An exploratory investigation into the shape of the science journalism employment market within the UK national press and across business to business (b2b) magazines.

Benjamin Nealon

UCard No: 190183202

Supervisor: Dr Millie Mockford

Science journalism represents a unique and important area of the journalism industry. In this research, we have characterised the national newspaper employment market for science journalists within the UK and tried to better understand the content being produced. We found that across six newspaper's digital platforms, 64 journalists wrote more than three science articles between the 22nd June and the 28th June 2019 and 2020. On average tabloid journalists produced more articles than broadsheet journalists. Health articles made up the bulk of the science articles written, with the Daily Mail being found responsible for 40.2% of these. We found that health and environment articles have a larger wordcount in comparison with biology and physics articles. It is suggested that this is due to their tendency to be more relevant to reader's lives.

Women were responsible for writing more health articles and fewer technology articles than men. This indicates that gender imbalances exist in the science journalism, roughly reflecting the imbalances within the scientific industry. There were no differences in wordcount found between the genders.

Science trade presses were investigated in order to gain a preliminary look into the area. Out of the 64 publications sampled, all have an editorial team of between one and six members. Only some have regular contributors. There is variation in how often they are released from two per year to 12 per year. Some magazines do not have original articles and are primarily made up of press releases. Some members of editorial teams are found to work for more than one publication.

Introduction

High-quality science communication is a vital part of a functioning society. Fostering an informed public and a respect for science breeds innovation in the field (De Semir 2010, p. 10). An increased trust in science also protects the public from misinformation. Therefore, understanding science writing – a major sector within science communication – is key to developing the groundwork for an informed public.

Science Writing

Irresponsible science journalism and writing can have catastrophic consequences. If misleading or contradictory scientific information is published, the public at large will be less likely to trust science and it will be perceived to be unreliable (Resnick, Sawyer & Huddleston 2015, p. 16).

As traditional outlets for media have given way to digital means, there has been an increase in misinformation. By moving online, a democratisation of journalism has occurred, which Weiss (2017) describes as a 'double-edged sword' (p. 427). An increased number of sources has caused more inaccurate information to seep in. Korsunska (2019) cites an overreliance on secondary sources as a reason that science misinformation is being propagated so much (p. 166).

It is for this reason that promoting of good science writing is important. Terms like 'fake news' have become widely used in recent years, highlighting the fact that longstanding defences against misinformation are beginning to deteriorate (Lazer et al. 2018). The protection of high-quality journalism is therefore absolutely vital.

Science Journalists

Classical science journalism is all journalism which directly cover scientific findings and events directly related to the scientific community at-large. However, this type of journalism is rarely found outside specialist magazines and newspapers (Wormer 2006 cited in Summ & Volpers 2016, p. 2). This is exacerbated by the need for mainstream journalists to find a 'human angle' when reporting on science for public consumption, a way to tie it into the reader's life and generate interest. That is why the broader definition has been used in this research: where 'the journalist refers to scientific expertise, cites studies, or includes scientific actors in the story to help explain certain events and incidents' (Summ & Volpers 2016, p. 2).

The term journalist can also refer to those working in broadcast media. The remit of this study is focused on science writing, so in this work, the term will exclusively mean 'science writer'.

Freelance Journalists

Freelance journalists are a self-employed sector of the media industry. As a result of the development of the telecommunications industry and cutbacks of the media industry, the opportunities for 'atypical' workers such as freelancers is growing (Edstrom & Ladendorf 2015, p. 1). Stanworth and Stanworth (1995, p. 228) write that 'all the indications are that 'non-standard' workers will continue to be a growing feature of the UK labour market'. Between 2000 and 2015, the number of freelance journalists increased by 67% in the UK (Spilsbury 2015, p. 8).

Working conditions of freelance journalists in the digital landscape are described as 'increasingly precarious' and research suggests that they have experienced a drop in both income and control in the digital age (Hayes & Silke 2018, p. 1019). Each freelancer's workload varies and to solidly define them is difficult.

ABSW

The Association of British Science Writers (ABSW), established in 1947 describes their membership as

> "anyone who writes, edits, sub-edits, produces or presents media content on science, medicine, environment, mathematics, engineering or technology, be it in trade press, mass media or elsewhere'

The ABSW is a UK-based society for science writers. It is dedicated to improving the quality of science journalism and to explain science to the public. The organisation offers training and advice to science writers at all career-levels. It hosts networking events for science writers and attempts to develop the industry through events and conferences, as well as annual awards to highlight science journalism of a particularly high standard. The remit of the ABSW is very broad but it consistently promotes the idea that well communicated science writing is vital for a healthy society.

The Medical Journalists Association (MJA) is a smaller association dedicated to medical journalists. There is some overlap between the ABSW and MJA as the former's mission statement also includes medicine.

By understanding the current employment market, the ABSW will be able to assess how well it represents science writers in the UK. Membership towards the ABSW requires that "Your principal source of earnings is professional journalism or writing". Defining it as such in this research, however, risks excluding science writers who may not be able to write full time. To omit them from any research would overlook a sector of the science writing market.

Newspapers

In the UK, science news makes up around 4% of total news flow (Vestergaard and Nielsen 2016) and according to an EU study (TNS Opinion & Social. 2013, p. 32), 36% of the UK gets its information about developments in science and technology from newspapers. The UK Science and the Media Expert Group (2010, p. 3) stated, "Surveys continue to show that the vast majority of the public get most of their information about science from the mass media". Mass media includes mediums like newspapers and news websites.

Traditionally, science journalists have been science 'gatekeepers' (Dudo 2015, p. 762), responsible for disseminating and reporting science accurately and in a way that is accessible to most people. Polman et al. (2012, p. 45) corroborates with this, writing that they are 'striving to filter any unsubstantiated rumours, bad science, or false technologies'. In a series of interviews, Hansen (1994) emphasises this role, stating that science journalists seek out and judge the reliability on their sources before reporting.

In the past, the failure of journalists to report science accurately and responsibly has caused real-world damage. Much of the UK press supported Dr Andrew Wakefield's study, linking MMR vaccines to autism, despite the research having very little backing from the scientific community (Stockl & Smajdor 2017). The myth still exists in the public discourse and aptly demonstrates the effects of bad science writing.

Today, however, the journalism staff are under more pressure than ever. A survey of UK science journalists in 2009 found that 61% of them believed 'in terms of staffing levels the UK national science beat is either stagnant or in decline' (Williams & Clifford 2009, cited in Ashwell 2016, p. 2).

This mood has been corroborated by other researchers and appears to be a worldwide trend – for example in 2008, CNN cut its entire science, technology and environment team.

In scientific journalism, exaggerations and sensationalised headlines and articles are - according to scientists - too common (Carsten & Illman 2002, p. 153). Davies (2009) popularised the word 'churnalism' for when journalists rely too heavily on press releases to report news, rather than fact-check the pieces they write themselves. Churnalism has become common across all fields of journalism, fuelled by the increased pressure brought about by falling profits and rising pressures (Dickinson, Matthews & Saltzis 2013, p. 4). As the expectations within newsroom have become more intense, journalists have become less likely to go out and fact-check information themselves (Fenton 2010, p. 8).

In tandem with the decline of journalism, has come the rise of science public relations (PR). Industries such as pharmaceuticals and biotechnology – in recent years – have invested in sophisticated PR departments to help control the story (Göpfert 2008, p. 218). Murcott and Willaims (2013) state that the role of PR in science journalism within the UK is 'undeniable'. They cite that 23% of reporters believe science specialists rely on PR too much (p. 156). As the pressures on journalists rise, they have less time to fact-check, consequentially increasing the influence that PR wields. Interviews with mainstream science journalists have revealed that many of them say they have 'less time to check facts for accuracy' (Murcott & Williams 2013, p. 155). This has been particularly scrutinised in the health industry as a risk to public wellbeing. Morrell et al. (2014) states that 'there is no doubt that health-related industries use numerous strategies to engage with journalists' (p. 3). This includes sponsoring journalism awards and events. Journalism has even been described as being 'compromised' by PR by some academics (Lewis, Williams & Franklin 2008). Connie St Louis (quoted in Thurman, Cornia & Kunert 2016, p. 25) puts the blame on science PR for making a science journalist's job harder in recent years.

These factors, compounded together, truly demonstrate the potential risk to science journalism in the future to carry out its duties as gatekeepers. The industry's decline is accompanied by a grim outlook by its own members, Bauer (2013, p. 29) found that only 29% of science writers in Europe would definitely encourage a young person to pursue science journalism. In a survey (Thurman, Cornia & Kunert 2016, p.25) of a sample of UK journalists, only 0.6% identified themselves as science specialist journalists. It shows the necessity for institutions like the ABSW to promote positive scientific stories.

Unlike in other European countries such as, there appears to be relatively little research into UK science journalists, especially when it comes to any information about the number of reporters. If organisations such as the ABSW are best going to promote public scientific understanding, having an idea of the number of science journalists is a necessity. Specialist science journalism has been reported as being in decline, which makes the need for information about the employment landscape particularly salient.

Gender

Historically, there have always been gender inequalities in journalism (Franks 2013, p. 1). Women are still, overall, a minority in the field (Chambers, Steiner & Fleming 2004, p. 2). There is also well documented discrimination against women in the sciences. White (2009, p. 1) writes that 'If media are a mirror of society…they certainly need to reflect better that gender equality is a fundamental human right'. In other journalism fields, it has been shown women are more likely to notice subtler frames than their male counterparts (Pan, Ryan 2007). Women are also frequently discriminated

against in STEM (Moss-Racusin et al. 2012). It has been recognised that positive female role models encourage more women into higher roles and contributes to a more egalitarian society (Shachar 2000, p. 349). It is for this reason that probing the number of women in science journalism is particularly pertinent.

Magazines

Borman (1978, p. 345) writes 'Magazines are an important source of science news, yet most studies investigating the accuracy of science coverage in the print media have focused on newspaper reporting.'. An important aspect in public discourse, mainstream magazines can offer a more focused outlet of scientific information.

Magazines can be broadly split into 'commercials' and 'trade presses'. Commercial magazines are similar to newspapers, in that they are relatively broad in their scope and appeal to a wide audience. Trade presses – or business to business (b2b) magazines – have a smaller scope. They focus on one industry within science and provide highly specialised information, catered for those who work in it. B2b publishers provide training and employment for specialised journalists who operate exclusively within the industry (Zhang 2016, p 18)

Trade presses tend to be a collection of press releases and guest columns, written by experts in the field. As for permanent writing staff, they usually have one or two editors but rarely any regular contributors. The employment of b2b science writing is a heavily under-studied area of journalism research. Science writing within this industry has received even less academic attention having been described as a 'minority subject within a minority subject of media research' (Zhang 2016, p. 44). Individual magazines typically have a small circulation of between 5000 – 20000 per issue.

With the rise of digital media, trade publications have expanded their roles to cope with the shifting landscape. On top of magazines, they also organise professional events such as seminars and conferences within their industries (Zhang 2016, p. 17).

Aims

Overall, the aims of this research are to explore the number of science writers working for national newspapers and shine a light on the content that is being produced by them. National newspapers are a significant form of journalism in the UK. A period of rapid digitisation, cutbacks and restructuring has led to much uncertainty in the industry. We aim to understand what the shape of the employment market looks like.

The role of the science journalist is to inform and as churnalism and consumer-based journalism becomes more dominant, it is also vital to get a better understanding of what is being produced by different types of publications. Therefore, we also aim to qualitatively assess the scientific content being produced by online newspaper platforms.

Gender imbalances are prevalent within journalism and science, so we will also investigate if this extends to science journalism and in which ways.

We hypothesise that the gender imbalances found in science journalism will mirror that of the scientific industry.

We hypothesise that one way this will be observed is a lesser wordcount for women than for men.

B2b magazines are an under-studied and unique area of the science writing environment. We aim to investigate the state of this 'invisible' industry to give a better overview of science writers.

Methodology

Newspapers

Data Source

The data source used in this study was the online editions of six national UK newspapers: The Guardian, the Telegraph, The Sun, The Daily Mail, The Daily Mirror and the i. These six were chosen because they give a good overview of the UK national newspaper landscape. They include an equal number of tabloids and broadsheets, the two types of paper within the UK media market (Halin & Mancini 2004, p. 12). The Sun, The Daily Mail and The Daily Mirror have the three highest UK tabloid online readerships and The Guardian and the Telegraph have the two highest UK broadsheet online readerships from data between April 2019 and March 2020 (PAMCo 2020).

Regional newspapers have been excluded due to their large number and a consistent lack of science sections. Therefore, contributing little to the total science writer market.

Tabloid Press			Broadsheet Press		
The Daily Mail	**The Daily Mirror**	**The Sun**	**The Guardian**	**The i**	**The Daily Telegraph**
Science	Science	Science	Science	Science	Science
Health	Health	Phone and Gadgets	Tech	Tech	Health
	Smartphones	Gaming	Environment	Environment	Global Health Security
		Health		Health	Tech

Figure 1 - Table showing the breakdown of the different sections analysed and what designation the papers have been given for this research

Articles were collected between 22nd June – 28th June in both 2019 and 2020. A sample from 2019 and 2020 was done to control for the potential effects of the 2020 Coronavirus pandemic. The same time period was chosen for each year to control for the scientific yearly schedule.

Collection of data.

From each article, the following variables were recorded: the article title, the author name, the author's gender, the date of publication, the publication title, and the science discipline.

The science articles were assigned to one of six categories: technology, health, biology/nature, physics, environment and other. The details of the categories are described below.

Technology: New inventions, computer technology advancements and privacy.

Physics: Any physics content, including astronomy and space technology developments

Biology/Nature: Nature and animal or plant sciences.

Environment: Climate change and human impact on nature. Includes the effects of climate change on humans.

Health: Human health conditions or new medical developments in the field.

Other: All articles that do not fall into any of the above five categories

These were chosen because they broadly represent most scientific topics covered by the UK press. No data analysis was done on articles that were classed as 'other'. The use of the 'other' category does not distinguish between scientific articles that do not fall into the other five categories and pure non-scientific articles.

For articles that fell into more than one of these disciplines, the major subject of the article was chosen. Personal judgement was used to determine this, basing it off the part of the article that took up more focus.

As this study is focused on the science writing job market, exclusively-video articles were excluded from the data. When calculating the wordcount for each newspaper, the secondary headlines and image descriptions were omitted from the final count.

Repeated parts of the articles taken out as quotes were also omitted. Subtitles were included. Some publications had their own formats which were handled in the following ways when calculating the wordcount.

The Daily Mail

Some Daily Mail articles included 'fact boxes'. These were parts of additional information, presented alongside the article. All text within these was omitted from the word count as they were usually written by a different author.

The Guardian

Several articles on The Guardian's website have been written for the international editions of the publication (Guardian US and Guardian Australia). These articles were excluded from the dataset because the research question is aimed at the UK Science employment market.

Some articles were book extracts. These were also excluded from the dataset.

The Sun

Video articles had a significant text portion, so these were included in the dataset. Similarly to the Daily Mail, these articles also had 'fact boxes'. These were omitted due to being written by a different author and appearing in multiple articles on the same subject.

Data analysis

All data analysis was done in Microsoft Excel.

Journalist number

By counting the number of individual journalists who have written or contributed to more than three articles in the same publication, the number of regular science journalists can be estimated.

By comparing this with the number of individuals who have written one or two articles, a rough estimate for the proportion of freelancers to regular staff can be established.

To get an understanding of how writing behaviours vary between publications, the total number of articles written by a regular contributor for each publication will be divided by the total number of regular contributors for that publication.

Total number of articles for each discipline

Across all articles, the number of articles for each discipline except 'other' was found. The number of health articles written by each individual publication was also counted.

Discipline/Wordcount

An ANOVA test followed by a Tukey test was used to see if there were any significant differences in wordcount between disciplines. Multiple author articles were included in this dataset, as the number of contributors to any article was not relevant to the variables being compared.

To help comparisons, the average wordcount for each discipline was also found.

Science Discipline/Gender

A chi-squared test was used to look for significant differences in gender distribution between science disciplines across all articles in the dataset.

The disciplines used excluded the 'other' category because it included both non-scientific and scientific articles. The scientific articles it did include were all different disciplines. Therefore, this category was too disparate to draw any meaningful conclusions.

Only articles with one author of a known gender were used in this analysis as contributions from articles with multiple authors are ambiguous.

Wordcount/Gender

A two tailed t-test was done to see if gender had a significant effect on average wordcount. As above, only articles with a single author of known gender were used for this test.

Strengths and Weaknesses

By using a complete list of articles written (as opposed to staff data), it means that freelance journalists will not be excluded from any demographics research.

The tabloid press tends to have a larger number of articles dedicated to health news than their broadsheet equivalent but the scientific content behind them is questionable. Therefore, it could be argued that including them in the data and treating them as scientific articles is unreliable. However, arbitrarily excluding the articles for not including enough scientific content would have introduced personal bias into the data.

When counting the journalist number, using the count of writers who have written 1 or 2 articles as the number who have counted freelancers will introduce some uncertainty into the figure. Firstly, some freelance journalists may have written more than 1 or 2, and by discounting them as such is quite broad. Furthermore, it assumes all people who have written articles are journalists, whereas some may have been guest writers with other jobs – not self-employed journalists.

B2b Magazines

Using the Audit Bureau of Circulations' (ABC) records, a non-exhaustive list of business to business (b2b) trade presses was used to establish a preliminary employment landscape. Due to resources available, I was not able to establish a full list. Using the incomplete list, the publications were sorted into 'scientific' and 'non-scientific'. Then, using information found from their websites, the number and type of employment of the scientific trade press' editorial teams was found. Common names that worked on multiple publications were noted.

From their teams, only editorial staff members were made a note of. Advertising, sales and circulation staff were all excluded.

Among the magazines, the number of regular editions published in 2019 were counted to get an understanding of how the circulation differs from newspapers.

The content of the publications was also qualitatively assessed to get an idea of the publication's role in the industry.

This will give a good estimate of the employment industry with little existing research.

Results and Discussion

Journalist number

The number of journalists who have written or contributed to at least three articles between the 22nd and 28th June 2019 and 2020 is 64. The breakdown of how these numbers were across each publication, as well as the gender split is shown in Figure 2.

Newspaper title	Male	Female	Total
Daily Mail	13	10	23
The Sun	5	4	9
The Guardian	6	7	13
The Telegraph	3	5	8
The Mirror	0	2	2
The i	5	4	9
Total	32	32	64

Figure 2 - A table showing the breakdown of regular contributors for the publications sampled

The average number of articles written by each regular contributor for each individual publication is shown in Figure 3.
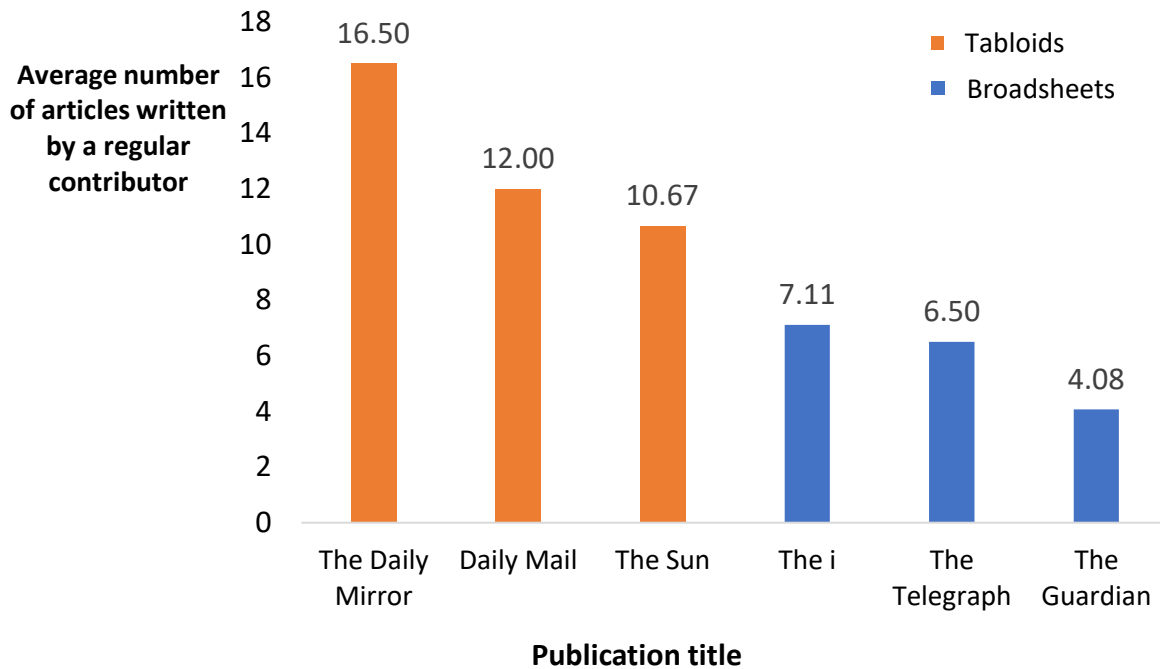
Figure 3 - The average number of articles written by a regular contributor for each publication

In this research, when determining a figure, we have assumed that journalists who contribute at least three articles are fulltime staff, as opposed to freelance journalists.

The average number of articles written by each regular contributor in the tabloids is statistically significantly higher than the broadsheet publications. This difference may reflect how the publications have adapted to the digital landscape and, by extension, the different audiences that they are catering towards. In 2001, Cowen noted that traditional media has had to reassess its role in the internet age (p. 189). To fight back against dropping revenues, news media became more advertisement driven. Thurman (2014, p. 175) writes that by publicly reporting using metrics such as "unique users", publications would increase the shift towards advertising models that ignore reader engagement and instead focus on individual impressions, a model that is catered directly towards social media. Tabloids are reported as having adapted to this model to a greater extent to broadsheets (Hedman & Djerf-Pierre 2013, p. 9). This is consistent with the data reported here, it appears that the tabloids have prioritised getting 'clicks' as their chief source of revenue – something that is common with digital news sights with free content (Chakraborty et al. 2017).

Alternatively, broadsheets appear to have focused more on building up base audiences. Since 2010, several UK broadsheets have adopted a series of online subscription models and 'paywalls' for some of their digital content (Franklin 2014, p. 256). From the sample used in this research, the Telegraph has a full subscription model, requiring a monthly payment to access any of its content and the Guardian has a donation model, where it strongly encourages its users to donate to it. These alternative forms of revenue streams served to replace the loss in advertising revenue experienced during the digitisation of the news and have been fairly successful in doing so (Dekavalla 2015, p. 112; Olsen, Kammer & Solvoll 2019). It would follow that this means the newspapers are less reliant on unique user traffic and advertising revenue. This is backed up by the lower number of articles, there appears to be less pressure on journalists to produce a high volume of articles (potentially at the expense of quality). The i has no such system in place for alternative revenues but has the highest average number of articles per writer out of the broadsheets, which backs up the proposed

relationship between the number of articles produced per journalist and the business model of the publication.

The effect of paywalls is explored by Sjøvaag's (2016) study of Norwegian digital newspapers. They found that content protected by paywalls tended to be the most valued and resource consuming journalistic work, whereas the open news tended to be the more highly traffic-generating articles. This corroborates with the explanation that without such paywalls, the tabloid publication model is reliant on generating traffic, and therefore they produce more articles. One possible reason is that these publications have more of a need to 'cast a wide net' when it comes to news. They need to appeal to as many people as they can to generate interest in their science articles.

Journalism has gone through a process known as 'tabloidization' over recent years (Spillane et al. 2018). Tabloidization is a phenomenon in which journalistic standards drop and there is an increased priority of articles to entertain, rather than to inform (Esser 1999, p. 293). The tabloid press has always been more suited towards social media, but a shift towards online platforms has caused a degree of tabloidization across all publications including broadsheets (Gran 2015). The online environment encourages spectacle over restraint (Chen, Conroy & Rubin 2015, p. 15) and so pushes all newspapers to manufacture a high volume of this kind of content. In the context of science, this undermines the role of a gatekeeper to bad science, as well as science journalist's duty to shape the public understanding on the health and environment.

Whilst assessing the quality of the articles was not in the scope of this research, from the journalist data alone it is possible that the adoption of paywall features has allowed publications to put more emphasis on high-quality, in-depth journalism. This is due to the presence of a second revenue stream and has been implied by the number of articles per journalist. This phenomenon has, in turn, staved off some of the practices that come with tabloidization. Alternatively, it could just be a short-term effect. Academics have suggested that we are merely at the beginning of massive changes to the media industry and adjustments to digital business models may be inadequate in the future as these trends exacerbate (Newman 2018, p. 46).

There are several industrial implications of these findings. Regular contributors hired by tabloid and broadsheet newspapers would have different expectations when it came to the volume of article output. There would also be a difference in the kinds of articles that journalists would be expected to write. Tabloid journalists would have more pressure on them to write universal science articles that would appeal to a wider audience.

The data also showed that 234 writers wrote one or two articles within the defined time period. These may have also been full-time writers and it cannot be assumed they were all freelance journalists. It also cannot be assumed that they are all science writers. There is a phenomenon across some publications, where non-science articles that contain a scientific element are assigned to the science section of a paper in addition to their own category. Therefore, little can be concluded from this number without further study. The figure is also from two disconnected time periods, a year apart from each other and it is possible that some publications have gone through significant employment changes between these dates. Nevertheless, it serves as a rough guideline about how many journalists are contributing to the publication's digital platforms and as a reflection of the newspaper's normal practices.

Total number of articles for each discipline

Comparing the total number of articles attributed to each discipline reveals that health news alone makes up 51.4% of the total number of science articles sampled (Figure 4). While it may have been

assumed that this was inflated by the 2020 Coronavirus outbreak, where more articles were written about health due to the unprecedented influence of COVID-19. In actuality, the number of health articles written in 2020 was 213, and the number written in 2019 was 205. The difference between them indicates no such effect and implies that health articles have always made up a large proportion of science articles.
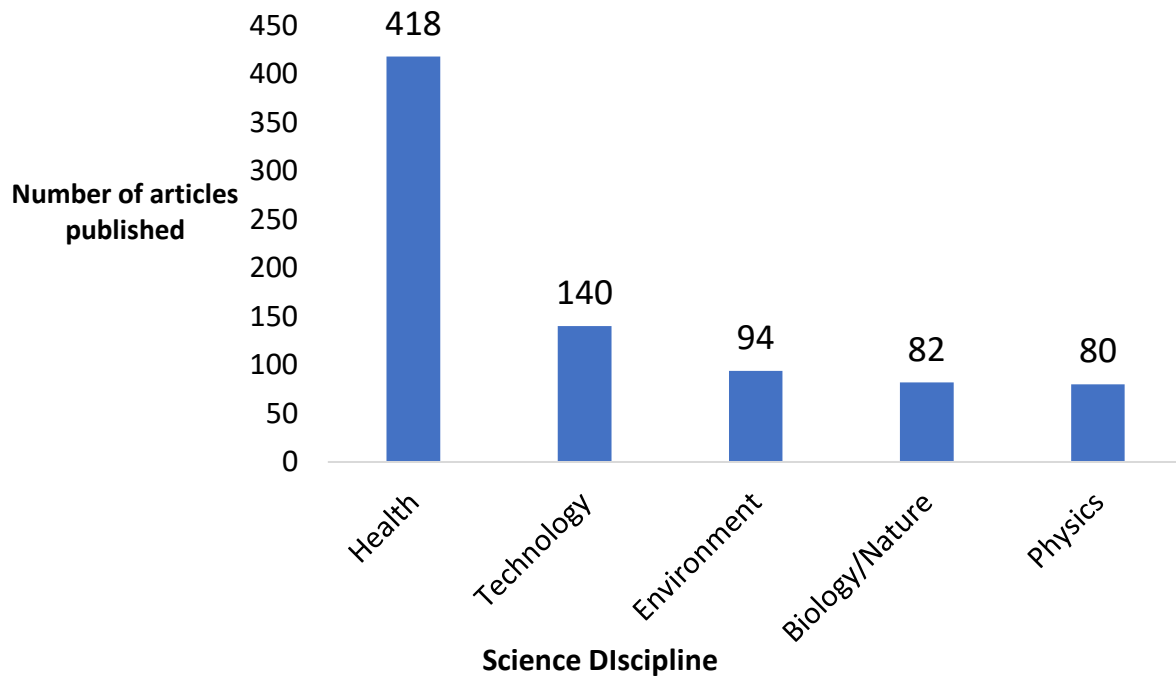

Figure 4 - The number of articles published of each science discipline

The domination of health news in the science news circuit is well documented. Bauer (1998) writes about the 'medicalization of science news' across the 20th century, wherein biomedical news became central to the public representation of science. Sklair (1973) cited in Bauer (1998) also noted, however, that there is always a large amount of interest in health-related matters among the public (p. 735). Bradshaw (1995), cited in Bauer (1998, p. 737), found that a higher proportion of science articles in 'popular' UK newspapers (in contrast to 'quality' newspapers) were health related.

In an analysis of health stories in print UK newspapers, Robinson et al. (2012) found that the Daily Mail published the most health stories, but that The Sun and The Daily Mirror published an average amount compared to other UK publications. By recording the number of articles categorised as 'health articles' and splitting it by publication shows that the Daily Mail does publish the most by a significant margin (Figure 5).
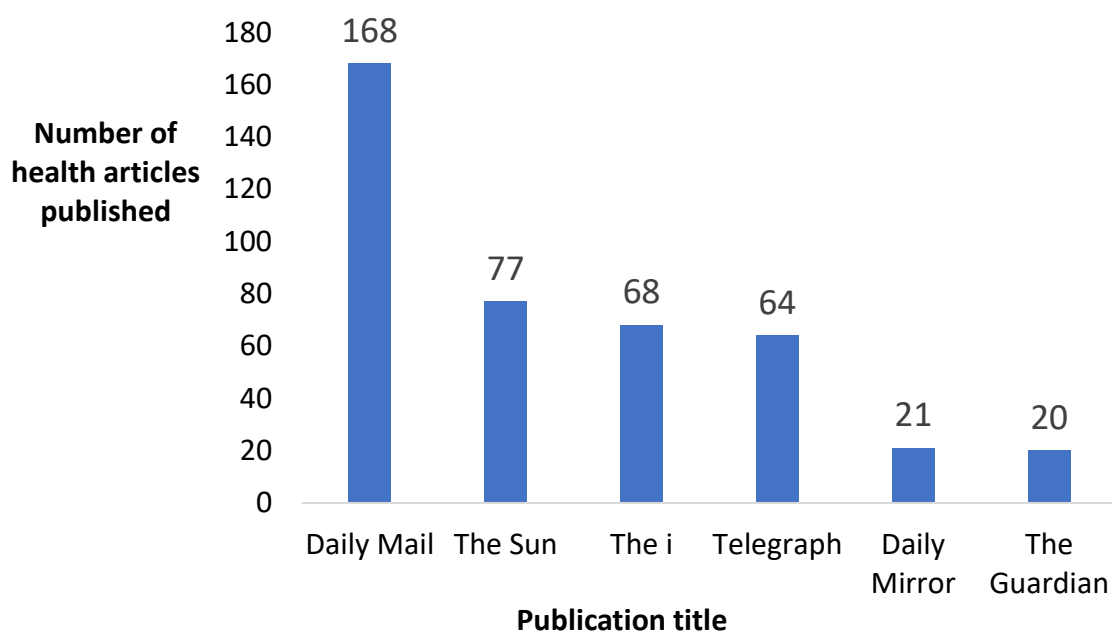
Figure 5 - The number of health articles, split up by publication

Robinson's study also scored the Sun, the Daily Mirror and The Daily Mail's articles as being lower quality than their broadsheet counterparts. The low quality is most common in articles about diet and nutrition (Kininmonth et al. 2017; Cooper et al. 2011). The scientific content of all of these 'health' articles is dubious, especially those in the tabloid media. It has been shown that quality broadsheet newspapers were more likely to provide scientific information. In contrast, the tabloid press was more likely to look at individual cases, create more sensationalised articles and be less objective overall (Entwistle & Hancock-Beaulieu 1992). Goldacre (2007) humorously writes that the Daily Mail is engaged in a project, "sifting through all the inanimate objects in the world, soberly dividing them into the ones which either cause – or cure – cancer"

The volume of health articles being written, compounded with tabloid's tendency to have fewer writers producing more articles, leaves the publication open to exploitation by science PR companies and press releases. In fact, Stryker (2002) showed that when press releases contained more 'newsworthy' information, they were more likely to be reported on by journalists. When newspapers like The Daily Mail prioritise medical information that is topical and has effects on lifestyle, rather than the news that has medical implications, it can cause this bias. Whilst it is important that journalism remains interesting and has a human angle, it is equally important that it remains as 'quality' journalism and is not used to serve an agenda.

It was notable that out of the 1346 total articles sampled, none were written about chemistry article. As written above, the majority of physics articles were astronomy or space-based. Both chemistry and non-astronomy-based physics are abstract sciences where communicating the latest discoveries usually requires some background explanation. This supports the idea that publications focus on producing science articles to attract an audience rather than to inform. It may be because finding a human angle to certain scientific discoveries is difficult. However, the complete lack of these two significant areas of science is cause of concern. Chemistry is one of the least favourably viewed sciences (Moreau 2009, p. 6) among the public. The duty of a science journalist is disputed,

but as a significant source of science to the public, having scientific representation across all disciplines is important so the public can be properly informed. It agrees with the trend that - on digital platforms – consumer-dictated journalism is extremely prevalent. Whether this extends to print media is not in the scope of this research.

The trend into consumer-based journalism is one that has affected science journalism the most. As an information-based topic, science relies on detail. If the decline of the more technical sciences being reported is related to the rise of social media, it may be a sign of what is to come for science journalism as this trend continues. If science journalists are to hold onto their designation as a fourth estate, they will need to adapt in a way that does not exclude certain scientific areas from mainstream journalism.

A point of concern is that journalists lack the ability to explain complex scientific concepts in a form fit for newspaper publications. Whilst there is little data on UK journalists, just 8% of journalists in the USA hold life sciences degrees (Viswanath et al. 2008). As newsrooms cut science sections, more non-specialist journalists are being given science stories to cover (Brennen, Howard & Nielson 2018, p. 2). Non-scientific journalists would feel less qualified to report on complex stories that require an in-depth insight into the subject, which could then discourage them reporting on it.

Discipline and wordcount

Using a one-way ANOVA test, the F value was found to be 8.5303 and the P-value was <0.000001. This shows a statistically significant difference between the different science disciplines and the wordcounts written for them. By doing a Tukey test as well, the P-Value between the following disciplines was found to be less than 0.05 and therefore significant.

Science Discipline	P-Value
Physics/Health	0.0002
Physics/Environment	0.0155
Biology/Health	0.0001
Biology/Environment	0.0140

Figure 6 - The P-Value of difference in wordcounts between disciplines

The difference between wordcounts in the sciences existed in physics and biology with the lowest average and health and environment with the highest average. The suggestion that health and environment articles have a significant difference with biology and physics may be related to the human angle of the stories. Both health and environment articles are generally tied closely into real world events or stories directly relevant to people reading them, whereas biology and physics are technical sciences that may have less impact on people. Wormer (2008, p. 1) even writes that many journalists reporting on health or environment news do not recognise that they are doing science journalism – demonstrating how divorced it can be from science in contrast to more 'traditional' science news.
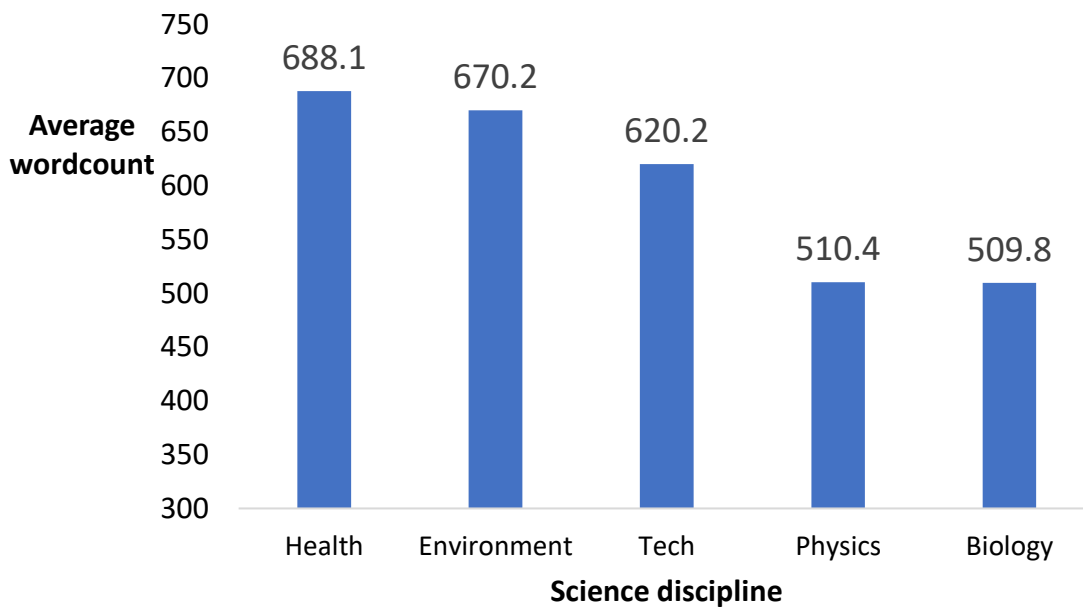
Figure 7 - The average wordcount of each science discipline

In the past, stories with a public affairs element have been shown to receive more engagement online than purely political stories (Boczkowski & Mitchelstein 2012) and our research suggests that this effect may extend to scientific journalism. This theory is backed up if we assume that these articles are operating on an advertising, 'click-based' revenue model as established above. This limits the more 'scientific news' to shorter wordcounts to retain its audience: people are less likely to share articles with a large amount of technical and background information. Environment and health articles, however, can usually be tied into many surrounding themes which allows for more relevant and interesting information from the reader's perspective.

Technology articles have no significant wordcount differences with any other disciplines. Technology reporting is an under-studied region of journalism studies (Brennen, Howard & Nielson 2020, p. 3) so the reason is unclear. However, by the same logic as that applied to health and environment news, it could be because it is a field that can walk the line between technical stories and ones with real-world effects – especially as the 21st century progresses and it has more of an impact on human lives. Technology writers in the past have been perceived simultaneously as 'utopians' peddling 'rose-tinted techno-boosterism' (Turner 2010, cited in Brennen, Howard & Nielson 2020, p. 1) and technical specialists (Geiß, Jackob & Quiring 2012). This crossover of both news that impacts public affairs and highly technical information gives technology news a unique quality that is reflected in the wordcount.

Science Discipline and Gender

A chi-square test was done, the sum of the chi-square value was 60.59 and the P-Value < 0.00001. With a P-value far below the significance value of 0.05, this showed a significant result, indicating that there is a relationship between author gender and science discipline. Furthermore, by looking at the individual chi-square values, certain values were much higher, showing that there is more of a relationship between certain variables.

	Male	Female	**Total**
Physics	36	37	73
Environment	41	43	84
Health	133	235	368
Biology	51	26	77
Technology	94	37	131
Total	355	378	733

Figure 8 - The number of writers of each gender by discipline

From the numbers for each discipline, the largest gender disparities for articles exist in health, biology and technology. Both physics and environment articles have a more even split between men and women (49.3%/50.7% and 48.8%/51.2% respectively).

Gender discrimination in journalism is well documented. Women have historically been excluded from key editorial decisions in the newsroom, furthermore, the people assigning the stories would usually be men (North 2014, p. 14). Reinardy (2009) found that female journalists are more likely to leave US newspapers and experienced a lower level of job satisfaction. Whilst change has occurred in the early 21st century, most feminisation has only happened at the junior level (Hannis & Strong 2007, p. 123). In 2010, the Global Media Monitoring Project (GMMP, p.25) showed that male reporters were more likely to report on so-called 'hard' news – items that were deemed important such as the economy or political decisions. It also showed women were more likely to report on 'soft' stories like culture, health and social issues. This imbalance has negative effects on the entire journalism industry – 'hard' news is generally more prestigious and those writing it are more likely to rise through the ranks more quickly.

This reported disparity is consistent with some of the results found in this sample of UK newspapers. More health articles (63.9%) are written by women, whereas more technology articles – traditionally considered as 'hard news' – are written by men (71.8%). However, physics and environment news have more equal gender splits, both of which are also considered 'hard' news.

A possible reason for this is the existing gender barriers in the technology industry. It has been reported that the UK IT industry does very little to promote or retain female representation (Penteli et al. 1999). Such a lack of specialists may bleed into the journalism industry, causing fewer female experts to write technology journalism. Alternatively, the lack of female technology journalists could be symptomatic of the prevailing attitudes towards women and technology. Female journalists have previously reported being 'pigeon-holed' into certain types of article because of their gender and that certain specialisations are 'jobs for girls' (Pate 2014). Rather than being the fault of the industry, it may be because of society's expectations on what women should write.

Despite the causes, it is clear that more needs to be done to not just promote women in science writing, but to promote them in places where they lack representation. Attempts to broadly encourage more women to enter science writing have the potential to just further current gender disparities by reinforcing the idea that female journalists only write certain types of science. If progress in gender equality is going to be made, a more precise outlook needs to be employed. Steps should be taken to promote female engagement in specific areas of science where there is less of them. This is reinforced by looking at the gender gap of the total number of writers of the articles- 48.4% male and 51.6% female; the total number of writers is relatively even but caveats exist in the individual disciplines.

The even split in physics news does not fall in line with past trends. Historically, physics has the lowest representation of all the sciences with regards to female representation (Ivie & Tesfaye 2012). However, this may be because the physics category used in the research included astronomy. Most of the physics articles indexed in this research were astronomy based, which, as an industry, is documented as having a much higher female representation than physics (Ivie & Ray 2005).

The gender gap recorded in biology also disagrees with trends within the wider field. Generally, biology is one of the more equal sciences when it comes to representation (Bonham & Stefan 2017), yet looking at the number of articles written by each respective gender, it shows the largest gaps recorded among the science disciplines (33.8% female/66.2% male). This has potentially been caused by the categorisation of the science disciplines. Health and biology were classed as two different disciplines in the study, but in the scientific industry, when assessing gender, the two are often conflated into a single subject area. This may have caused 'biology' to only include 'hard' biological news and 'health' to include the soft biological news. The gap in biology and health further reinforces the need for detailed approaches to promoting equal gender representation in science writing, promoting women into biology is not good enough, it needs to be the types of stories they are usually excluded from.

This falls in line with the hypothesis that gender imbalances somewhat reflect those in science industry.

Wordcount and Gender

By doing a t-test, the t-value was 1.07843 and the p-value was 0.281199. This was not significant and therefore showed no relationship between them.

The results show that the gender of the journalist does not affect the length of the article they write. The gender disparities between journalists shown above, therefore, do not extend to the lengths of articles written. The result indicates that there is no evidence that wordcounts are an effective metric to measure gender imbalance in science writing. The original hypothesis that gender would affect wordcount to disfavour females was made under the assumption that certain smaller articles would be purposefully assigned to women. The lack of difference between the article lengths suggests that women and men are generally expected to write articles of the same length.

Using wordcounts to assess gender differences may have been a flawed approach for this study. In the past, researchers have used 'column inches' as a measure for an article's importance on print newspapers – although not usually regarding gender - with larger columns being deemed more important (Stewart 1943, p. 288). On newspaper websites there is no such limit. The rules on space are not as restrictive as they once were and the guidelines for article length would be from the editor.

B2b Magazines

The b2b science writing industry appears to be structured differently to newspaper publications. The common permanent staff across all publications were editorial staff. Out of the 64 science b2b publications where information could be found, all had a permanent editorial team. Most publications also had an Editorial board, responsible for the general direction of the magazine. These have not been included in any analysis however, since their positions are advisory. There is also an international element to the trade presses. Whilst all the magazines sampled were based in the UK, it was not uncommon for editor-in-chiefs to be based abroad. Therefore the total number of editorial staff employed in the UK by this sample of magazines is likely to be lower.

The content of b2b magazines varies. Some are exclusively made up of press releases and interviews, with very few original pieces. Others are more like commercial science magazines, with features and articles written by contributors. This has made it difficult to determine a figure for the writing staff typically employed. Due to the number of science b2b publications, there are more science writers writing for these than for UK national newspapers. However, few of them have permanent writing staff, instead they have a mixture of regular editorial contributors and industry experts writing for them. There was no consistent way to record editorial contributions across publications, so they have been omitted from this study.

The b2b publications are all published on different schedules but all less frequently than newspapers (Figure 9) – out of the publications analysed, the highest number of editions published in a year was 12 which translates to a monthly schedule. Most were published more infrequently though, with some magazines only having two copies a year. This suggests that any science writing staff for these would work across multiple publications, however, there is no way to quantify this.
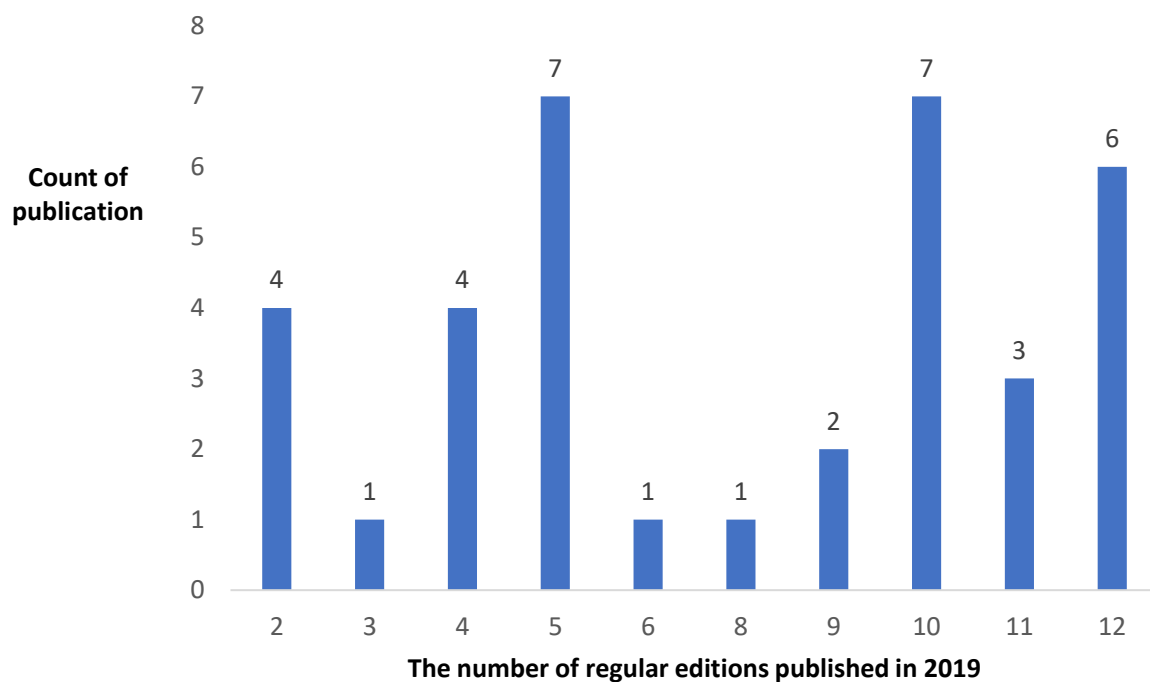
Count of publication

Figure 9 - The number of regular editions of each publication for which there was information, published in 2019

A common theme was that certain editorial staff operated across multiple publications. Out of 110 individual editorial team members across the 64 sampled publications, 22 of them were found to be working on more than one. This may have been because some companies owned several b2b publications – this is a recent trend, between 2012 and 2013, the number of digital editions owned by an average b2b publishing company increased by 433% (PPA 2013 cited in Zhang 2016, p. 24). This means that crossover in editorial staff could have been easier. This may be happening amongst writing staff too, especially since they tend to be highly specialised in the industry and many of the magazine's cover similar areas.

In addition to the magazines, some publications also publish weekly newsletters and articles exclusive to their websites. This captures how extensive their writing staff possibly is. The data on

editorial staff gives limited information on how the b2b publications are structures and what proportion of the science writing market they make up.

Conclusion

The overall aims of this research were to establish an overview of the science journalism employment market and to characterise the content being produced.

In this research, we found that across six national newspaper publications, there were 64 regular contributors who wrote three or more articles. The average number of articles written by these individuals was significantly different between broadsheets and tabloids. This is potentially linked to the business models they adopt. Tabloids – who's journalism lends itself to social media – relies on free content for a wide audience. In contrast, broadsheets tend to produce fewer articles, implying less of a need to do so. Further investigation could focus on comparisons from around five years ago when digitisation of the press was less widespread, so to better understand the implications of this process. It could also try to focus on the quality of the articles, so to better understand the changes in content that has happened in recent years.

Health news makes up a significant portion of the news cycle online and has been unaffected by the 2020 coronavirus pandemic. Much of the health news has been generated by the Daily Mail, falling in line with past research. Certain science disciplines, most notably chemistry, are reported on infrequently and more needs to be done to represent them to the public. Health and environment news also typically have longer articles written about them, something that is linked to how well they can tie into public affairs.

The gender of journalists is inextricably linked to the science discipline of their articles. Traditional gender expectations still hold true within the journalism industry – with women writing more articles that are traditionally perceived as less important. It is clear more needs to be done within the industry that looks on a precise level about the inequalities in the newsroom. Interviews with journalists and editorial teams could help explore the root causes of these results and what can be done to fix them. The gender imbalances partially mirror those traditionally seen in the scientific industry as stated in our hypothesis.

The wordcount of articles was not different between genders, disagreeing with our hypothesis and suggesting that the imbalances in the industry do not extend to the final article output.

B2b magazines are published on a less regular basis than newspapers. Their editorial teams tend to cross over with each other to a certain extent. They represent a unique subsection of the science writing market which has received little to know detailed analysis. Future research could focus on science writers within the field to better understand their working patterns.

This research has shined a light onto parts of the UK science writing employment landscape, helping form a picture – albeit incomplete – of how the industry works.

References

Ashwell, D. J., (2016). The challenges of science journalism: The perspectives of scientists, science communication advisors and journalists from New Zealand. *Public Understanding of Science* [online]. **25**(3), 379-393. [Viewed 22 June 2020]. Available from: doi: 10.1177/0963662514556144

Bauer, M. W. et al. (2013). *Global science journalism report: working conditions & practices, professional ethos and future expectations* [online]. London: Science and Development Network.

[Viewed 31 July 2020]. Available from:
http://eprints.lse.ac.uk/48051/1/Bauer_Global_science_journalism_2013.pdf

Bauer, M., (1998). The medicalization of science news – from the "rocket-scalpel" to the "gene-meteorite" complex. *Social Science Information* [online]. **37**(4), 731-751. [Viewed 5 June 2020]. Available from: doi: 10.1177/053901898037004009

Boczkowski, P. J., Mitchelstein, E., (2012). How Users Take Advantage of Different Forms of Interactivity on Online News Sites: Clicking, E-Mailing, and Commenting. *Human Communication Research* [online]. **38**(1), 1-22. [Viewed 9 August 2020]. Available from: doi: 10.1111/j.1468-2958.2011.01418.x

Bonham, K. S., Stefan, M. I., (2017). Women are underrepresented in computational biology: An analysis of the scholarly literature in biology, computer science and computational biology. *PLOS Computational Biology* [online]. **13**(10). [Viewed 7 July 2020]. Available from: doi: 10.1371/journal.pcbi.1005134

Borman, S. C., (1978). Communication Accuracy in Magazine Science Reporting. *Journalism Quarterly* [online]. **55**(2), 345-346. [Viewed 18 August 2020]. Available from: doi: 10.1177/107769907805500220

Brennen, J. S., Howard, P. N., Nielsen, R. K., (2018). *An Industry-Led Debate: How UK Media Cover Artificial Intelligence* [online]. Oxford: Reuters Institute for the Study of Journalism. [Viewed 11 June 2020]. Available from: https://reutersinstitute.politics.ox.ac.uk/sites/default/files/2018-12/Brennen_UK_Media_Coverage_of_AI_FINAL.pdf

Brennen, J. S., Howard, P. N., Nielsen, R. K., (2020). Balancing Product Reviews, Traffic Targets, and Industry Criticism: UK Technology Journalism in Practice. *Journalism Practice* [online]. [Viewed 10 June 2020]. Available from: doi: 10.1080/17512786.2020.1783567

Carsten, L. D., Illman, D. L.., (2002). Perceptions of Accuracy in Science Writing. *IEEE Transactions on Professional Communication* [online]. **45**(3), 153-156. [Viewed 23 June 2020]. Available from: doi: 10.1109/TPC.2002.801632

Chakraborty, A. et al., (2017). Tabloids in the Era of Social Media? Understanding the Production and Consumption of Clickbaits in Twitter. *Proceedings of the 21st ACM Conference on Computer-Supported Cooperative Work and Social Computing*. **1**(30). [Viewed 5 August 2020]. Available from: doi: 10.1145/3134665

Chambers, D., Steiner, L., Fleming, C., (2004). *Women and Journalism* [online]. New York: Routledge. [Viewed 19 August 2020]. Available from: doi: 10.4324/9780203500668

Chen, Y., Conroy, N. J., Rubin, V. L., (2015). Misleading Online Content: Recognizing Clickbait as "False News". *Proceedings of the 2015 ACM on Workshop on Multimodal Deception Detection, 9/11/2015, Seattle, USA* [online]. New York, USA: ACM, pp. 15-19. [Viewed 5 August 2020]. Available from: doi: 10.1145/2823465.2823467

Cooper, B. E. J. et al., (2011). The quality of the evidence for dietary advice given in UK national newspapers. *Public Understanding of Science* [online]. **21**(6), 664-673. [Viewed 9 August 2020]. Available from: doi: 10.1177/0963662511401782

Cowen, N., (2001). The future of the British broadsheet newspaper on the World Wide Web. *Aslib Proceedings* [online]. **53**(5), 189-200. [Viewed 3 August 2020]. Available from: doi: 10.1108/EUM0000000007053

Davies, N., (2009). *Flat Earth News*, London: Vintage Books

De Semir, V., (2010). *Science communication & science journalism meta-review: The crisis of media, the relocation of the journalists' world and the decline of science sections in the context of the internet communicative and social revolution* [online]. Spain: Pomeu Fabra University. [Viewed 2 August 2020]. Available from: https://www.observatorio-acuicultura.es/sites/default/files/images/adjuntos/libros/science_comunication.pdf

Dekavalla, M., (2015). The Scottish newspaper industry in the digital era. *Media Culture & Society* [online]. **37**(1), 107-114. [Viewed 4 August 2020]. Available from: doi: 10.1177/0163443714553565

Dickinson, R., Matthew, J., Saltzis, K., (2013). Studying journalists in changing times: Understanding news work as socially situated practice. *International Communication Gazette* [online]. **75**(1), 3-18. [Viewed 29 July 2020]. Available from: doi: 10.1177/1748048512461759

Dudo, A., (2015). Scientists, the Media and the Public Communication of Science. *Sociology Compass* [online]. **9**(9), 761-775. [Viewed 29 July 2020]. Available from: doi: 10.1111/soc4.12298

Edstrom, M., Ladendorf, M., (2012). Freelance Journalists as a flexible workforce in media industries. *Journalism Practice* [online], **6**(5), 711-721. [Viewed 1 August 2020]. Available from: doi: 10.1080/17512786.2012.667275

Entwistle, V., Hancock-Beaulieu, M., (1992). Health and medical coverage in the UK national press. *Public Understand. Sci.* [online]. **1**(4), 367-382. [Viewed 9 August 2020]. Available from: doi: 10.1088/0963-6625/1/4/002

Esser, F., (1999). 'Tabloidization' of news: A comparative analysis of Anglo-American and German press journalism. *European Journal of Communication* [online]. **14**(3), 291-324. [Viewed 4 August 2020]. Available from: doi: 10.1177/0267323199014003001

Fenton, N., (2010). Drowning or waving? New media, journalism and democracy in the digital age. In: Fenton, N., ed., *Drowning or Waving? New Media, Journalism and Democracy* [online]. London: SAGE. 3-16. [Viewed 5 August 2020]. Available from: doi: 10.4135/9781446280010.n1.

Franklin, B., (2014). The Future of Journalism In an Age of Digital Media and Economic Uncertainty. *Digital Journalism* [online]. **2**(3), 254-272. [Viewed 5 August 2020]. Available from: doi: 10.1080/21670811.2014.930253

Franks, S., (2013). *Women and journalism* [online]. London: I.B. Tauris. [Viewed 19 August 2020]. Available from: https://ora.ox.ac.uk/objects/uuid:cab61d4c-0866-4cb5-abac-081384ca8827/download_file?safe_filename=Women%2Bin%2BJournalism&file_format=application%2Fpdf&type_of_work=Book

Geiß, S., Jackob, N., Quiring, O., (2012). The impact of communicating digital technologies: How information and communication technology journalists conceptualize their influence on the audience and the industry. *New Media & Society* [online]. **15**(7), 1058-1076. [Viewed 10 August 2020]. Available from: doi: 10.1177/1461444812465597

Global Media Monitoring Project., (2010). *Who makes the news?* [online]. World Association for Christian Communication (WACC). [Viewed 6 August 2020]. Available from: http://cdn.agilitycms.com/who-makes-the-news/Imported/reports_2010/global/gmmp_global_report_en.pdf

Goldacre, B., (2007). The Mail gets it right, with one point missing. *The Guardian*. 8 December. [Viewed 18 August 2020]. Available from: https://www.theguardian.com/commentisfree/2007/dec/08/cancer.dailymail

Göpfert, W., (2008). The strength of PR and the weakness of science journalism. In: M. W. Bauer, M. Bucchi, eds. *Journalism, Science and Society: Science Communication between News and Public Relations* [online]. New York: Routledge, 215-226. [Viewed 19 August 2020]. Available from: https://www.mobt3ath.com/uplode/book/book-51809.pdf

Gran, C. S., (2015). Tabloidisation of the Norwegian News Media: A Quantitative Analysis of Print and Online Newspaper Platforms. MSc Dissertation, LSE. [Viewed 18 August 2020]. Available from: https://www.lse.ac.uk/media-and-communications/assets/documents/research/msc-dissertations/2014/Celine-Storstad-Gran-LSE-MediaSeries-AF.pdf

Halin, D. C., Mancini, P., (2004). *Comparing Media Systems: Three Models of Media and Politics* [online]. Cambridge: Cambridge University Press. [Viewed 19 August 2020]. Available from: https://books.google.co.uk/books?hl=en&lr=&id=PTRIBAAAQBAJ&oi=fnd&pg=PR8&dq=hallin+and+mancini+2004&ots=3YeSRblJfV&sig=T8C6og1rZXxv0NFMscllpcj2Mjk#v=onepage&q&f=false

Hannis, G., Strong, C., (2007). The visibility of female journalists in Australian and New Zealand newspapers: the good news and the bad news. *Australian Journalism Review* [online]. **29**(1), 115-125. [Viewed 10 August 2020]. Available from: https://search.informit.com.au/documentSummary;dn=200710465;res=IELAPA;type=pdf

Hansen, A., (1994). Journalistic practices and science reporting in the British Press. *Public Understand. Sci.* [online]. **3**(2), 111-134. [Viewed 29 July 2020]. Available from: doi: 10.1088/0963-6625/3/2/001.

Hayes, K., Silke, H., (2018). The Networked Freelancer? Digital labour and freelance journalism in the age of social media. *Digital Journalism* [online]. **6**(8), 1018-1028. [Viewed 1 August 2020]. Available from: doi: 10.1080/21670811.2018.1505438

Hedman, U., Djerf-Pierre, M., (2013). The social journalist. *Digital Journalism* [online]. **1**(3), 368-385. [Viewed 13 June 2020]. Available from: doi: 10.1080/21670811.2013.776804

Ivie, R., Ray, K. N., (2005). *Women in Physics and Astronomy* [online]. USA: American Institute of Physics. [Viewed 6 August 2020]. Available from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.561.7175&rep=rep1&type=pdf

Ivie, R., Tesfaye, L., (2012) Women in physics: A tale of limits. *Physics Today* [online]. **65**(2). [Viewed 6 August 2020]. Available from: doi: 10.1063.PT.3.1439

Kininmonth, A. R. et al., (2017). Quality assessment of nutrition coverage in the media: a 6-week survey of five popular UK newspapers. *BMJ Open* [online]. **7**(12). [Viewed 9 August 2020]. Available from: doi: 10.1136/bmjopen-2016-014633

Korsunska, A., (2019). The Spread and Mutation of Science Misinformation. In: Taylor, N., Christian-Lamb, C., Martin, M., Nardi, B., (eds) *Information in Contemporary Society* [online]. Cham: Springer.

pp. 162-169. [Viewed 26 June 2020]. Available from:
https://link.springer.com/chapter/10.1007/978-3-030-15742-5_15

Lazer, D. M. K. et al. (2018). The science of fake news. *Science* [online]. **359**(6380), 1094-1096.
[Viewed 19 August 2020]. Available from: doi: 10.1126/science.aao2998

Lewis, J., Williams, A., Franklin, B., (2008). *Journalism Studies* [online]. **9**(1), 1-20. [Viewed 17 August
2020]. Available from: doi: 10.1080/14616700701767974

Moreau, N. J., (2009). Public Images of Chemistry. *Chemistry International* [online]. **27**(4), 6-9.
[Viewed 10 August 2020]. Available from: doi: 10.1515/ci.2005.27.4.6

Morrell, B. et al., (2014). Rules of engagement: Journalists' attitudes to industry influence in health
news reporting. *Journalism: Theory, Practice & Criticism* [online]. **16**(5), 596-614. [Viewed 29 July
2020]. Available from: doi: 10.1177/1464884914525705

Moss-Racusin, C. A. et al., (2012). Science faculty's subtle gender biases favor male students. *PNAS*
[online]. **109**(41), 16474-16479. [Viewed 18 August 2020]. Available from: doi:
10.1073/pnas.1211286109

Murcott, T. H. L., Williams, A., (2013). The challenges for science journalism in the UK. *Progress in
Physical Geography*. **37**(2), 152-160. [Viewed 29 June 2020]. Available from: doi:
10.1177/0309133312471285

Newman, N., (2018). *Journalism, Media and Technology Trends and Predicitions 2018* [online].
Oxford: The Reuters Institute for the Study of Journalism. [Viewed 13 August 2020]. Available from:
https://ora.ox.ac.uk/objects/uuid:45381ce5-19d7-4d1c-ba5e-3f2d0e923b32

North, L., (2014). The Gender of "soft" and "hard" news. *Journalism Studies* [online]. **17**(3), 356-373.
[Viewed 18 August 2020]. Available from: doi: 10.1080/1461670X.2014.987551

Olsen, R. K., Kammer, A., Solvoll, M. K., (2019). Paywalls' Impact on Local News Websites' Traffic and
Their Civic and business Implications. *Journalism Studies* [online]. **21**(2), 197-216. [Viewed 4 August
2020]. Available from: doi: 10.1080/1461670X.2019.1633946

PAMCo., (2020). *Total Sector Reach – Newsbrands* [csv]. London: PAMCo. [Accessed 26 July 2020].
Available from: https://pamco.co.uk/wp-content/uploads/2020/06/Total-Market-Reach_PAMCo-2-
2020_V1.xlsx

Pan, S., Ryan, C., (2007). Gender, Framing, and Travelogues. *Journal of Travel Research* [online].
45(4), 464-474. [Viewed 10 August 2020]. Available from: doi: 10.1177/0047287506295910

Panteli, A. et al., (1999). The status of women in the UK IT industry: an empirical study. *European
Journal of Information Systems* [online]. **8**(3), 170-182. [Viewed 6 August 2020]. Available from: doi:
10.1057/palgrave.ejis.3000326

Pate, A. C. G., (2014). Women in journalism in the United Kingdom: an analysis of expectations and
experiences of equality within the profession 1970 to the present. Ph.D. thesis, University of the
West Scotland. [Viewed 9 August 2020]. Available from:
https://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.627898

Polman, J. et al., (2012). Scuience Journalism: Students learn lifelong science literacy skills by
reporting the news. *The Science Teacher* [online]. **79**(1), 44-47. [Viewed 29 July 2020]. Available
from: www.jstor.org/stable/43556756

Reinardy, S., (2009). Female Journalists More Likely To Leave Newspapers. *Newspaper Research Journal* [online]. **30**(3), 42-57. [Viewed 6 August 2020]. Available from: doi: 10.1177/073953290903000304

Shachar, O., (2000). Spotlighting women scientists in the press: tokenism in science journalism. *Public Understand. Sci.* [online]. **9**(4), 347-358. [Viewed 19 August 2020]. Available from: doi: 10.1088/0963-6625/9/4/301

Sjøvaag, H., (2016). Introducing the Paywall: A case study of content changes in three online newspapers. *Journalism Practice* [online]. **10**(3), 304-322. [Viewed 4 August 2020]. Available from: doi: 10.1080/17512786.2015.1017595

Spillane, B., Hoe, I., Brady, M. Vincent, W., Lawless, S., (2020). Tabloidization versus Credibility: Short Term Gain for Long Term Pain. In: *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20), 25-30 April 2020, Honolulu, Hawaii, USA* [online]. New York: Association for Computing Machinery. [Viewed 13 August 2020].

Spilsbury, M., (2015). *Exploring Freelance Journalism* [online]. Newport: National Countil for the Training of Journalists. [Viewed 2 August 2020]. Available from: https://www.nctj.com/downloadlibrary/EXPLORING%20FREELANCE%20JOURNALISM%20FINAL.pdf

Stanworth, C., Stanworth, J., (1995). The self-employed without employees – autonomous or atypical? *Industrial Relations Journal* [online]. **26**(3), 221-229. [Viewed 1 August 2020]. Available from: doi: 10.1111/j.1468-2338.1995.tb00739.x

Stewart, M. D., (1943). Importance in Content Analysis: A Validity Problem. *Journalism Bulletin*. [online]. **20**(4), 286-293. [Viewed 8 August 2020]. Available from: doi: 10.1177/107769904302000403

Stöckl, A., Smajdor, A., (2017). The MMR debate in the United Kingdom: vaccine scares, statesmanship and the media. In: Holmberg C., Blume S., Greenough P., eds., *The Politics of Vaccination: A Global History* [online]. Manchester: Manchester University Press pp. 239-259. [Viewed 25 June 2020]. Available from: https://www-jstor-org.sheffield.idm.oclc.org/stable/j.ctt1wn0s1m

Stryker, J. E., (2002). Reporting Medical Information: Effects of Press Releases and Newsworthiness on Medical Journal Articles' Visibility in the News Media. *Preventive Medicine* [online]. **35**(5), 519-530. [Viewed 9 August 2020]. Available from: doi: 10.1006/pmed.2002.1102

Summ. A., Volpers. A. M., (2016). What's science? Where's Science? Science journalism in German print media. *Public Understanding of Science* [online]. **25**(7), 775-790. [Viewed 29 July 2020]. Available from: doi: 10.1177/0963662515583419

Thurman, N., (2014). Newspaper Consumption in the Digital Age. *Digital Journalism* [online]. **2**(2), 156-178. [Viewed 3 August 2020]. Available from: doi: 10.1080/21670811.2013.818365

Thurman, N., Cornia, A., Kunert, J., (2016). *Journalists in the UK* [online]. Oxford: Reuters Institute for the Study of Journalism [Viewed 5 August 2020]. Available from: https://reutersinstitute.politics.ox.ac.uk/sites/default/files/research/files/Journalists%2520in%2520the%2520UK.pdf

TNS Opinion & Social. (2013). *Responsible Research and Innovation (RRI), Science and Technology* [online]. [Viewed 2 August 2020]. Available from: https://op.europa.eu/en/publication-detail/-/publication/ee9bacdf-fdad-46eb-8cd8-32879e310191/language-en

UK Science and the Media Expert Group., (2010). Science and the media: *Securing the Future*. [Viewed 22 June 2020] Available from: https://webarchive.nationalarchives.gov.uk/tna/+/http:/www.bis.gov.uk/wp-content/uploads/2010/01/Science-and-the-Media-Securing-Future.pdf/

Vestergaard, G. L., Nielson, K. H., (2016). Science news in a closed and an open media market: A comparative content analysis of print and online science news in Denmark and the United Kingdom. *European Journal of Communication* [online]. **31**(6), 661-677. [Viewed 21 June 2020]. Available from: doi: 10.1177/0267323116674110

Viswanath, K. et al., (2008). Occupational Practices and the Making of Health News: A National Survey of U.S. Health and Medical Science Journalists. *Journal of Health Communication* [online]. **13**(8), 759-777. [Viewed 11 June 2020]. Available from: doi: 10.1080/10810730802487430

Weiss, R., (2017). Nip misinformation in the bud. *Science* [online]. **358**(6362), 427. [Viewed 18 August 2020]. Availablee from: doi: 10.1126/science.aar2683

White, A., (2009). *Getting the balance right: gender equality in journalism* [online]. Belgium: International Federation of Journalists. [Viewed 1 August 2020]. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000180707

Wormer, H., (2008), Science Journalism. In: W. Donsbach ed. *The International Encyclopedia of communication* [online]. Oxford: Blackwell. pp. 4512-4514. [Viewed 12 August 2020]. Available from: doi: 10.1002/9781405186407.wbiecs016

Zhang, D., (2016). *Business-to-Business (B2B) Media in UK: A mixed methods study using product variables to assess the impacts of social media on product strategies.* Ph.D. thesis, University of Westminster. [Viewed 12 August 2020]. Available from: https://westminsterresearch.westminster.ac.uk/item/q10qy/business-to-business-b2b-media-in-uk-a-mixed-methods-study-using-product-variables-to-assess-the-impacts-of-social-media-on-product-strategies