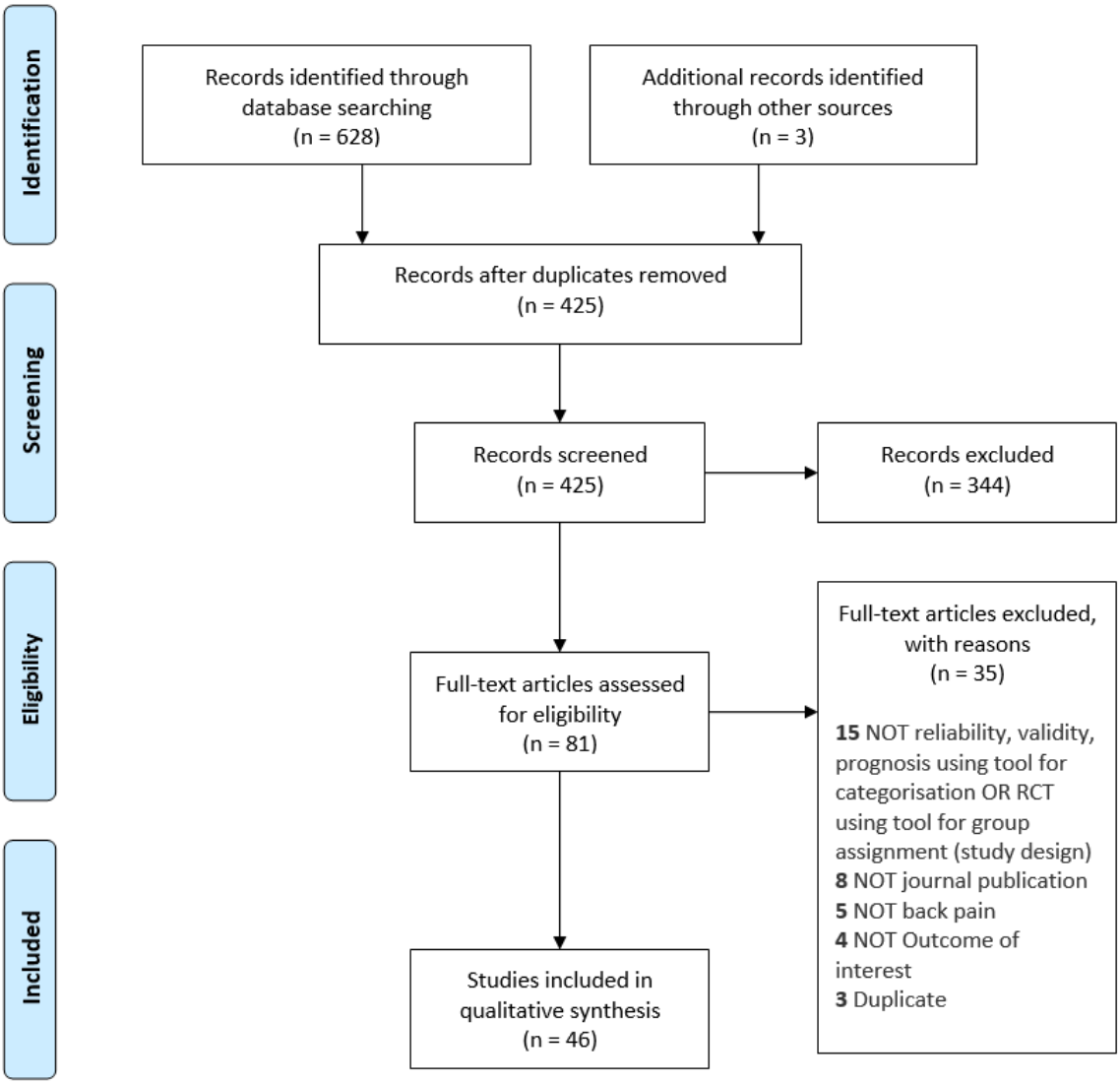
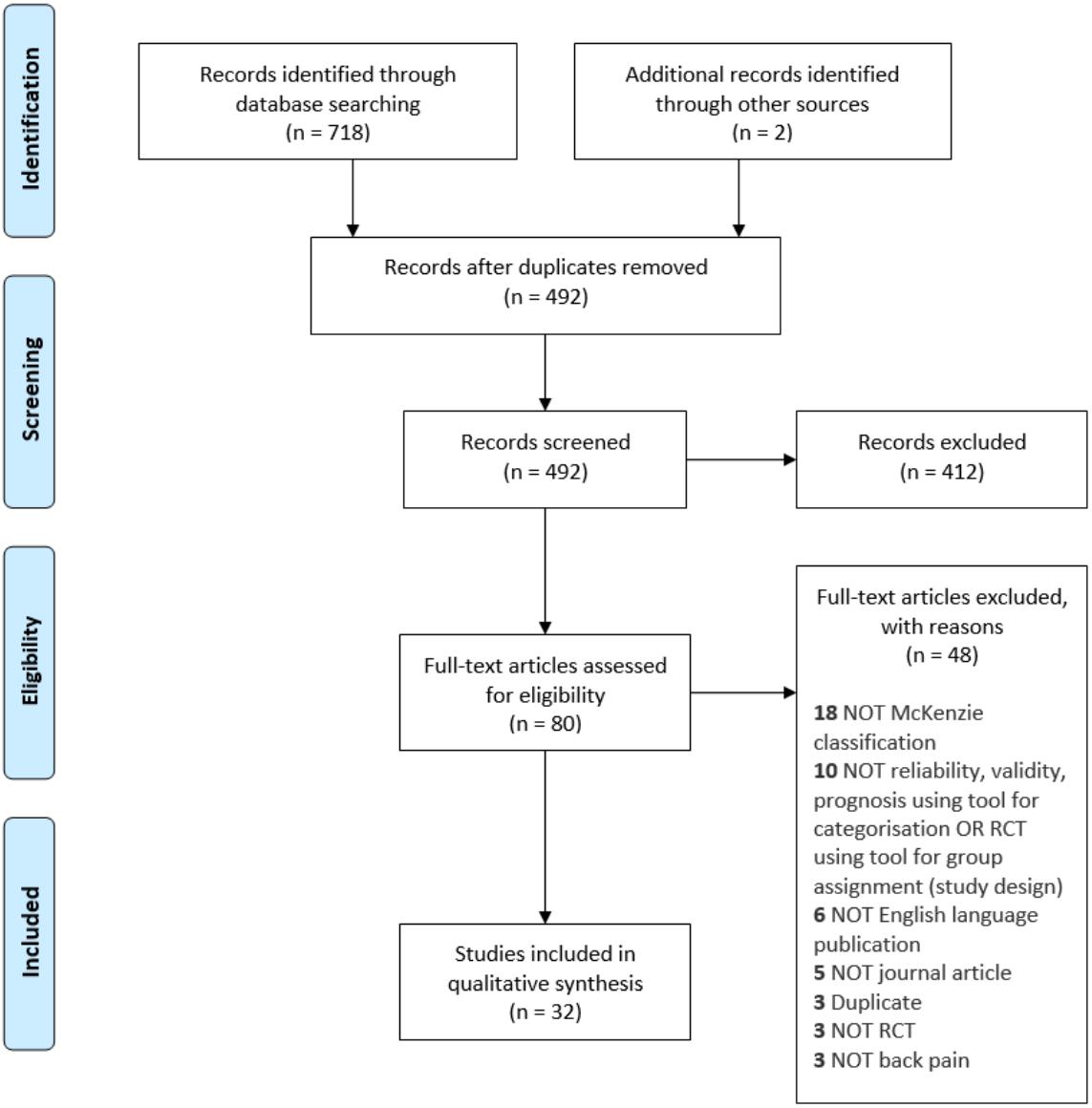



**Supplementary Figure 1.** PRIMSA diagram for STarT Back review




**Supplementary Figure 2.** PRISMA diagram for McKenzie review.

**Supplementary Table 1.** Reasons for exclusion at full-text screening for AI/ML studies.

| Authors | Year | Title | Exclusion Reason |
|---|---|---|---|
| Vaughn, ML; Cavill, SJ; Taylor, SJ; Foy, MA; Fogg, AJB | 1999 | Using direct explanations to validate a multi-layer perceptron network that classifies low back pain patients | Exclusion reason: Duplicate sample. |
| Siddall, Philip J; Stanwell, Peter; Woodhouse, Annie; Somorjai, Ray L; Dolenko, Brion; Nikulin, Alexander; Bourne, Roger; Himmelreich, Uwe; Lean, Cynthia; Cousins, Michael J | 2006 | Magnetic resonance spectroscopy detects biochemical changes in the brain associated with chronic low back pain: a preliminary report | Exclusion reason: NOT artificial intelligence / machine learning techniques. |
| Bounds; Lloyd; Mathew; Waddell | 1988 | A multilayer perceptron network for the diagnosis of low back pain | Exclusion reason: Duplicate sample. |
| N. Wang; Z. Zhang; J. Xiao; L. Cui | 2019 | DeepLap: A Deep Learning based Non-Specific Low Back Pain Symptomatic Muscles Recognition System | Exclusion reason: NO outcome of interest. |
| N. Wang; J. Xiao; L. Cui | 2018 | EasiSMR: Recognizing Non-Specific Low Back Pain Symptomatic Muscles Using Multi-Muscles Fusion based Machine Learning | Exclusion reason: NO outcome of interest. |
| M. L. Vaughn; S. J. Taylor; M. A. Foy; A. J. B. Fogg | 2001 | Investigating the reliability of a low-back-pain MLP by using a full explanation facility | Exclusion reason: Duplicate sample. |
| M. L. Vaughn; S. J. Cavill; S. J. Taylor; M. A. Foy; A. J. B. Fogg | 1998 | Interpretation and knowledge discovery from a MLP network that performs low back pain classification | Exclusion reason: NO outcome of interest. |
| M. Capecci; L. Ciabattoni; F. Ferracuti; A. MonteriÃ¹; L. Romeo; F. Verdini | 2018 | Collaborative design of a telerehabilitation system enabling virtual second opinion based on fuzzy logic | Exclusion reason: NO outcome of interest. |
| M. Bhatt; V. Dahiya; A. Singh | 2019 | Supervised Learning Algorithm: SVM with Advanced Kernel to classify Lower Back Pain | Exclusion reason: NO outcome of interest. |
| Sani, Sadiq; Wiratunga, Nirmalie; Massie, Stewart; Cooper, Kay | 2016 | SELFBACKâ€"activity recognition for self-management of low back pain | Exclusion reason: NOT back pain (e.g. image or signal processing excluded when not used for classification of back pain). |
| Biurrun Manresa, JosÃ© A; Nguyen, Giang P; Curatolo, Michele; Moeslund, Thomas B; Andersen, Ole K | 2013 | Probabilistic model for individual assessment of central hyperexcitability using the nociceptive withdrawal reflex: a | Exclusion reason: NOT back pain (e.g. image or signal processing excluded when not used for classification of back pain). |

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| | | biomarker for chronic low back and neck pain. | |
| Benditz, Achim; Faber, Florian; Wenk, Gabriela; Fuchs, Tina; Salak, Natalie; Grifka, Joachim; Vogl, Matthias; Menke, Matthias; Jansen, Petra | 2019 | The Role of a Decision Support System in Back Pain Diagnoses: A Pilot Study | Exclusion reason: NOT artificial intelligence / machine learning techniques. |
| Boissoneault, Jeff; Sevel, Landrew; Letzen, Janelle; Robinson, Michael; Staud, Roland | 2017 | Biomarkers for Musculoskeletal Pain Conditions: Use of Brain Imaging and Machine Learning | Exclusion reason: NOT original research (reviews excluded). |
| Faruqui, Syed Hasib Akhter; Alaeddini, Adel; Jaramillo, Carlos A.; Potter, Jennifer S.; Pugh, Mary Jo | 2018 | Mining patterns of comorbidity evolution in patients with multiple chronic conditions using unsupervised multi-level temporal Bayesian network | Exclusion reason: NOT back pain (e.g. image or signal processing excluded when not used for classification of back pain). |
| Apalit, Nathan | 2010 | The Work Ratio--modeling the likelihood of return to work for workers with musculoskeletal disorders: A fuzzy logic approach | Exclusion reason: NOT back pain (e.g. image or signal processing excluded when not used for classification of back pain). |
| Bishop JB | 1999 | Feature extraction and analysis of dynamic motion of the lumbar spine. | Exclusion reason: NOT peer-reviewed journal. |

**Supplementary Table 2.** Reasons for exclusion at full-text screening for STarT Back studies.

| Authors | Year | Title | Exclusion Reason |
|---|---|---|---|
| Hestbaek, Lise; Munck, Anders; Hartvigsen, Lisbeth; JarbÃ¸l, Dorte Ejg; SÃ¸ndergaard, Jens; Kongsted, Alice | 2014 | Low back pain in primary care: a description of 1250 patients with low back pain in danish general and chiropractic practice | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Kongsted, Alice; Johannesen, Else; Leboeuf-Yde, Charlotte | 2011 | Feasibility of the STarT Back Screening Tool in chiropractic clinics: A cross-sectional study of patients with low back pain | Exclusion reason: NOT Outcome of interest. |
| Bamford, Adrian; Nation, Andy; Durrell, Susie; Andronis, Lazaros; Rule, Ellen; McLeod, Hugh | 2017 | Implementing the Keele stratified care model for patients with low back pain: an observational impact study | Exclusion reason: NOT Outcome of interest. |
| Medeiros, F. C.; Costa, L. O. P.; Oliveira, I. S.; Costa, Ldcm | 2019 | A Responsiveness Analysis of the Subgroups for Targeted Treatment (STarT) Back Screening Tool in Patients With Nonspecific Low Back Pain | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Werneke Mw Pt, M. S. Dip M. D. T.; Edmond S Pt, DSc O. C. S.; Young M Pt, Cred M. D. T.; Grigsby D Pt, Cert M. D. T.; McClenahan B Pt, M. S. O. C. S. Dip M. D. T. Faaompt; McGill T Pt, PhD S. C. S. Dip M. D. T. | 2018 | Association between changes in function among patients with lumbar impairments classified according to the STarT Back Screening Tool and managed by McKenzie credentialed physiotherapists | Exclusion reason: NOT Outcome of interest. |
| Newell, D.; Field, J.; Pollard, D. | 2015 | Using the STarT Back Tool: does timing of stratification matter? | Exclusion reason: NOT Outcome of interest. |
| Bier, J. D.; Sandee-Geurts, J. J. W.; Ostelo, Rwjg; Koes, B. W.; Verhagen, A. P. | 2018 | Can Primary Care for Back and/or Neck Pain in the Netherlands Benefit From Stratification for Risk Groups According to the STarT Back Tool Classification? | Exclusion reason: NOT back pain. |
| Morso, Lars; Kongsted, Alice; Hestbaek, Lise; Kent, Peter | 2016 | The prognostic ability of the STarT Back Tool was affected by episode duration | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Wideman, T. H.; Hill, J. C.; Main, C. J.; Lewis, M.; Sullivan, M. J.; Hay, E. M. | 2012 | Comparing the responsiveness of a brief, multidimensional risk screening tool for back pain to its unidimensional reference standards: | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or |

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| | | the whole is greater than the sum of its parts | clinical trial using tool for group assignment (study design). |
| Wertli, Maria M.; Held, Ulrike; Lis, Angela; Campello, Marco; Weiser, Sherri | 2018 | Both positive and negative beliefs are important in patients with spine pain: findings from the Occupational and Industrial Orthopaedic Center registry | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Riis, A.; Jensen, C. E.; Bro, F.; Maindal, H. T.; Petersen, K. D.; Bendtsen, M. D.; Jensen, M. B. | 2016 | A multifaceted implementation strategy versus passive implementation of low back pain guidelines in general practice: a cluster randomised controlled trial | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Morso, L.; Albert, H.; Kent, P.; Manniche, C.; Hill, J. | 2011 | Translation and discriminative validation of the STarT Back Screening Tool into Danish | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Magel, J.; Fritz, J. M.; Greene, T.; Kjaer, P.; Marcus, R. L.; Brennan, G. P. | 2017 | Outcomes of Patients With Acute Low Back Pain Stratified by the STarT Back Screening Tool: secondary Analysis of a Randomized Trial | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Kloek, C. J. J.; van Tilburg, M. L.; Staal, J. B.; Veenhof, C.; Bossen, D. | 2019 | Development and proof of concept of a blended physiotherapeutic intervention for patients with non-specific low back pain | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Fuhro, F. F.; Fagundes, F. R.; Manzoni, A. C.; Costa, L. O.; Cabral, C. M. | 2016 | Orebro Musculoskeletal Pain Screening Questionnaire Short-Form and STarT Back Screening Tool: Correlation and Agreement Analysis | Exclusion reason: Duplicate. |
| Fritz, J. M.; Beneciuk, J. M.; George, S. Z. | 2011 | Relationship between categorization with the STarT Back Screening Tool and prognosis for people receiving physical therapy for low back pain | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Unsgaard-Tondel, M.; Kregnes, I. G.; Nilsen, T. I. L.; Marchand, G. H.; Askim, T. | 2018 | Risk classification of patients referred to secondary care for low back pain | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Rabey, Martin; Kendall, Michelle; Godden, Chris; Liburd, Jermaine; Netley, Hayley; O'Shaughnessy, Ciaran; O'Sullivan, Peter; Smith, Anne; Beales, Darren | 2019 | Start back tool risk stratification is associated with changes in movement profile and sensory discrimination in low back pain: A study of 290 patients | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |

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| Nitsch, Kristian P.; Davis, Katharine; Stipp, Kelsey | 2016 | Psychometric Measurement Properties and Clinical Utility of the Keele STarT Back Screening Tool in People With Low Back Pain | Exclusion reason: NOT journal publication. |
| Hill, J. C.; Afolabi, E. K.; Lewis, M.; Dunn, K. M.; Roddy, E.; van der Windt, D. A.; Foster, N. E. | 2016 | Does a modified STarT Back Tool predict outcome with a broader group of musculoskeletal patients than back pain? A secondary analysis of cohort data | Exclusion reason: NOT back pain. |
| Forsbrand, M. H.; Grahn, B.; Hill, J. C.; Petersson, I. F.; Post Sennehed, C.; Stigmar, K. | 2018 | Can the STarT Back Tool predict health-related quality of life and work ability after an acute/subacute episode with back or neck pain? A psychometric validation study in primary care | Exclusion reason: NOT back pain. |
| Forsbrand, M.; Grahn, B.; Hill, J. C.; Petersson, I. F.; Sennehed, C. P.; Stigmar, K. | 2017 | Comparison of the Swedish STarT Back Screening Tool and the Short Form of the Orebro Musculoskeletal Pain Screening Questionnaire in patients with acute or subacute back and neck pain | Exclusion reason: NOT back pain. |
| Field, J. R.; Newell, D. | 2016 | Clinical Outcomes in a Large Cohort of Musculoskeletal Patients Undergoing Chiropractic Care in the United Kingdom: A Comparison of Self- and National Health Service-Referred Routes | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Beneciuk, J. M.; Ballengee, L. A.; George, S. Z. | 2019 | Treatment monitoring as a component of psychologically informed physical therapy: A case series of patients at high risk for persistent low back pain related disability | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| DalkilinÃ§, M.; Parlak Demir, Y.; Ã‡irak, Y.; Yilmaz Yelvar, G. D.; Nur KaradÃ¼z, B.; UÇ§ur, R.; Kolsuz, M.; Evren, M. B.; Akman, M. | 2015 | Validity and reliability of Turkish version of start back screening tool | Exclusion reason: NOT journal publication. |
| Aili, K.; Bergman, S.; Haglund, E. | 2019 | Adding information on widespread pain to the start back screening tool when identifying low back pain patientsat increased risk for poor prognosis | Exclusion reason: NOT journal publication. |
| Suri, P.; Delaney, K.; Rundell, S. D.; Cherkin, D. C. | 2018 | Predictive Validity of the STarT Back Tool for Risk of Persistent Disabling Back Pain in a U.S Primary Care Setting | Exclusion reason: Duplicate. |

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| Storheim, Kjersti | 2012 | Targeted physiotherapy treatment for low back pain based on clinical risk can improve clinical and economic outcomes when compared with current best practice | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation or clinical trial using tool for group assignment (study design). |
| Mason, E.; Hill, J. C.; Lewis, M.; Dunn, K. M.; Hay, E. M. | 2011 | Does targeted treatment for low back pain improve patient satisfaction and better meet expectations compared to current best care? | Exclusion reason: NOT journal publication. |
| Forsbrand, M.; Grahn, B.; Hill, J. C.; Peterson,, II; Post Sennehed, C.; Stigmar, K. | 2015 | Validation of the swedish version of start back tool against the short version of the Ã¶rebro musculoskeletal pain screening questionnaire in patients with back and/or neck pain in primary health care | Exclusion reason: NOT journal publication. |
| Beneciuk, Jason Michael | 2014 | Investigation of the Start Back Screening Tool in outpatient physical therapy settings | Exclusion reason: NOT journal publication. |
| Beneciuk, J.; George, S. | 2013 | Prediction and clinical outcome implications of sustained STarT back screening tool high-risk status following 4-weeks of physical therapy for low back pain | Exclusion reason: NOT journal publication. |
| Karstens, S.; Krug, K.; Hill, J. C.; Stock, C.; Steinhaeuser, J.; Szecsenyi, J.; Joos, S. | 2015 | Validation of the German version of the STarT-Back Tool (STarT-G): A cohort study with patients from primary care practices Rehabilitation, physical therapy and occupational health | Exclusion reason: Duplicate. |
| Hill, J.; Dunn, K. M.; Lewis, M.; Mason, E.; Vohora, K.; Main, C.; Konstantinou, K.; Sowden, G.; Somerville, S.; Whitehurst, D.; et al., | 2011 | A randomised trial of targeted treatment for low back pain compared with current best practice: the start back trial | Exclusion reason: NOT journal publication. |
| Bier, J. D.; Ostelo, Rwjg; Koes, B. W.; Verhagen, A. P. | 2017 | Validity and reproducibility of the modified STarT Back Tool (Dutch version) for patients with neck pain in primary care | Exclusion reason: NOT back pain. |

**Supplementary Table 3.** STarT Back and reliability and validity for low back pain

| Study | Year | Type LBP | Duration LBP | Overview | Internal Consistency | Test-retest | Construct Validity | Discriminative Validity | Authors Conclusions |
|---|---|---|---|---|---|---|---|---|---|
| Abedi et al.[1] | 2015 | Chronic | Non-specific | Translation and validation of the Persian STarT Back | Cronbach α=0.83 | | RMDQ=0.81, CSQ=0.70<br>TSK=0.71<br>HADS-A=0.75<br>HADS-D=0.72 | 0.73-0.86[1] | Authors conclude the Persian version is a reliable and valid instrument for screening NSLBP. |
| Bier et al.[2] | 2017 | 184 | Non-specific | Mixed | | Kappa=0.65 | 0.28-0.63* | | Authors concluded that STarT Back was successfully translated into Dutch. |
| Beneciuk et al.[3] | 2013 | 146 | Non-specific | Mixed | | | 0.28-0.63* | | Authors conclude the data shows prediction of clinical outcome depends on domain of interest. |
| Bruyere et al.[4] | 2014 | Unclear | Unclear | Validity and reliability of the French STarT Back | Cronbach α=0.74 | ICC=0.90 | VAS=0.66 RMDQ=0.74<br>OMPSQ=0.74 | | Authors conclude that the French version is reliable and valid |
| Hill et al.[5] | 2008 | Mixed | Non-specific | A primary care back pain screening tool | | | | RMDQ=0.92<br>Leg Pain=0.84<br>Bothersome=0.92<br>PCS=0.79<br>TSK=0.79<br>PHQ-2=0.74 | Authors concluded that further work is now needed to establish if the STarT Back can improve clinical outcomes through targeted treatment. |
| Karstens et al.[6] | 2015 | Mixed | Non-specific | Validation of the German STarT Back tool | Cronbach α=0.52 | Kappa=0.67 | RMDQ=0.46<br>PCS=0.30<br>TSK=0.28<br>HADS-D=0.32 | RMDQ=0.76<br>PCS=0.70<br>HADS-D=0.71<br>Composite reference standard=0.77 | Authors conclude that the German STarT Back shows acceptable psychometric properties. |
| Luan et al.[7] | 2014 | Unclear | Unclear | Adaption of the Chinese version of the STarT Back tool | | ICC=0.93 | | | Authors concluded the psychometric properties were reliable and valid. |
| Matsudaira et al.[8] | 2016 | Unclear | Unclear | Psychometric properties of the Japanese STarT Back | Cronbach α=0.75 | | RMDQ=0.59<br>FABQ-PA=0.34<br>TSK=0.49<br>PCS=0.46<br>HADS=0.40<br>EQ-5D=-0.56<br>NRS=0.42 | RMDQ=0.83<br>Leg Pain=0.76<br>PCS=0.71<br>TSK=0.74<br>HADS=0.65 | Authors concluded there is acceptable reliability and validity |

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| Piironen et al.[9] | 2016 | Mixed | Non-specific | Psychometric properties of the Finnish STarT Back tool | Cronbach α=0.52 | ICC=0.78 | BDI=0.38<br>ODI=0.38<br>OMPSQ=0.45<br>Pain Intensity=0.31<br>Leg Pain Intensity=0.45 | | Authors concluded the Finnish translation showed to be linguistically accurate and acceptable for patient use. |
| Yelvar et al.[10] | 2019 | Mixed | Non-specific | Validity and reliability of the Turkish STarT Back | Cronbach α=0.75 | ICC=0.90 | RMDQ=0.68<br>TSK=0.47<br>ODI=0.54<br>BDI=0.34 | | Authors concluded the Turkish STarT Back reliability was perfect. |
| Pilz et al.[11] | 2014 | Unclear | Unclear | Brazilian version development of the STarT Back | Cronbach α=0.74 | Kappa=0.79 | | | Authors concluded the translation and cross-cultural adaption was performed in a satisfactory manner. |
| Raimundo et al.[12] | 2017 | Chronic | Unclear | Portuguese translation of the STarT Back | Cronbach α=0.93 | Kappa=0.74 | | | Authors concluded that future studies should analyse the validity different low back pain types |
| Robinson et al.[13] | 2017 | Unclear | Unclear | Reliability and screening ability of the STarT Back in physiotherapy practice | Cronbach α=0.51 | ICC=0.89 | TSK=0.40<br>PCS=0.27<br>HADS-A=0.41<br>HADS-D=0.26<br>PHQ-2=0.55<br>RMDQ=0.55<br>VAS=0.47 | | Authors concluded the SBT is reliable and the screening ability is good. |
| Aebischer et al.[14] | 2015 | Unclear | Non-specific | German adaption of the STarT Back tool | | | | RMDQ=0.79 | Authors conclude the German STarT Back showed appropriate convergent and discriminative validity in the tested sample. |
| Beneciuk et al.[15] | 2015 | Mixed | Non-specific | Subgrouping of patients with low back pain using a multidimensional cluster analysis and the STarT Back | | | | 0.91* | Authors concluded that the STarT Back can replace other unidimensional psychological measures. |
| Fuhro et al.[16] | 2016 | Mixed | Non-specific | Correlation and agreement analysis between the Orebro and STarT Back tools | | | RMDQ=0.76<br>TSK=0.60<br>Pain NRS (last episode)=0.48<br>Pain NRS (prior 2 weeks)=0.43 | | Authors conclude that the Orebro and STarT Back can be utilised by clinicians and researchers. |

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| | | | | | | | Pain NRS (at assessment)=0.31 | | |
| Hill et al.[17] | 2010 | Mixed | Unclear | Subgrouping with the STarT Back versus the Orebro tool | | | | Bothered by back pain (very)=0.92<br>RMDQ=0.94<br>PCS=0.79<br>TSK=0.79<br>Pain NRS=0.83<br>Leg Pain=0.84<br>Comorbid pain=0.68<br>Time off work=0.89<br>Chronic pain=0.71 | Authors conclude that the STarT Back and the Orebro have similar discriminative abilities. |
| Pilz et al.[18] | 2017 | Unclear | Non-specific | Construct and discriminative ability of the Brazilian STarT Back | | | FABQ-W=0.18<br>FABQ-PA=0.28<br>RMDQ=0.70<br>ODI=0.61 | FABQ-W=0.71<br>FABQ-PA=0.66<br>RMDQ=0.88<br>ODI=0.81 | Authors concluded SBST-Brazil is able to discriminate low back pain patients with disability and fear-avoidance beliefs. |

[1]Only range or total score provided

Construct validity noted as correlations, discriminative validity as area under the curve.

ICC=Intraclass Correlation Coefficient. RMDQ=Roland Morris Disability Questionnaire. ODI=Oswestry Disability Index. TSK=Tampa Scale of Kinesiophobia. PCS=Pain Catastrophizing Scale. FABQ=Fear-Avoidance Beliefs Questionnaire. FABQ-W=Fear-Avoidance Beliefs Questionnaire Work. FABQ-PA=Fear-Avoidance Beliefs Questionnaire Physical Activity. VAS=Visual Analogue Scale. NRS=Numeric Rating Scale. BDI=Beck Depression Inventory. HADS-A=Hospital Anxiety and Depression Scale – Anxiety. HADS-D=Hospital Anxiety and Depression Scale – Depression. PHQ-2=Patient Health Questionnaire 2. EQ-5D=EuroQol-5D. OMPSQ=Orebro Musculoskeletal Pain Questionnaire. CSQ=Coping Strategies Questionnaire.

**Supplementary Table 4.** STarT Back and prognosis for low back pain

| Study | Year | N | Type LBP | Duration LBP | Overview | Follow-up Duration | Score vs Category | Pain prediction: Univariate | Pain prediction: Multivariate* | Disability prediction: Univariate | Disability prediction: Multivariate[1] | Conclusions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bier et al.[2] | 2017 | 184 | Non-specific | Mixed | Validity and reproducibility of the Dutch version of the STarT Back | 3mo | Category | Y | - | Y | - | Authors concluded that STarT Back was successfully translated into Dutch. |
| Beneciuk et al.[3] | 2013 | 146 | Non-specific | Mixed | Prognostic capabilities of the STarT Back tool in an outpatient physical therapy setting | 6mo | Score | - | N | - | Y | Authors conclude the data shows prediction of clinical outcome depends on domain of interest. |
| Azevedo et al.[19] | 2019 | 148 | Non-specific | Chronic | Baseline characteristics to assess people who respond best to Movement System Impairment-Based classification treatment | 2mo | Category | N | - | N | - | Authors conclude the STarT Back tool did not modify the effect of an 8-week treatment protocol |
| Beneciuk et al.[20] | 2014 | 123 | Non-specific | Mixed | Predicting 6-month change patterns in an outpatient physical therapy setting | 6mo | Category | - | N | - | Y | Authors conclude reliance on initial SBT high-risk categorisation as an indicator for disability may have limitations. |
| Field et al.[21] | 2012 | 404 | Non-specific | Mixed | Prognosis of STarT Back for recovery with spinal manipulative therapy | 90d | Category | N | - | N | - | Authors conclude that the STarT Back does to predict risk of poor outcome based on categorisation. |
| Friedman et al.[22] | 2018 | 354 | Non-specific | Acute | Does pain one week after emergency department visit predict poor outcome for acute low back pain. | 3mo | Category | N | N | N | N | Authors concluded that the STarT Back was not associated with poor outcomes in this cohort. |
| George et al.[23] | 2015 | 111 | Non-specific | Mixed | Psychological predictors of | 6mo | Category | Y (combined with disability) | - | Y (combined with pain) | - | Authors concluded psychological risk |

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| | | | | | recovery from low back pain | | | | | | | status, depressive symptoms, and pain intensity were predictive of 6 months outcomes. |
| Karran et al.[24] | 2017 | 195 | Unclear | Mixed | The value of a prognostic screening tool for patients with low back pain in secondary care | 4mo | Category | Y (combined with disability) | - | Y (combined with pain) | - | Authors conclude modified screening strategies that could offer clinical value need to be considered. |
| Karstens et al.[25] | 2019 | 294 | Unclear | Chronic | Prognostic capability of the German STarT Back tool | 12mo | Category | Y | - | Y | Y | Authors concluded the disability differences are in accordance with subgroups. |
| Katzan et al.[26] | 2019 | 1169 | Unclear | Unclear | The STarT Back screening tool to predict functional disability. | 45d | Category | - | - | Y | - | Authors conclude the STarT Back predicts outcomes of physiotherapy in a real world setting. |
| Kendell et al.[27] | 2018 | 290 | Unclear | Chronic | Predictive ability of the STarT Back tool in chronic low back pain | 12mo | Category | Y | - | Y | - | Authors concluded that this study provides information on the usefulness for the STarT Back in chronic low back pain. |
| Kongsted et al.[28] | 2016 | 859 | Unclear | Mixed | Prediction of outcome in patients with low back pain | 12mo | Category | N | - | Y | - | Authors concluded that Chiropractors were able to predict outcomes as well as the STarT Back. |
| Matsudaira et al.[29] | 2017 | 1228 | Unclear | Unclear | Japanese STarT Back predicts clinical outcomes | 6mo | Category | Y | - | Y | - | Authors concluded the Japanese STarT Back predicted 6-month pain and |

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| | | | | | | | | | | | | disability outcomes. |
| Medeiros et al.[30] | 2017 | 148 | Non-specific | Chronic | Longitudinal monitoring of patients with chronic low back pain | 6mo | Category | - | Y | - | Y | Authors concluded it was possible to detect changes in the risk classification of the STarT Back. |
| Medeiros et al.[31] | 2018 | 200 | Non-specific | Acute | STarT Back in the emergency department for acute low back pain | 6mo | Category | - | Y | - | N | Authors conclude that studies are needed to test the use of stratification tools in emergency departments. |
| Mehling et al.[32] | 2015 | 605 | Unclear | Acute | To assess if the STarT Back can classify acute low back pain patients at high risk of chronicity | 24mo | Category | NR | - | NR | - | Authors concluded the STarT Back tool should be used cautiously in patients with acute low back pain. |
| Morso et al.[33] | 2013 | 928 | Unclear | Unclear | Predictive and external validity of the STarT Back in Danish primary care | 12mo | Category | Y | N | Y | Y | Authors concluded SBT is suitable for a triage tool. |
| Morso et al.[34] | 2014 | 344 | Non-specific | Mixed | Predictive ability of the STarT Back in a Danish secondary care setting | 3mo | Category | - | - | Y | - | Authors conclude STarT Back tool is less able to predict outcome in secondary care setting compared to primary care |
| Nielsen et al.[35] | 2017 | 1132 | Other | Mixed | Latent class analysis derived sub-groups of low back pain and their prognostic capacity | 6mo | Category | - | - | Y | - | Authors conclude the lower prognostic capacity from two-stage subgrouping may be from information loss. |
| Page et al.[36] | 2015 | 53 | Non-specific | Chronic | Chronic low back pain and prognosis of clinical outcomes using the STarT Back screening tool | 12mo | Score | Y | - | Y | - | Authors conclude the StarT Back can identify prognosis. |

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| Riis et al.[37] | 2017 | 441 | Non-specific | Unclear | Predictive ability of the STarT Back in a Danish general practice cohort | 12mo | Category | - | - | Y | Y | Authors concluded the STarT Back was predictive of functional impairments. |
| Storm et al.[38] | 2018 | 166 | Specific | Surgery | Usefulness of the STarTBack for predicting pain problems after lumbar spine surgery | 12mo | Category | N | - | - | - | Authors concluded the STarT Back could be used as a screening tool to guide treatment in surgery patients. |
| Suri et al.[39] | 2018 | 1109 | Non-specific | Mixed | Predictive validity of STarT Back in US primary care setting. | 6mo | Category | - | - | Y | - | Authors concluded that the STarT Back successfully separated people with back pain. |
| Tan et al.[40] | 2018 | 177 | Non-specific | Acute | Predicting outcomes for acute low back pain in the emergency department | 6mo | Score | Y | - | - | - | Authors conclude SBT total score has a predictive value for long-term pain. |
| Toh et al.[41] | 2017 | 207 | Unclear | Mixed | STarT Back tool for predicting back pain intensity in outpatient physiotherapy setting | 12wk | Category | Y | - | - | - | Authors concluded psychological sub-score was greater than total score for predicting future pain intensity. |
| Von Korff et al.[42] | 2014 | 571 | Unclear | Mixed | Comparison of back pain prognostic risk stratification tools | 4mo | Score | - | - | Y | - | Authors concluded there is comparable predictive validity amongst items. |

Pain and disability measures consider if the result was significant in either univariate analyses or in [1]multivariate analyses which was adjusted for baseline pain or disability (respective to outcome).

**Supplementary Table 5.** STarT Back in trials for low back pain.[1]

| Study | Year | N INT | N CON | Type LBP | Duration LBP | Overview | Study Duration | Pain Results Significant[2] | Disability Results Significant[2] | Cost Results Significant* | Authors Conclusions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cherkin et al.[43] | 2018 | 756 | 945 | Non-specific | Mixed | Effect of risk stratification on patient outcomes and care process | 6mo | N | N | - | Authors concluded the STarTBack did not improve patient outcomes in a US population. |
| Hill et al.[44] | 2011 | 568 | 283 | Non-specific | Mixed | Comparison of stratified care for management of low back pain | 12mo | N | Y | N | Authors concluded stratified management of low back pain significantly improves care. |
| Murphy et al.[45] | 2016 | 251 | 332 | Non-specific | Chronic | A non-randomised trial of stratified care versus usual group care | 3mo | Y | Y | - | Authors concluded that stratified care is effective for management of low back pain compared to usual care. |
| Foster et al.[46] | 2014 | 544 | 368 | Non-specific | Mixed | Effect of stratified care for low back pain in family practice | 6mo | N | Y | N | Authors concluded stratified care has more benefits and targeted use of healthcare resources without increasing health care costs. |

[1]Cherkin and Hill et al are randomised trials, Murphy and Foster are non-randomised.
[2]Significant in favour of STarTBack classification treatment

**Supplementary Table 6.** Reasons for exclusion at full-text screening for McKenzie studies.

| Authors | Year | Title | Exclusion Reason |
|---|---|---|---|
| Yarznbowicz, Richard; Tao, Minjing | 2018 | Directional preference constructs for patients' low back pain in the absence of centralization. | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |
| Kilpikoski, S; Alen, M; Paatelma, M; Simonen, R; Heinonen, A; Videman, T | 2009 | Outcome comparison among working adults with centralizing low back pain: secondary analysis of a randomized controlled trial with 1-year follow-up | Exclusion reason: NOT McKenzie classification. |
| Gillan, M. G.; Ross, J. C.; McLean, I. P.; Porter, R. W. | 1998 | The natural history of trunk list, its associated disability and the influence of McKenzie management. | Exclusion reason: NOT McKenzie classification. |
| Donelson R.; Silva G.; Murphy K. | 1990 | Centralization phenomenon. It usefulness in evaluating and treating referred pain | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |
| Guranowski T.; KuliÅ„ski WÅ‚.; Lipiec Z. | 2002 | Local experience in the treatment of low back pain using the Mckenzie method | Exclusion reason: NOT English language publication. |
| de Bruijn N; Doumen BM; de Mulder K; Ostelo RWJ; Nelissen-de Vos YCM | 2003 | Intra- and inter-tester reliability of the movement loss tests of the McKenzie assessment for the lumbar spine. | Exclusion reason: NOT English language publication. |
| Yamin, Faisal; Atiq-ur-Rehman; Aziz, Saima; Zeya, Nazia; Choughley, Ahlaam | 2016 | To Compare the Effectiveness of McKenzie Exercises v/s General Conditioning Exercises in Low Back Pain. | Exclusion reason: NOT McKenzie classification. |
| Waqqar, Saira; Shakil-Ur-Rehman, Syed; Ahmad, Shakeel | 2016 | McKenzie treatment versus mulligan sustained natural apophyseal glides for chronic mechanical low back pain. | Exclusion reason: NOT McKenzie classification. |
| van Ravensberg CDD; Oostendorp RAB; van | 2005 | Physical therapy and manual physical therapy: | Exclusion reason: NOT McKenzie classification. |

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| Berkel LM; Scholten-Peeters GGM; Pool JJM; Swinkels RAH; Huijbregts PA | | differences in patient characteristics. | |
| Tonosu, J; Matsudaira, K; Oka, H; Okazaki, H; Oshio, T; Hanaoka, I; Muraoka, Y; Midorikawa, M; Wakabayashi, K; Tanaka, S | 2016 | A population approach to analyze the effectiveness of a back extension exercise "One Stretch" in patients with low back pain: a replication study | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |
| Szulc, P; Wendt, M; Waszak, M; Tomczak, M; Cieslik, K; Trzaska, T | 2015 | Impact of McKenzie Method Therapy Enriched by Muscular Energy Techniques on Subjective and Objective Parameters Related to Spine Function in Patients with Chronic Low Back Pain | Exclusion reason: NOT McKenzie classification. |
| Stankovic R.; Johnell O. | 1995 | Conservative treatment of acute low back pain: A 5-year follow-up study of two methods of treatment | Exclusion reason: NOT McKenzie classification. |
| Stankovic, R.; Johnell, O. | 1990 | Conservative treatment of acute low-back pain. A prospective randomized trial: McKenzie method of treatment versus patient education in "mini back school". | Exclusion reason: NOT McKenzie classification. |
| Skikic, Emela Mujic; Suad, Trebinjac | 2003 | The effects of McKenzie exercises for patients with low back pain, our experience. | Exclusion reason: NOT Clinical Trial. |
| Sheth, Arpit; Arora, Anu; Yardi, Sujata | 2014 | Efficacy of Maitland's Spinal Mobilizations Versus Mckenzie Press-Up Exercises on Pain, Range of Motion and Functional Disability in Subjects with non Radiating Acute Low Back Pain. | Exclusion reason: NOT McKenzie classification. |
| Sheets, Charles; Machado, Luciana A. C.; Hancock, Mark; Maher, Chris | 2012 | Can we predict response to the McKenzie method in patients with acute low back pain? A secondary analysis of a randomized controlled trial. | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |

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| Schenk R.J.; Jozefczyk C.; Kopf A. | 2003 | A randomized trial comparing interventions in patients with lumbar posterior derangement | Exclusion reason: NOT McKenzie classification. |
| Ponte D.J.; Jensen G.J.; Kent B.E. | 1984 | A preliminary report on the use of the McKenzie protocol versus Williams protocol in the treatment of low back pain | Exclusion reason: NOT McKenzie classification. |
| Petersen, Tom; Larsen, Kristian; Jacobsen, Soren | 2007 | One-year follow-up comparison of the effectiveness of McKenzie treatment and strengthening training for patients with chronic low back pain: outcome and prognostic factors. | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |
| Petersen, Tom; Kryger, Peter; Ekdahl, C.; Olsen, Steen; Jacobsen, Soren | 2002 | The effect of McKenzie therapy as compared with that of intensive strengthening training for the treatment of patients with subacute or chronic low back pain: A randomized controlled trial. | Exclusion reason: Duplicate. |
| Nwuga, G; Nwuga, V | 1985 | Relative therapeutic efficacy of the Williams and Mckenzie protocols in back pain management | Exclusion reason: NOT McKenzie classification. |
| Murtezani, A; Govori, V; Meka, VS; Ibraimi, Z; Rrecaj, S; Gashi, S | 2015 | A comparison of mckenzie therapy with electrophysical agents for the treatment of work related low back pain: a randomized controlled trial | Exclusion reason: NOT McKenzie classification. |
| Mbada, C; Olaoye, M; Ayanniyi, O; Johnson, O; Odole, A; Dada, O | 2017 | Comparative efficacy of clinic-based and telerehabilitation application of mckenzie therapy in low-back pain | Exclusion reason: NOT journal article. |
| Mbada C.E.; Ayanniyi O.; Ogunlade S.O.; Orimolade E.A.; Oladiran A.B.; Ogundele A.O. | 2014 | Influence of Mckenzie protocol and two modes of endurance exercises on health-related quality of life of patients with long-term mechanical low-back pain | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |
| Matsudaira, K; Hiroe, M; Kikkawa, M; Sawada, T; Suzuki, M; | 2015 | Can standing back extension exercise improve or prevent low | Exclusion reason: NOT McKenzie classification. |

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|---|---|---|---|
| Isomura, T; Oka, H; Hiroe, K | | back pain in Japanese care workers? | |
| Limback Svensson G.; Kjellby Wendt G.; Thomee R. | 2015 | The occurrence of centralisation of pain after mckenzie therapy for patients with mri-verified lumbar disc herniation and long-standing pain | Exclusion reason: NOT journal article. |
| Hosseinifar, Mohammad; Akbari, Mohammad; Behtash, Hamid; Amiri, Mohsen; Sarrafzadeh, Javad | 2013 | The Effects of Stabilization and Mckenzie Exercises on Transverse Abdominis and Multifidus Muscle Thickness, Pain, and Disability: A Randomized Controlled Trial in NonSpecific Chronic Low Back Pain. | Exclusion reason: NOT McKenzie classification. |
| Hasanpour-Dehkordi, Ali; Dehghani, Arman; Solati, Kamal | 2017 | A Comparison of the Effects of Pilates and McKenzie Training on Pain and General Health in Men with Chronic Low Back Pain: A Randomized Trial. | Exclusion reason: NOT McKenzie classification. |
| Halliday, Mark H.; Pappas, Evangelos; Hancock, Mark J.; Clare, Helen A.; Pinto, Rafael Z.; Robertson, Gavin; Ferreira, Paulo H. | 2018 | A randomized clinical trial comparing the McKenzie method and motor control exercises in people with chronic low back pain and a directional preference. | Exclusion reason: Duplicate. |
| Gard G; Gille KA; Degerfeldt L | 2000 | McKenzie method and functional training in back pain rehabilitation. A brief review including results from a four-week rehabilitation programme. | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |
| Garcia, Alessandra N.; Gondo, Francine L. B.; Costa, Renata A.; Cyrillo, Fabio N.; Costa, Leonardo O. P. | 2011 | Effects of two physical therapy interventions in patients with chronic non-specific low back pain: feasibility of a randomized controlled trial. | Exclusion reason: Duplicate. |
| Donelson R.; Aprill C.; Medcalf R.; Grant W. | 1997 | A prospective study of centralization of lumbar and referred pain: A predictor of symptomatic discs and anular competence | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |

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|---|---|---|---|
| Deutscher, D.; Werneke, M. W.; Gottlieb, D.; Fritz, J. M.; Resnik, L. | 2015 | Physical therapists' level of mckenzie education, functional outcomes, and utilization in patients with low back pain. | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |
| Clare, Helen A.; Adams, Roger; Maher, Christopher G. | 2007 | Construct validity of lumbar extension measures in McKenzie's derangement syndrome. | Exclusion reason: NOT McKenzie classification. |
| Clare HA; Adams R; Maher CG | 2004 | Reliability of the McKenzie spinal pain classification using patient assessment forms. | Exclusion reason: NOT back pain. |
| Ali, S; Ali, SM; Memon, KN | 2013 | Effectiveness of core stabilization exercises versus McKenzie's exercises in chronic lower back pain | Exclusion reason: NOT McKenzie classification. |
| Al-Obaidi, Saud M.; Al-Sayegh, Nowall A.; Ben Nakhi, Huzaifa; Al-Mandeel, Mariam | 2011 | Evaluation of the McKenzie intervention for chronic low back pain by using selected physical and bio-behavioral outcome measures. | Exclusion reason: NOT Clinical Trial. |
| Werneke M.W.; Hart D.L. | 2005 | Centralization: Association between repeated end-range pain responses and behavioral signs in patients with acute non-specific low back pain | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group assignment (study design). |
| May S; Ross J | 2009 | The McKenzie classification system in the extremities: a reliability study using Mckenzie [sic] assessment forms and experienced clinicians. | Exclusion reason: NOT back pain. |
| Hiroshi Takasaki | 2016 | Agreement of Mechanical Diagnosis and Therapy Classification in People With Extremity Conditions. | Exclusion reason: NOT back pain. |
| Hefford, Cheryl | 2008 | McKenzie classification of mechanical spinal pain: profile of syndromes and directions of preference. | Exclusion reason: NOT reliability, validity, prognosis using tool for categorisation OR RCT using tool for group |

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| | | | assignment (study design). |
| Donelson R.G.; Spratt K.F. | 2016 | The impact of a precise mechanical diagnosis for low back pain: A cost comparison with standard community care | Exclusion reason: NOT journal article. |
| Gohil, D; Samuel, R | 2018 | The efficacy of a lumbar strengthening program in lumbar spine derangement syndrome 1 | Exclusion reason: NOT journal article. |
| Fiddian, J; Marx, J | 1986 | Comparison of passive mobilization and McKenzie protocol in treatment of low back pain | Exclusion reason: NOT journal article. |
| Cheng P.; Bi X.; Shen X.-L. | 2002 | Treatment of lower back pain: Application and evaluation of the McKenzie method | Exclusion reason: NOT English language publication. |
| Sedaghati, P; Arjmand, A; Sedaghati, N | 2017 | Comparison of the effects of different training approaches on dynamic balance and pain intensity in the patients with chronic back pain | Exclusion reason: NOT English language publication. |
| Morko A.; TruszczyÅ„ska A.; Reszelewska D. | 2014 | Inter-rater reliability of McKenzie functional diagnosis of low back pain patients between - The instructor and physiotherapist after A course | Exclusion reason: NOT English language publication. |
| Moncelon, S; Otero, J | 2015 | The McKenzie method of mechanical diagnosis and therapy in chronic low back pain with directional preference | Exclusion reason: NOT English language publication. |

**Supplementary Table 7.** McKenzie assessment and reliability or classification for low back pain

| Study | Year | N LBP | Type LBP | Duration LBP | Overview | Reliability | Classification % | Authors Conclusions |
|---|---|---|---|---|---|---|---|---|
| Clare et al.[47] | 2003 | 45 | Unclear | Unclear | Reliability to detect a lumbar lateral shift | Kappa=0.26-0.38 | | Authors concluded that lateral shift judgements have only moderate reliability. |
| Clare et al.[48] | 2007 | 25 | Unclear | Mixed | Reliability of McKenzie in cervical and lumbar pain | Kappa=0.89-1.00 | | Authors concluded that the McKenzie assessment is reliable when performed by McKenzie trained therapists. |
| Donahue et al.[49] | 1996 | 49 | Unclear | Mixed | Intertester reliability of lateral shift assessments in low back pain | Kappa=0.16 | | Authors concluded the role of lateral shift assessment in the McKenzie method should be reconsidered. |
| Flavell et al.[50] | 2016 | 150 | Non-specific | Chronic | Classification characteristics of chronic low back pain | | Dysfunction syndrome=36%, Derangement syndrome=32%, Mechanically inconclusive=31%, Postural syndrome=1% | Authors concluded that using a combined McKenzie classification helped improve the accuracy. |
| Fritz et al.[51] | 2000 | 12 | Non-specific | Unclear | Reliability of the centralisation phenomenon | Kappa=0.76-0.87 | | Authors concluded that examiners provided with clear definitions has substantial agreement, regardless of examiner training. |
| Kilby et al.[52] | 1990 | 41 | Unclear | Unclear | The reliability of back pain assessment with the McKenzie Algorithm | Kappa=0.51 | | Authors concluded with the exception of three areas, the algorithm was reliable. |
| Kilpikoski et al.[53] | 2002 | 39 | Non-specific | Mixed | Interexaminer reliability of the low back pain using the McKenzie method | Kappa=0.2-0.9 | | Authors concluded that the interexaminer reliability of the McKenzie examination is high when therapists have been trained. |
| Razmjou et al.[54] | 2000 | 45 | Non-specific | Mixed | Intertester reliability of the McKenzie evaluation for mechanical low back pain | Kappa=0.52-1.00 | | Authors concluded that therapists trained in McKenzie evaluation are highly reliable in reaching the same conclusion. |

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|---|---|---|---|---|---|---|---|---|
| Riddle et al.[55] | 1993 | 363 | Unclear | Unclear | Intertester reliability of McKenzie in low back pain | Kappa=0.02-0.48 | | Authors concluded that intertester reliability in patients with low back pain using the McKenzie system is poor. |
| Seymour et al.[56] | 2002 | 15 | Unclear | Unclear | Reliability of detecting a lateral shift in lumber derangement | Kappa=0.56 | | Authors concluded the reliability for detecting a lateral shift may be higher than previously reported. |
| Werneke et al.[57] | 2014 | 1662 | Unclear | Mixed | Inter-rater agreement by physical therapists with different levels of McKenzie training | Kappa=0.11-0.44 | | Authors concluded the level of agreement for judging McKenzie syndromes did not reach acceptable agreement. |

**Supplementary Table 8.** McKenzie classification and prognosis for low back pain

| Study | Year | N | Type LBP | Duration LBP | Overview | Follow-up Duration | Factors | Pain prediction: Univariate | Pain prediction: Multivariate* | Disability prediction: Univariate | Disability prediction: Multivariate* | Conclusions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Edmond et al.[58] | 2019 | 801 | Non-specific | Chronic | The association between directional preference and treatment outcomes from graded activity and exposure | NR | Directional preference vs no preference | Y | - | Y | - | Authors concluded that subjects manage by McKenzie credential clinicians, there was no added benefit of graded activity in those with a directional preference |
| Garcia et al.[59] | 2016 | 140 | Non-specific | Chronic | Identifying patients with chronic low back pain who respond best to mechanical diagnosis and therapy. | 4wk | Presence of clear centralizatio n | N | - | N | - | Authors concluded clear centralization was not an effect modifier |
| Karas et al.[60] | 1997 | 126 | Non-specific | Mixed | The relationship between centralization and prediction of return to work | 6mo | Centralizers vs no centralisatio n | - | - | Y | - | Authors concluded that individuals who do not centralize their symptoms and have high Waddell scores are unlikely to return to work. |
| Long et al.[61] | 2008 | 312 | Non-specific | Mixed | The comparative prognostic value of directional preference and centralization | 2wk | Treatment matched to directional preference | - | - | Y | - | Authors concluded subgroup matched treatment appears to be a useful tool for treatment prognosis. |
| Petersen et al.[62] | 2011 | 350 | Non-specific | Mixed | McKenzie compared to manipulations when used as an adjunctive therapy | 12wk | Centralizers vs peripheralis ers | - | - | N | - | Authors concluded that the results of this study support the value of classification approaches for management of low back pain. |
| Petersen et al.[63] | 2015 | 350 | Non-specific | Chronic | Predicting important change in patients with low back pain following McKenzie | 12wk | Centralizers vs peripheralis ers | - | - | N | - | Authors concluded, although not significant, nerve root involvement |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | therapy or spinal manipulation | | | | | | | and peripheralisation appear to be promising effect modifiers. |
| Sufka et al.[64] | 1998 | 36 | Unclear | Mixed | Centralization on functional outcomes in low back pain | 2wk | Centralizers vs no centralization | - | - | N | - | Authors concluded show greater improvements in function when there is complete centralization. |
| Werneke et al.[65] | 2001 | 223 | Non-specific | Acute | Centralization as a prognostic factor for chronic low back pain and disability | 52wk | Pain pattern classification | Y | - | - | - | Authors conclude pain pattern classification was a predictive variable of the development of chronic pain and disability. |
| Werneke et al.[66] | 2016 | 723 | Unclear | Unclear | Effect of adding McKenzie factors to a risk-adjusted model for predicting functional status | NR | Pain pattern classification | - | - | N | N | Authors concluded that classification approaches resulted in small non-significant improvement for explaining variance in functional outcomes. |
| Werneke et al.[67] | 2018 | 138 | Non-specific | Unclear | Directional preference and functional outcomes among subjects with high STarT risk | NR | Directional preference vs no preference | - | - | Y | Y | Authors concluded that patients with directional preference on the first visit have greater improvements in function than those who do not. |
| Yarznbowicz et al.[68] | 2018 | 639 | Unclear | Chronic | Pain pattern classification and directional preference on clinical outcomes in low back pain | NR | Directional preference, no directional preference, centralization, no classification | Y[1] | - | Y[2] | - | Authors concluded the findings may corroborate previous research and may assist providers in predicting clinical outcomes. |

Pain and disability measures consider if the result was significant in either univariate analyses or in *multivariate analyses which was adjusted for baseline pain or disability (respective to outcome).

[1]Pain intensity significant for (Comparison vs Reference): DP & Non-Cen vs DP & Cen, Non-DP & Non-Cen vs DP & Cen, Non-DP & Non-Cen vs DP & No classification, Non-DP & Non-Cen vs DP & Non-Cen, Non-DP & Non-Cen vs Non-DP and no classification. No other significant comparisons observed.
[2]Disability significant for (Comparison vs Reference): DP & Non-Cen vs DP & Cen, Non-DP & Non-Cen vs DP & Cen, Non-DP & Non-Cen vs DP & No classification, Non-DP & Non-Cen vs DP & Non-Cen, Non-DP & Non-Cen vs Non-DP and no classification. No other significant comparisons observed.

**Supplementary Table 9.** McKenzie in trials for low back pain.[1]

| Study | Year | N | Type LBP | Duration LBP | Overview | Study Duration | Pain Results Significant[2] | Disability Results Significant[2] | Cost Results Significant[2] | Authors Conclusions |
|---|---|---|---|---|---|---|---|---|---|---|
| Bid et al.[69] | 2017 | McKenzie: 64<br>Physio: 64 | Non-specific | Chronic | A study on McKenzie versus conventional physiotherapy for central sensitization | 8wk | Y | Y | - | Authors concluded that a McKenzie program can be used to reduce pain, central sensitization and disability. |
| Cherkin et al.[70] | 1998 | McKenzie: 133<br>Chiro: 122<br>Booklet: 66 | Non-specific | Unclear | A comparison of physical therapy, manipulation and educational booklet for low back pain | 12wk | N | N | N | Authors concluded that physical therapy and manipulation has similar treatment effects and costs. Both treatments were only marginally better than the booklet. |
| Garcia et al.[71] | 2013 | McKenzie: 74<br>Back School: 74 | Non-specific | Chronic | Back school verses McKenzie exercises in patients with chronic back pain | 4wk | N | Y | - | Authors concluded McKenzie had greater improvement in disability, but not pain compared to back school. The magnitude of effect was small meaning doubtful clinical importance. |
| Halliday et al.[72] | 2016 | McKenzie: 35<br>Motor Control: 35 | Non-specific | Chronic | A randomized trial comparing McKenzie to Motor Control exercise in chronic low back pain | 8wk | N | N | - | Authors concluded that perceived recovery was greater in the McKenzie group, but no differences were seen in other patient reported outcomes. |
| Johnson et al.[73] | 2010 | Total: 53 (group numbers no reported) | Unclear | Chronic | Comparison of four physiotherapy regimes for treating mechanical low back pain | 8wk | Y (to control only) | Y (to control only) | - | Authors concluded that all regimens apart from back education only, were effective for treating long term low back pain |
| Long et al.[74] | 2004 | Matched: 80<br>Opposite: 70<br>Standard Care: 80 | Non-specific | Mixed | Does it matter which exercise for the McKenzie method | 2wk | Y (favors matched direction) | Y (favors matched direction) | - | Authors concluded that matching treatment to directional preference rapidly improved outcomes. |
| Machado et al.[75] | 2010 | McKenzie: 73<br>First-line Care: 73 | Non-specific | Acute | The effectiveness of McKenzie method in acute low back pain | 3wk | Y | N | - | Authors concluded a treatment program based on the McKenzie method does not produce appreciable |
| Miller et al.[76] | 2005 | McKenzie: 14<br>Motor Control: 15 | Non-specific | Chronic | A comparison of McKenzie versus stabilization exercise for chronic low back pain | 6wk | N | N | - | Authors concluded there were no statistical differences between groups. |
| Paatelma et al.[77] | 2008 | McKenzie: 52<br>Manual Therapy: 45<br>Advice: 37 | Non-specific | Mixed | Manuel therapy, McKenzie and advice for low back pain in working adults | 12wk | N | N | - | Authors concluded that manipulations and McKenzie are only marginally more effective than advice-only. |

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|---|---|---|---|---|---|---|---|---|---|---|
| Petersen et al.[78] | 2002 | McKenzie: 132<br>Strengthening: 128 | Non-specific | Mixed | McKenzie compared to intensive strengthening for subacute and chronic low back pain | 8wk | N | N | - | Authors conclude McKenzie and dynamic strengthening are equally effective. |
| Petersen et al.[62] | 2011 | McKenzie: 175<br>Manipulations: 175 | Non-specific | Chronic | McKenzie compared to manipulations when used as an adjunctive therapy | 8wk | N | N | - | Authors concluded that the results of this study support the value of classification approaches for management of low back pain. |

[1]Only trials that clearly stated treatment based on classification were included.
[2]Significant in favour of McKenzie over other treatment or control.

**Supplementary Table 10.** Machine learning/artificial intelligence search

| **MEDLINE** | | |
|---|---|---|
| **Search** | **Query** | **Hits** |
| #1 | ((back pain[MeSH terms]) or low back pain[MeSH terms]) or ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 80928 |
| #2 | (Artificial Intelligence[MeSH Terms]) | 86883 |
| #3 | (#1 AND #2) | 96 |
| **SPORTDiscus (via EBSCOHOST) (DE = dictionary term). No Thesaurus term for Artificial Intelligence)** | | |
| **Search** | **Query** | **Hits** |
| #1 | (DE lumbar pain) OR (DE backache) OR (“back pain*” OR “lumb* pain” OR lumbago OR backache* OR “back ache*”) | 9623 |
| #2 | Artificial Intelligence OR "Computer Heuristics" OR "Expert Systems" OR "Fuzzy Logic" OR "Knowledge Bases" OR "Machine Learning" OR "Deep Learning" OR "Support Vector Machine" OR "Neural Networks" | 915 |
| #3 | S2 AND S3 | 2 |
| **CINAHL (via EBSCOHOST) (MH =coding for meshterm)** | | |
| **Search** | **Query** | **Hits** |
| #1 | ((MH "back pain") OR MH "low back pain") OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 34242 |
| #2 | (MH "Artificial Intelligence+") | 14604 |
| #3 | S1 AND S2 | 31 |
| **PsycINFO (via EBSCOHOST) (DE = coding for meshterm)** | | |
| **Search** | **Query** | **Hits** |
| #1 | (DE "Back Pain") OR (“back pain*” OR “lumb* pain” OR lumbago OR backache* OR “back ache*”) | 6308 |
| #2 | DE "Artificial Intelligence" | 9521 |
| #3 | S1 AND S2 | 2 |
| **EMBASE (Go to Emtree to find dictionary)** | | |
| **Search** | **Query** | **Hits** |
| #1 | “low back pain”/exp OR “backache”/exp OR “back pain*” OR “lumb* pain” OR lumbago OR backache* OR “back ache*” | 119608 |
| #2 | 'artificial intelligence'/exp | 20178 |
| #3 | #1 AND #2 | 14 |
| **CENTRAL (Go to the search. Click on MESH term. Type it in and then Look UP. Then Add/Edit Search line)** | | |
| **Search** | **Query** | **Hits** |

| | | |
|---|---|---|
| #1 | (MeSH descriptor: [back pain] explode all trees) OR (MeSH descriptor: [low back pain] explode all trees) OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 15247 |
| #2 | (MeSH descriptor: [Artificial Intelligence] explode all trees) | 976 |
| #3 | #1 AND #2 | 2 |
| **IEEE XPLORE** | | |
| **Search** | **Query** | **Hits** |
| #1 | (MeSH descriptor: [back pain] explode all trees) OR (MeSH descriptor: [low back pain] explode all trees) OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | |
| #2 | (MeSH descriptor: [Artificial Intelligence] explode all trees) | |
| #3 | #1 AND #2 | 41 |

**Supplementary Table 11.** STarT Back search

| **MEDLINE** | | |
|---|---|---|
| **Search** | **Query** | **Hits** |
| #1 | STarT Back Screen*[Title/Abstract] OR STarT Back Tool[Title/Abstract] | 108 |
| #2 | (((back pain[MeSH terms]) or low back pain[MeSH terms]) or ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*")) | 81272 |
| #3 | (#1 AND #2) | 108 |
| **SPORTDiscus (via EBSCOHOST) (DE = dictionary term).** | | |
| **Search** | **Query** | **Hits** |
| #1 | (DE lumbar pain) OR (DE backache) OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 9670 |
| #2 | TI STarT Back Screen* OR AB STarT Back Screen* OR TI STarT Back Tool OR AB STarT Back Tool | 32 |
| #3 | S1 AND S2 | 31 |
| **CINAHL (via EBSCOHOST) (MH =coding for meshterm)** | | |
| **Search** | **Query** | **Hits** |
| #1 | ((MH "back pain") OR MH "low back pain") OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 34219 |
| #2 | TI STarT Back Screen* OR AB STarT Back Screen* OR TI STarT Back Tool OR AB STarT Back Tool | 96 |
| #3 | S1 AND S2 | 90 |
| **PsycINFO (via EBSCOHOST) (DE = coding for meshterm)** | | |
| **Search** | **Query** | **Hits** |
| #1 | (DE "Back Pain") OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 6322 |
| #2 | TI STarT Back Screen* OR AB STarT Back Screen* OR TI STarT Back Tool OR AB STarT Back Tool | 18 |
| #3 | S1 AND S2 | 18 |
| **EMBASE (Go to Emtree to find dictionary)** | | |
| **Search** | **Query** | **Hits** |
| #1 | STarT Back Screen*:ab OR STarT Back Screen*:ti OR STarT Back Tool:ab OR STarT Back Tool:ti | 89 |
| #2 | "low back pain"/exp OR "backache"/exp OR "back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*" | 120269 |
| #3 | #1 AND #2 | 73 |
| **CENTRAL (Go to the search. Click on MESH term. Type it in and then Look UP. Then Add/Edit Search line)** | | |
| **Search** | **Query** | **Hits** |

| | | |
|---|---|---|
| #1 | (MeSH descriptor: [back pain] explode all trees) OR (MeSH descriptor: [low back pain] explode all trees) OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 15410 |
| #2 | STarT Back Screen* OR STarT Back Tool | 1054 |
| #3 | #1 AND #2 | 313 |
| #4 | Excluding protocols | 306 |

**Supplementary Table 12.** McKenzie search

| **MEDLINE** | | |
|---|---|---|
| **Search** | **Query** | **Hits** |
| #1 | McKenzie[Title/Abstract] | 494 |
| #2 | (((back pain[MeSH terms]) or low back pain[MeSH terms]) or ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*")) | 80930 |
| #3 | (#1 AND #2) | 178 |
| **SPORTDiscus (via EBSCOHOST) (DE = dictionary term).** | | |
| **Search** | **Query** | **Hits** |
| #1 | (DE lumbar pain) OR (DE backache) OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 9623 |
| #2 | TI mckenzie OR AB mckenzie | 786 |
| #3 | S1 AND S2 | 78 |
| **CINAHL (via EBSCOHOST) (MH =coding for meshterm)** | | |
| **Search** | **Query** | **Hits** |
| #1 | (DE lumbar pain) OR (DE backache) OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 9623 |
| #2 | TI mckenzie OR AB mckenzie | 786 |
| #3 | S1 AND S2 | 78 |
| **PsycINFO (via EBSCOHOST) (DE = coding for meshterm)** | | |
| **Search** | **Query** | **Hits** |
| #1 | (DE "Back Pain") OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 6308 |
| #2 | TI mckenzie OR AB mckenzie | 206 |
| #3 | S1 AND S2 | 2 |
| **EMBASE (Go to Emtree to find dictionary)** | | |
| **Search** | **Query** | **Hits** |
| #1 | "low back pain"/exp OR "backache"/exp OR "back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*" | 119644 |
| #2 | mckenzie:ab OR mckenzie:ti | 620 |
| #3 | #1 AND #2 | 214 |
| **CENTRAL (Go to the search. Click on MESH term. Type it in and then Look UP. Then Add/Edit Search line)** | | |
| **Search** | **Query** | **Hits** |
| #1 | (MeSH descriptor: [back pain] explode all trees) OR (MeSH descriptor: [low back pain] explode all trees) OR ("back pain*" OR "lumb* pain" OR lumbago OR backache* OR "back ache*") | 15247 |
| #2 | McKenzie | 956 |
| #3 | #1 AND #2 | 130 |

| | | |
|---|---|---|
| #4 | (Limit to Trials) | 108 |

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