Hays, Ron D., Herman, P., Qureshi, N., Rodriguez, A., & Edelen, M. O. (2023). A common factor is supported for seven self-report measures of back pain impact. Poster presented at the International Society for Quality of Life Research. Annual Meeting (Calgary, Alberta, Canada): October 19, 2023.

Funding

This work was supported by National Center for Complementary and Integrative Health (NCCIH) Grant No. 1R01AT010402-01A1

Corresponding Author

Ron D. Hays, PhD (ORCID: https://orcid.org/0000-0001-6697-907X)
Division of General Internal Medicine and Health Services Research
UCLA Department of Medicine
1100 Glendon Avenue Suite 850
Los Angeles, CA, USA
310-794-2294
drhays@ucla.edu

ABSTRACT

Background: The extent to which different measures of back pain impact represent an underlying common factor has implications for decisions about which one to use in studies of pain management and estimating one score from others.

Measures: Seven pain impact measures completed by Amazon Mechanical Turk adults are used to estimate internal consistency reliability and associations: Oswestry Disability Index (ODI), Roland-Morris Disability Questionnaire (RMDQ), short form of the Orebro Musculoskeletal Pain Questionnaire (OMPQ), Subgroups for Targeted Treatment (STarT) Back Tool, the Graded Chronic Pain Scale (GCPS) disability score, PEG (Pain intensity, interference with Enjoyment of life, interference with General activity), and Impact Stratification Score (ISS).

Results: The sample of 1874 adults with back pain had an average age of 41 and 52% were female. Sixteen percent were Hispanic, 7% non-Hispanic Black, 5% non-Hispanic Asian, and 71% non-Hispanic White. Internal consistency reliability estimates from 0.710 (OMPQ) to 0.923 (GCPS). Correlations among the measures ranged from 0.609 (RMDQ with OMPQ) to 0.812 (PEG with GCPS). Standardized factor loadings on the pain latent variable ranged from 0.782 (RMDQ) to 0.870 (ISS).

Conclusions: Scores of each measure can be estimated from the others for use in research.

Keywords: ODI, RMDQ, OMPQ, STarT Back, GCPS, PEG, ISS, pain impact

Introduction

There is a plethora of self-report measures used to assess the impact of back pain (Chiarotto et al. 2018; Maughan & Lewis, 2010). The Oswestry Disability Index (ODI) and the Roland-Morris Disability Questionnaire (RMDQ) are among the earliest developed and widely used measures (Chapman et al., 2011; Fairbank et al., 1980; Roland & Morris, 1983). An international multidisciplinary panel recommended the ODI, RMDQ, and pain intensity assessment as core measures for clinical trials of nonspecific low back pain (Chiarotto et al., 2018). The Orebro Musculoskeletal Pain Questionnaire (OMPQ) was designed to identify patients with musculoskeletal pain at risk for delayed recovery (Linton et al., 2011). The Subgroups for Targeted Treatment (STarT) Back screening tool has been used to identify risk factors for back pain disability in primary care patients (Hill et al., 2008). A meta-analysis indicated that the OMPQ and STarT Back were predictive of subsequent disability (Chiarotto & Koes, 2022). The Graded Chronic Pain Scale (GCPS) is often used to categorize those with back pain into five disability categories from no pain problem to high disability: 0 = no pain, 1 = low disability/low intensity, 2 = low disability/high intensity, 3 = high disability/moderately limiting, and 4 = high disability/severely limiting (Von Korff et al., 1992).

The Pain intensity, interference with Enjoyment of life, and interference with General activity (PEG) scale is a recent measure that is a subset of the Brief Pain Inventory (BPI) (Krebs et al., 2009). The PEG was recommended by the U.S. National Pain Strategy and by the Surgeon General's Turning the Tide campaign to reduce opioid use (Kroenke, 2018). The Veterans Health Administration work group for chronic musculoskeletal pain research suggested the BPI interference scale as a core outcome measure (Korenke et al., 2019). Another recently developed

measure is the Impact Stratification Score (ISS) (Deyo et al., 2014). The ISS was advocated by a U.S. National Institutes of Health Research Taskforce (Deyo et al., 2014).

These seven measures (ODI, RMDQ, OMPQ, STart Back, GCPS, PEG, ISS) were developed to capture the same general underlying pain impact construct and the choice of measure depends on multiple factors such as the needs of a particular application. Prior research indicates significant and often substantial associations among several of these measures. For example, Spearman rank-order correlations between the ODI and RMDQ ranging from 0.50 to 0.87 have been observed (Kersten et al., 2021; Reneman et al., 2002). The correlation of the PEG with the RMDQ was 0.60 in a sample of 500 primary care patients with chronic pain (Krebs et al., 2009) and 0.74 with the ISS in a sample of adults with current back pain (Hays, Qureshi et al., 2023). In a study of 218 adults undergoing epidural steroid injections, the Spearman correlation was 0.66 between the ISS and the RMDQ and 0.81 with the ODI, and the ISS was more responsive to change in symptoms than the RMDQ (Deyo et al. 2014). In samples of 750 active-duty military personnel and 1895 patients with low back pain, product-moment correlations of the RMDQ with Patient-Reported Outcomes Measurement Information System (PROMIS®)-29 measures (Cella et al., 2019) included in the ISS were: -0.69 and -0.71 with physical function, 0.65 and 0.69 with pain interference, and 0.45 and 0.48 with pain intensity (Edelen et al., 2021; Hays, Shannon et al., 2022). In a study of recipients of lumbar spine surgery, the correlation of the ODI with the PROMIS-29 physical function scale was -0.61, 0.66 with pain interference, and 0.52 with pain intensity (Cook et al., 2021). A rank-order correlation of 0.43 was observed between the StarT Back and the ODI in a sample of 53 adults with chronic low back pain (Pagé et al., 2015). A five-item version of the StarT Back had a rank-order

correlation of 0.34 with a 0-10 pain intensity item in a sample of 52,842 adult members of an online internet panel (Oka et al, 2017).

Prior studies have been largely limited to pairwise comparisons of pain impact measures. There is a need for simultaneous comparisons that examine the extent of common variance across many measures to provide information about the extent to which the choice of a particular pain impact measure matters. In this study, we examine associations among the seven commonly used measures of pain impact noted above.

Methods

Sample

Data was collected in 2021 from Amazon Mechanical Turk (MTurk) workers. MTurk is a crowdsourcing platform hosted by Amazon that is a source of temporary workers who are paid to complete tasks. The job or tasks are referred to as human intelligence tasks and include completing surveys, writing product descriptions, coding, or identifying content in images or videos. MTurk offers a low-cost, fast turnaround and widely used option for research studies. MTurk workers tend to be younger, more educated and have less income than the U.S. general population (Qureshi et al., 2022).

Eligible study participants were 18 years or older with an internet protocol address in the United States. We required that they have completed a minimum of 500 previous human intelligence tasks on MTurk with a successful completion rate of at least 95% to enhance data quality. Additional quality control measures included not telling participants that the study was targeting individuals with low back pain and deploying small batches of surveys hourly over several weeks to reduce selection bias. We also screened for excessive speediness in

completing the survey (< one second per item) but no one responded that quickly. The surveys were administered in English.

We asked participants whether they currently had back pain in an online survey. Those who reported having back pain (n = 1972) were administered several existing measures of back pain impact (described below). All participants provided electronic consent upon starting the survey. Those who completed the survey were paid $3.50 for participation. Payments were determined by approximating the amount of time needed to complete the survey and offering the equivalent of the U.S. federal minimum wage for completion of the general health survey and a slight bonus for completing the subsequent back pain survey.

All procedures were reviewed and approved by the research team's Institutional Review Board (RAND Human Subjects Research Committee FWA00003425; IRB00000051).

Measures

Pain Impact

ODI. The ODI focuses on functional disability across a range of domains such as physical function, pain, and sleep (Fairbank et al., 1980). A literature review concluded that there was support for the internal consistency reliability, test-retest reliability, and construct validity (including responsiveness) of the ODI (Vianin, 2008). The 10 ODI items range from 0-5 and are added together and then transformed linearly to a 0-100 possible range to obtain the ODI scale score, with a higher score representing greater disability.

RMDQ. The RMDQ asks about the impact of back pain on 24 daily activities. Support for the content validity (Burbridge et al., 2020), internal consistency reliability, test-retest reliability, and construct validity in a sample of 214 older adults with low back pain (Jenks et al.,

2022). The RMDQ score has a possible range of 0-24, with a higher score representing more negative pain impact (Roland & Morris, 1983).

OMPQ. The OMPQ was shown to be more accurate in identifying treatments leading to positive outcomes than the Work Assessment Triage Tool and clinician treatment recommendations in a sample of 2,872 patients with spinal conditions (Gergelé et al., 2021). The short form of the OMPQ assesses pain, role functioning, sleep, and anxiety with 10 questions (Linton et al., 2011. Nine of the questions are scored 0-10 and one question (pain duration) is scored 1-10; hence, the OMPQ short-form scale score has a possible range of 1-100, with a higher score representing more negative pain impact.

STarT Back. The STarT Back screening tool queries the location of pain, the functional impairment associated with back pain, and emotional well-being (Hill et al. 2008). The nine STarT Back items are dichotomous (scored 0 or 1) to obtain a total score with a possible range of 0-9, with a higher score representing greater impairment.

GCPS. The seven-item GCPS has a pain intensity score and a disability score (Von Korff et al., 1993). We examined correlations of the other six pain impact scales with the 5-category GCPS, the GCPS pain intensity, and GCPS disability scores. We used the GCPS disability score in the analysis because it had the largest correlations of the three GCPS indicators with the other 6 pain impact scales. A study of 127 people with spinal cord injury and experiencing pain provided support for the internal consistency reliability (> 0.90) and construct validity (e.g., -0.55 correlation with the SF-36 mental health score) of the disability score (Raichle et al., 2006). The GCPS disability score has a possible range of 0-10, with a higher score indicating greater disability.

PEG. The PEG scale is a three-item subset of the Brief Pain Inventory (BPI), and each item is administered using a 0 to 10 response scale (Krebs et al., 2009). A study of 427 adults with persistent back, hip, or knee pain recruited from primary care found that the PEG was as responsive as the BPI and more responsive than the SF-36 bodily pain scale to self-ratings of improvement in pain (Krebs et al., 2010). One PEG item is a BPI intensity item, and the other two items are from the BPI interference scale. The PEG scale is the mean of the 3 items and has a possible range of 0 to 10, with a higher score representing more pain intensity and inference.

ISS. Support for the internal consistency reliability and construct validity of the ISS was obtained in a study of 749 active-duty military personnel with low back pain (Hays et al., 2021). That study reported that the area under the curve for the ISS predicting improvement on the rating of change from baseline to 6 weeks later was 0.83. The ISS is made up of four physical function items, four pain interference items, and one pain intensity item. Physical function (*without any difficulty* = 1 to *unable to do* = 5) and pain interference (*not at all* = 1 to *very much* = 5) each contribute from 4 to 20 points, and pain intensity (0-10 rating) contributes from 0-10 points. The ISS has a possible range of 8 to 50.

Exogenous Variables

The supplemental file shows the wording of the exogenous variables. The concepts assessed were:

1) The frequency that back pain was a problem (How often has back pain been an ongoing problem for you in the last 6 months?).
2) Limitations in life (Over the past 3 months, how often did pain limit your life or work activities?).

3) Number of things done in the management of back pain (ever used Tetrahydrocannabinol/THC, Cannabidiol/CBD, over-the-counter medicine, prescription medications, narcotics, surgery, shots, chiropractic, exercise, massage).
4) Comorbidity count (hypertension, cholesterol, heart disease, angina, heart attack, stroke, asthma, cancer, diabetes, chronic obstructive pulmonary disease, arthritis, anxiety, depression, allergies, sciatica, neck pain, trouble seeing, dermatitis, stomach trouble, trouble hearing, trouble sleeping).
5) Gender.

Chronic and Non-specific Back Pain

Study participants were asked two yes/no questions: "Do you think that your back pain is chronic?" and "Has a provider ever told you that your back pain is caused by a medical condition?

Analysis Plan

Higher scores represent more pain impact for each of the measures. We estimated internal consistency reliability (coefficient alpha, Cronbach, 1951) for the seven pain impact measures and product-moment correlations among them. Then we specified a structural equation model with a pain impact latent variable defined by the seven pain impact measures and estimated correlations of the four covariates with the pain latent variable. Next, we used Lagrange multiplier tests to identify correlated errors among the seven indicators of pain impact to identify unique associations beyond the common factor. We evaluated model fit using the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). Good model fit is indicated by a CFI of about 0.95 or above, and an RMSEA of about 0.06 or less (Hu & Bentler, 1999). Analyses were conducted using SAS 9.4 software (SAS, 2016).

Results

From the starting sample of 1972, we had 1874 adults with back pain with complete data on the seven pain impact measures (analytic sample). The most common comorbid conditions reported were trouble sleeping (52%), depression (49%), allergies (47%), neck pain (46%), anxiety (38%), and hypertension (38%). Fifty-nine percent reported that their back pain was chronic.

The average age was 41 and 52% were female (Table 1). Sixteen percent were Hispanic, 7% non-Hispanic Black, and 5% non-Hispanic Asian. Ninety percent had more than a high school education; 68% were married or living with a partner; and 69% were working full-time. The subsample of MTurk respondents with back pain in this analysis had similar demographic characteristics to the overall MTurk sample (average age of 41 vs 40; 16% vs 14% Hispanic; 7% vs. 9% non-Hispanic Black) but, consistent with Wu et al. (2017), there were more females in this back pain subsample than the overall sample (52% vs 46% female).

Means and standard deviations for the measures are provided in Table 2. Reliability estimates ranged from 0.71 (OMPQ) to 0.92 (GCPS disability score). Intercorrelations among items within each measure were all positive except the correlations with the three reverse-worded items (items 3, 4, and 8) in the OMPQ were negative with item 1 ("How long have you had your current pain problems?"), and item 9 ("An increase in pain is an indication that I should stop what I'm doing until the pain decreases"). These correlations are at: https://labs.dgsom.ucla.edu/hays/files/view/docs/SupplementalFilePosted.pdf

Internal consistency reliability coefficients and product-moment correlations among the seven pain impact measures are given in Table 3. Correlations among the seven measures ranged

from 0.61 (RMDQ with OMPQ) to 0.81 (PEG with GCPS disability score). The average correlation of each measure with the others ranged from 0.67 (RMDQ) to 0.72 (PEG).

Standardized estimates for the structural equation model are shown in Figure 1. The model fit the data well according to the practical fit indices (χ^2=368.80, df=42, p <.0001; CFI = 0.98; RMSEA = 0.06) and similarly in those who reported having chronic pain (χ^2=231.91, df=42, p <.0001; CFI = 0.98; RMSEA = 0.06), not having chronic pain (χ^2=180.84, df = 42, p <.0001; CFI = 0.97; RMSEA = 0.07), and those having non-specific back pain (χ^2=313.87, df=42, p <.0001; CFI = 0.97; RMSEA = 0.07).

Standardized factor loadings on the pain latent variable ranged from 0.78 (RMDQ) to 0.87 (ISS). Correlated uniqueness terms were estimated between RMDQ and STarT Back (r = 0.11) and between PEG and the GCPS disability score (r = 0.09). Comorbidity (0.56) and female gender (0.05) had significant direct effects on pain impact. Significant correlations with the pain impact latent variable were r = 0.52 for *limitations* (pain limit life or work activities), 0.32 for *frequency* of back pain being an ongoing problem in the last 6 months, and r =0.07 for *management of back pain*. Significant correlations among exogenous variables are listed in Table 4. The largest correlation was between comorbidity and management of pain (r = 0.44).

Discussion

This study indicates that a single underlying pain impact factor is defined by the PEG, ISS, ODI, RMDQ, OMPQ, STarT Back, and the GCPS disability total scores. The smallest product-moment correlation among the pain impact measures pairs was between the ODI and the RMDQ (r = 0.64). The content of these two measures is similar, but the ODI uniquely taps into pain intensity and sex life. The largest correlation was between the PEG and the GCPS disability score (r =0.81). The content of these two measures overlaps substantially. The PEG assesses pain

intensity and the extent to which pain interferes with general activity and enjoyment of life. The GCPS disability score is a measure of difficulty performing daily, social and work activities. The largest standardized factor loading on the pain impact latent variable was found for the ISS (0.87) and the smallest loading was for the RMDQ (0.78).

All seven measures provide strong representations of the underlying pain impact factor. The support of a common factor among the 7 pain impact measures suggests that each measure can be estimated from the others. Indeed, the PEG has been linked to the ISS (Hays, Qureshi et al. 2023), the PROMIS measures that make up the ISS (physical function, pain interference, pain intensity) were linked with the ODI and the RMDQ (Edelen et al., 2023), and the PROMIS pain interference scale was linked to the ODI (Tang et al., 2021). Crosswalks among the remaining pairs of measures could be done to fill in the gaps.

The choice of which measure or measures to use depends on multiple factors and the needs of a particular research or clinical application (Gélinas et al., 2008). Lack of time is one barrier to administering patient-reported outcome measures in clinical settings (Östhols et al., 2019). All seven measures are relatively parsimonious. The ISS, ODI, OMPQ, and STarT Back measures have 9-10 items each. The standardized factor loadings for the measures with the fewest number of items (GCPS disability score and PEG, three items each) were substantial (0.84 and 0.86, respectively). Using a rule of thumb of about a minute to complete four polytomous items and eight dichotomous items (Hays & Reeve, 2020), the PEG and GCPS disability score take about one minute, the RMDQ about three minutes, and the other measures about two minutes to complete.

All seven measures reflect pain interference. The ODI, OMPQ, PEG, and ISS also reflect pain intensity. The ISS, ODI, and RMDQ assess physical function. The PEG, ODI, RMDQ,

OMPQ, and STarT Back each represent psychosocial issues (e.g., mood, enjoyment of life, social life). The OMPQ includes diverse item content, asking about the duration of pain, pain intensity, physical function, sleep, mental health, pain outlook, and perception of how active to be when experiencing pain. Indeed, the OMPQ had the lowest internal consistency reliability. The three OMPQ items worded in the opposite direction (positively worded) had negative correlations with two of the seven other items when all items were scored in the same (indicating more pain impact) direction. Use of the ISS may be appropriate if the focus is on physical health outcomes. If representing psychosocial content is important, the ISS could be supplemented with items assessing mental or social health. The other measures are dominated by physical health but also include some mental or social health items.

Limitations

The nature of the MTurk sample is a potential limitation of the study. The results reported here are from only a single sample and results may vary in other samples. Moreover, prior work finds that MTurk respondents tend to be young, White, male, highly educated, and report relatively poor mental health compared to the U.S. general population (Qureshi et al., 2022). The 7% non-Hispanic Black in the subsample was smaller than the 12% estimated for the general U.S. population by the U.S. Census, but back pain is more prevalent among non-Hispanic White adults (Lucas et al., 2019). In addition, the direction of the associations with the pain latent variable observed for pain-limiting life or work activities, the number of comorbidities, and being female are consistent with prior work (Gerlach et al., 2021). But it is uncertain how well the sample represents adults with back pain in general.

Conclusions

Future studies are needed to examine the robustness of the findings reported here. Investigation of longitudinal associations with the pain impact latent variable would be especially informative for further characterizing the common versus unique associations among the seven pain impact measures. It would be useful to compare the relative strength of associations of the various pain impact measures with future disability and other outcomes. In addition, this study analyzes the data using the standard scoring of the pain impact measures. Subsequent research could focus on associations among the items to evaluate alternative scoring and explore the extent to which item content impacts differences in the measures.

References

Burbridge, C., Randall, J.A., Abraham, L. & Bush, E.N. (2020). Measuring the impact of chronic low back pain on everyday functioning: content validity of the Roland Morris disability questionnaire. *J Patient Rep Outcomes*, 4, 70. https://doi.org/10.1186/s41687-020-00234-5.

Cella, D., Choi, S.W., Condon, D.M., Schalet, B., Hays, R. D., Rothrock, N. E., Yount, S., Cook, K. F., Gershon, R. C., Amtmann, D., DeWalt, D. A., Pilkonis, P. A., Stone, A. A., Weinfurt, K., & Reeve, B. B. (2019). PROMIS® adult health profiles: Efficient short-form measures of seven health domains. *Value in Health*, 22(5), 537-544. doi: 10.1016/j.jval.2019.02.004.

Chapman, J.R., Norvell, D.C., Hermsmeyer, J.T., Bransford, R. J., DeVine, J., McGirt, M. J., & Lee, M. J. (2011). Evaluating common outcomes for measuring treatment success for chronic low back pain. *Spine*, 36, 554-568. doi: 10.1097/BRS.0b013e31822ef74d.

Chiarotto, A., Boers, M., Deyo, R. A., Buchbinder, R., Corbin, T. P., Costa, L. O. P., Foster, N. E., Grotle, M., Koes, B. W. Kovacs, F. M., Lin, C. C., Maher, C. G., Pearson, A. M., Peul, W. C., Schoene, M. L., Turk, D. C., van Tulder, M. W., Terwee, C.B., & Ostelo, R. W. (2018). Core outcome measurement instruments for clinical trials in nonspecific low back pain. *Pain*, 159(3), 481-495. doi: 10.1097/j.pain.0000000000001117.

Chiarotto, A., & Koes, B.W. (2022). Nonspecific low back pain. *N Engl J Med*, 6, 386(18),1732-1740. doi: 10.1056/NEJMcp2032396.

Cook, C.E., Rethorn, Z.D., Chiarotto, A., Garcia, A. N., & Gottfried, O. (2021) Construct validity and item response theory analysis of the PROMIS-29 v2.0 in recipients of lumbar spine surgery. *Spine*, 46(24), 1721-1728. doi: 10.1097/BRS.0000000000004085.

Cronbach, L.J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3), 297–334. doi.org/10.1007/BF02310555.

Deyo, R.A., Dworkin, S.F., Amtmann, D., Andersson, G., Borenstein, D., Carragee, E., Carrino, J., Chou, R., Cook, K. Delitto, A., Goertz, C., Khalsa, P., Loeser, J., Mackey, S., Panagis, J., Rainville, J., Tosteson, T., Turk, D., von Korff, M., & Weiner, D. K. (2014). Report of the NIH Task Force on research standards for chronic low back pain. *J Pain*, 25(6), 569-585. doi: 10.1016/j.jpain.2014.03.005.

Edelen, M.O., Rodriguez, A., Herman, P., & Hays, R. D. (2021) Crosswalking the Patient-Reported Outcomes Measurement Information System physical function, pain interference, and pain intensity scores to the Roland-Morris Disability Questionnaire and the Oswestry Disability Index. *Arch Phys Med Rehabil*, 102(7), 1317-1323. doi: 10.1016/j.apmr.2021.02.014.

Fairbank, J.C., Couper, J., Davies, J.B., & O'Brien, J. P. (1980). The Oswestry low back pain disability questionnaire. *Physiotherapy*, 66(8), 271–273.

Gélinas, C., Loiselle, C.G., LeMay, S., Ranger, M., Bouchard, E., & McCormack, D. (2008). Theoretical, psychometric, and pragmatic issues in pain measurement. *Pain Manag Nurs*, 9(3), 120-130. doi: 10.1016/j.pmn.2007.12.001.

Gergelé, E., Parent, E., & Gross, D. P. (2021). Accuracy of the Örebro Musculoskeletal Pain Questionnaire and Work Assessment Triage Tool for selecting interventions in workers with spinal conditions. Journal of Back and Musculoskeletal Rehabilitation 34 (2021) 355–362. doi:10.3233/BMR-200169.

Gerlach, L.B., Solway, E., Maust, D.T., Kirch, M., Kullgren, J. T., Singer, D.C., & Malani, P. N. (2021). The COVID-19 pandemic and mental health symptoms among US adults. *J Gen Intern Med*, 36(10), 3285-3288. doi: 10.1007/s11606-021-07046-3.

Hays, R.D., Edelen, M.O., Rodriguez, A., & Herman, P. (2021). Support for the reliability and validity of the National Institutes of Health Impact Stratification Score in a sample of active-duty U.S. military personnel with low back pain. *Pain Med*, 22(10), 2185-2190. doi: 10.1093/pm/pnab175.

Hays, R.D., Qureshi, N., Edelen, M., Rodriguez, A., Slaughter, M., & Herman, P. M. (2023) Crosswalking the National Institutes of Health Impact Stratification Score to the PEG. *Arch Phys Med Rehabil*, 104(3), 425-429. doi: 10.1016/j.apmr.2022.08.006.

Hays, R.D., & Reeve, B.B. (2010). Measurement and modeling of health-related quality of life. In J. Killewo, H. K. Heggenhougen, &S. R. Quah (Eds.), *Epidemiology and demography in public health.* Amsterdam (pp. 195-205). Elsevier.

Hays, R. D., Shannon, Z. K., Long, C. R., Spritzer, K. L, Vining, R. D., Coulter, I., Pohlman, K. A., Walter, J., & Goertz, C.M. (2022). Health-related quality of life among United States service members with low back pain receiving usual care plus chiropractic care vs usual care alone: Secondary outcomes of a pragmatic clinical trial. *Pain Med*, 23(9), 1550-1559. doi: 10.1093/pm/pnac009.

Hill, J.C., Dunn, K.M., Lewis, M., Mullis, R., Main, C. J., Foster, N. E., & Hay, E. M. (2008). A primary care back pain screening tool: Identifying patient subgroups for initial treatment. *Arthritis Care Res*, 59(5), 632-641. doi: 10.1002/art.23563.

Hu, L.T., & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equation Modeling*, 6, 1-55. https://doi.org/10.1080/10705519909540118

Jenks, A., Hoekstra, T., van Tulder, M., Ostelo, R. W., Rubinstein, S. M., & Chiarottoo, A. (2022). Roland-Morris disability questionnaire, Oswestry disability index, and Quebec back pain disability scale: Which has superior measurement properties in older adults with low back pain? Journal of Orthopaedic & Sports Physical Therapy, 52(7), 457-460. doi/10.2519/jospt.2022.10802

Kersten, R.F.M.R., Fikkers, J., Wolterbeek, N., Öner, F.C., & van Gaalen, S.M. (2021). Are the Roland Morris Disability Questionnaire and Oswestry Disability Index interchangeable in patients after lumbar spinal fusion? *J Back Musculoskelet Rehabil*, 34(4), 605-611. doi: 10.3233/BMR-200206.

Krebs, E.E., Bair, M.J., Damush, T.M., Tu, W., Wu, J., & Kroenke, K. (2010). Comparative responsiveness of pain outcome measures among primary care patients with musculoskeletal pain. *Med Care*, 48(11), 1007-1014. doi:10.1097/MLR.0b013e3181eaf835

Krebs, E.E., Lorenz, K.A., Bair, M.J., Damush, T. M., Wu, J., Sutherland, J. M., Asch, S. M., & Kroenke, K. (2009). Development and initial validation of the PEG, a three-item scale assessing pain intensity and interference. *J Gen Intern Med*, 24, 733-738. doi: 10.1007/s11606-009-0981-1.

Kroenke, K. (2018). Pain measurement in research and practice. *J Gen Intern Med*, 33(Suppl 1), 7-8. doi: 10.1007/s11606-018-4363-4.

Kroenke, K., Krebs, E.E., Turk, D., Von Korff, M., Bair, M. J., Allen, K. D., Sandbrink, F., Cheville, A. L., DeBar, L., Lorenz, K. A., & Kerns, R. D. (2019). Core outcome measures

for chronic musculoskeletal pain research: Recommendations from a Veterans Health Administration work group. *Pain Med*, 20(8), 1500-1508. doi: 10.1093/pm/pny279.

Linton, S.J., Nicholas, M., & MacDonald, S. (2011). Development of a short form of the Örebro Musculoskeletal Pain Screening Questionnaire. Spine, 36(22), 1891-1895. doi: 10.1097/BRS.0b013e3181f8f775.

Lucas, J. W., Connor. E. M., & Bose, J. (2021). Back, lower limb, and upper limb pain among U.S. adults. 2019 NCHS data brief #415. Hyattsville, MD: National Center for Health Statistics. https://dx.doi.org/10.15620/cdc:107894

Maughan, E.F., & Lewis, J.S. (2010). Outcomes measures in chronic low back pain. *Eur Spin J*, 19(9), 1484-1494. doi: 10.1007/s00586-010-1353-6.

Oka, H., Matsudaira, K., Fujii, T., Kikuchi, N., Haga, Y., Sawada, T., Katsuhira, J., Yoshimoto, T., Kawamata, K., Tonosu, J., Sumitani, M., Kasahara, S., & Tanaka, S. (2017). Estimated risk for chronic pain determined using the generic STarT Back 5-item screening tool. *J Pain Res*, 10, 461-467. doi: 10.2147/JPR.S129585.

Östhols, S., Boström, C., & Rasmussen-Barr, E. (2019). Clinical assessment and patient-reported outcome measures in low-back pain—A survey among primary health care physiotherapists. *Disabil Rehabil*, 41(20), 2459-2467. doi: 10.1080/09638288.2018.1467503.

Pagé, I., Abboud, J., O'Shaughnessy, J., Laurencelle, L., & Descarreaux, M. (2015). Chronic low back pain clinical outcomes present higher associations with the STarT Back Screening Tool than with physiologic measures: a 12-month cohort study. *BMC Musculoskelet Disord*, 16, 201. https://doi.org/10.1186/s12891-015-0669-0

Qureshi, N., Edelen, M., Hilton, L., Rodriguez, A., Hays, R. D., & Herman, P. M. (2022). Comparing data collected on Amazon's Mechanical Turk to national surveys. *Am J Health Behav*, 46(5), 497-502. doi: 10.5993/AJHB.46.5.1.

Raichle, K.A., Osborne, T.L., Jensen, M.P., & Cardenas, D. (2006) The reliability and validity of pain interference measures in persons with spinal cord injury. *J Pain*, 7(3), 179-186. doi: 10.1016/j.jpain.2005.10.007.

Reneman, M.F., Jorritsma, W., Schellekens, J.M., & Göeken, LN. (2002). Concurrent validity of questionnaire and performance-based disability measurements in patients with chronic nonspecific low back pain. *J Occup Rehabil*, 12(3), 119–129. doi: 10.1023/a:1016834409773.

Roland, M., & Morris, R. (1983). A study of the natural history of back pain: Part I: Development of a reliable and sensitive measure of disability in low-back pain. *Spine*, 8(2), 141–144. doi: 10.1097/00007632-198303000-00004.

SAS®9.4 TS Level 1M6. (2016). Cary, NC: SAS Institute.

Tang, X., Schalet, B.D., Hung, M., Brodke, D. S., Saltzman, C. L., & Cella, D. (2021). Linking Oswestry Disability Index to the PROMIS pain interference CAT with equipercentile methods. *Spine J*, 21(7), 1185-1192. doi: 10.1016/j.spinee.2021.02.012.

Von Korff, M., Ormel, J., Keefe, F.J., & Dworkin, S.F. (1992). Grading the severity of chronic pain. *Pain*, 50(2), 133–49. doi: 10.1016/0304-3959(92)90154-4.

Vianin M. (2008). Psychometric properties and clinical usefulness of the Oswestry Disability Index. *J Chiropr Med*, 7(4), 161-3. doi: 10.1016/j.jcm.2008.07.001

Wu, A., March, L., Zheng, X., Huang, J., Wang, X., Zhao, J., Blyth, F.M., Smith, E., Buchbinder, R., & Hoy, D. (2020). Global low back pain prevalence and years lived with

disability from 1990 to 2017: Estimates from the Global Burden of Disease Study 2017. Ann Transl Med. 8(6):299. doi: 10.21037/atm.2020.02.175.

Table 1. Characteristic of the Sample (n = 1874)

Variable	Estimate
Age Mean (range)	41 (19-77)
Female	52%
Race/ethnicity	
Hispanic	16%
Non-Hispanic	
White	71%
Black	7%
Asian	5%
Other	1%
Education	
High school graduate or less	10%
Some college	17%
Associate in Arts degree	8%
Bachelor's degree	48%
Master's degree, Ph.D., or professional degree	17%
Working full-time	69%
Marital Status	
Married or living with partner	68%
Never married	22%
Separated, divorced, or widowed	10%
Comorbidity	

Trouble sleeping	52%
Depression	49%
Allergies	47%
Neck pain	46%
Anxiety	38%
Hypertension	38%
Stomach trouble	33%
Sciatica	28%
High Cholesterol	27%
Arthritis	23%
Trouble seeing	23%
Asthma	22%
Diabetes	17%
Dermatitis	16%
Trouble hearing	11%
Chronic obstructive pulmonary disease	8%
Cancer	7%
Angina	7%
Heart disease	7%
Myocardial infarction	6%
Stroke	6%

Table 2. Descriptive Statistics for Pain Impact and Exogeneous Variables

Variable	Mean (SD)
ODI	24.57 (16.14)
RMDQ	9.16 (6.60)
OMPQ	46.61 (14.87)
StarT Back	3.76 (2.56)
GCPS Disability	3.68 (2.37)
PEG	4.01 (2.13)
ISS	20.66 (8.07)
Comorbidity	5.10 (3.32)
Female gender	0.52 (0.50)
Frequency of back problem	2.06 (0.75)
Limitations in work or life	2.13 (0.67)
Management of Pain	4.06 (2.24)

Note: ODI = Oswestry Disability Index (ODI), RMDQ = Roland-Morris Disability Questionnaire, OMPQ = short form of the Orebro Musculoskeletal Pain Questionnaire, StarT Back = Subgroups for Targeted Treatment Back, GCPS = Graded Chronic Pain Scale disability score. PEG = Pain intensity, interference with Enjoyment of life, interference with General activity), ISS = Impact Stratification Score.

Table 3. Coefficient Alpha (Diagonal) and Product-Moment Correlations Among Seven Pain Impact Measures

	ODI	RMDQ	OMPQ	StarT Back	GCPS	PEG	ISS
ODI	**0.87**						
RMDQ	0.64	**0.92**					
OMPQ	0.65	0.61	**0.71**				
Start Back	0.65	0.75	0.69	**0.77**			
GCPS	0.68	0.67	0.70	0.67	**0.92**		
PEG	0.70	0.68	0.72	0.68	0.81	**0.89**	
ISS	0.74	0.67	0.68	0.69	0.73	0.75	**0.90**

Note: ODI = Oswestry Disability Index (ODI), RMDQ = Roland-Morris Disability Questionnaire, OMPQ = short form of the Orebro Musculoskeletal Pain Questionnaire, StarT Back = Subgroups for Targeted Treatment Back, GCPS = Graded Chronic Pain Scale disability score, PEG = Pain intensity, interference with Enjoyment of life, interference with General activity), ISS = Impact Stratification Score.

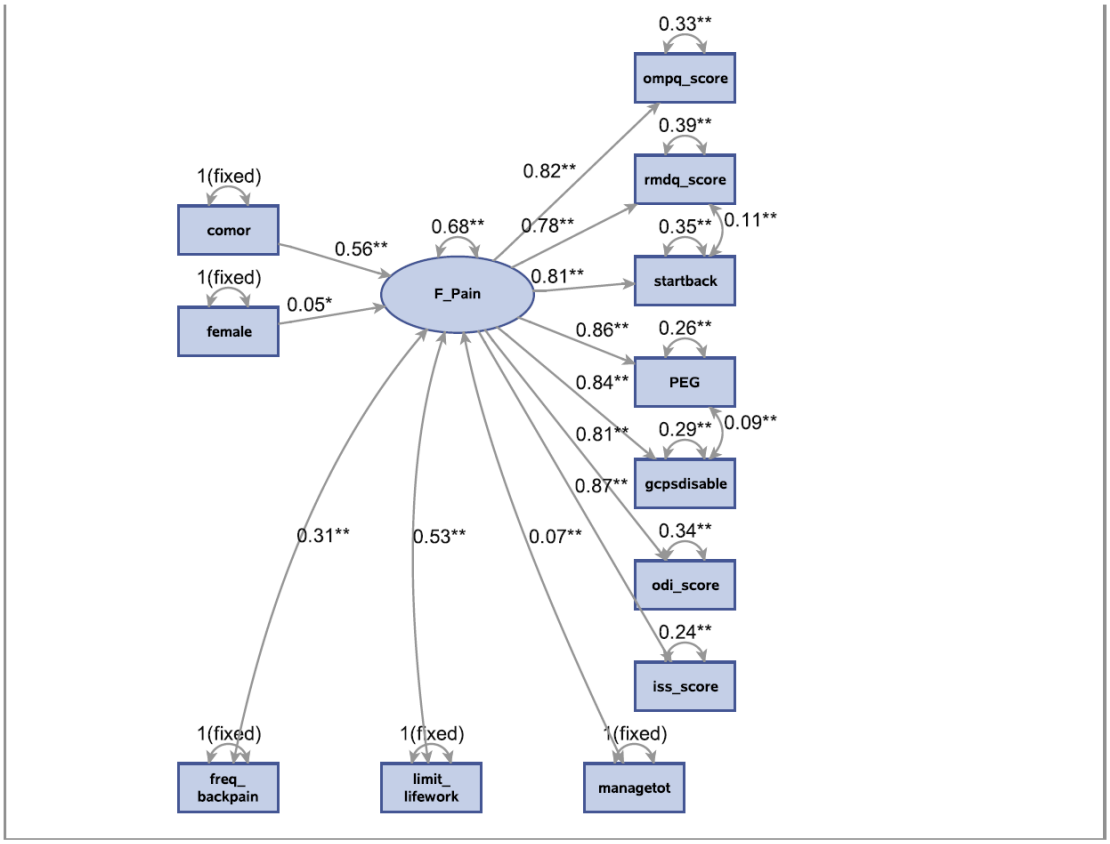
Internal consistency reliability estimates (coefficient alphas) are bolded in the table. All correlations are significant at $p<.0001$.

Table 4. Correlations Among Exogenous Variables in Structural Equation Model

Independent Variables	Correlation
Comorbidity with Management of Pain	0.44
Comorbidity with Limitations in Work or Life	0.34
Frequency Back Pain Problem with Limitations in Work or Life	0.34
Frequency Back Pain Problem with Comorbidity	0.28
Management of Pain with Limitations in Work or Life	0.21
Management of Pain with Frequency Back Pain Problem	0.18
Female with Management of Pain	0.08
Female with Comorbidity	0.07
Female with Limitations in Work or Life	0.05

Note: Female gender and duration were not significantly intercorrelated.

Figure 1: Standardized Estimates for Seven Indicators of Pain Impact



Female = female gender; comor = Comorbidity count; F_Pain = Pain impact latent variable; PEG = Pain intensity, interference with Enjoyment of life, interference with General activity; odi_score = Oswestry Disability Index; iss_score = Impact Stratification Score (ISS); gcpaindisable = Graded Chronic Pain Scale disability score; rmdq_score = Roland-Morris Disability Questionnaire; startback = Subgroups for Targeted Treatment (STarT) Back Tool; ompq_score = short form of the Orebro Musculoskeletal Pain Questionnaire (OMPQ); freq_backpain = frequency backpain has been a problem; limit_lifework= limitations in life and work; mangetot = total number of things done to manage back pain.

Single-headed arrow between two variables indicates a direct effect. Double-headed arrow between two variables indicates correlation. Double-headed arrow above a variable represents residual variance.

* p< .05

** p < .01

Exogeneous Items

Comorbidity Count
Have you EVER been told by a doctor or other health professional that you had…

(Response options: Yes, I have been told I have this condition; No, I have not been told I have this condition; I am unsure if I was ever told by a doctor or other health professional that I have this condition)

Hypertension, also called high blood pressure?
High cholesterol?
Coronary heart disease?
Angina, also called angina pectoris?
A heart attack, also called myocardial infarction?
A stroke?
Asthma?
Cancer or a malignancy of any kind?
Diabetes?
Chronic Obstructive Pulmonary Disease, COPD, emphysema, or chronic bronchitis?
Some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?
Any type of anxiety disorder?
Any type of depression?

Do you currently have...

(Response options: Yes, I currently have this condition; No, I don't have this condition; Don't know)

Chronic or seasonal allergies or sinus trouble?
Back pain?
Sciatica or radiating leg pain?
Neck pain?
Trouble seeing, even when wearing glasses or contact lenses?
Dermatitis or other chronic skin rash?
Stomach trouble (like frequent indigestion or ulcers)?
Trouble hearing, including deafness, in one or both ears?
Trouble sleeping?

Gender Identity
How do you describe yourself?

(Response options: Male; Female; Transgender; Do not identify as female, male, or transgender)

Frequency of Back Pain Problem

The next question focuses on the frequency of your low back pain <u>in the past 6 months</u>.

How often has low back pain been an ongoing problem for you in the last 6 months?

(Response options: Every day or nearly every day in the past 6 months; At least half of the days in the past 6 months; Less than half the days in the past 6 months)

Management of Back Pain

The following is a list of things people do to manage their back pain. Have you ever used any of the following to manage your back pain?

(Response options: Yes, I have used this to manage my back pain; No, I have not used this to manage my back pain; I don't know)

Surgery
Injections or shots (including steroids, epidurals, cortisol, etc.)
Chiropractic care
Psychological counseling
Acupuncture
Exercise (including yoga, walking, gym, stretching, etc.)
Massage therapy
Herbs, other supplements or vitamins specifically for pain
Marijuana (THC) products (e.g., Dried herb, edibles, hash or kief, wax, beverages)
Cannabidiol (CBD) products that *do not contain THC* (e.g., tinctures, lotions, oils)
Over the counter pain medicine such as ibuprofen (Motrin or Advil), naproxen (Aleve) and acetaminophen (Tylenol)
Prescription pain medicine such as celecoxib (Celebrex), diclofenac (Voltaren), meloxicam (Mobic), nabumetone (Relafen), cyclobenzaprine (Flexeril), tizanidine (Zanaflex), baclofen (Lioresal), carisoprodol (Soma), methylprednisolone (Medrol), duloxetine (Cymbalta), pregabalin (Lyrica), or gabapentin (Neurontin)
Prescription narcotics such as Vicodin, Lortab, Norco, hydrocodone, codeine, Tylenol #3 or #4, fentanyl, Duragesic,
MS Contin, Percocet, Tylox, OxyContin, oxycodone, methadone, Tramadol, Ultram, Dilaudid

Limitations in Work and Life

Over the past 3 months, **how often did pain limit your life or work activities?**
(Response options: Never; Some days; Most days; Every day)