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The sex and ethnicity or national origins of researchers in astronomy and oncology in four countries, 2006–2007 and 2011–2012

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Abstract This paper uses two large databases, one of given names and one of family names, to categorise the names of researchers from Italy, Sweden, the UK and the USA whose papers in astronomy and oncology were published in 2006–2007 and in 2011–2012 by sex (gender) and ethnicity or national origin. For all the countries, there were relatively many more females publishing papers in oncology than in astronomy, but their share of contributions was lower than the percentage of researchers. Sweden and the UK had much higher percentages of both other European and Rest of the World researchers than Italy did. US researchers with non-European names were categorised in six main country groups. The ones with the greatest presence were Chinese (mainly Mandarin) and South Asians (mainly Indians). The method could be adapted to investigate the progress of women in research in many other countries, and the role played by non-national researchers in their scientific output.

Keywords Onomastics · Bibliometrics · Women · Ethnic minorities

Introduction

This paper addresses two common concerns in national research policy: are women making a proportionate contribution in research, and are countries welcoming to

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researchers from other countries? Both these questions could be answered with reference to the names of the researchers, as listed on their papers, but it is only since 2006 that the Web of Science (WoS) has listed the given names of those researchers who put them on their papers. Given names often (but not always) connote the sex of the person, and we have compiled a list of some 0.7 million such names, including some misspellings and phonetic misrepresentations. This has recently been complemented with the given names of all UK doctors on the Medical Register—over 328,000 individuals, many of whom stem from other countries. However, this may under-estimate the numbers of women scientists, particularly in the USA, because the listing is partly based on telephone subscribers, where a woman may share a number with her husband or give only her initial for security reasons (Hanks 2003).

Surnames can be compared with our listing of 2.6 million family names which is based on records of the majority of the adult population in the following countries: Australia, Brazil, Denmark, Germany, Ireland, Italy, Netherlands, Norway, South Africa, Spain, Sweden, the UK and the USA as well as surname frequency distributions for Austria, Belgium, France, India and Japan. For some countries in eastern Europe and the middle east, the files were supplemented by data on the names of scientists from these countries found in the WoS. We are able to classify names into over 160 different ethnicities, nationalities and regions within countries (Longley et al. 2007; Webber 2010). However in this paper we have grouped them together simply as own country (except for the USA), other European, and non-European.

There is quite an extensive literature on the standing of women in science, and most of the papers fall into three categories. The first is where there is a national database of researchers, often those employed by the state in national laboratories, or the results of extensive surveys (Widnall 1988; Brush 1991; Einaudi 2011; Ivie and Tesfaye 2012; Ivie et al. 2013; NSF 2013) and there are studies on Brazil (Lewison and Leta 2003; Batista and Leta 2009), Italy (Abramo et al. 2009) and Spain (Mauleon et al. 2008) among others that use such databases, although they are confined to research outputs from these labs. The general finding is that the situation of women is improving and that, on the whole, their performance is equal to that of men. The second category is more general as these studies can cover all sectors within a country (including higher education and industry), but is limited to countries where surnames have gendered endings. Polish (Webster 2001) and Russian (Lewison and Markusova 2011) surnames (and those of some other countries in eastern Europe) often do this; in Iceland (Lewison 2001) family names are not generally used and patronymics ending in "sson" or "dottir" are used instead which show the sex of the person. The third type of paper is an examination of the difficulties that women experience in combining a research career with their family commitments, and these studies have been carried out in many countries, for example France (de Cheveigne 2009), Germany (Gupta et al. 2005), India (Kurup and Maithreyi 2011), and the Netherlands (Ellemers et al. 2004).

The second subject of this paper, ethnicity or national origin, is much less studied, at least among researchers, although the US has been collecting data for many years (NSF 2013). Indeed, the concept may be hard to define in an era when there are so many mixed marriages, and many second-generation immigrants who have been educated in the new country feel themselves to be part of it rather than the one from which their parents came. Surveys of race are routinely administered to people (at least in the UK) who use certain services, but many people decline to answer, or find it hard to categorize themselves (Beji-Becheur et al. 2012). The use of surnames, or family names, to characterize people has the advantages of being unobtrusive and comprehensive, but may mis-represent some people,

especially women who marry someone from a different ethnic or national group and change their surname. A further advantage is that application of the technique at different times (or to a database with date information) can provide data on time trends with low bias.

Just as there are efforts to increase the proportion of women in science, there are also campaigns to encourage "ethnic minority" members to become researchers and to ensure that they are promoted fairly (Cohen 1998; Palepu et al. 1998; Carnes et al. 2006). However there seem to be few studies on the ethnic composition of the research workforce. Webster (2004) examined UK researchers and their changing ethnicity over the 20-year period from 1981 to 2001. She found that the Chinese and Indians were making the largest contributions, the former especially in engineering and technology and the latter in clinical medicine. She also found that the Chinese were many times more highly represented among researchers than among the population, probably because most were visiting graduate students. Another name-based study was used to examine the situation of non-white scientists in South Africa after the ending of *apartheid* (Lewison and Jacobs 2011): they were doing better but although Indians were slightly over-represented among researchers, black Africans were still trailing far behind. More recently, a study of Indian cancer researchers in Canada and the USA showed that they were generating more papers than Indians in India (Basu et al. 2012).

For this paper, we focussed our attention on two large subject areas—astronomy and astrophysics, a physical science often thought to be dominated by men, and oncology (cancer research), a biological science where women are expected to play a relatively greater part. We also considered the situation in only four countries: Italy, Sweden, the UK and the USA. Italy is sometimes thought of as a fairly traditional society in terms of social policies, although women were permitted to study at university in the latter part of the 19th century (unlike the situation in Britain) and embraced science as a career at an early stage (Govoni 2013). On the other hand, Sweden is considered by many to be at the forefront of women's equality, despite women playing a smaller role in political activities (Adman 2011). Neither country is noted for large numbers of immigrants, and indeed opposition to immigration has stimulated right-wing parties in both countries (Zincone 2006; Green-Pedersen and Krogstrup 2008; Dahlstrom and Esaiasson 2013); the recent riots in Sweden seem to have been sparked by their presence. By contrast, both the UK and the USA have traditionally been seen as places where there are large immigrant communities, and the numbers of immigrants have recently led to some political tensions and discussions on how open these countries should be to further immigration (Mulvey 2010; Boswell 2012; Orrenius and Zavodny 2012). However, our aim was simply to demonstrate the method and show some sample results, with the intention that they could be replicated in other countries and subject areas as needed, and then used as a basis for policy.

Methodology

Since the WoS only started to include authors' full names (in the download column entitled AF) in 2006, we were constrained to cover the years 2006–2012, and for convenience we identified papers from two two-year periods at the beginning (2006–2007) and end (2011–2012) of the study period; this also allowed any recent trends to be seen. We selected articles and reviews from the WoS that had authors from institutions only in the selected countries, i.e. we excluded all papers with international co-authors. (One can do this in the WoS by ticking all the boxes except the one for the given country when the

selected papers are being analysed, and then excluding these papers. However it is rather tedious to do this, and we found it easier to tick the boxes for the major countries so as to reduce the number of papers to be downloaded, and then analyse the addresses on the papers and exclude any with foreign addresses.)

Papers in the two subject areas were identified by means of special filters based on specialist journals and title words. These were developed in consultation with relevant experts (Dr Aparna Basu of NISTADS, New Delhi and Dr Lynne Davies of Cancer Research UK in London). Although the oncology filter has been used extensively and works well with a precision (the proportion of papers identified that are relevant) and recall (the proportion of relevant papers that are identified) both equal to 0.93 (Lewison 2011), the astronomy filter (Basu and Lewison 2005) contains several title words that are ambiguous and so identifies some papers in subjects remote from astronomy. So the initial selection was refined by the exclusion of papers in inappropriate subject areas such as biology.

The classification of names took place in several rounds because initially the software was not able to cope with the somewhat varied formats in which family and given names appeared, and in particular with given names appearing after an initial. Given names were not recorded for some authors, particularly in 2006, and some of the names were not recognized because they did not appear in the admittedly large database of family names. Nevertheless, many of them could easily be attributed to a country (Italy, Sweden, the UK) or seen to be European (the USA). This enabled almost all the family names to be classed in one of the groups used for the analysis, but given names proved to be more difficult as some are ambiguous as to gender, or this can vary by country (e.g. Andrea is male in Italy but female in the UK). Some family names appeared to represent a different ethnicity than the given names (e.g. Choi, Heather): she may be a second-generation US immigrant from Korea who has "assimilated" to her new country.

Results

Table 1 shows the numbers of papers from the four countries and in the two sub-fields in the given years, the numbers of authors and the numbers with a discernable given name. The tally has gone down between 2006–2007 and 2011–2012 because of greater international collaboration which reduces the numbers of single-country papers, with which we are concerned here. The Swedish astronomy totals are rather low because so much of that country's output was internationally co-authored: 84 % in 2006–2007 and 91 % in 2011–2012.

Oncologists seem more willing to print their given names on their research papers than astronomers, and cancer research has more authors per paper than astronomy in all countries and years. [However, this is because we excluded internationally co-authored papers, where the author numbers are sometimes very large. For example, although the Swedish astronomy papers only averaged just over two authors per paper (see Table 1), their international papers averaged as many as 35 authors per paper in the 7 years, 2006–2012, and one paper had an astonishing 1,061 authors.] US authors seem more willing to divulge their given names than the Europeans, although some of them also have suffixes, such as Jr, Sr, II, III. (We are actually able to analyse the sex of somewhat more of the names by matching those only with initials to authors where the given names are available, e.g. Peterson, AB = Peterson, Albert B.) These results are presented graphically in Fig. 1.

Table 1 Tally of papers and author names for four countries in ASTRO (A) and ONCOL (O)

		2006–2007					2011–2012				
		Papers	Names	Au	Given	%	Papers	Names	Au	Given	%
IT	A	758	2,346	3.1	958	41	630	1,944	3.1	661	34
SE	A	70	141	2.0	45	32	68	163	2.4	74	45
UK	A	1,096	2,698	2.5	799	30	1,037	2,770	2.7	1,219	44
US	A	3,742	12,842	3.4	7,591	59	2,746	9,859	3.6	5,364	54
IT	O	2,719	22,442	8.3	11,504	51	3,880	33,474	8.6	27,864	83
SE	O	1,086	5,376	5.0	3,131	58	997	5,233	5.2	4,427	85
UK	O	5,143	24,627	4.8	11,728	48	4,984	26,483	5.3	19,017	72
US	O	21,065	123,377	5.9	91,802	74	23,945	157,524	6.6	151,315	96

Au mean number of authors per paper

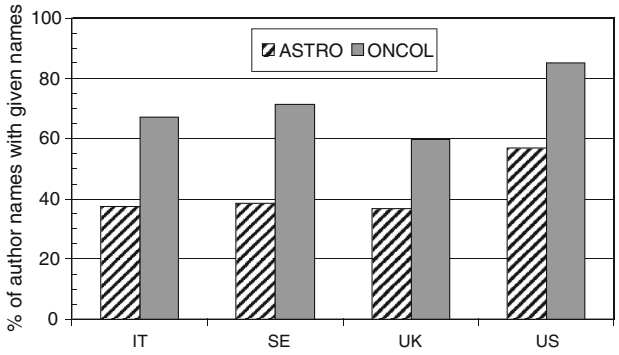

Fig. 1 Chart showing the percentages of authors in astronomy and oncology whose names appear in the WoS with their given names, 2006–2007 and 2011–2012 combined

The analysis of given names by sex and surnames by ethnicity/national origin is shown in Table 2, and for the USA, by ethnicity in Table 3. For the USA, we divided up the "Rest of the World" into six groups: Africa (AFR), China (CHI) including both the People's Republic and Taiwan; East Asia (EAS) comprising mainly Cambodia, Malaysia, Thailand and VietNam; Japan (JAP), South Korea (KOR); South Asia (SAS), comprising Bangladesh, India, Pakistan and Sri Lanka; and Other countries (OTH). In the USA, there are also likely to be many researchers of Latin American origin, who will have names that are similar to Spanish (or Portuguese) ones: these have perforce been classified as European as they are effectively indistinguishable from Spanish and Portuguese researchers.

The data in Tables 2 and 3 are for the individuals considered to be distinct, whereas the data in Table 1 are for each author on each paper without unification. Whereas these two tables show the estimates of sex and ethnic origins of researchers in the four countries, their contributions to the research *oeuvre* may be relatively less (or more). Tables 4 and 5 show the fractional count totals for the various groups. Thus if a paper had three authors, of whom one was male and two female, the female contribution would be treated as 0.67—it is, of course, impossible to make a sub-division of the relative amount of effort expended on the research by the different authors.

Table 2 Analysis of sex and ethnicity of authors of research papers for four countries in ASTRO (A) and ONCOL (O), 2006–2007 and 2011–2012

Researchers		% females		% European (other)		% rest of world	
Country	Field	2006–2007	2011–2012	2006–2007	2011–2012	2006–2007	2011–2012
IT	A	28.5	23.7	10.4	7.6	2.1	3.9
SE	A	12.2	9.6	26.5	35.3	11.5	24.8
UK	A	19.3	19.7	27.7	29.4	17.5	15.6
US	A	22.0	22.6	85.1	84.9	14.9	15.1
IT	O	47.9	53.0	7.6	6.4	4.2	3.5
SE	O	46.9	49.6	27.8	25.6	18.0	18.6
UK	O	40.8	43.5	16.2	17.2	23.0	25.1
US	O	41.0	34.9	75.6	74.7	24.4	25.3

US authors only classified as European or Rest of the World. For analysis of the latter researchers, see Table 3

Table 3 Analysis of US researchers' names in astronomy (A) and oncology (O) in both 2006–2007 and 2011–2012 that appear to be non-European in origin

Years	Total	EUR	AFR	CHI	EAS	JAP	KOR	SAS	OTH
2006–2007									
A	6,711	5,708	31	280	49	77	107	233	226
%		85.1	0.5	4.2	0.7	1.1	1.6	3.5	3.4
O	68,254	51,621	907	6,832	932	1,171	1,753	5,038	0
%		75.6	1.3	10.0	1.4	1.7	2.6	7.4	0.0
2011–2012									
A	5,681	4,825	27	282	36	62	76	191	182
%		84.9	0.5	5.0	0.6	1.1	1.3	3.4	3.2
O	84,751	63,304	1,819	8,788	1,787	904	603	7,546	0
%		74.7	2.1	10.4	2.1	1.1	0.7	8.9	0.0

EUR European, *AFR* African, *CHI* Chinese, *EAS* East Asian, *JAP* Japanese, *KOR* Korean, *SAS* South Asian, *OTH* Other

These four tables, which comprise the main data from our study, contain some expected results and some unexpected ones. In the first place, it is clear that women's contributions to research, both in numbers and papers, are much greater in oncology than in astronomy. [Although the figure for Sweden in 2011–2012 is based on only 52 names, in a subsequent analysis of Swedish astronomers from all their papers including international ones—the large majority—women accounted for only 30 of the 202 names where the sex could be determined, or 15 %.] In oncology, women appear to have reached close to parity with men except in the UK; in all countries their relative presence has increased from 2006–2007 to 2011–2012. However, their contributions to paper authorship (Tables 4, 5) are less than the relative numbers of researchers would suggest, indicating that their individual contributions are, on average, smaller and suggesting that they occupy more junior academic positions.

With regard to the ethnicity of the researchers, in both Italy and Sweden Europeans outnumber those from the Rest of the World (RoW), but in the UK the non-Europeans are

Table 4 Analysis of contributions to research papers for four countries in ASTRO (A) and ONCOL (O), 2006–2007 and 2011–2012, by authors of different sex and ethnicity

Contributions		% Females		% European (other)		% Rest of world	
Country	Field	2006–2007	2011–2012	2006–07	2011–2012	2006–2007	2011–2012
IT	A	21.4	17.5	10.0	7.5	1.7	3.9
SE	A	10.0	6.1	28.6	39.7	12.9	23.5
UK	A	15.7	16.9	23.7	22.7	18.8	19.0
US	A	17.9	19.3	84.9	84.6	15.1	15.4
IT	O	40.6	45.9	6.0	6.0	3.2	3.1
SE	O	38.8	43.8	23.1	24.9	16.8	16.1
UK	O	35.9	39.7	15.5	16.9	21.3	24.1
US	O	35.9	34.8	75.1	75.1	24.9	24.9

Table 5 Analysis of contributions to US research papers for four countries in ASTRO (A) and ONCOL (O), 2006–2007 and 2011–2012, by authors of different ethnicity (for codes, see Table 3)

Years	Total	EUR	AFR	CHI	EAS	JAP	KOR	SAS	OTH
2006–2007									
A	3,737	3,172	16	163	22	45	51	155	113
%		84.9	0.4	4.4	0.6	1.2	1.4	4.1	3.0
O	21,065	15,825	281	2,246	262	311	516	1,624	0
%		75.1	1.3	10.7	1.2	1.5	2.4	7.7	0.0
2011–2012									
A	2,745	2,322	12	151	15	33	37	103	72
%		84.6	0.4	5.5	0.5	1.2	1.3	3.8	2.6
O	23,586	17,709	495	2,375	468	225	155	2,159	0
%		75.1	2.1	10.1	2.0	1.0	0.7	9.2	0.0

more numerous in oncology. Immigrants of both groups are relatively very few in Italy, but somewhat surprisingly are relatively common in Sweden—about as much so as in the UK, a country that has traditionally been rather welcoming to non-Europeans and Europeans. For the most part, the researchers of foreign origin made a slightly smaller relative contribution to the research than ones from own country—an apparent exception is the ethnic contribution to Swedish astronomy, but since the numbers of Sweden-only astronomy papers are very small (only 138 in the 4 years), this may be an artefact of the data.

Within the USA, researchers with European family names dominate, with 85 % of the total in astronomy and 75 % in oncology. In astronomy, the non-Europeans are led in numbers by researchers with Chinese names, followed by South Asians, of whom the large majority (72 %) are from India. The Chinese can be separated into Cantonese (27 %) and Mandarin (73 %). In oncology, Chinese and Indians again dominate, and the latter have increased their share of the total from 5.0 to 5.6 %. These percentages can be compared with the presence of foreign-born Asians in the USA in 2011, which was 0.6 % for Indians, 0.72 % for Chinese, and 0.35 % for Koreans and 1.26 % for South-East Asians (Gryn and Gambino 2012). So the Indians were over-represented among researchers by a factor of about 10, but they were educationally highly qualified, with 65 % of those over 25 having a bachelor's degree or higher.

Discussion

This paper has demonstrated, by means of four countries and two subject areas, that it is possible to analyse the relative scientific contributions made by women and men, and by researchers who have come from another country. The results are intended to be illustrative rather than definitive, as both the databases of family and given names, and the software used to match the names of scientists to these names, are being continuously developed and improved. This process includes the better unification of the names of individuals (which would reduce somewhat the totals of researchers in Tables 2 and 3, but would probably hardly affect the percentages), and the ability of the programs to cope with the different formats in which names are expressed.

As for the results, perhaps the biggest surprise was the marked difference between Sweden and Italy in terms of their openness to foreign researchers, see Fig. 2. The difference is particularly marked with respect to non-Europeans, and it is also striking that Sweden has almost as high a proportion as the UK, which has long had a sizeable Indian population. This probably reflects the more friendly attitude of Swedes to foreign visitors, which has recently been tabulated by the World Economic Forum (Blanke and Chiesa 2013), see Table 6. Sweden does have a sizeable number of immigrants from poor developing countries who entered as asylum seekers, but the non-Europeans who do research in astronomy and oncology are likely to be foreign-born academics.

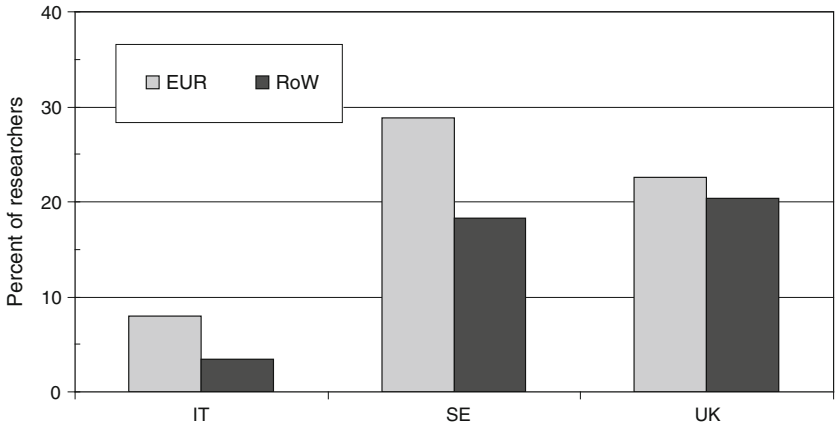

Fig. 2 Percentages of astronomy and oncology researchers (combined) in Italy (IT), Sweden (SE) and the UK who are from other European countries (EUR) or from the Rest of the World (RoW)

Table 6 Welcome score for foreign visitors (1 = very unwelcome, 7 = very welcome) in selected countries

Country	ISO	Score	Rank	Country	ISO	Score	Rank
Iceland	IS	6.8	1	Italy	IT	6.2	79
Canada	CA	6.6	12	United States	US	6.0	102
Sweden	SE	6.5	24	Denmark	DK	5.7	117
United Kingdom	UK	6.4	55	Latvia	LV	5.2	136
Japan	JP	6.2	74	Bolivia	BO	4.1	140

Within the USA, it would be possible to disaggregate the presence of the non-Europeans by state, as was done for the Indians in cancer research (Basu et al. 2012), but it is likely that the pattern will be similar to the distribution shown in Fig. 1 of Gryn and Gambino's report (2012) which showed the highest concentrations of Asian-born people in the north-east (Massachusetts, New York, Virginia), the mid-west (Illinois, Texas) and the west (California, Nevada, Washington).

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