

THE LANCET

Supplementary appendix

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Appendix for What low back pain is and why we need to pay attention

Table S1. Estimates of total costs, direct medical costs, and indirect societal costs, as well as cost per person in the population expressed in 2015 USD*

First authors, country	Year	Method	Total societal cost (billion)	Direct medical cot, %	Indirect societal cost, %	Total cost per person	Direct cost per person	Indirect cost per person
Maniatakis, UK ¹	1998	Top down	26.40	15	85	449	68	381
Rizzo, ² Lou, ³ USA	1998	Top down	81.24	47	53	308	145	163
van Zundert, ⁴ Belgium	1999	Top down	1.93	16	84	189	30	159
Ekman, ⁵ Sweden	2001	Top down	2.93	16	84	336	54	282
Walker, ⁶ Australia	2001	Top down	11.24	11	89	583	64	518
Weiser, ⁷ Switzerland	2005	Bottom up	8.92	38	62	1199	455	743
Lambeek, ⁸ Netherlands	2007	Top down	4.88	12	88	300	36	264

* For each study the reported total societal costs were inflation-adjusted to 2015 US dollars based on World Bank data, divided by the total population at time of data collection, to derive the total per person cost. Based on the reported fraction of direct and indirect costs, per-person direct and indirect costs were developed.

Table S2. Relative percentage of health care costs across studies

First author, country	Year	Inpatient care	Diagnostic evaluations	Outpatient care	Physical therapy chiropractic, massage	Prescription medication
Rizzo ² Lou, ³ USA	1998	38	NR*	56·0	NR	4·0
Ekman, ⁵ Sweden	2001	12·0	NR	25·0	55·0	6·0
Walker, ⁶ Australia	2001	20·0	6·7	17·4	48·2	7·5
Weiser, ⁷ Switzerland	2005	37·0	5·5	24·9	31·9	1·5
Labeek, ⁸ Netherlands	2007	21·0	1·0	25·0	49·0	4·0

* Not reported

Table S3. Performance and extent of validation of four low back pain prediction models

Model name (Country of development, year)	Örebro Musculoskeletal Pain Screening Questionnaire ⁹ (Sweden, 1998)	STarT Back Screening Tool ¹⁰ (UK, 2008)	The 'Hancock Rule' ¹¹ (Australia, 2009)	PICKUP ¹² (Australia, 2016)
Number of items	21	9	3	5
Concepts covered by predictors	Pain intensity Pain frequency Episode duration Multi-site pain Activity limitation Perceived pain control Perceived risk of persistency Fear of movement Fear avoidance beliefs Anxiety Depression Sick leave Physical work exposures Work expectations Work satisfaction	Bothersome pain Leg pain Multi-site pain Activity limitation Fear avoidance beliefs Anxiety Depression Catastrophizing	Pain intensity Episode duration Previous episodes	Pain intensity Leg pain Depression Perceived risk Disability compensation

	Sleep disturbed by pain			
Primary outcome in development sample	Sick leave days during 6 months (0, 1-30, >30).	High disability after 6 months (at least 7 points on the Roland Morris Disability Scale).	Days to recovery from pain. Discrimination based on recovery status at 11 weeks.	Non-recovery from pain after 3 months ('3 Mild' to '6 Very Severe' on a 6-point Likert scale).
Predictive performance in development sample	Cut-point 105 (scale 0–210): Specificity (identification of no sick leave): 0.75 Sensitivity (1–30 days): 0.86 Sensitivity (>30 days): 0.88 No overall performance measure reported	Sum scale (no cut-point): AUC (95% CI) = 0.92 (0.88–0.97)	AUC (95% CI) = 0.68 (0.57–0.79)	AUC = 0.67
Predictive performance in narrow validation sample*	Cut-point 105 (scale 0-210): Specificity (identification of no sick leave): 0.81 Sensitivity (1–30 days): 0.40 Sensitivity (>30 days): 0.67 AUC (95% CI) = 0.74 (0.64–0.84)	Sum scale (no cut-point): AUC (95% CI) = 0.90 (0.88–0.93)	AUC (95% CI) for 1 week recovery = 0.65 (0.60–0.70) AUC (95% CI) for 12 week recovery = 0.60 (0.56–0.64)	AUC (95% CI) = 0.66 (0.63–0.69)
Additional external validation of predictive performance Country (publication year)	External validations have been performed in: Canada (2007) ¹³ Netherlands (2007) ¹⁴ Norway, Australia and New Zealand (2009) ¹⁵ Australia (2011 & 2011) ^{16,17} Belgium (2012) ¹⁸ ` Sweden (2012) ¹⁹ China (2013) ²⁰ Switzerland (2016) ²¹ Turkey (2016) ²² [Additional translations and psychometric testing exist]	External validations have been performed in: UK (2012) ²³ USA (2013) ²⁴ Denmark (2013) Primary care ²⁵ Denmark (2014) secondary care ²⁶ Canada (2015) ²⁷ Denmark (2016) chiropractic care ²⁸ [Additional translations and psychometric testing exist]	N/A	N/A

<p>Predictive performance in external validation samples reporting Area Under the Curve</p> <p>Area Under the ROC Curve (95% CI)</p>	<p>Cut-point 113: AUC (95%CI)= 0.66 (0.52–0.81) (6 months outcome, Turkey) Sum score: AUC (95%CI)= 0.80 (0.66–0.93) (6 months outcome, Norway) AUC (95%CI)= 0.72 (0.57–0.86) (12 months outcome, Norway) AUC (95%CI)= 0.69 (0.62–0.76) (12-months outcome, China) AUC = 0.83 (6-months outcome, Belgium)</p>	<p>Sum score: AUC (95%CI) = 0.69 (0.66–0.73) (6 months outcome, secondary care Denmark) AUC (95%CI) = 0.71 (0.66–0.77) (6 months outcome, primary care Denmark) Three risk group: AUC (95%CI) = 0.84 (0.69–1.00) (6 months outcome, Canada) AUC (95%CI) = 0.59 (0.55–0.63) (3-months outcome, Denmark chiropractic care) AUC (95%CI) = 0.60 (0.56–0.64) (12months outcome, Denmark chiropractic care)</p>	<p>N/A</p>	<p>N/A</p>
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*validation performed by the same research team and in the same setting or in a very similar setting in the same country

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Declaration of interests

Johannes R. Anema is chief investigator, or co-investigator on multiple previous and current (personal) research grants from government research agencies in the Netherlands (e.g., Netherlands Organisation for Health Research & Development) and Canada (eg, IRSST). His research has also received funding from philanthropy and quasi-governmental agencies (Dutch Social Security Agency, Institute GAK) and charities linked to professional body membership (Dutch Foundation of Occupational Medicine). Prof Anema and his research team received a grant from Pfizer to write a report on depression and anxiety disorders based on a secondary analysis of data collected with funding from government research agencies. His travel expenses have been covered when he has been an invited speaker at conferences and he has received honoraria for talks and reviewing grants. Prof Anema was an invited co-opted member of the guideline development group for the Dutch Occupational Medicine guideline for low back pain and the Dutch national Insurance Medicine protocol for lumbosacral syndrome. He is President of the Work Disability Prevention and Integration Committee of the International Commission on Occupational Health (ICOH). He has published multiple papers on low back pain, some of which may be referenced in the series. He is editor of the International Handbook of Work Disability which is referenced in the series. Prof Anema is stockholder and senior consultant of Evalua Netherlands Ltd. His chair in Insurance Medicine is paid by the Dutch Social Security Agency.

Rachelle Buchbinder is chief investigator or associate investigator on multiple previous and current research grants from government research agencies from Australia (eg, NHMRC,

ARC), and overseas (eg, ZonMW in the Netherlands and PCORI in the USA). Her research has also received funding from philanthropy (eg, Arthritis Australia) and government agencies (eg, NSW WorkCover). She has been funded by research fellowships from NHMRC since 2005. She has received travel expenses for speaking at conferences from the professional organisations hosting the conferences. She chaired the back pain expert group for the 2010 Global Burden of Diseases, Injuries, and Risk Factors (GBD) Study. She was appointed to the Australian Medical Services Advisory Committee in May 2016. She has published multiple papers on low back pain some of which may be referenced in the series.

Dan Cherkin is chief investigator, or co-investigator on multiple previous and current research grants from government-related research agencies in the USA (eg, NIH and PCORI). His travel expenses have been covered when he has been an invited speaker at conferences and he has received honoraria for talks, reviewing grants and theses (no honoraria or travel expenses from pharmaceutical or device companies). Dr. Cherkin has published multiple papers on low back pain some of which may be referenced in the series.

Roger Chou has received funding from the Agency for Healthcare Research and Quality and the Centers for Disease Control and Prevention to conduct systematic reviews on low back pain treatments, was an author on the 2016 CDC guideline, receives royalties from UpToDate as an author on low back pain topics, has had travel expenses covered when he has been an invited speaker at conferences and has received honoraria for talks (no honoraria or travel expenses from pharmaceutical or device companies).

Stephen P. Cohen is Principal Investigator for multiple clinical trials evaluating interventions for low back pain funded by the U.S. Department of Defense (Congressionally Mandated Research Programs). He serves on the Advisory Boards of a company that make radiofrequency equipment (Halyard) and another one working with the U.S. Food and Drug Administration (FDA) to design a steroid approved for epidural injection (Semnur). He was the lead speaker on the effectiveness of epidural steroid injections at the FDA-convened panel on the procedure following the fungal meningitis outbreak. He serves on several National Institutes of Health task forces, including one for pain education and another for research priorities for chronic pain. He is a member of the American Society of Regional Anesthesia and Pain Medicine (ASRA) Board of Directors. He was a “stakeholder” for ASRA and the Dept. of Defense for the recent U.S. Drug Enforcement guidelines on opioids for chronic pain. He has published numerous studies on low back pain, some of which are referenced in this series.

Luciola Menez Costa is chief investigator or associate investigator on multiple previous and current research grants from government research agencies FAPESP and CNPq from Brazil. She has published multiple papers on low back pain some of which may be referenced in the series.

Peter Croft has been chief investigator or co-investigator on multiple previous research grants for musculoskeletal pain research from UK government agencies (including National

Institute for Health Research and the Medical Research Council) and UK charitable organisations (Arthritis Research UK and the Wellcome Trust), but none from industry. His travel expenses have been covered by the organising professional organisations (including rheumatology, pain specialists, physical therapy, primary care) when he has been an invited speaker at conferences. He has received honoraria for reviewing grant proposals from government organisations in Canada, Norway and Sweden. PC's department has received payment for two reports to the UK Committee on Advertising Practice. He has published multiple papers on low back pain some of which may be referenced in the series.

Manuela Ferreira holds a Sydney Medical Foundation Fellowship/Sydney Medical School and is chief investigator, or co-investigator on multiple previous and current research grants from government research agencies in Australia (NHMRC) and Brazil (eg, CAPES/CNPQ), philanthropy (eg, Arthritis Australia), industry (eg, Medibank Research Fund) and institutional research funds (eg, International Research and Research Training Fund/The University of Melbourne). Her travel expenses have been covered when she has been invited speaker at conferences and she has received honoraria for talks, reviewing grants and theses. She has published multiple papers on low back pain some of which may be cited in this series.

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(eg, CNPQ, FAPESP). The University of Sydney funds his salary. His travel expenses have been covered when he has been an invited speaker at conferences or through his research funding (no honoraria or travel expenses from pharmaceutical or device companies). He has received industry related funding from competitive peer-reviewed schemes (eg, Medibank Private Research Foundation – Australia) for a trial investigating the effects of physical activity for recurrent low back pain (IMPACT). IMPACT is currently in its pilot stages. He has published multiple papers on low back pain some of which may be referenced in the series.

Nadine E. Foster is chief investigator, or co-investigator on multiple previous and current research grants from government research agencies in the UK (eg, NIHR), USA (e.g. PCORI) and Australia (eg, NMHRC). For 10 years her salary has been covered by research fellowships from the UK's National Institute for Health Research (NIHR). Her research has also received funding from philanthropy (e.g Arthritis Research UK, Medical Research Council) and charities linked to professional body membership (eg, Chartered Society of Physiotherapy's Charitable Trust). Her travel expenses have been covered when she has been an invited speaker at conferences and she has received honoraria for talks, reviewing grants and theses (no honoraria or travel expenses from pharmaceutical or device companies). Prof Foster was an invited co-opted member of the guideline development group for the UK's National Clinical Guideline on low back pain and sciatica. She is the President of the Society of Back Pain Research in the UK and has published multiple papers on low back pain some of which may be referenced in the series.

Julie Fritz is chief investigator, or co-investigator on multiple previous and current research grants from government research agencies in the United States including NIH, AHRQ, DOD and PCORI. Her research has also received funding from Foundations in the USA including the Foundation for Physical Therapy and National Athletic Trainers Association Research Foundation. Her travel expenses have been covered when she has been an invited speaker at conferences and she has received honoraria for talks and reviewing grants (no honoraria or travel expenses from pharmaceutical or device companies). Dr. Fritz has received payment as a journal editor (Journal of Orthopaedic and Sports Physical Therapy). She is an author or co-author on multiple papers on low back pain some of which may be referenced in the series.

Stéphane Genevay is principal investigator or associate investigator on multiple previous and current research grants from Swiss research foundation (e.g. HUG). His research has also received funding from philanthropy (eg, Rheumasearch, Centre de Recherches Médicales Carlos & Elsie de Reuter, Eugenio Litta). He has received funding from pharmaceutical companies (Abbvie, MSD, Pfizer) for investigator-initiated trials. He has received travel expenses and honorariums for speaking at conferences from the professional organisations hosting the conferences. He has papers on low back pain some of which may be referenced in the series.

Douglas P. Gross is chief investigator, or co-investigator on multiple previous and current research grants from government research agencies in Canada (eg, Canadian Institutes for

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Mark Hancock is chief investigator, or associate investigator on previous and current research grants from government agencies (e.g. NHMRC and WorkCover) and from philanthropy (e.g., Arthritis NSW and International Mechanical Diagnosis and Therapy Research Foundation). His travel expenses have been covered when he has been an invited speaker at conferences. He is chief investigator on two investigator-initiated NHMRC-funded trials that have received supplementary industry funding. The first trial, PACE, was published in Lancet in 2014 and had co-funding from GSK. PACE demonstrated that paracetamol was ineffective for acute low back pain. The second NHMRC-funded trial, PRECISE, is evaluating

pregabalin for sciatica. Pfizer provided the study medicine at no cost but provided no other funding. PRECISE is currently under review. He has published multiple papers on low back pain some of which may be referenced in the series.

Jan Hartvigsen is chief investigator, or co-investigator on multiple previous and current research grants from government research agencies in Denmark (e.g. the Danish Ministry of Science and Innovation), and the USA (e.g. Health Resources and Service Administration). He holds tenured positions at the University of Southern Denmark and the Nordic Institute of Chiropractic and Clinical Biomechanics, which cover his full salary. His research has also received funding from philanthropy (e.g. Danish League against Rheumatism) and charities linked to professional bodies (e.g. the Danish Chiropractors Research Fund). His travel expenses have been covered when he has been invited speaker at conferences and he has received honoraria for talks, reviewing grants and theses. He has received honoraria for speaking from one pharmaceutical company (Nycomed 2002) but no device companies. Prof Hartvigsen was invited member of the expert groups that in 2014-16 developed Danish National Guidelines commissioned by the Danish Health and Medicines Authority for the management of low back pain, lumbar radiculopathy, and cervical radiculopathy. He has published multiple papers on low back pain some of which may be cited in this series.

Damian Hoy is the principal epidemiologist for the Pacific Community. This work involves dealing with all conditions in the Pacific that cause burden. It is funded by multiple donors, including the Governments of Australia, New Zealand, and France. It has included funding to

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Jaro Karppinen is chief investigator or associate investigator on multiple previous and current research grants from Finnish government research agency (Finnish Academy). He has received travel expenses for speaking at conferences from the professional organisations hosting the conferences. He was nominated as a member of the European Academy of Rehabilitation Medicine in 2012. He has published multiple papers on low back pain some of which may be referenced in the series.

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Alice Kongsted's position at University of Southern Denmark is financially supported by The Foundation for Advancement of Chiropractic Research and Postgraduate Education,

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Quinette Louw is the principal or associate investigator on grants from South African government research agencies, including the Medical Research Council and National Research Foundation. She has published multiple papers on low back pain some of which may be referenced in the series. She received travel expenses when she was an invited speaker at conferences or workshops and has received honoraria for talks and theses (no honoraria or travel expenses from pharmaceutical or device companies). Prof Louw was invited to assist with the South African Physiotherapy Society’s low back pain clinical practice guidelines.

Chris Maher is chief investigator, or associate investigator on multiple previous & current research grants from government research agencies from Australia (eg, NHMRC), Brazil (eg, FAPESP) and the Netherlands (eg, ZonMW). For the past 10 years his salary has been covered by research fellowships from Australia’s National Health and Medical Research Council and The Australian Research Council. His research has also received funding from

philanthropy (eg, Arthritis Australia) and government agencies (eg, NSW WorkCover). He has received travel expenses for speaking at conferences from the professional associations hosting the conferences, and has received honoraria for talks from professional associations and industry hosting the talks, honoraria for reviewing grants from government grant agencies and honoraria for marking theses from the relevant university. Prof Maher has received supplementary industry funding for two investigator-initiated NHMRC-funded trials. The first trial had co-funding from GlaxoSmithKline. Pfizer provided the study medicine for the second trial, PRECISE, at no cost, but provided no other funding. He has published multiple papers on low back pain some of which may be referenced in the series.

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Wilco Peul has no conflicts of interest to disclose.

Glenn Pransky is chief investigator or co-investigator on multiple previous and current research studies, primarily funded by his employer, the Liberty Mutual Research Institute. He has also collaborated on studies funded by the US National Institute of Health, the National Institute of Occupational Safety and Health, the Canadian Institute of Health

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Mark Schoene receives the majority of his funding from the publishing company Wolters Kluwer for writing/editing an international newsletter on spine/back pain research (*The BackLetter*). He authors all the articles and shares editorial control with the executive editor (a researcher, academic spine surgeon, and Chairman, Dept of Orthopaedics at Georgetown University Medical Center). Neither has any conflicts of interest with drug or device companies. MS has co-authored several editorials for journals owned by publishers (*The Spine Journal*, *Spine*—owned respectively by Elsevier and Wolters Kluwer). The editorials concerned the inadequacy of the evidence base for regulated surgical devices or drugs/biologics. He received nothing of value for those editorials. The remainder of his funding comes from the non-profit Sports Health and Safety Institute at the University of Washington for research, writing, and editing in the concussion area. He was previously a paid consultant for the non-profit Informed Medical Decisions Foundation in Boston, involved in the preparation of Decision Aids and Shared Decision Making materials. He occasionally receives travel funding from professional societies to take part in symposia sponsored by those societies. MS has been an unpaid editorial board member and Consumer Representative at the Cochrane Collaboration Back and Neck Group since 1999.

Joachim Sieper has no conflict of interest as related to these manuscripts. Outside the submitted manuscripts he reports grants and personal fees from Abbvie, personal fees from Boehringer Ingelheim, grants from Eli-Lilly, personal fees from Galapagos, grants and personal fees from Janssen, grants and personal fees from Merck, personal fees from Novartis, grants and personal fees from Pfizer, personal fees from Roche, personal fees from UCB.

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Martin Underwood was Chair of the NICE accreditation advisory committee until March 2017 for which he received a fee. He was chair of the guideline development group that produced the 2009 NICE back pain guidelines. He is chief investigator or co-investigator on multiple previous and current research grants from the UK National Institute for Health Research, Arthritis Research UK and is a co-investigator on grants funded by Arthritis Australia and Australian NHMRC. He has completed trials of manual therapy, group exercise, and a cognitive behavioural approach as treatments for low back pain. He has received travel expenses for speaking at conferences from the professional organisations hosting the conferences. He has received travel and subsistence to attend meeting by the EU Joint Research Centre. He is a director and shareholder of Clinvivo Ltd that provides electronic data collection for health services research. He is part of an academic partnership with Serco Ltd. He is an editor of the NIHR journal series for which he receives a fee. He has published multiple papers on low back pain some of which may be referenced in the series.

Maurits van Tulder is chief investigator, or co-investigator on multiple previous and current research grants from government research agencies in the Netherlands (ZONMW; the Dutch

Health Insurance Council) and Australia (NMHRC). His research has also received funding from professional organisations (eg, the Royal Dutch Association for Physiotherapy; the Netherlands National Chiropractic Association and the European Chiropractic Union). His travel expenses have been covered by the organizing professional organizations when he has been an invited speaker at conferences. He has received honoraria for reviewing grant proposals from the Swedish Medical Research Council and VINNOVA (Sweden's innovation agency). He has not received any honoraria or travel expenses from the industry. Prof van Tulder was chairman of the Netherlands National Multidisciplinary Guideline on Low Back Pain. He has published multiple papers on low back pain some of which may be referenced in the series.

Anthony Woolf has been chief investigator or co-investigator on projects to identify burden of musculoskeletal conditions and to develop strategies for their control. He has been an expert advisor to the World Health Organisation (WHO). He is chair of the Global Alliance for Musculoskeletal Health. The European Community, professional bodies and research agencies have supported his work. Professional bodies or organisers of scientific meetings have supported his travel expenses. He has not received any funding from the private sector.