Geodiversity of research: geographical topic focus, author location, and collaboration: a case study of SDG 2: zero hunger

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Scientometrics (2024) 129:2701–2727
https://doi.org/10.1007/s11192-024-04994-5

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Received: 20 July 2023 / Accepted: 11 March 2024 / Published online: 22 April 2024

Abstract
This bibliometric study examined three aspects of geodiversity of research, namely the geographical topic focus of the study, author location, and international collaboration dynamics. The publication dataset comprised 60,000 papers from the Dimensions database that have been associated with hunger research using Digital Science's machine learning algorithm that enhances expert led search strategies. As the research was related to hunger, papers were mapped on to the Global Hunger Index country categories as convenient classification. Only 41% of hunger-related publications that focus on countries most affected by hunger feature authors affiliated to institutions in those countries. Even fewer of those publications feature locally based authors in first or last position. These numbers gradually reverse as the level of hunger declines. We analyse sample papers in an attempt to understand the reasons for these trends. These included differences in research infrastructure, sub-authorship recognition such as acknowledgements, and limitations of the relationship between country mention and real topical focus. We did not find evidence of widespread differences between senior and overall authorship and consequently urge caution before judging international collaborations as 'helicopter' research based only on author country affiliations and authorship position.

Keywords Geodiversity · Country focus · Hunger · Helicopter research · Author position · SDG 2

Introduction

In 2020 Nature, in collaboration with Scientific American, published a collection of articles on diversity in research (Nature, 2020). The aim of this collection was to identify sections of society that are underrepresented in research and investigate the challenges they face. Subsets of society identified in the collection included women, people with disabilities, ethnic minorities, and socially disadvantaged populations. We aim to contribute to the

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body of research on socially disadvantaged populations, specifically those affected by the problems associated with hunger. Alleviating hunger is a global challenge and has been defined as one of the United Nations sustainable development goals (UN SDGs) (United Nations General Assembly, 2015). We specifically investigate three geographical aspects of diversity: the geographical focus of research, author location, and collaboration patterns of researchers from different places. Rather than delving into the underlying socio-economic issues, this paper is a large-scale bibliometric study that will inform debates around the 'geodiversity of research'.

The geographical focus of research plays an important role in the sustainable development agenda because of the increasing involvement of the scientific community (Brundtland, 1987; Hassan, 2001; IUCN–UNEP–WWF, 1980; Kates et al., 2001). During many of these discussions, it has been established that studies of society's most pressing challenges offer more value when conducted at locations where most impact is felt (Balvanera et al., 2017; Mirtl et al., 2018; Sutterlüty et al., 2018). In this study, we assume that if a country name is mentioned in the title or abstract of a paper, then it signifies some topical focus on that country. Consequently, using bibliometric data we can conduct large scale studies of the geographical focus of research articles by looking at the titles and abstracts of publications. This macro level analysis enables us to build a picture of which countries researchers are focusing on.

The geographical location of researchers is equally interesting to investigate, especially when the topical focus of the study is in developing regions of the world. There is a notable difference between the global, often theoretical perspectives of well-funded academics in countries with established research infrastructures, and the action-based urgency of resource-poor local scientific communities in developing countries (Kates, 2011). There is growing concern about practices of researchers from wealthy nations using samples or data from developing regions (e.g., Amugune & Otieno-Omutoko, 2019; Bockarie et al., 2018; van Groenigen & Stoof, 2020). By using author affiliations on published research, we can contribute quantitative analyses to support this discussion.

In many cases, research in resource-poor nations can benefit from collaboration with scientists based in developed countries because they can contribute additional funding and expertise. The dynamics of cooperation between international scientists and academic communities in developing regions is key to the success and acceptance of sensitive projects. There have been concerns that such collaboration dynamics have not always been appropriate, and questions have arisen around whether due consideration has been given to local scientists. There is a growing complaint of 'helicopter' or 'parachute' research where researchers from wealthy countries are said to drop in to poorer regions, collect samples, and leave (Nature, 2022). In response, guidelines that were initially established to ensure individual scientists adhered to ethical collaborative research practices (Yakubu et al., 2018) have been expanded to call for oversight of partnerships by funders, societies, and academic publishers (e.g., Aramesh, 2019; Heinz et al., 2021; Nature, 2022; PLOS, 2021). The 2022 World Conference on Research Integrity hosted a discussion that will lead to a "Cape Town Statement" on equitable research partnerships (Horn et al., 2022). Our bibliometric analysis of international collaboration on hunger-related research is intended to provide data that will contribute to this discussion.

In our study, we use bibliometric data to investigate these three aspects of geodiversity of research, i.e., the geographical focus of the study, location of its authors, and collaboration dynamics. With nearly one in ten people today suffering from chronic hunger (von Grebmer et al., 2020), we chose SDG 2 as the focus of this case study. Our bibliometric data was sourced from the Dimensions database because it has broader coverage than

databases such as Scopus or Web of Science (Hook et al., 2018) and indexes a substantial amount of short scientific documents such as meeting abstracts and scientific communications not included in Scopus (Visser et al., 2021). In our view, additional coverage beyond traditional peer-reviewed journals is important in the context of research on local issues in countries with less developed academic publishing systems. Other studies have shown advantages of the Dimensions coverage in the social sciences (van Leeuwen et al., 2022) and infectious diseases (Rahim et al., 2021). Using Dimensions is therefore a deliberate decision aimed at maximising coverage of relevant scholarly content.

Our paper on geodiversity of hunger-related research is intended to form a large-scale bibliometric analysis that can be used to support discussion around the following questions.

Research questions

1. To what extent is hunger research focused on countries affected by hunger?
2. To what extent are authors of hunger research located in countries severely affected by hunger?
3. To what extent are research publication partnerships between international experts and local scholars equal in hunger research?

Literature review

An important aspect of geodiversity of research is the geographical focus of the topic under study. We have used mentions of country names in research papers as indicators of topical focus on that country. Previous work on country naming suggests there may be an association with socio-cultural patterns related to characteristics of the topic, author location, or whether samples used in the study (Kahalon et al., 2021). Kahalon et al. (2021) found that authors are less likely to mention the country name in an article title if the study includes samples from WEIRD (Western, Educated, Industrialised, Rich, and Democratic) countries. The same authors point out that while naming countries in non-WEIRD countries can initially seem inclusive, the practice could be counterproductive by inadvertently suggesting the findings are geography-specific and not generalizable. This suggestion may reinforce the implicit belief that knowledge produced by scientists in and about individuals located in WEIRD countries represent the universal or default position (Castro Torres & Alburez-Gutierrez, 2022). The implication continues that when authors from non-WEIRD countries declare regional focus of their study, these signify exceptions to the rule thereby reducing the articles' usefulness in global research (Kahalon et al., 2021).

Another aspect of this study is the geographical location of the authors. As global sustainability challenges such as hunger, poverty, and climate change affect populations differently, author location helps us investigate the extent to which local academics publish research related to addressing problems faced by communities close to them. There is a lack of bibliometric studies on author location in hunger research, however studies on author location in related fields e.g., Reyes-García et al. (2019) suggest that indigenous and local knowledge have the potential to contribute an additional layer of knowledge to research on social-ecological systems. The true benefit of the locally grounded research model is achieved by attracting ideas and people into a specific place where they gain access to local knowledge (Billick & Price, 2010; Gerlak et al., 2018; The British Academy, 2021).

Where local authors are underrepresented, there may be a missed opportunity to employ local knowledge to improve research outcomes. Previous studies on local author representation have lamented the lack of local authors. For instance, authors from tropical countries who have the most knowledge to contribute to conservation science and the most to suffer from its impact (Mammides et al., 2016) are underrepresented in conservation science studies. In medical fields, there is a clear under representation of authors from non-high income countries (Campbell et al., 2023; Mooldijk et al., 2021). Meanwhile, there may be inherent sampling bias in even the most inclusive global bibliometric databases as demonstrated by the relative lack of linguistic studies on global South languages and by authors based in the global South (Bylund et al., 2023).

The third aspect of geodiversity in this study is the formation of international collaboration as represented by author affiliations and the order in which authors appear on published research papers. International collaboration including capacity building and joint research projects can play a role in the response to localised social challenges and even humanitarian tragedies (Bajoria, 2011). The 2013–2016 Ebola virus disease outbreak in West Africa generated international attention and stimulated collaboration that involved collaborative clinical studies, training of local outbreak responders, and the establishment of diagnostic and surveillance laboratories (Arias et al., 2016; Heymann et al., 2016; Yozwiak et al., 2016). Attempts to improve capacity of West African communities to respond to disease outbreaks have been termed 'rooted' collaboration (Yozwiak et al., 2016) because of the co-creation of sustainable local capacity building. Lamentably, not all the international collaborators contributed in the same spirit and some were described as sub-optimal 'parachute' research (Heymann et al., 2016).

Helicopter or parachute research (North et al., 2020) portrays the image of privileged academics who come to troubled regions from wealthy countries and avoid real collaboration with local scientists. These researchers are said to drop in, collect samples, and leave, sometimes without the knowledge or permission of authorities in the visited country (Heymann et al., 2016). Others have used the term 'colonial research' or 'neo-colonial research' (Minasny & Fiantis, 2018) to suggest that scholars from developed economies feel entitled to take samples from less well developed areas for their own purposes and limit the input of local colleagues.

Where local scientists are excluded from collaboration, or their role is limited to locating and collecting samples, international research teams could be failing to use the chance to increase the capacity of scholars at the collection site, and instead offer little benefit to the local community (Minasny & Fiantis, 2018). Following the particularly devastating Indonesian peat fires of 2015 that destroyed vast areas of peatland, local scientists set out practical solutions as a priority, and encouraged research into responsible and effective peatland management (Sabiham et al. 2018). These authors lamented international teams in Indonesia concentrating efforts on more academic research into deforestation, greenhouse gas emissions, and peat fires with less practical value.

As research becomes more collaborative, the number of authors per paper has grown more than five-fold in the last 100 years (Aboukhalil, 2014). That makes the relative contribution of authors less obvious, and readers have turned to proxies such as author position to infer leadership of research projects. In academic literature, first and last author positions are considered 'key' contributors (Mattsson et al., 2011; Wren et al., 2007). The corresponding author also holds considerable weight and has been shown to coincide most frequently with first and then last author position (Mattsson et al., 2011).

Africa-based authors are traditionally underrepresented in the scientific literature. An analysis of author affiliation position on 1,182 biomedical studies conducted in Africa,

showed over 93% featured at least one Africa-based co-author (Mbaye et al., 2019). However, Africa-based co-authors featured in fewer than half the articles in first author position, and even fewer in the prestigious last author position. A similar study concurred (Hedt-Gauthier et al., 2019) and called on the research community from high income countries to challenge the established power balance. Despite increased inclusion of local scholars in Africa-based research, inequity remains regarding their relative roles in the team.

The scholarly community has begun to call for action to discourage helicopter or parachute research and instead promote ethical and sustainable collaboration with academics from low- and middle-income countries. A group of editors and researchers published a consensus statement to promote equitable authorship which includes practical advice to journal editors on evaluating manuscript submissions resulting from international collaborations (Morton et al., 2022).

A related discussion has been published in Geoderma, about the prevalence of helicopter research in soil science, along with the limited involvement of local knowledge owners, and the lack of structural improvement in the community at the place of the study (van Groenigen & Stoof, 2020). One participant from Ethiopia suggested building local capacity in young scientists though involvement of students from Masters and PhD programmes who should be first authors where they conducted the work (Haile, 2020). As part of the same discussion, Giller (2020) described how the Dutch research funding agency, NWO-WOTRO Science for Global Development made its grants subject to a compulsory workshop with stakeholders from the country of the proposed study. The workshops often led to closer collaboration between the local and visiting scientists (Giller, 2020). Other journals have taken similar steps to tackle helicopter research and ethics dumping (Morton et al., 2022; Nature, 2022).

Hunger is a complex problem that is interlinked with political or military instability, e.g. South Sudan (Mayai, 2020), Yemen (De Souza, 2017). In regions under civil and military conflict, severe malnutrition contributes to mortality (Leaning & Guha-Sapir, 2013; Salama et al., 2004). Under such circumstances, the local education and research infrastructure is often limited (Lai & Thyne, 2007) and much of the work is conducted by researchers in other countries or foreign non-governmental organizations (Ford et al., 2009; Kalleberg, 2009).

Following high profile events such as famine or war, it is natural to want to help. However in some cases, Western researchers have arrived in affected regions with preconceived research protocols thereby limiting the role of local participants and scholars (Asiamah et al., 2021). A more progressive approach is involves local scholars and participants in an inductive and iterative way (Firchow & Gellman, 2021; Yom, 2014). Studies of the dynamics between the researcher and the researched have demonstrated benefits in an inclusive approach where those with local knowledge are included at every stage of the research design (Riley et al., 2003) including the very question being addressed. That way, international research teams ought to engage local participants as actors with agency (Gellman, 2021) and avoid limiting their roles.

Data and methods

We extracted publications from a version of the Dimensions database hosted by the Centre for Science and Technology Studies (CWTS) at Leiden University. Dimensions uses a multistep process to tag publications considered relevant to sustainable development

goals that utilises a machine learning algorithm to enhance expert driven search strategies (Wastl et al., 2020, 2021). We selected all records linked to SDG 2: Zero Hunger. The time window used was six full publication years (2016–2021). We included journal articles, conference papers, books, monographs, and book chapters, but excluded preprints because they have not been peer-reviewed. We also excluded papers that did not list any author affiliations because the affiliations formed an important part of our analysis.

For country population, we used the most recent UN estimates (The World Bank, 2022).

For ease of comparison, we present the results in groups of countries, rather than individual nations. As the case study is on hunger related research, we classified papers by country according to the categories described in the Global Hunger Index (GHI) 2021 report (von Grebmer et al., 2021) and shown in Fig. 1 with full country listing in Appendix A.

We counted the number of publications in which a country was mentioned in either the title or abstract of the article. These were termed 'country mentions'. If one or more countries within one of the GHI categories were mentioned in a publication, then it counted as one mention for the category. If one or more countries were mentioned in the publication for two categories, then it counted as one mention for each category.

To determine the geographical location of researchers, we examined the countries in the author affiliations of each paper. These were termed 'country affiliations'. Similar to the mentions, if one or more country affiliation in any one category appeared in a publication, then it counted as one country affiliation for that category. Meanwhile, if one or more country affiliations were found from two GHI categories, it counted as one country affiliation for each category.

In order to create these categories, the GHI ranked countries using a composite score based on four indicators (Table 1); undernourishment, child wasting, child stunting, and child mortality (Wiesmann et al., 2015). There was sufficient data to calculate individual scores for 116 countries. An additional 12 countries were provisionally designated and

Fig. 1 GHI country categories based on the severity of hunger

Table 1 Global Hunger Index composition

Dimension	Indicator	Weighting	Source
Inadequate food supply	Calorie deficiency Proportion of the population that is undernourished	1/3	UN Food and Agriculture Organization (FAO)
Child undernutrition	Proportion of children < 5 years suffering from stunting	1/6	UN United Nations Children's Fund (UNICEF) World Health Organization (WHO) World Bank
	Proportion of children < 5 years suffering from wasting	1/6	UN United Nations Children's Fund (UNICEF) World Health Organization (WHO) World Bank
Child mortality	Child < 5 years mortality rate	1/3	UN Inter-Agency Group for Child Mortality Estimation (UN IGME)

Source: Global Hunger Index 2021 (von Grebmer et al., 2021)

for seven countries there was insufficient data for even a provisional categorisation. We assigned countries to categories if they were assigned or provisionally assigned by the GHI 2021 report but did not include the remaining seven countries in the study.

The International Food Policy Research Institute (IFPRI) was founded in 1975 and organises research projects in the areas of food supply, nutrition, food trade systems, agricultural economies, and governance. It also runs country level research programmes because of the different challenges faced by each country (International Food Policy Research Institute, 2021) and the different opportunities to address them. The information gathered at country level can help us identify where the problem is most acute.

In order to address our first research question about the extent to which research on hunger focuses on countries afflicted by hunger, we calculated the aggregate number of country mentions for each category. To address our second research question about the country affiliation of hunger research scholars, we calculated the aggregate number of papers in each GHI country category. We presented the country mentions and the country affiliations as absolute numbers and normalised for combined population of the country category.

To answer the first two research questions more fully, for each of the GHI country categories and for the non-assessed countries, we combined the country mentions with the author affiliations in a Venn diagram. This enabled a visualisation of the relationship between local authorship and the severity of hunger. For the mentions-only papers and the affiliations-only papers, we performed bibliometric analyses and we conducted manual examination of random samples of the non-overlapping papers.

The mentions-only papers mention a country but do not feature any authors in the country mentioned. In order to discover where the authors are based, we quantified the number of country mentions for the country with most publications in the SDG 2 dataset from each GHI category.

We then manually examined the full text of 100 mentions-only papers (20 selected at random from each GHI category) to gain insight into the possible reasons that no locally affiliated authors were listed on the paper.

The affiliations-only papers do not mention the countries that the authors are affiliated to. We aim to find out whether these papers mention any country at all by comparing the affiliations-only papers with the SDG 2 papers that include no country mentions.

We then manually examined the full text of 100 affiliations-only papers (20 selected at random from each GHI category) to look into reasons why authors have not mentioned the country in which they are affiliated.

For the sample analyses, we grouped countries by GHI categories and assigned each paper to the most severe category it could belong. For example, a publication that mentioned a country from the low hunger category and another country from the serious category was only counted in the serious category. This way, we avoided papers being counted in multiple categories.

To address our third question about the equality of research collaborations, we determined the author position for each paper and aggregated them for each GHI country category. We then presented the share of first author country affiliations, last author affiliations, and overall country affiliations from each of the country categories.

Results

The Dimensions database contains 59,778 papers published between 2016 and 2021 that are related to SDG 2—Zero hunger. In one third of these papers, the authors mention at least one country in the title or abstract. Within the same Dimensions SDG 2 dataset, 31,769 (53%) publications featured author affiliations in countries listed in the categories of the Global Hunger Index (GHI) 2021 report. The number of countries with their combined populations and number of country mentions and affiliations are shown in Table 2. There is only one country in the extremely alarming category (Somalia), and we have therefore combined the two most severe categories as 'alarming / extremely alarming'. We also show the number and combined population of countries not assessed for the GHI report. The 'not assessed' category includes many of the world's wealthy and economically developed nations. For a full list of country categorisation, see Appendix A.

Geographical focus (country mentions)

Our first research question was 'To what extent is hunger research focused on countries affected by hunger?'. We found that 26% of the SDG 2 papers in our study mentioned countries listed in the GHI 2021 report (Table 2). Within the GHI country categories, we see an interesting pattern. First, the countries in the low category have the fewest mentions per population. The moderate countries have more than twice the number of mentions per population as the low countries. However, as the severity of hunger increases from moderate, to serious, and then to alarming/extremely alarming, the number of mentions per population declines again. The frequency of mentions per population is higher for countries not assessed by the GHI (4.00) than for any of the categories that are assessed.

Geographical location (author affiliations)

Our second question was 'To what extent are authors of hunger research located in countries severely affected by hunger?' We found that more than half the papers in our dataset featured at least one author whose affiliation was in one of the countries assessed in the GHI report (Table 2). The GHI categories with the highest number of affiliations were the low and serious categories followed by the moderate category. The alarming/extremely alarming categories featured by far the lowest (288) number of author affiliations. Due to

Table 2 GHI country categories by population, country mentions and affiliations

GHI Hunger category	# Countries	Combined population	Mentions	Mentions per pop (m)	Affiliations	Affiliations per pop (m)
Alarming/extremely alarming	10	232	434	1.87	288	1.24
Serious	37	2610	7281	2.79	12,873	4.93
Moderate	31	1214	4475	3.69	7870	6.48
Low	50	2624	4776	1.82	13,973	5.33
Not assessed	105	1235	4938	4.00	35,834	29.02

the variation in population between the countries within the GHI categories, the population normalised country affiliations are presented on a world map in Fig. 2.

We can see at a glance that the higher number of author affiliations per population are associated with wealthy countries, while countries in developing regions such as Sub-Saharan Africa tend to have fewer author affiliations per population. Similar to the geographical focus, we found a downward trend in population-normalised geographical author affiliations as the severity of hunger increased. Within the GHI categories, the affiliations per population peaks in the moderate category and then declines markedly as the severity of hunger increases. Indeed, researchers from countries most afflicted by hunger are twenty times less likely to publish research papers on hunger than those in wealthy, non-assessed countries.

Relationship between regional focus and regional authorship

The relationship between country mentions and country affiliations is shown by GHI category in Fig. 3.

For each GHI category, the circle on the left represents the number of papers which mention at least one country in that category. If a paper mentions the same country more than once or more than one country in the same category, it still only counts as one paper for that category. However, it the paper mentions one or more papers in two categories, then it counts as one paper for each category. The circle on the right follows the same rules but refers to author's country affiliation.

In the top-left diagram, the overlapping section shows that 178 of the papers that mentioned countries in the alarming/extremely alarming countries also featured at least one author affiliated to one of the countries in the same category, i.e. papers that featured local authors. Meanwhile, 256 of the mentions did not feature locally based authors and indeed did not feature any author affiliated with any country in the alarming/extremely alarming

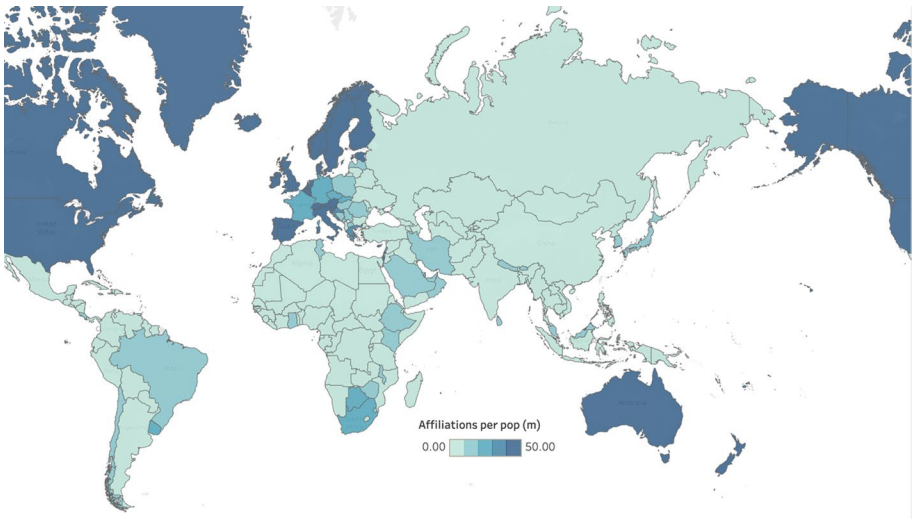


Fig. 2 Author affiliations per million population by country

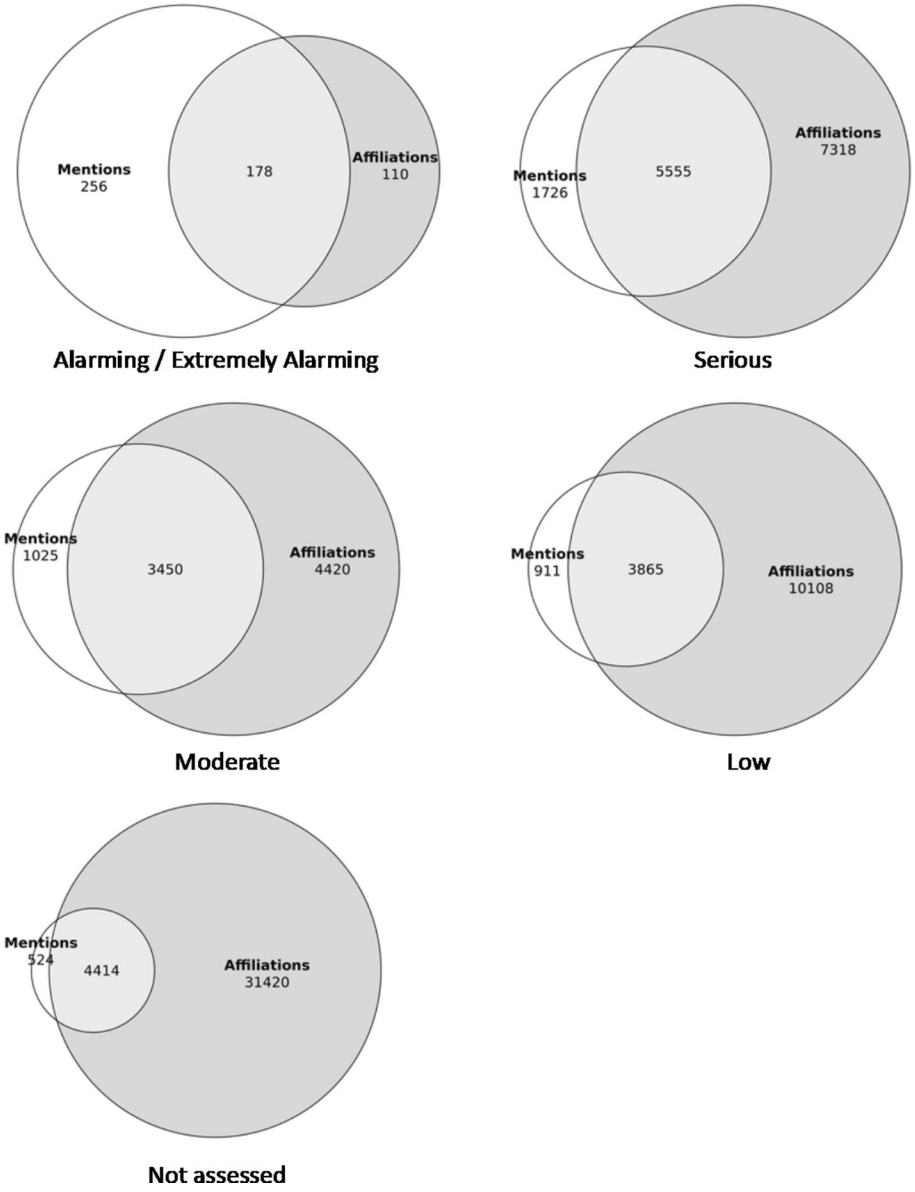


Fig. 3 Mentions and affiliations by GHI categories

category. The 110 affiliations-only papers on the right section of the diagram tells us that 110 papers that featured authors from countries in this category did not mention any country in the same category. Figure 3 illustrates that the share of mentions-only papers grows, and the share of affiliations-only papers declines as the severity of hunger increases.

In Fig. 4, we concentrate on the share of overlapping papers, i.e. those that mention countries from a GHI category and also feature at least one author from the same category.

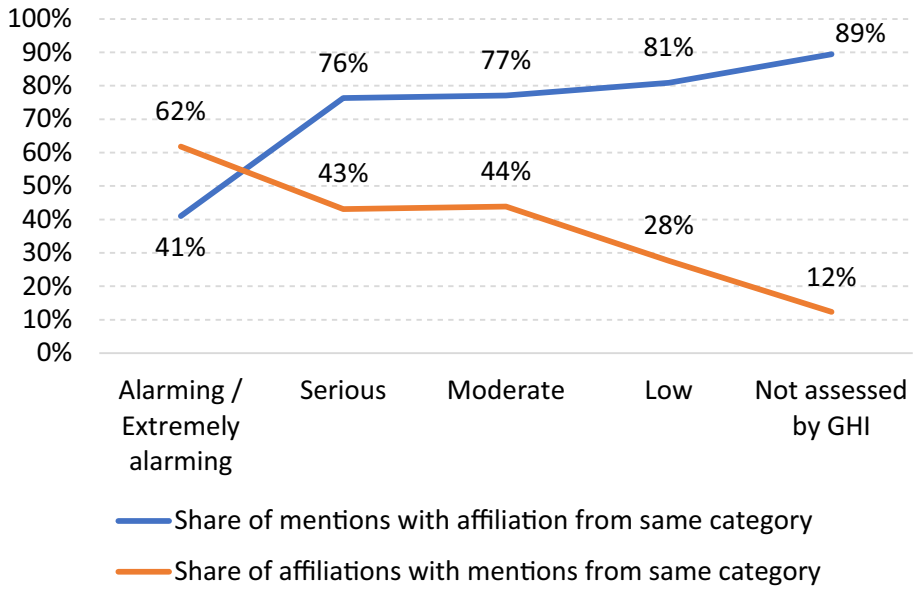


Fig. 4 Share of mentions and affiliations by country category

The blue line shows the overlapping papers as a share of all the mentions of countries in a particular category. For instance, 41% of the papers that mention alarming or extremely alarming countries also feature at least one author affiliation from these categories. This is the lowest share and as the hunger severity decreases, the share of country mentions that also feature authors from the same category increases. The orange line shows the number of overlapping papers as a share of author affiliations in a particular GHI category. Of the papers featuring author affiliations from countries with the most severe hunger problems, 62% also mention countries from the same category. As the severity of hunger decreases, this share decreases until only 12% of the papers with authors from countries in the not assessed category mention countries in the same category.

Location of non-local authors (mentions-only papers)

The mentions-only papers do not feature authors affiliated to the countries mentioned in the article. Now we know where the authors are not located, we would like to know where they are located. In B1 we show the most frequently occurring country affiliations on the mentions-only papers for the country with the most mentions in each GHI category. In the alarming/extremely alarming categories, the Democratic Republic of the Congo (DRC) is the most frequently mentioned country. Authors that mention the DRC but are not based there are most frequently located in the USA, UK, and India (Table 3).

In all groups, many of the mentions-only papers were published by authors affiliated to countries with large populations and high publication output such as the United States, United Kingdom, China, and India. There were however, some prominent appearances from regional neighbours. For instance, Bangladesh was listed among the leading author

Table 3 Location of authors on mentions-only papers

Democratic Republic of the Congo mentions (alarming)	Papers	% Share	India (Serious)	Papers	% Share	Indonesia (Moderate)	Papers	% Share
United States	25	24%	United States	195	8%	United States	23	3%
United Kingdom	7	7%	United Kingdom	74	3%	India	15	2%
India	3	3%	Australia	41	2%	Australia	13	2%
South Africa	3	3%	China	31	1%	Japan	12	2%
Australia	3	3%	Germany	30	1%	United Kingdom	11	1%
Belgium	3	3%	Canada	29	1%	Thailand	7	1%
China	3	3%	Switzerland	17	1%	Germany	6	1%
Canada	2	2%	South Africa	14	1%	South Africa	6	1%
Denmark	2	2%	Bangladesh	14	1%	Switzerland	6	1%
France	2	2%	Japan	13	1%	France	5	1%

China (low)	Papers	% Share	USA (Not assessed)	Papers	% Share
United States	83	5%	India	48	3%
India	62	4%	United Kingdom	44	2%
United Kingdom	40	2%	China	41	2%
Australia	30	2%	Australia	38	2%
Germany	23	1%	Canada	30	2%
Netherlands	20	1%	Italy	16	1%
Japan	16	1%	Iran	14	1%
Canada	14	1%	Germany	13	1%
France	12	1%	Russia	12	1%
Italy	12	1%	Brazil	11	1%

locations on papers that focused on India, and authors based in Thailand frequently published papers that focused on Indonesia.

Other relationships between countries may also have contributed to authors in one country focusing on another country that might not be a direct neighbour. For instance, authors based in South Africa and Belgium published papers that focused on the DRC that featured no locally based authors.

We also conducted a manual analysis of 100 randomly sampled mentions-only papers (20 for each of the GHI categories) to assess the reason for there being no locally based author affiliation. We examined the full text of each paper in the sample and present the results in Appendix B. We found two main reasons for the lack of a local author affiliation. First, while authors may not be in the same country as that mentioned in the title or abstract, it doesn't mean they are very remote. We found several papers that featured authors in neighbouring countries to those mentioned. In one case (https://doi.org/10.1186/s12889-020-08657-x), an international group sought to improve the criteria for community-based treatment of malnutrition in South Sudan. Some of the authors were based in Kenya, just across the border with South Sudan.

In other mentions-only papers, the studies were not really focused on the countries that were mentioned in the title or abstract of the paper. This was caused by authors making passing mention of a country. For instance, in the abstract of a study of a rice production system used throughout India (DOI: https://doi.org/10.1007/978-981-10-3692-7), the authors mention that the method originated in Madagascar, and although Madagascar is not mentioned again, the paper has been classified as focusing on Madagascar.

Lack of country mentions (affiliations-only papers)

The affiliations-only papers make no mention the countries in which the authors are affiliated in their title or abstract. We wanted to know whether this is because the paper lacked geographical focus entirely or if the focus was on another geographical location. In Table we show the number of affiliations-only papers for the country with the highest number of hunger-related research papers for each of the GHI country categories. We also show the number and share of affiliations-only papers that did not mention any country at all (Table 4).

In all GHI categories, a high share of affiliation-only papers did not mention any country name at all. The lowest share was in the Democratic Republic of the Congo whose authors mentioned no country in 65% of the affiliations-only papers. We also conducted an analysis of 100 randomly sampled affiliations-only papers (20 for each of the GHI categories). We examined the full text of each paper in the sample to determine the reason for the lack of country mention and the tabular results are available in Appendix B.

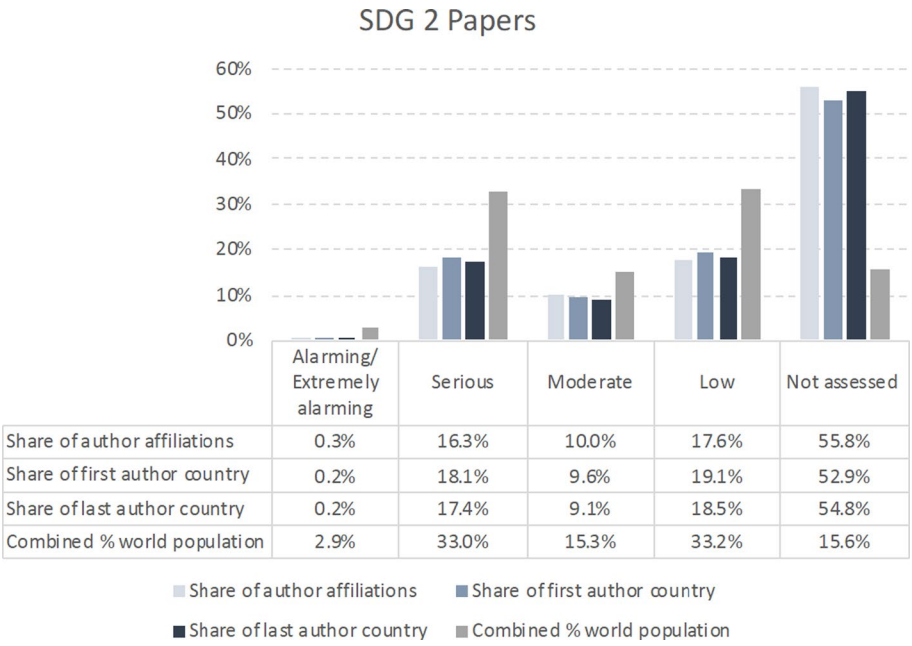
One common reason for not mentioning the country where the authors are based is that the article has no regional focus. For instance, we found several papers with author affiliations in the serious category were published by authors in India and focused on methods for improving agricultural methods and had no regional focus.

A second group of affiliations-only papers were indeed studies that focused on a specific country, but the authors had not mentioned the country at all in the title or abstract of the paper. One example (https://doi.org/10.1155/2019/4740825) is a clinical study with all the authors based in the Democratic Republic of the Congo (DRC) and thanking a local hospital in the acknowledgements. The study is clearly focused on the DRC but the authors have not mentioned the country in the title or abstract of the paper.

In a third set of affiliations-only papers, the authors do mention the local site of the study but not necessarily the country name. We found evidence of authors using city names e.g., Royapettah (https://doi.org/10.18203/2349-3291.ijcp20174153), islands e.g., Zanzibar

Table 4 Papers with no country mention

Country name	GHI category	Affiliations-only papers	Papers with no country mentioned	Share of papers that mention no country
Democratic Republic of the Congo	Alarming/ extremely alarming	37	24	65%
India	Serious	5119	4915	96%
Indonesia	Moderate	995	952	96%
China	Low	3936	3615	92%
United States	Not assessed	13,058	9771	75%



	Alarming/ Extremely alarming	Serious	Moderate	Low	Not assessed
Share of author affiliations	0.3%	16.3%	10.0%	17.6%	55.8%
Share of first author country	0.2%	18.1%	9.6%	19.1%	52.9%
Share of last author country	0.2%	17.4%	9.1%	18.5%	54.8%
Combined % world population	2.9%	33.0%	15.3%	33.2%	15.6%

Fig. 5 Author position—All SDG 2 papers

(https://doi.org/10.1093/cid/cix500), or simply referring to 'our nation' (https://doi.org/10.1007/978-981-16-6124-2_1).

Partnerships

To address our third research question about the equality of international partnerships, we analysed the author position in more detail. For 55,422 (93%) of the SDG 2 papers, we could identify the country affiliation of the first and last authors, often associated with lead author positions. We found that the last author has an affiliation in a country listed in the GHI 2021 categories on 40% of the SDG 2 papers.

Considering all SDG 2 papers, only 0.35% of author affiliations were from countries in the alarming or extremely alarming GHI country categories (Fig. 5). The share was even lower for authors in first (0.23%) and last author (0.17%) positions. Meanwhile, the combined population of the countries in the alarming and extremely alarming countries comprises 2.9% of the world's population. Authors from these countries are therefore underrepresented in scholarly research on hunger and especially underrepresented in lead author positions.

Authors from countries in the serious, moderate, and low GHI categories are also underrepresented when compared with their share of the world's population albeit to a lesser extent. The share of lead author positions is not very different from overall authorship. In those countries not assessed by the GHI, which includes relatively wealthy countries, the pattern is reversed with authors overrepresented compared with their combined share of the world's population.

Discussion

We used country mentions and author country affiliations to study the geographical diversity of researchers, using scholarly papers related to SDG 2: Zero hunger as a case study. For ease of comparison, we used the country categories as described in the 2021 Global Hunger Index (GHI) report which are based on the severity of hunger.

About one third of hunger research papers mention at least one country in their title or abstract, although this trend diminished when mentioning the country categories most severely affected by hunger. This was a counterintuitive result, and we consider possible explanations. First, there are only ten countries in the alarming and extremely alarming categories compared with 118 in the less severe categories and 106 not assessed countries. That means countries in less severe categories comprise more country names that are available to be mentioned. Similarly, the smaller relative population in the alarming categories means there are fewer local authors who can focus on their own country than in the less affected categories.

We cannot be sure of authors' motives when they decide to name a country in the title or abstract of their paper. There is evidence that authors from wealthy, developed countries with established research infrastructure, especially the United States, are less likely to mention the country names even in locally based studies (Castro Torres & Alburez-Gutierrez, 2022; Kahalon et al., 2021). Consequently, there are potentially studies with a country focus that do not mention the country of focus, and that those papers missed are predominantly in the lower GHI country categories. That means the real tendency of decreasing topical focus in countries less affected by hunger may not be as sharp as our results show.

We used authors' affiliations to determine their geographical location and defined local authors as those whose country affiliation matched the name of the country mentioned in the paper. We found the presence of local authors declined as the severity of hunger in the mentioned country increased, especially on papers that mentioned countries in the alarming and extremely alarming categories which are the most severe. We suggest potential reasons for the lack of local authors on research papers that focus on the most severely affected countries.

Countries most severely affected by hunger are also among the world's poorest countries and poverty can be a barrier to young people entering higher education. The impact of long-term poverty, especially in countries experiencing war or civil conflict, may have limited the development of a research infrastructure in some countries categorised as suffering from alarming levels of hunger. Less developed research infrastructure is therefore proposed a possible explanation for the lack of local academics and associated research publications in the most severe GHI categories. Meanwhile, academic publishing has flourished in some countries with large populations in the less severe hunger categories such as India (serious) and Indonesia (moderate). The prolific scholarly output in these countries has contributed to relatively large numbers of country mentions in hunger research.

That researchers from countries not assessed by the GHI publish the majority of hunger-related research papers is not surprising. The GHI doesn't assess developed, wealthy countries and these countries traditionally publish the most research in general. In 2015, the UN called for the whole world, not just those living in affected areas, to respond to a series of challenges. The contribution of academics in developed nations could be interpreted as an encouraging sign that the global research community is engaged in addressing the grand challenges of our time. It may also be symptomatic of a sampling bias caused by overrepresentation of country affiliations from high income countries (Bylund et al., 2023).

In all the GHI categories, our results showed in most cases that authors either mention the name of their own country or they do not mention any country at all. Papers that do not mention any country may have no regional focus, or the authors have decided not to mention the name of the country in which the study was conducted.

The appearance of local contributors mentioned in the acknowledgements section of the article but who did not appear as co-authors might also partially explain the absence of local authors. In some papers, collaborators from the country of focus were acknowledged and thanked in the publication even if they did not feature as authors of the study. Acknowledgements form part of the reward triangle bestowed by researchers on those who have helped or significantly influenced academic publications (Costas & van Leeuwen, 2012; Cronin & Weaver, 1995). The difference between a contribution that deserves 'only' acknowledgement, and one worthy of co-authorship is a key distinction. The observation of acknowledgements in our analysis of sample papers warrants further examination to see whether this phenomenon has any relation with the GHI country categories.

Author position and partnership dynamics

Author position in the context of partnerships between visiting and local researchers has come under scrutiny by the academic publishing community (e.g., Morton et al., 2022; Nature, 2022; PLOS, 2021; van Groenigen & Stoof, 2020). This study contributes to the discussion by demonstrating the relationship between author position and affiliation from both geographical focus and geographical location perspectives.

We specifically identified the country affiliation for authors who appeared in first or last author position. First, and especially last author position have been used as a proxy for lead authorship in several studies. We found that authors from countries in the most severe GHI categories were underrepresented in lead author positions. However, in all the other categories the share of lead author positions was close to the overall share of authors. In the serious and low GHI categories, local authors were slightly overrepresented compared with all author positions. However, where countries from GHI categories were the focus of research, authors from the same category featured far more frequently and were even overrepresented in lead author positions. This result is suggestive of greater participation of local academics in studies with a regional focus.

This part of our study builds on earlier work conducted in health fields that reported underrepresentation of local researchers in lead author positions (Hedt-Gauthier et al., 2019; Mbaye et al., 2019). Our results support the idea that unequal partnerships may exist in international collaborative research, but only in the countries most severely affected by hunger. In all other categories, our author position analysis showed that the share of local researchers in lead author positions was similar to the overall share of local authors. We therefore encourage further discussion on the partnership dynamics between local academics and international collaborating partners.

These findings could be interpreted as showing that international academics from wealthy nations more frequently occupy leadership roles in hunger research studies on the most severely affected regions than local authors. The underrepresentation of local authors presented in this paper may also support the idea that local contributors might play a limited role in international collaborative research in their own country such as data collection but not authorship (Asiamah et al., 2021).

Study limitations

This study was the first to examine the geodiversity of research using SDG 2 as a case study. However, we acknowledge the study has a number of limitations that could be used to identify areas for follow on studies.

First, the GHI country categories are based on a composite indicator. The cut-off scores that assign countries to one category or another are necessarily arbitrary but mean that there might be greater differences between countries at the extremities of a category than between countries separated by the cut-off score. We also hypothesise that conditions may vary within a country, such that different regions of a country would meet the conditions for different GHI country categories. We have presented evidence of community-based collaboration across international borders between countries that have landed in different GHI categories. The GHI categories are therefore not infallible in their indication of severity of hunger. We could have used nation states grouped by geographical or political regions instead, but those groupings would of course be subject to the same limitations as the GHI categories.

The definition of the body of research papers on hunger research is not unequivocal. We used the Dimensions database because of its inclusive coverage (Hook et al., 2018; Huang et al., 2020; Visser et al., 2021) and because Dimensions has developed a method that uses an AI algorithm to tag papers related to the different SDGs. However, competing bibliometric databases have used slightly different approaches to identifying SDG research which make huge differences to the papers retrieved. Comparisons have shown very limited overlap between databases in specific SDG searches (Armitage et al., 2020; Purnell, 2022). Using alternative publication data sources for SDG related research studies could have therefore produced different results in our study. Indeed, the varying search techniques and use of AI algorithms between publication databases is a limitation now applicable to every bibliometric study that uses SDG related research.

While Dimensions coverage is broad, it is not comprehensive and relies mainly on Crossref and PubMed as it sources. For publications to be in Crossref, they need to register a digital object identifier (DOI). This requires some expertise and a financial arrangement where publishers pay $1 US for each paper assigned a DOI. While these arrangements may be easily achievable in some regions, in other less economically developed areas of the world they might pose a barrier to publishing. In these cases, papers are more likely to appear in local university presses, not be assigned a DOI, and therefore not be indexed by Dimensions. Unfortunately, poorer countries appear in the most severe GHI categories and are at the highest risk of lower database coverage (Giménez-Toledo et al., 2017). As a consequence, there might be proportionately fewer research papers on hunger published by authors affiliated to the most affected countries in our study. Crossref has recently announced an initiative to address this obstacle (Collins, 2022).

We have used mention of a country name in the title or abstract of an article as an indicator that the study focuses on that country to a certain extent. However, our manual examination of sample papers uncovered evidence of countries that were only mentioned in passing, and that did not represent the geographical focus of the study.

This finding shows that a single appearance of a country name should not alone be accepted as a reliable indicator of geographical focus. Future studies could look for ways to improve knowledge surrounding the use of country mentions as indicators of focus such as interpreting the country name in context. The passing mentions in our

study only mention a country once and consequently multiple mentions of a country name in an article might strengthen the indication of focus.

Conversely, we have assumed that the absence of country name in the article title or abstract means the study was either focused somewhere else or had no regional focus at all. This assumption might not always hold true. Scholarly papers by authors in wealthy countries with long established research infrastructure often do not mention the name of the country even in locally focused studies (Castro Torres & Alburez-Gutierrez, 2022; Kahalon et al., 2021). Some authors refer to regions of the world, e.g., Sub-Saharan Africa rather than countries, or to smaller units of countries like cities, islands, or regions. These examples serve as further evidence to support research into the use of country mentions as indicators of geographical focus.

Conclusion

This is the first large-scale bibliometric study on the geodiversity of research that used country mentions as an indicator of topic focus and author affiliations to identify geographical location. In light of the urgent and growing problem presented by hunger, we used the body of research papers related to SDG 2: Zero Hunger in the Dimensions database as a case study, and the Global Hunger Index (GHI) country categories for ease of comparison.

We found that hunger research papers focused less on the countries in the most severe GHI country categories (extremely alarming or alarming) although that may be partially explained by the comparatively low aggregate population of those countries. On the majority of papers that mentioned countries in the alarming and extremely alarming GHI country categories, the were no authors from the country mentioned. Instead, the majority of authors on the mentions-only papers were from relatively populous and wealthy countries. However, we conducted a manual examination of random samples of the mentions-only papers and found that some authors were based in neighbouring countries.

There were also methodological reasons for the low rate of mentions of countries most severely affected by hunger. There are fewer countries in the severe GHI countries to mention and the aggregate population is relatively small. Researchers based in wealthy countries are also less likely to mention the geographical focus of their study than authors in the severe GHI country categories. Use of country mention as an indicator of geographical focus might therefore not be uniform across the countries in this paper and future studies could investigate further.

Our study showed declining participation of local authors affiliated to institutions in the most severe GHI country categories. Author affiliations per population in the extremely alarming and alarming categories was one-twentieth of that in the wealthy countries not assessed by the GHI. Authors based in the most severe GHI country categories mentioned their country in most cases but not in the less severe country categories. We found in all country categories, that most affiliations-only papers did not contain mention of any country at all. Either the authors chose not to mention the country of the study, or the study had no regional focus.

Our examination of a random sample of affiliations-only papers revealed that in some studies with a localised geographical focus, the authors simply omitted to mention the site of the study. Others mentioned the city, island, or region name but not the country name. Again, this shows the shortcomings of using country names as a reliable method of capturing the whereabouts of all authors. To improve recall, the method could be extended to

cover additional geographical terms. Future studies would then more accurately determine the share of studies that have no regional focus.

We observe that many of the countries in the most alarming categories have also faced civil conflict, famine, and other causes of long-term instability that may limit the development of research infrastructure and consequent publication output.

The underrepresentation of academics from countries most affected by hunger in last author position is of concern in the context of equitable and fair international research collaboration. Our manual analyses of sample papers in the extremely alarming and alarming categories showed that sometimes local contributors are mentioned in the acknowledgements section of the paper, rather than being included as co-authors. We encourage further analysis on the criteria that warrant co-authorship and whether it is justly applied across all countries. The trend was not repeated in the other categories and our findings therefore did not support the notion of widespread unequal publication practice. Indeed, the examples in our manual analyses did not seem to resonate with the 'helicopter' or 'parachute' research practices described in recent literature (e.g., Heymann et al., 2016; Minasny & Fiantis, 2018; North et al., 2020).

Manual examination of the papers revealed that other factors were at play. For instance, the assumption that non-local authors are based in safe, wealthy countries is often wrong. Many are in fact located just across an international border from a country facing sever hunger problems, or they are based in a country in an even more severe hunger category than the country mentioned. We also found that some papers that mentioned a country didn't really focus on it and the lack of authors from that country could not therefore be interpreted as evidence of questionable research practice.

In our view, reports of helicopter research that call into question researchers' motives require clear definitions and methods that include a level of qualitative assessment including at the very least, manual examination of the publication. While some high-profile examples of questionable research ethics have been published, we urge caution when extrapolating superficial metrics such as author affiliation or author position to ensure they don't lead to unfounded conclusions (e.g., Nature, 2022).

Appendix A

Countries designated or provisionally designated by category in the GHI 2021.

Extremely alarming		
Somalia		
Alarming		
Burundi	Chad	Yemen
Comoros	Central African Republic	
Madagascar	South Sudan	
Democratic Republic of the Congo	Syrian Arab Republic	
Serious		

Afghanistan	Iraq	Papua New Guinea
Angola	Kenya	Rwanda
Benin	North Korea	Sierra Leone
Botswana	Lesotho	Sudan
Burkina Faso	Liberia	Tanzania
Congo (Republic of)	Malawi	Timor-Leste
Côte d'Ivoire	Mali	Togo
Djibouti	Mauritania	Uganda
Ethiopia	Mozambique	Venezuela
Guinea	Namibia	Zambia
Guinea-Bissau	Niger	Zimbabwe
Haiti	Nigeria	
India	Pakistan	
Moderate		
Bangladesh	Ghana	Nicaragua
Bolivia	Guatemala	Oman
Cabo Verde	Guyana	Philippines
Cambodia	Honduras	Senegal
Cameroon	Indonesia	Solomon Islands
Ecuador	Lao PDR	South Africa
Egypt	Malaysia	Sri Lanka
Eswatini	Mauritius	Suriname
Gabon	Myanmar	Thailand
Gambia	Nepal	Viet Nam
Low		
Argentina	Georgia	Paraguay
Albania	Iran	Peru
Algeria	Jamaica	Russian Federation
Armenia	Jordan	Saudi Arabia
Azerbaijan	Kazakhstan	Trinidad & Tobago
Bulgaria	Kyrgyzstan	Tunisia
Colombia	Lebanon	Turkmenistan
Costa Rica	Mexico	Ukraine
Dominican Republic	Mongolia	Uzbekistan
El Salvador	Morocco	
Fiji	Panama	
Countries assessed but insufficient data for categorisation		
Bahrain	Eritrea	Qatar
Bhutan	Libya	
Equatorial Guinea	Maldives	
Countries not assessed by GHI		

Andorra	Kiribati	Slovenia
Antigua and Barbuda Australia	Liechtenstein	Spain
Austria	Luxembourg	Sweden
Bahamas	Macao	Switzerland
Barbados	Malta	Tonga
Belgium	Marshall Islands	Tuvalu
Belize	Micronesia	United Arab Emirates
Bermuda	Monaco	United Kingdom
Brunei	Nauru	United States
Canada	Netherlands	Vanuatu
Cook Islands	New Zealand	Vatican
Cyprus	Niue	Western Sahara
Czech Republic	Norway	
Denmark	Palau	
Dominica	Palestine	
Finland	Poland	
France	Portugal	
Germany	Puerto Rico	
Greece	South Korea	
Greenland	Saint Kitts and Nevis	
Grenada	Saint Lucia	
Hong Kong	Saint Vincent and the Grenadines	
Hungary	Saint-Barthélemy	
Iceland	Samoa	
Ireland	San Marino	
Israel	Sao Tome and Principe	
Italy	Seychelles	
Japan	Singapore	

Appendix B

See Tables 5 and 6.

Table 5 Reasons for mentions-only publications

	Alarming/ extremely alarming	Serious	Moderate	Low	Not assessed
International researchers focusing on a different region	13	15	17	12	3
Researchers affiliated to neighbouring country	3	2	3	0	1
Passing mention of country but no topical focus	4	3	0	8	16

Sample data is made available in Zenodo (Purnell, 2023)

Table 6 Reasons for Affiliations-only publications

	Alarming/ extremely alarming	Serious	Moderate	Low	Not assessed
Study focuses on other region, or has no regional focus	13	17	13	9	17
Local region is mentioned but not the country name	4	3	5	4	2
Local study but region not mentioned	3	0	2	7	1

Sample data is made available in Zenodo (Purnell, 2023)

Acknowledgements Ton van Raan and Ludo Waltman for expert advice and guidance throughout the study. Marja Spierenburg, Rodrigo Costas, Ismael Rafols, and the two anonymous reviewers for feedback on earlier versions of the paper.

Data availability The sample records manually examined for this study and summarized in Appendix B in Tables 5 and 6 are available in Zenodo (Purnell, 2023).

Declarations

Competing interest The authors have no relevant financial or non-financial interests to disclose.

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