Institution: Keele University

Unit of Assessment: 2

a. Overview: Keele's submission to UoA 2 represents the Arthritis Research UK (ARUK) Primary Care Centre of Excellence and focuses on the impact, long-term outcomes and primary care management of pain and arthritis. Since RAE 2008, our grant income has increased by 87%, our staff FTE has increased by 81%, PGR student numbers have doubled and Doctoral awards have increased two and a half-fold. In addition to being the ARUK Primary Care Centre-of-Excellence, and as a result of our performance in RAE 2008, we are a member of the National Institute of Health Research School for Primary Care Research (NIHR SPCR). Since RAE 2008, we have been awarded £27,489,000 in grants (a four-fold increase from RAE 2008). Grant highlights include our ARUK Primary Care Centre-of-Excellence (2008 – 2013, competitively renewed 2013 – 2018; £4,700,000), NIHR School of Primary Care (SPCR) competitive grants (£2,749,000), 3 National Institute of Health Research (NIHR) Programmes, 8 project and 9 fellowship grants (£9,106,363), a Wellcome Trust Career Development grant (£616,000) and 4 MRC grants (£1,412,000). We are a strongly multi-disciplinary group of academic general practitioners, rheumatologists, allied health professionals (AHP), epidemiologists, bio-statisticians and social scientists, supported by a NIHR fully-registered Clinical Trials Unit, specialist IT and health informatics staff, an active research user group and an exceptionally strong clinical infrastructure. Our research group, infrastructure staff and the leadership teams of our NHS clinical partnerships are co-located within our flagship purpose-built research centre at the main entrance to the university campus, and we form the largest research grouping within Keele. Our regional and national strategic partnership with NHS primary care commissioners, GPs and community healthcare providers secures intensive NHS engagement in designing, delivering and disseminating our research, a supportive environment for our clinical academics and strong career pathways to underpin our clinical research training initiatives. Our leadership of the Primary Care Research Network (Central England: PCRN-CE) ensures high quality delivery of our applied research programmes. Our more recent leadership of the Primary Care Innovation Unit within the West Midlands Academic Health Sciences Network (AHSN) strengthens our capacity to disseminate and implement our research in the NHS and internationally. We are committed to ensuring our research results advance health policy and clinical practice in our field, to improve patients' experience of healthcare and their outcomes. The impact of our work in these arenas was demonstrated by our being awarded the Queen's Anniversary Prize in 2009 for *Pioneering the early prevention and treatment of chronic pain.*

b. Research strategy: Painful musculoskeletal disorders are the most common limiting long-term conditions in the western world. They represent a huge and growing burden on population health, accounting for 30% of all years lived with disability, and 7.5 million days lost from work each year. In the UK, they are the second most common reason for consulting primary care with 24% of adults presenting with a musculoskeletal disorder annually. Our **mission** is to reduce the impact of chronic musculoskeletal pain in individuals and the population, by improving the content and delivery of primary care. Our **strategy** is to underpin a shift in the primary care management of arthritis and pain away from a narrow biomedical focus on disease, to holistic, bio-psycho-social approaches which address the syndromes of pain and disability in their own right, within the broader context of managing multi-morbid long term conditions in primary care. Unifying themes which drive our research strategy include:

Surveillance and monitoring of musculoskeletal disease – by combining long-term cohort data-sets with large-scale primary electronic health records from the UK, Europe and Canada, we aim to increase understanding of the extent, course and impact of musculoskeletal and pain-related disorders on individuals' and population health, and to describe and investigate trends over time. We develop clinically reliable case definitions, model prognostic trajectories and long-term outcomes, and examine the effect of collecting standardised quality indicators and Patient Reported Outcome Measures (PROMs) on improving service quality and patient outcomes.

Identifying predictors of poor outcome and developing prognostic models which can support stratification of patients according to risk – we investigate the prognostic value of biological, physiological, psychological and behavioural markers, and social and work-related factors, across the range of musculoskeletal conditions. We apply novel statistical methods to

investigate the inter-relations between different prognostic factors and their cumulative effect over time, to gain a better understanding of their association with health outcomes, identify those prognostic factors that may be modifiable through targeted interventions and develop these into practical tools that can support clinical decision-making in primary care.

Developing and evaluating models of stratified care – we lead our field in developing practical prognostic and diagnostic tools for stratifying patients with musculoskeletal disease into specific sub-groups for targeted personalised packages of care. We have demonstrated that this approach can be implemented in primary care settings and that it leads to improved clinical and cost-effective outcomes (e.g. significant reductions in sickness absence). We target primary care management to explicit patient characteristics, and provide pro-active advice, care and treatment which promote activity and reduce the risk of long-term pain and disability, with fast-track referral and secondary care for more complex patients.

Improving the content and organisation of primary care, by designing, delivering and evaluating co-ordinated treatments and care pathways – our management interventions and models of care address the complex combinations of needs in managing pain and disability, and include pharmacological and non-pharmacological approaches to clinical management and to supporting self-management. We design and evaluate life-style and behavioural change interventions which may either be condition-specific (e.g. physiotherapist supervised individualised exercise prescription for knee osteoarthritis) or generalizable to multi-morbid chronic disease conditions (e.g. improving adherence to increased physical activity). We evaluate the clinical and cost effectiveness of new models of primary care (e.g. direct access physiotherapy, innovative approaches to supported self-management, musculoskeletal interface clinics).

Our methodological expertise in observational and interventional research underpins these themes. Our innovative **epidemiological research** combines analysis of well-characterised and long-term observational cohorts with linked medical record data. We provide dynamic classifications of musculoskeletal phenotypes, which account for fluctuation over time and the effect of concurrence of other conditions, including treatment response predicted by comorbid pain. This research feeds in to our large programmes of **randomised controlled trials** by underpinning the development of innovative assessment tools, informing novel approaches to clinical and prognostic phenotyping, and thus supporting our development of targeted primary care treatments. These methodological strengths address the major long term conditions in primary care, with a particular focus on Musculoskeletal Pain; Osteoarthritis; and Inflammatory Arthritis.

Musculoskeletal Pain: The flagship topic of **back pain** highlights how our strategic themes and areas of methodological expertise are integrated to deliver research of direct benefit to patients, health care practice and policy. Within this programme we have developed approaches to *stratified care* for low back pain, which can be delivered in general practice and primary care physiotherapy settings. Using novel methodological approaches within long-term follow-up of our high quality observational cohorts (six-year follow-up data from the BaRNs and BeBack cohorts and clinical trials data both linked to medical records), we have described phenotypic sub-types and the prognostic factors which predict patients' long-term trajectories of pain and disability. We have investigated how biological, psychological and social risk factors interact to predict, mediate or moderate poor or positive outcomes in low back pain. We have then used this information to develop practical prognostic tools which can support accurate primary care assessment and clinical decision-making (STarTBack screening tool (http://www.keele.ac.uk/sbst/ **Hay**: ARUK Programme Grant; **Dunn**: Wellcome Trust Career Development Fellowship). Linked to this, we have defined best usual care, and developed "targeted" preventative strategies and treatments, which address potentially modifiable prognostic factors, to improve patients' clinical and health economic outcomes (ARUK: STarTBack Trial - *Lancet).* In STarTBack, we randomised 851 patients from 10 General Practices, and demonstrated that prognostic screening combined with targeted treatment is superior to best current physiotherapy care for back pain in terms of clinical and cost effectiveness (e.g. less pain, better activity, fewer unnecessary referrals). We have also successfully tested implementation of the STarTBack approach in real-life primary care (Foster: the IMPaCT Back study, Health Foundation), where 90 GPs and physiotherapists used the screening tool to inform their referral decisions and treatment choices in 922 patients. This study again demonstrated significant improvement in patient outcomes and cost savings, alongside positive changes in practitioners' attitudes to and confidence in delivering back pain care. Our strategy in supporting implementation of our spinal pain research is clearly described in our impact statement.

Our current NIHR programme in **spinal pain** (**Hay**: 2009 – 2014) emphasises the close integration of our epidemiological prognosis work with intervention studies. It includes establishment of a new cohort (ATLAS) of 600 primary care back pain patients with leg pain / nerve root pain (sciatica), in which we have tested a new standardised clinical assessment and developed optimal management pathways which include clear criteria to identify different patient subgroups (overcoming the ambiguity of sciatic symptoms in the primary care clinical assessment of back pain patients) and support matched treatment pathways for each subgroup (including a fast track approach to secondary care). This programme of work has underpinned early career development for key staff (Konstantinou NIHR AHP Clinical Lectureship (2009 – 2013), HEFCE Senior Clinical Lectureship (2013 – 2018); Stynes NIHR PhD Fellowship (2012 – 2016)) and informed the design of a new pragmatic randomised controlled trial of 420 patients with sciatica, where distinct subgroups of patients will be identified based on prognostic and diagnostic information to receive stratified treatment that is matched to their subgroup (HTA shortlisted). Within the same NIHR programme in spinal pain, we are completing a cluster randomised trial (360 patients from 6 GP Practices), which tests the acceptability, feasibility and effectiveness of a new stepped vocational advice service in General Practice (SWAP), providing targeted individualised support to patients with Musculoskeletal pain who struggle to maintain work, with the aim of reducing sickness certification and work absence (Wynne-Jones, NIHR Post-doctoral Fellowship 2011 – 2016).

Our trials aim to identify the most promising treatments for **common musculoskeletal complaints** by investigating the effectiveness of common primary care interventions which have a poor evidence-base, and by developing and evaluating new models of care, including novel ways to support self-management to improve long term outcomes. TATE (**van der Windt**, NIHR RfPB 2009 – 2012, *BMJ*) assessed the clinical and cost effectiveness of a self-management package of treatment for tennis elbow that included TENS as an add-on to primary care management in 241 patients. The results show large improvements in pain and function in participants receiving good information and advice on exercise and pain medication. The additional use of TENS as a self management approach did not provide additional benefit. The WISE trial (**Chew-Graham**, *BMJ*) has tested multi-disciplinary approaches to self-care support for chronic disease that build on the existing skills of patients and professionals and include the different ways patients self-manage. SUPPORT (**Foster, Hay:** NIHR RfPB 2009 - 2013) is a factorial RCT evaluating physiotherapist-led individualised exercise and ultrasound guided subacromial injection for patients with subacromial impingement of the shoulder joint (recruitment completed, in follow-up); EaseBack (**Foster,** HTA pilot 2011 – 2014) investigates the acceptability of acupuncture for back pain in pregnant women; developed the new intervention and is testing the feasibility of conducting a trial in this group of patients. INSTINCTS (**Hay,** ARUK 2012 – 2016) compares the clinical and cost effectiveness of local steroid injection or night splinting for carpal tunnel syndrome.

Along-side these “condition-specific” trials, and as part of our broader strategy to improve access to and content of primary care, we collaborated with Bristol University in the MRC PhysioDirect trial (**Foster**, 2008 – 2011 *BMJ*). This compared usual face-to-face physiotherapy care with GP referral, to a telephone physiotherapy advice service in 2,256 consulters to General Practice. Whilst the trial demonstrated that PhysioDirect is no more cost-effective than usual care, its cost is within current “willingness to pay” thresholds and the trial showed that PhysioDirect is equally clinically effective and acceptable to patients, and that patients accessed physiotherapy treatment much more quickly, within 7 days compared to 34 days, when traditional referral routes were followed. STEMS (CSP £200,000) extends this approach to test the benefit of adding self-referral to physiotherapy to usual GP-led primary care for adults with musculoskeletal problems. Whilst physiotherapy referral is one way of promoting physical activity, we recognise that demand is likely to continue to outstrip supply and hence there is also a need to engage people directly in simple strategies which have been shown to be beneficial to health. We continue to develop new trials which test positive primary care approaches to increase physical activity for pain and co-morbid long term conditions (the “Walking Trial” (shortlisted by ARUK).

Led by **Foster** (NIHR Research Professor : 2012 – 2017) our next step is to develop and test a broader stratified care model by extending our successful back pain approach to include the five most common musculoskeletal problems in primary care - back, neck, shoulder, knee and widespread pain (NIHR Programme grant 2013 – 2018). In line with our concerns to ensure our research has rapid impact in improving the quality of musculoskeletal services and patient outcomes, we have developed a brief patient reported outcome measure (PROM) which can be

used to monitor the effect of musculoskeletal care on patient outcomes (**van der Windt**, RfPB 2010 – 2013) and now plan to investigate its extended use across general practice, physiotherapy, rheumatology and orthopaedic settings (ARUK 2013 – 2015). Future directions for our Musculoskeletal Pain Programme include extending our investigations across the whole life course, firstly with a Pain in Older People Programme, specifically aimed at untangling how physical and psychological factors influence and compound the impact of pain (**McBeth**). This programme investigates the pathways and processes by which biological, psychological and social factors mediate treatment outcomes in older people with chronic pain (MRC EME). At the other end of the spectrum, our Pain Across the Lifecourse Programme (**Dunn**; Wellcome Trust Career Development Fellowship) investigates the onset of pain problems and the role of family and social factors in the development of chronic pain, and has identified the extent to which early adolescence may be a crucial period with potentially modifiable risks for long-term trajectories of pain and disability.

Osteoarthritis (OA): taking joint pain in older age-groups and OA as our topic area, we investigate how best to identify and assess OA, to introduce early preventative approaches and optimise self-management and novel primary care treatments in order to improve long-term outcomes. Our 6-year follow-up of large population (26,625 patients) and clinical cohorts (2,002 patients) of older adults with knee, hand and foot OA (**Croft**: MRC Programme grant 2006 -2010; **Peat**: ARUK Programme grant 2008 – 2013) have demonstrated the long-term trajectory of OA pain in the community at the level of the person and by anatomical region, identified the key risk factors for onset, and defined clinically important phenotypes to classify sub-groups of OA at highest risk of poor outcome who may benefit from early or additional treatment (erosive OA; patella-femoral radiographic change). We have developed prognostic models to predict the clinical course and long-term impact of joint pain, OA and associated disability (regardless of pain site), to identify those at high risk who may be targeted for interventions, We have demonstrated that it is feasible to apply simple prognostic tools at the point-of-care (**Mallen**, ARUK Clinician Scientist), and that their systematic use improves accuracy of predicting patient outcomes (*JAMA Internal Medicine)*. A series of linked applied clinical studies have been completed. The SMOOTH trial (**Hay,** ARUK 2009 – 2011, *Annals of the Rheumatic Diseases*) a two-by-two factorial design in 257 patients with hand OA identified from a large population survey, evaluating hand exercise and joint protection, showed that a joint protection programme aimed to support self-care increases self-efficacy and improves self-reported benefit. Within our NIHR Programme (**Croft; Hay** Optimal management of OA, 2008 – 2014), we have developed and tested the feasibility of a model consultation for OA. MOSAICS is a cluster RCT (8 practices; 525 patients), which includes an OA patient guidebook (jointly developed by OA patients and health care professionals), a model GP consultation incorporating systematic recording of quality indicators for OA care, provision of an innovative practice nurse clinic for OA patients and a parallel in-depth study of the process of adoption and implementation (using Normalisation Process Theory). BEEP (650 patients) compares three different approaches to optimising long-term adherence to exercise in people with knee OA (usual physiotherapy care, an individualised tailored and supervised exercise programme and a targeted adherence and lifestyle intervention) has completed recruitment ahead of target and is in 3 year follow-up. POST, a cluster RCT of 1200 patients in 50 practices has also completed recruitment ahead of timescale and is now in 12 month follow-up. This trial investigates the effect of holistic assessment of OA, through screening for anxiety and depression in patients who consult their GP for joint pain, to improve outcomes in patients with OA plus comorbid mental health problems. We are developing more ambitious approaches to prioritising, managing and monitoring people with joint pain and OA who present with other co- morbidities in primary care. In our partnership with Birmingham and Warwick Universities (NIHR *Collaboration for Leadership in Applied Health Research and Care (*CLAHRC): 2014 – 2019), we will bring consideration of OA into the mainstream of primary care management of other long-term conditions. We will embed a quality indicators framework for GP to address management of key chronic diseases in a holistic way (rather than treating individual conditions without cross-reference to co-morbid conditions), develop broader GP and Practice Nurse assessments, which take account of the needs of patients with complex multi-morbid conditions and which inform care pathways to targeted interventions, supported by practice-nurse led teams, physiotherapy or specialist care. Alongside this holistic approach to management of individual patients with joint pain, multi-morbidity and disability, we have developed our definitions and phenotypes for OA and chronic pain to provide the basis for

public health needs assessments and intelligence **(Jordan)**, and for evaluation of the impact and usefulness of practical diagnostic and prognostic tools to support GP identification and decision-making in clinical practice. We will develop our partnership with Public Health England and ARUK (**Peat, Jordan**) to provide new intelligence on Musculoskeletal Health, based on large UK datasets plus linkage of our long-term clinical cohorts to validated medical records to provide information on long-term trajectories and outcomes from consultation, in order to monitor this condition over time and to initiate anticipatory and preventative care in general practice. We intend to apply these case-finding and treatment methods in a future cohort multiple RCT design, where all symptomatic OA cases will be identified, best practice for OA and joint pain care will be implemented, its cumulative effect measured, and high priority groups will be targeted to test for novel interventions.
Inflammatory Arthritis: Renewal of our ARUK Primary Care Centre-of-Excellence and our collaboration in the NIHR School of Primary Care Research underpin development of this new programme (**Mallen**, ARUK Clinician Scientist; 3 NSPCR Postdoctoral Fellowships). Responding to needs identified by our multidisciplinary Clinical Advisory Group and our research user group, our initial focus is on gout: the most prevalent inflammatory disease managed in primary care but where management continues to be sub-optimal, and polymyalgia rheumatica (PMR): under-researched in primary care, but where early diagnosis and optimal early treatment are important predictors of long term outcome. Our mixed method epidemiological and qualitative research aims to explain and understand variations in prescribing and patients' use of urate-lowering therapies for gout to identify short and long term outcomes important to patients, and to prioritise future intervention studies. In PMR, we are undertaking the first primary care inception cohort to describe its clinical presentation and management, course, severity and predictors of outcome. In both these conditions we use large general practice data bases to investigate the hitherto under-recognised consequences of common inflammatory musculoskeletal disorders and have published new findings indicating links with vascular disease for gout and with cancer for PMR. CONTACT aims to identify the most effective primary care treatment for acute attacks of gout by comparing two commonly used medicines (low-dose colchicine and naproxen) which have hitherto not been evaluated head to head (NIHR SPCR). In collaboration with clinical scientists in Birmingham (Buckley, Raza) we are extending our inflammatory programme to investigate opportunities for how primary care can make a real difference to the management of rheumatoid arthritis, where there is compelling evidence that early detection and treatment improves patients' outcomes. We will investigate whether using novel near-patient testing can identify the presence of very early inflammatory arthritis at a stage where appropriate intervention affords the real possibility of cure.
Overview: Our research plan described in RAE 2008 has been funded through a broad range of large programme, project and fellowship grants and its research output submitted in this REF. Our strategic plan for the next five years is in place, supported by new programme grants. Linked fellowship and project applications support capacity development among our early career PIs.

c. People, including:

i Staffing strategy and staff development: The research group has grown by 34% since RAE2008 and includes 162 FTE staff. The Centre's Director (**Hay**, NIHR Senior Investigator) is supported by a senior Executive Team: Hughes (infrastructure, NHS research strategy and partnerships) and the five Research Programme Leads: **van der Windt** (Epidemiology and Prognosis of Musculoskeletal Pain); **Foster** (Musculoskeletal Pain Trials); **Mallen** (Inflammatory Arthritis and Applied OA), **Peat** (OA Epidemiology) and **Chew Graham** (Mental Health & Long Term Conditions). The Executive team set the research strategy, review long-term sustainability, skill-mix and individual career trajectories, and prioritise grant applications. Regular research "Think Tanks", which include research staff from all levels, review and shape the future direction of our research programmes, and prioritise and target new grant proposals. A broader Research Strategy Board ensures coordination of strategy and operational delivery. All staff are mapped to core research themes (Musculoskeletal Pain, OA and Long Term Conditions, Prognosis) and specific programmes. Line management arrangements reflect disciplinary and research topic needs. Joint appraisal of clinical academic staff ensures NHS recognition and support of clinicians' academic career development and a balanced clinical and academic work-plan. Individualised career plans are reviewed through the annual appraisal process, which addresses training and other personal development needs, publication plans, grant application plans, conference presentations, and promotion plans. Line management and appraisal arrangements are supplemented by an active programme of exchange visits with international collaborators, personal

mentorship (linking with national and international leaders in our field), coaching and leadership training opportunities (provided through external consultants and the NIHR Ashridge programmes). A lively programme of external and internal seminars and a series of journal clubs and specialist meetings provide peer-development in the range of topic areas and methodologies important to the Centre's research. All staff are supported to participate fully in academic "civic" duties, including peer and grant review activities, research dissemination, conference presentations and participation on editorial boards and in relevant professional bodies. We take our responsibilities to support multi-disciplinary research capacity development of early career staff particularly seriously. Research training opportunities are embedded within our programmes. We have a ring-fenced bridging fund which is used to underpin contract continuity, enabling a longer term approach to plan the development and career progression of our key junior and early-career academic staff, and securing protected time for them to write high quality grant applications. As a result, 28 staff have held externally funded fellowships within the assessment period (22 postdoctoral fellowships or lectureships, 6 senior fellowships). Our NIHR accredited CTU also provides structured training and support for early career staff to be trained as PIs and MPhil / PhD supervisors.
Staff promotions demonstrate our success in supporting career progression among our Early Career Researchers. 4 have been promoted from post doc to Professor (two of whom hold prestigious senior fellowships from ARUK and NIHR); 4 have been promoted from doctoral students to Reader, (with one holding a Wellcome Trust Career Development Fellowship); 7 have been promoted from doctoral students to Senior Lecturer and 3 from doctoral positions to lecturer (all of whom also hold RCUK, ARUK or NIHR Fellowships). Our Athena Swan Silver award (2013), supported by the University's Vitae award of HR Excellence in the Research and Keele's Equality and Diversity Committee, reflects our performance in providing flexible, family friendly working arrangements on an equitable basis across all types and levels of staff (e.g. part-time working and job-share arrangements, working at home, flexible hours, particularly for those returning from maternity / paternity leave, those with carer responsibilities, and staff with culturally specific needs).
ii Research students: 36.1 FTEs (53 students) are currently undertaking PhDs within our Centre. For this Unit, 12 students completed their PhDs (26 PhD completions supported by the ARUK Primary Care Research Centre overall). 92% of our students completed their PhDs within RCUK targets. Keele offers a competitive PhD Bursary scheme (ACORN), attracting the brightest young graduates, which has supported significant growth in our PhD cohort. Doctoral projects are integrated into our research programmes, are targeted to cover the range of relevant disciplines, and in the case of academic clinicians (Medicine and AHP), are designed to be complementary to clinical training pathways. We have hosted 7 NIHR Clinical Academic Training Fellowships in General Practice, 3 in Rheumatology and 4 in Nursing and AHP. We consistently support our best students to compete successfully for NIHR (12 PhD fellowships) and ARUK (3 PhD Fellowships) doctoral training awards. **Mallen** is the training and capacity- building lead for the NIHR SPCR. We offer an intensive research methods module and mentorship scheme for undergraduate medical students. 7 students have undertaken MPhil intercalation within our Centre. Doctoral students are required to complete 60 masters credits, carefully tailored to individual circumstances and needs. We provide every graduate student with a research fund of up to £3000 to support their training needs and participation at conferences. We emphasise development of transferable skills and provide tailored training programmes, including individualised coaching, time and project management, one to one language and communication skills training, intensive supervisory sessions, and enhanced writing skills training. Of the 26 doctoral completions supported by the ARUK Centre since 2008, 23 have achieved post-doctoral academic appointments.

d. Income, infrastructure and facilities: New research grants awarded in the REF period amount to £27,489,000. Research income has increased by 87%, and the research group has grown by 81%. The quality of our research and its importance and relevance to health providers in filling the second gap in translation is reflected in the range of research funders who support our work, (NIHR, ARUK, MRC, Wellcome Trust) and the impact of our research dissemination. An active research user group (RUG) with over 50 members of the public and supported by two staff who are themselves users of musculoskeletal health care services, ensures that our research is shaped by patient priorities. RUG members support all aspects of the design, delivery, interpretation and dissemination of our work. A dedicated team leads our strategy to support dissemination and implementation of our research, and output from this work is reflected in our Impact case-studies. Our Intellectual Property Rights (IPR) Policy (developed with the support of the University

Research and Enterprise Service), secures free and open access to our research IP, to promote its rapid dissemination by health providers nationally and internationally. Our research and infrastructure staff are co-located within purpose built offices at the gateway to the Keele Campus (the result of significant investment from the Wellcome, Dinwoodie and Dunhill Trusts). Our NIHR-registered CTU provides high quality methodological support to our study designs and this is aligned to strong clinical academic leadership, innovative trials methodologies and dedicated IT support, which underpins successful delivery of our studies. Alongside our CTU, a strong NHS infrastructure supports clinical and patient participation in our research, through a joint research strategy with our Commissioning groups and NHS partners (the Research Consortium), our leadership of the Comprehensive Research Network (**Hay**) and the Primary Care Research Network (Hughes, Porcheret). 83% of the General Practices in our region are research active and accredited as "Research Ready" by the Royal College of GPs (n = 231) and Keele research makes a significant contribution (80%) to overall recruitment in PCRN (n = 64,000 since 2008). We have developed innovative techniques to support patient recruitment to research, including automated recruitment and data collection systems at the point-of-care. We have undertaken secondments to the NIHR (Hughes) to support set-up of the Clinical Research Networks and national development of streamlined approaches to research governance such as the Research Passport scheme.

e. Collaboration and contribution to the discipline or research base: A recent independent bibliometric analysis (Centre for Science and Technology Studies, Leiden University) showed that 36% of our publications are in the top 20% of most highly cited papers in the world. 44% of our output produced between 2008 and 2011 include international collaborators and achieve a mean normalised citation score of 2.1 placing us well ahead of the world average. We attract world-leading collaborations which are strengthened by visiting professorships. In our OA programme, collaborators from Sweden (Petersen: Lund University), Australia (Blyth: University of Sydney; Menz: LaTrobe University), are appointed as Visiting Professors and support development of consensus definitions for a range of musculoskeletal disorders, and international comparisons of the course, impact and prognosis of these conditions using electronic health records. They provide crucial expertise in musculoskeletal epidemiology, public health epidemiology and multi-morbidity, facilitate mutual use of data resources, and provide training opportunities for junior staff. **Croft, Peat, Dunn, Van der Windt, Jordan** participate in PROGRESS an MRC funded partnership grant on prognosis and stratified care research, led by UCL (Hemingway, Hingorani, Timmis) with Oxford (Altman), Birmingham (Riley), London School of Hygiene and Tropical Medicine (Roberts, Perel). The PROGRESS Partnership published a series of papers in BMJ and PLOS Medicine in 2013 describing the concepts, methods and recommendations to enhance the translational impact of prognosis research across medical conditions. Close collaborations with the University of Washington (Von Korff & Cherkin), University of Southern Denmark (Albert, Mørso), and University of Oslo (Grotle, visiting professor) has enabled research into the international generalizability and implementation of the STarTBack screening tool in Europe and the US. We collaborate with the other leading UK departments of Primary Care, including Bristol (MRC PhysioDirect), Oxford (CONTACT), Birmingham (West Midlands CLAHRC), Manchester (Mental Health) on novel primary care intervention studies. We hold multiple leadership roles with key funders in our field (NIHR Senior Investigators: **Croft, Hay**; NIHR HTA, Programmes and Research for Patient Benefit committee members: **Hay, Croft, Foster,** Thomas, **Jordan,** Roddy**, Chew-Graham**); ARUK Clinical Studies Groups: Chair (**Hay**) and members (**Foster, Peat**) , ARUK Clinical Studies Committees, Fellowship Committee members: (**van der Windt, Mallen,**), NIHR School for Primary Care Research Board members (**Hay, Mallen**); and with key professional and editorial bodies (**Chew-Graham, Croft, Mallen**: Royal College of General Practitioners; **Chew-Graham**: National Collaborating Centre, Mental Health; **Hay**: British Society for Rheumatology; **van der Windt**: Cochrane Diagnostic Test Accuracy Reviews; **Croft**: International Association for the Study of Pain; **Foster, Peat**: Chartered Society of Physiotherapists; **Mallen**: Society for Academic Primary Care). All our senior academics routinely undertake PhD examining, peer-reviewing and commissioned editorials for the major medical and specialist journals in our fields, provide plenary invited lectures at major international conferences, and Chair Trial Steering Committees for national studies. **Chew-Graham, Croft, Mallen, Peat, Foster** have acted as expert members or reviewers in UK (NICE) European (EULAR) and Worldwide (OARSI) guideline groups on the management of OA, back pain, gout, polymyalgia rheumatica, depression and anxiety.