The transition from a new episode of back pain to persistent pain and disability in older adults

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Abstract

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This dissertation examines the transition from a new episode of back pain to persistent pain and disability in older adults. The aims are: 1) to describe the course of low back pain after a new healthcare visit, 2) to investigate predictors of persistent back pain and disability, and 3) to investigate the use and type of physical therapy interventions and their association with pain and disability compared to no physical therapy use.

We used the Back pain Outcomes using Longitudinal Data (BOLD) registry, a prospective cohort study, for all analyses. BOLD consists of 5,239 adults ≥65 with a new visit for back pain. They are from primary care settings of three integrated healthcare systems in the United States. Data were collected at baseline and participants were followed for 12 months. Participants' electronic medical record data was also available during the 12 months before and after their index visit.

The first study describes back related functional status [Roland Morris Disability Questionnaire (RMDQ)], a numerical rating scale of pain, pain interference with activity, and resolution of back pain at baseline, 3, 6 and 12 months. Small improvements in outcomes

occurred over the 12 months, and only 22.6% of participants reported that their back pain had resolved at 12 months.

Analysis for the second study investigated demographics, back pain characteristics, general health characteristics, comorbidities, and imaging findings as predictors of persistent back pain and disability. Gender; worse baseline clinical characteristics of back pain, leg pain, back-related disability, and duration of symptoms; smoking; anxiety; cervical pain; wide-spread pain syndromes; and an index diagnosis of lumbar spinal stenosis were predictive of both persistent back pain and persistent disability. Moderate or severe facet joint arthropathy was the only imaging finding associated with long-term function or pain.

The last study used Marginal Structural Models to estimate the average causal effect for dosage of overall physical therapy, active physical therapy, passive physical therapy, and manual therapy use on pain and disability. Few patients used high levels of physical therapy. Higher use of active physical therapy was most consistently related to the greatest improvement in pain intensity.

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INTRODUCTION

As the United States and world population ages, low back pain (LBP) in older adults is likely to grow as a significant public health problem. Basic epidemiological information on the burden and risk factors specific to older adults is scare. Similarly, the effectiveness of many interventions for back pain is unknown in older adults. As with other chronic health conditions, persistent back pain greatly impacts the burden, health care use, and cost for all back pain.

Understanding how older adults transition from a new episode of pain to persistent back pain and disability is important because this continuing pain and disability contributes to a lower quality of life. Additionally, people with persistent back pain have greater consumption of healthcare services while experiencing little improvement in the magnitude of disability or resolution of symptoms. In order to better address this major and growing health issue among older adults, better knowledge of the prognosis for LBP, risk factors for continued pain and disability, and the role of physical therapy services is needed.

Background: Incidence and Prevalence of Back Pain in Older Adults

Low back pain is a common health condition. Estimates for the one year incidence of an episode of LBP for all ages range from 1.5% to 36.5% of the general population. [1] Results vary greatly depending on low back pain definitions and research methods, but one of the higher quality population-based studies found the cumulative incidence for a back pain episode was 18.6% (95% confidence interval of 14.2% - 23.0%) in Canadian adults 20-69 years old. They found incidence did not differ by age. [2] Makris et al. conducted one of the few studies investigating incidence of back pain specifically in older adults using a cohort of community-dwelling adults at least 70 years old. They reported the cumulative incidence of LBP leading to restricted activity over 10 years was 77% in men and 82% in women. The incidence rate was 32.9 per 1000 person-months, and the vast majority of episodes (80%) were less than one month. [3] Although these participants did not report LBP leading to restricted activity at baseline, it is not clear if each episode was new, a recurrence, or a flare-up of chronic LBP.

Few studies have estimated the prevalence of chronic LBP for any time period in older adults. It is estimated that as many as 23% - 58% of older adults have prevalent LBP. [4-7] Docking et al. found that 23% of British adults ≥75 years had non-disabling back pain while 6% reported disabling back pain. The proportion with disabling back pain increased with age, and women had higher prevalence of non-disabling and disabling back pain compared to men. [4] An Italian study found the prevalence of frequent back pain over the past 12 months was 31.5% among adults ≥65 years, but only 7.4% of the cohort reported their usual activities being limited by back pain. Women had a greater prevalence of frequent back pain. [5] Lastly, Jacobs et al. reported the point prevalence of chronic LBP at age 77 as 58% for an Israeli cohort of 277 persons. [6]

It is unclear whether older adults have a greater prevalence of LBP than younger adults. [8] Results from two higher quality, population-based studies addressing this question are summarized here. Macfarlane et al. conducted a population-based study investigating the prevalence of any back pain and high disability back pain, measured using the Chronic Pain Grade scale, in the United Kingdom. They found the prevalence of back pain in the last month peaked at 29.8% for adults 41-50 years and decreased minimally to 25.5% for adults >80 years. The prevalence of high disability chronic back pain increased with older age, with the highest prevalence being 10.0% among people >80 years. [9] Using survey of the entire United States, Deyo et al. estimated the prevalence of LBP during the past 3 month was 29% in adults > 45 years old and about 24% in adults 18-44 years old. [10] Comparisons among studies and between age groups are challenging because of limited data coupled with different definitions of LBP and different research methods.

Prognosis of Back Pain for Older Adults

Even less is known on the prognosis and natural history of LBP in older adults. The prognosis for adults as a whole with acute LBP is typically favorable, and most patients have resolution of their symptoms within three months of onset. [11,12]. For adults whose pain persists for at least three months, the prognosis worsens. [12-14]

Henschke et al. conducted an inception cohort study of 973 participants, ≥14 years old, with recent onset non-specific LBP from primary care settings in Sydney, Australia. The results showed that the median time to recovery of disability was 31 days and the median time to recovery of pain was 58 days. At 12 months 28% still had persistent LBP. [11]

Mehling et al. recently conducted a prospective cohort study using a clinical population from Northern California. They investigated the prognosis of LBP in 605 adults 18-70 years old who presented to primary care with non-specific LBP of < 4 weeks duration. They followed-up with participants at 6 months and 2 years. They defined persistent LBP as either a rating of less than "much improved" on a question about perceived recovery. They found that 13% and 19% of patients met the primary definition for persistent LBP at 6 months and 2 years, respectively.[15]

Carey et al. conducted an earlier prospective cohort study of both acute and chronic LBP in North Carolina. Participants were defined as having chronic LBP if they were "unable to perform their 'usual daily activities' as they had before the LBP episode" 3 months after the index visit. Outcomes were assessed over 22 months. At 3 months, 7.7% of responders were had chronic LBP. Many of the patients with new onset chronic LBP did not recover, with 67% reporting functionally limiting symptoms at 22 months. [14]

These studies are informative, but none are specifically on older adults. Scheele et al. [16] recently published the first known inception cohort study on the prognosis of LBP in older adults using a Dutch cohort of 675 adults greater than 55 years. They found 61% of patients had not recovered from their back pain at three months. Even though they only reported 3 month outcomes, their findings show the prognosis of LBP in older adults was worse compared to the prognosis in younger populations. Longer term information on the prevalence of persistent LBP, duration of a LBP episode, and the amount of pain and disability during a course of LBP for older adults is an important gap in our evidence base.

My dissertation addresses this important gap in the literature by investigating the prognosis of back pain over a one year period among older adults. In Chapter 1, my collaborators and I describe the prognosis of back pain by presenting data on pain intensity, functional status, pain interference with activity and resolution of back pain symptoms in a cohort of older adults presenting with a new primary care visit for back pain. These data come from the Back pain Outcomes using Longitudinal Data study (BOLD). [17] BOLD is a large inception cohort of 5,239 older adults from three integrated healthcare systems, Kaiser Permanente Northern California (Oakland, CA), Henry Ford Health System (Detroit, MI), and Harvard Vanguard Medical Associates/ Harvard Pilgrim Health Care (Boston, MA), during the years 2010-2013. BOLD follows participants for 12 months after an initial primary care visit for back pain, and we used this cohort to provide a comprehensive description of the clinical course of back pain over one year for older adults.

Predictors of Persistent Back Pain and Back-Related Disability in Older Adults

Understanding risk factors for the transition from a new episode of LBP to persistent LBP and disability in older adults is another vital area that needs further elucidation. The transition to persistent LBP has been studied prospectively in a handful of studies of adults of all ages. [6,11,14,15,18,19] These studies have found psychological variables (depression, anxiety and loneliness), other musculoskeletal pain, older age, and higher baseline pain or functional limitation were predictors of later persistent pain. Women also have a greater prevalence of chronic LBP. [6,11,19]

Fewer studies have prospectively examined the transition to persistent LBP specifically in older adults. Jacobs et al. assessed a cohort of 70 year olds and then follow-up with them seven years later. They found that being a women, joint pain, loneliness, hypertension, and prior back pain were associated with future pain, but their study design does not clarify risk factors for primary care patients with new episodes of low back pain. [6]

Scheele et al. investigated risk factors for persistent back pain at three months. They found the most predictive baseline variables were: longer duration of the back pain, greater severity of back pain, history of back pain, no leg pain below the knee, a greater number of comorbidities, expectations of non-recovery, and a longer duration of the timed 'Up and Go' test. [16] Both of these studies provide some insight into risk factors for developing persistent LBP in older adults, but important data on risk factors for longer term persistent pain and disability in a cohort with a new episode of back pain are needed.

My dissertation adds to the limited literature on risk factors for persistent back pain in older adults. Chapter 2 investigates risk factors associated with progression to persistent low back pain and disability over 12 months in older adults with a new primary care visit for back pain. I add novel information by presenting predictors of persistent back pain and persistent disability at 6 and 12 months, and we examine previously unstudied risk factors in older adults, such as lumbar imaging findings and race.

The Use of Physical Therapy Services for Back Pain in Older Adults

The effectiveness of many interventions for LBP is unknown in older adults. While evidence-based clinical guidelines exist for the diagnosis and treatment of LBP for adults in general, there is a deficit of research and guidelines specific to older adults (>64 years old). [20]

Potentially, older adults with back pain have a different distribution of risk factors for low back pain, including a higher prevalence of degenerative processes, and a greater number of comorbidities than younger adults. For this reason, LBP in older adults may need to be managed differently than for a younger population. Unfortunately, there is insufficient research to guide how we can best address this problem in older adults.

The use of physical therapy services and their association with later back pain and disability in older adults is also unknown. Current guidelines for managing LBP support exercise for patients with subacute and chronic LBP. Thus, emphasizing active interventions, such as therapeutic exercise or functional training, is a preferred practice pattern for physical therapists when managing LBP in adults. The effectiveness of passive interventions, such as ultrasound and transcutaneous electrical nerve stimulation, are not supported by the literature, and interventions like traction have insufficient evidence to recommend routine use in clinical practice. [20] Adhering to these recommendations for active physical therapy in adults <65 years old with acute LBP resulted in greater improvement in disability and less healthcare utilization compared to patients receiving mostly passive modalities. [21] Whether these results and recommendations generalize to older adults is unknown.

My dissertation provides the first estimates of how current patterns of physical therapy services for managing back pain in older adults are associated with clinical outcomes. In Chapter 3, I report the association between dose and type of physical therapy services and disability and pain intensity from low back pain over the course of one year. Using marginal structural models, we study use of physical therapy and outcomes over time while minimizing bias time-varying confounding which traditional statistical models cannot accomplish.

Significance

Overall, my dissertation research addresses fundamental gaps in the literature concerning back pain in older adults. First, adding foundational descriptive data on the course of back pain and back-related disability in the elderly is vital to understanding the prognosis for these patients. Additionally, these prognostic data will help guide clinical interventions and provide a point of reference for measuring their effectiveness. Second, identifying risk factors for persistent pain and disability will provide clinicians and researchers essential information for assessing a patient's prognosis and identifying those who should be targeted more intensive treatment. Lastly, physical therapy is commonly used to improve functional limitation in older adults with back, yet little research has been done to investigate specific patterns of physical therapy treatments in this population. Observational research on the association between patterns of physical therapy practice and patients' pain and disability is an important first step to gaining insight into how physical therapists can improve their management of patients with back pain. These findings will inform the design of future clinical research on interventions for back pain in older adults.

Chapter 1:

The clinical course of pain and function in older adults with a new primary care visit for back pain

The clinical course of pain and function in older adults with a new primary care visit for back pain.

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ABSTRACT

OBJECTIVES: Little research has investigated the long-term prognosis of back pain in older adults. We report the prognosis of older adults presenting to a new primary visit for back pain by describing pain intensity, functional status, pain interference with activity and resolution of back pain symptoms over 12 months.

DESIGN: Prospective, inception cohort study

SETTING: Participants are from primary care settings of three integrated healthcare systems in the United States that participated in the Back pain Outcomes using Longitudinal Data (BOLD) registry.

PARTICIPANTS: 4038 of 5,239 adults ≥65 years from the BOLD registry who had reached their 12 month follow-up date by June 2013.

MEASUREMENTS: Baseline measurements include: demographic characteristics, the EQ-5D, duration of back pain, expectation for recovery, depression, and anxiety. Patient reported outcomes, including back related functional status [Roland Morris Disability Questionnaire (RMDQ)], numerical rating scale of pain, pain interference, and resolution of back pain were collected at baseline, 3, 6 and 12 months.

RESULTS: Small improvements in outcomes occurred over 12 months. The mean RMDQ decreased from 9.5 [standard deviation (SD) 6.5] at baseline to 8.3 (SD 6.8) at 12 months. Mean back pain intensity decreased by 1.4 points, from 5.0 (SD 2.8) at baseline to 3.6 (SD 2.7). Only 22.6% of participants reported that their back pain had resolved at 12 months. Improvements in function and interference with activity over 12 months differed by age and back pain duration.

CONCLUSION: These data provide a more formative understanding of the prognosis and typical course of back pain for older adults in the United States and can provide a point of reference for benchmarking the effectiveness of interventions in this population.

INTRODUCTION

Back pain may affect over 80% of individuals at some point in their lifetime[22], and is the number one health condition for most years lived with disability in the United States and worldwide.[23,24] In older adults, back pain is common, with the prevalence of chronic back pain estimated to be from 32% - 58%. [5,6] The prognosis for all adults with acute back pain is favorable, with most patients reporting resolution of their symptoms within three months of onset.[11,12] For adults whose pain persists for at least three months, the prognosis is considerably worse,[12-14] with approximately 8%-30% of people reporting pain and disability persisting beyond 3 months. [11,14]

Older adults with back pain may have a different distribution of risk factors for back pain, including a higher prevalence of degenerative processes and a greater number of comorbidities than younger adults. These differences suggest that the prognosis of back pain may be worse in older adults compared to younger ones. However, few data exist on the long-term prognosis and course of back pain in older adults. Limited evidence suggests a worse prognosis for older adults. Henschke et al. found older age was associated with a longer duration of symptoms, [6] and Scheele et al. reported a larger proportion of their cohort of Dutch older adults with back pain had pain persisting at 3 months compared to younger cohorts.[16]

These gaps in the literature concerning the course and prognosis of back pain in older adults demonstrate the lack of foundational epidemiological knowledge in this population. To further address this deficiency, a description of the course of a new episode of back pain in older adults is needed. This is especially important since back pain can have a deleterious effect on older adults; they tend to have lower health related quality-of-life and greater functional limitations.[25] As the United States population ages, back pain in older adults is likely to grow as a major public health issue with higher costs and increasing prevalence.

Descriptive epidemiological information on the clinical course of pain and function will allow us to better target populations with worse prognosis and provide point of reference for measuring the effectiveness of interventions. In this report, we describe the prognosis of back pain by presenting data on pain intensity, functional status, pain interference with activity and resolution of back pain symptoms in a cohort of older adults presenting with a new primary care visit for back pain. A second purpose is to describe the prognosis by subgroups of age, gender and symptom duration.

METHODS

Study Design and Participants

We conducted an inception cohort study using patients from the Back pain Outcomes using Longitudinal Data (BOLD) registry. Creation of the BOLD registry has been previously described in more detail, and we only summarize major characteristics here.[17] BOLD is a multicenter study that enrolled 5239 adults ≥65 years old, all of whom had a new primary care visit for back pain. We enrolled cohort members from three integrated healthcare systems, Kaiser Permanente in Northern California, Henry Ford Health System in Detroit, and Harvard Vanguard Medical Associates/ Harvard Pilgrim Health Care in Boston, during the years 2010-2013. We identified patients if, at the index visit, they had an eligible International Classification of Diseases, Ninth Revision (ICD-9) code for a back pain diagnoses commonly seen in primary care settings.[17] We excluded patients if they had a healthcare visit for back pain within six months of the index visit, but we allowed patients to have back pain for any duration prior to the index visit. Additional exclusion criteria included: prior lumbar spine surgery, developmental spine deformities, inflammatory spondyloarthropathy, known spinal malignancy or infection, history of cancer in the past five years, history of human immunodeficiency virus infection, serious medical co-morbid condition with life expectancy < 1 year, no telephone, planning to move within a year, unable to understand English, or severe mental impairment that would interfere with answering questions.

We followed all participants for 12 months, and collected patient reported outcomes at 3, 6 and 12 months by telephone or mailed questionnaire. For this manuscript, we included all BOLD participants who had reached their 12 month follow-up date as of June 2013.

Questionnaires

At baseline, we collected data on demographic characteristics: age, gender, ethnicity (Hispanic versus non-Hispanic), race, education, and marital status. We also measured general health status using the EQ-5D, duration of back pain, and expectation for recovery (rated from 0, no confidence in recovery, to 10, complete confidence in recovery) at baseline. We ascertained depression and anxiety symptoms over the previous two weeks using the Patient Health Questionnaire-4 Depression and Anxiety Screen (PHQ-4). The PHQ-4 has good construct validity and reliability, and the depression questions have a high level of sensitivity and specificity for detecting major depression.[26,27]

At baseline and all follow-up time-points we collected back and leg pain intensity, functional status, interference with activities, depression and anxiety symptoms. We measured severity of both back and leg pain using a 0 to 10 numeric rating scale (NRS) for average pain in past 7 days. This measures has good content validity[28] and is responsive to change in patients with back pain.[29] We measured back pain related functional status using the 24-item Roland Morris Disability Questionnaire (RMDQ); we used a modified version that added "or leg (sciatica)" to "back pain" where appropriate.[17] The RMDQ is scored from 0 (no disability) to 24 (maximal disability), and is well validated and responsive to change[30,31] We assessed back pain interference with activities using the Brief Pain Inventory (BPI).[32] The BPI is scored as an average of seven domains, (general activity, mood, walking, work, interpersonal relationships, sleep and enjoyment of life), each of which are each scored on a 0 (no interference) to 10 (interferes completely) scale.

Based on the definition of recurrent back pain proposed by Stanton et al.[33], we defined recovery from back pain as 30 days with no pain, i.e. pain NRS of 0. We assessed recovery of back pain at 3, 6 and 12 months with the question: "How long has it been since you last had back pain?" Because we added this question after study enrollment had begun, few participants answered this question at their 3 month follow-up, and not all participants were asked these questions at 6 or 12 month follow-ups. Consequently, the number of responses available for this question is substantially smaller than the total sample. (Figure 1-1)

Statistical Analysis

We used descriptive statistics to characterize the cohort and to estimate the proportion of patients who recovered from back pain. We estimated the prevalence of recovery by the proportion of patients who met the definition for resolved back pain at 6 and 12 months after the index visit. We also calculated the proportion of participants who achieved a 30% or 50% improvement on back pain intensity at 3, 6, and 12 months, and calculated similar proportions of 30% or 50% change for RMDQ. We calculated means and standard deviations (SD) at baseline and 3, 6, and 12 months for pain intensity, RMDQ, and BPI scores producing summaries for both the entire cohort and for specific strata based on gender, age, and duration of current symptoms.

To examine whether the course of a back pain episode differed by baseline characteristics, we used generalized estimating equations (GEE) with an unstructured correlation structure to model each outcome over time by gender, age group, or category of back pain duration. We used single models to examine main effect and interactions. Post-estimation tests for main effects, which is the association between a variable and outcome, estimated whether mean baseline scores differed among strata. Post-estimation tests for the group by time interaction estimated whether change over time differed among strata. We adjusted all models for age, study site, marital status, and educational level. The Institutional Review Board (IRB) at the University of Washington as well as all site IRBs approved the BOLD registry. We set the statistical significance threshold at $p<0.05$. We performed all analysis using STATA IC, version 12. (College Station, TX.)

RESULTS

Baseline Characteristics

We included a total of 4038 participants from the BOLD registry in this analysis. (Figure 1-1) All patients completed the RMDQ, back pain NRS, and BPI at baseline. Two participants (< 1%) had missing values for leg pain NRS at baseline. Follow-up was high with all outcome measures completed by 3,578 (89%) participants at three months, 3,477 (86%) at six months, and 3,416 (85%) at 12 months.

The mean age of participants was 74 years, 2599 (64%) were women, 946 (24%) were non-white, 2359 (59%) had less than a college degree, and 2461 (61%) were married or living with a partner. Approximately one-third had back symptoms for less than four weeks, while another third had back symptoms for one year or longer. Almost two-thirds of participants reported leg pain at baseline. Relatively few patients had evidence of anxiety (500=12.4%) or depression (324=8.0%). (Table 1-1)

Course of Back Pain

The mean RMDQ score gradually decreased by 13% over the course of a year, from 9.5 [standard deviation (SD) 6.5] at baseline to 8.3 (SD 6.8) at 12 months. For the mean NRS, the largest decrease in back and leg pain occurred within the first 3 months [1.3 points (26%) for back pain NRS and 1.5 points (28%) for leg pain NRS]. After three months, mean back and leg pain NRS scores remained similar for the remaining 9 months of follow-up. Back pain interference with activity followed a similar pattern as pain intensity. The average BPI score decreased 0.4 points (12%) from baseline to three months, and it decreased by only 0.1 points at each follow-up time afterwards. (Figure 1-2) (Table 1-2)

Recovery from Back Pain

Among the 1404 participants who were asked the 6 month back pain resolution questions, which were included after the study began enrolling, 290 (20.7%) reported resolution of their back pain. At the 12 month follow-up, 2076 participants received the back pain resolution questions and 469 (22.6%) reported resolution of their back pain. At the time of this analysis, only 494 participants completed the back pain resolution question at both 6 and 12 months. In this group, 67 (69.1%) of the 97 participants with resolution at 6 months remained resolved at 12 month, and 40 (10.1%) of the 397 without resolution at 6 month had their back pain resolve by 12 months. (Table 1-3)

The proportion with a 30% improvement in back pain gradually increased from 1,516 (42.3%) at 3 months to 1,540 (44.8%) by 12 months. Fewer participants achieved a 50% improvement in back pain: 1,141 (31.8%) at 3 months and 1,211 (35.2%) at 12 months. A smaller proportion saw improvements in functional status. We found 1,054 (29.3%) and 1,234 (35.9%) had a 30% improvement in function at 3 and 12 months, respectively. The proportion with a 50% improvement in functional status increased from 794 (22.1%) at 3 months to 968 (28.2%) at 12 months.

Course of Back Pain Stratified by Age, Gender, and Duration of Symptoms

Table 1-2 presents data on back related function, intensity and interference stratified by age group, gender, and duration of back pain prior to index visit. The older age groups, 80-84 years and ≥85 years, had worse functional status at every time point compared to the younger categories, and these oldest categories had less improvement in function over 12 months than the younger groups. Back and leg pain intensity decreased over 12 months for each age group, with virtually all of the improvement having occurred within the first three months. Pain interference with activity decreased over 12 months for all age groups with slightly less improvement in the older age groups. (Table 1-2) Adjusted GEE models found that the mean RMDQ (p= 0.004) differed among the age categories. Improvements in RMDQ and BPI differed by age group (interactions for age by time were p=0.007 for the RMDQ and p < 0.001 for the BPI

Women had greater limitations in function, higher pain intensity and more pain interference with activity at each time point compared to men. These differences were all statistically significant at p<0.001, but not clinically meaningful. [34,35] (Tables 1-2) However, there was no statistically significant gender by time interactions for any outcome measure, with p ≥0.30 for all interaction tests.

Participants with longer duration of back symptoms at their index visit had greater than average limitations in functional status, more pain interference with activity, and higher pain scores over the course of one year (p< 0.001). In addition, they showed less average improvement in these outcomes over the 12 months, and all group by time interactions were statistically significant (p< 0.001). (Table 1-2)

DISCUSSION

In this inception cohort, over 75% of older adults reported persistent back pain 12 months after a new visit to primary care. Additionally, almost 30% reporting resolution of back pain at 6 months had back symptoms at 12 months. Mild but progressive improvement in functional status was seen over 12 months, but pain and activity interference changed minimally after 3 months. These data suggest persistent pain, limited function, and interference with activity continues to be problematic for the vast majority of older adults after they present to a new primary care visit for back pain.

The magnitude of functional limitation, pain, and activity limitation differed by gender and back pain duration, but only functional limitation differed by age category. The change in function and interference with activity over 12 months differed by age and back pain duration. The oldest age groups had less improvement in function and interference with activity actually worsened for those ≥90 years, even though, on average, their pain decreased similarly to other age groups. These results suggest that back pain associated functional limitation and interference with activities over one year is greater for the oldest adults. This is consistent with the findings of Patel et al. who found mobility/walking disability increased with older age in a recent national survey of older adults. [7]

Basic epidemiological information on the prognosis of a new episode of back pain in older adults is scarce, but Scheele et al. recently examined the prognosis in a Dutch cohort of 675 adults >55 years. [16] At baseline, the RMDQ and back pain severity were similar to our sample, and at 3 months, back pain NRS was exactly the same as for our study (mean of 3.6). However, they found greater improvement in function during the first 3 months; RMDQ decreased two points versus a decrease of 0.4 points for the BOLD cohort. They found 39% of patients reported recovery at 3 months, while we found approximately 21% had recovery at 6 months and 23% at one year.

Part of these differences may be explained by the difference in age distributions. The BACE cohort was slightly younger; they included participants under 65 years old. Our analysis showed greater disability with increasing age, and cross-sectional description the BACE cohort as baseline found greater disability in their older participants (>75 year) compared to their younger participants (55-75 years).[36] Inconsistency in the definitions for recovery of back pain between the two studies is another important factor. We used a more rigorous definition of 30 days pain free, which is recommended by Stanton et al.,[33] while they used either "completely recovered" or "strongly improved" on a global perceived effect scale. Consequently, it is not surprising that our study had a smaller proportion of patients with recovery, even with a longer follow-up period.

Our finding of more rapid improvement in the first 3 months followed by a period of limited improvement from 3 months to 12 months is consistent with the pattern of back pain seen in other studies.[12,16] However, compared to younger adults, the prognosis of back pain in older adults appears worse. We found the prevalence of recovery was only 22.7% at 12 months, whereas Henschke et al. found the cumulative probability of being pain free for one month at one year was 73% among adults of all ages.[11] It could be that the prevalence of recovery is much higher in their sample, although direct comparisons cannot be made. Additionally, another recent prospective cohort study of adults 18-70 years old presenting to primary care found 87% and 81% of patients were without persistent back pain at 6 months and 2 years, respectively.[37] Even though the analysis or definition of recovery varied in these studies, these differences suggest recovery from back pain appears to be much less common for older adults.

Principal strengths of our study include our use of an inception cohort with a large, multisite sample, our long follow-up period and our high follow-up rates. Inception cohorts are an ideal design to characterize the prognosis and course of a new episode of back pain in older adults because they begin following participants at a uniform time, typically early on in the disease or at a salient event, such as a visit to a primary care provider, and then follow them longitudinally to ascertain outcomes.[38-41]

The main limitation is that some participants entering the cohort had prevalent, chronic back pain rather than a new episode. Even though this study enrolled patients at a new primary care visit, we know that some patients presented with new onset or new exacerbation of back pain while other patients presented without a change in status or had a gradual progression of symptoms. Mixing of incident with prevalent cases might bias the true prognosis and course of back pain in older adults who have a new episode or exacerbation of back pain. However, some literature suggests that increased pain is a major reason for most patients with chronic back pain to seek healthcare. [42] Additionally, the outcomes stratified by pain duration provide better insight to the prognosis and course for shorter episodes of back pain in older adults.

Another limitation of our design is that this cohort is formed solely from members of integrated healthcare systems in urban or suburban settings. It is not completely clear how these patients are different from the general population of older adults in other healthcare settings, but data from the Health and Retirement Study shows older adults with any physician visits are more likely to be women and married compared to those without a physician visit.[43] Additionally, among a nationwide sample of community dwelling older adults in the United States, women and people with less than a college education had a higher prevalence of bothersome pain. [7] These characteristics generally are consistent with the BOLD cohort. However, differences in demographic factors and the structure of the healthcare system may affect the generalizability of these results to other settings. A third limitation is that only a smaller subgroup received the back pain resolution questions, and this makes it difficult to track how resolution changed over time for most of the cohort.

Clearly, based on the larger proportion of older adults with continuing back pain and functional limitations, persistent back pain in older adults is an important healthcare problem, and further research on the prognosis and course of back pain for older adults is needed. Future work can investigate risk factors for non-recovery, and refining a valid, easy to use risk score may be helpful for clinicians to determine prognosis and guide clinical decision making. The STarT Back Screening Tool has shown good results, and examining its performance specifically in older adults will contribute important information for directing care in this population. [44] Also, further examining how the course of back pain varies by diagnostic category, comorbidities common in older adults, or intervention strategies will provide valuable information to researchers and clinicians.

Figure 1-1: Flow diagram of study enrollment

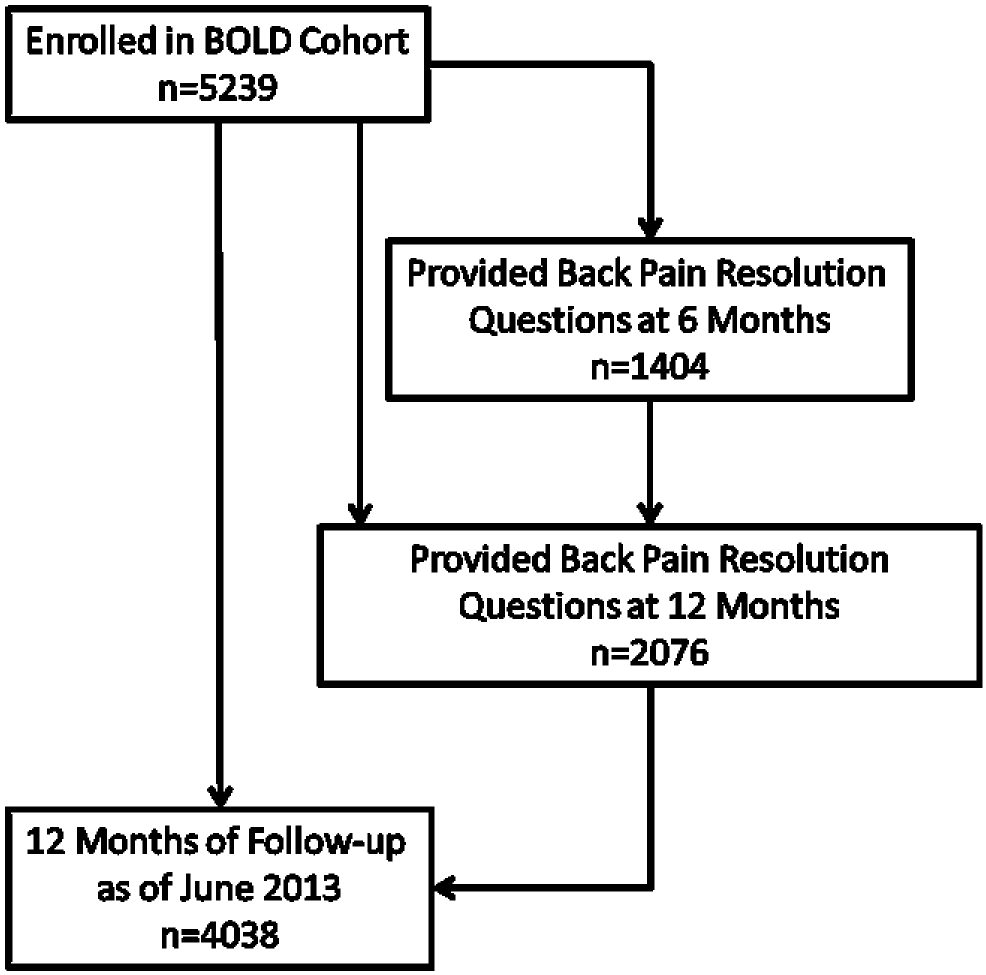

Figure 1-2. Box plots of functional status, back pain, leg pain, and pain interference with activity at each time point

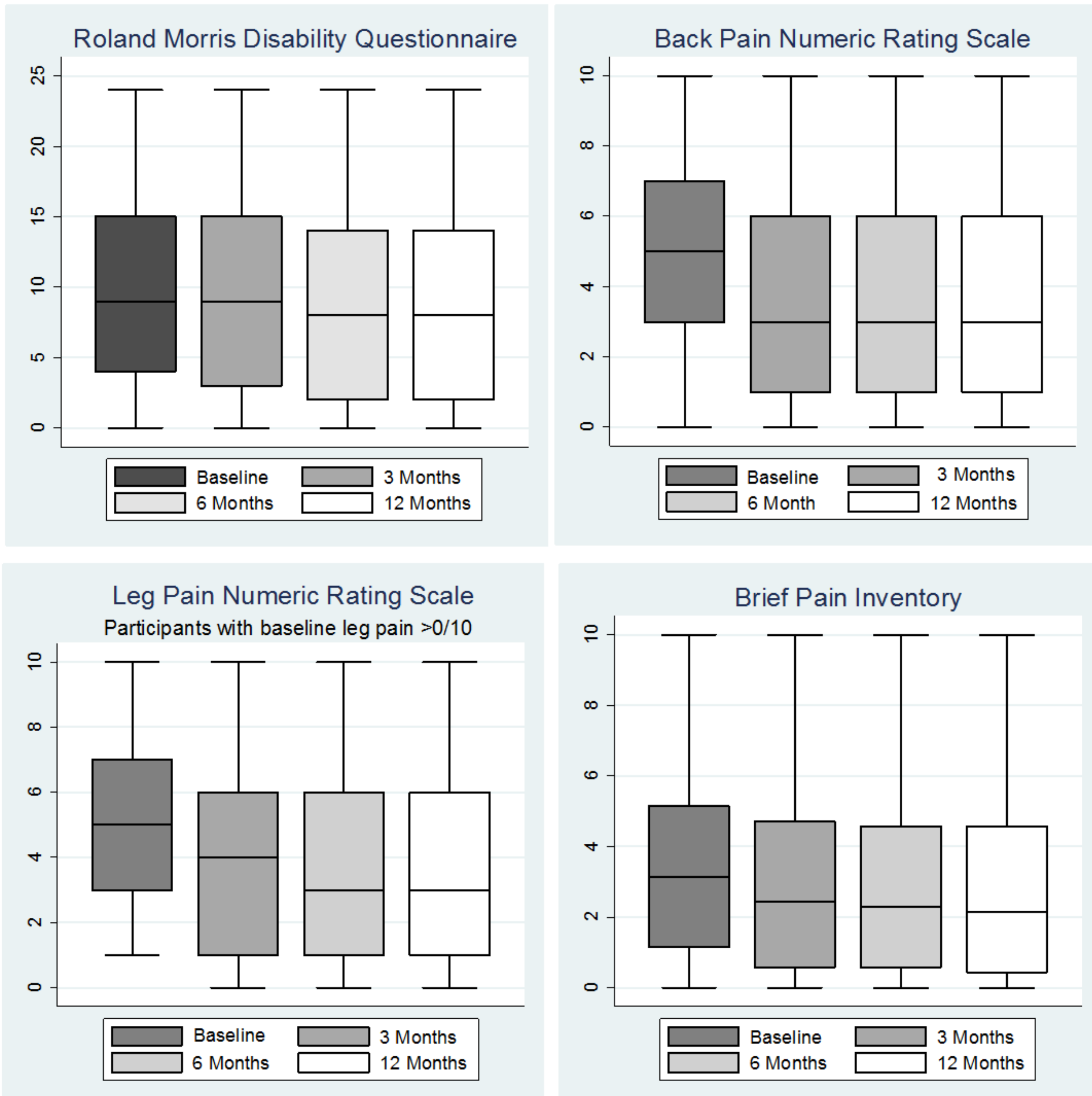

Table 1-1. Baseline Characteristic of older adults with a new visit for back pain

Variable	N	All Participants with 12 Month Follow-up (n=4038) mean (standard deviation) or n (%)
Demographics		
Age (mean SD[a], years)	4038	73.9 (6.9)
Men (n %)	4038	1439 (35.6)
Hispanic (n %)	4016	239 (6.0)
Race (n %)	4038	
Black		536 (13.3)
Native American/Alaskan/Hawaiian or Pacific Islander		29 (0.7)
Asian		154 (3.8)
White		3044 (75.4)
Other		227 (5.6)
NA[b]		48 (1.2)
Education (n %)	4038	
Less Than High School Graduate		217 (5.4)
High School Graduate/GED or Vocational/Tech/Trade School		1149 (28.5)
Some College		993 (24.6)
Four Year College Graduate		957 (23.7)
Professional or Graduate Degree		709 (17.6)
NA		13 (0.3)
Marital Status (n %)	4038	
Married or Partner		2467 (61.1)
Separated or Divorced		461 (11.4)
Never Married and Single		192 (4.8)
Widowed		905 (22.4)
NA		13 (0.3)
Back Pain History and Current Episode		
Symptom Duration (n %)	4038	
< 1 month		1320 (32.7)
1 - 3 months		801 (19.8)
3 - 6 months		288 (7.1)
6 - 12 months		237 (5.9)
1 - 5 years		584 (14.5)
> 5 years		803 (19.9)
NA		5 (0.1)
Functional Status (mean SD, 0-24 RMDQ[c])	4038	9.5 (6.5)
Back pain (mean SD, 0-10 NRS[d])	4036	5.0 (2.8)
Leg pain present (n %)	4036	2530 (62.7)
Leg pain [d] (mean SD, 0-10 NRS)	2530	5.3 (2.5)
Pain Interference with Activity (mean SD, 0-10 BPI[e])	4038	3.3 (2.5)

Table 1-1 continued. Baseline Characteristic of older adults with a new visit for back pain

General Health Status		
EQ5D (mean SD, 0-1)	4024	0.75 (0.17)
Other		
Smoking (n %)	4038	
Never		2167 (53.7)
Quit > 1 year ago		1640 (40.6)
Smoker or quit < 1 year ago		220 (5.5)
NA		11 (0.3)
Expectation for Recovery (mean SD, 0-10 NRS)	4025	5.5 (3.7)
Positive Anxiety Screen (n %)	4038	500 (12.4)
Positive Depression Screen (n %)	4038	324 (8.0)

a Standard Deviation
b Not Answered
c Roland Morris Disability Questionnaire
d Patients with leg pain present only
e Brief Pain Inventory

Table 1-2. Clinical outcomes at each time point by age, gender, and back pain duration prior to index visit, Mean (Standard Deviation)

	Roland Morris Disability Questionnaire				Back Pain (NRS[a])			
	Baseline	3 Months	6 Months	12 Months	Baseline	3 Months	6 Months	12 Months
All	9.5 (6.5)	9.1 (6.6)	8.6 (6.7)	8.3 (6.8)	5.0 (2.8)	3.7 (2.7)	3.6 (2.7)	3.6 (2.7)
Age Group								
65-69	9.2 (6.7)	8.5 (6.6)	8.0 (6.7)	7.3 (6.7)	4.9 (2.7)	3.5 (2.7)	3.5 (2.7)	3.3 (2.7)
70-74	9.3 (6.4)	8.9 (6.6)	8.4 (6.6)	8.2 (6.9)	5.0 (2.9)	3.7 (2.7)	3.6 (2.7)	3.6 (2.7)
75-79	9.4 (6.5)	9.2 (6.7)	8.8 (6.7)	8.8 (6.7)	5.0 (2.7)	3.7 (2.7)	3.7 (2.7)	3.6 (2.7)
80-84	9.9 (6.2)	9.6 (6.7)	9.6 (6.8)	9.4 (6.9)	5.1 (2.8)	3.9 (2.7)	3.8 (2.7)	3.8 (2.8)
85+	10.9(6.2)	10.9(6.3)	10.3(6.4)	10.4 (6.8)	5.1 (2.8)	3.9 (2.7)	3.8 (2.7)	4.0 (2.6)
Gender								
Men	8.3 (6.3)	7.6 (6.5)	7.1 (6.5)	6.9 (6.6)	4.5 (2.7)	3.1 (2.5)	3.0 (2.6)	2.9 (2.5)
Women	10.2(6.5)	9.9 (6.6)	9.5 (6.7)	9.1 (6.8)	5.3 (2.8)	4.0 (2.7)	4.0 (2.7)	3.9 (2.7)
Duration of Back Pain								
<1 Mo[d]	8.3 (6.6)	7.0 (6.4)	6.6 (6.4)	6.3 (6.4)	4.6 (3.0)	2.7 (2.5)	2.6 (2.5)	2.7 (2.5)
1-3 Mo	9.4 (6.2)	8.5 (6.6)	8.0 (6.4)	7.6 (6.6)	4.8 (2.7)	3.3 (2.6)	3.4 (2.6)	3.1 (2.5)
3-6 Mo	9.0 (6.0)	9.5 (6.6)	8.6 (6.6)	7.8 (6.7)	5.0 (2.6)	3.9 (2.6)	3.8 (2.5)	3.5 (2.6)
6-12 Mo	10.4(6.4)	10.6(6.3)	10.2(6.4)	10.0 (6.7)	5.3 (2.6)	4.4 (2.6)	4.4 (2.7)	4.1 (2.6)
1-5 Yrs[e]	11.0(6.3)	11.3(6.1)	10.7(6.4)	10.4 (6.7)	5.3 (2.6)	4.6 (2.6)	4.5 (2.5)	4.5 (2.7)
>5 Yrs	10.4(6.5)	10.9(6.6)	10.9(6.6)	10.7 (6.7)	5.3 (2.6)	4.6 (2.7)	4.7 (2.7)	4.7 (2.6)

	Leg Pain (NRS)[b]				Pain Interference with Activity (BPI[c])			
	Baseline	3 Months	6 Months	12 Months	Baseline	3 Months	6 Months	12 Months
All	5.3 (2.5)	3.8 (2.9)	3.7 (2.9)	3.6 (2.9)	3.3 (2.5)	2.9 (2.4)	2.8 (2.4)	2.7 (2.5)
Age Group								
65-69	5.3 (2.5)	3.7 (2.9)	3.6 (2.9)	3.5 (2.8)	3.5 (2.6)	2.8 (2.5)	2.6 (2.5)	2.5 (2.4)
70-74	5.2 (2.6)	3.9 (2.9)	3.6 (2.9)	3.8 (2.9)	3.3 (2.5)	2.9 (2.5)	2.7 (2.5)	2.7 (2.5)
75-79	5.4 (2.6)	3.7 (2.9)	3.8 (2.8)	3.6 (2.8)	3.2 (2.4)	2.8 (2.4)	2.8 (2.4)	2.8 (2.4)
80-84	5.5 (2.4)	3.9 (3.0)	3.5 (2.9)	3.5 (3.0)	3.2 (2.3)	3.0 (2.4)	3.0 (2.5)	2.9 (2.5)
85+	5.5 (2.4)	4.1 (2.9)	3.9 (2.9)	3.8 (2.8)	3.3 (2.3)	3.2 (2.3)	3.2 (2.3)	3.1 (2.5)
Gender								
Men	4.8 (2.5)	3.3 (2.8)	3.1 (2.7)	3.0 (2.7)	2.9 (2.3)	2.4 (2.3)	2.3 (2.3)	2.3 (2.3)
Women	5.6 (2.5)	4.1 (3.0)	3.9 (2.9)	3.9 (2.9)	3.6 (2.5)	3.1 (2.5)	3.0 (2.5)	2.9 (2.5)
Duration of Back Pain								
<1 Mo	5.0 (2.7)	2.8 (2.7)	2.7 (2.7)	2.8 (2.8)	3.1 (2.6)	2.1 (2.2)	2.0 (2.3)	2.0 (2.3)
1-3 Mo	5.3 (2.5)	3.5 (2.9)	3.5 (2.8)	3.2 (2.7)	3.3 (2.4)	2.7 (2.4)	2.6 (2.4)	2.4 (2.3)
3-6 Mo	5.6 (2.2)	4.3 (2.8)	4.0 (2.9)	3.6 (2.7)	3.2 (2.4)	3.0 (2.5)	2.7 (2.4)	2.5 (2.4)
6-12 Mo	5.5 (2.3)	4.3 (2.8)	4.1 (2.7)	4.0 (2.8)	3.2 (2.3)	3.3 (2.4)	3.1 (2.3)	3.1 (2.4)
1-5 Yrs	5.5 (2.5)	4.5 (2.8)	4.3 (2.7)	4.3 (2.9)	3.6 (2.4)	3.7 (2.3)	3.5 (2.4)	3.4 (2.5)
>5 Yrs	5.5 (2.5)	4.7 (2.9)	4.4 (3.0)	4.5 (2.9)	3.5 (2.4)	3.5 (2.5)	3.5 (2.5)	3.6 (2.6)

a Numerical Rating Scale
b Patients with Baseline Leg Pain NRS >0
c Brief Pain Inventory
d Month
e Years

Table 1-3. Proportion of participants with resolved back pain (no back pain for past 30 days) who completed both 6 and 12 month questions, n (row %)

Resolved at 6 Months	Resolved at 12 Months		
	No	**Yes**	**Total**
No	357 (89.9)	40 (10.1)	397
Yes	30 (30.9)	67 (69.1)	97
Total	387	107	494

Chapter 2:

Risk factors for persistent back pain and persistent disability in older adults with new episodes of back pain

Risk factors for persistent back pain and persistent disability in older adults with new episodes of back pain.

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ABSTRACT

BACKGROUND AND PURPOSE: Although many studies have investigated predictors of poor outcome for back pain in younger adults, there is little information on risk factors for persistent back pain and disability in older adults. Our primary objective was to investigate predictors of persistent back pain and disability in older adults.

METHODS: We conducted a prospective cohort study using the Back pain Outcomes using Longitudinal Data (BOLD) registry. BOLD enrolled 5,239 adults ≥65 years with a new primary care visit for back pain. We analyzed 3671 participants with both 12 month outcomes and 24 months of electronic medical record data. Baseline measurements included: demographics, index diagnosis, duration of back pain, expectation for recovery, and comorbidities. We abstracted 423 radiology reports for imaging findings from a subset of the cohort. The primary outcome was the Roland Morris Disability Questionnaire (RMDQ). We also collected a 0-10 numerical rating scale for back pain. We defined persistent back pain as pain ≥3 of 10 at both 6 and 12 months and persistent disability as RMDQ ≥4 at both 6 and 12 months. We used logistic regression to estimate predictors of persistent back pain and persistent disability. We used linear regression to estimate the relationship between imaging findings and back pain or RMDQ scores.

RESULTS: There were 1,467 (40.0%) participants with persistent back pain and 1,739 (47.4%) had persistent disability. Adjusted analyses showed the following characteristics were most strongly predictive of persistent back pain and persistent disability: gender; worse baseline clinical characteristics of back pain, leg pain, back-related disability, and duration of symptoms; smoking; anxiety; cervical pain; wide-spread pain syndromes; and an index diagnosis of lumbar spinal stenosis. Within the imaging subset, moderate or severe facet joint arthropathy was the only imaging finding that had significant associations with long-term RMDQ and pain.

CONCLUSION: We found multiple predictors for both persistent back pain and disability in older adults with a new visit for back pain. These findings may be used to inform future research validating screening tools for persistent back pain in older adults.

INTRODUCTION

The transition from a new episode of back pain to persistent pain and disability is understudied in older adults, and we do not fully understand how it may differ from younger adults. Persistent back pain is an important problem for older adults as it contributes to a lower quality of life. Older adults with persistent low back pain have greater functional limitations and more depressive symptoms compared to those without persistent back pain. [25,45] Persistent back pain in older adults has a large economic impact as well. Healthcare utilization and charges for back pain in Medicare beneficiaries are increasing. [46,47] In order to better develop prevention and management strategies for this major and important health issue among older adults, we need a better understanding of the predictors of persistent back pain and disability.

Few prognostic studies of back pain involving older adults have prospectively followed participants from an index episode of back pain. Most well-designed prognostic studies of back pain have included adults of all ages. [11,14,16,18,19,48] Collectively, these studies have found psychological variables (depression, anxiety and loneliness), non-back-related joint pain, older age, and higher baseline pain or functional limitation to be predictors of later persistent back pain. Women also tended to have a greater prevalence of chronic back pain. [6,11,19] Only two prospective studies [6,16] have focused on the transition to persistent back pain in older adults. One study, which prospectively examined the transition to chronic back pain in older adults, assessed a cohort of 277 participants 70 years old with and without back pain and then followed-up with them seven years later. [6] Although prospective, the design of this study does not optimally inform clinical decision making by clarifying risk factors for patients with new episodes of low back pain presenting to primary care settings. Scheele et al. [16] reported 3-month follow-up from a well-designed study that prospectively followed older adults presenting to primary care settings in the Netherlands. To our knowledge, no high quality study design with long-term follow-up of older adults has been published. Consequently, there is a need for additional research that prospectively examines risk factors for developing persistent back pain and disability after a new visit for back pain in older adults.

Our primary objective was to investigate predictors of persistent back pain and disability over one year in older adults with a new primary care visit for back pain. We hypothesized that women, arthritis in non-lumbar spine joints, depressive symptoms, anxiety symptoms, higher baseline pain, longer duration of symptoms and lower expectation regarding recovery would be associated with having persistent back pain and disability. Our second objective was to examine prevalent lumbar imaging findings associated with back pain and back-related disability 12 months after the index visit. We hypothesized the presence of central spinal stenosis diagnosed by imaging would be associated with greater pain and disability at 12 months.

METHODS

Study design, setting, and participants

We conducted a cohort study using the prospectively created Back pain Outcomes using Longitudinal Data (BOLD) registry. The formation and baseline description of this cohort is described in detail elsewhere.[17] Briefly, BOLD is a cohort of 5239 older adults (≥65 years old) presenting to primary care settings for new episodes of back pain during the years 2010-2013. It is a multisite study of three integrated health systems: Kaiser Permanente in Northern California, Henry Ford Health System in Detroit, and Harvard Vanguard Medical Associates/ Harvard Pilgrim Health Care in Boston. The main exclusion criteria are: a healthcare visit for back pain less than six months before the index visit, prior lumbar spine surgery, developmental spine deformities, inflammatory spondyloarthropathy, known spinal malignancy or infection, history of cancer in the past five years, history of human immunodeficiency virus infection, serious medical co-morbid condition with life expectancy < 1 year, no telephone, planning to move within a year, unable to understand English, or severe mental impairment that would interfere with answering questions. We contacted participants at 3, 6 and 12 months to collect patient reported outcomes either by telephone or mailed questionnaire, depending on the study site.

For this analysis, we selected participants from the BOLD registry who had both 12-month outcome data and full 24-months of electronic medical record (EMR) data available as of November 2013. EMR data included 12 months of data both prior to and after the index visit. (Figure 2-1) The institutional review boards at the University of Washington, Kaiser Permanente Northern California, Henry Ford Health System, and Harvard/Vanguard Health System all approved the BOLD protocol.

Variables/measurement

We collected baseline demographic data [including age, gender, ethnicity (Hispanic versus non-Hispanic), race, marital status, education level, employment status, and study site] by interview within three weeks of an eligible index visit for back pain. We categorized the back pain-related International Classification of Diseases, Ninth Revision (ICD9) code at index as: axial pain, back and leg pain, lumbar spinal stenosis, or other (see Appendix for details). We asked participants about the duration of current back pain in months, expectation for recovery on an 11-point numeric rating scale (0=no confidence in recovery, 10=complete confidence in recovery), and smoking status. We measured recent depression and anxiety symptoms using the Patient Health Questionnaire-4 Depression and Anxiety Screen (PHQ-4), [26,27] and we measured general health status with the EQ-5D. [49]

Using electronic medical records, we looked for the following comorbidities (as defined by at least one ICD9 code during the 12 months prior to the index visit): knee osteoarthritis, hip osteoarthritis, osteoporosis, cervical pain, and chronic wide-spread pain/fibromyalgia. We selected these comorbidities because they were hypothesized to be associated with persistent LBP *a priori*. (see Appendix for details)

We abstracted imaging findings from the radiology reports of lumbar imaging procedures in the electronic medical record for a subset of study participants. We examined the reports of three imaging modalities: radiographs, Magnetic Resonance Imaging (MRI), or Computed Tomography scans (CT). Since degenerative changes in the lumbar spine are relatively stable over time and new imaging findings are uncommon, [50,51] we abstracted lumbar imaging procedures that occurred from seven days prior to index through 12 month follow-up. The primary author (SDR) abstracted manually abstracted each radiology report. We used a standardized data collection form for each modality and recorded the presence or absence of each relevant imaging finding for a modality.

We created an analytic subsample of randomly selected imaging records across all three study sites. We excluded reports with incomplete or duplicate data, and consequently, the subsample was generated over three rounds due to the presence of unusable imaging reports in the first two rounds. Out of the 2703 imaging reports with a qualifying lumbar imaging Current Procedural Terminology, Fourth Edition (CPT) code (CPT Codes: 72100, 72110, 72114, 72131, 72132, 72133, 72148, 72149, and 72158), we conducted two rounds with 400 randomly selected imaging reports each, stratified on site and modality. We abstracted additional MRI reports from the two sites with good quality reports to increase the number of MRI reports. We then formed the final analytic subset by combining the abstracted imaging report data from all three rounds. We removed all duplicate abstractions. If a participant had multiple unique reports for the same imaging modality, we selected the report created closest to the index date and excluded the later report.

We measured patient reported outcomes for back pain at baseline and 3, 6, and 12 months. We used a modified version of the Roland Morris Disability Questionnaire (RMDQ) to measure functional status. The RMDQ is a 24-item questionnaire, and we modified it by adding "or leg (sciatica)" to the words "back pain" for each item. [17,34,52] We recorded average back and leg pain intensity during the prior 7 days using an 11-point pain numerical rating scale (NRS) (0=no pain, 10=worst pain) [28]. We defined the presence of persistent back pain as back pain NRS ≥3/10 at both 6 and 12 months, and we defined persistent disability as RMDQ ≥4 at both 6 and 12 months. [53]

Missing data

We accounted for missing outcomes using inverse probability weights. Missing 12 month outcomes were bivariately associated with: older age, non-white race, lower education, higher baseline RMDQ, cervical pain, baseline anxiety, and baseline depression at $p \leq 0.1$. We included these variables along with study site in a logistic model to estimate the probability of having a competed 12 month RMDQ. This method reduces potential selection bias by creating a “pseudo population” with a similar probability of having a complete 12 month RMDQ. [54] Most participants with missing 6 month outcomes, also had missing 12 month outcomes and most with missing RMDQ scores also had missing back pain NRS scores. Consequently, we applied the inverse probability weights for a completed 12 month RMDQ in all regression models since it essentially accounted for missingness of either outcome.

Statistical Analysis

We used means and standard deviations (SD) or frequencies and proportions of demographic variables, baseline health characteristics, and baseline patient reported outcomes to describe the sample. We report the prevalence of imaging findings using frequencies and proportions within the subsample with abstracted imaging records. We described unadjusted 6 and 12 month outcomes by mean and SD of back pain NRS and RMDQ. We also present the number and proportion of participants meeting our definition of persistent disability and persistent back pain at 6 and 12 months.

We examined the associations between each predictor variable and persistent back pain or persistent disability using logistic regression models. We re-weighted all models using the inverse probability weights for complete outcomes. We adjusted for age, gender, race, marital status, education level, employment status, and study site. We present odds ratios and their 95% confidence intervals to describe each predictor's association with a patient having persistent pain or persistent disability after a new episode of back pain.

We tested the association between imaging findings and back-related disability or back pain using the subset with abstracted radiology reports. We used multiple linear regressions to test the association between each radiographic feature and 12 month back-related disability or back pain. We applied the inverse probability weights and adjusted for age, gender, race, and study site.

All statistical analysis was performed using STATA IC version 12.1 (College Station, TX). We used a standard significance value of $p < 0.05$ since this study is intended to explore potential predictors of persistent back pain in an understudied population rather than for confirmatory analysis.

RESULTS

We analyzed 3671 participants from the BOLD registry (Figure 2-1). The mean age was 74 years (SD 6.9), 2369 (64%) were women, 917 (25%) were non-white, 1509 (41%) were at least college graduates, and 2270 (62%) were married or living with a partner. Most participants (n=1937; 53%) had back pain for less than 3 months. Mean reported intensity of back pain was

4.9 (SD 2.8) and mean back-related functional status (RMDQ) was 9.4 (SD 6.5). About two thirds (n= 2294; 63%) had leg pain. (Table 2-1)

The final subsample with imaging findings included 423 imaging reports: 232 participants with radiographs, 141 with MRI, and 50 with CT. We describe the prevalence of imaging findings in the lumbar spine by type of imaging procedure in Table 2-2. The most common findings were disc space narrowing; radiographs: n=176 (75.9%) and CT: n= 29 (58.0%); foraminal or lateral recess stenosis; MRI: n= 97 (68.8%) and CT: n=35 (70.0%); and moderate to severe facet arthropathy; radiographs: n= 98 (42.2%), MRI: n= 71 (50.4%), CT: n= 30 (60.0%). (Table 2-2)

Outcomes

After a year of follow-up, 40.0% (1,467of 3118) of participants had persistent back pain at both 6 and 12 months and 47.4% (1,739 of 3119) had persistent disability at 6 and 12 months. At 12 months, the mean back pain intensity decreased to 3.6 (SD 2.7) and the mean RMDQ was 8.3 (SD 6.8).

Unadjusted Associations

Most predictors were bivariately associated with persistent back pain and persistent disability in the unadjusted analyses (Table 2-2 and 2-4). However, a comorbid diagnosis of osteoporosis was not associated with either persistent back pain [Odds Ratio (OR): 1.08, 95% Confidence Interval (CI): 0.82, 1.42] or persistent disability (OR: 1.13, 95% CI: 0.86, 1.48). Additionally, a prior diagnosis of hip osteoarthritis was not significantly associated with persistent back pain or persistent disability (OR: 1.06, 95% CI: 0.63, 1.80 and OR: 1.11, 95% CI: 0.66, 1.87, respectively).

Adjusted Associations

Estimates adjusted for demographic variables, study site, and missing outcomes found that for every 10 year increase in age there was a small increase in persistent disability (OR: 1.10, 95% CI: 0.98, 1.23). Men had less persistent back pain (OR: 0.63, 95% CI: 0.54, 0.74) and persistent disability (OR: 0.67, 95% CI: 0.58, 0.78) compared to women. Compared to whites, African-Americans had greater persistent pain (OR: 1.31, 95% CI: 1.04, 1.64), but no difference in persistent disability. Participants working full or part-time had less persistent disability and persistent back pain (Table 2-5 and Table 2-6).

We found worse baseline clinical characteristics of back pain, leg pain, back-related disability, duration of symptoms, and health status were associated with both persistent disability and persistent back pain. (Table 2-5 and Table 2-6) Compared to people who never smoked, those who were current or recent smokers were more likely to have persistent disability and persistent back pain (OR: 1.49, 95% CI: 1.09, 2.04 and OR: 1.58, 95% CI: 1.15, 2.16, respectively). Increased expectations for recovery were associated with better prognoses, such that for every one point increase in expectation of recovery the odds of persistent disability decreased by 11% (OR: 0.89, 95% CI: 0.87, 0.91) and the odds of persistent back pain decreased 12% (OR: 0.88, 95% CI: 0.86, 0.90). Comorbid anxiety, cervical pain, and wide-spread pain syndromes were associated with both persistent disability and persistent back pain, while comorbid depression and knee osteoarthritis were only associated with persistent disability. Compared to participants with a diagnosis code in the category of axial back pain at their index visit, participants who had a diagnosis consistent with back and leg pain or lumbar spinal stenosis were more likely to have persistent disability and those with a diagnosis of lumbar spinal stenosis were more likely to have persistent pain. (Table 2-5 and Table 2-6)

No findings from the radiograph imaging reports were associated with 12 month outcomes (Table 2-7). However, a few findings on CT and MRI were associated with 12 month outcomes. Compared to participants with mild or no facet joint arthropathy, those with moderate or severe facet joint arthropathy had worse back-related function and back pain scores at 12 months. Their adjusted back-related function scores were 2.3 points higher (95% CI: -0.1, 4.7) and adjusted back pain intensity was 1.1 points greater (95% CI: 0.1, 2.1) versus those with mild or no facet joint arthropathy. Although patients with type one Modic changes reported on MRI had some of the strongest associations with 12 month back-related disability (mean 3.8 points greater versus those without type one Modic changes, 95% CI: -2.7, 10.4) and 12 month back pain (mean 1.6 points higher, 95% CI: -0.5, 3.8), they were rare so the confidence intervals were wide and included one. (Table 2-7)

DISCUSSION

Among older adults with a new primary care visit back pain, we found gender, employment, duration of symptoms, baseline pain intensity, baseline back-related function, baseline health status, co-morbid pain conditions, and a lumbar spinal stenosis diagnosis were associated with persistent back pain and disability. There are additional modifiable risk factors for persistent disability and persistent back pain, which include expectation for recovery, smoking, and anxiety. Facet joint arthropathy was the only imaging finding that showed significant associations with long-term pain or disability.

Our results are consistent with much of the recent research examining predictors of poor outcome in adults of all ages with back pain from primary care settings. Several studies have found clinical characteristics; such as pain intensity, disability, and leg pain; and psychosocial factors are associated with worse back pain outcomes. [55-59] The commonalities between our results and these prior studies suggest that predictors of poor outcome for back pain may be similar for adults of all ages. Using the strongest known risk factors for poor outcome, the STarT Back Screening Tool was developed and validated in primary care settings to screen patients with back pain for risk of a poor outcome. [44,48] Four constructs from the STarT Back Screening

Tool (i.e., leg pain, comorbid pain, disability, and expectation for improvement) were also risk factors that we found associated with persistent back pain and persistent disability in older adults, and we did not collect data on the other constructs included in this tool. This similarity indicates further work investigating the validity of the STarT Back, or other similar screening tools, [60] in older adults living in the United States may be productive.

In a cohort of Dutch older adults with new episodes of low back pain, Scheele et al. investigated predictors for non-recovery of back pain at three months. Common predictive variables at baseline between our studies were: longer duration of back pain, greater severity of back pain, and expectation for recovery. The presence of leg pain was one risk factor with contradictory results between the studies. We found the presence of leg pain was greater in those with persistent disability and pain. Scheele et al. report that older adults with pain below the knee have a lower risk of non-recovery.[16]

Our study examined longer term outcomes (6 and 12 months) than Scheele et al. [16] Regardless of the length of follow-up, many predictors of poor outcome appear similar between the two studies. This is consistent with our prior research showing that pain and disability outcomes improve little after three months (in submission). Additionally, a review by Chou et al., which involved patients of all ages, found predictors of chronic disabling low back pain were similar for 3, 6, or 12 month outcomes. [55]

The primary strength of our cohort study on older adults is its large size and one year follow-up. By including only patients identified during a new primary care visit for back pain, our large inception cohort provides some of the best estimates of risk factors for persistent back pain and persistent disability in older adults with a new episode of back pain. Another strength of this study is the excellent long-term follow up, with roughly 85% of participants completing 12 month outcomes. Additionally, our use of inverse probability weights further minimizes the potential selection bias due to attrition.

An important limitation of this study is that some potentially important predictors of persistent back pain were not measured in the BOLD cohort. Prior studies suggest self-efficacy, passive coping, catastrophizing, and illness perception beliefs may often predict the development of persistent pain. [57-59] These measures were not included in the baseline assessment for the BOLD cohort, and other studies will be needed to determine their association with persistent back pain in older adults. A second limitation is that not all participants underwent lumbar imaging. The substantially smaller sample size for the imaging analysis reduced the precision of our estimates for several imaging findings, especially those that were uncommon. Additionally, the subsample receiving lumbar imaging may be different from those who did not have these diagnostic procedures. We caution that these results cannot be generalized to all older adults with back pain as selection bias may exist.

We found many predictors of persistent back pain and disability in older adults with a new visit for back pain are similar to those for younger populations, and none of the predictors seem to be unique to older adults. Future research will need to further look into the importance of specific risk factors and the validity and clinical utility of screening tools for persistent back pain in older adults.

Figure 2-1. Flow diagram of study enrollment

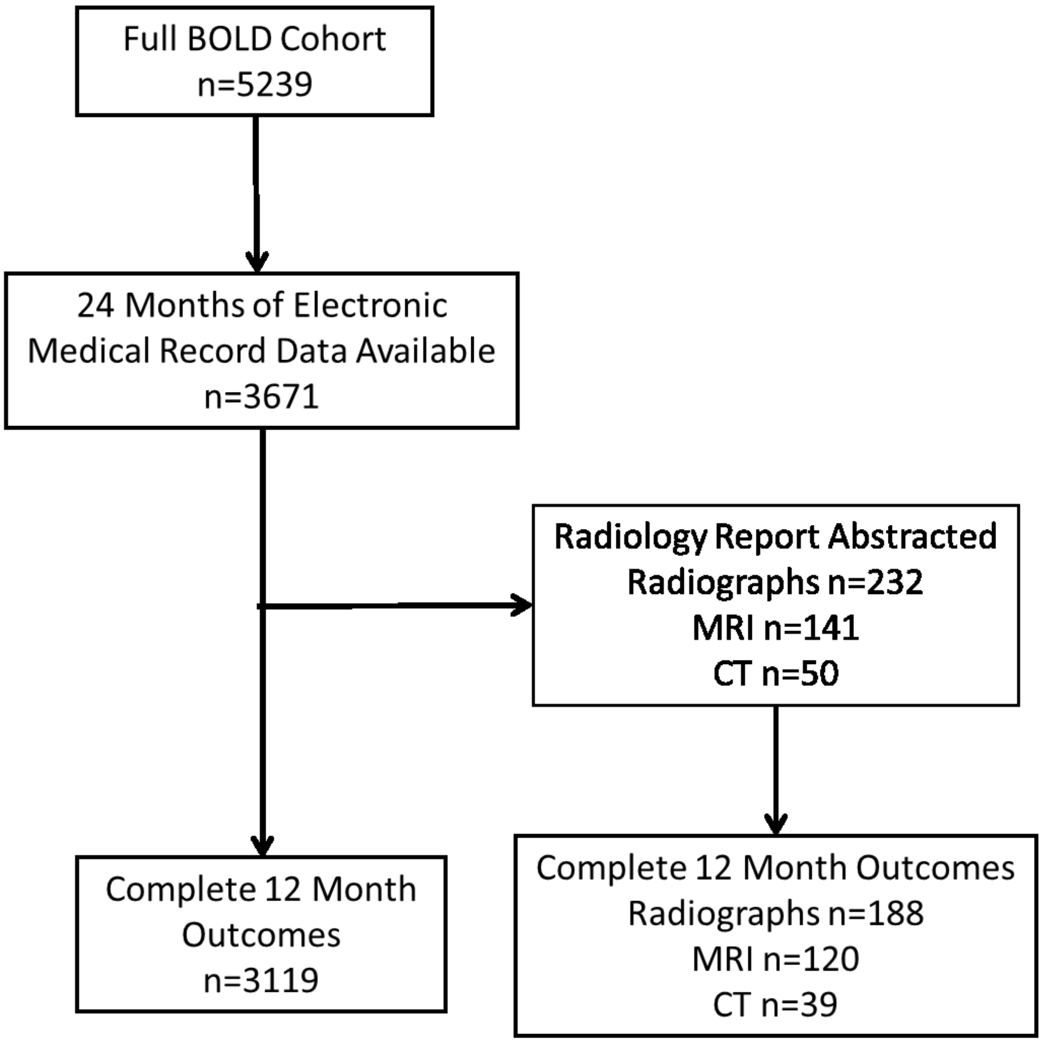

Table 2-1. Baseline Characteristic of older adults with a new visit for back pain

	All Participants with 12 Month Follow-up (n=3671)		
Variable	N	Mean or n	SD[a] or %
Demographics			
Age (mean SD, years)	3671	73.9	6.9
Men (n %)	3671	1302	35.5
Hispanic (n %)	3650	218	6.0
Race (n %)	3671		
Black		489	13.3
Native American/Alaskan/Hawaiian or Pacific Islander		26	0.7
Asian		146	4.0
White		2754	75.0
Other		212	5.8
NA[b]		44	1.2
Education (n %)	3671		
Less Than High School Graduate		200	5.5
High School Graduate/GED or Vocational/Tech/Trade School		1043	28.4
Some College		906	24.7
Four Year College Graduate		863	23.5
Professional or Graduate Degree		646	17.6
NA		13	0.4
Marital Status (n %)	3671		
Married or Partner		2270	61.8
Separated, or Divorced		403	11.0
Never Married and Single		171	4.7
Widowed		815	22.2
NA		12	0.3
Employment (n %)	3671		
Working full-time/part-time		419	11.4
Retired (not due to ill health)		3014	82.1
Retired or disabled because of ill health		89	2.4
Other		134	3.7
NA		15	0.4
Study Site (n %)	3671		
Detroit		487	13.3
Northern California		2,328	63.4
Boston		856	23.3
Back Pain Characteristics			
Symptom Duration (n %)	3671		
< 1 month		1192	32.5
1 - 3 months		745	20.3
3 - 6 months		260	7.1
6 - 12 months		214	5.8
1 - 5 years		531	14.5
> 5 years		724	19.7
NA		5	0.1

Table 2-1 Continued. Baseline Characteristic of older adults with a new visit for back pain

Back Pain Characteristics			
Back pain (mean SD, 0-10 NRS[c])	3671	4.9	2.8
Leg pain present (n %)	3669	2294	62.5
Leg pain (mean SD, 0-10 NRS)[d]	2294	5.3	2.5
Functional Status (mean SD, 0-24 RMDQ[e])	3671	9.4	6.5
Pain Interference with Activity (mean SD, 0-10 BPI[f])	3671	3.3	2.4
General Health Status			
EQ5D (mean SD, 0-1)	3659	0.76	0.17
Health Characteristics			
Smoking (n %)	3671		
Never		1984	54.1
Quit > 1 year ago		1486	40.5
Smoker or quit < 1 year ago		191	5.2
NA		10	0.3
Expectation for Recovery (mean SD, 0-10 NRS)	3659	5.5	3.7
Positive Anxiety Screen (n %)	3655	442	12.1
Positive Depression Screen (n %)	3655	277	7.6
Osteoporosis (n %)	3671	225	6.1
Knee Osteoarthritis (n %)	3671	258	7
Hip Osteoarthritis (n %)	3671	58	1.6
Cervical Pain (n %)	3671	400	10.9
Wide-spread Pain Syndromes (n %)	3671	187	5.1
Index Diagnostic Code Category (n %)	3671		
Axial Pain		2,433	66.3
Back and Leg Pain		815	22.2
Lumbar Spinal Stenosis		201	5.5
Other		222	6.1

a Standard Deviation
b Not Answered
c Numerical Rating Scale
d Patients with leg pain present only
e Roland Morris Disability Questionnaire
f Brief Pain Inventory

Table 2-2. Prevalence of imaging findings from abstracted imaging reports (n=423)

Radiographs (n=232)		
Anatomic Feature	**n**	**(%)**
Decreased Disc Space	176	75.9
Central Stenosis	1	0.4
Foraminal Stenosis	0	0.0
Facet Arthropathy	98	42.2
Grade 1 Listhesis	82	35.3
Grade 2 Listhesis	3	1.3
Severe Scoliosis	3	1.3
Severe Kyphosis	0	0.0
Compression Fracture	11	4.7

Computed Tomography (n=50)		
Anatomic Feature	**n**	**(%)**
Decreased Disc Space	29	58.0
Disc Bulge	8	16.0
Disc Protrusion	9	18.0
Disc Extrusion	1	2.0
Disc Herniation	2	4.0
Central Stenosis	24	48.0
Foraminal Stenosis	35	70.0
Nerve Root Compression	14	28.0
Facet Arthropathy	30	60.0
Grade 1 Listhesis	26	52.0
Grade 2 Listhesis	2	4.0
Severe Scoliosis	0	0.0
Severe Kyphosis	0	0.0

Magnetic Resonance Imaging (n=141)		
Anatomic Feature	**n**	**(%)**
Disc Desiccation	31	22.0
Decreased Disc Space	47	33.3
Disc Bulge	33	23.4
Disc Protrusion	29	20.6
Disc Extrusion	9	6.4
Disc Herniation	15	10.6
Type 1 Modic Changes	7	5.0
Central Stenosis	52	36.9
Foraminal Stenosis	97	68.8
Nerve Root Compression	41	29.1
Facet Arthropathy	71	50.4
Grade 1 Listhesis	69	48.9
Grade 2 Listhesis	1	0.7

Magnetic Resonance Imaging and Computed Tomography Combined (n=184)		
Anatomic Feature	**n**	**(%)**
Decreased Disc Space	75	40.8
Disc Bulge	8	4.4
Disc Protrusion	36	19.6
Disc Extrusion	10	5.4
Disc Herniation	17	9.2
Central Stenosis	74	40.2
Foraminal Stenosis	129	70.1
Nerve Root Compression	55	29.9
Facet Arthropathy	98	53.3
Grade 1 Listhesis	69	37.5
Grade 2 Listhesis	3	1.6

Table 2-3. Univariate logistic regression results between predictors and persistent disability (Unadjusted)

Persistent Disability (RMDQ[a] ≥4 at 6 and 12 months)				
Variable	**Odds Ratio**	**95% Confidence Interval**		**p-value**
Age	1.02	1.01	1.03	<0.001
Men	0.61	0.53	0.70	<0.001
Race				
Black	reference			
White	0.70	0.58	0.85	<0.001
Other	0.64	0.49	0.84	<0.001
Education				
Less Than High School Graduate	reference			
High School Graduate/GED or Vocational/Tech/Trade School	0.98	0.72	1.32	0.870
Some College	0.99	0.73	1.35	0.963
Four Year College Graduate	0.65	0.48	0.89	0.006
Professional or Graduate Degree	0.59	0.43	0.81	0.001
Marital Status				
Married or Partner	reference			
Separated, or Divorced	1.19	0.96	1.47	0.114
Never Married and Single	1.12	0.82	1.52	0.487
Widowed	1.48	1.26	1.74	<0.001
Employment				
Working full-time/part-time	reference			
Retired (not due to ill health)	1.72	1.39	2.13	<0.001
Retired or disabled because of ill health	2.99	1.87	4.80	<0.001
Other	2.83	1.90	4.22	<0.001
Symptom Duration				
< 1 month	reference			
1 - 3 months	1.34	1.11	1.61	0.002
3 - 6 months	1.45	1.11	1.90	0.007
6 - 12 months	2.56	1.90	3.45	<0.001
1 - 5 years	2.31	1.87	2.84	<0.001
> 5 years	2.41	1.99	2.91	<0.001
Functional Status (RMDQ)	1.12	1.10	1.13	<0.001
Back pain intensity (NRS[b])	1.17	1.14	1.20	<0.001
Leg pain intensity (NRS)[c]	1.10	1.06	1.13	<0.001
Leg Pain Present	2.01	1.75	2.31	<0.001
EQ-5D	0.04	0.02	0.06	<0.001
Smoking				
Never	reference			
Quit > 1 year ago	1.11	0.97	1.27	0.144
Smoker or quit < 1 year ago	1.47	1.09	1.99	0.011
Expectation for Recovery (NRS)	0.89	0.87	0.91	<0.001
Positive Anxiety Screen	1.56	1.28	1.91	<0.001
Positive Depression Screen	1.50	1.17	1.92	0.001
Osteoporosis	1.13	0.86	1.48	0.377
Knee Osteoarthritis	1.71	1.32	2.21	0.000
Hip Osteoarthritis	1.11	0.66	1.87	0.686

Table 2-3 continued. Univariate logistic regression results between predictors and persistent disability (Unadjusted)

Cervical Pain	1.53	1.24	1.88	<0.001
Wide-spread Pain Syndromes	1.48	1.10	2.00	0.009
Index Diagnostic Code Category				
Axial Pain	reference			
Back and Leg Pain	1.26	1.08	1.48	0.004
Lumbar Spinal Stenosis	1.75	1.31	2.34	<0.001
Other	0.99	0.75	1.30	0.934

a Roland Morris Disability Questionnaire

b Numerical Rating Scale

c Patients with leg pain present only

Table 2-4. Univariate logistic regression results between predictors persistent back pain (Unadjusted)

Persistent Back Pain (NRS[a] ≥3/10 at 6 and 12 months)				
Variable	**Odds Ratio**	**95% Confidence Interval**		**p-value**
Age	1.01	1.00	1.02	0.006
Men	0.57	0.49	0.66	<0.001
Race				
Black	reference			
White	0.65	0.54	0.79	<0.001
Other	0.60	0.45	0.78	<0.001
Education				
Less Than High School Graduate	reference			
High School Graduate/GED or Vocational/Tech/Trade School	1.06	0.78	1.44	0.717
Some College	1.11	0.82	1.51	0.506
Four Year College Graduate	0.70	0.51	0.96	0.027
Professional or Graduate Degree	0.60	0.43	0.83	0.002
Marital Status				
Married or Partner	reference			
Separated, or Divorced	1.27	1.03	1.58	0.028
Never Married and Single	1.00	0.73	1.38	0.995
Widowed	1.42	1.21	1.67	<0.001
Employment				
Working full-time/part-time	reference			
Retired (not due to ill health)	1.55	1.24	1.93	<0.001
Retired or disabled because of ill health	3.23	2.02	5.17	<0.001
Other	2.37	1.59	3.53	<0.001
Symptom Duration				
< 1 month	reference			
1 - 3 months	1.34	1.10	1.63	0.003
3 - 6 months	1.84	1.39	2.43	<0.001
6 - 12 months	2.75	2.04	3.69	<0.001
1 - 5 years	2.66	2.15	3.28	<0.001
> 5 years	2.83	2.33	3.43	<0.001
Functional Status (RMDQ[b])	1.09	1.08	1.10	<0.001
Back pain intensity (NRS)	1.22	1.19	1.25	<0.001
Leg pain intensity (NRS)[c]	1.10	1.06	1.14	<0.001
Leg Pain Present (Yes)	1.84	1.60	2.12	<0.001
EQ-5D	0.06	0.04	0.10	<0.001
Smoking				
Never	reference			
Quit > 1 year ago	1.03	0.90	1.18	0.695
Smoker or quit < 1 year ago	1.51	1.12	2.03	0.007
Expectation for Recovery (NRS)	0.88	0.87	0.90	<0.001
Positive Anxiety Screen	1.41	1.16	1.72	0.001
Positive Depression Screen	1.36	1.07	1.74	0.013
Osteoporosis	1.08	0.82	1.42	0.566
Knee Osteoarthritis	1.27	0.98	1.64	0.067
Hip Osteoarthritis	1.06	0.63	1.80	0.824

Table 2-4 continued. Univariate logistic regression results between predictors and persistent back pain (Unadjusted)

Cervical Pain	1.37	1.11	1.68	0.003
Wide-spread Pain Syndromes	1.39	1.03	1.86	0.029
Index Diagnostic Code Category				
Axial Pain	reference			
Back and Leg Pain	1.11	0.95	1.31	0.197
Lumbar Spinal Stenosis	1.63	1.22	2.18	0.001
Other	1.04	0.79	1.38	0.778

a Numerical Rating Scale

b Roland Morris Disability Questionnaire

c Patients with leg pain present only

Table 2-5. Adjusted association between predictors and persistent disability (Adjusted for demographics, site, and inverse probability weight for missingness)

Persistent Disability at both 6 & 12 months (RMDQ[a] ≥4)

Variable	Odds Ratio	95% Confidence Interval		p-value
Age	1.01	1.00	1.02	0.034
Men	0.67	0.58	0.78	<0.001
Race				
White	reference			
Black	1.07	0.86	1.34	0.548
Other	0.90	0.72	1.13	0.385
Education				
Less Than High School Graduate	reference			
High School Graduate/GED or Vocational/Tech/Trade School	1.13	0.82	1.56	0.443
Some College	1.18	0.85	1.63	0.328
Four Year College Graduate	0.94	0.67	1.33	0.743
Professional or Graduate Degree	0.85	0.60	1.21	0.370
Marital Status				
Married or Partner	reference			
Separated, or Divorced	0.98	0.78	1.22	0.827
Never Married and Single	0.97	0.70	1.35	0.872
Widowed	1.04	0.86	1.25	0.699
Employment				
Working full-time/part-time	reference			
Retired (not due to ill health)	1.39	1.11	1.74	0.005
Retired or disabled because of ill health	2.15	1.31	3.52	0.002
Other	2.17	1.44	3.29	<0.001
Symptom Duration				
< 1 month	reference			
1 - 3 months	1.33	1.10	1.62	0.003
3 - 6 months	1.48	1.12	1.95	0.006
6 - 12 months	2.38	1.75	3.25	<0.001
1 - 5 years	2.28	1.83	2.84	<0.001
> 5 years	2.53	2.06	3.10	<0.001
Functional Status (RMDQ)	1.11	1.10	1.13	<0.001
Back pain intensity (NRS[b])	1.15	1.12	1.18	<0.001
Leg pain intensity (NRS)[c]	1.08	1.04	1.12	<0.001
Leg Pain Present	1.94	1.69	2.24	<0.001
EQ-5D	0.05	0.03	0.08	<0.001
Smoking				
Never	reference			
Quit > 1 year ago	1.18	1.02	1.37	0.022
Smoker or quit < 1 year ago	1.49	1.09	2.04	0.012
Expectation for Recovery (NRS)	0.89	0.87	0.91	<0.001
Positive Anxiety Screen	1.49	1.20	1.85	<0.001
Positive Depression Screen	1.35	1.04	1.75	0.026
Osteoporosis	0.95	0.72	1.26	0.729
Knee Osteoarthritis	1.63	1.24	2.13	<0.001

Table 2-5 continued. Adjusted association between predictors and persistent disability
(Adjusted for demographics, site, and inverse probability weight for missingness)

Hip Osteoarthritis	1.14	0.67	1.95	0.623
Cervical Pain	1.44	1.16	1.79	0.001
Wide-spread Pain Syndromes	1.52	1.12	2.07	0.008
Index Diagnostic Code Category				
Axial Pain	reference			
Back and Leg Pain	1.39	1.17	1.64	<0.001
Lumbar Spinal Stenosis	1.89	1.39	2.56	<0.001
Other	1.12	0.84	1.50	0.441

a Roland Morris Disability Questionnaire
b Numerical Rating Scale
c Patients with leg pain present only

Table 2-6. Adjusted association between predictors and persistent back pain (Adjusted for demographics, site, and inverse probability weight for missingness)

Persistent Back Pain at both 6 & 12 months (NRS[a] ≥3/10)				
Variable	Odds Ratio	95% Confidence Interval		p-value
Age	1.01	1.00	1.02	0.195
Men	0.63	0.54	0.74	<0.001
Race				
White	reference			
Black	1.31	1.04	1.64	0.019
Other	0.90	0.72	1.14	0.387
Education				
Less Than High School Graduate	reference			
High School Graduate/GED or Vocational/Tech/Trade School	1.18	0.86	1.63	0.305
Some College	1.25	0.90	1.73	0.189
Four Year College Graduate	0.96	0.68	1.35	0.798
Professional or Graduate Degree	0.82	0.58	1.17	0.281
Marital Status				
Married or Partner	reference			
Separated, or Divorced	1.01	0.80	1.27	0.942
Never Married and Single	0.83	0.60	1.16	0.277
Widowed	1.01	0.84	1.22	0.933
Employment				
Working full-time/part-time	reference			
Retired (not due to ill health)	1.27	1.01	1.61	0.044
Retired or disabled because of ill health	2.39	1.46	3.91	0.001
Other	1.78	1.18	2.68	0.006
Symptom Duration				
< 1 month	reference			
1 - 3 months	1.34	1.09	1.64	0.005
3 - 6 months	1.84	1.39	2.45	<0.001
6 - 12 months	2.61	1.92	3.55	<0.001
1 - 5 years	2.67	2.14	3.34	<0.001
> 5 years	3.08	2.50	3.80	<0.001
Functional Status (RMDQ[b])	1.08	1.07	1.09	<0.001
Back pain intensity (NRS)	1.21	1.17	1.24	<0.001
Leg pain intensity (NRS)[c]	1.07	1.04	1.11	<0.001
Leg Pain Present (Yes)	1.73	1.50	2.01	<0.001
EQ-5D	0.08	0.05	0.12	<0.001
Smoking				
Never	reference			
Quit > 1 year ago	1.08	0.94	1.26	0.279
Smoker or quit < 1 year ago	1.58	1.15	2.16	0.004
Expectation for Recovery (NRS)	0.88	0.86	0.90	<0.001
Positive Anxiety Screen	1.31	1.06	1.62	0.014
Positive Depression Screen	1.21	0.93	1.57	0.152
Osteoporosis	0.91	0.69	1.21	0.526
Knee Osteoarthritis	1.17	0.90	1.53	0.241

Table 2-6 continued. Adjusted association between predictors and persistent back pain (Adjusted for demographics, site, and inverse probability weight for missingness)

Hip Osteoarthritis	1.13	0.66	1.93	0.663
Cervical Pain	1.27	1.03	1.58	0.028
Wide-spread Pain Syndromes	1.38	1.02	1.87	0.039
Index Diagnostic Code Category				
Axial Pain	reference			
Back and Leg Pain	1.16	0.98	1.38	0.086
Lumbar Spinal Stenosis	1.73	1.28	2.35	<0.001
Other	1.13	0.84	1.52	0.429

a Numerical Rating Scale
b Roland Morris Disability Questionnaire
c Patients with leg pain present only

Table 2-7. Adjusted association between imaging findings and 12 month disability or back pain scores (Adjusted for age, gender, race, and study site; inverse probability weight for missing)

	Back Related Disability (RMDQ[a])				Back Pain (Pain NRS[b])			
Variable	Beta	95% Confidence Interval		p-value	Beta	95% Confidence Interval		p-value
Radiographs (n=188)								
Disc Space Narrowing	1.64	-0.69	3.97	0.17	-0.16	-1.15	0.83	0.75
Facet Arthropathy	0.67	-1.34	2.69	0.51	0.42	-0.51	1.36	0.37
Listhesis (Grade 1)	0.47	-1.67	2.61	0.67	-0.06	-1.01	0.89	0.90
Compression Fracture	0.43	-4.71	5.57	0.87	0.57	-1.31	2.45	0.55
Magnetic Resonance Imaging (n=120)								
Disc Desiccation	0.48	-2.42	3.38	0.74	0.06	-1.17	1.29	0.92
Disc Space Narrowing	1.62	-0.93	4.17	0.21	0.26	-0.85	1.37	0.64
Disc Bulge	0.65	-3.01	4.30	0.73	-0.31	-1.74	1.12	0.67
Disc Protrusion	0.94	-2.10	3.98	0.54	0.13	-1.29	1.55	0.86
Disc Extrusion	3.18	-3.06	9.43	0.32	1.50	-1.03	4.03	0.24
Disc Herniation	-1.68	-5.96	2.60	0.44	-0.41	-2.07	1.25	0.63
Type 1 Modic Changes	3.81	-2.72	10.35	0.25	1.62	-0.52	3.76	0.14
Central Stenosis	0.58	-2.22	3.39	0.68	-0.05	-1.19	1.09	0.93
Lateral Stenosis	0.98	-2.03	3.98	0.52	-0.18	-1.42	1.06	0.77
Nerve Root Compression	0.97	-2.24	4.18	0.55	0.13	-1.17	1.43	0.84
Facet Arthropathy	2.60	-0.16	5.36	0.06	1.05	-0.05	2.16	0.06
Listhesis (Grade 1)	-0.77	-3.39	1.85	0.56	-0.14	-1.21	0.92	0.79
Computed Tomography (n=39)								
Disc Space Narrowing	0.09	-3.66	3.84	0.96	0.54	-1.34	2.42	0.56
Disc Bulge	1.99	-4.29	8.27	0.52	0.37	-2.43	3.18	0.79
Disc Protrusion	3.06	-1.89	8.02	0.22	1.55	-0.38	3.48	0.11
Disc Extrusion	7.28	3.37	11.18	0.00	0.76	-1.00	2.52	0.39
Disc Herniation	0.11	-10.90	11.12	0.98	-0.37	-5.43	4.69	0.88
Central Stenosis	-0.41	-4.43	3.62	0.84	-0.07	-2.12	1.98	0.94
Lateral Stenosis	0.11	-4.58	4.80	0.96	1.11	-0.98	3.20	0.29
Nerve Root Compression	-1.20	-6.59	4.19	0.65	0.02	-2.21	2.25	0.99
Facet Arthropathy	1.62	-3.26	6.51	0.50	1.29	-0.85	3.43	0.23
Listhesis (Grade 1)	2.83	-1.32	6.97	0.17	0.01	-2.11	2.14	0.99
Magnetic Resonance Imaging and Computed Tomography (n=152)								
Disc Space Narrowing	0.34	-1.98	2.66	0.77	-0.35	-1.35	0.65	0.49
Disc Bulge	2.34	-4.23	8.92	0.48	1.02	-1.43	3.48	0.41
Disc Protrusion	1.19	-1.43	3.82	0.37	0.25	-0.98	1.49	0.69
Disc Extrusion	3.17	-2.20	8.54	0.25	1.18	-1.03	3.39	0.29
Disc Herniation	-1.54	-5.82	2.73	0.48	-0.51	-2.24	1.22	0.56
Central Stenosis	0.16	-2.19	2.51	0.89	-0.08	-1.08	0.91	0.87
Lateral Stenosis	0.73	-1.94	3.40	0.59	0.02	-1.13	1.16	0.98
Nerve Root Compression	0.50	-2.20	3.20	0.72	0.05	-1.07	1.16	0.94
Facet Arthropathy	2.28	-0.11	4.67	0.06	1.10	0.14	2.06	0.02
Listhesis (Grade 1)	-0.83	-3.18	1.53	0.49	-0.20	-1.20	0.80	0.70

a Roland Morris Disability Questionnaire
b Numerical Rating Scale

Appendix
Back Pain Diagnosis Category and associated International Classification of Disease, 9th Revision Code

Axial Back Pain	Back and Leg Pain	Other
307.89 Psychogenic backache	722.1 Displacement of thoracic or lumbar disc w/o myelopathy	721.6 Ankylosing vertebral hyperostosis
721.3 Lumbosacral spondylosis w/o myelopathy	722.2 Degeneration of intervertebral disc, unspecified	721.7 Traumatic spondylopathy
721.5 Kissing spine	724.3 Sciatica	721.8 Other allied disorders spine
721.9 Spondylosis of unspecified site w/o myelopathy	724.4 Back pain w/radiation, unspecified	722.3 Schmorl's nodes
722.5 Degeneration of thoracic or lumbar intervertebral disc		722.9 Other and unspecified disc disorder
722.51 Degeneration of thoracic or thoracolumbar intervertebral disc	**Lumbar Spinal Stenosis**	724.1 Pain in thoracic spine
722.52 Degeneration of lumbar or lumbosacral intervertebral disc	724.0 Spinal stenosis, not cervical	733.1 Pathologic fractures
722.6 Degeneration of intervertebral disc, site unspecified	724 Spinal stenosis- thoracic	733.1 Pathologic fractures, unspecified site
724.2 Lumbago	724 Spinal stenosis- lumbar	733.1 Pathologic fractures, vertebrae
724.5 Backache, unspecified	724 Spinal stenosis- lumbar with neurogenic claudication	734 Stress fracture of other bone
724.6 Disorders of sacrum	724.1 Spinal stenosis- other region	738.4 Acquired spondylolisthesis
739.3 Nonallopathic lesions, lumbar, not elsewhere classified		738.5 Other acquired deformity of back or spine
739.4 Nonallopathic lesions, sacral, not elsewhere classified		739.2 Nonallopathic lesions- thoracic, not elsewhere classified
846 Lumbosacral sprain		756.1 Spondylolysis
846.1 Sacroiliac (ligament) sprain		756.1 Spondylolisthesis
846.8 Other specified sites of sacroiliac region sprain		846.2 Sacrospinatus sprain
847.2 Lumbar sprain		846.3 Sacrotuberous sprain
847.3 Sacral sprain		846.9 Unspecified, sacroiliac sprain
847.9 Sprain- unspecified site of back		847.1 Thoracic sprain

Appendix
Co-morbidities and associated International Classification of Disease, 9th Revision Code

Knee Osteoarthritis	Hip Osteoarthritis	Fibromyalgia/Chronic Pain Syndrome
715.16	715.15	338.2x
715.26	715.25	338.4
715.36	715.35	729.1
715.96	715.95	
716.66	716.65	

Osteoporosis	Cervical Pain
733.00	721.0
733.02	721.1
733.03	722.0
733.09	722.4
	722.71
	722.81
	722.91
	723.x
	847.0

Chapter 3:

Patient reported outcomes associated with physical therapy services for older adults with a new visit for back pain

Patient reported outcomes associated with physical therapy services for older adults with a new visit for back pain

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ABSTRACT

BACKGROUND: Among older adults it is not clear how different types or dosage of physical therapy (PT) may be associated with improvement in back pain and function. This knowledge can help prioritize treatment approaches.

OBJECTIVE: To investigate how use of PT services is associated with improvement of back-related function and pain in older adults.

DESIGN: Prospective cohort study

METHODS: We studied 1775 older adults enrolled in a cohort study who had a new primary care visit for back pain. We ascertained PT utilization from electronic health records. We collected patient reported outcomes (back-related disability: Roland Morris Disability Questionnaire; back and leg pain intensity: 11 point numerical rating scale) over 12 months. We used Marginal Structural Models to estimate the average effect of different PT utilization dosage levels on patient disability and pain for all PT, active, passive, and manual therapy.

RESULTS: A total of 713 (40%) participants received some PT. There was no apparent dose-response relationship between use of physical therapy and back-related disability. Use of passive and manual therapy was not associated with pain outcomes. Greater use of active PT was associated with decreased back and leg pain ($p=0.011$ and $p=0.007$, respectively) and an increased odds of clinically meaningful improvements in back and leg pain ($p=0.001$ and $p<0.001$, respectively).

LIMITATIONS: Few patients used high levels of PT. This limits precision and the ability to test non-linear dose-response relationships.

CONCLUSIONS: Greater use of active PT was most consistently related to the largest improvement in pain intensity.

INTRODUCTION

Low back pain (LBP) is an important public health issue for older adults. Approximately, one-quarter to one-third of older adults have prevalent LBP, [4,25] and older adults with low back pain have lower health-related quality of life and greater functional limitations. [25] As the United States population ages, LBP in older adults is likely to grow as a significant public health problem. Increased morbidity and care due to LBP can strain the utilization of our healthcare systems. Specifically, Medicare costs and healthcare utilization associated with LBP have increased disproportionately compared to Medicare enrollment, [46] and as Medicare enrollment grows, the demand will escalate.

Physical therapy services are commonly used to address functional limitation in older adults with LBP, yet the frequency, type, and intensity of the use of physical therapy and its impact on persistent back pain and function in older adults is unknown. One study using Medicare data found early physical therapy visits were associated with less subsequent utilization of back-related healthcare in patients with non-specific LBP. [61] However, since this study utilized administrative data, the authors had no information on corresponding change in pain and functional status. Additionally, the authors did not examine the types of interventions provided by physical therapists. In order to better understand the relationship between practice patterns in physical therapy and patients' pain and function, research investigating the comparative effectiveness of active and passive physical therapy services is needed.

Current guidelines for managing LBP support some interventions commonly provided by physical therapists: exercise for patients with subacute and chronic LBP and spinal manipulation for acute, subacute and chronic LBP. [20] Emphasizing active interventions, such as therapeutic exercise or functional training, is one preferred practice pattern for physical therapists when managing LBP in adults. The effectiveness of passive interventions, such as ultrasound and transcutaneous electrical nerve stimulation, are not supported by the literature, and interventions such as traction have insufficient evidence to recommend routine use in clinical practice. [20] In one study, adhering to these guideline recommendations for active physical therapy interventions in adults <65 years old being treated by a physical therapist for acute LBP resulted in greater improvement in disability and less overall healthcare utilization when compared to patients receiving non-adherent care involving passive modality use. [21] However, it is not clear whether these recommendations and findings generalize to older adults.

The purpose of this study is to investigate the association between the overall use and type of physical therapy services and patient outcomes such as disability and pain intensity among older adults over the course of one year. The primary aim is to estimate the difference in patient reported outcomes among groups defined by dose of utilization, and the secondary aim is to estimate the difference in the number of participants achieving a clinically important difference in outcome among these utilization groups.

METHODS

Study design, data source, study population

We conducted an observational cohort study using the Back pain Outcomes using Longitudinal Data (BOLD) registry. The BOLD registry is comprised of 5239 adults 65 years and older who presented to primary care for a new back pain visit. We recruited participants from three integrated health systems in the United States: Kaiser Permanente, Northern California; Henry Ford Health System in Detroit; and Harvard Vanguard Medical Associates/ Harvard Pilgrim Health Care in Boston. We collected demographic and baseline clinical characteristics. We then followed participants prospectively for 12 months collecting patient reported outcomes at 3, 6, and 12 months after the initial index visit. We also collected health care utilization for the 12 months before and after the index visit from participants' electronic health record (EHR).

We excluded patients if they had a healthcare encounter for back pain six months prior to the index date, a prior lumbar spine surgery, developmental spine deformities, inflammatory spondyloarthropathy, known spinal malignancy or infection, primarily nerve compression-related symptoms, or a serious medical co-morbid condition with life expectancy less than one year. We have previously published a complete description of the BOLD cohort formation. [17] The institutional review boards at the University of Washington and each study site (Kaiser Permanente, Henry Ford Health System, and Harvard/Vanguard Health System) approved the BOLD registry.

For this analysis, we selected BOLD participants who had 12 month outcomes and complete EHR data available as of August, 2013. We excluded participants who had withdrawn from the study or died prior to their 12 month follow-up. We also excluded participants from Henry Ford Health System since Current Procedural Terminology (CPT), Fourth Edition code level data for physical therapy services were not available from this study site.

Physical therapy utilization

We ascertained the patients' physical therapy utilization using physical therapy-associated CPT Codes in their EHR (CPT codes: 97001-97535). Physical therapy interventions were categorized as active, passive, or manual therapy based on CPT code. (see Appendix) Time-based treatment CPT codes, such as those for therapeutic exercise, neuromuscular re-education, or manual therapy, approximately correspond to 15 minute increments of treatment. Untimed codes (e.g. group therapy, mechanical traction) refer to a single procedure being performed per session and can only be charged once per session. Multiple CPT codes may be charged during a physical therapy visit, but Medicare specifies that the total number of timed CPT codes billed per session must not exceed the total treatment minutes. [62]

We recorded cumulative use of physical therapy as the sum of all physical therapy CPT codes recorded in the EHR from baseline through the 12 month follow-up period. We described utilization as the sum of CPT codes specific to each treatment category (active, passive, or manual therapy) during this same time period. We categorized the volume of physical therapy utilization for the 12 months after the index visit based on the sum within each category: none, low (1-4), medium (5-9), and high (≥10). For hypothesis testing, we collapsed passive and manual therapy utilization categories into none, low (1-4), and medium to high (≥5) since few participants had more than 10 CPT codes in each of these categories.

Outcomes

The primary outcome measure was the Roland Morris Disability Questionnaire (RMDQ). The RMDQ is a 24 item, well validated questionnaire for back-related disability, and it is recommended for back pain studies. [31,52] The questions were slightly modified to specify disability from back pain or leg pain (sciatica). [17] Secondary outcome measures were numeric rating scales (NRS) for back pain and leg pain. [28] We measured the pain NRS outcomes using a 0-10 NRS for average pain in the past 7 days. We pre-specified minimal clinically important differences (MCID) for the change in RMDQ, ≥5 points improvement from baseline [35] and each pain NRS, an improvement of ≥ 30% from baseline. [35]

Covariates

At baseline, we collected demographic variables of age, gender, ethnicity (Hispanic/Non-hispanic), race, marital status, and education. Health characteristics assessed at the baseline interview were duration of current back pain, the Patient Health Questionnaire (PHQ)-4 Depression and Anxiety four item screen [26,27], a 0 (no confidence) to 10 (complete confidence) scale for expectation of recovery, smoking history, the Brief Pain Inventory (BPI), and the EQ5D. The BPI is a 0 (no interference) to 10 (interferes completely) scale measuring interference with 7 domains: general activity, mood, ability to walk, normal work, relations with other people, sleep and enjoyment of life. The composite score is an average of the seven domains.[32] The EQ5D is a standardized, preference-based health outcome measure. It consists of an index assessing five domains (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) and a 0-100 visual analog scale.[49]

We also identified the use of additional interventions or diagnostic imaging during the 12 months after participants' index visits from the EHR. We used the date of service for all back-associated CPT codes pertaining to diagnostic imaging, chiropractic visits, injections, and surgeries to define the timing and type of all concomitant interventions during the study period.

Statistical Analysis

We used descriptive statistics to describe the baseline characteristics of the entire cohort and the participants with no, low, medium or high total physical therapy utilization. We described unadjusted means and standard deviations (SD) for each outcome measure at each time point by strata of overall physical therapy utilization.

We used Marginal Structural Models (MSM) to estimate the population average causal effect for the dosage of all physical therapy, active physical therapy, passive physical therapy, and manual therapy utilization on back-related disability and pain. In this analysis, physical therapy interventions are a time-varying intervention since they are initiated at different time points and the dose of exposure varies over time. This longitudinal analysis of cumulative physical therapy interventions over multiple time points also creates time-dependent confounding bias since physical therapy utilization and long-term outcome are associated with past outcomes and treatments. Standard longitudinal statistical methods cannot fully adjust estimates in the presence of time-dependent confounding and a time-varying intervention.

Consequently, MSMs are an appropriate method to create an unconfounded effect estimate. [63] [64]

Essentially, MSMs reweight participants by the inverse of their probability of receiving the dose of physical therapy services which they used. MSMs involve a two-step process. Step one is to create inverse probability of treatment weights (IPTW), and step two is to apply these weights to a regression model. To generate IPTWs, we created propensity scores for the probability of receiving physical therapy interventions during three time periods (0-3 months, 3-6 month, and 6-12 months). We categorized treatment level as no physical therapy interventions (0 CPT codes), low physical therapy utilization (1-3 CPT codes), or high physical therapy utilization (>3 CPT codes), and we used ordinal regression to predict the propensity for each treatment category using both the baseline demographic and clinical data, intermediate pain and function outcomes, and any prior treatments or imaging. The primary idea is that there may be confounding by indication where patients with a worse health status seek additional care, and marginal structural models can correct for this selection bias. The inverse of a participant's probability of receiving their specific treatment level is their IPTW at each time period. We then created stabilized weights by including the probability of receiving treatment given the baseline characteristics in the numerator of each weight. We multiplied the stabilized IPTWs for each time period by each other to create a participant's cumulative IPTW for the entire study period, 0-12 months.

We applied the cumulative IPTWs to generalized estimating equations (GEE) which estimated the average treatment effect of each intervention category over the 12 month study period using 3, 6, and 12 month outcome measures. [65] [66] All physical therapy, active, passive, and manual therapy services were investigated with separate GEE models. We dropped participants with cumulative IPTWs of >10 from analysis. The first set of models tested the difference in mean patient reported outcomes score comparing each level of utilization to the reference group, or those having no utilization for that specific PT intervention category. The second set of models compared the odds of having a minimal clinically important difference (MCID) between each level of utilization and those having no utilization for that intervention category. We adjusted each model for pre-specified confounders: study site, age, gender, marital status, education, back pain duration, PHQ-4, expectation for recovery, baseline RMDQ, baseline back and leg NRS, and time. We tested for trend with increasing dose within each intervention category using a Wald test.

Missing Data

We only analyzed participants with complete 12 month outcomes. For creating IPTWs and hypothesis testing, we used a simple single imputation for missing outcome measures at three and/or six months. We imputed missing three month outcomes by carrying the baseline measure forward. Missing six month outcomes were imputed by carrying the three month measure forward.

Sensitivity Analysis

We performed an additional sensitivity analysis to better understand if exercise specific interventions had a different association with outcomes compared to analysis of all active interventions. We subset exercise specific CPT codes (CPT codes: 97110, 97112, and 97116) from the active category, and we then ran the same GEE models used for active physical therapy with dose of exercise replacing dose of active physical therapy CPT codes. The significance level was set at $p < 0.05$ for all analyses. Analysis was performed using STATA IC version 12.1. (College Station, TX).

RESULTS

We identified 1775 participants from the BOLD registry who met all inclusion and exclusion criteria. (Figure 3-1) Among those identified, the typical participant was 74.1 years, women, white, married or living with a partner, and a non-smoker. Approximately 30% had a high school education or less and 60.1% had back pain for 3 months or less. At baseline, the mean RMDQ was 9.5 (SD 6.1), mean back pain NRS was 4.8 (SD 2.8), and mean BPI score was 3.4 (SD 2.5). The majority of participants had leg pain (66.4%), 16.6% had symptoms of anxiety, and 10.0% had symptoms of depression. There were 393 (22.1%) participants with low utilization of all physical therapy services (1-4 PT CPT codes), 197 (11.1%) with medium utilization (5-9 PT CPT codes), and 123 (6.9%) with high utilization (≥10 PT CPT codes). The baseline characteristics of the cohort and participants within each utilization category are described further in Table 3-1.

Physical Therapy Utilization

A total of 713 (40.2%) participants received physical therapy services. Among those patients, the median number of physical therapy CPT codes was 4 and the interquartile range (IQR) was 2 to 8. The median number of active CPT codes was 2 (IQR: 1-2). Passive physical therapy and manual therapy had a median of 0 CPT codes (IQR: 0-0 and 0-1, respectively). Table 3-2 further describes the number of participants within each utilization category.

Patient Reported Outcomes

Table 3-3 displays unadjusted outcomes of back-related disability (RMDQ), back pain, and leg pain for each time-point by utilization group. Figure 3-2 displays the proportion of patients experiencing a clinically important improvement in back-related disability, back pain and leg pain at each follow-up time point by utilization group. At 12 months, 190 (17. 9%) of the no physical therapy group, 94 (23.9%) of the low physical therapy group, 50 (25.4%) of the medium physical therapy group, and 31 (25.2%) of the high physical therapy group experienced a clinically important improvement in back-related disability. The no physical therapy group had 373 (35.1%) and 267 (25.1%) participants experience a meaningful change in back pain and leg pain, respectively. Clinically important improvements in back pain and leg pain occurred in 170 (43.3%) and 146 (37.2%) of the low physical therapy group, 76 (38.6%) and 76 (38.6%) of the medium physical therapy group, and 55 (44.7%) and 51 (41.5%) of the high physical therapy group, respectively. (Figure 3-2)

Comparing Adjusted Outcomes by Utilization Category

Results from the marginal structural models are displayed in table 3-4 and table 3-5. The table presents either the adjusted difference in mean outcome and 95% confidence intervals (95% CI) or the adjusted odds ratio (OR) and 95% CI for each utilization category compared to those with no utilization in that particular category.

Both back-related disability and average back pain rating were similar among dosage categories of all physical therapy services. However, those using greater doses of all physical therapy services had greater improvements in leg pain (p=0.023) and were more likely to have a clinically important improvement in leg pain (p=0.001).

Back-related disability, back pain and leg pain had no relationship with use of passive interventions. In general, use of manual therapy was not related to improvements in back-related disability, back pain or leg pain. However, participants receiving ≥5 manual therapy CPT codes were more likely to have a clinically important improvement in leg pain (OR: 2.10; 95% CI: 1.14, 3.88).

Average back-related disability did not differ by dose of active physical therapy. However, participants with low active utilization were slightly more likely to have clinically important improvements in their back-related disability compared to those with no utilization

(OR: 1.32; 95% CI: 1.01, 1.70). Participants with greater use of active physical therapy services had reduced back pain intensity (p=0.011), and participants with greater dosage of active physical therapy services were more likely to have a clinically important change in back pain (p=0.001).

Similar patterns were seen for leg pain intensity. Increasing use of active physical therapy services corresponded to reduced leg pain (p= 0.007). Increasing use of active physical therapy services corresponded to an increased odds of clinically important improvements in leg NRS as well (p <0.001). (Table 3-4 and Table 3-5)

Sensitivity Analysis

Secondary analysis investigating the exercise specific subset of active physical therapy utilization found participants receiving ≥5 exercise CPT codes had increased odds of a clinically meaningful improvement in back-related disability (OR: 2.06; 95% CI: 1.07, 3.98). Participants receiving greater exercise interventions had less back and leg pain (p=0.010 and p=0.014, respectively), and were more likely to experience a clinically important improvement in back and leg pain (p=0.002 for both). (Table 3-4 and Table 3-5)

DISCUSSION

We found the use of all physical therapy services and active physical therapy were more consistently associated with a greater likelihood of clinically important improvements in pain, but not function. However, differences in mean back-related disability or pain scores among patterns of physical therapy use were either insignificant or small over the course of 12 months. Few patients received a high volume of physical therapy service. Most physical therapy services were active interventions. Post hoc analysis revealed higher levels of the exercise utilization had the largest and most consistent association with reduced pain scores and clinically important improvements in pain and back-related disability.

These results vary from other observational studies that have examined back-related disability associated with physical therapy utilization patterns for back pain. American adults <65 years old with acute back pain who were treated by physical therapists using guideline recommendations for active physical therapy had greater improvement in disability and used less healthcare when compared to patients receiving non-adherent care involving passive modality use. [21] A Dutch study found better adherence to guideline recommended active interventions was associated with improvements in back related function for patients with low back pain of unspecified duration. [67]

Some key differences between these studies and ours could explain these findings. Firstly, these prior studies compared treatment patterns within a cohort receiving physical therapy services. By contrast, we compared use of physical therapy to those not receiving any type of physical therapy in order to evaluate the effectiveness. Additionally, our study consists of adults ≥65 years old. Potentially, different types of physical therapy interventions may have different effectiveness in older adults. It could be that the RMDQ may not be as responsive a measure of functional change in older adults, although we are not aware of any studies on this topic. Lastly, roughly 40% of our cohort had chronic symptoms, even though all patients entered the BOLD cohort because they had a new back pain visit. The studies by Fritz et al. and Rutten et al. used younger cohorts with no or a smaller proportion with chronic symptoms. [21,67]

Our results suggest that current practice patterns of physical therapy for managing LBP in older adults may provide modest or no clinical improvements over the course of one year, depending on the interventions selected. There are several potential reasons for these results. One, older adults with a new episode of LBP may not receive the most effective interventions from physical therapists, or the interventions may not be well matched to the individual. Currently, there is limited evidence on physical therapy interventions for older adults in general or for specific subgroups of older adults with LBP. Clinical guidelines and meta-analyses support active, exercise based interventions for modest improvements of LBP in adults of all ages. [20 68 69 70] However, this evidence is not specific to older adults, and there are few clinical trials of older adults that examine interventions used by physical therapists for back pain. The two trials relevant to physical therapy interventions suggest general conditioning exercise and/or percutaneous electrical nerve stimulation are equally effective for pain and function in older adults. [71,72] Overall, there is little high quality evidence to guide physical therapists in choosing optimal interventions when treating older adults with LBP.

In addition to unknown efficacy of various interventions for older adults, how physical therapy services are delivered may affect the “real world” effectiveness of interventions for LBP in older adults. Older adult populations with back pain typically have more chronic back pain and have co-morbidities [73 45] Consequently, more coordinated, interdisciplinary models of care, rather than physical therapy alone, may be needed to produce the best outcomes in this population. Lastly, the expected prognosis for older adults with back pain is not as good as for younger adults. [16] Older adults have a greater prevalence of health conditions such as lumbar spinal stenosis, [74] which may have a poorer prognosis. Consequently, large improvements in function and pain may not be anticipated for older adults seeking care for their back pain.

Our results coupled with the lack of interventional studies on older adults with back pain highlight the need for greater research on rehabilitation interventions for this population. In addition to randomized clinical trials of interventions for older adults with back pain, much more information is needed on effective service delivery models for older adults with back pain. Investigating innovative models of interdisciplinary healthcare may help us make wider reaching improvements in outcomes than single interventions in isolation. Additionally, investigating other outcomes that are important to older adults with LBP is vital to allow physical therapists and researcher to better tailor interventions toward the outcomes this group of patients may value most. Unfortunately, we are not aware of any qualitative studies on this topic.

This is one of the few studies to longitudinally investigate patterns of use of specific types of physical therapy and their relationship to patient reported outcomes in a large cohort of older adults with LBP. By using advanced epidemiological methods, we were able to examine the cumulative effects of physical therapy services over time while account for the influence of prior treatments and outcomes. Additionally, this cohort used less restrictive exclusion criteria, which makes it a better reflection of the current population of older adults being seen by physical therapists for back pain.

Even with a strong study design and analytical methods there are limitations to this research. One limitation is that we defined our levels and types of treatment using CPT codes. CPT codes allowed us to examine categories of physical therapy services, but there may be some inaccuracy in coding that would result in misclassification of intervention categories. Misclassification may bias or attenuate the estimates. [75] Additionally, observational research using coarse categories may not be sensitive enough to detect the true effectiveness of some interventions used by physical therapists when grouped with other treatments. However, most exercise based interventions for low back pain show comparable effectiveness, and we do not have the clinical data available to further sub-group patients. Thirdly, residual treatment selection bias, also known as confounding by indication, may still be present if all confounders are not measured and the marginal structural models are not fully specified correctly. One potential unmeasured confounder is a patient's treatment preferences. A patient's preference for physical therapy services in general or for specific physical therapy interventions may influence the type and amount of treatment they receive. This can cause bias depending on how strongly it is related to a person's function and pain outcomes.

Another limitation is the relatively paucity of patients with high utilization of various types of physical therapy. This makes it difficult to test for non-linear dose response relationships, and it limits our ability to generate precise estimates for those with high use. Lastly, all participants were recruited from integrated health systems. Consequently, any unique factors that influence service delivery patterns in this setting may limit the generalizability of these results to other settings.

Conclusion

We found greater use of active physical therapy was most consistently related to the largest improvement in pain intensity, although differences in outcomes were small. There is relatively little research on optimal interventions for older adults with back pain to guide physical therapists' decision making. These findings underscore the need to better understand what treatment strategies physical therapists can use to best manage back pain in older adults.

Figure 3-1. Flow diagram of study enrollment

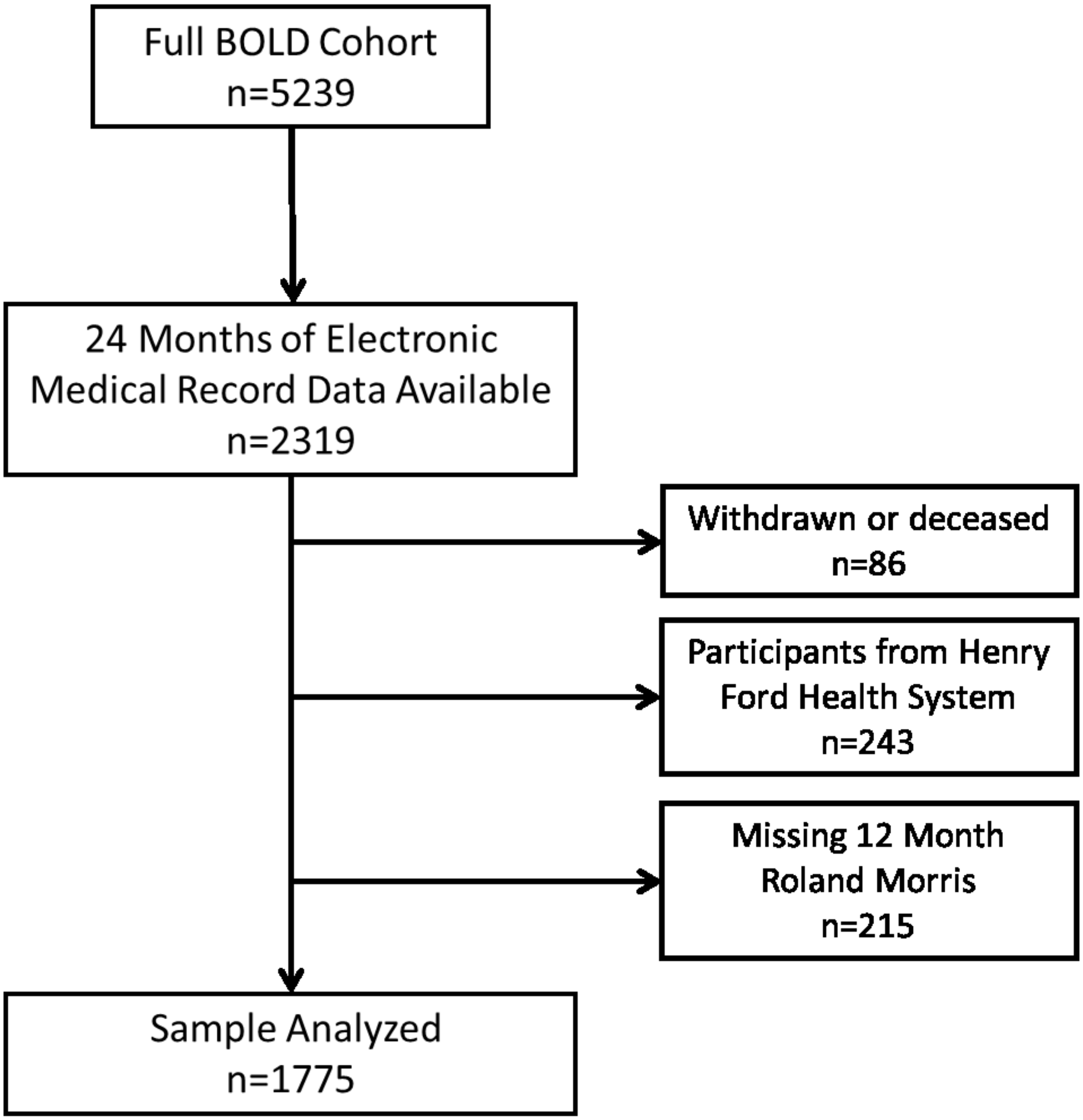

Figure 3-2. Proportion of participants achieving a minimal clinically important difference on the Roland Morris Disability Questionnaire (RMDQ), back pain numerical rating scale (NRS), and leg pain NRS at each follow-up time point.

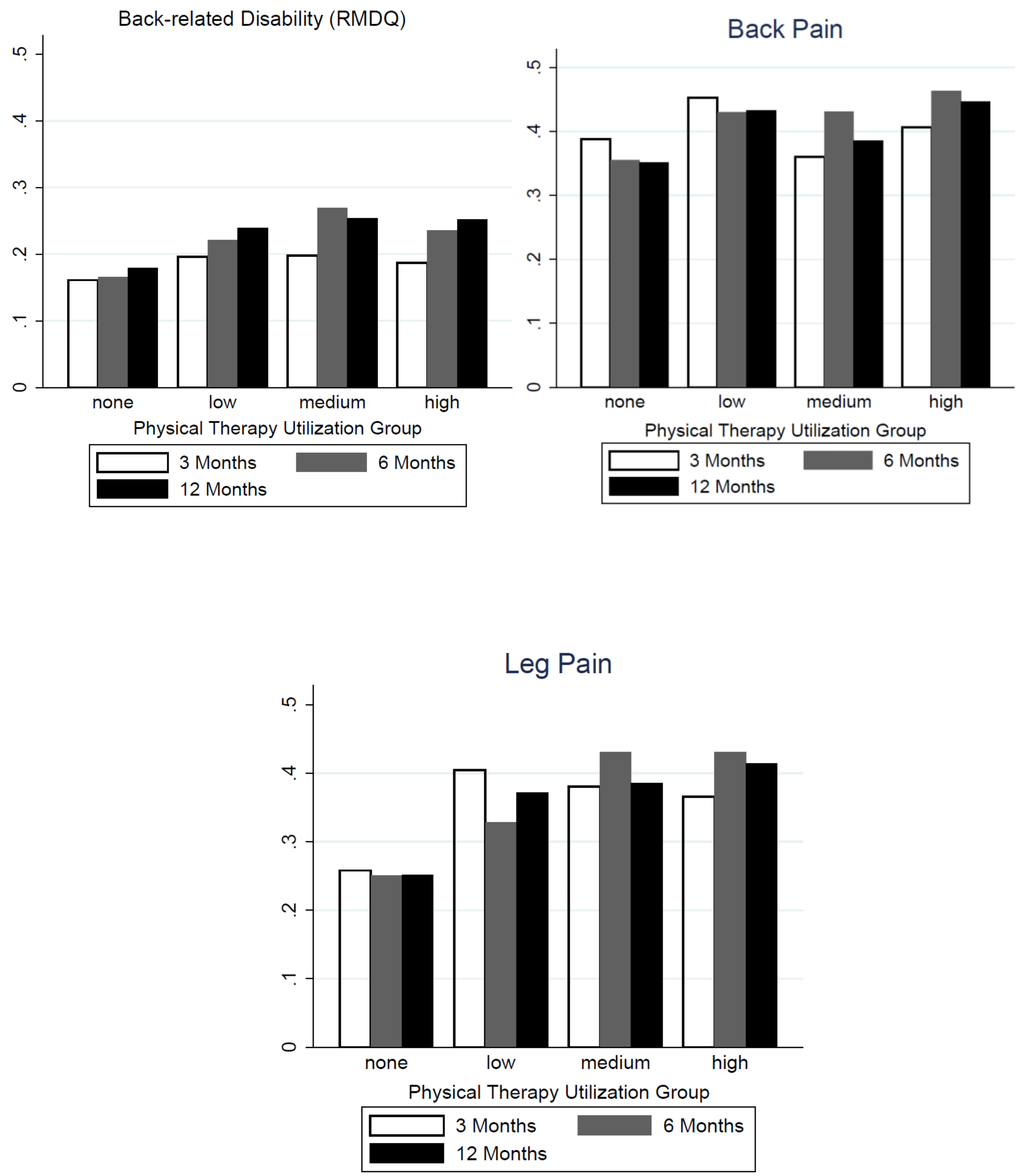

Table 3-1. Baseline characteristics of patients receiving physical therapy services compared those receiving no physical therapy services, mean (standard deviation) or number (%)

	No Physical Therapy Utilization n= 1062 (59.8%) **Mean (SD[a]) / n (%)**	**Low Physical Therapy Utilization** n= 393 (22.1%) **Mean (SD) / n (%)**	**Medium Physical Therapy Utilization** n= 197 (11.1%) **Mean (SD) / n (%)**	**High Physical Therapy Utilization** n=123 (6.9%) **Mean (SD) / n (%)**
Demographics				
Age (mean SD, years)	74.1 (7.0)	73.8 (6.3)	72.7 (6.4)	73.4 (6.5)
Men (n %)	391 (36.8)	135 (34.4)	68 (34.5)	32 (26.0)
Hispanic (n %)	89 (8.4)	23 (5.9)	12 (6.1)	11 (8.9)
Race (n %)				
Black	82 (7.7)	26 (6.6)	13 (6.6)	2 (1.6)
Native American/Alaskan/ Hawaiian or Pacific Islander	9 (0.9)	6 (1.5)	2 (1.0)	0 (0)
Asian	59 (5.6)	20 (5.1)	8 (4.1)	10 (8.1)
White	820 (77.2)	315 (80.2)	161 (81.7)	96 (78.1)
Other	78 (7.3)	17 (4.3)	11 (5.6)	10 (8.1)
NA[b]	14 (1.3)	9 (2.3)	2 (1.0)	5 (4.1)
Education (n %)				
Less Than High School Graduate	60 (5.7)	16 (4.1)	8 (4.1)	3 (2.4)
High School Graduate/GED or Vocational/Tech/Trade School	297 (28.0)	92 (23.4)	46 (23.4)	24 (19.5)
Some College	315 (29.7)	128 (32.6)	50 (25.4)	35 (28.5)
Four Year College Graduate	181 (17.0)	74 (18.8)	41 (22.8)	27 (22.0)
Professional or Graduate Degree	207 (19.5)	81 (20.6)	52 (26.4)	32 (26.0)
NA	2 (0.2)	2 (0.5)	0 (0)	2 (1.6)
Marital Status (n %)				
Married or Partner	605 (57.0)	248 (63.1)	125 (63.5)	72 (58.5)
Separated, or Divorced	122 (11.5)	38 (9.7)	33 (16.8)	10 (8.1)
Never Married and Single	63 (5.9)	17 (4.3)	9 (4.6)	7 (5.7)
Widowed	267 (25.1)	89 (22.7)	30 (15.2)	32 (26.0)
NA	5 (0.5)	1 (0.3)	0 (0)	2 (1.6)

Table 3-1 continued. Baseline characteristics of patients receiving physical therapy services compared those receiving no physical therapy services

Back Pain History and Current Episode				
Symptom Duration (n %)				
< 1 month	396 (37.3)	138 (35.1)	71 (36.0)	41 (33.3)
1 - 3 months	213 (20.1)	117 (29.8)	55 (27.9)	35 (28.5)
3 - 6 months	80 (7.5)	34 (8.7)	25 (12.7)	14 (11.4)
6 - 12 months	47 (4.4)	22 (5.6)	7 (3.6)	6 (4.9)
1 - 5 years	149 (14.0)	46 (11.7)	19 (9.6)	8 (6.5)
> 5 years	175 (16.5)	35 (8.9)	20 (10.2)	18 (14.6)
NA	2 (0.2)	1 (0.3)	0 (0)	1 (0.8)
Functional Status (mean SD, 0-24 RMDQ[c])	9.2 (6.2)	9.6 (6.1)	10.6 (5.9)	10.8 (6.2)
Back pain (mean SD, 0-10 NRS[d])	4.8 (2.8)	4.9 (2.6)	4.9 (2.8)	5.3 (2.6)
Leg pain present (n %)	646 (60.8)	280 (71.3)	155 (78.7)	98 (79.7)
Leg pain (mean SD, 0-10 NRS)[e]	5.1 (2.6)	5.3 (2.6)	5.7 (2.5)	5.5 (2.3)
Pain Interference with Activity (mean SD, 0-10 BPI[f])	3.2 (2.4)	3.5 (2.5)	3.9 (2.4)	3.9 (2.4)
Index Visit Back Pain ICD9[g] (n %)				
Axial Pain	463 (43.6)	147 (36.4)	69 (35.0)	46 (37.4)
Back and Leg Pain	156 (14.7)	97 (24.7)	57 (28.9)	34 (27.6)
Lumbar Spinal Stenosis	23 (2.2)	6 (1.5)	6 (3.1)	0 (0)
Other	420 (39.6)	149 (37.9)	65 (33.0)	43 (35.0)
General Health Status				
EQ5D (mean SD, 0-1)	0.77 (0.16)	0.74 (0.17)	0.74 (0.16)	0.73 (0.19)
Other				
Smoking (n %)				
Never	521 (49.1)	201 (51.2)	107 (54.3)	59 (48.0)
Quit > 1 year ago	473 (44.5)	172 (43.8)	83 (42.1)	59 (48.0)
Smoker or quit < 1 year	64 (6.0)	18 (4.6)	7 (3.6)	4 (3.3)
NA	4 (0.4)	2 (0.5)	0 (0)	1 (0.8)
Expectation for Recovery (mean SD, 0-10 NRS)	5.4 (3.8)	6.4 (3.5)	6.0 (3.6)	6.2 (3.2)
Positive Anxiety Screen (n %)	159 (15.0)	60 (15.3)	43 (21.8)	33 (26.8)
Positive Depression Screen (n %)	102 (9.6)	41 (10.4)	19 (9.6)	16 (13.0)

a Standard Deviation
b Not Answered
c Roland Morris Disability Questionnaire
d Numerical Rating Scale
e Patients with leg pain present only
f Brief Pain Inventory
g International Classification of Diseases, 9th Revision Code

Table 3-2. Counts of Physical Therapy Current Procedural Terminology codes (CPT) by dosage category over 12 months for those receiving any Physical Therapy (PT), number (%)

Number of CPT Codes	All PT n(%)	Active PT n(%)	Passive PT n(%)	Manual Therapy n(%)	Exercise (Active Subgroup) n(%)
None	0 (0)	78 (10.9)	568 (79.7)	458 (64.2)	221 (29.59)
Low (1-4)	393 (55.1)	481 (67.5)	17 (16.4)	220 (30.9)	419 (58.7)
Medium (5-9)	197 (27.6)	118 (16.6)	23 (3.2)	30 (4.2)	71 (98.3)
High (10+)	123 (17.3)	36 (5.1)	5 (0.7)	5 (0.7)	12 (1.7)
Total	713 (100)	713 (100)	713 (100)	713 (100)	713 (100)

Table 3-3. Unadjusted outcomes for back-related disability, back pain, and leg pain by physical therapy use category, mean (standard deviation)

	Back-related disability (RMDQ[a])			
Physical Therapy Use Category	**Baseline**	**3 Months**	**6 Months**	**12 Months**
No Physical Therapy (n=1062)	9.2 (6.2)	8.6 (6.6)	8.4 (6.6)	8.0 (6.8)
Low Physical Therapy Utilization (n=393)	9.6 (6.1)	8.2 (6.4)	8.0 (6.6)	8.1 (6.7)
Medium Physical Therapy Utilization (n=197)	10.6 (5.9)	9.8 (6.3)	8.5 (6.4)	8.1 (6.6)
High Physical Therapy Utilization (n=123)	10.8 (6.2)	10.7 (6.3)	10.1 (6.7)	9.6 (6.9)
	Back Pain (NRS[b])			
Physical Therapy Use Category	**Baseline**	**3 Months**	**6 Months**	**12 Months**
No Physical Therapy (n=1062)	4.8 (2.8)	3.5 (2.6)	3.6 (2.6)	3.6 (2.7)
Low Physical Therapy Utilization (n=393)	4.9 (2.6)	3.3 (2.5)	3.4 (2.6)	3.3 (2.6)
Medium Physical Therapy Utilization (n=197)	4.9 (2.8)	3.6 (2.6)	3.3 (2.4)	3.2 (2.6)
High Physical Therapy Utilization (n=123)	5.3 (2.6)	4.1 (2.4)	3.6 (2.5)	3.6 (2.6)
	Leg Pain (NRS)[c]			
Physical Therapy Use Category	**Baseline**	**3 Months**	**6 Months**	**12 Months**
No Physical Therapy (n=1062)	5.1 (2.6)	3.7 (2.9)	3.6 (2.8)	3.7 (2.9)
Low Physical Therapy Utilization (n=393)	5.3 (2.6)	3.2 (2.8)	3.4 (2.8)	3.3 (2.8)
Medium Physical Therapy Utilization (n=197)	5.7 (2.5)	3.5 (2.9)	3.0 (2.6)	2.9 (2.5)
High Physical Therapy Utilization (n=123)	5.5 (2.3)	3.9 (2.7)	3.5 (2.8)	3.5 (2.8)

a Roland Morris Disability Questionnaire
b Numerical Rating Scale
c Patients with leg pain present only

Table 3-4. Adjusted mean difference and test for trend in Roland-Morris Disability Questionnaire, back pain, or leg pain scores associated with dose of physical therapy for each type of physical therapy

Utilization Category	RMDQ[a]		Back Pain NRS[b]		Leg Pain NRS	
	Coefficient	95% CI[c]	Coefficient	95% CI	Coefficient	95% CI
Any PT[d]						
1-4 CPT[e] Codes(n=393)	-0.34	(-0.87, 0.19)	-0.16	(-0.38, 0.06)	-0.18	(-0.43, 0.07)
5-9 CPT Codes (n=197)	0.11	(-0.71, 0.94)	-0.18	(-0.50, 0.14)	-0.30	(-0.70, 0.11)
10+ CPT Codes(n=123)	-0.60	(-1.67, 0.46)	-0.37	(-0.85, 0.11)	-0.39	(-0.84, 0.07)
Test for trend	p=0.400		p=0.050		p=0.023	
Active PT						
1-4 CPT Codes (n=481)	-0.21	(-0.71, 0.29)	-0.14	(-0.35, 0.07)	-0.26	(-0.49, -0.03)
5-9 CPT Codes (n=118)	-0.65	(-1.54, 0.23)	-0.52	(-0.94, -0.10)	-0.43	(-0.86, 0.002)
10+ CPT Codes (n=36)	0.09	(-2.07, 2.24)	-0.56	(-1.81, 0.70)	-0.49	(-1.56, 0.60)
Test for trend	p=0.212		p=0.011		p= 0.007	
Exercise						
1-4 CPT Codes (n=419)	0.06	(-0.45, 0.57)	-0.14	(-0.36, 0.08)	-0.15	(-0.39, 0.09)
5+ CPT Code (n=83)	-1.02	(-2.55, 0.51)	-0.95	(-1.68, -0.21)	-0.86	(-1.52, -0.20)
Test for trend	p=0.511		p=0.010		p=0.014	
Passive PT						
1-4 CPT Codes (n=117)	0.39	(-0.67, 1.45)	-0.09	(-0.47, 0.29)	-0.06	(-0.55, 0.42)
5+ CPT Code (n=28)	-0.99	(-3.23, 1.25)	-0.77	(-1.58, 0.03)	-0.50	(-1.08, 0.09)
Test for trend	p=0.918		p=0.112		p=0.303	
Manual Therapy						
1-4 CPT Codes (n=220)	0.57	(-0.38, 1.51)	0.22	(-0.09, 0.52)	0.18	(-0.22, 0.57)
5+ CPT Code (n=35)	-0.64	(-2.56, 1.28)	-0.34	(-1.18, 0.50)	-0.56	(-1.42, 0.29)
Test for trend	p=0.492		p=0.559		p=0.948	

a Roland Morris Disability Questionnaire
b Numerical Rating Scale
c Confidence Interval
d Physical Therapy
e Current Procedural Terminology

Table 3-5. Adjusted odds ratio and test for trend of having a minimally clinically important change in the Roland-Morris Disability Questionnaire, back pain, or leg pain associated with dose of physical therapy for each type of physical therapy

Utilization Category	RMDQ[a]		Back Pain NRS[b]		Leg Pain NRS	
	Odds Ratio	95% CI[c]	Odds Ratio	95% CI	Odds Ratio	95% CI
Any PT[d]						
1-4 CPT[e] Codes (n=393)	1.29	(0.98, 1.70)	1.26	(1.02, 1.54)	1.36	(1.07, 1.71)
5-9 CPT Codes (n=197)	1.14	(0.75, 1.73)	1.11	(0.79, 1.56)	1.26	(0.92, 1.74)
10+ CPT Codes (n=123)	1.46	(0.87, 2.44)	1.40	(0.92, 2.13)	1.91	(1.25, 2.91)
Test for trend	p=0.102		p=0.072		p=0.001	
Active PT						
1-4 CPT Codes (n=481)	1.32	(1.02, 1.71)	1.24	(1.02, 1.52)	1.41	(1.13, 1.75)
5-9 CPT Codes (n=118)	1.37	(0.83, 2.26)	1.77	(1.14, 2.75)	1.80	(1.21, 2.67)
10+ CPT Codes (n=36)	0.90	(0.32, 2.56)	2.39	(0.92, 6.23)	2.02	(0.69, 5.92)
Test for trend	p=0.098		p=0.001		P <0.001	
Exercise						
1-4 CPT Codes (n=419)	1.08	(0.82, 1.42)	1.19	(0.96, 1.49)	1.24	(1.00, 1.55)
5+ CPT Code (n=83)	2.06	(1.07, 3.98)	3.18	(1.55, 6.53)	2.29	(1.28, 4.08)
Test for trend	p=0.086		p=0.002		p=0.002	
Passive PT						
1-4 CPT Codes (n=117)	0.92	(0.57, 1.49)	1.13	(0.76, 1.68)	0.93	(0.61, 1.41)
5+ CPT Code (n=28)	1.64	(0.66, 4.09)	1.67	(0.63, 4.42)	1.63	(0.70, 3.81)
Test for trend	p=0.583		p= 0.236		p=0.543	
Manual Therapy						
1-4 CPT Codes (n=220)	0.99	(0.68, 1.43)	0.83	(0.62, 1.11)	1.01	(0.76, 1.35)
5+ CPT Code (n=35)	1.72	(0.74, 4.01)	1.20	(0.62, 2.32)	2.10	(1.14, 3.88)
Test for trend	p=0.571		p=0.438		p=0.214	

a Roland Morris Disability Questionnaire
b Numerical Rating Scale
c Confidence Interval
d Physical Therapy
e Current Procedural Terminology

Appendix

Current Procedural Terminology Codes for physical therapy treatment categories
Active Physical Therapy Services
97110, 97350, 97112, 97113, 97116, 97150, 97535
Passive Physical Therapy Services
97010, 97012, 97014, 97018, 97022, 97026, 97032, 97033, 97035, 97039, 97124
Manual Physical Therapy Services
97140

DISCUSSION

This dissertation addresses three understudied and important questions regarding back pain in older adults: the long-term prognosis of back pain and function, predictors of persistent back pain and back-related disability, and the role of physical therapy services in clinical outcomes over the course of a year. Data for these analyses come from the Back pain Outcomes using Longitudinal Data (BOLD) registry, a large inception cohort of older adults with a new primary care visit for back pain, and the results provide fundamental epidemiological information on the longitudinal experience of older adults with back pain.

Chapter one describes the clinical course of pain and function in older adults with a new primary care visit for back pain. This description provides valuable insight into the long-term prognosis of older adults when they present to primary care for back pain. These analyses found that only 23% patients in the BOLD cohort reported resolved back pain 12 months after their initial visit. On average back pain, function limitation, and interference with activity improve only modestly over 12 months. Most improvement occurs within the first 3 months. The burden of back pain over 12 months is greater for women and people with longer duration of back pain symptoms. Functional limitation is greater for the oldest, older adults.

In chapter two I examined predictors of persistent pain and persistent disability at 6 and 12 months in this cohort. Several baseline variables are predictors for persistent symptoms in older adults with new visits for back pain, including: gender; worse baseline clinical characteristics of back pain, leg pain, back-related disability, and duration of symptoms; cervical pain; wide-spread pain syndromes; smoking; and anxiety. These predictors are not unique to older adults, and several match constructs of the STaRT Back, a previously validated screening tool for persistent back pain in primary care.

Lastly, chapter three investigated how different types of physical therapy affect clinical outcomes for older adults with new back pain visits. In general, use of any type of physical therapy was associated with either no or minimal difference in mean back-related disability or pain scores. Active physical therapy, especially exercise based physical therapy, had the strongest association with improved back pain outcomes and back-related function. The volume of physical therapy services was modest for most patients receiving physical therapy and few patients actually utilized a high volume of these services.

Implications and future directions

These results provide an important foundation for further research on back pain in older adults. Back pain is a substantial health problem, and as we found, most older adults presenting to primary care for a new back pain visit continue to have long-term pain and functional limitations. With this knowledge, there are several areas where more and better information concerning back pain in older adults will be valuable.

Descriptive Epidemiology

Back pain is a complex, biopsychosocial health conditions that is simply named for its location and prominent symptom, pain. Understanding the clinical course of pain and function in older adults with back pain is important foundational information, but additional research is needed to more fully understand the complexity and interplay between physical, psychological, social and environmental aspects of this health condition.

Future studies on prognosis can examine a variety of outcomes to further broaden our understanding of the clinical course of back pain in this population. As a part of this, it will be imperative to consider health consequences beyond pain which may be important to the patients coping with back pain. Currently, we know little about what outcomes are valued or expected by older adults with back pain, [76] and further qualitative work to elicit patient preferences will allow researchers to better examine outcomes that are important to older adults with back pain in the United States.

Collecting a more complete set of outcome measures across multiple domains related to back pain (physical, psychological, and social) is needed. A more comprehensive battery of outcomes, including measures of physical activity level, satisfaction with care, satisfaction with their conditions, and key psychological outcomes such as depression, fear-avoidance, and catastrophizing have been recommended as standard outcome in back pain research. [77] Further descriptive epidemiology on the long-term course of these outcomes for older adults with back pain will be useful for better understanding a complex, biopsychosocial condition such as back pain.

Older adults often have multiple health conditions, [45,73] and longitudinally investigating the impact back pain has on common co-morbidities for older adults will also enrich our understanding of back pain as a co-morbid health condition. Older adults with back pain and back pain with leg pain are at greater risk of falling than those without back pain. [25] In addition, older women with chronic low back pain have poorer mobility and falls related self-efficacy. [78] Due to this elevated risk of an adverse event, reporting falls in studies of back pain in older adults is imperative to more accurately establish the scope of this problem and to better understand the relationship between persistent back pain and falls.

Depression is another health condition that is closely associated with back pain. Depression alone is a major source of disability in older adults, [79] depression is a risk factor for the development of chronic pain, and depression is more common among older adults with chronic back pain [45]. Similarly to falls, depression causes significant morbidity and the combination of chronic back pain and depression results in greater disability than either alone. [80] The close relationship between back pain and depression in older adults and the negative consequences of comorbid depression suggest that it is an important construct to measure longitudinally.

Lastly, fatigue and sleep are other aspects of health that are associated with pain, including chronic back pain, [81-83] and they may be important aspects of health to older adults with back pain. The associations between back pain and either fatigue or sleep is not well studied, and the relationships between pain, fatigue and sleep are likely intertwined with each other along with depression. [83] Future studies will need to build on this minimal base of knowledge to clarify the relationships between back pain, fatigue, and sleep while accounting for the confounding effects of medication and other comorbidities common in older adults.

Predictors of persistent back pain

Prognostic variables can either help identify patients with an elevated risk for chronic back pain or suggest modifiable risk factors to target in interventions and prevention strategies. In either case, researchers can utilize this information to inform and target their studies on the effectiveness of interventions for back pain in older adults.

Our study found several predictors of persistent back pain for older adults matched domains of the STarT Back screening tool. STarT Back was validated as a screening tool for persistent back pain in a primary care population of all ages in the United Kingdom, [48] and stratified care based on its risk categories is a promising subgrouping system. [44] However, generalization to settings within the United States has not been reported. Older adults and younger adults do appear to have some similar predictors of persistent back pain symptoms, but further refinement of screening tools, such as the STaRT Back, for older adults should be performed to see if their performance can be improved among this population.

In addition to research on the generalization of STarT Back to older adults in the United States, it will be important to further investigate other potential predictors of persistent back pain specific to older adults. Even though a sizable amount of research has been done on younger populations, prognostic research specifically on older adults with back pain is still in the early stages. Investigating predictors that may be unique to older adults will provide added value to the data from this dissertation. Markers of frailty, such as gait speed or activity level, may be important factors to examine independently in older adults. Scheele et al. looked at gaits speed using the timed “Up and go” test in their study of prognostic factors among Dutch older adults. Longer duration on the timed “Up and go” test was associated with increased risk of non-recovery from back pain. [16] Further replication including other measures of gait speed in older adults is warranted. There are no other known studies examining activity level or other markers of frailty as prognostic factors for older adults with back pain, and research in this area will make important, novel contributions.

Use of physical therapy

Use of physical therapy is common in older adults with back pain, but much more information is needed to inform optimal treatment patterns for these patients. The results from this research suggest that exercise based interventions should be a primary focus for physical therapist providing an episode of care. However, the effect sizes in our large cohort were small although statistically significant. A dose response relationship was observed between the amount of physical therapy provided and the improvement in back pain. Surprisingly, there was minimal to no association with improvement in back-related function, an emphasis of most physical therapy care. These findings are consistent with prior research on therapies for back pain in adults of all ages. In fact, most large randomized clinical trials of conservative therapy show either no or only modest improvement in patients with back pain, and this is true in the physical therapy literature as well. [84]

Future clinical and health services research should investigate how to best structure the timing, type, and amount of physical therapy services to the appropriate patients to produce the best outcomes for older adults. These results direct us toward new questions and facilitate hypothesis generation for further research on the use of physical therapy, and these ideas may tie into the prior two topics as well.

One area of future research can focus on how physical therapy services may impact outcomes beyond pain and back-related function. Investigating how physical therapists can impact other outcomes that are important to older adults will be an important area for future investigation. Also, determining treatment pathways that minimize iatrogenic effects of treatment (chronic opioid use, surgical complications), reduce over utilization of health services, or improves other health outcome (depression, falls) in older adults with back pain will also be valuable.

Another important direction for research can look at targeting the patients who are most likely to receive benefit from receiving physical therapy services. Research that further refines and examines the use of screening tools, such as the STarT Back, can clarify which patients will receive the most benefit from physical therapy services. Stratified care using the STarT Back screening tool, which involves referrals to physical therapists based on risk categories, is one example which has been shown to produce better outcome while being cost-effective. [44] Determining how to best implement these strategies and further improve outcomes when using these strategies can be an important next step for this line of research.

Conclusion

Back pain in older adults is a common and complex health issue. Much more research is needed, but these findings indicate that back pain is a challenging health condition to study in older adults as it is in younger ones. This dissertation provides information on important gaps in our knowledge of older adults' transition from a new visit for back pain to persistent pain and disability. It also provides a foundation to advance back pain research in older adults. It is my hope that building off this knowledge will allow us to continue making important contributions to improve the health of older adults.

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