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Authors, wordsmiths and ghostwriters: Early career researchers' responses to artificial intelligence

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Abstract: Presents the results of a study of the impact of artificial intelligence on early career researchers (ECRs). An important group to study because their millennial mindset may render them especially open to AI. We provide empirical data and a validity check of the numerous publications providing forecasts and prognostications. This interview-based study—part of the Harbingers project on ECRs—covers a convenience sample of 91 ECRs from all fields and seven countries using both qualitative and quantitative data to view the AI experience, engagement, utility, attitudes and representativeness of ECRs. We find that: (1) ECRs exhibit mostly limited or moderate levels of experience; (2) in regard to engagement and usage there is a divide with some ECRs exhibiting little or none and others enthusiastically using AI; (3) ECRs do not think they are unrepresentative when compared to their colleagues; (4) ECRs who score highly on these measures tend to be computer scientists, but not exclusively so; (5) the main concerns regarding AI were around authenticity, especially plagiarism; (6) a major attraction of AI is the automation of 'wordsmithing'; the process and technique of composition and writing.

INTRODUCTION

We report here on an exploratory study, in preparation for a more expansive international study. It investigates the impact of Generative AI on junior researchers from the sciences, social sciences, and the arts & humanities—the latter much neglected. The data was collected from open-ended, in-depth interviews with a convenience sample of 91 ECRs mainly from China, Malaysia, Poland, Portugal, Spain. We sought to discover what experience they had with AI, including what they defined to be AI, their level of engagement and application. We also asked what concerns they had and sought to gauge how representative they were in comparison to their colleagues. In the presentation here, we have quoted their own words as much as possible. Only by doing so can we convey the variety of attitudes and personality of our respondents.

It should be noted that we were not interviewing just experts or specialists in 'AI', the views of those who are uninterested, uninformed or passive may be just as influential on future developments. Also, although ChatGPT was of current interest it is just one example of Generative AI, and that in turn only a sub-set of what may be considered as Artificial Intelligence.

The Harbingers study of early career researchers (ECRs), their work life and scholarly communications, began by studying generational change in 2016, then moved to pandemic change in 2020 and is now investigating another potentially huge agent of

change: artificial intelligence (AI) (2024–), the focus of this paper.[1] The paper constitutes a companion paper for one published in this journal on ECRs, AI and scholarly communications (Nicholas et al., 2024).

AIMS

Because of the exploratory nature of a preliminary study and the novelty of the subject our prime interests were the opportunities, issues and ECRs take-up of the technology. Our main research questions were:

- What is ECRs' experience of 'AI'—both within and beyond academic or work context?
- What kind of 'AI' are they talking/thinking about? (In affect letting ECRs define the field)
- What is the extent of their use and engagement? Who are the superusers?
- How do they view 'AI' and to what purpose do they use it?
- Are they concerned about the use of 'AI' in any way?
- Do they think their experience and opinion of 'AI' typical when compared to colleagues?

SCOPE AND DEFINITIONS

Early career researchers

Lacking a universally accepted definition, a pragmatic concept of the ECR has been adopted. It focusses on common factors: being employed in a research position, being relatively young, in an early phase of their career, not yet established as permanent faculty. Thus, researchers who are generally not much older than 40,[2] who either have received their doctorate and are currently in a research position or have been in research positions, and are currently doing a doctorate. In neither case are they in established or tenured positions.

Subject

Throughout the Harbingers project, we have covered science and social science ECRs; with this study we had the fortunate opportunity to include the Arts & Humanities. Given the relatively high numbers included (23, a quarter of the cohort), we can make some tentative comparisons with other disciplines.

Key points

- Fills a big knowledge gap on artificial intelligence (AI) and early career researchers with empirical data on their experience, usage and attitudes.
- Scholarly integrity and ethics were a big concern with issues of authenticity, plagiarism and cheating being raised.
- What appears a major aspect of Generative AI is the automation of 'wordsmithing' and a prospective 'Ghost Writer in the Machine'.

Country

While a collaborative international study, including China, Malaysia, Poland, Portugal, Spain, and a small sample of the United Kingdom and United States, given the differences in the size of the national cohorts, country comparisons can only suggest things for the planned further study.

Artificial intelligence

Artificial Intelligence has no firm or formal definition, consequently, when asking about attitudes to and anticipations of the place of AI it necessary to consider—'what do you actually mean by AI' and we had several questions which explored that. The responses to these questions suggest a variety of software and 'apps' are considered by some to be 'AI'. From those responses, we sought to establish differences and similarities in definition. Essentially, seeking definition by literary warrant.

Our immediate interest was Generative AI, especially large language models (LLMs) of which ChatGPT has become best known. Generative AI can be seen as creating an output based on a massive collation and synthesis of texts, and images. The output can be very plausible—a convincing and realistic fiction—but is in essence an aggregate, a mash-up. In essence, the process is statistical, the output text is plausible because the words are arranged in ways that match the probabilities derived from the training input. But the process tends to be occult, there is no facility to determine, verify, or analyse the logic or 'reasoning' of the process. Contrast that with 'symbolic AI' (McCarthy, 1958; McCarthy et al., 1955) and cybernetics (Wiener, 1961) where there is an 'audit trail'—an algorithm that may be verified or an activity that can be tested and demonstrated to work. With Generative AI, we must judge appearances, what is presented: truth or fiction?

LITERATURE REVIEW

The past 2 years have seen much hype directed towards generative AI systems and tools, among which those based on LLMs, such as ChatGPT, have been attracting the most attention. Unsurprisingly, perhaps, for ChatGPT and similar tools, capable as

[1]A short account of the Harbingers studies and a list of publications arising out of all three rounds can be found at ECRs_Harbingers_3_publications-20230912 (4).pdf.

[2]While this was true for H-1 and H-2 more ECRs in their forties are in H-3 because our cohort aged.

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they are of producing ostensibly human-created new content on any topic in response to natural-language queries, do meet an important need for many. In fact, ChatGPT's 1 million users within the first 5 days of its release heralded a shift in public AI recognition and popularity, both of which have been steadily growing ever since. Thus, a survey from Ipsos on global attitudes towards AI products showed that in 2023 the proportion of those who thought that AI would dramatically affect their lives in the next 3–5 years had grown from 60% to 66% (Maslej et al., 2024).

Usage has been growing in tandem with the changing attitude to AI (despite concerns, a point we will come to later): for example, according to a Pew Research Center (2024) survey, conducted in 2024, Americans' use of ChatGPT is ticking up, with 23% of U.S. adults saying they have used it, up from 18% in 2023. A 21-country survey from the University of Toronto suggests that by the end of 2023 international use was even more impressive: 63% of respondents were aware of ChatGPT and of those aware, around half reported using ChatGPT at least once weekly (University of Toronto, Schwartz Reisman Institute for Technology and Society, 2024). Importantly, in the context of the research reported here, which focusses on ECRs, in the Pew survey it is adults under 30 among the users who stand out, with 43% of them having used ChatGPT, up 10 percentage points since the previous summer, as do highly educated adults, with 37% of those with a postgraduate or other advanced degree most likely to have used the chatbot, up 8 points from the 2023 survey.

It is, of course, the natural inclination of today's ECRs, as digital natives born into an internet-centred and media-rich world (Prenksy, 2001a, 2001b), to find all digital technologies appealing. They are also millennials, a cohort that is characterized by openness to change, flexibility and adaptability (Duffy et al., 2017). However, perhaps above all, with scholarly success in terms of employment, tenure, promotions, resources, job mobility, awards/prizes and monetary remuneration hinging on research productivity, the most important incentive for them to embrace AI must be the direct performance increases that have been shown to result from knowledge workers' employing artificial intelligence-based tools (AlZaabi et al., 2023; Dell'Acqua et al., 2023; Dwivedi et al., 2023; Imran & Almusharraf, 2023; Van Dis et al., 2023). Indeed, the scholarly world is slowly but surely awakening to the potential capabilities of AI-based tools and systems to enhance each constitutive part of the research process (Grimes et al., 2023; Herman et al., 2024), although for the time being their appreciation of the affordances of AI tends to be more theoretical.

Still, if in 2023 researchers had only begun to try out ChatGPT, using the chatbot more for 'creative fun' than to help with their scholarly pursuits (Owens, 2023), in a few months' usage of AI-powered novel techniques and platforms for research purposes has become more prevalent, if still far from being ubiquitous. Thus, in a *Nature* survey of 1600 international researchers, ChatGPT and its LLM cousins were deemed the most impressive or useful AI tools, expected by more than half of the respondents to become very important and even essential for their fields in the next decade. Nevertheless, researchers who used regularly LLMs for work purposes were still a minority, even among researchers interested in AI or studying AI (Van Noorden & Perkel, 2023).

The findings of a survey, conducted by the ERC - European Research Council (2023) among its more than 1000 grantees, again pointed to the optimistic views held by researchers when it comes to the future of AI-associated scholarly undertakings: notably, 81% found it 'highly likely' or 'likely' that AI-human collaboration would become widespread in the scientific process, and 75% thought to knowledge sharing and interdisciplinary work within and across scientific fields. However, at least where data analysis is concerned, AI tools were already seen as an essential tool and used, with their employment for the purpose very much discipline-specific.

A survey of UK academics, which explored their utilization of AI within the wider framework of the ways they opt for to alleviate their employment insecurity, also indicated that interest in AI tools was widespread among the participants, with 83% anticipating greater use in the future. However, only 52% said they were AI users, with a similar percentage—48%—saying they were not (Watermeyer et al., 2023). By the same token, a study, which investigated how digital humanities scholars adopt, practice, as well as critically evaluate AI technologies, such as ChatGPT, in their research, found divisive sentiments towards the value of AI in scholarship, mainly because of the ethical risks involved (Dedema & Ma, 2024).

As to the age-associated differences in the views held on AI adoption: in the scholarly world, too, the younger cohorts are more enthusiastic supporters of AI-powered tools. For example, an exploratory study into the use of ChatGPT in education, research and healthcare found that junior academics were not only more interested in using the technology than senior faculty, having more positive views, interest, and acceptability beliefs in using it, but more of them had already tried it, too (Hosseini et al., 2023). Similarly, in another *Nature* survey, this time covering postdocs, 31% of employed respondents reported using chatbots, with 43% of them doing so on a weekly basis and 17% daily, even if for most (67%) AI brought no change in their day-to-day work or career plans (Nordling, 2023).

METHODS

Recruitment of interviewees

National interviewers from China, Malaysia, Poland, Portugal, Spain, United Kingdom and the United States, recruited ECRs using their local research networks and connections supplemented by mail-outs from scholarly publisher lists. For the preliminary study, our intention was to interview 10 ECRs in each country, however, this changed to accommodate opportunities and constraints. Malaysia, Portugal and Spain did recruit to the target of 10. However, in China it turned out to be a very hot topic and 22 ECRs were recruited. In the case of Poland, we were

TABLE 1 Demographic breakdown of cohort.

Discipline										
	CHEM	ENV	HUM/ARTS	LIFE	MATH	MED	PHY	SOCH*	SOCS**	Total
N	7	4	23	6	9	12	16	5	9	91
%	8%	4%	25%	7%	10%	13%	18%	5%	10%	100%
Country										
	CN	ES	GB	MY	PL	PT	US			
N	22	10	3	10	31	10	4			91
%	24%	11%	3%	11%	35%	11%	4%			100%
Age										
	Youngest (26–30)	Younger than most (30–34)		Median (35–37)	Older than most (37–39)		Oldest (39–51)	N/A	Median	
N	18	18		18	18		18	1	36	91
%	20%	20%		20%	20%		20%	1%		100%
Gender										
			Male	Female						
N			43	48						91
%			47%	53%						

* Includes Economics and Business, Geography and Psychology.
** Includes Anthropology, Politics and Sociology.

fortunate to obtain local funding to include an extra 22 from A&H (National Science Centre in Poland, grant: 2022/45/B/HS2/00041). The United Kingdom and United States were represented by just seven ECRs due to time constraints. France, although originally part of the project found it impossible to recruit any ECRs, interestingly, because of their fear of providing their opinions 'on the record'. Given the exploratory and qualitative nature of the study this imbalance it was not considered to be an issue, particularly given the importance of China internationally and the attraction of extending the study to A&H ECRs in the case of Poland. In total 91 ECRs were recruited, relatively large for a preliminary study. Interviews were conducted between November 2023 and January 2024.

Interviewees included both ECRs who participated in Harbingers-2 and were happy to continue (26) and new ones, recruited to fill the ranks of participants who had left research, no longer qualified as ECRs, or declined because of work commitments or lack of interest.

The breakdown of the ECR cohort by country, discipline, gender and age band are given in Table 1. Note the age distribution of the cohort and especially how many relatively old researchers there are. This being a preliminary study, for convenience we retained ECRs from previous stages of the project and hence they are all a year or two older. Also, it is the nature of academic, or indeed any employment, that while not everyone moves forever upward some have very recently become tenured.

The broad disciplinary breakdown is: Science 54 (59%); A&H 23 (25%); social sciences 14 (16%). So, we are strong on science, sound on A&H and weak on social sciences. The imbalance can be explained by the interest of the funders of H1 and H2 in sciences and for this (H3) preliminary study the funding of A&H in Poland from government sources.

The youngest ECR is 26 years, the median age 36, and there is a long tail to the oldest at age 51. But the median quintile is quite narrow (34–37) and 60% are aged between 30 and 39. Although Poland has the oldest ECR, the country tends to have a slightly younger balance overall. China also tends to have a younger cohort, and that while most are male all the females fall into the youngest 20% overall. Maths and Physics ECRs are predominantly male, younger and most likely come from China. Whereas for Social scientists (soft) the youngest tend to be female.

Data collection

Semi-structured, free flowing interviews lasting 60–90 min were the main source of data and this was supplemented by the in-country knowledge of the national interviewers, who were in the main research professors. The interview schedule consisted of seven pages of questions,[3] covering broad AI matters, general scholarly communication questions and questions about the impact of AI on scholarly activities. This paper concerns just the preliminary questions, which covered AI in general. ECRs were asked about their knowledge of AI in general not just in the context of scholarly communication. 'Intelligence', artificial or otherwise, is a broad concept which is hard to pin down, so this

[3] https://ciber-research.uk/download/ECRs_Harbingers%203_Pilot%20Interview_schedule_1610DN.pdf.

preliminary 'AI' section was intended to gauge our interviewees' prior knowledge and experience of 'AI' and how they defined its scope, so that responses and observations in the succeeding scholarly communications section could be understood and explained in context. Overall, it could tell us if we had an informed and experienced cohort or not. These questions also conditioned ECRs for the scholarly communications questioning that followed, the results of which have already been published (Nicholas et al., 2024).

Interviewers sought to gather a broad view of 'AI', but remained alert to potential confusion and hearsay. They were also tasked to distinguish between, a 'wish list' of things people believe or would like AI to do, and what it can do. The questions designed to be open and free-flowing: ideally, we sought a broad conversational answer gathered without too many leading questions. We hoped to gather quotable texts and commentary, not monosyllabic coded responses.

A guide document, was provided for interviewers which furnished an explanatory background and possible prompts if the conversation stalled.

There were six lines of questioning which match the project's six stated aims. A full list is provided in the results section.

Data analysis

All interview transcripts, accepted by ECRs were translated to English where necessary and transferred by the national interviewers to a coding sheet, which closely matched the questions of the original interview schedule, but left room for information derived from additional enquiries or clarifications during the interview process. The translated transcript and coding were then transferred to a database that enabled full-text retrieval of transcripts, notes, coding and thematic analysis.

RESULTS

Our analysis of the interview data looks at AI from several perspectives and applyies several methods. There are four parts to the results section: (1) a description of the key questions and a summary of responses; (2) an exposition and comparison of various themes that were found running through the responses; (3) an examination of 'superusers'—respondents who offered an informed, extensive, and notable commentary on the subject; (4) an analysis of AI platform mentions.

Topics covered by the questions

The interviews began with questions about experience, engagement, utility and attitudes regarding AI. These general questions, with accompanying prompts and guidance are the main data source for this paper. They are described here with some summary observations of the overall responses obtained. It needs to be stressed that our methods favour broad questioning and an open and free flowing conversation, so that responses can overlap. Furthermore, the questions as written are quite long and detailed, but when asked in interview were somewhat softer and in many cases in a different language. Much of this section consists of quotations; the essence of qualitative studies is to be found in quotes, which can carry subtext and nuance.

AI experience/encounters

The question asked was: 'What, if any, is their experience of, or at least encounters with 'AI'—not just in an academic or work context'. If so, what kind of 'AI' are we talking about? Anticipating a varied notion of what constitutes 'AI' and wide differences in exposure we needed to establish a context for subsequent questions.

Many responses to the question mentioned ChatGPT; this pre-loading of the context was not unexpected; at present, it is difficult to discuss AI without such association. We found a range of responses from professed total ignorance to undoubted enthusiasm. What stands out is the extent to which it is being used as an aid to writing and translation, what we will refer to for want of a better term as 'wordsmithing'. For instance, this from a Polish humanities ECR:

> I know that artificial intelligence is increasingly entering all areas of life. Personally, I don't use AI. I use DeepL and Grammarly if I'm writing a text in English, but I don't know if that can be counted as AI.

Also notable, is the awareness that AI is already embedded in many mundane activities; to what extent this is advanced computing, let alone AI, may be questioned, but we sought literary warrant for examples of 'AI' and that is what entails. In terms of 'AI' as advanced computing the most notable applications other than text processing appear to be data analysis, medical imaging and visualization. This comment from a Malaysian computer scientist:

> In my data science research, I use AI to extract meaningful insights from complex datasets. Use AI tools for data analysis, with emphasis on predictive modelling, data visualisation, and optimisation techniques. My research now applies predictive analytics to healthcare data, to forecast patient outcomes, to help the clinicians in making proactive and personalised treatment decisions. Also use text mining and sentiment analysis to extract insights from unstructured clinical notes, medical literature, and patient records.

Extent of AI use/engagement

The question: 'What is the extent of their use or engagement'. The follow-up prompts, only used if needed were: Played with ChatGPT; Have 'AI' features in their web browser and, if so have they used them?; Used 'AI' to detect gaps in knowledge in order to locate a topic for new research and to construct hypotheses; Used 'AI' as a tool in their own work: as a try-out,

as an auxiliary method, is a key element of work, current research is an 'AI' project; Used 'AI' to assist in data analysis and debugging code for data analysis; Used 'AI' to assist in qualitative research: to identify patterns and trends within large data sets, to extract meaningful information from text, to code responses; As an additional tool, that will be embedded in their tool box, with no specific purpose, but that can be used when necessary for a task.

The responses to this question tended to be an extension of what had already been said. In sum, we had some 'superusers' and some non-users, but in-between a lot of trials with ChatGPT, an awareness of 'AI' in everyday things, and a lot of wordsmithing and ghost writing. For instance, this comment from a Portuguese chemist:

> Essentially to review the writing of documents when they are written in languages other than the native one. Very occasionally to improve the writing and clarity of texts and in bibliographical research.

And this one from a Portuguese humanities ECR:

> Regularly. I would even say dependently. I've tried Google's Bard and Bing's chatbot. I've used AI to strengthen logical arguments. ChatGPT is useful for pointing out basic flaws in reasoning. I use AI as a tool, but it's not a key element. It's a good starting point that can give us models, create skeletons and revise/translate texts. In this context, I often use Grammarly and ChatGPT occasionally.

Views/opinions on AI

The question: 'How do they view 'AI'. The follow-up prompt used if necessary was: for instance, as a thought provoker; as provider of a supplementary view or data point; as a short cut to something that can be independently verified; as the supplier of missing but not critical information; it is essential to the task; 'AI' is their research project.

This question was notable for one very long, learned and considered response from a computer scientist from China where a concern with authenticity and authority was very apparent:

> Firstly, the sheer volume of data it uses is enormous, and some of that data may not be legally certified. There are ongoing efforts in our country regarding standardisation work for this type of production, but some aspects are still being improved. In this process, especially for beginners and young people, it might be challenging to judge whether the information is beneficial or harmful. Therefore, some level of filtration is crucial. […] This poses a significant threat to our societal and public safety, leading to various problems, ranging from negative political influences to personal scams.

In general, there was also evidence of confusion between what AI does and what it might do; it is very difficult in any discussion of AI to separate anticipations from actual experience. Thus:

> It facilitates the functions of the human being in almost all areas. But the greatest interest I see in it is its application to the medical environment, being able to support doctors' diagnoses or even anticipate them and thus avoid major complications. [Spanish computer scientist]

> I am excited about the prospect of using generative AI to enhance the quality of academic writing and publishing. Still exploring automated proofreading, citation analysis, and content summarisation, I think this could significantly contribute to the extra oomph to scholarly publishing. [-Malaysian life scientist]

> I view AI rather positively. I see it not so much as an inspiration, a stimulant of thought or an opportunity to supplement deliberations, but rather, above all, as a chance to free researchers from the monotonous work involved in, for example, the manual annotation of research material. In my discipline, however, AI is unlikely to bring some kind of revolution. [Polish humanities ECR]

> Useful for technical aspects, useful for optimisation/engineering, useful for finding information, not useful for scientific research itself, in the sense of trying to understand reality and causality. [Portuguese physical scientist]

Then there is this comment from a Portuguese life scientist who points to the dichotomy between the usefulness and potential danger of AI:

> In general, I see IA as a useful tool, especially in research. However, it should be used with the necessary precautions, always taking care not to introduce information or data that has not yet been made public and that we intend to publish. Finally, we should always be critical and validate the answers given by the IA by other means. I am also aware of the flip side of the coin in that AI is a very powerful tool that in the hands of malicious people can be a very dangerous tool.

Concerns about AI

The question was phrased as: 'Are they concerned about the use of 'AI' in any way'? If so, why? Follow-up prompt if needed was: If their concern is about what might happen rather than something they have observed or experienced to-date:

a. Do you think they will come about (now, in a year or two, this decade, in your working lifetime);

b. In general, would these speculative uses be a good or bad thing?

Discussion here becomes more parochial, with concerns about plagiarism and cheating generally in the context of academic outputs. This, for instance, from a Polish humanities ECR:

> Graduate theses are already slowly becoming meaningless, we have neither the time nor the tools to verify them. (…) I'm afraid that AI will get to such a level of sophistication that I won't be able to recognise a scientific paper created with AI tools, and this is very likely because scientific language is quite simple, 'dry'. I am afraid that it will not matter whether the text was created by a human or a machine. In about 10 years, this nuance will be gone, that's what I fear, we are in danger of intellectual simplification.

And this from a British chemist:

> The level of English amongst many international MSc students is already very low and AI makes it easier for them to complete coursework without needing to learn English. If they understand the chemistry does this matter? What do employers expect from a student with a degree from an English university?

Also, from another Polish humanities ECR:

> …privacy risks (control over the content reaching the recipient and selection of content based on the recipient's preferences, access to private content, location, etc.). In addition, loss of control over the computer system is possible. Autonomous cars, for example, scare me.

There is, perhaps, a deeper theme running beneath all this—not really 'AI', but a symptom of late-modernism, of virtualisation and detachment from reality. What one ECR referred to as a 'post-truth era' and another to 'a failure to distinguish between information and knowledge'.

> We are all living in a post truth era and but information online has been coming from a person whom you may know and trust but falsified images make life difficult. There is general distrust in experts and he is an expert and he loses his role. [British life scientist]

> …a failure to distinguish between information and knowledge… [Portuguese physical scientist]

These two ECRs are echoing previous concerns:

> We could lose even more of our ability to distinguish between what is authentic and what is fabricated. [Portuguese life scientist]

> The fact that it brings a false sense of knowledge and nullifies the capacity for critical thinking, reflection and systemic analysis. [Portuguese environmental scientist]

Finally, a Portuguese mathematical scientist raised something that might have been in the back of many minds, would AI lead to job loss or job gain:

> Yes, especially generative AI and its ability to generate erroneous (through hallucinations) or false information. Something that also worries me is the trust that the population is gaining in 'AI' and, after a while, they tend to trust blindly when they are not in the know. Finally, the loss of some jobs, although in this case the 'AI' itself may create some 'new' jobs, so this concern may not be so prevalent.

In AI terms how representative are they?

'Do they think their experience and opinion of 'AI' are typical when compared to colleagues and friends'? Advice to interviewer was: It is not the intention of this question to be a proxy interview of others. We are asking if they think they are atypical in their attitude to or use of AI.

This question proved difficult to answer for many, to some extent a cultural factor, being unwilling to comment on others. On the whole no great divergence was apparent. Some noted a difference where co-workers shared much the same outlook, but friends and wider acquaintance presented more differences.

> People in my work environment tend to share these opinions. On the other hand, family and quite a few friends rather think that such systems can be a kind of threat, or competitors in the labour market. Their opinions are built on what the media reports, and in my opinion, certain technological possibilities are very often exaggerated in the media. [Polish mathematical scientist]

> In my circle of people around 40 years old, many use AI in a similar way as I do, that is, mainly translator as an aid to writing letters, applications, emails. You can choose the style of such a letter, whether it should be more or less formal. [Polish humanities ECR]

> I observe two opposing positions among my colleagues from work (academic teachers) and school teachers with whom I have contact. On the one hand, this is the position that AI poses only threats. The arguments include, for

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> example, plagiarism of works, fraud, spreading fake news, etc. On the other hand, scientists and teachers are looking for ways to wisely use AI in education and science, they treat AI as a tool that can improve scientific and teaching work. Personally, I am closer to the second position. [Polish soft social scientist]

Overall AI characteristics and demographic differences

For the AI questions about experience (B01, B02), engagement (B03), utility (B04) and representativeness (B06), we experimented with a coded analysis to assess the overall characteristics of our cohort. The coding was not a question to be asked of the ECR, but a comparative assessment by the interviewer of the ECRs responses where that individual stood regarding the whole group. A Likert type scale (0–9) was used where 0 is equivalent to a null response (NA) and there was a general progression from least (1) to most intensive or positive (9). For values between 1 and 9, interviewers were asked to make a relative judgement by comparing to the other ECRs they interviewed. A 9-point scale is too fine grained, especially in view of the small sample, so our interviewers were advised to grade over the full 0–9 range, but not necessarily at all points on the scale.

Thus: Experience (B01): 0 = nothing to say, no interest and 9 = an AI researcher; Engagement (B03): 1 = 'Played with ChatGPT'—9 = 'current research is an AI project'; Utility (B04): 1 = inessential—9 'AI is their project'; Representativeness (B06): 1,2 'more resistant, sceptical'; 3,4 'less interested, cautious'; 5 'typical, average'; 6,7 'more interested'; 8,9 'enthusiast, early adopter'.

With all these questions the coding and grading was not of the essence, our prime concern was to record what the ECR said. As an example, on the topic of representativeness this ECR was coded as four 'cautious' on basis of this quote:

> My colleagues have similar experiences and opinions to mine, but my friends (non-researchers) end up using AI more nonchalantly and even see it as a business opportunity with little effort through the rapid generation of content that can be sold. It's also a means of leisure.

And this illustrative comment from the interviewer: *This ECR was a AI beginner and a pessimist one. His quotes are crystal clear.*

Of course, as a subjective measure, it may reveal as much about the perspectives of our diverse interview team as about the ECRs. Indeed, this was in part its original intention. So, the data was reviewed by a third party to detect obvious issues and in a few cases moderate and provide a second opinion based on the transcript alone. An overview is presented in Fig. 1. It shows the cohort to have limited or moderate experience (peaks at 4), not unexpected given the novelty of LLMs. Regarding engagement there is a divide with some exhibiting little or no use and others enthusiastic users of the technology. In contrast with engagement, we have peaks at 1, 3, 5 and 7. Utility data shows a similar pattern to engagement. AI seems a bit like view about Marmite you either like it a lot or not at all. Determining how representative they are is difficult to determine as few in China responded to the question, but it appears that ECRs overall do not think they are unrepresentative.

Experimental and subjective, this approach nevertheless has been useful in sifting and collating the many varied responses; one product of which is the identification of 'superusers' which we cover in a later section of this report.

For the three key questions on experience (B01), engagement (B03) and utility (B04) we have provided a more detailed breakdown of the data by age (Table 2a), gender (Table 2b), subject (Table 2c) and country (Table 2d). Regarding age, the median group (35–37) score the highest, but there are some weak signs that the older cohort score lower than the younger ones. There were no differences according to gender. As to subject, not surprisingly the mathematical sciences including computing, are most advanced and medical scientists are well behind. In country terms, Poland and Malaysia score the highest (both over 5) and we must discount the United States and United Kingdom because of the low cohort numbers. If we drill down deeper into the data, in terms of experience Malaysia has a higher percentage of experienced or perhaps enthusiastic AI researchers and China has the least. Malaysians also appear to be more engaged, but contrast with Poland, equally engaged, but more sober in their comments. In terms of utility and value, the Poles are somewhat ahead of the other countries and the Chinese lag. The 'Representative' question proved difficult to evaluate as the Chinese tended to duck the question. It appears the Portuguese were more likely to think they were ahead of the game.

Malaysians are certainly enthusiastic, but as with our WhatsApp study (Clark et al., 2024) can seem somewhat immature. The addition of 22 Poles from A&H has brought a lot of high-quality commentary, broader experience and, compared with Malaysia, they seem much more sober in their attitude, yet also in their own way just as engaged.

The Chinese response is odd and after consultation with our local interviewer, we can offer this explanation. The interviews in China were early in the project (December 2023) when the publicity around LLMs and ChatGPT was at a peak, however China has strong restrictions on internet use and using virtual private networks (VPNs) to access foreign tools is illegal, so there was far less impact there.

> …developing [our] own large-scale models, seem very commendable. By having control over such tools, ensuring data security, and utilising them for analysis while filtering out suspicious data, it becomes a valuable resource. However, directly using foreign tools for analysing data related to people's lives seems imprudent. [Chinese mathematical scientist]

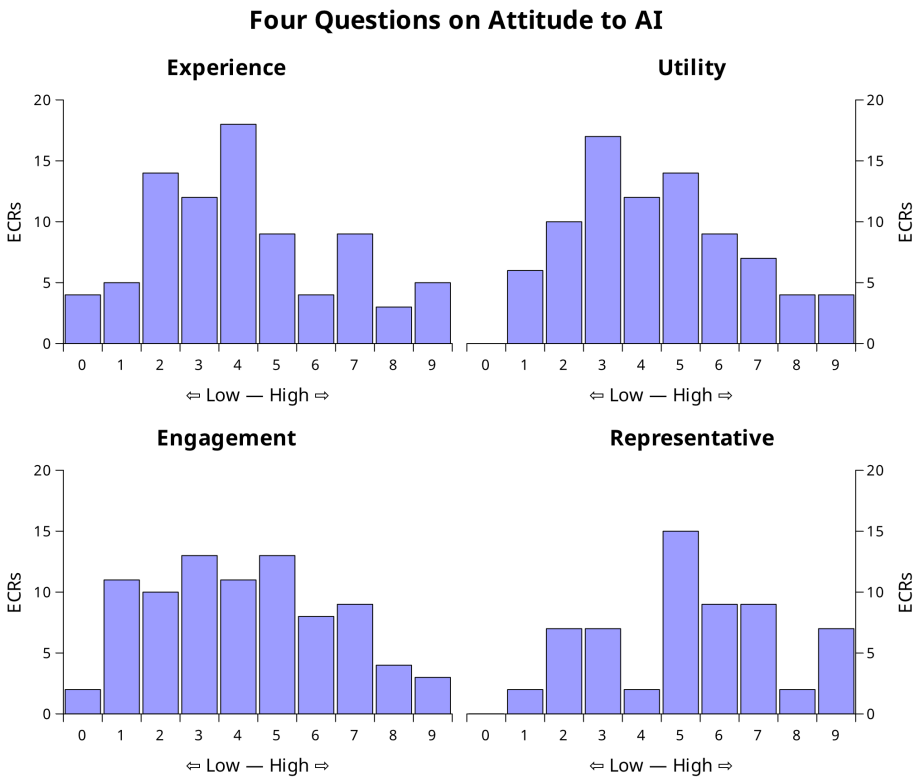

FIGURE 1 AI experience, engagement, utility and representativeness of ECR cohort.

TABLE 2a Scoring of three key questions by Age (quintile ranges).

Age	Ages	ECRs	Experience	Engagement	Utility	Average score
n/a	–	1	4.0	5.0	3.0	4.0
Youngest	(26–30)	18	4.1	4.6	4.2	4.3
Younger	(30–34)	18	4.1	3.9	4.2	4.1
Median	(35–37)	18	4.9	5.1	5.8	5.3
Older	(37–39)	18	3.4	3.3	3.9	3.5
Oldest	(39–51)	18	3.9	3.5	3.8	3.8

TABLE 2b Scoring of three key questions by Gender.

Gender	ECRs	Experience	Engagement	Utility	Average score
F	43	4.3	4.1	4.1	4.2
M	48	3.8	4.1	4.6	4.2

Many of those we interviewed in China worked in fields such as computer science, information science, and remote sensing and mapping, all appeared very confident, both in their academic abilities and a belief that human capabilities were superior to the generative AI tools that were available at the time. There has been some change since; there are currently 200+ Chinese large model tools, among which more than 70 are specifically designed for scientific research applications.

The 'superusers'

Our cohort had mostly limited or moderate experience and engagement, which is to be expected given the novelty of the technology. But, using our grading of responses, were there any ECRs who could be considered pathfinders or 'superusers'? For this purpose, a superuser was envisioned as variously: engaged, an enthusiast, 'switched-on' to the current AI offering; had a

TABLE 2c Scoring of three key questions by Subject.

Subject (lowest to highest)	ECRs	Experience	Engagement	Utility	Average score
MED	12	2.8	2.4	3.2	2.8
PHY	16	2.4	3.6	3.9	3.4
SOCH	5	3.4	3.6	3.2	3.4
LIFE	6	4.0	3.2	3.6	3.6
SOCS	9	3.6	3.8	4.0	3.8
ART	5	4.2	3.6	3.8	3.9
HUM	18	4.4	4.0	4.2	4.2
CHEM	7	4.2	4.5	5.5	4.7
ENV	4	6.3	6.3	7.3	6.6
MATH	9	7.1	7.1	6.9	7.1

TABLE 2d Scoring of three key questions by Country.

Country (lowest to highest)	ECRs	Experience	Engagement	Utility	Average score
GB	3	0.0	0.0	0.0	0.0
US	4	0.0	0.0	1.0	0.3
CN	22	3.1	3.6	3.3	3.3
PL	32	4.0	3.8	4.1	3.9
ES	10	4.5	4.6	5.6	4.9
MY	10	4.8	5.3	5.0	5.2
PT	10	5.7	5.1	6.2	5.7

well-considered view of AI, but not necessarily positive; works on AI or shows significant technical knowledge. To identify them we sought those who scored the highest in three questions, the ones about experience, engagement and utility. We selected those whose average grade was 7 or more. There were 14 out of 91, so about 15% of our cohort were potentially 'superusers' (Table 3). There was a mix of countries involved, with China the most notable absentee for the reasons previously given. There was no notable gender or age difference. The presence of mathematics and computer science was not a surprise, but a full-range of subjects were found including the A&H.

At the top of the table, which can come of no surprise, was a 35-year-old Spanish artificial intelligence researcher. Two other Spanish ECRs high in the table were both marine sciences researchers who exhibit great interest in AI and are relatively older (39 and 43). The superusers from Malaysia were using quantitative methods to analyse large datasets, applying statistical techniques and machine learning algorithms to extract numerical insights and identify patterns in the data. But among the Polish superusers we find: a film-maker, a graphic designer and linguist. The first two exhibit a keen interest in technological innovations in their profession and the third participated in projects about language corpora. The Portuguese superusers come from a wide range of fields—mathematical sciences, soft social sciences and the humanities. AI is of interest to everybody regardless of fields. We also see here how for some there is no perceived separation of 'AI' from everyday uses of technology.

> In addition to the passive use I make of AI, namely by using SPAM filters or being targeted by the various intelligent algorithms offered by the social networks and streaming platforms I use, I also make active use of AI every day. It's impossible for me not to use my bank's app every day, with which I pay for almost everything, without using my card or physical cash. I also use the search engine and maps every day, as well as my phone's digital assistant and chatbots/artificial creation generators. [Portuguese humanities ECR]

Let us look now in detail at what the top two superusers (scoring 9 points) told us, both providing almost an essay on the topic. First a Spanish mathematical scientist:

> I do research in topics connected to AI. I consider myself to have quite a bit of experience in AI. I use it in my

TABLE 3 Description and breakdown of 'superusers'.

Respondent status	Country	Subject	Gender	Age	B01	B03	B04	Avg. score
Associate professor	ES	MATH	F	Median (35)	9	9	9	9.0
Senior lecturer	MY	MATH	M	Younger (31)	9	9	9	9.0
Invited assistant professor	PT	MATH	M	Median (35)	9	9	8	8.7
Associate professor	MY	MATH	F	Oldest (41)	9	8		8.5
Research associate	ES	ENV	F	Oldest (42)	8	8	8	8.0
Research and teaching assistant	PL	HUM	F	Younger (34)	9	8	7	8.0
Researcher, invited assistant professor	PT	SOCS	M	Median (36)	7	7	9	7.7
PhD student	PT	HUM	F	Youngest (28)	8	8	7	7.7
Research and teaching assistant	PL	ART	M	Younger (31)	8	7	7	7.3
Researcher	PT	MATH	M	Youngest (25)	7	7	8	7.3
Graduate researcher	ES	ENV	F	Older (38)	7	7	7	7.0
Senior lecturer	MY	MATH	F	Older (37)	7	7	7	7.0
Programme coordinator/fellowship	MY	CHEM	M	Median (35)	7	7	7	7.0
Research and teaching assistant, adjunct	PL	ART	M	Median (36)	7	7	7	7.0
Invited professor	PT	ENV	F	Older (38)	6	6	9	7.0

> research to solve different types of problems (medical, production, etc.) and I also teach machine learning classes. It facilitates the functions of the human being in almost all areas. But the greatest interest I see in it is its application to the medical environment, being able to support doctors' diagnoses or even anticipate them and thus avoid major complications. The only problem I see is that people do not use it ethically. More and more applications are emerging that are made so that everyone can use them, such as photo editing, video, voice, etc., and if we do not use them correctly, in the end we will not be able to trust anything we see. However, I see many more positive (and more important) consequences than negative ones. For example, its application in the field of medicine or in the performance of certain jobs to reduce time. My experience is like that of most of my colleagues and friends. Although not all of us think the same.

This Malaysian superuser who was a mathematical scientist was also researching AI related to medicine:

> In my data science research, I use AI to extract meaningful insights from complex datasets. Use AI tools for data analysis, with emphasis on predictive modelling, data visualization, and optimization techniques. My research now applies predictive analytics to healthcare data, to forecast patient outcomes, to help the clinicians in making proactive and personalized treatment decisions. Also use text mining and sentiment analysis to extract insights from unstructured clinical notes, medical literature, and patient records. I frequently rely on AI-driven summarization tools, such as OpenAI's GPT, to help me condense extensive articles or reports into brief summaries. This not only saves time but also enables a swift understanding of the document's main ideas.

Note that these two 'superusers' are both working in the medical field and thus show the limitations of our classification by 'broad disciplinary category' which classifies them as Mathematical scientists. Nor is it surprising that our 'real-AI-researchers' are working with medicine-oriented applications. CAT scans, MRI and so forth have been around a quite long time now, and endure long after the present buzz around ChatGPT has faded.

So, in some senses these are the least interesting of the high-flyers. They are not users but fabricators, producers and makers of 'AI' rather than consumers. The more interesting examples are those further down the list who are not AI researchers yet use it. It is among them that we find the predominant use of writing tools and, particularly in the Arts, image creation. Even in otherwise rather staid Poland, artists and humanists are using LLM-based AI to create as much as analyse and diagnose and are often appear closer to balancing pros and cons.

'AI' applications mentioned

Using a technique, we developed when looking at social media usage (Clark et al., 2024) we looked at what our ECRs mentioned in the scripts when talking about AI. Not presuming any conception of 'what is AI' but noting what themes emerge from the conversation; what 'apps', programmes, uses and abuses, come to

TABLE 4 Applications mentioned.

Terms mentioned	Number of mentions
ChatGPT	68
Generative AI	15
Google	11
Grammarly	8
LLM	6
Translator	6
Baidu	5
Bing	5
Midjourney	5
Nest	3
DeepL	3

mind when talking about AI. That is to seek a 'literary warrant' (evidence from use) to inform our definition and scope of AI. The results are given in Table 4:

ChatGPT is over-represented here (68 mentions); given that it initiated something of a 'Cambrian Explosion' of interest and investment in LLMs and prompted this research, it would be impossible to eliminate the element of prompting for comments about that particular application. That aside, the table covers only the 'section B' general AI questions, that is those specifically about AI, not scholarly activity in general, so the appearance of 'Google' and other not overtly 'AI' applications here does show how AI in practice does merge into the world of familiar and widely accepted applications. Note also that we have a mix of generic (e.g., Generative AI) and specific proprietary terms (e.g., Nest).

Perhaps, they key thing to note at this early and incomplete analysis is how LLMs are already integrated into the authoring process. Grammarly, for example does not immediately appear to be 'AI' and yet it is mentioned in this context quite frequently. AI in practice, here and now, is used just as spell-checking, autocomplete are used, as an automation of the more tedious parts of the writing process. It also features as a way around language barriers and even 'writers block'.

Indeed, we can see here a demonstration of the principle that there are arguably two motives for automation: because things are too hard, or because they are too easy. Spell checking, and so forth is not hard but boring, tedious. Adopting the right tone, even in one's native language, can be a hard task, why not let the machine provide guidance?

What follows examines ECR comments made in respect to the top 4 in the table.

ChatGPT

This interesting comment is from a Polish hard social scientist, who uses it as a sounding board, much as explaining a problem even to a non-expert can cause one to see one's own errors.

> In October 2023 I started to use AI—both in my academic and private life. When writing my dissertation, I happened to: ask which economist to quote (I took AI advice); ask me to write a text on the topic of one subsection (I did not take the comments, I did it out of curiosity); ask to check the stylistic correctness of the text and make any corrections (this is my favourite ChatGPT utility). Mostly I took the comments into account. On a few occasions the comments made no sense; ask for a synonym (here I feel disappointment because completely the ChatGPT did not cope). Disadvantages I discovered during this time: I also notice that ChatGPT sometimes creates neologisms, combining Polish and English. Unfortunately, ChatGPT also fantasises if it doesn't know what to write. It is not able to provide information on which specific scientific items to use and give definitions of some terms from textbooks.

This as well from A Chinese physicist, which shows flexibility in using Generative AI tools in a variety of jobs, while not blindly trusting it:

> I use it when I write my project application, and if I don't have any ideas, I can ask ChatGPT to give some information and polish, such as replying to the reviewer's comments and asking ChatGPT to put my thoughts in a euphemistic way. Because we may all have to be polite to reviewers

Google

Google has become almost a generic rather than proprietary term and it occurs with many variants, such as Google Assistant, ~Gemini, ~Nest, ~Bard, ~Meet, ~Translate and ~Scholar.

> Google products mostly use AI, like Google translate, Google Search it has a machine learning algorithm to recommend articles and even Google Map, uses AI. [Malaysian computer scientist]

> Virtual assistants, personalised recommendation, language translation. Our students heavily rely on Google Translate and now ChatGPT to translate abstracts into Malay or even entire papers in a seconds. [Malaysian computer scientist]

> I might not be aware of it, but yes, I believe AI is extensively utilised in searching and discovery behaviours, especially in platforms like Google and various online databases. Google, being one of the most widely used search engines, heavily depends on AI algorithms to improve search results. Although I may not explicitly think of it as AI, my everyday use of Google is, in fact, an engagement with AI-driven algorithms. [Malaysian life scientist]

Grammarly

One standout application was unexpected, Grammarly. Yes, it only ranks fourth in our table, but in contrast to Google and 'generative AI' it is a distinct proprietary product rather than a generic portmanteau term. It highlights what we consider a key insight from this preliminary study; that 'AI' is already implicit in many of the products and services we use today. The use of these tools to enhance the 'wordsmithing' process even to the extent of 'ghost writing' is likely to be a significant development. See here how highly ECRs appreciate and are engaged with this application:

> I've found a couple of AI tools and platforms particularly handy like ChatGPT, Grammarly, well it incorporates AI for grammar checking, suggest style even tone of the language. I think these tools for AI-driven language enhancement is a valuable asset to us especially non-native English speakers. [Malaysian mathematical scientist]

> Being able to write is a useful skill (which many chemists don't have), but only in the same way as being able to do multiplication, spell or recall facts and provided they will have access to these tools in the future as well then future employers probably shouldn't care either. A lot of this it is a development from what they used before. [British chemist]

> Grammarly and Scholarcy have been pretty cool for my writing. I got into it because everyone was talking about how these models can turbocharge your PhD research. So, turns out, they're like superheroes for literature reviews, like someone said on YouTube. 'AI zoom through loads of data! Pull out the stuff that matters, and that's a game-changer'. When it comes to writing, like ChatGPT helps come up with text that sounds smart and on-point, saving me from those writer's block moments. My peers and students said that it is very good for writing. Like virtual editors and give tips to write. Got so much interested when the AI influencers say using AI made their life easier. So, then I spend more time digging into more for research, like analysing data and making sense of it. Totally worth it—like having a super-smart partner in the world of academia. [Malaysian computer scientist]

While Grammarly stands out in the keywords list there are other wordsmithing applications, both generic such as 'translation' and proprietary, for example, 'deepL' and of course 'ChatGPT'.

CONCLUSIONS

In general, our data shows that ECRs exhibit mostly limited or moderate levels of experience and this maybe expected given the novelty of LLMs at the time of interviewing (early 2024). The most recent data shows (for Summer 2024) that, for China at any rate, this is changing fast. Regarding levels of engagement, there is a divide with some ECRs exhibiting little or none and others enthusiastically using the technology and sometimes even conducting research on AI. Utility data, however, shows a similar pattern to engagement data. In some ways, it seems that with AI you either like it a lot or not at all. Determining how representative ECRs are in respect to their colleagues is more difficult to determine, but it appears that ECRs, overall, do not think they are unrepresentative. So not the pioneers some might have expected.

Looking at demographics, regarding age, the median group (35–37) scored the highest marks, and again not the youngest as might have been expected. There were no differences according to gender. As to subject/discipline, not surprisingly, the mathematical sciences, which included computing ECRs, were the most advanced and medical scientists well behind. As to the Arts & Humanities, which feature for the first time in our surveys, they provided a lot of high-quality commentary, a broader experience and seemed much more sober in their attitudes. By country, ECRs from Poland and Malaysia scored the highest in AI terms and in enthusiasm the Malaysians certainly scored highest.

Looking for and at 'superusers' in the belief we would learn something about what the future might be, we discovered that about one in six of our cohort could potentially regarded as such. They came from a mix of countries, although with Spain and Malaysia at the head of the pack. There were no notable gender or age differences. The presence of mathematical sciences and computer science among superusers was not a surprise, but a full-range of subjects were on show, including A&H.

The mention analysis of apps and platforms showed how broadly AI was interpreted, including not overtly 'AI' applications, such as Google and Grammarly, which shows that in practice AI merges into the world of familiar and widely accepted applications. There was also evidence that 'wordsmithing' is key for many ECRs. It is implicit in the current focus of AI on LLMs. Both native and non-native English writers want to improve their productivity, presentation and language skills. Investment in AI, particularly LLMs, is clearly rapidly advancing the automation of literacy far beyond spell-check, auto-complete and machine translation: creating, a ghost-writer in the machine. This will be something we shall follow-up on in the future study.

In general, there was also evidence of confusion between what AI does and what it might do; it seems very difficult in any discussion of AI to separate anticipations from actual experience. Finally, concerns were evident in the context of academic outputs, in particular plagiarism and cheating. The questioning of what constitutes knowledge and distinguishes truth also came up frequently, with one ECR believing we have arrived at the 'post-truth era' and this too we shall follow-up on.

Standing back a little and trying to make sense of what is happening in the broadest sense (and really none of our ECRs thought that big changes were not on the horizon); we appear to be facing a world of algorithmic knowledge, derived, in some

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senses created, from data processing and algorithms, which are too complex, too dense, to be fully picked apart. As observed, in the case of our 'mathematical scientists' working on medicine, there are complex technologies which require the cooperation of many varieties of expert knowledge. Thus, no one person has a full, complete understanding of the process. It is, we might say, distributed knowledge. Machine learning, automated diagnostics; in that there is a process of detachment that leads to algorithmic knowledge. That is, knowledge that is the output of opaque machine processes, it requires not just trust in experts who build machine and algorithm but the output itself, an artefact or epiphenomenon of the process, a ghost in the machine.

It is another step away from direct, intuitive knowledge, and even proven symbolic knowledge. Nor is it trust in experts, who we might presume or hope to be authors of knowledge, but in what amounts to arguments from authority generated by a machine. Hence, we may find ourselves not trusting to experts, nor even the makers of the 'algorithmic machine', but rather on the machine itself as a fabricator of knowledge: a ghost-writer in the machine.

Finally, this was a preliminary study attempting to inform and plan for a major study, which would have a larger and more representative cohort of ECRs. Our findings should be treated with caution, more as informed observations, filling a knowledge vacuum.

AUTHOR CONTRIBUTIONS

David Clark provided the AI expertise, initial ideas and planning and conducted data analysis and provided technical support and insights. David Nicholas also conducted the analyses and wrote much of the paper and edited it. Marzena Swigon undertook the A&H element of the study. Eti Herman conducted the literature review. The rest of the authors undertook their country analyses and provided general feedback.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

INFORMED CONSENT STATEMENT

Participants who freely opted to take part in the interviews were asked to provide their names and contact details for follow-up questions regarding the accuracy of the interview transcripts, but access to all personal data was restricted to the investigating team and was removed before the analysis of the results.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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