1   **Title page**

2   **A scoping review on what constitutes a good research culture**

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17 **ABSTRACT**

18 **Background:** The crisis in research culture is well documented, covering issues such as a tendency for

19 quantity over quality, unhealthy competitive environments, and assessment based on publications,

20 journal prestige and funding. In response, research institutions need to assess their own practices to

21 promote and advocate for change in the current research ecosystem. The purpose of the scoping review

22 was to explore '*What does the evidence say about the 'problem' with 'poor' research culture, what are the*

23 *benefits of 'good' research culture, and what does 'good' look like?'*

24

25 **Aims:** To examine the peer-reviewed and grey literature to explore the interplay between research

26 culture, open research, career paths, recognition and rewards, and equality, diversity, and inclusion, as

27 part of a larger programme of activity for a research institution.

28

29 **Methods**: A scoping review was undertaken. Six databases were searched along with grey literature.

30 Eligible literature had relevance to academic research institutions, addressed research culture, and were

31 published between January 2017 to May 2022. Evidence was mapped and themed to specific categories.

32 The search strategy, screening and analysis took place between April-May 2022.

33

34 **Results:** 1666 titles and abstracts, and 924 full text articles were assessed for eligibility. Of these, 253

35 articles met the eligibility criteria for inclusion. A purposive sampling of relevant websites was drawn from

36 to complement the review, resulting in 102 records included in the review. Key areas for consideration

37 were identified across the four themes of job security, wellbeing and equality of opportunity, teamwork

38 and interdisciplinary, and research quality and accountability.

39

40 **Conclusions:** There are opportunities for research institutions to improve their own practice, however

41 institutional solutions cannot act in isolation. Research institutions and research funders need to work

42   together to build a more sustainable and inclusive research culture that is diverse in nature and supports

43   individuals' well-being, career progression and performance.

44

45   **Keywords**: research culture, research institutions, funding organisations, academia, open research, early

46   career researchers, transparency, research integrity

47

48   **BACKGROUND**

49   Concerns about the pressures of working in research and the potential negative impact of a poor research

50   culture are well documented in academic literature across diverse disciplines.[1, 2] There is a strong

51   connection between concerns about research culture and the inappropriate use of metrics and indicators

52   that drive both institutional and individual researcher behavior, assessment and reward.[3-5] In response

53   to these concerns, a number of actions have emerged to enable and encourage the adoption of a healthier

54   research culture.[6-8] International action to address the underlying drivers of poor research culture include

55   INORMS SCOPE framework for responsible research evaluation[9]; Declaration on Research Assessment

56   (DORA)[10]; development of 10 principles for the measurement of research performance: the Leiden

57   Manifesto for Research Metrics[11]; establishment of the International School on Research Impact

58   Assessment (ISRIA)[12]; and the HuMetricsHSS Initiative.[13]

59   In response to concerns about the experience of working in research, the Wellcome Trust undertook work

60   in the UK to better understand research culture, which has enabled initiatives from the Russell Group and

61   the Royal Society to actively work towards enabling researchers to 'flourish'.[14] A survey conducted by the

62   Wellcome Trust, focused on the experience of researchers, revealed that poor research culture is leading

63   to unhealthy competition, bullying and harassment, mental health issues, and a system that favours

64   quantity over quality.[15] Unfortunately, these experiences mirror previous findings, and show the

65   longevity of the issues as the research environment continues to be pressured, competitive and uncertain

66   for many researchers.[16]

67   The consequences of poor research culture does not only impact researchers, it also effects research

68   support staff (e.g., technicians, research managers and administrative staff), the production and quality

69   of research, reduces innovation in research and affects public trust in research.[17-21] Funding organisations

70   such as UK Research and Innovation (UKRI) enhanced its 2021-2022 allocation of research culture funding

71   to Higher Education Providers (HEPs) to further explore research processes and experiences of working in

72   research, through piloting new initiatives or enhancing existing activities.[22]

73   Striving for excellence and changing research culture is a collective responsibility, requiring action from

74   research institutions, funding organisations and researchers.[14] Higher Education Institutions (HEIs) need

75   to assess their own practices to promote and advocate for change in the current research ecosystem. As

76   highlighted by the Wellcome Trust and others, there remains a tendency for quantity over quality,

77   assessment based on publications, journal prestige and funding.[5, 15, 23, 24] Any attempts on reform requires

78   commitment from everyone (e.g., publishers, research institutions, funders, researchers etc.) so that

79   diversity, impact, teamwork, open research, and assessment systems are valued. In turn, we may begin

80   to see enhancements for the promotion of transparency, open access, knowledge mobilisation and

81   collaborative networking practices.

82   The consequences and challenges associated to an inadequate research culture is well evidenced across

83   the research ecosystem and several reports, from funding organisations to independent providers,

84   demonstrating the extent of the problem (for whom and in what context) and the need for a cultural

85   change in research.[14, 15, 25, 26] However, the evidence very much focuses on the challenges and barriers,

86   with limited evidence on solutions or how to implement change, initiate opportunities, or what works for

87   whom and in what context that is fit for purpose for all individuals (inclusive of all research and non-

88   research staff in an academic environment).[27-29]

89   The purpose of this scoping review was to explore the evidence on what constitutes a good research

90   culture and how open research, career research paths (recognition and awards) and equality, diversity,

91   and inclusion interplay to enhance and promote a more sustainable research culture environment. The

92   scoping review was intended to inform future practice within a specific research organisation (the

93   University of Southampton, UK), recognising the broader interest in and application of the findings. The

94   scoping review was conducted to address the following question: *What does the evidence say about the*

95   *'problem' (barriers, challenges, consequences etc.) with 'poor' research culture, and what are the benefits*

96   *of 'good' research culture, and what does it look like?*

97

98   **METHODS**

99   Scoping reviews are relevant to addressing research questions that seek to identify priorities for research,

100 clarification on concepts and definitions, identifying research frameworks, or locating background

101 information in preparation for a systematic review. Scoping reviews aim to understand *'What has been*

102 *done previously?'* and *'What does the literature say?'* compared to systematic reviews that ask the

103 question *'Does this intervention work for this group of individuals?'* The purpose of this scoping review

104 was to identify the current evidence and body of relevant literature using the Joanna Briggs Institute (JBI)

105 guidance/approach to guide the development, analysis and write up of the scoping review.[30-32] Using this

106 approach enabled the reviewers to map the evidence to four key areas highlighted from existing published

107 work from the Wellcome Trust, to ensure consistency and continuity to predefined areas already

108 established by the research environment.[15]

109

110 *Eligibility criteria*

111 **Context:** The context included UK and international settings within the academic environment (research

112 ecosystem).

113 **Participants:** Academic, administrative, and technical staff and students of all levels, grades, disciplines,

114 and professions. To be inclusive of academic and non-academic staff to ensure an inclusive approach and

115 incorporating the principles of 'team science' and organisational culture.

116 **Inclusion criteria:** Evidence from research institutions only (considering Education, Enterprise and

117 Research, the triple helix approach[33, 34]) for both academic and grey literature were included. All

118 disciplines within the academic environment were included.

119   **Exclusion criteria**: Anyone undertaking or supporting research outside of a research institution / Higher

120   Education Institutes environment (for example in the health and social care field the National Health

121   Service (NHS) Trusts, hospital settings, primary health care settings, allied health professional settings).

122   Industry and non-academic businesses (including consultancies) were not included as they were not

123   considered to have an academic focus. Non-English articles were excluded if no translation was available

124   for the full article.

125   The database searches and grey literature did not have any limitations on country of origin, apart from

126   news items that were restricted to the UK, Europe, North America, and Australasia.

127

128   *Types of sources*

129   The scoping review considered all types of study designs for inclusion (e.g., randomised controlled trials,

130   non-randomised controlled trials, before and after studies and interrupted time-series studies, analytical

131   observational studies including prospective and retrospective cohort studies, case-control studies,

132   analytical cross-sectional studies, descriptive observational study designs including case series, individual

133   case reports and descriptive cross-sectional studies).

134   Qualitative studies were also considered that focused on qualitative data including, but not limited to,

135   designs such as phenomenology, grounded theory, ethnography, qualitative description, action research

136   and feminist research. In addition, systematic reviews that met the inclusion criteria were considered,

137   depending on the research question. Editorials and opinion papers were also considered for inclusion in

138   the scoping review.

139   A range of data were required to be as inclusive as possible due to the diverse nature of how research

140   culture is reported and discussed in the public domain (and its associated parts in Open Access (OA),

141   Equality, Diversity, and Inclusion (EDI) and career paths). Therefore, the review included published

142   material from academic outputs (e.g., Journal articles, commentaries, editorials, perspectives, opinion

143   letters) and from grey literature (e.g., reports, blogs, web-based articles, and newsletters including

144   associated webpages of relevance).

145

146   *Search strategy*

147   The search strategy aimed to locate both published and unpublished citations. An initial limited search of

148   Medline and Web of Science (WoS) was undertaken to identify articles on the topic, to develop and pilot

149   the search strategy. The text words contained in the titles and abstracts of relevant articles and reports,

150   and the index terms used to describe the articles were used to develop a full search strategy.[15, 35-38] The

151   search strategy, including all identified keywords and index terms, were adapted for each included

152   database and/or information source (**see Supporting materials S1 Appendix: Search terms and**

153   **keywords**).

154

155   There were no study or language limits applied in the information retrieval process. The search strategy

156   was limited from 2017 to 2022 but a preliminary search of citations during 2015-2022 was initially

157   screened for relevance. Preliminary scoping and piloting of the search terms and strategies suggested that

158   five years was sufficient for literature to be relevant, current, and broad (including relevant citations on

159   the reporting of initiatives such as DORA, and any changes due to the COVID-19 pandemic). The review

160   included UK and international literature (including grey literature, although see below for pragmatic

161   restrictions for news items).

162   *Databases*: Six databases were searched (Medline, Engineering village, Scopus, JSTOR, ProQuest and WoS)

163   during the period 29 April to 18 May 2022. A range of databases enabled the reviewers to capture several

164   disciplines and to be as inclusive as possible (**see supporting materials for Table S1: Database search**

165   **examples).**

166   *Grey literature searches:* A pragmatic systematic search was undertaken of the Lexis-Nexis Academic

167   database concentrating on newspapers and news items. The scoping and piloting of the search terms in

168   the database suggested that geographical exclusions were needed due to the scale of results from the

169   searches. As part of discussions with team members as well as an experienced librarian, the results were

170   filtered to only include news outlets and organisations based in UK, Europe, North America, and

171   Australasia. To augment the news searches, purposive sampling of relevant research websites was

172   documented in an Excel spreadsheet to record all platforms and webpages visited. The sampling of

173   websites was drawn from discussions with team members as well as an experienced librarian. Examples

174   of research websites explored include: The Conversation, Nature, Science, UK Research and Innovation

175   (UKRI) and Research on Research Institute (RoRi). Relevant citations were identified from Wellcome

176   Trust[14, 15] as well as snowballing. The key references of the included articles and/or reports were screened

177   for additional citations to be included as part of the overall screening process (including grey literature).

178

179   ***Data extraction and evidence selection***

180   Following the searches, all identified articles were collated and uploaded into Endnote version 20

181   *(Clarivate Analytics, PA, USA)* and duplicates were removed. Following a pilot test, all titles and abstracts

182   were screened, by two independent reviewers for assessment against the inclusion criteria for the review

183   using Rayyan. Potentially relevant articles were then retrieved for full extraction. At the full citation

184   screening stage, reasons for exclusion were noted independently by both reviewers. Where the

185   independent reviewer was unsure, the article was discussed, and a decision was made by consensus.

186   Screening at both stages (title and abstract and full extraction) was piloted using Rayyan and labels were

187   applied to categorise the focus of the articles based on four areas:

188   -   Security (including career paths, career progression, stability contracts/careers, issues affecting

189   early career researchers etc.)

190   -   Wellbeing and equality of opportunity (including equality, diversity and inclusion, mental health,

191   and wellbeing, bullying and harassment)

192   -   Teamwork (including team science, recognition of broad contribution to research, incentives)

193   -   Research quality and accountability (including research integrity, reproducibility, policy, and

194   governance).

195   These focus areas were reported in the Wellcome Trust report and formed the basis of the current scoping

196   review, to enable the University of Southampton to build on activity already undertaken, activity

197   underway and enable alignment for future consideration.[14, 15]

198

199   The list of included articles for full extraction were then exported to a Microsoft Excel spreadsheet using

200   the labelling of articles from Rayyan (these categories were grouped together under the four focused

201   areas). The results of the search and the study inclusion process are reported in full in a Preferred

202   Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR)

203   flow diagram (see **Fig 1**).

204

205   Both reviewers extracted data from the full text articles using a data extraction tool developed by the

206   reviewers to address the research question. This included the focus of the article, issues and/or problems

207   reported in the article, solutions and/or recommendations provided in the article and details about

208   whether the article related to more than one topic area.

209

210   No risk of bias or assessment on quality was conducted due to using a scoping review methodological

211   approach. All the evidence was mapped and categorised into the four areas, which were discussed and

212   agreed between team members at various stages of data extraction and during the write-up of the

213   findings.

214   **RESULTS**

215   A total of 3,042 articles were retrieved from the six databases. With 1,376 duplications that were

216   removed, 1666 titles and abstracts and 924 full text articles were assessed for eligibility. Of these 924 full

217   text articles, 253 articles met the eligibility criteria for inclusion (**see supporting materials for Table S2:**

218   **Full details of the included database articles).**

219

220   A total of 341 documents were retrieved (Lexis-Nexis) or identified across all the sources based on the

221   titles. These were assessed for eligibility of which 102 met the criteria for inclusion (**see supporting**

222   **materials for Table S3: Full details of the included grey literature articles).**

223   **Fig 1** provides a full account of the records of identification flow diagram, including the reasons for the

224   excluded articles.

225

226   **Insert Fig 1 here.**

227

228   *Characteristics of the included studies*

229   From the evidence there was a steady rise in the number of published articles over the last five years,

230   with a notable increase from 2019. **Table 1** shows that from the 253 included articles, there were 135

231   original research articles (this included qualitative and quantitative studies), 20 review articles (using a

232   range of methodological review approaches), 86 perspective articles and 10 conference proceedings.

233

234   The location of the study generation was captured for the included articles (based on location of the

235   research and/or authors location). The included articles covered a global perspective with 71 articles from

236   USA and Canada, 73 from international locations such as Africa (n=13), China (n=7), Australia (n=7) and

237   Pakistan (n=4), 36 from Europe and 17 from the UK.

238

239   The grey literature provided 102 additional materials, 40 perspective articles reported in journals, 29

240   newspaper articles, 17 webpages (including educational webpages such as The Conversation:

241   https://theconversation.com/uk) and including 10 reports. The remaining six were either a podcast, blog

242   or case study. A majority of the grey literature material could not be grouped by location due to the nature

243   of the material (76.5%, 78/102).

244
245   **Table 1: Characteristics of the included studies**

Characteristics	N=253 (%) Databases	N=102 (%) Grey literature
Areas of focus: *		
Security	72	69
Wellbeing and equality of opportunity	52	50
Teamwork	64	40
Research quality and accountability	133	52
Year of publication:		
2017	20 (7.9)	12 (11.7)
2018	18 (7.1)	30 (29.4)
2019	47 (18.6)	15 (14.7)
2020	61 (24.1)	11 (10.8)
2021	85 (33.6)	27 (26.5)
2022**	22 (8.7)	7 (6.9)
Country:		
UK	17 (6.7)	7 (6.9)
Europe	36 (14.2)	2 (1.9)
USA and Canada	71 (28.2)	4 (3.9)
International	73 (28.7)	11 (10.8)
NA	56 (22.2)	78 (76.5)
Article type:		
Journal – Original research (including panel discussions)	135 (53.5)	0
Journal – Review	20 (7.9)	0
Journal – Perspective***	86 (33.9)	40 (39.3)
Conference proceeding	10 (3.9)	0
Book	2 (0.8)	0
Blog	0	2 (1.9)
Case study	0	2 (1.9)
Newspaper	0	29 (28.5)
Podcast	0	2 (1.9)
Report	0	10 (9.8)
Webpages / Educational webpages	0	17 (16.7)

246   *Note that some articles reported under more than one area of focus. The total number does not equal to the
247   number of articles included in the scoping review
248   **Jan-April inclusive, searches were conducted during April-May 2022
249   ***Includes, editorial, commentaries, news features, correspondence, and perspective articles in journals

250

251

252   *Summarising the evidence*

253   The evidence found in the database searches and grey literature was grouped according to the four

254   focused areas, based on the key concepts developed during the full screening of the articles (based on the

255   Wellcome Trust report).[15] Several included articles were relevant to more than one focus area, which

256   showed the breadth of the topic but also how these areas are overlapping and mutually reinforcing. For

257   example, evidence reported under security was also closely linked to wellbeing and equality of

258   opportunity (especially for early career researchers (ECRs) and Science, Technology, Engineering,

259   Mathematics and Medicine (STEMM)).

260

261   The sections below provide a summary of the evidence based on the four focused areas, with particular

262   attention on security, wellbeing, equality of opportunity and teamwork, and research quality and

263   accountability.[14, 15] (see **Fig 2**) The quality or assessment of these initiatives were not explored as part of

264   this scoping review and the key considerations arising from the evidence are not presented in order of

265   priority.

266

267   **Insert Fig 2 here.**

268

269   *Security and career progression*

270   From the evidence it was clear that there is a global drive to expose the challenges and barriers in

271   academic research culture. It was evident that these factors were not exclusive to specific countries,

272   disciplines, or research institutions and the challenge is at a system level. Concerns over job security,

273   career progression and sustainability were particularly experienced by PhD students, ECRs and junior

274   researchers from a range of academic environments.[39-42] The evidence reflects the range of research

275   careers, roles, skills and expertise that are involved in research activity. Research Institutions often

276   separate staff into job families such as research, education, technical, clinical, and managerial and

277   professional roles titles reflecting different career pathways.[17, 43-45]

278

279   The evidence suggests there are concerns that research institutions are not managing career progression

280   expectations or providing ways to develop and train staff, which can result in inequality between career

281   types.[17, 43-45] This can accumulate in feelings of failure by staff, or staff feeling pressured to be successful,

282   which ultimately could promote unhealthy working practices such as excessive workloads and working

283   long hours to meet expectations.[46-48] These issues affect all research institution staff but the evidence

284   suggests they are particularly acute for several groups such as ECRs, STEMM, people on Fixed Term

285   Contracts (FTC), people with caring responsibilities, and people with disabilities.[46-48] (see **Table 2** for a

286   summary of the key considerations associated to security and career progression).

287

288   The review suggests that the problem is reinforced by a culture where researchers are incentivized to

289   produce many funding applications and academic publications where high rejection rates.[47] A related

290   issue identified was the risk of evaluating academic performance based on the use of inadequate proxies

291   (e.g., publication productivity, impact factor and citations).[3, 49] Evidence suggests that this can result in a

292   lack of workload oversight, a culture discouraging of appreciation, that in turn makes researchers feel

293   pressured to be successful, often resulting in a significant amount of time in pursuit of success at the cost

294   of their wellbeing.[42, 46, 47, 49-51]

295
296
297   **Table 2: Key concepts and statements associated to security and career progression.**

Key themes	No	Statements	No. refs
Support and train established researchers to	1	Consider evaluating supervisors and mentor support by including impact statements of projects and career progression, including encouraging multiple career paths, benefits of collaboration across disciplinary boundaries and pooling scarce resources[8, 14, 24, 44-47, 51-83]	40

be leaders, managers, and mentors	2	Provide all staff with access to flexible approaches and methods to mentoring and peer coaching schemes, enabling self-learning, innovation and productivity[6, 17, 46, 47, 52, 53, 55, 56, 58, 61, 62, 64, 66-69, 71-73, 75, 76, 78, 81, 82, 84-98]	35
	3	Consider feedback initiatives to support continued professional development for supervisors and team leaders or collate benchmarking data focused on the culture of the research team between supervisor-student[23, 24, 42, 43, 48, 54, 57, 59, 60, 62, 64, 66, 70, 80, 92, 98-111]	30
	4	Explore opportunities for leadership and management training (including project management) for all staff, levels, stages, and position within academia)[24, 43, 54, 57, 60, 62, 64, 66, 67, 70, 90, 95, 96, 100, 103, 104, 107, 112-121]	27
	5	Provide those who supervise PhDs, counsel researchers (including ECRs/junior staff) with clear guidelines on best practice and mechanisms for support (including benefits of networking), encouraging an open mind about career progression[26, 45, 51, 52, 57, 59-62, 66, 69, 74, 79, 81, 83, 85, 104, 114, 122-129]	26
	6	Seek ways to reduce the administrative burden for those involved in leading and managing research, including innovative tools to support meaningful networking connections (e.g., MyNRMN, National Research Mentoring Network, Kaupapa Māori Frameworks)[8, 24, 46, 53, 55, 61, 62, 66, 67, 71, 73, 78, 81, 82, 85, 90, 92, 107, 126, 129]	21
	7	Explore ways to support staff with line management skills including appraisal and inclusive management practices and motivate managers to prioritise these duties, including upskilling of staff[43, 54, 69, 118, 125, 130]	6
Reduce hyper competition and provide a culture of kindness	1	Recognise and incentivize all staff for developing equitable practices and partnerships (e.g., capacity building with Low Middle Income Countries (LMICs) as collaborators and beneficiaries) and focus less on publication numbers and citations (including grant awards)[4, 17, 37, 41, 57, 68, 70, 80, 94, 102-106, 108, 109, 116, 117, 130-139]	28
	2	Provide regular opportunities for informal, open, safe and honest conversations (and how to optimise the role of networking), including environmental tensions between research, education, teaching etc.[42, 47, 48, 52, 57, 61, 63, 67, 69, 81, 95, 104, 113, 122, 125, 132, 136, 137, 140-144]	24
	3	Consider ways to demonstrate support for other researchers to secure funding as part of progression (and review current reward systems), ensuring education, teaching and research are equally prioritised[37, 48, 55, 60, 61, 88, 94, 96, 114, 124, 132, 137, 140-143, 145]	17
	4	Encourage staff to provide positive feedback and praise to each other, making the working environment friendly, productive and conducive for learning[6, 48, 62, 63, 84, 86-88, 91, 95, 97, 98, 139, 141, 145-147]	17
	5	Raise awareness on the value of sharing science outreach goals, promoting mutual learning for all (including academic induction and orientation practices) to help with retention and progression[17, 40, 54, 55, 59, 63, 66, 68, 95, 115, 122, 137, 138, 143, 144, 148, 149]	17
	6	Provide opportunities for shared learning and to develop from failure in funding applications and publishing, avoiding the stresses of perceived failure[47, 59, 68, 114, 122, 130, 150]	7

Promote fair and transparent process for career progression	1	Ensure greater alignment between individual and institutional values that encourages teamwork (team science), collective leadership and shared decision-making, building a more supportive academic culture, and facilitating institutional and departmental recognition in faculty career development[17, 23, 24, 26, 37, 41, 43-45, 47, 48, 51, 54, 55, 57, 60, 62, 63, 65-69, 72, 74, 79, 83, 87, 89, 91, 93, 98-107, 109, 110, 112, 114, 117, 123, 125, 130, 133, 134, 137, 138, 140, 141, 143, 149, 151-154]	61
	2	Consider approaches to award and recognition of performance that is not solely based on academic publications that is fair and transparent for all staff, differentiating key performance areas, as well as the workload of academics in various career stages and positions[4, 17, 23, 45, 47, 52, 54, 55, 57, 63, 68, 79, 101, 103, 114, 116, 123, 125, 132, 135-137, 139, 142, 144, 145, 151, 152, 154]	29
	3	Raise awareness about using research metrics responsibly and appropriately. For example, do not use journal-based metrics, such as Journal Impact Factors, as a surrogate measure of the quality of individual research articles, to assess an individual scientist's contributions, or in hiring and promotion (flaws in the current awards system not promoting research)[3, 4, 20, 26, 37, 50, 56, 61, 68, 84, 124, 126, 139, 155, 156]	15
	4	Consider and optimise how academic CVs are used. Provide instructions for researchers and evaluators; prioritise actual achievements; focus on recent achievements, relevant activities and outputs; acknowledge the broad range of contributions; balance and control incentives; use academic age not biological age; encourage narratives; and use metrics cautiously (Open Researcher and Contributor ID organization (ORCID) as a spin-off from ORCID's Reducing Burden and Improving Transparency (ORBIT) project to foster exchange and pool expertise, to optimise the responsible use of contributions and metrics)[3, 4, 20, 26, 50, 55, 56, 84, 114, 126, 155, 156]	12
Cultivate a culture of support that fosters a diverse set of skills and career pathways	1	Raise awareness of the issues surrounding research culture amongst ECRs so they can contribute to the University, their departments or research teams by: facilitating membership of formal networks, provide opportunities to connect with colleagues for social and work-related activities, and review policies around office attendance that support integration and innovation[6, 23, 26, 40, 41, 46, 48, 54-57, 61, 63, 69, 87-89, 93, 98, 99, 101, 104-106, 109, 119, 126-128, 137, 149, 150, 154]	34
	2	Consider ways to embed 'career optimism' to teach, prepare and respect the diversity of career pathways of PhD students / early career researchers within and beyond the University (and finding your research niche)[17, 23, 42, 44-46, 51, 52, 54, 55, 59, 63, 83, 96, 101, 102, 111, 115, 119, 123, 127, 128, 142-144, 151, 153, 154, 157]	29
	3	Provide opportunities to encourage ECRs to join and engage in conversations that affect them, such as research assessment, career progression, awards system (including sabbatical leave)[3, 6, 26, 44, 54, 55, 60, 61, 63, 74, 83, 88, 96, 101, 104, 105, 115, 117, 119, 124, 126-128, 145, 149, 151, 155-157]	29
	4	Recognise and value the diverse skill-set of research managerial and technical staff and provide opportunities for them to host and supervise researchers, apply for research grants and undertake research promoting the benefits of collaboration rather than competitive research culture[4, 8, 17, 37, 41, 44, 45, 59, 63, 68, 80, 91, 94, 95, 104, 106, 109, 110, 118, 142, 147, 149, 153, 154, 157, 158]	27

	5	Offer opportunities to build hybrid careers by offering different and multiple pathways and opportunities in research, including alignment with the private sector and employment outside of academia for when long-term academic employment is not viable[6, 45, 52, 55, 65, 74, 79, 83, 102, 113, 115, 117, 122, 124, 142, 149, 151, 153, 154]	19
	6	Consider how to develop a career development mindset that supports people in all aspects of research not just research projects, therefore attracting a diverse workforce and provide greater career stability (e.g., type of contract)[44, 45, 52-55, 63, 73, 83, 100, 101, 103, 125, 145, 151, 154, 157, 159]	18
	7	Offer or provide opportunities for writing retreats, boot camps, away days and mentoring including cross disciplinary training, enabling informed decisions such as choosing your own mentor[17, 46, 52, 53, 58, 64, 69, 71-73, 75, 76, 82, 89, 96, 117, 160]	17
	8	Consider how those in research management and technical roles (including librarians) have adequate routes to continued professional development through inhouse or formal training (examples from University of California Curation Center, part of the CDL, and the Digital Curation Centre in Edinburgh, UK)[40, 43, 70, 95, 96, 108, 113, 117, 119-121, 142, 147, 149, 153, 158]	16
	9	Explore ways to implement a 'culture of structure' for graduate students where expectations are clear and students have contact with multiple faculty members, including focus on sources that support all students, faculty, and staff[23, 40, 42, 45, 55, 59, 91, 92, 102, 110, 111, 122, 144, 152, 154]	15

298

299 The concept of research culture and job security was broad and included (but is not limited to) career

300 paths; stability of contracts and careers; and issues affecting ECRs and students.[57, 141, 145] A wide range of

301 initiatives were explored in the literature covering a broad spectrum of factors (as detailed in **Table 2**).

302 The evidence showed how, where, and why changes are needed to establish a global cultural change to

303 the research ecosystem to enable fair and transparent progression for all research staff[99, 104, 161]; cultivate

304 a culture that fosters diversity across career pathways[17, 55] and; initiate deeper integration of knowledge

305 to ensure institutional stability.[57, 153]

306

307 The evidence suggests that offering potential solutions or supportive actions for academic institutions and

308 the research community may enhance and stabilise career paths, particularly those in the early career

309 stage, including those in technical and managerial roles. Although these solutions and supportive actions

310 are by no way exhaustive, they do provide a summary of the range of factors that could go some way in

311 promoting a better research culture.[54, 138, 154, 162]

312

313 *Wellbeing and equality of opportunity*

314 A key consideration from the evidence suggests that there are disparities across the research ecosystem,

315 which are in turn influencing individuals' wellbeing.[39, 40, 43, 70, 92, 96, 99, 118, 163-166] The impact of these

316 disparities are preventing or slowing down initiatives to seek for a cultural change in the academic

317 environment. Although there has been some progress, the evidence suggests progress is slow and

318 continues to be a challenge, especially for under-represented groups.[166-169] The disparities highlighted in

319 the literature suggests that under-represented groups are less likely to be promoted or receive funding,

320 and have a higher risk of decreased well-being.[18, 64, 83, 89, 170-179] However, as Lee (2022) pointed out,

321 although underrepresented groups and junior staff are more likely to experience these challenges,

322 including microaggression (and being victimised regardless of their role or position), anyone can, at some

323 point in their academic career experience some form of microaggression (e.g., bullying, patronage power,

324 exploitation, discrimination).[20] This also extends to the notion of imposter syndrome as noted by Hagan

325 (2020).[169] Moreover, the way disciplines are taught at university means that curricula focusing on

326 traditional perspectives may not be inclusive to everyone.[123, 176]

327 The review revealed that the risks associated with a lack of diversity and inclusion often result in

328 individuals leaving academia, low job satisfaction, increased stress, burnout and mental health problems,

329 and decreased productivity.[18, 44, 74] The evidence suggests that these issues have an impact not only at

330 the institutional level such as having a lack of diversity in organisational leaderships[73, 97, 180], but also for

331 individuals, leading to a lack of role models and peer mentors[163] skills shortages in particular disciplines,

332 sectors and roles,[44, 92, 181] and drives off talent.[8] Moreover, the increasing demands of heavy workloads

333 and the risk of perpetuating a culture of academic rejection can impact an individual's wellbeing.[18, 46, 47,

334 106, 182] **Table 3** provides a summary of the key considerations associated to wellbeing and equality of

335 opportunity.

337 **Table 3: Key concepts and statements associated to wellbeing and equality of opportunity.**

Key themes	No	Statements	No. refs
Embed and support an inclusive culture	1	Create a climate for diversity and inclusivity by working collectively to reduce attitudes of hostility and competition that are pervasive, including among STEM fields (e.g., SciComm, diversity programs), including combating the barriers to inviting diverse speakers and self-nomination[6, 44, 69, 73, 78, 79, 81-83, 89, 106, 109, 111, 120, 123, 129, 146, 147, 156, 170, 171, 173, 175, 176, 183-202]	43
	2	Lead with data by moving from expert opinion and commentary on effective measures for advancing Diversity Equity and Inclusion (DEI) to objective, validated, and evidence-based research and evaluation[6, 18, 73, 78, 79, 81-83, 88, 89, 98, 106, 109, 111, 120, 129, 156, 166, 167, 170, 173, 175-177, 189-191, 193-195, 198-207]	41
	3	Enable honest conversations around the complexities, challenges and barriers to achieving diversity in leadership[6, 73, 78, 79, 81-83, 89, 92, 98, 106, 109, 111, 120, 123, 129, 156, 165, 167, 175, 176, 184-186, 188, 193, 195, 197-205]	36
	4	Diversify visible reporting routes to encourage institutions to move away from performative actions and acknowledge that institutional factors play a role in improving mental health for individuals (e.g., 'Me Too' movement, #STEMToo social media hashtag to share stories)[6, 18, 20, 42, 46, 51, 69, 74, 75, 79, 80, 89, 91, 97, 101, 107, 111, 146, 147, 171, 179, 189-191, 197, 202, 208, 209]	28
	5	Encourage and support staff and students to build support groups, to reach out for help, to talk openly about mental health, and to ask how others are doing[6, 20, 42, 46, 51, 74, 75, 79, 80, 89, 91, 96, 97, 101, 107, 111, 120, 123, 173, 198, 202, 209]	22
	6	Use institution-specific data to drive changes in policy and programming to improve the social culture and climate, including shift institutional practice in a context-specific way[61, 89, 98, 101, 109, 162, 167, 169, 170, 177, 179, 184, 186, 197, 210, 211]	16
	7	Create greater emphasis on cultural competency, to enable the ability to understand, honor, appreciate, and respect the values, beliefs, attitudes, and behaviors of those from cultures different to our own[89, 98, 101, 109, 167, 169, 170, 173, 183, 195, 212]	11
	8	Enable conversations that shine a light on power imbalances within academia through initiatives (e.g., "Me Too" Movement)[18, 122, 165, 167, 169, 170, 177, 195, 197, 204, 211]	11
	9	Explore avenues which will help to identify how disciplines could be taught through a more inclusive and ethical lens, ensuring that socio-economic data on employees is collected and monitored (as recommended by the Social Mobility Commission)[123, 189-192, 194, 195]	7

	10	Improve professional workplace mental health and access to services/support for mental health and ensure that use of such services does not stigmatize. In addition, invest to improve mental health literacy across the institution, supporting those who provide assistance and training in mental health, particularly post COVID[18, 46, 51, 96]	4
Investing in people to reduce burden and improve wellbeing	1	Train leaders, principal investigators, staff and students in mental health and diversity, and dignity and respect[6, 20, 42, 46, 51, 74, 75, 78-82, 89, 91, 97, 101, 107, 109, 120, 123, 129, 156, 164, 175, 176, 184, 185, 187, 190-193, 198-202, 205, 209]	42
	2	Enable access to childcare near or on campus, extend paid maternity/ parental leaves, parttime options for work, a career pause during children's formative childrearing years, greater access to administrative and research support, and the fundamental recognition of family status in academic policies and practices[6, 20, 42, 46, 51, 73-75, 79, 80, 83, 89, 91, 96, 97, 101, 107, 111, 122, 146, 147, 165, 167, 177, 179, 196, 203, 209, 213]	29
	3	Provide or maximise mentorship, sponsorship and collaboration between academics at all stages of their career [44, 46, 47, 61, 64, 69, 73, 89, 98, 101, 109, 162-165, 172, 184, 193, 196, 197, 199, 202, 212, 214]	27
	4	Consider courses aimed at underrepresented groups to improve confidence, assertiveness and to manage negative influences, such as imposter syndrome; empower staff through participation in decision-making/problem solving[118, 162, 173, 179, 187, 197, 199, 210-212, 214]	11
	5	Consider pre-assessing research skills so that different types of mentor-mentee matching strategies can be formed in as many areas as needed, which can help new investigators, early-stage investigators and underrepresented minorities[47, 61, 64, 69, 163, 184, 193, 203, 212]	9
	6	Reward or emphasize collaboration over competition[44, 80, 89, 98, 101, 109, 215]	7
Making use of and learning from existing tools and initiatives to support cultural change	1	Consider adopting an inclusive and shared leadership model such as Networked Improvement Community (NIC) which focuses on shared leadership, inclusive practices in different contexts (e.g., for STEM, establishing a culture of equity and engagement) to strengthen infrastructure at local levels[69, 78, 89, 96, 98, 101, 109, 146, 147, 164, 165, 169, 171, 173, 177, 179, 183, 184, 189, 194, 197, 204-206, 215, 216]	26
	2	Encourage/signpost staff to peer groups to enable and encourage networking and shared understanding including critically reflect on cultural identity(e.g., Blackett Lab Family, Black Heroes of Mathematics, Africans in STEM)[69, 122, 146, 164, 166, 170, 171, 175, 207, 214, 217]	11
	3	Implement and encourage staff development opportunities (e.g., StellarHE) that are inclusive to and for everyone, regardless of characteristics, career stage or job role, including Learn from networks and initiatives such as the National Research Mentoring Network (NRMN), Athena Swan (UK	10

		based), sign up to UK's Concordat to Support the Career Development of Researchers[53, 69, 123, 162, 163, 179, 189, 194, 197, 203]	
	4	Consider adopting PRESS, an evidence-based framework for achieving racial equity; as well as using well-designed metrics that can help to manage discrimination 'blind spots' and encourage a 'sense of belonging' (e.g., Challenged Sense of Belonging Scale)[166, 169, 173, 180, 204-206, 217]	8
	5	Seek to safeguard the physical and emotional well-being of PEER trainees, by equipping STEM allies with tools to combat discrimination (e.g., Allyship for PEER trainees (Persons Excluded from science because of Ethnicity and Race (PEERs))[69, 122, 146, 166, 169, 171, 180, 214]	8
	6	Increase uptake of digital tools and inclusion-sensitive pedagogy to support equal participation in Higher Education programmes, including promotional materials and promote open knowledge institutions (OKIs) in diversity, communications and coordination, support opportunities for virtual conferences to increase access for researcher participation in training, symposia, and conferences[162, 168, 180, 185, 187, 194, 208]	7
	7	Consider the use of Authentic Interrogation, Acknowledgment, and Accountability that requires SciCommers to explicitly articulate the ways in which STEM and SciComm have been used as systems of oppression[69, 146, 169, 171, 183]	5
Support for a balanced and flexible working pattern	1	Ensure staff contracts can accommodate better pathways for flexible working so there are no unintended consequences on career for focusing on care-giver responsibilities or changing circumstances[69, 78, 92, 96, 118, 122, 146, 147, 162, 165, 167, 169, 177, 179, 196, 203, 213]	17
	2	Put in place options that help staff to return to work after a period of absence to improve transition back to work and promote life-work balance (for students and staff)[18, 69, 96, 118, 120, 123, 146, 162, 165, 167, 177, 196, 198, 203]	14
	3	Commit to the ring-fencing of research-time and ensure researchers confirm time against other duties (i.e., teaching, administration, marking and preparation), including leaders model healthy working practices[46, 48, 78, 122, 146, 162, 212]	7
	4	Include working hours as a standing item on appraisals and manage expectations around working hours, breaks and holidays to reduce excessive working hours, including use more inclusive job descriptions in hiring processes[46, 48, 96, 122, 156]	5

338

339 The review illustrates that over the last three years, the COVID-19 pandemic has highlighted some

340 important challenges to this already highly pressured working environment, with mixed effects.[18, 44, 74]

341 Although, the pandemic has brought about challenges to the research workforce, there is also emerging

342 evidence over the last two years showing the potential benefits and opportunities as a result of COVID-

343 19.[18, 44, 64, 73, 74, 97, 177, 194] For example, use of online platforms for training and teaching purposes has

344 opened up opportunities to bring together specific communities and countries. The pandemic also

345 initiated 'kindness in research' where empathy replaced the usual expectations on work-life balance.[73, 97,

346 180]The review also identified clear efforts to improve and raise awareness of the need for academia to

347 embrace the EDI agenda through several initiatives, movements, and policy implementations (as detailed

348 in **Table 3**). Most prominently, focusing on efforts to improve individuals' opportunities through

349 networking, collaborations, mentoring and peer-to-peer support, balancing career, and family aspirations

350 can help to guide inclusivity and strengthen infrastructure and local capacity.[171, 177, 183, 205]

351

352 ***Teamwork and supportive working relationships***

353 Collaboration, openness, and transparency were highlighted in the evidence as key indicators of success

354 for driving forward a positive cultural change. However, the emerging evidence suggested that perverse

355 incentives within the research ecosystem, a lack of training, opportunity, support, and infrastructure can

356 undermine ambitions for change, which is further hampered by researcher perceptions.[4, 24, 60, 154, 181, 218,

357 219]

358

359 The evidence pointed to a range of barriers that have repercussions on the notion of teamwork, such as

360 the ongoing tradition of first and last authors taking most or all of the credit for the work[220], the use of

361 'gift authorship' to enhance research publication of academics with poor research performance[5], and the

362 pressures to have global impact on the scientific community through high-quality scientific writing.[164]

363 Researchers are incentivized to attain research excellence, which can often result in hyper-

364 competitiveness and unfair working practices.[4, 19, 24, 50, 59, 88, 89, 206] The evidence further suggested that the

365 Research Excellence Framework (REF) in the UK has been criticised as promoting competition between

366   departmental colleagues rather than collaboration due to criteria on contributors and the increased

367   demand on publications.[49, 89]

368

369   These practices can have a detrimental impact for the promotion of research integrity and team science,

370   especially for ECRs. Research careers encompass a range of roles, skills, and expertise but as the evidence

371   suggests this is not universal, with some universities separating research active staff from colleagues such

372   as research managers, technicians, administrators, and librarians, some of whom have research-level

373   qualifications and experience.[41, 99, 158] Separation in this way could lead to inequality of how staff are

374   included (or not), trained, mentored and perceived by fellow colleagues (see **Table 4** for a summary of the

375   key considerations associated to teamwork and supportive working relationships).

376

377   **Table 4: Key concepts and statements associated to Teamwork and supportive working relationships.**

Key themes	No	Statements	No. refs
Everyone feeling valued and having equality of opportunities to contribute	1	Encourage faculties to support collaborations and networks that provide a sense of mutual support and culture of team effort rather than individual competition, through interactive learning environments and faculty members as supporters and mentors[5, 19, 23, 26, 41, 43, 45, 46, 49, 59, 60, 69, 72, 73, 87-89, 92, 95, 98, 99, 101, 107, 109, 130, 141, 164, 172, 177, 178, 181, 193, 206, 212, 220-236]	51
	2	Consider incentives and mechanisms to share open data and empower multi-disciplinary teams to reuse data, and adopt incentives that are transparent across funding agencies, journals and institutions (including replication research)[23, 26, 41, 43, 48, 49, 87, 89, 98, 99, 101, 109, 141, 154, 215, 218, 220, 232, 233, 235-240]	24
	3	Encourage transformative interdisciplinary research to diversify teams, deepen integration of knowledge and move beyond separate disciplinary research[19, 23, 26, 41, 46, 49, 57, 69, 73, 87-89, 101, 109, 164, 206, 220, 222, 224, 235, 236, 241, 242]	23
	4	Bring researchers together under a common goal to address specific research issues through a challenge-led (problem-led) research approach (including the health of labs)[19, 45, 46, 57, 69, 73, 88, 89, 92, 98, 101, 158, 178, 224, 229, 239, 241]	17

	5	Provide greater opportunities and capacity for technical and library staff to improve their own research skills through networking, collaborative partnerships and being contributors to research, including raising accessibility for multi-disciplinary teams and interaction[45, 90, 95, 107, 130, 158, 215, 224, 234, 243-245]	12
	6	Ensure that those in research management and technical roles have adequate routes to continued professional development through inhouse or formal training (including ethical considerations and issues)[95, 99, 152, 158, 178, 224, 227, 244, 246-249]	12
	7	Recognise and value the diverse skillset of research management and technical staff (and early career researchers), and provide opportunities for them to host and supervise researchers, apply for research grants and undertake research[41, 45, 59, 95, 158, 227, 231, 239, 246]	9
Measuring success that rewards contribution and open research practices	1	Ensure that the term research excellence is understood and qualified within assessment processes to minimise opportunities to reward individualism at the expense of the collaborative, and create environments that assess the performance of the collective rather than only individuals (e.g., performance-based research funding systems PBRFS, and productivity)[3, 5, 6, 8, 21, 23, 26, 50, 57, 84, 87-89, 91, 92, 94, 97, 98, 107, 109, 130, 139, 153, 158, 212, 221, 223, 227, 233-236, 242, 250-255]	39
	2	Reward multidisciplinary work through separate evaluation structures to encourage team science initiatives (consider including data sharing and collegiality as part of employment evaluation criteria)[23, 24, 26, 41, 43, 49, 87, 89, 98, 99, 101, 109, 154, 164, 206, 215, 220, 222, 226, 235, 236, 242]	22
	3	Review how research is recognised, incentivised and rewarded (subjective and objective measures of quantity, quality and impact), including Key Performance Indicators (KPIs) and whether monitoring systems are contributing to optimum solutions (including financial support and elevating barriers)[3, 8, 23, 26, 50, 84, 92, 98, 109, 178, 217, 221, 232, 237, 239, 241, 243, 252, 254]	19
	4	Review, consider and evaluate the value, role, and purpose of incentives. Consider questions such as 'Do they foster scientific knowledge?' and 'Are large collaboratives, open science practices innovative enough?'[8, 19, 23, 24, 57, 98, 107, 108, 130, 164, 212, 218, 237, 250]	14
	5	Reward credible research practices that are addressing problems with credibility, rigour, and reproducibility in grant guidelines (e.g., incorporating Registered Reports in two stage funding model). Seek to encourage practice across publishers and institutions to not disadvantage researchers who engage in open practices (consider frameworks to improve quality publication practices (QPPs))[8, 23, 24, 45, 98, 108, 227, 233, 237, 240, 247, 250, 256]	13
	6	Consider 'human-oriented' knowledge practices over 'output-oriented' practices so that researchers and educators are evaluated based on value, quality and contribution, including early career researchers[4, 45, 145, 177, 193, 221, 231, 241, 247]	9
Ensure routes for development are	1	Develop and reward cross-disciplinary training and mentoring aligned with development of on the job skills to promote interdisciplinary	26

inclusive and for everyone (regardless of position, role or discipline)		insight[19, 46, 60, 69, 72, 73, 88-90, 92, 95, 98, 101, 152, 154, 172, 181, 193, 217, 222, 228, 232, 247-249, 257]	
	2	Invest capacity in fostering change for different specializations and teams to create a trusting environment for knowledge-exchange, particularly around inefficiencies and pressure on grant funding[23, 26, 41, 43, 45, 49, 59, 87, 89, 98, 99, 101, 109, 164, 177, 220, 222, 223, 226, 235, 236, 243, 258]	23
	3	Invest in leadership training and encourage a culture of knowledge sharing between senior leaders to foster a healthy work environment, in particular around Open Science, Open Research practice and competencies (including project management and oversight and training such as awareness and motivation)[8, 19, 23, 24, 60, 98, 108, 152, 164, 172, 178, 222, 228, 230, 243, 247-250, 257, 259]	21
	4	Implement an Inclusive leadership programme, and promote the benefits of a collaborative rather than competitive research culture[19, 57, 59, 60, 107, 130, 154, 158, 172, 225, 227, 229, 230, 241, 259]	15
	5	Provide access to research capacity building activities that value research and provide access to resources[19, 90, 164, 212, 217, 223, 241, 243, 258]	9
Make use of or build on existing tools and initiatives to advance innovation	1	Centralize computing and experimental infrastructure to engage core facilities to provide data services, including ways to enhance productivity through social media use (and digitalisation)[3, 6, 8, 21, 23, 24, 26, 50, 84, 87, 88, 91, 92, 97, 98, 109, 139, 154, 227, 233, 236, 245, 246, 250-252, 254, 255]	28
	2	Consider implementing a Complementary Capacity Building (CCB) programme to improve the sustainability of research partnerships (including productivity), with particular focus on LMIC research capacity (and identifying synergies between research and services for development (R&S4D)[6, 8, 21, 23, 26, 50, 84, 87, 88, 90-92, 94, 97, 98, 139, 153, 221, 223, 234, 236, 250-252, 254, 255, 258]	27
	3	Promote or encourage use of: the Open Science Framework platforms; project management tools designed to enhance transparency and foster collaborations; the Open Innovation Science (OIS) concept/framework; Network data centres and task forces (e.g., UK Reproducibility Network and developing framework / guidelines to enhance understanding); and implement and encourage use of contributorship approaches such as mandating the use of CRediT[7, 24, 107, 130, 178, 215, 233, 260]	8
	4	Consider optimal models of collaboration which promote integration that is appropriate and relevant as different problems (including different countries) require different approaches[154, 221, 223, 225, 228, 233]	6

378

379 As the evidence has shown, working relationship challenges in research culture require structural changes

380 by transforming people, places, and practices.[247] Any steps to reform will require accessibility to

381 opportunities and resources that collectively bring research staff together in a unified and cohesive way

382 to promote and create trust (rather than having intensive competitive pressures to achieve based on

383 individual merit).[51, 164, 247]

384

385   The evidence reveals multiple layers of complexity around the notion of 'teamwork' and the interrelated

386   social and environmental factors that unfortunately reinforce a status quo. For change to occur there

387   needs to be synergy for collaboration to ensure individuals, Research Performing Organisations (RPOs),

388   Research Funding Organisations (RFOs) and society share a unified approach to move beyond solitary,

389   isolated teams to a deeper integration of multi-disciplinary / inter-disciplinary culture.[7, 57] An inclusive,

390   representative, and collaborative research environment contributes to improvement in researchers'

391   sense of belonging and to positive cultural change.[206]

392

393   The identified evidence suggests that there is a need to take a holistic and integrated view of the intrinsic

394   (those within disciplines) and extrinsic factors (those outside of disciplines) that affect the research

395   environment to come up with novel ways to tackle the challenges with teamwork and collaboration to

396   ensure openness and a cultural shift in the right direction.[7] Given the growing evidence that success in

397   research and innovation requires diversity in roles, knowledge, and skills, an inclusive, representative, and

398   collaborative research environment contributes to improvement in researchers' sense of belonging and

399   to positive cultural change is required.[206]

400

401   ***Research quality and accountability – open and trustworthy research***

402   From the existing evidence it was clear that transparency, open research, and integrity requires

403   collaboration from RPOs, RFOs, researchers, publishers, and other sectoral organisations such as

404   industry.[27, 260, 261] A large proportion of the evidence (more than a quarter of articles (133/253) included

405   from the database searches and half of the grey literature (52/102)) highlighted several issues inhibiting

406   open research practices, which some have termed as a 'replication or reproducibility crisis'.[24, 86, 216, 235, 237,

407   257, 262] These increasing pressures on researchers suggest that it is causing a 'publish or perish' practice,

408   and has meant that researchers are prioritising 'getting it published' rather than 'getting it right'.[24, 86, 235,
409   237, 254, 255, 257]

410   However, as noted by Munafo (2022), the replication crisis could be regarded as an opportunity to

411   promote motivation for improvements. Determining where effort is most needed and what changes are

412   required, not only provides opportunity for the research ecosystem but also how RPOs and RFOs can

413   mandate open research practices, and therefore coordinate change at both research integrity and

414   researcher integrity level. [261] (see **Table 5** for a summary of the key considerations associated to

415   teamwork and supportive working relationships)

416

417   **Table 5: Key concepts and statements associated to teamwork and supportive working relationships**

Key themes	No	Statements	No. refs
Incentives and Innovation	1	Synthesize insights across multiple disciplines to help to unify collaborative practices and breakdown boundaries and disconnect to signal organisational values, such as the Open Innovation in Science (OIS) Research Framework (particularly for early career researchers, supervisors, technicians), enabling change to the research ecosystem becoming interoperable and responsive to the open assess movement[7, 8, 19, 23, 26, 43, 49, 55, 84-86, 92, 98, 101, 109, 119, 126-128, 151, 156, 192, 224, 234-236, 241, 263-278]	43
	2	Encourage greater efficiency and use of innovative and alternative approaches such as alternative publishing models (e.g., Octopus); registering with Center for Open Science; methods to assess research and researchers (e.g., SPACE); and, Open Knowledge Indicators, mapping diversity, communication and coordination[23, 55, 85, 108, 127, 151, 162, 169, 208, 216, 237, 247, 256, 261, 263-265, 279-291]	30
	3	Prioritise shared decision making to ensure all perspectives of the full research eco system are captured, to initiate change in practice, including policy makers, funders, publishers, technicians, researchers, institution leaders, editors, including level of appropriateness for performance based funding schemes[5, 26-28, 36, 84, 85, 92, 98, 127, 138, 151, 156, 224, 233, 236, 244, 257, 268, 278, 283, 287, 288, 292-296]	28
	4	Maintain hiring, appointment and promotional policies are fair and not solely based on authorship, publications or secured grants, and value softer skills[24, 55, 85, 135, 136, 169, 216, 231, 237, 247, 256, 257, 263, 264, 275, 279, 297-306]	26

	5	Develop a coordinated approach to incentivize open access policies to optimise a positive cultural shift based on Government recognition of UK Research and Innovation's position on open access research practice, (including European and international position and status of progression/advancement in open research)[8, 27, 85, 98, 126, 135, 162, 218, 250, 268, 271, 272, 274, 275, 288, 301, 306, 307]	18
	6	Ensure continued monitoring and evaluation, including meta-research/research on research takes place to avoid unintended consequences, efficient use of resources and demonstrate which aspects are beneficial to the research ecosystem (including where improvements are required at institutional and professional level)[21, 200, 247, 261, 288, 296, 304, 308-312]	12
Creation and Facilitation	1	Monitor, evaluate and embed learning from education, training, supervision and mentoring to improve research integrity and to create a responsible research culture that is not individualized (including publishing culture built on individual reputation and rankings) but is a collective role in promoting and fostering research/academic integrity, through initiative such as open science peer networks, not to capitalize on individual researchers compliance[4, 19, 21, 26, 43, 55, 76, 85, 98, 101, 106, 108-110, 119, 121, 126, 127, 129, 138, 151, 169, 185, 210, 234-236, 241, 247, 250, 253, 256, 257, 261-264, 268, 272, 277, 278, 280-283, 285-287, 289, 294, 300, 308, 309, 311, 313-331]	74
	2	Adopt open practices early on at all staff levels, but also at the institutional and funders level particularly around software and digital tools (including social media, Artificial Intelligence capabilities, the digital context, management tools), publishing mechanisms, workflows, ethics and data accessibility, supporting collaborations and training progression[36, 43, 55, 56, 70, 72, 76, 85, 86, 99, 101, 106, 108, 110, 119, 121, 129, 142, 162, 214, 233, 237, 241, 253, 257, 260, 263, 264, 266, 284, 286, 287, 290-292, 304, 308, 309, 316, 317, 321, 323, 326, 332-342]	71
	3	Ensure alignment between grant funding and publication outputs as well as consistency with open research initiatives, and opportunities to create mechanisms for reproducibility so greater collaboration can be gained, including understanding of authorship/contributorship consideration[8, 19, 24, 55, 84, 85, 98, 127, 135, 136, 151, 169, 231, 233, 235, 237, 241, 250, 251, 255-257, 262, 264, 274, 276, 279, 280, 284-288, 291, 298, 299, 301, 302, 305, 306, 319, 327, 329, 343, 344]	46
	4	Coordinate and facilitate research integrity officers/champions to promote and create a responsible research culture, including opportunities for an academic integrity framework for policy and practice (including institutional improvements and avoiding the persistence of behaviors detrimental to reproducibility while encouraging responsible research conduct)[19, 21, 28, 43, 76, 84, 98, 101, 106, 110, 119, 121, 127, 151, 210, 235, 236, 251, 255, 262, 272, 277, 278, 280, 285, 286, 288, 294, 296, 309, 311, 313, 314, 318, 322, 324, 326-331, 345]	44

	5	Support Responsible Research Practices (RRP) as they require facilitation, advice and steer from the Government, funding organisations and academic institutions (progression and progress cannot be done in isolation). Such activity should consider six key areas: research policies; research practices; training researchers; evaluating research(ers); rewarding researchers; funding research(ers)[4, 27, 43, 56, 70, 72, 76, 85, 86, 92, 98, 99, 101, 106, 108, 110, 119, 121, 129, 156, 185, 233, 247, 277, 281, 286, 294, 298, 307, 309, 314, 315, 323, 325, 326, 346]	36
	6	Enable researchers to have a voice in articulating (and contextualizing) how research could be evaluated and provide a mechanism for more detailed and transparent reporting of scholarly activities, using formal evaluative systems that explicitly captures behaviors that support reproducibility[36, 84, 127, 128, 131, 151, 227, 235, 251, 255, 262, 272, 273, 276, 280, 285, 286, 288, 297, 312, 327, 329, 332, 333, 347, 348]	26
Fostering Transparency and Visibility	1	Provide clarity, transparency and understanding of research mandates, policies and procedures to permit and maintain productivity in research for all staff and students (including career advantages), across all disciplines (acknowledging the reproducibility networks)[4, 8, 22, 23, 26, 36, 43, 84, 86, 92, 97, 101, 115, 127, 128, 138, 142, 151, 156, 162, 185, 192, 227, 234-236, 241, 250-252, 254, 255, 262, 267, 269, 270, 272-276, 278, 280, 285, 286, 288, 297, 312, 314-316, 326, 327, 329, 333, 337, 343, 349]	58
	2	Support open research to allow research to be more reliable by sharing protocols, data, reproduction of analyses, and offers greater scrutiny to ensure good quality and replication of findings is critical to increase reliability and benefit all researchers, at all levels (making research accessible), including knowledge exchange[8, 19, 36, 84, 85, 98, 127, 128, 142, 151, 162, 208, 233-235, 250, 251, 253, 255, 257, 262, 273, 276, 280, 281, 285, 286, 288, 290, 297, 298, 301, 304, 314, 316, 317, 321, 327, 329, 332, 333, 335, 337, 339, 341, 343, 347, 350, 351]	51
	3	Gain greater understanding and consideration of existing steps to promote open science practices such Center for Open Science and its pre-registration process (https://cos.io/prereg/); Editor's Code of Ethics (http://editorethics.uncc.edu/); Committee of Publication Ethics (COPE, http://publicationethics.org/); Transparency and Openness Promotion (TOP) guidelines; Open Science Grid (http://opensciencegrid.org/); Open Knowledge institutions (OKIs); European Network of Research Integrity; SPACE (SPACE is a rubric for analyzing institutional progress indicators and conditions for success); Open Government Data Act; FAIR (findable, accessible, interoperable, and reusable); alternative repositories for open access publications (University Journals)[21, 23, 43, 76, 85, 98, 106, 108, 110, 119, 121, 127, 151, 208, 236, 262, 278, 280-282, 285-287, 289, 292, 303, 304, 323, 326-330, 334, 338, 340, 344]	38
	4	Increasingly adopt and promote publicly available data sets shared through repositories (e.g., Figshare, Zenodo), data management techniques, open materials and open data badges through the Center for Open Science, increasingly being mandated by funders and journals (including networks such as the Open Traits Network and toolkits for open access, and self-assessment of digital	37

		research)[3, 8, 23, 26, 49, 56, 84, 85, 98, 108, 109, 127, 129, 151, 156, 208, 224, 250, 252, 254, 260, 266, 274, 280, 282, 284-287, 289, 317, 321, 328, 332, 336, 337, 342]	
	5	Ensure scholarly outputs are credited using alternative contributorship models (e.g., CREDiT) and moving away from the traditional authorship models including becoming more preventative than reactive[21, 24, 76, 85, 136, 231, 279, 284, 288, 298, 302, 305]	12
	6	Incorporate and consider web-based tools such as Open Science Framework (OSF), Open Knowledge Institutions framework (OKIs) to increase transparency and visibility of research at an international, global and institutional level[23, 108, 127, 208, 260, 280, 282, 285, 286, 289, 317, 343]	13
	7	Become a signatory of initiatives such as DORA involvement with the Reproducibility Networks at local, institutional and sectoral level (UKRN Committee, 2021)[22, 27, 36, 98, 260, 261, 268, 304, 312, 329]	10

418

419   The existing evidence demonstrated that open research practices (e.g., research integrity, researcher

420   integrity, open data, open access and transparency) requires a global effort, as well as involvement from

421   all sectors of the research ecosystem (e.g., institutions, researchers, funding organisations, publishers,

422   industry). However, more evidence is needed to demonstrate where and in what circumstances the

423   change is having tangible benefit.[43, 260, 261, 282, 329]

424   As the evidence suggests, practices should be evaluated to assess whether change has been of value,

425   enhancing the research pathway and algin to be evidence informed, therefore avoiding any unintended

426   consequences.[5, 7, 135, 261, 272] Meta research (e.g., research on research, meta science) is one way to

427   evaluate and evidence any innovation taking place, and therefore determine the impact and tangible

428   benefit of these changes to promote and enhance the research ecosystem.[7, 24, 36, 247, 261, 281, 329, 341]

429   The evidence found several initiatives such as the UK Reproducibility Network (UKRN), Declaration on

430   Research Assessment (DORA), and the European Network of Research Integrity (ENRI) to promote,

431   encourage and prioritise the facilitation and creation of open research practices.[7, 22, 281, 285, 325] Adopting

432   such initiatives enhances innovation across all aspects of the research ecosystem but there is variation on

433   how far they have been implemented (including what stage of the development) and the acceptance level

434   from researchers, RPOs and RFOs.[303, 322, 325, 330]

435

436   **DISCUSSION**

437   From the evidence, it was clear that there were several initiatives to seek a cultural change across the

438   research institutions/Higher Education Institutions. Although this was promising to see, the commitment

439   is complex considering the multifaceted structures and processes governing the research ecosystem.

440   Adding to the complexity, is the acknowledgement from research institutions that they too have a role to

441   play in not only supporting research staff, at all levels, but also recognise the role and function of research

442   management staff.[76, 85, 114, 137, 156, 229] As noted in the recent Research and Development report on people

443   and culture strategy, high quality research and innovation requires an acknowledgment of the full range

444   of people needed.[8] An inclusive, representative and collaborative research environment contributes to

445   improvement in researchers' sense of belonging and to positive cultural change.[206]

446   The increasing competitiveness within the research environment, with research funding organisations

447   (RFOs) placing greater focus on impact rather than creativity and innovation, is causing a global initiative

448   for cultural change. The health of the research group and those that lead them has been identified as an

449   area that universities need to pay more attention to, rather than centering on individual researchers,

450   particularly in the context of preventing research misconduct.[43] Team leaders play an important role in

451   creating trustful environments, which support knowledge exchange processes and open research[164] and

452   crucially they act as mentors and role models for research integrity and working practices.[43, 92]

453   There was a strong sense and recognition of the value and importance of research capacity building, and

454   the evidence clearly provided a wealth of initiatives to embark on. Interestingly, models, approaches and

455   initiatives for capacity building have been reported by several countries.[57, 70, 90, 103, 130, 133, 159, 223, 310, 352]

456   Initiatives taking place in many countries, emphasising the benefits of learning from experiences in other

457   countries was encouraging to report from the literature. Factoring some of these initiatives, it is evident

458   that academia is confronting the challenges 'head on' to build a more sustainable and credible research

459   environment.[20, 162, 216] Although this is promising, the evidence suggests that research institutions must

460   not assume that 'one size fits all'. There is diversity across disciplines, research staff (research, education,

461   enterprise, and professional services) and several types of research institutions. To enhance research

462   culture, different solutions will require different approaches at individual, institutional and systemic

463   levels.

464   Over the last five years, and particularly the last two years (i.e., post the COVID-19 pandemic), there is a

465   surge of evidence to capture the effects of these challenges and barriers and how these failings in our

466   research ecosystem can be mitigated. Much of the literature focusing on career stability, job security and

467   career progression suggested the need to build research capacity that spans across research, education,

468   enterprise, and professional services. However, with this comes new challenges and pressures for

469   teaching staff to also mentor, support and educate, whilst also having committed time to conduct their

470   own research.[7, 24, 44, 50, 73, 74, 97, 177, 194, 337]

471   Guidance on how to create a global long-term sustainable model that has representation at all levels is

472   going to take time, and the COVID-19 pandemic has aggravated this already challenging and highly

473   pressured working environment.[18, 44, 73, 74] The COVID 19 pandemic may have perhaps initiated more

474   transparency on obtaining a work/life balance, particularly at a time when many parents across the world

475   were not only managing increasing work demands but also having to manage home life and home

476   schooling simultaneously. The effect of the COVID-19 pandemic has started to emerge in the literature,

477   particularly how additional burden placed on women reduced their productivity far more than men with

478   women having 'borne the brunt of the pandemic in academic settings.'[177] There has been a steady

479   increase in mental health distress arising from COVID-19 pandemic reported, which added to the existing

480   strain in academia can often feel detrimental to an individual's career.[18]

481   However, despite the pandemic causing global disruption and concern, it has initiated new opportunities

482   to bring communities and countries together using digital tools.[194, 241, 245, 257, 264, 332, 342, 344] Research,

483   training and teaching took place online, and the evidence seemed to suggest that offering greater

484   accessibility through virtual platforms goes some way to reform the connectivity and diversity of the

485   research environment. A good example of this is virtual conferences, as those with accessibility issues,

486   family commitments, funding limitations and research communities from Low- and Middle-Income

487   Countries (LMIC) now can attend, where they could not before.[208, 245] Any changes will inevitably take

488   time, but small improvements over time can have an impact, affecting both research institutions and

489   funding organisations.[180] In addition, the pandemic provided the impetus to embed kindness in research

490   where empathy replaced the usual expectations on work-life balance[97], and researchers who felt

491   supported during the pandemic tended to have better indicators of well-being.[73, 74]

492   Given the growing evidence that success in research and innovation requires diversity in roles, knowledge,

493   and skills, embedding a research culture of inequality between career types within the same research

494   team discourages a culture of collaboration and appreciation of a diversity of roles, specialisations and

495   contributions.[41, 164] With increasing demands to incentivise and promote change it is necessary to

496   acknowledge that both funding organisations and research institutions have responsibility to transform

497   and shape best practice in research.   Providing opportunities for research staff to combine their academic

498   research with work in other sectors could bring more value to academia and strengthen the synergies for

499   cultural change in the long-term.[153]

500

501   *Study strengths and limitations*

502   The main strength of the review was using several systematic database literature searches, which was

503   complemented with additional grey literature searches of known online education articles and websites.

504   However, a limitation is that scoping reviews only map the evidence and do not assess the quality of the

505   articles or risk of bias. Most of the database articles had an international focus, with most of them from

506   USA, Canada (28.0%) and other international countries (27.2%). For a large proportion of the grey

507   literature, it was not possible to ascertain the articles countries region. Moreover, on a pragmatic basis,

508   news items from news organisations based outside of UK, Europe, Norther America, and Australia were

509   excluded, which along with the exclusion of non-English language documents means that other initiatives

510   being used to improve research culture may well have been missed. On this basis, there could have been

511   international and regional biases, but it could also be that there is a lack of evidence from these regions

512   rather than missing articles from the systematic searches.

513   The review found more than 200 articles from the systematic database searches (n=253) and more than

514   100 from the grey literature searches (n=102) which suggested that there is growing literature around

515   what constitutes a 'good' research culture and what this could look like. However, as the literature has

516   shown, progress has been slow and although the evidence provided several examples of established

517   initiatives and networking opportunities, the evidence was more anecdotal, and opinion focused.

518

519   ***Conclusions***

520   The review has shown that there is a wealth of evidence suggesting how and where changes are needed

521   to establish a global cultural change to the research ecosystem. However, research organisations cannot

522   act in isolation. Individuals, research organisation and funding organisations need to be responsible and

523   work together; to uphold and ensure fair and transparent policies and governance. Change will not

524   happen overnight, but by working together in a collaborative and diverse way to ensure all views, opinions

525   and expectations are fully inclusive that strengthen and enhance research culture for the better.

526   The barriers to a sustainable research culture are complex and underneath linger more multi-faceted

527   challenges, such as the impact on the wellbeing of research staff, resistance to innovation, equity for

528   research institution staff and career progression.[28, 62, 64, 85, 195, 260, 336] Adding to the complexity is the

529   increasing pressure for academic institutions, research groups, disciplines, and researchers to

530   demonstrate impact. The growing focus on performance measures has undoubtedly caused unintended

531   consequences for the whole research ecosystem. This model is not sustainable, not only for the quality of

532   research and trust in research, but also for the next generation of talented researchers. Researchers are

533   leaving academia, leaving behind a career that should be fostering innovation and building research

534   capacity at its core. Removing such barriers and adopting best research practice and enhancing the

535   diversity of opportunities for all is ultimately down to everyone working within the research environment.

536

537   **Supporting information**

538   **S1 Appendix.** Search terms and keywords (docx)

539   **S2 Appendix.** PRISMA checklist (PDF)

540   **S1 Table.** Database search examples (docx)

541   **S2 Table.** Full details of the included database articles (PDF)

542   **S3 Table.** Full details of the included grey literature articles (PDF)

543

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550   phase for grey literature searches using Lexis-Nexis.

551

552   **Availability of data and material**

553   All relevant data are provided in the article and the supporting material files.

554

Competing interests

556   The authors declare no competing interests exist.

557

562

Authors' contributions

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574

Abbreviations

576   AI   artificial Intelligence
577   CCB   Complementary Capacity Building

578	COPE	Committee of Publication Ethics
579	COS	Center for Open Science
580	COVID-19	Coronavirus Disease
581	CRediT	Contributor Roles Taxonomy
582	CV	Curriculum Vitae
583	DEI	Diversity Equity and Inclusion
584	DORA	Declaration on Research Assessment
585	ECR	Early Career Researchers
586	EDI	Equality Diversity and Inclusion
587	ENRI	European Network of Research Integrity
588	FAIR	Findable, Accessible, Interoperable and Reusable
589	FTC	Fixed Term Contract
590	HEI	Higher Education Institution
591	HEP	Higher Education Provider
592	INORMS SCOPE	International Network of Research Management Societies (INORMS)
593	ISRIA	International School on Research Impact Assessment
594	JBI	Joanna Briggs Institute
595	JSTOR	Journal Storage
596	KPI	Key performance Indicator
597	LMIC	Low Middle-Income Countries
598	MyNRMN	National Research Mentoring Network
599	NA	Not applicable
600	NHS	National Health Service
601	NIC	Networked Improvement Community
602	NRMN	National Research Mentoring Network
603	OA	Open Access
604	OKI	Open Knowledge Institutions
605	OIS	Open Innovation Science
606	ORBIT	ORCID's Reducing Burden and Improving Transparency
607	ORCID	Open Researcher and Contributor IDentifier
608	OSF	Open Science Framework
609	PEER	Persons Excluded from science because of Ethnicity and Race
610	PhD	Doctor of Philosophy
611	PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-analyses extension
612		for Scoping Reviews
613	QPP	Quality Publication Practice
614	REF	Research Excellence Framework
615	RFO	Research Funding Organisations
616	RoRi	Research on Research Institute
617	RPO	Research Performing Organisations
618	RRP	Responsible Research Practice
619	STEM	Science, Technology, Engineering, Mathematics
620	STEMM	Science, Technology, Engineering, Mathematics and Medicine
621	TOP	Transparency and Openness Promotion
622	UK	United Kingdom
623	UKRI	UK Research and Innovation
624	UKRN	UK Reproducibility Network
625	USA	United States of America
626	WoS	Web of Science

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627

628

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