
Diagnostic Tests Category	5	0.698	Excellent agreement

Table 5: ICC Among Raters in Different Categories

From table 5, the highest level of agreement among raters is in the diagnostic test category that includes 5 items only, with ICC = 0.698.

An alternative to the ICC for inter-rater reliability analysis is Cronbach's Alpha. Like the ICC, it is basically a variation of the average correlation between different raters and it is used to measure the inter-consistency among raters [77]. Cronbach's alpha is included in this research study because many people are more familiar with it. In fact, Cronbach's alpha and ICC are closely related (under some assumptions) and as noted, both are related to the basic Pearson correlation. For the current data, the Cronbach's alpha was $\alpha = 0.472$. As with the ICC, this value would be considered "fair", but not "good" agreement. The analysis further demonstrated that one of the participants (Participant # 2) was the least consistent and deleting his data would increase the level of Cronbach's alpha slightly to 0.508. This value is still in the fair level of agreement among raters.

There are other methods of analysis conducted as part of this research and have been included in the appendix as they are not as useful in providing an average inter-rater reliability. (See Appendix G.1).

6.1.2.6 The Degree to Which Items Captured or Not by Experts in Current Practice

The same four participants rated the list of predictive factors (items) for their personal use in their practice. Each participant scored each item on whether it is captured or not during the assessment of CLBP. The scoring was binary (captured = 1, not captured = 0). Inter-rater reliability was assessed for the collection of the same 81 predictive factors.

As noted above there are many possible statistics that can be computed for measuring inter-rater reliability. In this case, because the measure is binary, there are even more options. As before, the most appropriate measure is the ICC. For the current data, the ICC= 0.461 ($F(80,240)=2.287$, $p < .001$). As mentioned in the previous section, a value of 0.41 to 0.60 is “moderate” agreement between raters [95, 94].

Again an alternative to the ICC is the Cronbach’s alpha. For this dataset, the Cronbach’s alpha was $\alpha = 0.495$. As with the ICC, this value would be considered "moderate", but not "good" agreement [95]. The analysis further demonstrated that one of the participants (Participant # 4) was the least consistent and deleting his data, will slightly increase in the level of Cronbach’s alpha to 0.6. This value is still in the moderate level of agreement between raters.

Moreover, there are some alternative measures that have been included in the appendix as they are not as useful in providing an average inter-rater reliability. (See Appendix G.2).

6.1.2.7 Development of an Electronic Standardized Assessment Form

To determine the final selection of items, the mean of each rating was computed. Each predictive factor with a mean of four or higher was selected. As a result of that, 49 items were selected for inclusion in the electronic standardized assessment form for CLBP.

From the total 49 selected predictive factors with mean equal to four or higher are shown in the tables below (table 6,7, and 8). These predictive factors are under three categories: pain characteristics category, psychological symptoms, and social, demographic, and work category

Pain Characteristics Category	
Onset of pain	4.75
Pain intensity	4.75
Pain type	4.5
Pain location: leg pain below the knee	5
-Hip pain	4.5
- Thigh pain	4
- Lumbar-spine tender	4
Pain duration of current episode	4.25
Numbness in leg	4.75
Hyperesthesia in leg	4.25

Table 6: Pain Characteristics Category of Selected Predictive Factors with Mean >= 4

Psychological symptoms	
Catastrophizing	4
Depression / Distress	4.25
Difficulty maintaining weight	4
Difficulty coping with pain	4.25
Difficulty falling asleep	4
Difficulty staying asleep	4.25
BMI	4.25

Table 7: Psychological Symptoms Category of Selected Predictive Factors with Mean >= 4

Table 8, shows the social, demographics, and work related predictive factors that were selected for inclusion in the electronic standardized assessment form due to its mean which is equal or higher than four.

Social, Demographic, and Work	
Education	4
Age	4.5
Sex	4.25
Employment status	4.75
Occupation Type	4.5
Reason for not working	4

Table 8: Social, Demographic, and Work Category of Selected Predictive Factors with Mean >= 4

For the same three categories some of the predictive factors with mean less than 3 are shown in the tables below (table 9, 10, and 11)

Pain Characteristics	
Pain location: mid back pain	3.75

Table 9: Pain Characteristics Category of Selected Predictive Factors with Mean < 4

Psychological Symptoms	
Fear Avoidance	3.5
Recurring Thoughts	3.25
Worrying	3.5
Panic Attack	3.75
Low self-esteem	3.25
Mood changes	3.5
Anger	3.5
Anxiety	3.75
Frustrated	3.75

Table 10: Psychological Symptoms Category of Selected Predictive Factors with Mean < 4

Table 11, shows the social, demographics, and work related predictive factors that were not selected to be in the electronic standardized assessment form due to its mean which is less than four.

Social, Demographic, and work	
Eating habits	3.25
Marital / living with	3.75
Social exclusion	3.75
Knowledge about pain physiology	3.5
# of children for women	3.25
Job satisfaction	3.75
# of sick days over the previous year	3.5

Table 11: Social, Demographic, and work Category of Selected Predictive Factors with Mean < 4

The captured values for each of these 49 items were examined. All of these selected predictive factors were captured either by all of the participants or by some of them. Twenty-nine out of the 49 selected predictive factors were captured by all of the four participants; whereas, only 14 were captured by three out of four participants and the remaining six predictive factors were captured by two out of four participants.

A couple of screenshots from the electronic standardized assessment form for CLBP are shown in the figures below.

Figure 19, shows some of the demographic, social, and work predictive factors from the electronic standardized assessment form for CLBP.

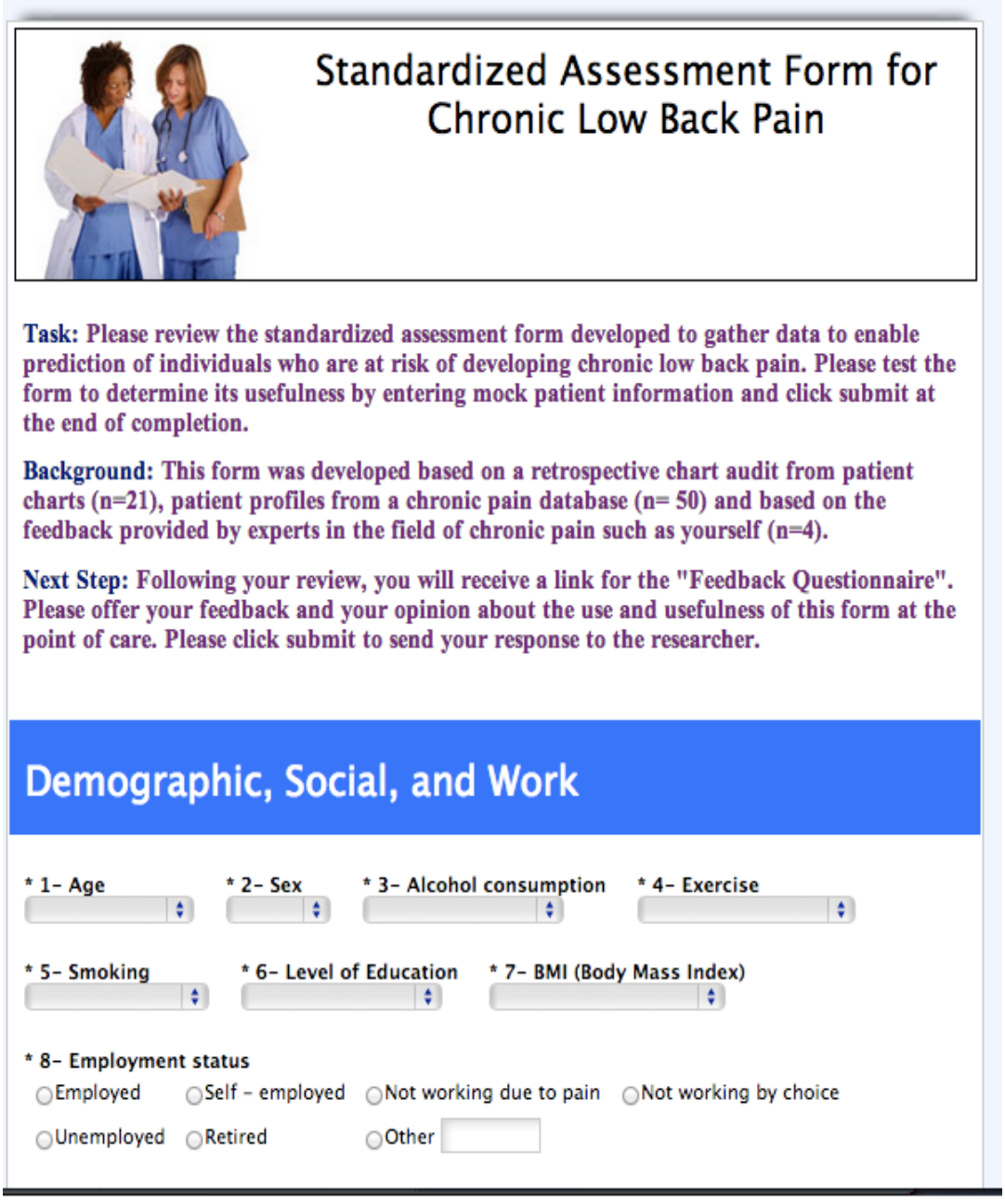

Figure 19: Screenshot from the Electronic Standardized Assessment Form showing Demographic, Social, and Work Predictive Factors

Figure 20, shows another screenshot of the electronic standardized assessment form for CLBP with the financial and some of the clinical predictive factors.

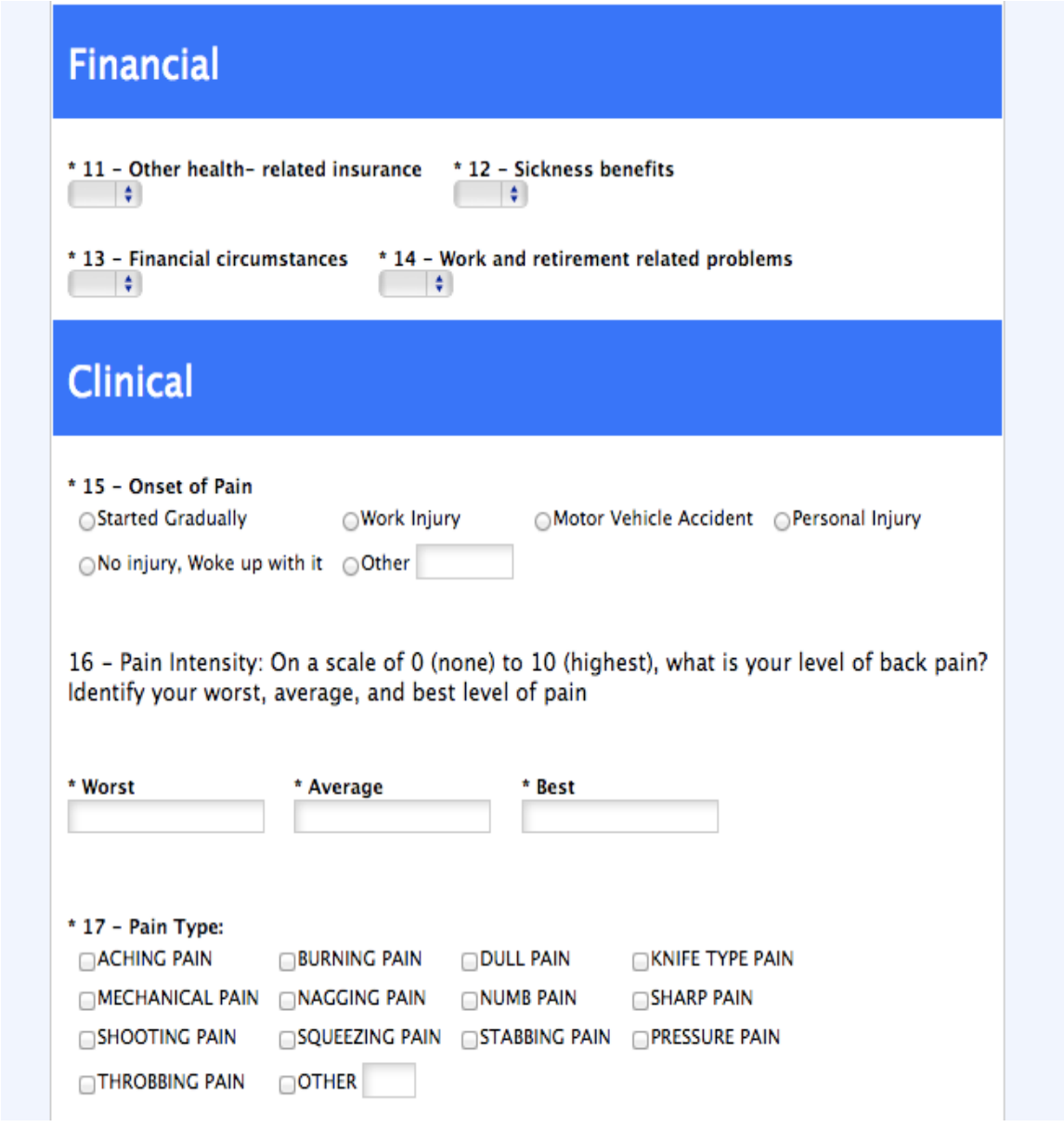

Figure 20: Screenshot from the Electronic Standardized Assessment Form Showing Financial and Some Clinical Predictive Factors

Figure 21, is another screenshot from the electronic standardized assessment form that shows the psychological symptoms associated with CLBP and some other predictive factors with the submitting button at the end of the form.

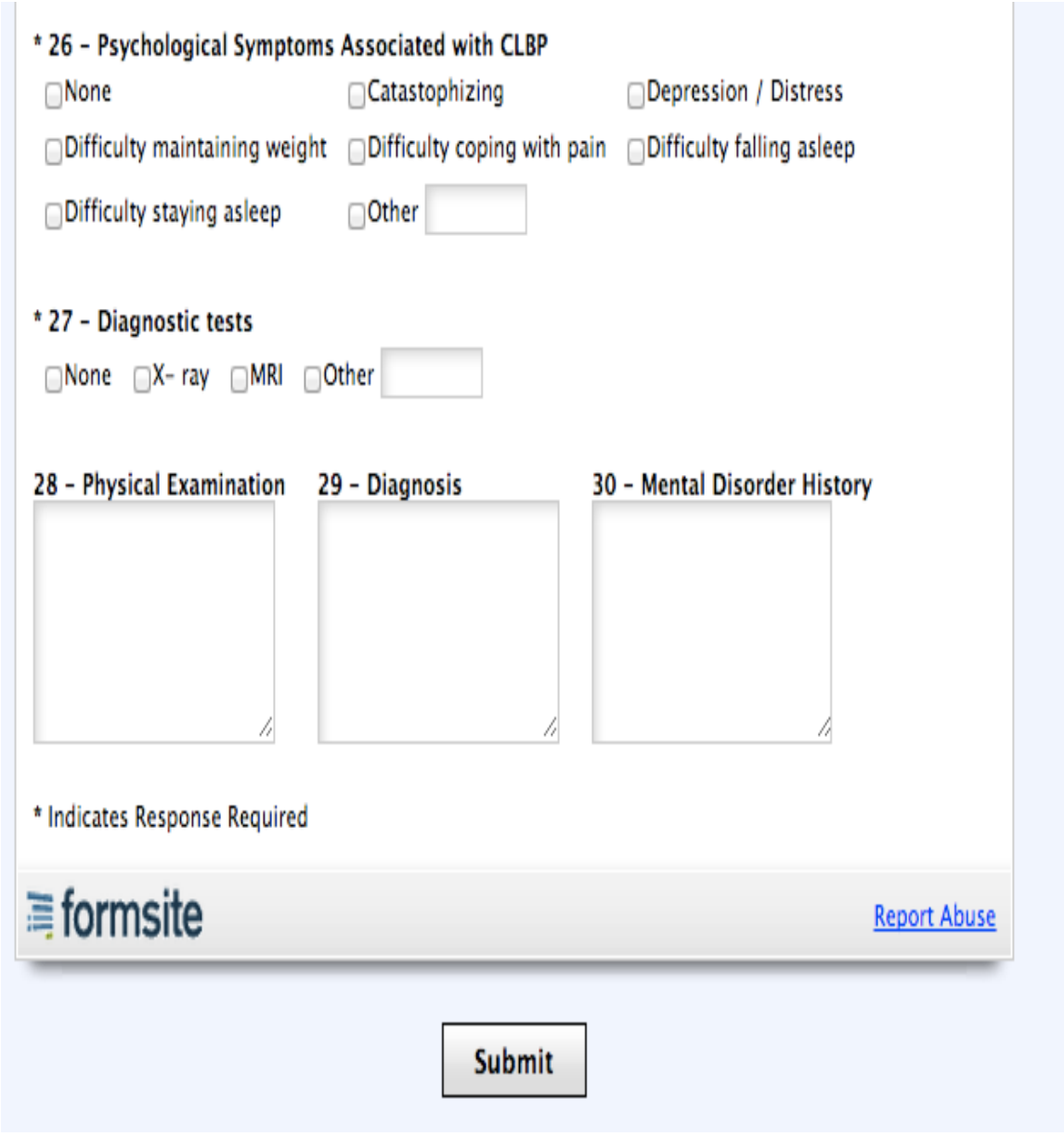

Figure 21: Screenshot from the Electronic Standardized Assessment Form Showing Psychological Predictive Factors.

6.1.2.8 Feedback Questionnaires Regarding the Electronic Standardized Assessment Form for its Use, Usefulness, and Usability

The final analysis considered the complete 49 items questionnaire as a whole. Five participants rated the questionnaire as a whole on use, usefulness, and usability. The use and usefulness questions asks about the usefulness of the form in indicating people at risk of developing CLBP, the completenece of the form regarding patietns assessment, and the interest of using the form in clinical practice. The usability questions concerns about how easy to use and to learn how to use the form in clinical settings. There were seven questions, each scored on a five point Likert scale (1 = strongly disagree, 5 = strongly agree). The ICC = 0.412 ($F(6,24) = 2.225$, $p < .076$). The ICC value is considered moderate agreement among raters, from the previously mentioned interpretation scale for ICC [95, 94].

Again an alternative to the ICC is the Cronbach's Alpha. For the current data, the Cronbach's alpha was $\alpha = 0.551$. As with the ICC, this value would be considered "moderate", but not "good" agreement. The analysis further demonstrated that one of the participants (Participant # 1116) was the least consistent and deleting his data will slightly increase in the level of Cronbach's alpha to 0.587. This value still in the moderate level of agreement among raters.

6.1.3 Standardization of Clinical Vocabularies

Standardization of clinical vocabularies included mapping the predictive factors items from the electronic standardized assessment form for CLBP with a standardized reference terminology: SNOMED CT. This was followed by evaluation of SNOMED CT standardization by medical experts.

6.1.3.1 Mapping of Predictive Factors in the Electronic Standardized Assessment Form with SNOMED CT

There are a total of 30 charts' terms with its sub-groupings that were mapped with SNOMED CT terminology and concept ID's. The mapping process was done by searching the SNOMED CT browser for pre-coordinated or post-coordinated terms. The pre-coordinated terms include matches with an individual term name and a single concept ID. The post-coordinated matches with combined terms and multiple simpler concept ID from the SNOMED CT. The percentage of pre-coordinated matches is 90 % while only 10 % had a post-coordination matches with SNOMED CT (See Figure16).

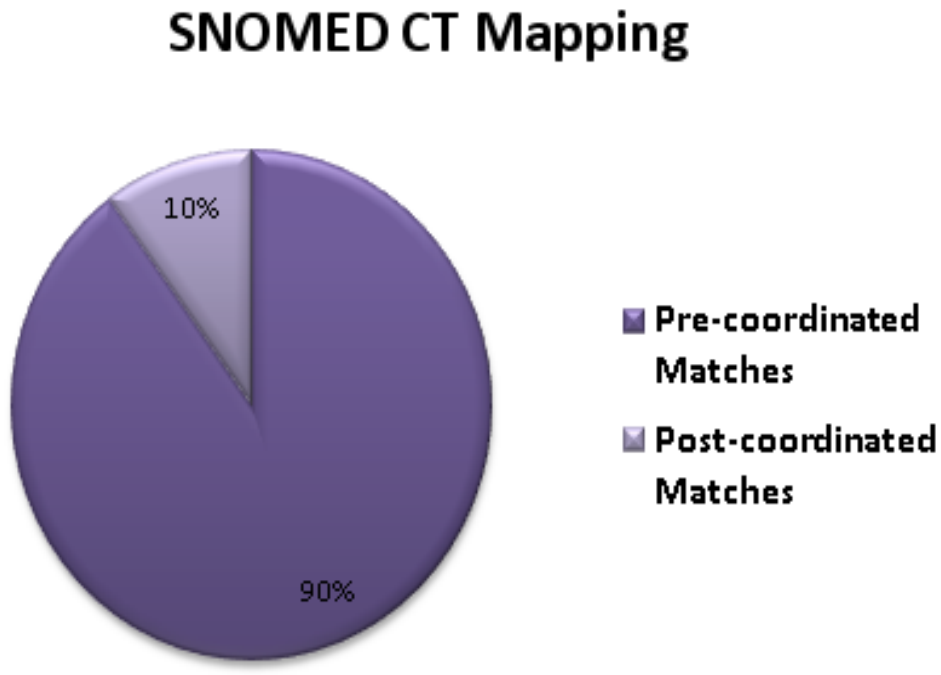

Figure 22: Mapping with SNOMED CT Percentages.

Table 12, shows the post-coordinated matches in this research.

Display Name	Standardized terms found in SNOMED CT (post-coordination)	SNOMED CT concept ID
Not working due to pain	Giving up work + due to+ pain	276059007 + 42752001 + 22253000
Reason for not working	Reason for + unemployed	410666004 + 73438004
No injury, woke up with it	finding related to onset of pain + causative agent + unknown (origin)	428209001 + 246075003+ 54690008
Numb Pain	finding of pattern of pain + numbness	301369003 + 44077006
Pain Duration of Current Episode	pain + temporal context + current - specified	22253000 + 408731000 + 410584005
Hyperesthesia in leg	Hyperesthesia + finding site + skin of knee and/or leg and/or ankle	14151009 + 363698007 + 304625001
Prolonged standing	standing +prolonged	10904000 + 255224006
Worsened by changing position	Pain +provoked by +changing position	22253000 + 410658008 + 299981009
Worsened by bending or kneeling down	pain + provoked by +forward bending or + kneeling	22253000 + 410658008 + 417188003 +55864004
Previous Treatment by healthcare professional	Treatment pain by + healthcare professional + temporal context + past	110363002 + 223366009 + 408731000 + 410513005
Psychological symptoms Associated with CLBP	Psychological finding + associated with + CLBP	116367006 + 47429007 + 278860009

Table 12: Post-Coordinated Mapping with SNOMED CT.

6.1.3.2 Evaluation of Standardized Terminology

The same five medical experts (1 pain specialist, 2 surgeons, 1 family physician, and 1 nurse practitioner) were asked to look at the chart terms and their mapping of SNOMED CT terms and concept ID. These participants are asked to give their feedback on the use of SNOMED CT in the standardized assessment form for CLBP. There were only two questions, each scored on a five point Likert scale (1 = strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5 = strongly agree). The statistical analysis for these feedback questionnaires was done with the intra-class correlation for inter-rater reliability among experts. The ICC = 0.571 ($F(1,3) = 3.0$, $p = 0.182$) and it is considered moderate agreement among raters, from the previously mentioned interpretation scale for ICC [95, 94].

Again an alternative to the ICC is the Cronbach's Alpha. For the current data, the Cronbach's alpha was $\alpha = 0.667$. As with the ICC, this value would be considered "moderate", but not "good" agreement. The analysis further demonstrated that two participants (participant # 1111and participant # 1113) are least consistent and deleting anyone of them will increase Cronbach's alpha to 0.750. This value still in the moderate level of agreement between raters.

Statistical analysis of data collected from heterogeneous sources was explored in this chapter and the inter-rater reliability measurements were calculated for different feedback questionnaires regarding the standardized assessment form and the use of SNOMED CT.

As a conclusion, this chapter represent the results and statistical analysis of this thesis research. It shows frequency analysis of collected data and some measurements of inter-

rater reliability among raters in the evaluation of the use and usefulness of the developed standardized assessment form.

Chapter 7 Discussion

In this chapter we discuss the research in terms of its contributions, limitations, future directions, and conclusions.

Early identification of CLBP can help PCPs[13] in the assessment and management of CLBP which will improve the quality of care provided to patients [11]. It also assists PCPs in the decision making process regarding care plans [6].

The primary objective of this research was to develop and evaluate an electronic standardized assessment form through the application of a triangulation methodology with a broad goal of improving care for CLBP patients and assisting PCPs in the early identification of CLBP patients. The triangulation methodology was used in this research to harmonize the dataset from heterogeneous sources of location, knowledge and methods [89, 90]. Location heterogeneity included patient charts, literature, pain database, experts and reference vocabulary. Knowledge heterogeneity included clinical knowledge, evidence knowledge, expert knowledge and standardized knowledge. Methods heterogeneity included retrospective chart audit, questionnaires, observation and qualitative data. Applying triangulation enabled a greater level of confidence and reliability regarding the outcome of this research [23]. Another objective of this research was to standardize the predictive factors with a well known reference set SNOMED CT [75, 76]. Evaluation of the use, usefulness, usability, and the standardizing of predictive factors items with SNOMED CT was completed through electronic feedback questionnaires sent to five medical experts. These medical experts deal with CLBP

[13] Primary Care Providers

patients and they are from various departments (pain management unit, surgery department, and primary care unit).

The developed electronic standardized assessment form contains 30 predictive factors for CLBP organized under different categories. These categories are: clinical, financial, psychological, demographic, social, and work-related. Having predictive factors for the required and relevant categories of care can help in early detection and timely treatment of care for CLBP patients [6].

Having an electronic standardized assessment form in the primary care office is helpful in improving the communication and collaboration among healthcare providers. This form can provide effective information and possibly assist the PCPs in submitting complete and accurate referral forms to specialists. The form is fairly short and this can help PCPs use it at the point of care, as it wouldn't take them long to complete it.

7.1 Limitations

There were some limitations in this thesis research that include the small sample size from patient charts and the small number medical experts who participated. Even with the small sample size from patient charts (n=21) and from the chronic pain database (n=50), the collected items that represent the predictive factors for CLBP are sufficient for analysis for comparison and for analysis with the reference dataset. The smallness of the sample size of medical experts participating this study was due to the short period of time and the difficulty of keeping in touch with them. There were supposed to be eight medical experts participating in the various phases of this research, unfortunately only five participants completed the final feedback questionnaire regarding use, usefulness, usability, and the standardization with SNOMED CT.

The results might be significantly improved if there was a higher number of participants and more patients' charts to review.

Even though there were a limited number of experts and a limited number of viewed patient charts, this research can be considered as an opportunity for establishing baseline standards through the application of evidence, clinical knowledge and expert involvement in the development of an assessment form to improve prediction of CLBP.

7.2 Outstanding Research Steps

One of the medical experts who participated in this research, the nurse practitioner, showed an interest in using the electronic standardized assessment form on three new patients with CLBP. Having such an interest shows there is a huge potential for future development arising from this research. After using this form on three new patients' profiles, the same survey will be done to evaluate its use, usefulness, usability, and the standardization of terms with SNOMED CT. However, due to the short time frame involved in finishing this research, and the busy schedule of the participant, this step could not be completed.

Having interested participants test the form by using it is truly an outstanding step in this research.

7.3 Contributions of the Research

There are some key phases of the triangulation methodology used in this research, which include:

- Development of an electronic standardized assessment form for CLBP from heterogeneous sources of data collection.

- Evaluation and feedback from experts regarding the use, usefulness, usability, and standardization of terms with SNOMED CT

There are also some long-term benefits of this research which include:

- Better understanding of knowledge of predictive factors for CLBP.
- Improvement in the assessment and management of LBP patients.
- Improvement of the communication and collaboration between PCPs and specialists with the improvement of timely referrals.

7.4 Conclusion

Conclusions from this thesis research are summarized as follow:

- Triangulation methodology was used to develop an electronic standardized assessment form for CLBP.
- This methodology contains three levels of standardization. One is based on evidence, involving knowledge from the Multinational Musculoskeletal Inception Cohort Study. The second is standardization of clinical information, involving retrospective chart audit of patient charts, a chronic pain database, and from experts' opinions.
- Vocabularies were standardized through the use of SNOMED CT.
- The electronic standardized assessment form for CLBP was evaluated for its use, usefulness, usability, and the standardization of terminology with SNOMED CT.
- The electronic standardized assessment form provides consistent and standardized information which leads to a better understanding of the predictive factors for CLBP.

- Improvement of the communication and collaboration among healthcare providers through the early identification and prediction of CLBP can be achieved through the use of the standardized assessment form.

7.5 Future Contributions

As a continuation for this research study, there is potential for developing an electronic referral form that can help in improving the communication and collaboration among healthcare providers and improving of the quality of healthcare.

To expand this research in the future, the need for a larger sample size of patietn charts and experts with homogeneous disciplines can lead to the development of a scoring scale and automated results which can help in identifying patients' different levels of developing CLBP. Consideration of the sensitivity and specificity measurment of each factor is another point that can validate the assessment tool predictive factors [96]. That will lead to early identification and early intervention with patients at risk of developing CLBP. Applying these improvements can lead to better care for patients' with CLBP, possibly reduce high costs related to treatment, reduce inappropriate referrals to specialists and improve work satisfaction for PCPs [7, 8].

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Appendix A MMICS Predictive Factors for CLBP

- Clinical

1. BMI
   - Disability
2. Stay at home most of the time because of my back.
3. I change position frequently to try and get my back comfortable.
4. I walk more slowly than usual because of my back.
5. Because of my back I am not doing any of the jobs that I usually do around the house.
6. Because of my back, I use a handrail to get upstairs.
7. Because of my back, I lie down to rest more often.
8. Because of my back, I have to hold on to something to get out of an easy chair.
9. Because of my back, I try to get other people to do things for me.
10. I get dressed more slowly than usual because of my back.
11. I only stand for short periods of time because of my back.
12. Because of my back, I try not to bend or kneel down.
13. I find it difficult to get out of a chair because of my back.
14. My back is painful almost all the time.
15. I find it difficult to turn over in bed because of my back.
16. My appetite is not very good because of my back pain.
17. I have trouble putting on my socks (or stockings) because of the pain in my back.
18. I only walk short distances because of my back.
19. I sleep less well because of my back.
20. Because of my back pain, I get dressed with help from someone else.
21. I sit down for most of the day because of my back.
22. I avoid heavy jobs around the house because of my back.
23. Because of my back pain, I am more irritable and bad tempered with people than usual

24. Because of my back, I go upstairs more slowly than usual.

25. I stay in bed most of the time because of my back

26. Leg pain below knee
27. Pain intensity
28. Pain duration of current episode

- Financial

29- Duration on current benefits
30- Other health-related insurance
31- Pending compensation
32- Sickness benefits

- Life Style

33- Alcohol consumption
34- Exercise
35- Smoking

- Psychological

36- Catastophizing
37- Depression / Distress
38- Fear avoidance

- Social, demographic, and work

39- Education
40- Employment status
41- Job-related factors: a- job satisfaction
b- Social support
c- Sense of control
42- Marital / Living with
43- No. of sick days over previous year
44- Reason for not working
45- Type of work

Appendix B The Interview Questionnaire

Study Title: Standardization of Predictive Factors for Chronic Low Back Pain: A Pilot Study
Researchers: Ghdeer Tashkandi, Dr.Tara Sampalli, Dr.Grace Paterson.
Instructions: Please print questionnaire, fill the survey and fax to Tara Sampalli at 860-2046. Anytime not later than June 4, 2012.
Interview questions

1. Do you consistently use predictive factors in clinical practice to identify patients that may be at a risk to develop chronic low back pain problems (CLBP)?

   Please choose one Yes ☐ No ☐ Other _____

2. If your response was yes for question #1, can you list the predictive factors that you currently use as predictive factors for CLBP?

   _____

3. Do you currently have or plan to have a standardized way of capturing predictive factors for CLBP?

   Please choose one Currently have ☐ Plan to have ☐ Don't have ☐

   Other _____

4. Do you currently refer to any particular guidelines or standards in literature to assist you in the management of CLBP? If yes, please mention the name of the guidelines or standards.

   _____

5. Do you feel that consistently using a standardized way of capturing predictive factors for CLBP can improve the process of identifying patients at risk?

   Please choose one Yes ☐ No ☐ Other _____

6. Do you feel you need additional supports in the form of technology or standardized forms to consistently use guidelines or standards in the prediction of CLBP?

   Please choose one Yes ☐ No ☐ Other _____

   Additional information or comments:_____

Appendix C The Experts' Opinion Survey

Selected Terms	Level of agreement					Practice	
➢ **Subjective**	**SA**	**A**	**N**	**D**	**SD**	**Captured**	**Not Captured**
1- Onset of pain	☐	☐	☐	☐	☐	☐	☐
2- Pain intensity	☐	☐	☐	☐	☐	☐	☐
3- Pain characteristics	☐	☐	☐	☐	☐	☐	☐
a. Radiating pain	☐	☐	☐	☐	☐	☐	☐
b. Aching pain	☐	☐	☐	☐	☐	☐	☐
c. Continuous pain	☐	☐	☐	☐	☐	☐	☐
d. Hot pain	☐	☐	☐	☐	☐	☐	☐
e. Knife type pain	☐	☐	☐	☐	☐	☐	☐
f. Mechanical pain	☐	☐	☐	☐	☐	☐	☐
g. Squeezing pain	☐	☐	☐	☐	☐	☐	☐
h. Stabbing pain	☐	☐	☐	☐	☐	☐	☐
4- Pain location	☐	☐	☐	☐	☐	☐	☐
a. Leg pain below the knee	☐	☐	☐	☐	☐	☐	☐
b. Hip pain	☐	☐	☐	☐	☐	☐	☐
c. Lumbar spine tender	☐	☐	☐	☐	☐	☐	☐

Selected Terms	Level of agreement					Practice	
	SA	A	N	D	SD	Captured	Not Captured
d. Musculoskeletal pain	☐	☐	☐	☐	☐	☐	☐
e. Mid back pain	☐	☐	☐	☐	☐	☐	☐
5- Pain duration of current episode	☐	☐	☐	☐	☐	☐	☐
6- Sensation in leg	☐	☐	☐	☐	☐	☐	☐
a. Hyperesthesia in leg	☐	☐	☐	☐	☐	☐	☐
7- Aggravating / Alleviating factors	☐	☐	☐	☐	☐	☐	☐
a. Prolonged standing	☐	☐	☐	☐	☐	☐	☐
b. Prolonged sitting	☐	☐	☐	☐	☐	☐	☐
c. Extension and flexion	☐	☐	☐	☐	☐	☐	☐
d. Ambulation slow and guarded	☐	☐	☐	☐	☐	☐	☐
e. Exercise	☐	☐	☐	☐	☐	☐	☐
f. Work	☐	☐	☐	☐	☐	☐	☐
g. Vacuum	☐	☐	☐	☐	☐	☐	☐
h. Stay at home	☐	☐	☐	☐	☐	☐	☐
i. Stay in bed	☐	☐	☐	☐	☐	☐	☐
j. Lie down	☐	☐	☐	☐	☐	☐	☐

Selected Terms	Level of agreement					Practice	
	SA	A	N	D	SD	Captured	Not Captured
k. Change position frequently	☐	☐	☐	☐	☐	☐	☐
l. Sit down	☐	☐	☐	☐	☐	☐	☐
m. Walk slowly	☐	☐	☐	☐	☐	☐	☐
n. Walk short distance	☐	☐	☐	☐	☐	☐	☐
o. Get up stairs	☐	☐	☐	☐	☐	☐	☐
p. Get out of an easy chair	☐	☐	☐	☐	☐	☐	☐
q. Putting on socks	☐	☐	☐	☐	☐	☐	☐
r. Bending or kneeling down	☐	☐	☐	☐	☐	☐	☐
s. Turnover in bed	☐	☐	☐	☐	☐	☐	☐
t. Work around the house	☐	☐	☐	☐	☐	☐	☐
u. Getting dressed up	☐	☐	☐	☐	☐	☐	☐
v. Sleeping	☐	☐	☐	☐	☐	☐	☐
w. Eating	☐	☐	☐	☐	☐	☐	☐
x. Activity of daily living	☐	☐	☐	☐	☐	☐	☐
y. Medication	☐	☐	☐	☐	☐	☐	☐
z. Ice packs	☐	☐	☐	☐	☐	☐	☐

Selected Terms	Level of agreement					Practice	
	SA	A	N	D	SD	Captured	Not Captured
aa. Hot packs	☐	☐	☐	☐	☐	☐	☐
8- Past medical history	☐	☐	☐	☐	☐	☐	☐
9- Past surgical history	☐	☐	☐	☐	☐	☐	☐
10- Obstetrical history	☐	☐	☐	☐	☐	☐	☐
11- Psychological symptoms associated with CLBP	☐	☐	☐	☐	☐	☐	☐
a. Catastrophizing	☐	☐	☐	☐	☐	☐	☐
b. Depression / Distress	☐	☐	☐	☐	☐	☐	☐
c. Fear avoidance	☐	☐	☐	☐	☐	☐	☐
d. Difficulty maintain weight	☐	☐	☐	☐	☐	☐	☐
e. Difficulty coping with pain	☐	☐	☐	☐	☐	☐	☐
f. Difficulty falling asleep	☐	☐	☐	☐	☐	☐	☐
g. Difficulty staying asleep	☐	☐	☐	☐	☐	☐	☐
h. Recurring thoughts	☐	☐	☐	☐	☐	☐	☐
i. Worrying	☐	☐	☐	☐	☐	☐	☐
j. Mental disorder history	☐	☐	☐	☐	☐	☐	☐

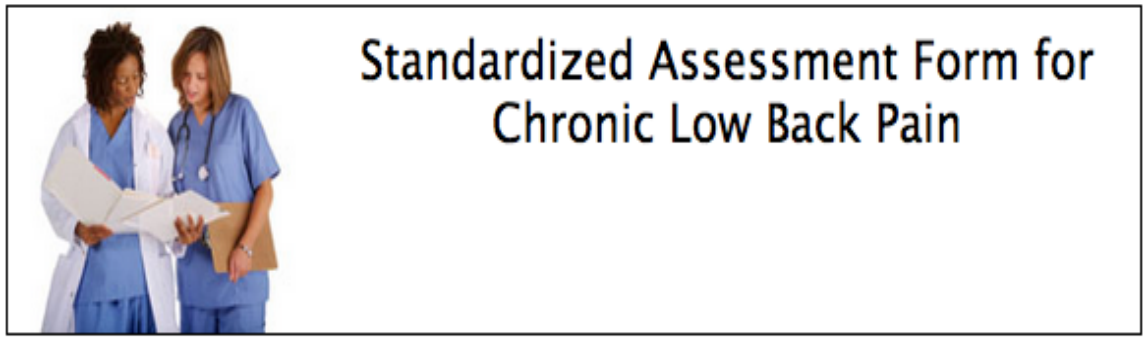
Selected Terms	Level of agreement					Practice	
	SA	A	N	D	SD	Captured	Not Captured
k. Panic attack	☐	☐	☐	☐	☐	☐	☐
l. Low self-esteem	☐	☐	☐	☐	☐	☐	☐
m. Mood changes	☐	☐	☐	☐	☐	☐	☐
n. Anger	☐	☐	☐	☐	☐	☐	☐
o. Anxiety	☐	☐	☐	☐	☐	☐	☐
p. Frustrated	☐	☐	☐	☐	☐	☐	☐
q. Cranky	☐	☐	☐	☐	☐	☐	☐
➢ Objective							
12- BMI	☐	☐	☐	☐	☐	☐	☐
13- Review of previous test and exams	☐	☐	☐	☐	☐	☐	☐
14- Posture and body mechanics status	☐	☐	☐	☐	☐	☐	☐
15- Physical examination of the lumbosacral spine	☐	☐	☐	☐	☐	☐	☐
➢ **Assessment**							
16- Diagnosis	☐	☐	☐	☐	☐	☐	☐
➢ **Planning**							
17- Suggestion to attend pain self management program (PSMP)	☐	☐	☐	☐	☐	☐	☐
18- Complementary and alternative medicine	☐	☐	☐	☐	☐	☐	☐

Selected Terms	Level of agreement					Practice	
	SA	A	N	D	SD	Captured	Not Captured
a. Chiropractor	☐	☐	☐	☐	☐	☐	☐
b. Message therapy	☐	☐	☐	☐	☐	☐	☐
c. Herbal therapies	☐	☐	☐	☐	☐	☐	☐
d. Relaxation techniques	☐	☐	☐	☐	☐	☐	☐
e. Yoga, Tai chi, Qi Gong	☐	☐	☐	☐	☐	☐	☐
f. Acupuncture	☐	☐	☐	☐	☐	☐	☐
➢ **Financial**							
19- Duration on current benefits	☐	☐	☐	☐	☐	☐	☐
20- Other health-related insurance	☐	☐	☐	☐	☐	☐	☐
21- Pending compensation	☐	☐	☐	☐	☐	☐	☐
22- Sickness benefits	☐	☐	☐	☐	☐	☐	☐
23- Financial problem findings	☐	☐	☐	☐	☐	☐	☐
24- Finding of entitlement to benefits status	☐	☐	☐	☐	☐	☐	☐
25- Financial circumstances finding	☐	☐	☐	☐	☐	☐	☐
26- Loss of benefits finding	☐	☐	☐	☐	☐	☐	☐
27- Unable to retire	☐	☐	☐	☐	☐	☐	☐
28- Income assistance	☐	☐	☐	☐	☐	☐	☐

Selected Terms	Level of agreement					Practice	
	SA	A	N	D	SD	Captured	Not Captured
29- Work social assistance	☐	☐	☐	☐	☐	☐	☐
30- Suspended from work	☐	☐	☐	☐	☐	☐	☐
➢ **Life Style**	☐	☐	☐	☐	☐	☐	☐
31- Alcohol consumption	☐	☐	☐	☐	☐	☐	☐
32- Exercise	☐	☐	☐	☐	☐	☐	☐
33- Smoking	☐	☐	☐	☐	☐	☐	☐
➢ **Social, Demographic, and Work**	☐	☐	☐	☐	☐	☐	☐
34- Marital / Living with	☐	☐	☐	☐	☐	☐	☐
35- Education	☐	☐	☐	☐	☐	☐	☐
36- Knowledge about pain physiology and pain self management program (PSMP)	☐	☐	☐	☐	☐	☐	☐
37- Age	☐	☐	☐	☐	☐	☐	☐
38- Sex	☐	☐	☐	☐	☐	☐	☐
39- Number of children for women	☐	☐	☐	☐	☐	☐	☐
40- Employment status	☐	☐	☐	☐	☐	☐	☐
41- Work type	☐	☐	☐	☐	☐	☐	☐
42- Job-related factors: a. Job satisfaction	☐	☐	☐	☐	☐	☐	☐

Selected Terms	Level of agreement					Practice	
	SA	A	N	D	SD	Captured	Not Captured
b. Social support	☐	☐	☐	☐	☐	☐	☐
c. Sense of control	☐	☐	☐	☐	☐	☐	☐
43- No. Of sick days over the previous year	☐	☐	☐	☐	☐	☐	☐
44- Reason for not working	☐	☐	☐	☐	☐	☐	☐

Appendix D The Electronic Standardized Assessment Form for CLBP



Task: Please review the standardized assessment form developed to gather data to enable prediction of individuals who are at risk of developing chronic low back pain. Please test the form to determine its usefulness by entering mock patient information and click submit at the end of completion.

Background: This form was developed based on a retrospective chart audit from patient charts (n=21), patient profiles from a chronic pain database (n= 50) and based on the feedback provided by experts in the field of chronic pain such as yourself (n=4).

Next Step: Following your review, you will receive a link for the "Feedback Questionnaire". Please offer your feedback and your opinion about the use and usefulness of this form at the point of care. Please click submit to send your response to the researcher.

Demographic, Social, and Work

* 1- Age
* 2- Sex
* 3- Alcohol consumption
* 4- Exercise
* 5- Smoking
* 6- Level of Education
* 7- BMI (Body Mass Index)

* 8- Employment status

○ Employed ○ Self - employed ○ Not working due to pain ○ Not working by choice

○ Unemployed ○ Retired ○ Other

*** 9- Occupation Type**

To understand more about the occupation type please follow the link

The National Occupation Classification (NOC)

10 - Reason for not working

0/255 characters

Financial

*** 11 - Other health- related insurance**

*** 12 - Sickness benefits**

*** 13 - Financial circumstances**

*** 14 - Work and retirement related problems**

Clinical

*** 15 - Onset of Pain**

- Started Gradually
- Work Injury
- Motor Vehicle Accident
- Personal Injury
- No injury, Woke up with it
- Other

16 - Pain Intensity: On a scale of 0 (none) to 10 (highest), what is your level of back pain? Identify your worst, average, and best level of pain

*** Worst**

*** Average**

*** Best**

*** 17 – Pain Type:**

- ☐ ACHING PAIN
- ☐ BURNING PAIN
- ☐ DULL PAIN
- ☐ KNIFE TYPE PAIN
- ☐ MECHANICAL PAIN
- ☐ NAGGING PAIN
- ☐ NUMB PAIN
- ☐ SHARP PAIN
- ☐ SHOOTING PAIN
- ☐ SQUEEZING PAIN
- ☐ STABBING PAIN
- ☐ PRESSURE PAIN
- ☐ THROBBING PAIN
- ☐ OTHER

*** 18 – Pain Location:**

☐ Leg pain below the knee ☐ Hip pain ☐ Thigh Pain ☐ Lumbar spine tender ☐ Other

*** 19 – Pain Duration of Current Episode**

*** 20 – Is there any numbness in leg?**

*** 21 – Is there any hyperesthesia in leg?**

*** 22 – Aggravating / Alleviating Factors:**

- ☐ Worsened by bending or kneeling down
- ☐ Relieved by lying down
- ☐ Prolonged standing
- ☐ Worsened by changing position
- ☐ Relieved by medication
- ☐ Relieved by changing position
- ☐ work / house work
- ☐ Worsened by exercise
- ☐ Others

23 – Past Medical History

24 – Past Surgical History

*** 25 – Previous Treatment by healthcare professional**

☐ None ☐ Physiotherapy ☐ Chiropractor ☐ Acupuncture ☐ Massage Therapy ☐ Other

*** 26 – Psychological Symptoms Associated with CLBP**

- ☐ None
- ☐ Catastophizing
- ☐ Depression / Distress
- ☐ Difficulty maintaining weight
- ☐ Difficulty coping with pain
- ☐ Difficulty falling asleep
- ☐ Difficulty staying asleep
- ☐ Other

*** 27 – Diagnostic tests**

☐ None ☐ X- ray ☐ MRI ☐ Other

28 – Physical Examination

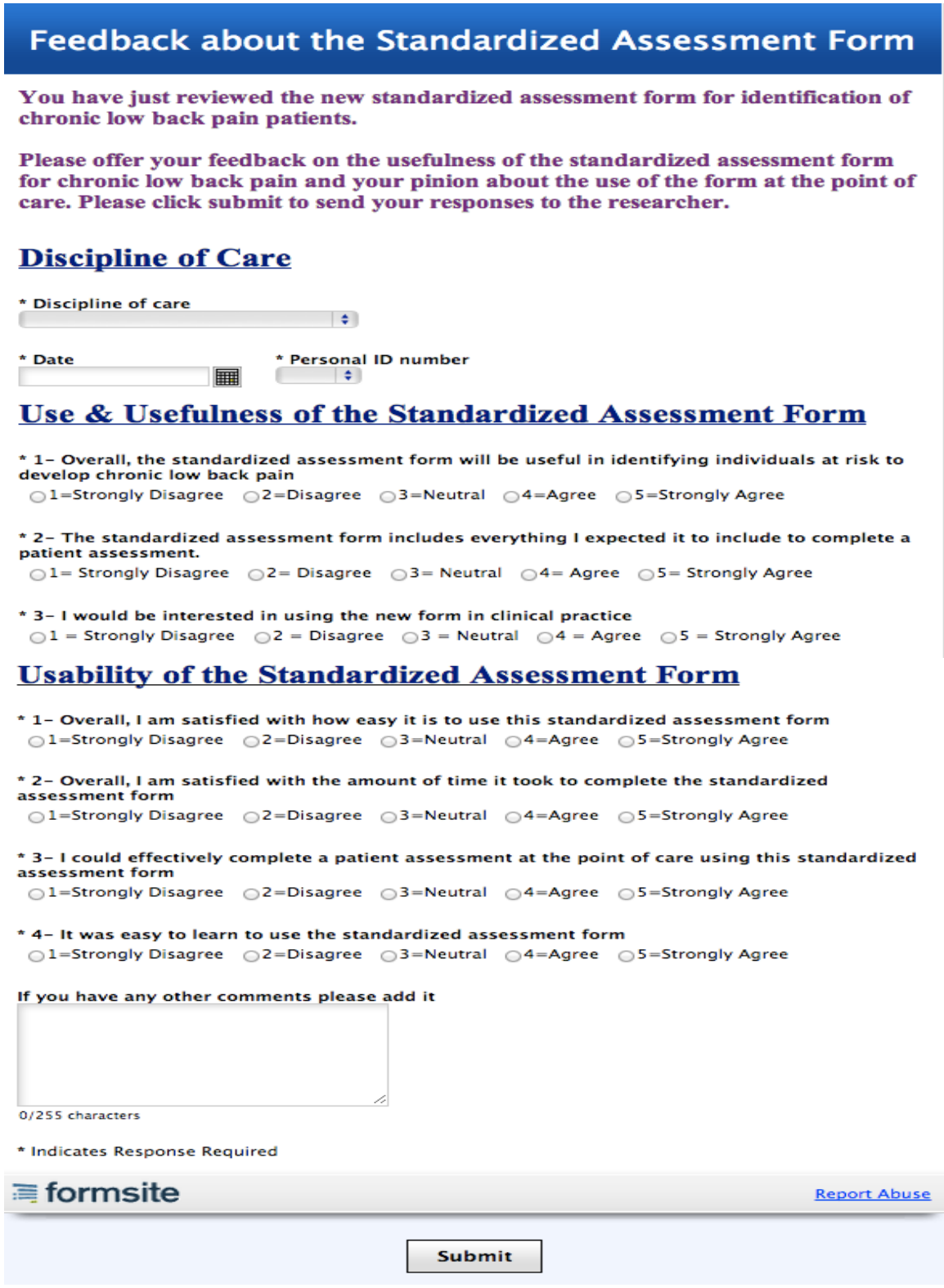
29 – Diagnosis

30 – Mental Disorder History

* Indicates Response Required

Submit

Appendix E Feedback Questionnaire Regarding the Electronic Standardized Assessment Form use, usefulness, and usability



Feedback about the Standardized Assessment Form

You have just reviewed the new standardized assessment form for identification of chronic low back pain patients.

Please offer your feedback on the usefulness of the standardized assessment form for chronic low back pain and your pinion about the use of the form at the point of care. Please click submit to send your responses to the researcher.

Discipline of Care

* Discipline of care

* Date

* Personal ID number

Use & Usefulness of the Standardized Assessment Form

* 1- Overall, the standardized assessment form will be useful in identifying individuals at risk to develop chronic low back pain
1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

* 2- The standardized assessment form includes everything I expected it to include to complete a patient assessment.
1= Strongly Disagree 2= Disagree 3= Neutral 4= Agree 5= Strongly Agree

* 3- I would be interested in using the new form in clinical practice
1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

Usability of the Standardized Assessment Form

* 1- Overall, I am satisfied with how easy it is to use this standardized assessment form
1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

* 2- Overall, I am satisfied with the amount of time it took to complete the standardized assessment form
1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

* 3- I could effectively complete a patient assessment at the point of care using this standardized assessment form
1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

* 4- It was easy to learn to use the standardized assessment form
1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

If you have any other comments please add it

0/255 characters

* Indicates Response Required

formsite Report Abuse

Submit

Appendix F Feedback Questionnaire about the Standardized Assessment Form Using SNOMED CT

Feedback about standardizing the terminologies in the Standardized Assessment Form with SNOMED CT

Please review this form that shows the standardization of the terminologies used in the assessment form using SNOMED CT. Please note that when a single SNOMED CT name is not available a combination of SNOMED CT names is created to standardize the terms

Background of standardization: Studies have shown that standardization of clinical terminology can enable better and accurate sharing of information among multiple users. We have used Systematized Nomenclature of Medicine - Clinical Terms (SNOMED CT) to standardize the terminologies used in the standardized assessment form using SNOMED CT.

1- The standardized terminologies are presented as a table (shown below) using SNOMED CT, with the assessment form terms, the standardized terms found in SNOMED CT, and the SNOMED CT concept ID.

2- Following your review, please offer your feedback on the usefulness of the standardized terminologies by completing the 2 survey questions at the bottom of the form. Please click submit to send the form to the researcher once you have offered your rating.

* Please indicate your discipline of care from the options below

* Date

* Personal ID number

Chart audit terms	Standardized terms found in SNOMED CT (SNOMED CT individual name or combined name)	SNOMED CT concept ID
Demographic, Social, and Work		
1- Age	Age	397669002
2- Sex	Gender	263495000
i- Male	Male	248153007
ii- Female	Female	248152002

3- Alcohol Consumption	finding relating to alcohol drinking behaviour	228273003
i- Don't drink alcohol	non - drinker	105542008
ii- Drink occasionally	occasional drinker	228276006
iii- Drinks a lot	heavy drinker	86933000
iv- Alcoholic	Alcoholic	228281002
4- Exercise	exercise history finding	365993003
i- Never	gets no exercise	228445002
ii- Rarely	gets little exercise	228446001
iii- Once or twice a week	exercises regularly	228448000
iv- Every other day	Alternate days	225760004
v- Daily	excessive exercise	102533007
5- Smoking	tobacco use and exposure - finding	365980008
i- Not smoker	non-smoker	8392000
ii- Light smoker	light cigarette smoker	230060001
iii- Heavy smoker	heavy cigarette smoker	230063004
iv- Ex-smoker (quit)	ex-smoker	8517006
6- Level of Education	education and/or schooling finding	365458002
i- High school or less	educated to secondary school level	224297003
ii- Some college	higher education	161122005
iii- College graduate	received higher education college education	224302000
iv- Post graduate	received postgraduate education	440344006

7- BMI	body mass index	60621009
i- Underweight (16 – 18.5)	underweight	248342006
ii- Normal (18.5 – 25)	normal weight	43664005
iii-Over weight (25 – 29)	body mass index 25-29 - overweight	162863004
iv-Obese (+ 30)	BMI 30+ - obesity	162864005
8- Employment Status	employment status	224362002
i- Employed	employed	224363007
ii- Self-employed	self-employed	160906004
iii-Not working due to pain	giving up work + due to+ pain	276059007+ 42752001 + 22253000
iv-Not working by choice	chronic unemployment	160900005
v- Unemployed	unemployed	73438004
vi-Retired	retired	105493001
9- Occupation Type	occupation type	276212005
i- Managerial occupations	managerial occupation	159326004
ii- Professional occupations	social group 1 - professional	160482007
iii- Skilled	social group 3 - skilled	160484008
iv- Semi-skilled	social group 4 - semi-skilled	160485009
v- Low-skilled	social group 5 - unskilled	160486005
10- Reason for not Working	reason for + unemployed	410666004+ 73438004
Financial		
11- Other health-related insurance	private health insurance held	185952002
12- Sickness Benefits	sickness benefit	160979005
13- Financial Circumstances	financial circumstances	224164009

14- Work and retirement related problems	work and retirement-related problems	302122003
Clinical		
15- Onset of Pain	finding related to onset of pain	428209001
i- Started gradually	gradual onset of pain	427128002
ii- Work injury	accident while engaged in work-related activity	17542004
iii- Motor vehicle accident	motor vehicle accident	418399005
iv- Personal injury	injury	417163006
v- No injury, woke up with it	finding related to onset of pain + causative agent + unknown (origin)	428209001 + 246075003 +54690008
16- Pain Intensity	pain intensity	406127006
17- Pain Type	finding of pattern of pain	301369003
i- Aching pain	aching pain	27635008
ii- Burning pain	burning pain	36349006
iii-Dull pain	dull pain	83644001
iv-Knife type pain	cutting pain	162503007
v- Mechanical pain	mechanical pain	9626006
vi-Nagging pain	gnawing pain	301371003
vii- Numb pain	finding of pattern of pain numbness	301369003 + 44077006
viii- Sharp pain	sharp pain	8708008
ix-Shooting pain	shooting pain	49575005
x- Squeezing pain	squeezing pain	428557006
xi-Stabbing pain	stabbing pain	55145008
xii- Pressure pain	Sensation of pressure	397645001
xiii- Throbbing pain	throbbing pain	29695002

18- Pain Location	pain finding at anatomical site	279001004
i- Leg pain below the knee	structure of below knee region	8289001
ii- Hip pain	hip pain	49218002
iii-Thigh pain	thigh pain	78514002
iv-Lumbar spine tender	lumbar spine – tender	298673002
19- Pain Duration of Current Episode	pain + temporal context + current - specified	22253000 + 408731000 + 410584005
i- Just started	just noticeable	260351008
ii- Days	days	258703001
iii-Months	months	258706009
iv-Years	years	258707000
20- Numbness in leg	numbness of lower limb	309537005
21- Hyperesthesia in leg	Hyperesthesia + finding site + skin of knee and/or leg and/or ankle	14151009 + 363698007 + 304625001
22- Aggravating / alleviating factors	symptom aggravating factors /symptom relieving factors	162473008 / 162483007
i- Prolonged standing	Standing +prolonged	10904000 + 255224006
ii- Worsened by exercise	Provoked by exertion	427341007
iii-Work / house work	condition made worse by work	413904000
iv-Relieved by lying down	Relief by supine body position	428643002
v- Relieved by changing position	Relief related to position	429147006
vi-Worsened by changing position	Pain + provoked by + changing position	22253000 + 410658008 + 299981009
vii- Worsened by bending or kneeling down	pain +provoked by + forward bending or+kneeling	22253000 + 410658008 + 417188003 + 55864004

viii- Relieved by medication	Pain relief by medication	428346000
23- Past Medical History	past medical history	417662000
24- Past Surgical History	past surgical history of	161615003
25- Previous Treatment by healthcare professional	Treatment pain by + healthcare professional + temporal context + past	110363002 + 223366009 + 408731000 +410513005
i- Physiotherapy	physical therapy procedure	91251008
ii-Chiropractor	chiropractic visit	2530001
iii-Acupuncture	acupuncture	44868003
iv- Massage therapy	massage physiotherapy	387854002
26- Psychological symptoms Associated with CLBP	psychological finding + associated with + CLBP	116367006 +47429007 + 278860009
i- Catastrophizing	Catastrophization	285247003
ii- Depression / Distress	depressive disorder or distress	35489007 or 69328002
iii-Difficulty maintaining weight	difficulty maintaining weight loss	170806001
iv-Difficulty coping with pain	difficulty coping with pain	16399001
v- Difficulty falling asleep	difficulty falling asleep	59050008
vi-Difficulty staying asleep	difficulty staying asleep	67233009
27- Diagnostic Tests	diagnostic imaging	363679005
i- X-ray	X-ray	168537006
ii- MRI	MRI - Magnetic Resonance Imaging	113091000
28- Physical Examination	physical examination	5880005
29- Diagnosis	diagnosis	439401001
30- Mental Disorder History	mental health history	385888009

*** 1- Overall, I agree that SNOMED CT terms adequately and accurately represents the clinical terms in the standardized assessment form**

- 1=Strongly Disagree
- 2=Disagree
- 3=Neutral
- 4=Agree
- 5=Strongly Agree

*** 2- Representing the terminologies in the standardized assessment form using a widely recognized reference terminology such as SNOMED CT will improve understanding of the clinical terms used.**

- 1=Strongly Disagree
- 2=Disagree
- 3=Neutral
- 4=Agree
- 5=Strongly Agree

If you have any other comments please add it

* Indicates Response Required

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Appendix G Additional Statistical Analysis

G.1 The Rating of the Quality of Items

There are other statistical measures that can be calculated but are not as useful as those that have been discussed previously. Cohen's Kappa is only applicable to binary data and can only be used for two raters at a time, so it is not applicable to the rating data. Fleiss' Kappa is an extension f Cohen's Kappa, but it only applies to categorical (nominal data). Hence, it cannot be used with the rating data.

However, the Pearson r, Spearman r and Kendall's tau b are still applicable and can be calculated for my dataset. The Pearson's correlations are provided in Table G.1.1.

	Participant #1	Participant #2	Participant #3	Participant #4
Participant #1	1.00	0.205	0.258	0.352
Participant #2	0.205	1.00	0.153	- 0.085
Participant #3	0.258	0.153	1.00	0.213
Participant #4	0.352	- 0.085	0.213	1.00

Table G.1.1: : Pearson's Correlation between Raters

As noted previously, the standardized Cronbach's alpha is directly related to the average correlation. In this case, the average correlation is $r_{aver} = 0.183$. Hence,

$$\alpha = (K * r_{aver}) / (1 + (K-1)*r_{aver}) = 0.472$$ where K = the number of raters = 4

This computation is the same as the previously cited value of 0.472. The values for the Spearman rank correlation are provided in Table G.1.2

	Participant #1	Participant #2	Participant #3	Participant #4
Participant #1	1.00	0.191	0.289	0.352
Participant #2	0.191	1.00	0.164	- 0.127
Participant #3	0.289	0.164	1.00	0.137
Participant #4	0.352	- 0.127	0.137	1.00

Table G.1.2: Spearman Rank Correlation between raters.

Note that these are similar to the Pearson correlations. The values for Kendall's tau_b are provided in Table G.1.3.

	Participant #1	Participant #2	Participant #3	Participant #4
Participant #1	1.00	0.221	0.323	0.352
Participant #2	0.221	1.00	0.181	- 0.143
Participant #3	0.323	0.181	1.00	0.147
Participant #4	0.352	- 0.143	0.147	1.00

Table G.1.3: Kendall's tau_b between raters

Again, the same pattern emerges. The three correlations (measures of association) provide the same information. The rating are "somewhat", but not "highly" related.

In summary, the two analyses indicated that the raters do agree "somewhat" on the utility and use of the items. Perfect agreement cannot be expected from such a diverse group of participants from different disciplines of care.

G.2 The Degree to Which Items Captured in Current Practice

For the assessment of the captured data, other statistical measures would include Cohen's Kappa. Kappa is simply the probability that the two raters agree (both say "Yes" or both say "No"). SPSS provides Cohen's Kappa which is only useful for rating the similarity of two raters at a time. For the current data, the values are provided in Table G.2.1.

	Participant #1	Participant #2	Participant #3	Participant #4
Participant #1	1.00	0.607	0.112	0.114
Participant #2	0.607	1.00	0.078	0.034
Participant #3	0.112	0.078	1.00	- 0.081
Participant #4	0.114	0.034	- 0.081	1.00

Table G.2.1: Cohen's Kappa between raters

For this measure, Kappa values less than 0 imply poor agreement, values between 0 and 0.2 imply slight agreement, values between 0.21 and 0.40 imply fair agreement, values between 0.41 and 0.60 imply moderate agreement, values between 0.61 and 0.80 imply substantial and values between 0.81 and 1.0 imply almost perfect agreement [97]. Note that the individual agreements are low. However, such values are not as useful as the previously cited Cronbach's alpha or ICC.

Fleiss's Kappa is often considered an option when there are more than two raters. However, it is not technically appropriate for the current data. The statistic only applies to categorical (nominal data). Given that the capture data is binary, this is not a problem (i.e., Fleiss's Kappa also, assumes that 4 different raters will rate each item/predictive factor). In addition, there is no agreement upon tests of significance and there is no agreement upon criteria defining quality. Hence, it was not used.

One can also consider the simple Pearson bivariate correlation, the Spearman rank correlation or Kendall's tau-b measure of concordance. The Pearson is the "standard" correlation. The Spearman is the correlation after the data have been converted to ranks. However, when there are few possible values (in this case "2") the ranks are the same as the original data (e.g., data values 0 1 0 0 1 would be ranks 0 1 0 0 1). The Kendall's tau-

b counts the number of times the two raters agree or disagree. However, because the data is binary, all of these reduce to the same values (Table G.2.2).

	Participant #1	Participant #2	Participant #3	Participant #4
Participant #1	1.00	0.614	0.204	0.206
Participant #2	0.614	1.00	0.162	0.070
Participant #3	0.204	0.162	1.00	- 0.081
Participant #4	0.206	0.070	- 0.081	1.000

Table G.2.2: Pearson Correlation between raters (also equivalent to Spearman's rank and to Kendall's tau-b).

The values indicate that there is some agreement, but the agreement is not high. Participant # 4 is the most distinct. As noted previously, the standardized Cronbach's alpha (for the four raters) is directly related to the average correlation. In this case, the average correlation is $r_{aver} = 0.197$. Hence,

$$\alpha = (K * r_{aver}) / (1 + (K-1)*r_{aver}) = .494 \qquad \text{where K = the number of raters = 4}$$