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Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed.
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Appendix

Table: Major evidence gaps and how to address them

	How to address the evidence gap
Population burden	
Low back pain in older age groups; low back pain in low-income and middle-income countries	Use population surveys and registries; combine datasets for new knowledge without additional cost; develop informed perspective on low back pain impact in low-income and middle-income countries
Population monitoring	
No standard low back pain definition; no universal patient-relevant outcome measures in routine health care; health care use—eg, opioids, imaging; occupational data	Agree on and apply a standard definition and new back health measure for inclusion in national surveys and health-care databases that can be compared across countries; develop indicators and population surveillance to monitor impact of population strategies
Identification of effective and cost effective treatments for low back pain	
Mechanisms and phenotypes of persistent disabling low back pain to drive new interventions; paucity of highly effective and cost-effective interventions for low	Commission research on pathophysiology and prognosis of different low back pain phenotypes including trajectories of low back pain from childhood through the life

back pain; paucity of trials of complex interventions and including complex and older patients; need for new technologies to deliver interventions and to collect patient data

course, mechanisms of persistent low back pain, and development of theories to guide research integrating pain mechanisms, patient perceptions and behaviours, and social determinants of persistent low back pain; realign the research agenda to restrict and focus research funding to important questions that will change practice and improve patient-relevant outcomes; align and combine research questions, priorities and funding, with other health conditions to avoid duplication, increase efficiency, and improve the low back pain share of research funding; fund more innovations that exist entirely outside of health care; investigate innovative approaches that combine primary care with occupational rehabilitation and multidisciplinary interventions, such as placing musculoskeletal therapists as the gatekeepers for all care of low back pain patients and providing systems-level support to ensure safe and successful

	<p>implementation; improve the evidence base for individualised and stratified care for people with low back pain; develop or improve the evidence base for effective prevention of low back pain; develop the evidence base for effective management of low back pain in older adults and children</p>
<p>Implementation of evidence into practice</p>	
<p>Paucity of knowledge about how best to improve the uptake of low back pain evidence into practice</p>	<p>Realign the research agenda to restrict and focus research funding to investigate better strategies for implementing what is already known into practice; fund evidence syntheses and policy research; develop or improve the evidence base for effective prevention of low back pain, prolonged disability due to low back pain, and seeking of ineffective care; develop the evidence base for effective management of low back pain outside of health care</p>
<p>Identification of effective and cost- effective population-based strategies to reduce low back pain burden</p>	
<p>Gap in research on how to shift cultural beliefs about common low back pain;</p>	<p>Develop and test strategies designed to address popular misconceptions about low</p>

paucity of integrated research programme into prevention of long-term disabling conditions; paucity of trials investigating population-level social and psychological interventions to prevent disability; how to avoid mistakes of high-income countries in low- and middle-income countries

back pain; realign the research agenda to focus research funding on important questions that will tackle the rising prevalence and burden of disabling low back pain; develop or improve the evidence base for low back pain population-based social strategies to reduce disability; develop or improve the evidence base for promotion of wellbeing despite chronic low back pain; determine an agenda for research as a priority in low-income and middle-income countries; foster links between low-income, middle-income and high-income countries among policy-makers and researchers to allow all countries to benefit from the successes and failures of attempts to tackle the burden of low back pain in different settings

Panel 1: What should well-informed consumers, patients, and clinicians know about low back pain?

- Bed rest can delay recovery from back pain
- Early return to normal activity and work increases speed of recovery
- Pain does not always equal injury, especially in the case of long-term pain
- It is not necessary to be pain-free to have a healthy, productive life; usually it is best to continue or resume activity before the pain is gone
- For those who find it difficult to resume activity, programmes are available to help in health centres and workplaces
- Only a few people will have an identifiable cause for their back pain that calls for use of a specific treatment
- Many people should be encouraged to self-manage and avoid unnecessary engagement with health care, including diagnosis and treatment
- Because the experience of pain has effects on both body and mind, treatments targeted at both factors have greater potential for reducing pain and disability than medical care alone

Panel 2: What should well-informed policy-makers know about low back pain?

- Back pain and related disability are expensive problems that are difficult to solve and have not received adequate attention from policy makers
- Governments can play a key part in resolving some aspects of problems related to low back pain by altering policies that incentivise work absence, inactivity, and work disability payments that support ineffective care
- Ineffective, low-value care should be eliminated
- Increased investment in implementation research could uncover why evidence is not being taken up in practice and identify and test strategies to ensure rapid uptake of evidence into clinical care
- Investment in promotion of healthy lifestyles will reduce disability and costs associated with low back pain
- Research that leads to improved management and prevention of low back pain across low-income, middle-income and high-income countries is an urgent priority
- To identify optimal approaches for most of the world's population, there is a need to test suitably considered strategies for the local context in low-income and middle-income societies

Panel 3: Indicators that could be used globally to monitor progress

- Number of people with disabling low back pain and their characteristics
- Number of people unable to do activities of daily living because of low back pain
- Number of people not working (whether paid or unpaid) because of chronic low back pain
- Number of people unable to participate in usual sport and leisure activities because of chronic low back pain
- Number and characteristics of people with low back pain who do not have any of the above problems
- Health care use among people with chronic low back pain, as indicated by:
 - Number of people undergoing imaging for acute and persisting low back pain and the imaging that they receive
 - Number of people with chronic low back pain prescribed or taking opioid medication and the duration of use
 - Number of people undergoing spinal injections, the indications for these injections, and the injections that they receive
 - Number of people undergoing spinal surgery and other invasive interventions, the indications for these interventions, and the specific interventions that they receive
- Regular national surveys to assess whether there is a change in population knowledge and behaviour over time

Conflicts of interest for the *Lancet* Low Back Pain Series Working Group

Johannes R. Anema is chief investigator, or co-investigator on multiple previous and current (personal) research grants from government research agencies in the Netherlands (eg, 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.

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.

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.

Paulo H Ferreira is chief investigator, or associate investigator on multiple previous & current research grants from government research agencies from Australia (eg, NHMRC, Arthritis Australia), USA (eg, MDT Research Foundation), Spain (e.g. MAPFRE foundation), and Brazil (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 M 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 Health Research, Alberta Innovates Health Solutions) and the Netherlands (eg, TechForFuture Centre of Expertise HTSM Oost). His research has also received funding from philanthropy and quasi-governmental agencies (eg, Workers' Compensation Board of Alberta, Workers' Compensation Board of Manitoba, WorkSafeBC, Institute for Health Economics, Canadian Hemophilia Society) and charities linked to professional body membership (eg, Physiotherapy Foundation of Canada, Canadian Occupational Therapy Foundation). He has received funding from pharmaceutical companies (Bayer Hemophilia Awards Program) to undertake investigator-initiated research. 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). Prof Gross was an invited co-opted member of the guideline development group for the Ontario Ministry of Government Services Community Research Award, "Development of a Minor Injury Treatment Protocol". He has published multiple papers on low back pain, some of which may be referenced in the series.

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 travel to one research conference on surveillance. He is a member of the Global Burden of Diseases, Injuries, and Risk Factors (GBD) Study Musculoskeletal Expert Group, and is co-deputy chair of the Global Alliance for Musculoskeletal Diseases Surveillance Taskforce. He has published multiple papers on low back pain some of which may be referenced in the series.

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.

Bart W Koes is chief investigator or associate investigator on multiple previous and current research grants from government research agencies from the Netherlands (eg ZonMW, NWO) and overseas (eg, NHMRC, Australia). His research has also received funding from philanthropy (eg, Dutch Arthritis Foundation). He has received travel expenses for speaking at conferences from the professional organisations hosting the conferences. He has published multiple papers on low back pain some of which may be referenced in the series.

Alice Kongsted's position at University of Southern Denmark is financially supported by The Foundation for Advancement of Chiropractic Research and Postgraduate Education, Denmark. She was the content area expert in the development of Danish national clinical guidelines for treatment of neck pain for which she received a fee. She has received funding from The Foundation for Advancement of Chiropractic Research and Postgraduate Education and "IMK Almene Fond" to conduct observational cohort studies in Danish general practice and chiropractic practice. Her travel expenses have been covered when she has been invited as a speaker at conferences. She has published multiple papers on low back pain some of which may be referenced in the series.

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 G 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. 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 Research, and others. He has received travel expenses for speaking at conferences from the professional organizations hosting the conferences, and support for conference travel from his employer. He chaired the Work Disability Prevention and Integration section of the International Commission on Occupational Health from 2010- 2015. He has published multiple papers on low back pain and work disability, some of which are referenced in this series.

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.

Rob Smeets is chief investigator or associate investigator on multiple previous and current research grants from government research agencies from the Netherlands (ZonMW), and overseas (eg, NHMRC in Australia and Swedish Research Council). His research has also received funding from philanthropy (eg, Eurospine, Revalidatiefonds, Stichting Annadal) and health care insurance companies (eg, CZ and VGZ) and government agencies (eg, Province of Limburg). He has received travel expenses for speaking at conferences from the professional organisations hosting the conferences. He chaired the IASP Special Interest Group Pain, Mind and Movement and was member of the governmental working group protocol lumbosacral radicular syndrome for insurance medicine (Gezondheidsraad) and is member of the project group Dutch Quality Care Standard Chronic pain. He has published multiple papers on low back pain some of which may be referenced in the series.

Judith A. Turner is co-investigator on multiple previous and current research grants from US government agencies, including NIH, AHRQ, and PCORI. She is President of the International Association for the Study of Pain. Her travel expenses have been covered when she has been an invited speaker at conferences and she has received honoraria for talks (no honoraria or travel expenses from pharmaceutical or device companies). She is an author on multiple articles on low back pain, some of which may be referenced in this series. She receives royalties from PAR, Inc. for questionnaires not referenced in this series.

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 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 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.