**Research priorities to reduce the impact of Musculoskeletal Disorders: a priority setting exercise using the CHRNI method**

Short title:

**Research priorities to reduce the impact of MSK Disorders**

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**Abstract**

Involving research users in setting priorities for research is essential to ensure research outcomes are patient-centred and to maximise research value and impact. The Musculoskeletal (MSK) Disorders Research Advisory Group Versus Arthritis led a research priority setting exercise across MSK disorders. The Child Health and Nutrition Research Initiative (CHRNI) method of setting research priorities with a range of stakeholders was utilised, involving four stages and two surveys, to: 1) gather research uncertainties; 2) consolidate these; 3) score uncertainties against importance and impact; and 4) analyse scoring, for prioritisation. 213 and 285 people responded to the first and second surveys respectively, representing clinicians, researchers and people with MSK disorders.Key priorities included developing and testing new treatments, better treatment targeting , early diagnosis, prevention and better understanding and management of pain, with an emphasis on understanding underpinning mechanisms. We present a call to action to researchers and funders to target these priorities.

**Introduction**

Rheumatic Musculoskeletal Diseases (RMD) include two broad areas: inflammatory RMDs (inflammatory arthritides, autoimmune and multisystem diseases) and other musculoskeletal (MSK) disorders. These other MSK disorders include a range of short-lived and long-term conditions that affect the MSK system, including many highly prevalent disorders such as osteoarthritis, osteoporosis and back pain.1,2 These disorders are characterised by pain and impaired physical function, often increasing the risk of immobility, obesity, other comorbidities including chronic physical and mental health conditions, some vascular conditions and all-cause mortality.3,4 MSK disorders affect an estimated 20 million people across the UK, with one in five people consulting primary care about them annually.5,6 MSK disorders account for more than 22% of the total burden of ill health in the UK and the third largest area of NHS programme spending (£4.7 billion), with substantial costs including total joint replacement and other forms of orthopaedic surgery.5 Furthermore, the societal impact is great. MSK disorders are the leading cause of work disability, sickness absence from work and ‘presenteeism’, resulting in lost productivity as high as 2% of gross domestic product.7 As the incidence of many non-inflammatory MSK disorders increases with age, and developed world population profiles are becoming older, the prevalence of these disorders is set to increase. In recognition of its impact and unmet need, several MSK disorders including osteoarthritis and back pain have been designated as serious diseases by the FDA.8 Recognising the public health importance of MSK health across the lifecourse, a new multi-sector 5-year prevention framework was launched in England in 2019.9

Research into MSK disorders has been demonstrated to produce a 25% economic return on investment; considerably greater than the rate of return for cancer research (10%) and the UK government minimum threshold for investment (3.5%).5,10 Yet, although MSK conditions account for 11.5% of Disability Adjusted Life Years in the UK in 2017 they received only 4.5% of research funding in 2014.5

In 2019, Versus Arthritis, the largest UK MSK charity, convened a MSK Disorders Research Advisory Group (RAG) with the long-term aim of improving quality and impact of MSK disorders research [<https://www.versusarthritis.org/research/information-for-researchers/our-approach-to-research/research-advisory-groups/musculoskeletal-disorders/>]. This group considered the current state of knowledge and research into MSK disorders and the current evidence for how research activity in this area might be prioritised by governments and funding agencies. Although over 20 ‘research priority’ publications in MSK disorders were identified by the group, these either focused on individual MSK disorders,11-24 causes,25-26 or treatments.13,15,24,27,28 Only one publication addressed a wide range of MSK disorder research priorities, but this was not derived using formal prioritisation methods.29 Some priorities were informed by either the views of experts or patients alone.20-22,25 Involving all relevant research users in priority setting, including people with lived experience, is essential to ensure research outcomes are patient-centred, relevant, and have a high likelihood of resulting in patient benefit, and to increase research value and impact, and reduce research waste.30 A scoping review of priority setting exercises in rheumatic disorders identified that the majority of published priorities focused on treatments, rather than economic impact, implementation or early discovery science.31 Limitations identified by this review included lack of robust methods, research questions which were not answerable and lack of implementation strategy.31 In summary, a large number of research priorities have been identified, but none which comprehensively address the full range of MSK disorders, across all stages of research and involving all stakeholders. To address this gap, the MSK Disorders Research Advisory Group Versus Arthritis aimed to conduct a formal research prioritisation setting exercise across MSK disorders.

**Methods**

*Project oversight, aims and scope*

The MSK Disorders RAG Versus Arthritis (henceforth referred to as ‘the group’) designed, led and contributed to this research; the group has 26 members including public contributors with lived experience of a range of MSK disorders, researchers and healthcare professionals. The group and its membership is facilitated by the charity. Among clinician and researcher members, there is wide representation of clinical specialties (general practitioners, orthopaedic surgeons, physiotherapists, rheumatologists), of subspeciality interest and research disciplines (clinical and applied health services researchers, discovery scientists, epidemiologists). The group is committed to diversity, with representation of varying gender, ethnicity, age, geographical location, stage of career. The group determined the purpose and remit of the priority setting exercise, including definition of the population, audience and timeline of interest, as outlined in Table 1. The long-term goal of the research prioritisation exercise was to improve the quality and impact of research which seeks to develop our understanding and management of MSK disorders.

*Overview of methods*

The group considered and compared a range of prioritisation methods and selected the Child Health and Nutrition Research Initiative (CHNRI) method of priority setting as it enabled a range of stakeholder perspectives to be incorporated, could consider discovery science, clinical and applied health services research questions together and would incorporate objective scoring to enable ranking.32,33 In addition to the first step to determine scope and purpose, the CHNRI method involves four main stages, to: 1) gather research uncertainties; 2) consolidate uncertainties; 3) score uncertainties using agreed criteria; and 4) analyse scoring, for prioritisation (Figure 1). The detailed methods including design and distribution of two surveys (for stages 1 and 3), agreed scoring criteria, method of analysis and ranking were all predefined by the group in advance in a published protocol.34 In a modification to the original described CHNRI method, we involved all stakeholders including public contributors at every stage, as has been done by others.35,36 The CHNRI uses specific terms to describe suggested areas of research, which we adopted (Figure 1). Briefly, Research Domains are defined as broad areas of research, while Research Avenues are more specific areas within a Research Domain which might align to research funder calls and could include a number of more specific research questions. In the CHNRI process, Research Avenues are identified, scored and prioritised. Research Domains were identified a priori (Table 1) based on agreed importance, potential impact and/or research unmet need.34 These were: Diagnosis and Impact; Living Well with MSK disorders; Mechanisms of Disease; Successful Translation. The group appointed a lead with relevant experience for four sub-groups representing each Research Domain; a public contributor was appointed to lead the Living Well sub-group (Diagnosis – EC; Living Well – CW; Mechanisms – CLM; Translation – DM; full subgroup membership detailed in Contributor’s statement). The detail of the four stages is presented below, and in further detail in the published protocol.34 Ethical approval for the research prioritisation exercise was given by a University Research Ethics Committee (Medical Sciences Division, University of Oxford, R71769/RE001).

*Stage 1. Gathering research uncertainties (e-survey 1)*

An electronic survey (e-survey 1) was developed, asking for important uncertainties or unanswered questions (hereafter referred to as uncertainties) which could be answered by research, to be distributed to our audience (as defined in Table 1). Participants gave electronic consent to participate following information provision about the exercise. E-survey 1 asked for important uncertainties within each of the four Research Domains, but participants also could enter uncertainties in an uncategorised section of the e-survey (see Web Appendix, pg 2). E-survey 1 also included questions on which Domain was perceived as most important, perceived barriers to research (to be reported separately), demographics, and where relevant, employer, research experience and research interests. E-survey 1 was distributed, aiming to reach different stakeholders in each of these predefined audience groups (Table 1), via: Versus Arthritis existing mailing lists and newsletters for researchers, health professionals and lay volunteer research partners; via web pages and social media (Versus Arthritis, other charities and organisations, patient groups); and professional networks identified and accessed by the group (see Web Appendix, pg 12 for a full list). Group members were able to complete e-survey 1, which remained open for a 6-week period in 2020/2021.

*Stage 2: Consolidating uncertainties and generating Research Avenues*

The process of consolidating the uncertainties into Avenues is detailed in Figure 1. First, the uncertainties from e-survey 1 were separated from the responder characteristics by CF. The anonymised uncertainties then underwent data cleaning (by FM) to i) separate text entries containing multiple entries to individual numbered uncertainties, ii) remove out-of-scope uncertainties (e.g. outside of our population of interest defined in Table 1), iii) allocate uncategorised uncertainties entered in the survey’s ‘other’ section to a Research Domain, iv) re-classify uncertainties to different Domains, where considered appropriate. Next, the uncertainties within each Domain were coded and grouped into themes using descriptive thematic analysis by FM. This was achieved by familiarisation with the data, coding the whole data set, looking for themes across the coded data, in an iterative process with discussion between FM, FW and ZP.34 FM produced a draft list of themes for each Research Domain. Each Domain sub-group held 1-2 meetings in which the draft list of themes was discussed and refined, with reference to the source data (e-survey 1 uncertainties). In these meetings, the Domain sub-groups reviewed, edited and agreed themes and subsequently drafted potential Research Avenues corresponding to each theme. The Research Avenues were drafted to start with a verb e.g., evaluate, determine, investigate.

A one-day workshop of the group was convened to review the themes including any duplication, consider the appropriateness of the Research Domains derived a priori, and to refine the Research Avenue wording. In refining the wording, attention was paid to consistency between the Domains and balance between Research Avenues to ensure they were not too broad or specific and used similar (lay) terminology. Finally, the Research Avenues underwent further review by an additional group of lay volunteer research partners, involved in Versus Arthritis but independent of this group, which resulted in further edits to improve readability. These were presented to and agreed with the group by email.

*Stage 3: Scoring the Research Avenues (e-survey 2)*

The consolidated Research Avenues were scored using a second e-survey (e-survey 2). The original CHNRI method suggested that each Research Avenue should be scored against five criteria.35 Subsequently, researchers have adapted the number of criteria (more and less than five), and also introduced their own criteria.38 The group reviewed a range of criteria previously associated with the CHNRI method35,38 and initially identified importance, impact and feasibility as the most important criteria; equity was considered a cross-cutting criterion that should be reflected throughout the process and criteria, but not specifically scored. Following feedback from public contributors, two criteria, importance and impact, were felt sufficient, minimised the length and burden of e-Survey 2 and maximised its accessibility to intended stakeholders.34

In the survey, which was co-designed by the group and pilot tested by public contributors, the list of Research Avenues was presented with two questions representing the Importance and Impact scoring criteria respectively: ‘Will this research lead to important new knowledge?’ and ‘Will this research make a difference and lead to impact?’. Respondents were asked to score to what extent each Research Avenue met these criteria, using a numeric rating scale, where 1 equated to ‘not likely’ and 10 equated to ‘extremely likely’. An ‘I am unsure’ option was also available. Answers could also be missed and there was an option to save and return. It was made clear that each respondent should answer based on their own knowledge and perspective. Optional additional questions on age, sex and ethnicity, employment and interests, similar to e-survey 1, were included at the end of the survey. For the full survey text see Web Appendix, pg 5. Each respondent received the questions in a random order, meaning that partial completion of the e-survey would not result in some questions having many more responses than others, preventing bias in scoring.

E-survey 2 was distributed to participants from the first survey who gave their consent to further email contact as well as being advertised more broadly, through similar channels to the first survey (Web Appendix, pg 12). Group members were excluded from participating in the e-survey 2. E-survey 2 was open for 7 weeks in 2021.

*Stage 4: Analysis for prioritisation*

Before any analysis, scores were separated from responder characteristics. The group supported equal weighting of the two criteria and presenting a single ranked ordering of the Avenues, irrespective of Research Domain. The CHNRI method suggests summing mean scores for each criterion in order to calculate scores for ranking. Normality testing was conducted by CLM who was provided with the data with anonymised identifiers rather than Avenue labels to carry this out in a blinded manner and avoid bias. This normality testing (Skewness, Kurtosis, Royston chi-sq, Shapiro-Wilk W and Shapiro-Francia W’)(Stats Direct version 3.3.5) of the raw score data, demonstrated that the majority of criterion score responses did not follow a normal distribution. Therefore, the analysis plan was amended to calculate the median rather than the mean of the criterion scores, range and interquartile range were adopted as measures of dispersion, and box and whisker plots were utilised to demonstrate data dispersion.

For each Research Avenue, a ‘median criterion score’ was calculated for each of the two criteria, and then the two median criterion scores summed to create a ‘total score’,

i.e. for each Research Avenue:

*Median Important Knowledge score = Median of all importance scores for that criterion*

*Median Impact score = Median of all impact scores for that criterion*

*Total score = Median Important Knowledge score (K) + Median Impact score (I)*

The total score was then used to present the Research Avenues in rank order from highest to lowest. Median scores for each Avenue were calculated for responder groups, to aid interpretation, but not for ranking. All available data was analysed, from all respondents completing the survey in full or in part. ‘Unsure’ or missing responses were not allocated a score and not included in the data from which the median was derived. Descriptive statistics were used to summarise the demographic data of participants, the response rates for each criterion and Research Avenues. To indicate dispersion of scores within the same rank, box and whisker plots were utilised with research avenues within rank ordered alphabetically.

**Results**

*Stage 1. Gathering research uncertainties (e-survey 1)*

The first survey was live from 5 November 2020 to 17 January 2021 with a total of 213 respondents taking part. The demographics of the respondents are shown in Table 2. People with an MSK disorder were the highest responders, accounting for 75 respondents (35·0%). Clinical researchers, healthcare professionals and non-clinical researchers formed most of the remaining responses (n = 47 (22·1%), 41 (19·2%) and 32(15·0%) respectively).

The majority of participants entered uncertainties under each of the four Domains (Diagnosis - 192 (90·1%); Living well - 200 (93·9%); Mechanisms – 203 (95·3%); Translation - 184 (86·4%); additionally, 70 (32·9%) entered uncertainties in the ‘other’ uncategorised section.

Preference for Research Domain was ranked by 86·4% (184) of respondents. Understanding the causes and development of MSK disorders (‘Mechanisms’) was ranked as the most important overall (57, 30·8%). The other three categories had similar proportions of responders scoring as most important: Diagnosis 42 (22·7%); Living well: 42 (22·7%); Translation: 43 (23·2%).

*Stage 2: Consolidating uncertainties and generating Research Avenues*

Following separation of discrete research uncertainties and reclassifying ‘other’ into one of the four Domains, a total of 1300 uncertainties (Diagnosis = 335; Living Well = 300; Mechanisms = 411; and Translation = 244) were submitted by the 213 respondents (mean 6.4 per respondent). Respondents entered 0-18 uncertainties per Domain (mean per Domain: Diagnosis = 1.7; Living Well = 1.5; Mechanisms = 2.0; Translation = 1.3). A total of 151 uncertainties were considered out-of-scope for the exercise, not answerable by research or highlighting barriers to research (to be reported separately). The final number of research uncertainties was therefore 1149 (Figure 2). At researcher review, 222 uncertainties were moved between Domains, leading to: Diagnosis n = 301; Living well n= 407; Mechanisms n = 301; and Translation n = 140.

Initial review consolidated these uncertainties into 108 draft themes (Figure 2) which were further refined to 64 themes after sub-group review (Web Appendix pg 13,17). It was noted that themes relating to personalised or stratified care, prognosis, prevention, healthcare professional education, genetic influences and delivering standardised care appeared in more than one Domain. However, although the themes were duplicated, the focus of the uncertainties was different in each Domain.

During the sub-group meetings and whole group workshop it became clear that the majority of uncertainties and themes related to over-arching issues that were relevant to many, if not all MSK disorders. A decision was made to phrase all Research Avenues without reference to specific MSK disorders to be as generalisable and inclusive as possible. Further consolidation of similar questions and separation of questions where they occurred in different Domains was performed, leading to a final list of 68 Research Avenues. Of these, 19 were in Diagnosis, 20 in Living Well, 19 in Mechanisms, and 10 in Translation (Figure 2)

*Stage 3: Scoring the Research Avenues (e-survey 2)*

The second survey was live from 16 August 2021 to 3rd October 2021. One hundred and fourteen respondents from e-survey 1 who opted to receive further contact about a second survey were invited to participate. A total of 285 people answered questions in e-survey 2 (Table 2). A further 197 people gave consent to take part but did not contribute any survey data.

Of those who contributed data, 189 (66·3%) completed in full and a further 96 people (33·7%) partially completed the survey (i.e. more than 1 question completed, mean 36 responses, range 28-42).

The largest group of respondents represented patients and carers (74, 39·2%), followed by researchers (58, 30·7%) and healthcare professionals (43, 22·8%). The respondents were from a range of age groups and represented both sexes, although more women than men completed the survey (Table 2). Information on ethnicity was not provided by a proportion of respondents (25, 13·2%). Where this information was provided, 152 (92·7%) were of white ethnicity. Where respondents were researchers, a wide range of stages of research was represented (Web Appendix pg 20). There was only 1 responder (0·5%) who reported representing industry such as pharma or medical technology companies.

The responses for partial respondents were approximately evenly distributed across the questions; the mean number of responses per criterion question were 215, 210, 217 and 207 for Diagnosis & Impact, Living Well, Mechanisms, and Translation respectively. The minimum number of responses for a criterion question was 200 and the maximum number 227. Considering the completeness of data, of 30964 answered questions, there were 1296 (4·2%) unsure responses and 670 (2·2%) skipped responses (Web Appendix, pg 21).

*Stage 4: analysis for prioritisation*

A ranked list was produced from the complete responders plus any partial responders for each Avenue, based on the total scores for each Research Avenue (Table 3). Considering a maximum possible score of 20 (10+10), and minimum score 2 (1+1), the highest-ranking Research Avenue was “Develop and test new treatments to prevent or reduce progression of MSK disorders” with a score of 18. The second ranking Avenue with a score of 16.5 was “Identify the best ways to manage pain and/or improve quality of life”. The next 23 Research Avenues all tied in third ranking with a score of 16 and covered a range of areas. There were a total of 8 different rankings, with scores ranging between 12 and 18. The minimum score was equivalent to a median score of 6/10 for each criterion, meaning that all Research Avenues had moderate to high scores. The median and distributions of each of the criterion scores for each research avenue are shown in Web Appendix, pg 36 8A-C.

The top 3 rankings (scores 16 and above) comprised of 25 Research Avenues which included a mixture of all four research Domains, with a preponderance of questions from Mechanisms (12) and from Living Well (8). Furthermore, no research avenues from Mechanisms were included within ranks 6-8. When examining the median scores by responder characteristics, there was little difference between lay, clinical and researcher responders for the top-ranking Research Avenues (Web Appendix, pg 21). However, differences between researcher and lay respondents’ median scores were larger (3 or 4 points) in Avenues concerning research in overcoming barriers to implementation of, or access to care, which researchers tended to score as less important.

**Discussion**

If research is to address and resolve important questions and lead to impact, the identification and development of research questions must involve those people affected by the research.29 This exercise set out to include all relevant stakeholders in a valid, equitable, transparent and pre-defined process to define, score and then rank research priorities across all stages of research in a wide range of pre-defined MSK disorders.

The process identified the top priority as developing new treatments that prevent or reduce progression of these diseases. This is important as in contrast to this, much recent research and clinical management focus has been on optimising existing treatments, self-management or strategies managing symptoms. The association of common MSK disorders with ageing contributes to the normalisation, tolerance and de-prioritisation of these disorders among individuals,37,38 and it is likely these views permeate across government, healthcare systems and society leading to an ‘acceptance’ of their occurrence, the associated pain, loss of function and relative paucity of treatment options. The top ranking of this research avenue sends a clear message that our respondents felt efforts must be increased to identify novel approaches to treat underlying disease process and to reject this ‘status quo’.

We also identified key themes relating to: better understanding and management of pain; improving disease prevention, accurate diagnosis and prediction; understanding how to better implement, personalise, target, combine and monitor treatments;, with a key emphasis on understanding the underpinning mechanisms. MSK pain, and stratified medicine have also been highlighted as important by Versus Arthritis insight gathering and recent UK Research Council funding calls, respectively.39 Despite the relative paucity of discovery science questions in previous priority setting exercises,31 and the assumption that lay responders are less likely to prioritise discovery science questions which may be further from patient benefit than applied research,40 research about disease mechanisms was rated as the most important Domain in e-survey 1, and mechanistic Research Avenues dominate the top 3 ranks. Of note, we also included priorities relating to health services, implementation and economic factors with overcoming barriers to implementation of evidence-based treatments ranking highly (rank 3); these areas have been noted to be lacking in previous MSK priority setting exercises although the need for implementation studies is increasingly recognised.31,41 We identified that in general, lay responders rated Avenues higher than researchers. However, researchers tended to particularly rate other Avenues concerning overcoming barriers to implementation of, or access to care of lower importance than lay responders. The reasons for this are unclear but it is possible that academic responders are less aware of, or do not value health services and implementation research.42

We would not encourage comparison of the ‘performance’ of the Research Domains as there was significant overlap between them and we adopted a flexible approach to moving uncertainties between Domains. As an example, the top-ranking Research Avenue relating to developing and testing new treatments was identified within Mechanisms but highly relevant to Translation.

This is the first exercise of its kind to identify and rank priorities for research across MSK disorders, from discovery science to applied clinical and health research, including translation. Further strengths of this process were that it was robust, transparent, disease and research stage agnostic and included a wide range of stakeholders at all stages. The whole process was overseen by an expert steering group with a final ranking process which was independent to them. Public contributors played a vital role throughout, particularly to optimise accessibility and minimise the length of the second survey.

There are some limitations to this exercise. First, we chose not to produce a top ten or top twenty priorities which might be more easily disseminated; we chose not to select a threshold above which to highlight top scores, as all 68 of the Research Avenues received high to moderate scores. This is perhaps not surprising, as those with the lowest ranking were still derived from themes arising from multiple respondents’ priorities in e-survey 1. The separation between the highest and lowest score was relatively modest (a difference of 6 points out of a possible 18, (i.e. maximum possible total score 20 minus minimum possible total score 2). The seemingly large number of possible Research Avenues appears justifiable, given the wide range of disorders and research stages and high prevalence of unmet need. Arguably, our pre-defined Research Domains may not represent the full remit of MSK research and could have biased responses to e-survey 1; however, we felt that these Domains adequately covered the breadth of all uncertainties elicited and areas submitted under other could be assigned to these four domains. Although this priority setting exercise has addressed a number of limitations identified in a previous scoping review of priority setting of research topics for MSK conditions31 economic evaluation was perhaps underrepresented and this may need to be considered as Research Avenues are further refined. Due to the pandemic, the entire exercise was carried out electronically and it was not feasible at the time to collect data by other means, e.g. in person, by paper-based questionnaire, meaning that some people may have been excluded from taking part. Although we reached a good balance in terms of accessing our target groups, and a majority of lay respondents, there appeared to be a bias towards females, white respondents, and those living in England (as opposed to the devolved nations of the UK) and with a paucity of respondents from industry or pharma, or representing carers, suggesting the processes put in place for advertising did not sufficiently reach these groups. In addition, the lack of demographic data (none from partial responders) limits our ability to make conclusions about the generalisability of the sample. Finally, we made some important intentional departures from the CHNRI method. These included using only using two criteria with which to score, to minimise burden of the survey and ensure all criteria were understandable to all stakeholders. In addition, our scoring methods needed to be refined following the publication of the protocol, to use median criterion scores rather than mean scores. This was the first instance that we could find within a CHNRI-type process where the distribution of data and appropriateness of use of a mean as a component of a summary score had been scrutinised, demonstrating the use of means were not appropriate for this data. Mean values are included within the box and whisker plots demonstrating that on a number of occasions the mean score which is affected by skewness of data would have influenced rank. The distribution of the data might have been influenced by our decision to use a numeric rating scale rather than yes/no responses; nonetheless, our experience suggests other researchers using the CHNRI method need to consider data distribution in their plans for analysis. Furthermore, as rating scales were ordinal, parametric analysis is not appropriate.

This prioritisation exercise provides a source of information and evidence, but should also be a call to action: for funders of research to support research priorities in MSK disorders research, for researchers and healthcare professionals to consider stakeholder views on what might be important and impactful. As these avenues or areas are developed into specific research questions or projects, it is vital that stakeholders including public contributors are involved at all stages in this process, and that these priorities are reviewed to identify the extent to which they have informed subsequent relevant funding calls.31 There is also a need to address the many barriers and challenges to successful research in this area. There is undoubtedly some overlap between barriers and some of the priorities in the Translation Domain; regulatory or policy changes may be needed to address these.41

In summary, we have presented the prioritisation process and associated scores and rankings of 68 identified Research Avenues in ranked order of their combined likelihood of leading to important new knowledge and impact. These research uncertainties and their rankings were generated by a mixed stakeholder user group, including public contributors, health practitioners and researchers. Further work is now needed to translate these priorities into researchable questions for calls by funders, in the UK and elsewhere. We will seek to disseminate and develop these priorities and audit their uptake. Specifically, the MSK RAG and Versus Arthritis are committed to further develop the top priorities, with funders and stakeholders, into more specific questions within avenues, and/or translation of the avenues into PICO (population, intervention, comparison, outcome) questions where this is possible. In the meantime, we hope the findings and key themes we have summarised will empower the research community (including public contributors) to identify within their own fields of work what is important. We expect this work to catalyse greater attention and funding of high-quality research leading to improved knowledge and impact in the understanding and management of MSK disorders.

**Contributors**

ZP, CF and FW wrote the manuscript. CF oversaw the survey activity, data collection and summary data analysis for both surveys. CLM and SR contributed to analysis. CLM performed statistical analysis of normality and performed data presentation. All authors are RAG members except FM, who carried out the thematic analysis on data from survey 1 with input from ZP and FW. The subgroup members were as follows: Diagnosis – EC (lead); FW (Deputy), ES, AC, CB, EW, GMP; Living Well – CW (Lead), ZP (Deputy), HP, FB, TB, MM; Mechanisms – CLM (Lead); RJ (Deputy), SR, LT, DA, JT; Translation DM (lead), NM (Deputy), RW, JL, MG, DD. Subgroup leads had responsibility for the review of source data, themes and drafting of the Research Avenues working with their respective subgroups. All authors substantially contributed towards all parts of the process in group and subgroup meetings, critically revised the protocol, survey information and manuscript. All authors are accountable jointly for all aspects of the work in the prioritisation process, ensuring that accuracy and integrity of the work are upheld. FW takes responsibility for the overall integrity of the process and the manuscript. All authors reviewed, edited and approved the final version of the manuscript.

**Declaration of interests**

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