How Arab Journalists Engage and Use Statistics to Report Science:

The Case of Statistics in Science News in Saudi Arabia, Kuwait and Egypt

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Abstract

This study examines journalists' use of statistical information within science news. The study focuses on how news reporters use statistics when articulating science news in two broad areas, that of health and technology news in Arab countries, specifically, of Egypt, Saudi Arabia and Kuwait. It does so by triangulating content analysis, close reading, expert panel and triangulating this with semi-structured interviews with journalists. Overall, the study found that despite a rich Islamic historical tradition of engagement with science in general and maths in particular in these societies, news reporting of science presents severe deficiencies and gaps when it comes to engaging and using statistics and numbers to articulate science news. The results suggest that a lack of professional autonomy influences the use and articulation of statistical data and attributes this to the constrains that the political system places upon reporters. Indeed, the data indicates that reporters rely too heavily upon official sources for accessing statistics and data and experience important restriction when covering these issues. Equally, it shows that constrains and restrictions often associated with censorship and self-censorship also hinders their work. However, the study does not attribute to these restrictions all the gaps and deficiencies and points out instead that many of them can be attributed rather to the lack of training and skills, which is a similar situation that the coverage of the same news beat faces in Western countries. Moreover, the study's results indicate that journalists' lack of training and skills regarding statistics and science understanding in general affect their abilities to provide sound, comprehensive and critical news coverage of science. The thesis suggests that in Arab societies, science journalism remains overall a deficient professional activity, full of flaws and gaps -including the lack of graphics and visual data to make this information more accessible- when reporting these topics. These gaps include the scarcity of specialized science journalists, general reporters' lack of knowledge and basic understanding of science and, the lack of public interest in science news. Given also the role of woman in these countries, the study also assesses inter-gender issues around the use of statistics in science reporters. Finally, the study makes recommendations to improve this situation and offers guidance in relation to where further research might go from here in order to advance this research agenda.

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Chapter 1 Introduction

1.1 Overview

Statistics are a significant part of journalism practice, particularly regarding the science news beat. This because numbers are a key component in informing and substantiating news stories in news beats that require additional transparency and accountability such as economics and science.[1] Moreover, one can easily argue that without incorporating statistics in their news stories about scientific work or technological advances, news reporters would be simply telling stories rather than informing the public (Reed 2001). Today it is almost inconceivable that any story about science would appear in the mainstream news media without explicitly or implicitly referring to statistics. From covering a new treatment against cancer to the exploration of exoplanets, news relating to science is based on numbers, one way or the other. The reason is simple; without the ability to quantify and produce mathematical models in all branches of natural science, science itself would be unable to formulate theories that could claim universal and demonstrable truth about the universe.

However, contrary to a much-lauded backdrop that keeps parroting the newness of Big Data (or just 'data') in journalism, the incorporation of statistics into news stories in general is really a trend that can be traced back to the 17th century and that is closely linked to the Enlightenment period in the West. Indeed, as I will discuss in this thesis, the incorporation of statistics into modern news reporting is profoundly rooted in the efforts of mathematization of social sciences that took place within the broader context of positivism in Europe. One, which consolidated in between the late-19th century and in the 1930s together with the full incorporation of the ideology of objectivity in the West (Lugo-Ocando 2014, Anderson 2018) thanks, in part, to the normative aspirations of journalism as a political institution to be scientific (Lippmann 2012, Galison 2015, Seyb 2015).

Several scholars have argued that science communication is important to the public (Nelkin 1995, Bauer and Bucchi 2008) and that contributes to societies' renaissance and development by increasing the rationality of public debate; making it sounder and more likely to debate key issues from an evidence-based point of view. Science communication not only informs the public audience about what happens in science but also provides information that shapes public attitudes, which in turn are essential in shaping views on public policy (Nelkin 1995, P. 2, Treise and Weigold 2002, P. 311). However, many factors can influence societies' reception of science, including culture, religion and politics, among others. There are times when science in itself conflicts with a society's values or even its core concepts regarding humanity. For instance, a society's religious beliefs and ethical standards might contribute towards a negative reception of new scientific findings. Some scientific breakthroughs, including Clusters

of Regularly Interspaced Short Palindromic Repeats (CRISPR) technology or genetic modification of food, might even be considered attacks on collective safety or moral codes of humanity. Moreover, the ways in which these breakthroughs and new scientific findings are presented to the public may also affect their trust in not only science communication but also in science itself (Brewerb and Ley 2013).

There are also historical and cultural reasons within many of these societies as to why there is public distrust towards science. Colonialism, for example, used science to impose power and subjugate the people in that part of the world. Racial hierarchies, the mortal use of gunpower and forced sterlisations were some of the many ways in which modern science manifested itself into the Arab world. Therefore, for many in these societies, science became closely associated with the imperialist face of modernity in the public imagination (Ziadat and Jallow 1986, Pimentel 2000). Religion of course, at least in the way that many conceptualise it in modern times, has also a significant effect on public views of science. However, it is one that varies from period to period and that depends upon people's own understanding of their faith in the context of their particular societies and specific communities. In the past, for example, science in Europe depended on religion when most thinkers in Europe during the Middle Ages were ascribed to monasteries as monks, with their work and efforts being directed mostly towards serving the purposes of the Catholic Church (Lindberg 1980). It was in this same period that the Arab world under Islam preserved classical knowledge and advanced science (Nasr and De Santillana 1968, Yusoff et al. 2011, Huff 2017). Hence, it is not a problem of religion in itself but an issue around the role that religion plays in a particular historical and political context. In today's Arab societies, religion continues to play a central role and defines many aspects of public life although far from being as powerful and influential as Christianity was in the Middle Ages in Europe. However, one must add, the power of religion in these societies to supersede scientific narratives and explanations around the natural world is limited.

Having said that, Arab religious leaders continue to have a notable influence in these societies, particularly around defining public speech. They influence governments, which then go to produce legislation that incorporate further restrictions to what journalists can say and do. Nevertheless, we also need to acknowledge that there have been some changes -not necessarily ample progress- in some of the countries over the past years and censorship and restrictions in the overall region are not as monolithic or widely accepted by the general public as they once were, this despite very visible single cases (Ahmed 2019, Dennis et al. 2020). In truth, despite continuing to be at the centre of public life in these societies, religion now coexists with a hybrid culture created by modernity, hence they are equally shaped by globalization and mass consumption capitalism. The idea that the identities of these individuals or how that the political power wielded in their capitals can be define and explained

solely through faith, seems to obviate the complexities of the modern world and the fact that these same societies are extremely interconnected with the rest of the planet (Kraidy 2005, Kraidy 2016). Moreover, as societal and technological changes have transformed both the overall media ecology and specifically the epistemology of journalism -that now seems to be far more focused on data mining and analysis- one has to recognise that things in the Arab world might no longer appear to be what it was in the Western eyes, if ever that was the case. It is this particular sense of 'newness' of this data-driven epistemology of journalism that offers us the opportunity to produce a more comprehensive and de-Westernised understanding of journalism. This by means of an innovative journalism studies' research agenda that examines how reporters interact, embrace and use data in general (Lewis and Westlund 2015, Borges-Rey 2016, Nguyen and Lugo-Ocando 2016) within different context and cultures. Numbers continue to be in science and public discourse the most indivisible and pure element of absolute and universal truth as it is anchored in mathematical reasoning. No other branch of science can make this claim. So far, most studies around the use of statistics and data in journalism have concentrated in the USA and Western Europe, where most of the fieldwork have been carried out. This despite significant and emerging contributions in relation to exploring the work of news reporters in relation to data in many places of the so-called Global South (Borges-Rey et al. 2018, Lewis and Nashmi 2019, Mutsvairo et al. 2019). Nevertheless, there continue to be important gaps in relation to the so-called Global South. Particularly around non-liberal societies where journalism is also practised, such as the Arab world at large and specifically in relation to science journalism where there is very little to none advanced research around these topics.

Hence, the purpose of this study is precisely to understand how journalists engage with and use statistics to articulate science news in the Arab media, specifically in the cases of Egypt, Saudi Arabia and Kuwait. In so doing, the study explores the relationship between journalism and information in relation to how statistics are used by news reporters to articulate their stories about science in terms of accessibility, engagement, accuracy and rigour. Consequently, this study involves looking at how journalists engage with, use and manage statistical data when gathering and producing science news. The study also aims to assess the current capabilities of journalism and to identify key knowledge gaps in the area. In addition, and in order to better understand how reporters engage with statistics, the research examines the nature of the news sources that provide this data and how journalists handle these sources in relation to the outputs that they produce.

The research attempts to develop an explanatory theoretical framework and to set a design model that allows for the analysis of both process and outputs around uses and engagement with statistics in the production of science news, while permitting a more comprehensive understanding of the rationale, dynamics and interactions between journalists and data. The

study adapted an interdisciplinary approach that triangulates a variety of methods in order to facilitate a much clearer and critical picture of this area. Science journalists were outlets were chosen from the Arabian region because 'science reporting' as a newsbeat in this region has received limited scholarly research attention in comparison to other parts of the world. By doing so, the study has aimed at producing an innovative and critical contribution to the fields of journalism studies and science communication from a non-Western perspective.

The study's methodology relied on two approaches: quantitative and qualitative. This mixed-methods strategy was used to review the research literature related to the use of statistics in science journalism. First of all, a content analysis of science news was conducted, focusing on health and technology news stories, which included statistical data from selected newspapers in Arab countries. Secondly, it examined science news using a close-reading structural-rhetorical method to assess the ways in which statistics are presented in such news. Thirdly, there was an 'experts panel method' put in place to examine the accuracy of science news in terms of its use of statistical data. Finally, the study made use of semi-structured interviews to understand how journalists in Arab countries engage with and use statistics and to identify journalists' main challenges and opportunities when reporting science news.

The results of the content analysis identified vital characteristics about the use of statistics in science news. Not only is there over-reliance on official statistical sources but also there is widespread use of statistics from unknown sources, which make up about 25% of the statistical sources used in science news. In addition, visual data is almost absent in science news stories in Arab countries, despite ample evidence that such data makes science news accessible to the public (Segel and Heer 2010, Ma et al. 2011, Hill 2017). The results of the close-reading method suggested various trends: an over-reliance on statistical sources, a lack of verification of the statistical data in science news and a lack of understanding of the difference between official statistics and those from other sources.

The findings of the expert panel showed that more than half of the science news items analysed failed to use statistics effectively to communicate science. The semi-structured interviews with journalists and editors on Arab newspapers indicated that most journalists found it difficult to access statistics because of official sources. Furthermore, the study identifies issues that are internal and external to the news organizations where the journalists work. This can prevent reporters from dealing appropriately with statistical data when dealing with science news.

Overall, the study's results suggested that journalists' lack of training and skills account for most of the deficits. This as it affects their abilities to provide sound, comprehensive science news. This situation is aggravated by the absence of an educational framework to address these deficits. These results come to support the findings of other studies (Rugh 2004, Nguyen and Lugo-Ocando 2016). Hence, the present study's findings confirmed that this lack of an

educational framework is a major barrier that needs to be addressed, more even than the political constrains as they rarely affect the news science beat.

This is not to say that the lack of professional autonomy does not influence the use and articulation of statistical data, which the study also confirms as other studies have done (Rugh 2004, Sakr 2007, Hadland and Zhang 2012). Moreover, the results indicate in fact that journalists reporting science news in Arabic newspapers rely heavily on official sources and that this has a detrimental effect in bringing about criticality and accountability to science. However, and contrary to some common assumptions that place the blame only on religion or politics, science journalism in Arab societies remains deficient not for one but for several reasons. This including the scarcity of science journalists and journalists' lack of general knowledge about science and that the reading public lacks interest in science news.

1.2 Research Background

Despite being a relatively recent area of study, the use of statistics by journalists has already received some attention from several scholars (Curtin and Maier 2001, Genis 2001, Maier 2003, Brand 2008, Mahmood 2008, Al-Qafari 2009, Utts 2010, Koetsenruijter 2011, Porlezza et al. 2012, Nguyen and Lugo-Ocando 2015, Alhumood et al. 2016, Ibnrubbian 2016, Lugo-Ocando and Brandão 2016, Cushion and Lewis 2017, Nguyen 2017). In this sense, the Lugo-Ocando and Brandão (2016) found that journalists in the UK are also, as their Arab colleagues, over-reliant on official sources to produce news stories while lacking the capabilities to engage critically with these numbers.

Indeed, scholarly research goes to show that the background and training of journalists play a crucial role in allowing reporters to examine and validate claims made on the basis of statistical information in the press (Nguyen and Lugo-Ocando 2015). Brand (2008) own study in South African concluded that journalists in general have inadequate skills in arithmetic when dealing with quantitative elements in news reports, which translates into a high rate of numerical errors. In other words, the lack of training and skills is a global issue in this field. In the case of the US, Martin (2016) suggests that only a fifth of the journalism educational programmes actually require their students to undertake statistics. However, few of these programmes have academic courses in statistics that not only meet the traditional standards for such courses but that are actually tailored to news reporting.

Curtin and Maier (2001), on the other hand, examined how journalists deal with numbers in the news. They pointed out how maths anxiety in its different forms causes many journalists to have considerable dissimilarities when dealing with numbers, making some more or less prone to critically engage with them. Maier (2002), observing how mathematics are

incorporated in a daily newspaper, highlights the failure of journalists to pay attention to, and exercise care with, numbers that they regularly employ in different sections of their work. Maier (2003, p. 58) would later go on to suggest, in a study about 'Math Errors in News', that journalists need direction and assistance in how to understand and illustrate statistics, so they can refrain from making mistakes in calculating numbers.

Another important observation, this time made by Genis (2001, p. 32) in a study about the important ability of journalists to work with numbers, pinpoints the significance of the ability of journalists to change and simplify numbers in their news stories to make them understood by their readers. He also pointed out the general worry concerning journalists' poor skills, by stating that 'experienced journalists, academics in the communications field, mathematicians and statisticians are either "taken aback" by the inability of journalists to do even the most basic calculations or "horrified" by the "amount of numeric incompetence" in newsrooms. In this sense, Frank Swain, National Coordinator for Science Training for Journalists, pointed out in his final report for the Royal Statistical Society that, "an understanding of numbers and statistics are key to many of the common errors in reporting science" (Harrison 2014, p. 2). One of the conclusions we can draw from these works is a sustained concern around the limited capabilities within professional mainstream journalism to engage with statistics.

The other area singled out by the body of scholarly research is in relation to the use itself that journalists make of statistics, particularly around the area that concerns this study. Brandao (2016) carried out a study about 'How Statistics Are Used to Articulate and Shape Discourses of Science in the Newsroom'. She found that journalists lean towards using statistics mostly to preserve the objectivity and reinforce the legitimacy and autonomy/authority of their own work; something that Tuchman (1978) addressed when referring to professional values associated with news people such as 'objectivity', which are used as mechanisms to achieve legitimacy in the newsroom. The research suggests that statistics are often used as a legitimising tool although few reporters are familiar with scientific mathematical language.

Despite all these contributions, the studies centred on this issue are still limited, while those focusing on Arab journalism and science statistics are almost non-existent. Hence, it is possible to identify an important knowledge gap regarding how Arab journalists engage with statistics when producing science news. Moreover, there are distinctive settings that enhance, constrain and potentially hinder the autonomy and legitimacy of professional journalists in this region. Therefore, examining how journalists operating in this part of the world - who already face very distinctive challenges associated with culture, religion, post-colonial history, politics and economics - is a promising opportunity not only to understand the subject in question, but also to contribute to the wider debates around the de-Westernisation of media studies as a whole in the context of science communication.

1.2.1. Why Science Communication?

Although the field of science communication is a broad one and encompasses multiple dimensions and areas, it is the role of the news media in reporting science that has received most attention by scholars (Nelkin 1995, Bucchi 1998, Treise and Weigold 2002, Fjæstad 2007, Bauer and Bucchi 2008, Fischhoff and Scheufele 2013). This is because the news media have an important role in communicating science to the public (Bucchi 1998), and in doing so it not only raises awareness about science and its methods but also makes science relevant to the people (Nguyen and Lugo-Ocando 2015) and, subsequently it can have an impact upon both policy and allocation of resources. It is in this context that science journalism becomes relevant as it helps shape public opinion and engagement with science.

Moreover, science communication in general has been a major part of journalism throughout the past few decades (Fjæstad 2007). In this sense, science journalism is the third most prolific news beat after social science and life science, with 15% of all news stories (Al-Qafari 2009), mostly because it includes sub-areas such as health and technology in its news beat. Moreover, science journalism has a significant role in developing countries (Mbarga et al. 2012, Bauer et al. 2013). This is because it is considered a platform for the introduction of ideas, innovations and exchanges of expertise and experiences while fostering creative ability (Al-Qafari 2009, p. 89). In addition to this, in developed countries, science news is considered one of the most trusted types of news. A YouGov survey revealed that print and online news stories about science and sports are considered the most trustworthy by the British public, with sports having 17%, while Science 14% of the total of trust (Matter 2017).

In addition, scholars argue that science communication is important to the public not only because it fosters civic engagement with science as a topical issue, but also because it introduces a degree of further rationality into all public debates, making these discussions sounder and more prone to evidence-based discussion (Nelkin 1995, Bauer and Bucchi 2008, Mbarga et al. 2012). For sure, science communication not only informs people about what happens in science but it can also provide the public with essential information to shape their views about public policy (Treise and Weigold 2002, p. 311). Nelkin (1995, p. 2), for example, pointed out that science communication supports 'the individual's ability to make rational choices. Thus, science communication can aid people in making better decisions about their society and their own lives. In this sense,

> *We all need science for making effective decisions in our lives. Are the expected benefits of a medical procedure worth its risks? Does it make sense to rebuild homes along the seashore after a hurricane? How good are the predictions for storm surges? Should we sign a lease for hydrofracking on our property? What are the risks to our drinking water? Science is, potentially, the best source for*

> *the evidence needed to answer these questions. Realizing that potential will require effective two-way communication with those whom science hopes to serve – so that it produces relevant information and conveys it in a credible, comprehensible form. (Fischhoff and Scheufele 2013, p. 14031).*

The ability of journalists to report science news in an accessible and accurate manner, while making these topics relevant to the general public, allowing people to engage and actively participate in science discovery, is, therefore, of vital importance given the reasons enunciated above in relation to the need for society's engagement with science (Nelkin 1995, Bauer and Howard 2009, Nisbet and Scheufele 2009).

In relation to this, the debate within the science communication field has mostly centred around two key aspects. On the one hand, there are those – particularly scientists - who have stressed the need for 'accuracy' when dealing with science news (Murcott 2009, Hansen 2016). For these voices, the most important issue relates to the accuracy of media reporting of science (Seale 2010). Fjæstad (2007, p. 123) has argued, in this respect, that the way in which science news is reported, especially when it comes to natural science, is inadequate because of its non- or under-reporting of important scientific progress, tendency to sensationalism and negativity in wording and in presentation, and inaccurate reporting.

The other camp, on the other hand, has argued more around the need for journalists to make science news more relevant to the general public while approaching science news in general in a more critical manner (Nguyen and McIlwaine 2011). For these authors, the problem is not so much to do with accuracy -although they recognise the underlying issues around this- but the fact that many ordinary citizens fail to engage with science news because it does not seem to be relevant enough to their individual and collective lives. In addition, and perhaps more importantly, these authors point to the lack of criticality around science news reports. For them, many journalists, with few exceptions, lack the necessary capabilities and tools to scrutinise science, therefore leaving it unaccountable as a news source. It is because of these two camps in particular, and the wider debates around science communication in general, that I have decided to explore in my study the importance of statistics in the articulation of science news.

1.2.2. Use of Statistics in Journalism

All in all, statistics have become an important part of the world and a universal feature of daily life (Nguyen and Lugo-Ocando 2015, p. 1). They play a significant role in delivering information in a way that helps the public to understand social issues (Dorling and Simpson 1999, Fioramonti 2014) while facilitating scrutiny and critical examination of public policy and governance in general. Many decisions are based on, underpinned and/or justified with

statistics regarding various individual and collective issues that affect our lives, such as equality, governance and policy-making (Spirer and Spirer 1998, p. 3) among others.

Consequently, statistics have become a key component of daily news and they are particularly relevant to science news. This is even more the case at a time when the so-called 'big data society' is becoming widespread (Maier 2003, Nguyen and Lugo-Ocando 2015, Borges 2017). According to Zillmann and Brosius (2012), at least 44% of the news includes some sort of numbers. In news beats such as science, news reporters rely on statistics to produce, contextualise and/or substantiate their stories (Lugo-Ocando and Brandão 2016) and they play a fundamental role in reinforcing the accuracy of science stories; something that is directly related to the quality of the news (Nguyen and Lugo-Ocando 2015, p. 6).

In science news, numbers also underpin the notion of objectivity in the making of news as they summarise and contextualise reality in qualitative terms. This is of particular importance at times in which we increasingly face a mathematized understanding of society in which one has to "travel mathematical roads in order to arrive at objectivity in the real world" (Davis and Hersh 2005, p. 276). Those who embrace this view have argued that an understanding of statistics can account for more reliable and trustworthy news (Livingston and Voakes 2011) because numbers have an important role in making news more credible (Koetsenruijter 2011, Lugo-Ocando and Brandão 2016) and evidence based.

Having said that, most research so far has suggested that an inappropriate use or misinterpretation of these numbers often occurs in the news (Maier 2003, Brand 2008, Nguyen and Lugo-Ocando 2015, Lugo-Ocando and Brandão 2016), something that has received ample attention from scholars. According to Utts (2010), misleading science reporting of statistical results can be found easily, and in fact tends to be widespread. For instance, a 2008 study titled 'You Are What Your Mother Eats', which asserted that pregnant mothers who eat cereal for breakfast are more likely to have boys than pregnant mothers who do not. This was refuted by a group of experts the following year in their own analysis, which showed that this result was almost certainly a false positive. However, this did not stop the study from gaining widespread media attention (Utts 2010) and people making badly substantiated assumptions.

Many working in the Fourth Estate itself know this, as many journalists acknowledge that they struggle to engage, accurately interpret and adequately report numbers (Maier 2003). Way back in the 1990s, Hough (1995, p. 377) had already observed that many journalists did not understand the meaning of numbers as "too many people today, including journalists, are innumerate — they lack an understanding of what numbers mean" a situation that generally persists today. In this respect, Kilpatrick (1999), who was a US newspaper journalist, collected examples of errors, particularly mathematical errors in newspapers. He found several examples of misuse and concluded that many journalists cannot even deal with school-grade mathematics.

Furthermore, it has been suggested that ‘many journalists have basic issues with interpreting the statistics’ and that they did not understand ‘all of the statistical tests presented and whether they were appropriately applied’ (Genis 2001, p. 13). I refer to this, in this study, as problems of statistical reliability in journalism practice. For example, “a scientist describing a finding as significant refers to its statistical significance; a journalist will think the result is significant for the population out there" (Genis 2001, p. 13).

Nevertheless, a study by Maier (2003, p. 930) did find out that the majority of journalists are capable of handling the kinds of elementary calculations demanded for most day-to-day reporting and editing even though about one in six news editorial staff failed to answer most of the mathematical questions posed by him in his study (Maier 2003). Overall, as Cohn (1989, p. 1) pointed out almost three decades ago, journalists’ misunderstanding and misuse of statistics continues to lead them to repeatedly provide poor reports, as they do not consider some statistics or ‘get bamboozled by phoney or unreliable numbers’ .

1.2.3. Factors in Reporting Statistics

In addition to all of this and in order to perform an analysis that is exhaustive and comprehensive in relation to how journalists producing science news interact and engage with statistics, it is important to analyse some contextual factors that can play a role both in the use of statistics by science journalism in particular, and in journalistic practices more generally speaking. These contextual factors or background issues influence the capabilities of journalists when producing and presenting news stories. There is an ample body of literature around the structural issues and background that affect the ability of journalists to produce news (McNair 1998, Schlesinger 1999). However, in the specific context of the Arab Gulf one can broadly pinpoint issues such as the political system, religion and culture, economics, media ownership, and the background, education and training of journalists in that region (Rugh 2004).

Among the elements that may influence the way the news media produces and disseminates news, it is perhaps religion and culture that are the most important ones. Indeed, religion and politics are considered the most relevant categories influencing journalistic practices. Of these two elements, politics is considered the most important factor affecting the media in this region (Hamdy 2013, p. 71) as most scholarly analysis has been performed from the perspective of secular liberal democracy in contrast to non-liberal systems.

Therefore, when looking at the Arab media, the analysis has often been closely associated with non-liberal governments and the role of Islamic culture (Rugh 2004, p. 5-8) even after the Arab Spring (Lynch 2015). In this sense, Arab governments largely continue to be the main

funders and owners of the mainstream media outlets since the emergence of the press in those countries and are credited for exercising strict laws against freedom of expression. This situation goes back in history when the first Egyptian papers, the journals al-Khadyu and al-Waqa al Masriya, which were first produced in 1827 and 1828, respectively, were published by the Egyptian government at a time in which private proprietors already had control of the commercial press in places such as England and the USA.

Because of this control, Arab media outlets tend to operate under official government guidance and follow authorised editorial policy (Rugh 2004, p. 6) and in so doing, their main role has been to promote government politics (Hamdy 2013, p. 71). Hence, rather than scrutinise policy or challenge those in power they behave often as being subservient to the state. In these countries, the media functions within political systems that, as a result of post-colonial settings and the legacy of the Cold War, continue to be, mostly monarchical or authoritarian. Although, these media systems, are also partly a reflection of their societies in which the distinctions between the private and public spheres and between religion and secularism have never occurred in the ways it happened in Europe (Asad 2003, Fitzgerald 2003).

The control of the media continued in subsequent governments in the Arab world even after revolutions that brought about a certain degree of modernisation under movements such as the pan-Arab Baath party. To be sure, Gamal Abdel Nasser's coming to power in Egypt and the more general role of the Baath party across the Arab region failed to deliver openness on this front and in many cases – such as in Syria and Iraq – became even more oppressive and authoritarian in relation to the press than its monarchical predecessors (Devlin 1991, Daragahi 2003). Even more recently, such as the Arab Spring of 2011 which occurred in four countries in the Arab region (Egypt, Tunisia, Libya and Yemen), only a few of the new rules that have developed open up space for the media (Bebawi 2016, p. 11), but even in these cases there have been as many timid regressions as there have progressive steps. For example, despite initial political change in Egypt, the media has continued to be mostly a mouthpiece of the government (Bebawi 2016). In that country, successive regimes have continued a long tradition of media control through a variety of institutional mechanisms such as the Supreme Press Council (which licenses newspapers) and the Shura Council's control over the creation of new political parties – in many cases the ones who set up new media outlets– and, more recently, by means of emergency measures and anti-terrorism legislation (Rugh 2004, p. 124-125).

Even private newspapers in these countries remain under the strict control of governments, which continue to monitor and censor the media at large (Awad 2010, p. 36). This control is not restricted to political-administrative and legal aspects; it also extends to the financial realm. In these countries the private newspapers are still largely dependent on governmental funding (Rugh 2004, p. 65-76). Egypt is, again, a good example of this as the government can put

economic pressure on private newspapers via its official agencies and related organisations - such as publicly-owned enterprises- that contribute a great deal to these newspapers' revenues, therefore becoming a common form of inducement by proxy. Moreover, as the Egyptian government controls the Supreme Press Council, which also determines advertising distribution (Rugh 2004, p. 127), it can easily deprive a particular media outlet of the necessary resources to continue to operate, and therefore can exercise economic pressure on the media (Bebawi 2016, p. 10).

However, the main controls come from explicit mechanisms such as the laws in Arab countries, which openly include several bans on freedom of expression and which give regimes the authority to act against any breach in the broadest and most discretional terms possible (Rugh (Rugh 2004, p. 125). In addition, these governments not only aim to control freedom of expression but also to ensure that what is published and broadcast to the public is in line with the government's objectives (Sakr 2007, p. 15, Mellor 2011, p. 164). For instance, under the penal code of Egypt, journalists can be fined or imprisoned for 'insulting' -a very discretional term- the president, government officials, the leader of a foreign country, the armed forces or even the parliament as an institution (Rugh 2004).

In more recent times, as a result of the aftermath of 9/11, many emergency and anti-terrorism laws were enacted, as well as other vaguely defined pieces of legislation that provide these governments with the ability to limit the publication of news and commentary that may be considered a threat to national harmony (Rugh 2004). In one instance, the Egyptian authorities closed the ethnoreligious Coptic weekly newspaper al-Naba in 2001 for publishing a personal story about a priest because they considered that it could 'undermine public order' (Rugh 2004). Some private newspapers avoid controversial issues altogether or set their newsrooms outside the region (Mellor 2011, p. 61).

In relation to citizens' access to information, a UNESCO (2013) report pointed out that in comparison to other parts of the world, progress on Freedom of Information (FOI) legislation has been slow in Arab states. Jordan passed an FOI law in 2007, but this has gone through a difficult implementation stage. In Tunisia, a decree on FOI was enacted in 2011. Following this, Yemen also passed an FOI law in 2012 (UNESCO 2013). It has been claimed that the general issue regarding FOI in Arab countries is that there are no clear policies or procedures; the policies that have been put in place are seen as 'window-dressing for donors' (Bebawi 2016, p. 11).

In fact, the region presents a particular political setting in which access to news-gathering and production – i.e. access to news sources – needs to be analysed in relation to its own specificities and characteristics.[2] To be sure, one of the most significant elements regarding credibility of news stories are news sources.

This problem of accessing news sources that provide relaible statistics and data, especially in relation to science news, is not only a problem of Arab countries but it is also very present in many places around the globe. Neither is it restricted to government censorship or corporate intervention. The lack of capabilities to engage and use effectively statistics to communicate news effectively is at the cornerstone of this problem. As Livingston and Voakes (2011, p. 2) have argued “if we value independence as a cornerstone of journalism ethics, part of that independence must be the ability to assess numerical information without relying on the source” something that is not always the case.

In relation to this, many journalists from around the world still treat statistics as a primary source. Statistics in journalistic practice are an atypical news source as they are rarely cross-referenced or critically challenged (Lugo-Ocando and Brandão 2016). Furthermore, due to limited sources and rising pressures in the newsroom (Davies 2011), journalists tend to accept the interpretations provided by the officials. Some entities, such as the police, are legally obliged to provide statistics for public evaluation, but they do so through spin doctors and other PR officials who help obscure rather than elucidate public debate. These entities, including government agencies, frequently attempt to doctor information that might otherwise have a negative impact on their reputation (Nguyen and Lugo-Ocando 2015). Thus, not all data from government sources is valid and reliable (Messner and Garrison 2007).

In addition to this, decreasing resources in the newsroom, and rising workloads, risk compromising the quality of reportage (Bauer and Howard 2009). As a result, journalists may rely on sources that do not necessarily have the public interest at heart and who could provide inaccurate statistical information or vested interpretations around facts and policy (Davies 2011). At the end, not all sources are equally credible and there is certainly a hierarchy of news sources with associated degrees of reliability and legitimacy (Van Dijk 2013). The fact remains that in the case of certain news sources they have occasionally misinterpreted or misunderstood their own numbers (Maier 2003).

In this sense, reporters in the Arab media face persistent difficulties in obtaining information and access to news sources and government data in many cases is more tightly controlled and restricted. In addition, many journalists covering science have little or no access to news sources because in many cases they simply do not exist. As Mahmood (2008) points out, finding science sources in that region has proved to be one of the most difficult tasks faced by journalists. If we look at the sources of science news in that part of the world, we rapidly learn that they usually come from Western media. This situation may lead to another challenge; one in which journalists cannot find a suitable local source to clarify or critically analyse the statistical information.

Another key factor that can influence not only media but also many issues in the societies of the Arab region, as suggested before, is religion and culture. These factors have a particularly

strong effect in places such as Saudi Arabia (Awad 2010, p. 35), which is not only considered the hub of the Islamic world by many Muslims but also the centre of a particular strand of that religion, which has been extremely influential in shaping political and societal institutions and practice in that country.

In. addition, the political cultures among Arab journalists need to be considered as a wider issue that might affect their ability to engage and use statistics in science news. Indeed, cultural backgrounds affect journalists' understanding of concepts such as objectivity, neutrality, fairness and bias (Weaver 2015, p. 10). For instance, El-Feki (2008) cites the example of a popular Sudan-based newspaper, which in 2007 published an article on homosexuality in Khartoum high schools. It alleged that half of the students engaging in gay/lesbian activities were contracting AIDs and quoted a local HIV non-governmental organization to support this. As a consequence, there was a court case involving the Sudanese Ministry of Education and the said NGO as well as the newspaper. The newspaper's stance was that it was acting in the public interest but the court saw it as a dishonest effort to spin science statistics into scaremongering tactics against gay/lesbian groups in society. The newspaper was accordingly penalised when the said NGO showed that it had no connection to the story (Muchtar et al. 2017).

While this example shows an extreme example of how science statistics can be misconstrued, intentionally or otherwise because of culture/religion, it does underline the danger of 'playing with numbers' (El-Awady 2015). Moreover, the above example serves to illustrate some of the everyday problems associated with science reporting in Arab regions and in particular in relation to areas such as health, about which journalists seem to have scant knowledge and ability to interpret some statistics thoroughly (ibid). In fact, while Sudan has a significant AIDS issue, news stories in the media in that country continue to portray the issue as confined to the LGBT community, making unacceptable, professionally dishonest and unsubstantiated claims that talk about a 50% infection rate among homosexuals when is just over 9% (El-Feki 2008). Clearly, this was not the work of an experienced science or health journalist; the statistics were either taken from a small group of people or manipulated to make an unjustified claim that homosexuality causes disease and to condemn people with such an orientation (El-Awady 2015).

In wider terms, El-Feki (2008) has observed that 'journalists often have little knowledge of medical and scientific issues, and a poor grasp of basic tools, among them statistics'. This author also suggested that even obtaining accurate data and statistics regarding scientific news poses a challenge for journalists (El-Feki 2008), often leaving journalists to rely on extremely basic datasets as the foundation for their reporting. Mahmood (2008, p. 50) presented a similarly negative account of scientific reporting in Arab countries, claiming that

there are many inaccuracies in scientific content in newspapers, as well as a lack of sources cited when specific claims are made.

These types of episodes have been noted by organisations such as the World Federation of Science Journalists (WFSJ 2015), which have deployed efforts to promote the better use and interpretation of science statistics. The WFSJ (2015) reported that these efforts have promoted statistical reports on current problems, such as AIDS, in many Arab areas. They are directed at addressing the need for the urgent delivery of safe-sex items such as condoms; the implementation of cheaper AIDS-testing programmes; parliamentary debates on taking maternal mortality seriously; the action of NGOs, delivering bed-nets and malaria drugs; stopping environmental damage caused by the felling of trees for military purposes (Jordan); halting an environmentally harmful petrochemical plant (Egypt) and motivating public and private sector groups to protest against toxic and electronic waste in Jordan.

It is because of these types of issues that this study gives particular consideration to the existing tensions between the history of open engagement with science within Islam and, paradoxically, more conservative tendencies today, which are, in my view, more closely associated with the legacy of colonialism in many Arab countries since the 19th century and the end of the Ottoman empire and what that meant for the rise of nation-states in the region. As it is discussed here, religion and culture are problematic categories (Fitzgerald 2003, Masuzawa 2005) that need to be incorporated into any analysis of journalistic practices in Arab countries and that cannot be assumed to be static aspects of society.

It is also important to contrast the richness in the history of science in Islamic countries (Masood 2017) which were known for their long and robust tradition of public discussion on science – for example, medieval Islam was more scientifically advanced than European culture (Huff 2017), and the more modern perceptions about Islam that predominate today not only in the West but also among the Arab societies themselves. Looking at their history one cannot fail to observe that Islamic scientists, especially in astronomy and medicine, managed to reach notable heights of knowledge, even preparing the way for the scientific revolution in the West (Huff 2017, P. 362), something that remains largely unacknowledged in media representations of Islam (Said 2003 [1978], Said 2008 [1981]).

Islamic scholars were drawn to the city's burgeoning libraries and debating salons, and this gathering of intellect produced fruitful Islamic scientists such as ibn-Sina (or Avicenna), who made enormous contributions to philosophy, mathematics, astronomy and medicine. Among his astonishingly varied insights were his view that light and heat were just different forms of energy; that diseases could spread through water; and that nerves transmit pain (Masood (Masood 2017, .P 84). Interestingly, as I keep mentioning, it was the imposition of modernity by the West in the form of colonial rule, and how this defined the political institutional and

religious frameworks that followed independence, that set many Arab countries backwards in relation to the communication of science and the relationship of journalists with numbers.

1.2.4. Gender Issues

Closely associated with these categories – which can be compressed into one according to many authors –there is also the factor of 'gender', which in Arab countries is considered an issue in itself within the available scholarly literature on the topic (Abu Samra 1995, Abdulrahman 2008, Al-Mutairi 2009). This is not only because women represent half of the population of those societies but also because they have played a significant historical role in different fields of public life and especially in journalism, which regrettably has largely remained unrecognised (Sakr and De Burgh 2005, Byerly 2016, Melki and Mallat 2016). This is not to say that women's position in Arab journalism is equal in terms of the workplace. On the contrary, women still get fewer opportunities than men with regard to facilities that help journalists improve their skills, as well as having less access to the hierarchies of the media and continue to be discriminated against across the region. Many female journalists continue to be treated differently and to be seen, by many men in position of editorial power, as not capable of producing work of as high a quality as that of men. Furthermore, some news sources avoid giving information to female journalists because they do not believe in their journalistic abilities, especially when the woman mentions her name on the news (Abdulrahman 2008, Melki and Mallat 2016).

Although there are calls for equality by a number of organisations, and also by female journalists, the state of journalism in general in the Arab region with regards to women continues to be dire. This of course is a paradox as both Arab culture and Islamic tradition normatively claim to recognise the role of women in society and despite a historical tradition in Islam of empowering women. These are what we can call the problems associated with the imposition of the Enlightenment as a political project in the Arab countries during and after the Napoleonic wars, problems that persist as a result of post-colonial realities since the First and Second World Wars and of the reaction and resistance to them by those who came to power in Islamic societies, including Iran, in the 20th century.

In this context, and according to Abdulrahman (2008), there are a number of obstacles faced by female journalists. This is due to the male domination of the journalistic environment, which means that many in these Arab countries view female journalists as lacking sufficient professional journalistic skills. This is a view that is reinforced by the lack of media schools that teach female students, and limited opportunities for them to train as reporters. For example, in Saudi Arabia, the eight media and journalism schools, many of which were

established more than twenty years ago, tend to teach mostly male students. Having said that, there have been renewed efforts to open up education for female reporters and some of these schools, in the last five years, have started teaching female students. One of the points the study explores in my own study is how these challenges, faced by female journalists and based on gender issues, could be overcome in areas such as science news and in particular in relation to the use of statistics.

However, the problem of background, training and education of journalists when it comes to engaging and using statistics in science reporting cannot be seen as limited to women. The problems are as dire and challenging for men in this particular aspect. Nor can it be seen as restricted to the Arab region, although there are reasons to be perhaps more concerned about those countries. In this sense, Philip Meyer emphasised that journalists should be aware of the importance of understanding numbers: "write with words, but we must learn to read in numbers" (Meyer 2002, p. 145). Numerical competence is considered a necessary quality for journalism (Maier 2003). According to the Poynter Institute in the USA, numeracy is one of ten fundamental abilities for journalists: "Without math skills, journalists are certain to fall short in their quest for accuracy. And if they keep their jobs, their numerical incompetence will only undermine the already shaky credibility of the news organizations for which they work" (Maier 2003, p. 921).

Moreover, Shirky (2014) advised journalists that, in order to save their jobs and their profession, they should "get good with numbers":

> *"The old 'story accompanied by a chart' was merely data next to journalism; increasingly, the data is the journalism [...] Learning to code is the gold standard, but even taking an online class in statistics and getting good at Google spreadsheets will help. Anything you can do to make yourself more familiar with finding, understanding, and presenting data will set you apart from people you'll be competing with, whether to keep your current job or get a new one".*

A journalist's job is not to learn and calculate complex things, but to deal with already processed data from other sources. Thus, they need a basic level of statistical reasoning to enable them to constantly question the data (Nguyen and Lugo-Ocando 2015). According to Potter (2010), "you don't need to be a nerd to improve your reporting of news with numbers, you just need to remember one basic journalistic question: does this make sense?". "Journalists do not need a set of skills to create or calculate their own data; they need instead to use logical, valid reasoning and journalistic scepticism to (a) find and acquire data, (b) explore and evaluate their real meaning in context, (c) investigate non-numerical factors shaping them, and (d) report them in a balanced, fair, accurate, accessible and engaging

manner, none of which requires any special mathematical skills" (Nguyen and Lugo-Ocando 2015, p. 5).

For Nguyen and Lugo-Ocando (2015), journalists must learn and use statistics comprehensively for two reasons. The first is the emergence of the big data community, which means that daily news work itself is increasingly dependent on 'number-crunching'. The second is that journalism is operating in an increasingly chaotic world of "lies, damn lies and statistics" (Nguyen and Lugo-Ocando 2015, p. 6). Beer (2016, p. 1) argues that "the term big data has the effect of making up data and as such, is powerful in framing our understanding of those data and the possibilities that they afford". Numbers themselves are neutral and objective; the problem, however, is those who produce and disseminate the numbers for the public. Journalists should present statistics easily and clearly to increase the public's understanding, especially as "the public is susceptible to political and commercial manipulation of their anxieties and hopes, which undermines the goals of informed consent and shared decision making." (Gigerenzer et al. 2007, p. 53).

One of the elements that helps journalists present statistical information easily and accurately is their training. They should have undergone training programmes that teach statistics. These programmes help them acquire basic statistics and statistics-related capabilities. Although it is difficult to find journalism programmes in universities that have statistics courses, institutions in some countries do make their journalism students engage with statistics in a comprehensive manner (Wilby 2007, Nguyen and Lugo-Ocando 2015). An example is the Indiana University Bloomington, which, in 1999, realised that their students were not using numbers in their reporting, even though they were required to include statistics. Departing from that concern, the Department of Mathematics and the National Science Foundation created a mathematics course specifically for journalism (Livingston and Voakes 2011). However, there are still few courses in the USA that fully incorporate statistics, as a recent study from Justin D. Martin, Associate Professor of Journalism & Strategic Communication Program at Northwestern University in Qatar showed (Martin 2016).

In the UK, numeracy is a suggested skill of the professional accreditation bodies such as the Broadcast Journalism Training Council and the National Council for the Training of Journalists (Harrison 2014), but few institutions in that country actually make any provision to fulfil this requirement. In the US, statistical training in journalism education is less common. The Accrediting Council on Education in Journalism and Mass Communication has for some time required affiliated journalism schools to "apply basic numerical and statistical concepts" in its 13 essential values and capabilities (Nguyen and Lugo-Ocando 2015, p. 3). However, as Martin's (2016) study has shown, there are few provisions across the US that actually do so.

In the case of the Arab region, the lack of statistics education among journalists has also been noted (Alhumood et al. 2016, Ibnrubbian 2016). For instance, Alheezan (2007) conducted a

study on media education in Saudi Arabia and found that statistics is taught in just one media school, which can help explain the lack of skills in dealing with statistical information within the profession. Furthermore, the importance of statistics is often ignored among journalists themselves, who did not see it as a priority in their work. According to El-Nawawy (2007), news practitioners and educators do not consider the ability to deal with statistics important, and they do not see it as part of their main job. All this despite efforts to raise the awareness of the importance of teaching statistics in media schools, which has improved as many media schools in places such as Saudi Arabia have started to teach statistics as part of their journalism and media programmes.

Nonetheless, this weakness in managing statistics persists and it can be linked not only to the inability of journalists to deal with numbers but also to the generally poor state of statistics and mathematical literacy education in the Arab region in general. In 2015, the Programme for International Student Assessment (PISA 2015) carried out a study about the mathematical skills of 15-year-olds around the world. Some Arab countries - such as Qatar, Lebanon, United Arab Emirates, Tunisia, Algeria and Jordan - were found to be at the bottom of the list in terms of mathematics performance (out of 70 Organisation for Economic Co-operation and Development [OECD] countries).

Country	Rank	Score
Tunisia	67	367
Jordan	64	380
Lebanon	60	396
Qatar	58	402
United Arab Emirates	47	427

Table 1. Mathematics performance among 15-year-olds in some Arab countries in 2015.

The same assessment found that all these Arab countries performed below the OECD average ranking between 427 and 367 points (scored). They also performed below the average for science (between 437 and 386 points (scored) and reading (between 434 and 361 points (scored). Moreover, the situation is deteriorating, as the PISA assessment showed that the mathematics performance of Arab students in 2015 was worse than in 2012, with most Arab countries obtaining lower rankings than before. Only Qatar scores better as it went from 376 in 2012 to 402 in 2015.

In terms of science news, Arab journalists do face several challenges because of issues and factors related to the political and sociological context in which science is communicated. The prevalent news cultures in Arab countries and the way in which Arab journalists are trained

and prepared to deal with statistics are in many cases an obstacle to a more comprehensive debate around science.

However, perhaps one of the most important challenges in these countries is the scarcity of science journalists themselves (Al-Qafari 2009), which is aggravated by the lack of specialised gatekeepers in the newsroom. Indeed, like in many countries in the Global South, the professionalization of journalists in general, and the specialisation of science journalists in particular, is a worrying issue in the Arab region, which has been examined by several scholars (Rugh 2004, Mellor 2005, Hamdy 2013, Bebawi 2016). They single out the political context in which journalists operate, the historical relation to the prevalent political system and cultural/idiosyncratic framework (namely religion) as some of the main reasons. It is impossible to disassociate the way science journalism is practised in these countries from the way politics, culture, economy and history have defined their specific media systems.

In addition, it is important to note that this scarcity of professional science reporters is exacerbated by both a lack of general knowledge about science in the newsroom and a wider public disinterest in science news compared to other beats such as politics and sports (El-Awady 2009). This vicious circle in which journalists do not engage with science because, allegedly, their audiences are not interested in science has the inevitable consequence that, as a whole, science communication tends to be neglected and remains unprofessional.

1.2.5. The Importance of Science News

So let us start by highlighting The lack of scientific communication culture in the Arab region (Mahmood 2008, Al-Qafari 2009, El-Awady 2009). By this, it is meant the specific culture that fosters the professional and organisational dynamics to produce science news and promote public interest in science. A culture that, as we know, is an essential source of science information for many people (Long 1995) and that is critical in underpinning public awareness and engagement with science in general. Take for example Atwater's study, which found that newspapers were a significant source of environmental information for Michigan residents (Atwater 1988, p. 34). In addition, Pierce et al. (1988) obtained cross-cultural evidence of people's reliance on the media for scientific information. It is precisely because it has such an effect on the public understanding of science that there are long-standing concerns about the accuracy of media reporting of science (Seale 2010). According to Goldacre (2009, p. 225),

> *There is an attack implicit in all media coverage of science: in their choices of stories, and the way they cover them, the media create a parody of science. On this template, science is portrayed as groundless, incomprehensible, didactic truth statements from scientists, who themselves are socially powerful,*

arbitrary unelected authority figures.

Having said that, and in defence of science journalism, some studies, such as that carried out by Long (1995), found that the majority of science stories in newspapers do contain some scientific explanation, although scarce. It is because of this that my study also examined the relationship of professional journalism with science in the context of the tensions provoked by modernisation and post-colonialism. This means that my thesis assumes that journalism reflects the sociological dynamics that are present in many other nations. However, these dynamics are historical by-products and therefore cannot be analysed simply through Western lenses and 'orientalise' our assessment (Said 2003 [1978], Thompson 2016). Having said that, and as interesting as it is, my study mostly applies to one part of the whole dimension of science communication; that which relates to journalists and how they engage with and use statistics. Reasons of time, resources and scope underpin the decision to focus on the communication and use of statistics. It is with this focus in mind that I developed and designed my methodological approach.

1.2.6. Professional Autonomy

One of the most important dimensions in journalism is professional autonomy, which has been defined as 'the degree of judgment or ability to make personal decisions without being affected by external or internal influences' (Mellado and Humanes (2012, p. 985). Several elements may affect the autonomy of a journalist in his/her journalistic work, such as the media organisation in which he/she works or his/her professional experience. Nygren et al. (2015, p. 80), stated that professional autonomy can be categorised into five levels: external autonomy, internal autonomy, autonomy of the ideal, perceived autonomy and factual autonomy.

External autonomy is 'a question of relationships between the profession as a group and power in society' (Nygren 2012, p. 78). Politics influences the independence of newspapers in developing countries because they are less independent than developed countries that have strong liberal traditions Nygren et al. (2015, p. 80).

Internal autonomy is 'autonomy for journalists in their daily work in relation to the media organisation' (Nygren 2012, p. 78). Nygren et al. (2015) stated that internal autonomy for journalism concerns the position of journalists in relation to the owners and other parts of the media company. It can also be a question of financial pressure from owners and other sections within the firm.

In journalism studies, autonomy of the ideal is the degree of autonomy that is required to consider journalism a separate field (Benson and Neveu 2005). The notion of perceived

autonomy targets decisions that must be carried out in the daily work of media companies and raises questions concerning the effect on media content (Weaver and Willnat 2012).

Finally, factual autonomy is considered more complex to study than the aforementioned forms because it is difficult to obtain reliable indicators of autonomy, and one's degree of factual professional autonomy changes over time and across various conditions (Nygren et al. (2015, p. 80).

The degree of journalists' professional autonomy either increases or decreases based on several key factors. Weaver and Willnat (2012) noted that financial pressures, for example, exist within media companies. Other types of pressure come from political dimensions, the development of the media (because journalists must compete with other types of information on social networks) and from outside sources, including PR industries (Nygren 2012). Total dependence on certain sources may contribute to weakening the professional independence of journalists.

Carlson (2015, p. 12), stated that the protection of autonomy, which is a significant element of professionalism, is about 'defending journalism from non-professional outsiders, such as keeping editorial control away from business managers or the influence of government'. Moreover, McDevitt (2003) argued that professional autonomy gives journalists professional advantages. In this way, he backed journalists' right to oppose any threat to their autonomy. In the case of Arab countries, professional autonomy can be lower at Arab newspapers that rely on limited scientific sources, which may occur because of the scarcity of scientific journalists and the lack of freedom of expression in Arab countries.

Professional autonomy was valued as a key element in maintaining journalistic credibility because it assumes the independence of journalists from external pressures and the full loyalty of the public (Kovach & Rosenstiel, 2001). According to Scholl and Weischenberg (1999), journalistic professional autonomy has three levels. The first is the individual level, at which journalists should be free to choose information and cover news stories. The second is the organisational level, at which newsrooms should be free of commercial and political restrictions. The third is the media-systems level (society), at which these systems should guarantee freedom of the press and the absence of censorship.

In the current media environment, journalistic autonomy is challenged in many ways (Singer, 2007). However, Shoemaker and Reese (2014) developed a model of journalistic professionalism, the Hierarchical Influences Model, which includes five levels of effect on media content: individual, routine practices, media organisations, social institutions and social systems. At the individual level, the characteristics of individual communication, on a personal and professional level, affect media content. On this level, the innate characteristics of an individual, including race and religious and political backgrounds, influence media content indirectly by shaping personal attitudes and values as well as professional roles and education.

At the routine-practices level, three sources of routine restrict and empower communicators in their work processes: organisations, audiences and content suppliers. The media-organisation level describes the larger organisational and professional contexts, including organisational policy and professional roles and how the media organisation itself is structured. The social-institutional level represents the effects erived from the media field across the larger organisation. The social-systems level is the external link of the paradigm, which describes the effects of social systems, and this level centres on how ideological forces form and affect media content.

Scholars have viewed these challenges in light of political and economic or commercial constraints (Schudson, 2010). Changes in organisational structures and work cultures also provide challenges (Hanitzsch et al., 2010; Hanitzsch & Mellado, 2011). While some views consider political and economic pressures as crucial to the reduction of journalistic autonomy, journalists consider the factors arising from their direct environments (newsrooms, news organisations and daily work routines) or the profession to be more significant (Lauk & Harro, 2017).

In the Arab world, we cannot talk about freedom of expression, objectivity and independence, but we can talk about professional autonomy, and I use this concept because it is applicable in the Arab region, even given the limitations that Arab journalists face in their work. This study explores the issues of professional autonomy in journalists' ability to take science into account and communicate science to their societies. Therefore, I believe the study's importance lies in its exploration of the contrasting one of the grounds against the normative expectations of what journalists should be doing, which enables us to understand that the flaws in Arab science journalism lie in communicating science in general term.

1.3 Statement and Justification

The media plays an important, influential role in communicating science to the public (Bucchi 1998). However, few studies have addressed the role of the Arab media in science communication. Of these, some have suggested that the science communication sector is deficient and has not kept up with other media sectors (Al-Qafari 2009). In addition, journalists on the science beat in Arab countries have been accused of inaccurate work and a lack of specialised sources (Mahmood 2008, P. 50). This criticism extends to the use of data and statistics in science reporting, as both play a significant role in supporting and substantiating science news. This is true because both data and statistics develop a sense of knowledge in readers (Al-Qafari 2009) and are instrumental not only in substantiating news stories about science but also in informing audiences.

The issues raised herein allows to formulate the following key research question: 'How do science journalists in three countries in the Arab region—Saudi Arabia, Kuwait and Egypt—

engage with and use statistics when reporting science news, and what does analysis of this tell us about the professional autonomy of science reporters in relation to science communication in illiberal political systems?' In asking this question, the study aims to understand how journalists engage with and use statistics to articulate science news in the Arab media while exploring the role of numbers in both elucidating science in the public realm and bringing accountability and transparency to the subject. Therefore, the study explores the relationship between journalism and statistics as they apply to the articulation of science news stories. In doing so, the study aims to assess the levels of professional autonomy displayed by journalists in the three countries and how this autonomy translates into injecting accessibility, engagement, accuracy and rigour into the reporting of science as a news beat. Thus, this study looks at how journalists engage with, use and manage statistical data when gathering and producing science news. The study also aims to assess the current capabilities of journalism and to identify key knowledge gaps in the area. In addition, in order to better understand how reporters engage with statistics, the research examines the nature of the news sources that provide these data and how journalists handle these sources as regards the outputs that they produce.

In asking and unpacking this question, we should notice that there are multiple, substantial issues facing journalists who report science news in Arab media and that the potential answers are inevitably complex. However, by developing my research questions around clear aims and objectives, one can aspired to produce an innovative body of knowledge that could enhance our understanding of the communication of statistics in particular, and of the public discourse regarding science in general. Therefore, one of the main objectives here was to fill the gaps regarding how journalists produce science news in the Arab region in the context of a critical discussion of politics, Islam and modernity. The other, and perhaps more pressing, objective was the need to understand these issues so as to be able to build capabilities for positive change in a region of the world.

Three countries (Egypt, Saudi Arabia and Kuwaiti) were chosen because of the nature and dimensions of their media systems and because each reflects in great part other similar systems in the region. In addition, the three countries have distinctive levels of media freedom and liberality of political institutions. More importantly, they also differ in terms of their relationships between politics and religion. Given that my scholarship was provided by the government of the Kingdom of Saudi Arabia, it was chosen as one of the countries included in the research. Nevertheless, from the beginning, it was determined that the study should be comparative. Therefore, the countries had to have comparable sizes and populations and similar degrees of investment in their media systems. Finally, these three countries top the Arab world for spending in the science fields in terms of GDP.

1.4 Aims and Objectives

The main purpose of this study is to understand how journalists engage and use statistics to report science news in the Arab media and to understand the challenges and opportunities that journalists face in these countries in the wider context of science communication. The study attempted to generate innovative knowledge about the use of statistics in science news stories in three Arab countries: Egypt, Saudi Arabia and Kuwait.

The study has eight main objectives: (1) To understand how they use statistics to report science news; (2) To identify the capabilities of journalists and editors in the Arab region through their use of statistics in articulating science news; (3) To examine the validity, accuracy and reliability of the statistics that journalists and editors use to articulate science news; (4) To identify the nature of the sources used by science journalists when engaging and using statistics; (5) To examine journalists' key challenges and opportunities regarding their use of statistics to report science news; (6) To identify issues affecting the way journalists and editors use statistics; (7) To illustrate the cross-national similarities and differences that affect science journalists' use of statistics in Egypt, Saudi Arabia and Kuwait; and (8) To identify how to improve journalists' use of statistics in reporting science news.

1.5 Definitions of Main Terms

It is important to define certain main concepts integral to the study. The five principle ones are: statistics, science communication, science journalism, health news and technology news. First, the concept of statistics. This concept, despite the broad, common assumptions about it, tends to be as debatable as journalism itself. Indeed, 'statistics' has been defined in a variety of ways. Therefore, there are marked differences in their definitions stemming from the multiple backgrounds of those employing these numbers. In some cases, statistics have been conceptualised as 'a way of gathering and analysing data to extract information, seek causation and calculate probabilities' (Cohn and Cope 2011, p. 169). In others, such as the definition provided by the Royal Statistical Society (RSS 2017) in Great Britain, statistics is considered as 'changing numbers into information'. For the RSS, statistics 'is the art and science of deciding what the appropriate data to collect are, deciding how to collect them efficiently and then using them to answer questions, draw conclusions and identify solutions'. For the purpose of this study, however, it understands statistics as informative numerical data resulting from the collection of varied statistical information. This is because of the need to operationalize the term so it can be employed in the specific analysis of journalism practice. Consequently, the study focuses on two elements of statistics, which allow us to examine engagement and use while assessing the capabilities of science journalists in the Arab region. These elements are numbers (e.g., probabilities and percentages) and visual graphs (e.g., histogram and pie chart).

In this sense, however, it is important to explore the more general/universal factors that tend to impact upon journalists' capabilities to use statistical information in the news. Regarding this, some authors have pointed out that reliability, validity, absence and interpretation need to be considered as the most significant elements influencing journalists' abilities to use statistics in their news writing (Nguyen and Lugo-Ocando 2015, Lugo-Ocando and Brandão 2016). The following graphic shows the different categories and notions I worked with in my analysis of this interaction between journalists and numbers:

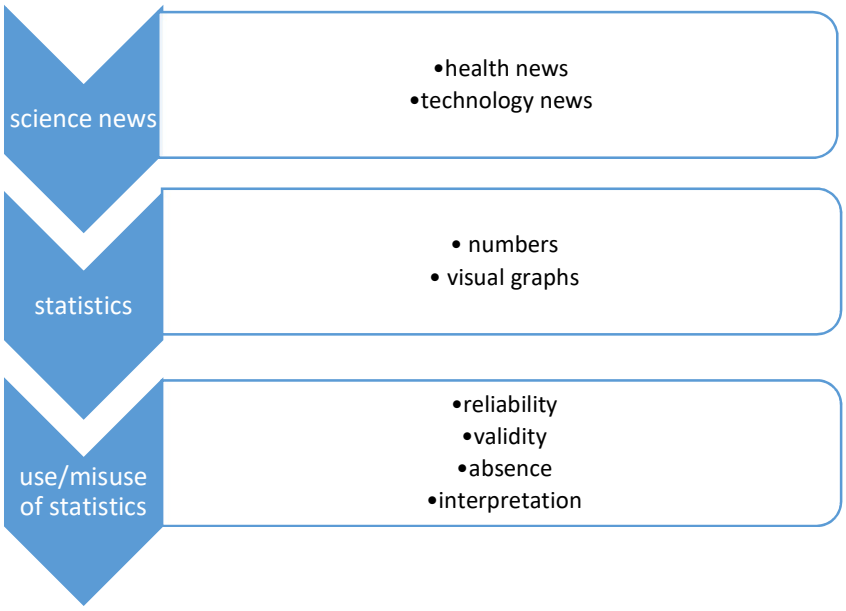


Figure 1. Assessing the use of statistics in science news through the processes shown.

Embracing this typology allows for a structured and comparative examination of the use of, and engagement with, statistics by professional journalists. The study therefore relates its observations to 'absence', 'reliability', 'validity', and 'interpretation' in the use of statistics by journalists. This is because these four notions are crucial in identifying key problems and issues around the use of statistics by news reporters. Consequently, it is important to define and discuss the meaning of these elements and how they need to be conceptualised in the context of this study.

'Reliability' refers to a notion that has many meanings in different contexts and therefore requires further examination and a narrower definition. This means 'the degree to which the result of a measurement, calculation, or specification can be depended on to be accurate' (Oxford 2017). However, in professional journalism practice, 'reliability' tends to refer to the fact that the source of the news 'can be trusted'. Examples of reliable sources, therefore, are experts in the field and officials or international organisations. The reliability of news sources also depends on whether the source of statistical information is mentioned or not, this element is often referred to as 'anonymous sources'. In this sense, Carlson (2011) stated that unknown sources have a negative impact on content credibility.

In contrast to the above, the notion of 'statistical reliability' as applied by journalists covering science news is numbers that are being presented to the public in the news media. It is supposed to summarise a particular phenomenon (e.g. levels of crime in a particular community). Therefore, to achieve 'statistical reliability' the numbers will need to follow adequate mathematical and statistical procedures such as choosing the appropriate 'test' and

selecting a representative sample. Hence, a news report that uses numbers which do not follow these procedures should not be considered statistically reliable. For example, in the post-Arabic survey, which was published in some media outlets, it claimed that the majority of young people in Saudi Arabia prefer the King's son Mohammed Ibin Salman to be king after his father rather than Mohammed Ibin Nayef who was the next in line to be king after King Salman. However, a closer look at these reports showed that the statistics had come from a survey carried out among only 561 people, and that this sample was not randomly chosen, making it unrepresentative of the larger universe despite the claims made by the authors of the reports (Osama 2016).

Furthermore, particular statistics can be unreliable when an unsuitable test is used for the wrong data set. For example, although a Chi-Square test is often used to predict differences between a variable (i.e. pay gap between men and women in a particular labour sector), it is not as reliable when comparing other different variables such as grades among different groups of pupils given their distinctive socio-economic backgrounds for which there are, perhaps, much stronger and more reliable tests. Nevertheless, this has not stopped some journalists from referring to a particular statistical test that is not adequate for the type of data being analysed. Moreover, in journalism practice statistical reliability can also be compromised because of other factors, such as an improper data collection process or mistakes inputting the data into the processing software. These are aspects that are not always checked by reporters before they publish the data in their stories.

As in the previous case, we have to make the distinction between what it is often understood as 'validity' in the common jargon, what it means for the statistical sciences and how we need to discuss it in the context of this work. In this sense, among statisticians the notion of validity is often defined as 'the connection between the concept and the measured value' (Spirer and Spirer 1998, p. 14). However, for the purpose of this research, I have adopted the notion that 'validity' refers to the legitimacy of the claims made around the statistical information being presented by the journalists (Lugo-Ocando 2017). Therefore, in relation to my study, validity refers to whether the statistical data are proving what journalists are claiming to say. An example of this would be when a tabloid newspaper claims – as they have done in the past – that the crime rate is increasing as a result of immigration, due to the fact that both rates are increasing simultaneously, therefore assuming correlation and causation at the same time. In this case, even when a correlation is established, the statistical information is still not valid because the assumption of causation is not established except in the mind of the journalist.

Other cases in which the validity of a certain set of statistics used by journalists can be questioned include the reporting of the stock market average to make inferences about the health of the general economy. In this last case, the performance of a particular index in the stock markets is not necessarily indicative of the larger economy in a country, so such claims

lack validity. Consequently, the study looks at 'validity' in science news by performing content analysis and expert panel analysis around a set of news stories.

Another issue around journalism practice in relation to the use of, and engagement with, statistics is that of 'absence', to which I also pay close attention in the study. By this term we mean that journalists do not have or do not include in their stories the necessary statistical information to underpin the claims that they are making. Hence, some numbers are left out deliberately that could have provided a better substantiated view, a more balanced discussion or simply challenge/underpin the claims made in a particular news story.

Although not all news stories require these numbers, in some cases presenting them is crucial in the articulation of a sound and comprehensive perspective around a particular issue. An example is the headlines referring to a study carried out by a think-tank led by the British Conservative parliamentarian and former leader of that party, Iain Duncan Smith. The study claimed that married couples tended to be less likely to live in poverty and hence the government should incentivise couples to stay married through tax-breaks for married couples, and other similar policies. The news media failed to include other statistics that showed that instead it is poverty that affects the ability of couples to stay married (Porter 2011). Consequently, the study examines journalists' failure to use and incorporate statistics in science news.

Finally, the other aspect that needs to be looked at is interpretation. This refers to the ability of journalists to understand, critically examine and explain, in an accessible and comprehensive way, the numbers in question in the context of the news stories being produced. One example of where interpretation of the numbers was not successfully achieved was the case of a newspaper in Saudi Arabia that claimed that the unemployment rate had increased to 12%, while also mentioning in the same story that the total number of Saudi employees accounted for 42% of the Saudi population. The interpretation offered was somewhat imprecise as it referred to the percentage of Saudi employees by alluding to both Saudi nationals and residents and therefore compiled this as a single number with other nationalities who are in transition between employment or have a temporary status, and which make up the bulk of the total statistics.

Overall, reviewing existing scholarly work around these issues, it became clear that these measures could help describe, explain and analyse how professional journalists in their daily practice use and engage with statistics in order to produce news stories about science. These measures are the pillars of my theoretical framework for understanding the role of statistics in journalism practice.

The second term that needs to be defined, that of scientific communication, plays a major role in modern society, not only in the context of reporting science news, but also in those of promoting scientific awareness, understanding, literacy and culture. According to Burns et al.

(2003, p. 183), science communication is ‘defined as the use of appropriate skills, media, activities and dialogue to produce one or more of the following personal responses to science: awareness, enjoyment, interest, opinion-forming and understanding’. In the present study, science communication is defined as science media that play roles in exchanging science information; that are directed toward the science community; and that publicise science with the aim of increasing public access to relevant, accurate science knowledge.

The third term to be defined is science journalism. It is important to know how the study will use this term and what content it will specify as science journalism. It can be complex to determine what science journalism comprises. It could be all the news published in the science section or written by science journalists (Summ and Volpers 2016). However, in the present study, science journalism is defined as the journalism that covers various types of science news, including health, technology and environment. Journalists are defined as specialists who deliver science developments and events to their audiences, offer analysis and research background and scrutinise the sources and reliability of research.

It is important to note that the present study places particular emphasis on the fourth and fifth terms to be defined: health news and technology news. The study divides health news into three categories: (1) public health stories, which describe common problems influencing health or public safety; (2) policy health stories, which describe the systems that affect access to the healthcare market; and (3) disease health stories, which present new information on diseases and treatments. Technology news is defined as news related to software applications and machines. The reasons for focusing on these two types of technology news are discussed in Chapter 4, which includes the background of, and constraints faced, by journalists in the three countries. For now, let us say that the reasons relate to finding news beats in which journalists feel freer to speak openly about their work without political constraints that might jeopardise their work or personal safety.

1.6 Overview of the Structure of the Thesis

The following outlines the structure of the thesis by summarising its chapters. Chapter 2 provides an overview of science communication and Islamic religion. It includes the meaning of science, the relation between science and communication and classifying science communication models. In addition, it reviews the role of science in the Golden Age of Islam and the role of religion in promoting science. The chapter concludes by mentioning the contributions of Muslim scholars to the world.

Chapter 3 introduces Arab science journalism and reviews the emergence of science journalism in the Arab region, specifically in Egypt, Saudi Arabia and Kuwait, the historical stages of development of the scientific press in those countries. In addition, recommendations

for improving Arab science journalism. The chapter also discusses the difficulties faced by present-day science journalists and, furthermore the role of governments in finding these difficulties.

Chapter 4 presents the study's methodology provides a combination of several methods was used, including content analysis, close reading, expert panel and semi-structured interviews. The chapter also details the study's data collection and the data analysis.

Chapter 5 presents the study's findings from analysing science news stories and interviewing science journalists in selected Arab countries. The main findings in this chapter are divided into four categories, based on the methodologies used: content analysis, close-reading rhetorical structure analysis, expert panel and semi-structured interviews.

Chapter 6 outlines the contributions of this thesis to the field of study and discusses the conclusions in the literature in comparison to those of the present study. This chapter summarises the main findings regarding the research question and presents conclusions based on those findings. Finally, it provides recommendations to help researchers and journalists fill gaps in the current knowledge.

Before starting this study, is important to highlight religion as a core element (to be discussed within my overall rationale), which has historically played a major role in the Arab region. Indeed, the vast majority of the population of the Arab countries embrace the Islamic religion and are thus largely influenced by the rituals of that religion. I am also very aware that for many scholars in the West, it is impossible to speak about dynamics in the newsrooms, professional and deontology of journalism in Arab societies without talking about Islam. Hence, when looking at the Arab media, the analysis has always to consider the role of Islamic culture (Rugh 2004). Moreover, as Mellor (2005) points out, Islam plays a fundamental role in defining journalistic practices in Arab countries. The question, which is more of a moral inquiry, is whether this influence is positive or negative.

Islam is often portrayed in the West as having a negative impacts on journalistic practice (Mostyn 2002, Davey-Quantick 2016). There is an assumption that Islam creates an intrinsic culture that curtails freedom of expression and journalists' autonomy (Merskin 2004). There are assumptions in the West that the Arab world in general and its press in particular have problems with freedom of expression because the Arab world follows Islam (Merskin 2004). These assumptions, which is common among some in the West, suggests that the solution to the problems in the Arab press is to abandon the Islamic press (Lind and Danowski 1998). Of course, one has to acknowledge, Islamic religion has a key role in influencing journalistic practice because of the jurisprudence and institutional framework that derives from it in Arab nations. The argument goes that news reporters are limited in their actions and constrained in their deontology by the effects of the moral impositions deriving from institutionalized faith. Moreover, some authors argue, Saudi newspapers are prone to the pressures from religious

leaders when they are disseminating the news (Al-Kahtani 1999). The problem with this argument is that it assumes that ‘religion’ is an entity with agency that somehow has power in society at large. Those who suggest that religion has a restrictive and negative impact upon journalists’ professional autonomy seem to obviate the fact that these same restrictions and pressures happen in many secular societies as well (Muchtar et al. 2017). It is also a simplistic assumption based on the false notion that it is the separation of Church and State that bring about enlightenment into the discussions and debates in the public spheres. It is also an assumption that tends to brush aside the very fact that it is not only religion but mostly the very authoritarian nature of the political and legal systems of hegemonic structures inherited from colonial powers that are the root cause of lack of freedom of expression. In defence of religion, Pintak (2014, p. 5-8) points out that truth and objectivity instead occupy a pride of place in the Islamic approach to communication. The attitude towards religion shows also a lack of a proper understanding of the difference between the political system and the role of Islamic religion in culture and society in these countries. This is a distinction that needs to be made if one wishes to elucidate further these discussions.

Chapter 2 Science Communication and Islamic Religion

2.1 Introduction

Several scholars have argued that science communication is important to the public (Nelkin 1995, Bauer and Bucchi 2008) as it contributes to societies' renaissance and development by increasing the rationality of public debate, making it sounder and more likely to be evidence based. It not only informs the public about what happens in science but also provides information essential to shaping views on public policy (Nelkin 1995, Treise and Weigold 2002). Nevertheless, many factors may play roles in influencing societies' reception of science, including their cultures, politics or religions. Sometimes, science communication conflicts with societies' values or even their core concepts regarding humanity.

For instance, a society's religious beliefs and ethical standards might contribute to its negative reception of new scientific findings. The aforementioned factors exist in societies worldwide, but the degree to which each exists differs among societies. In the West, there is a view that one of the biggest factors countering science communication in Islamic societies is a limited freedom of expression that is seen as attributable to Islam (Merskin 2004). Countering this view, there is, for example, the Golden Age of Islam, during which science was widespread. This thesis examines Islam's role in science communication both during that age and to date. To that end, this chapter discusses science and science communication in the context of Islam's role in them.

2.2 What is Science?

To enable an understanding of science communication, science must first be defined, which has been done as follows: 'Science is the systematic enterprise of gathering knowledge about the world and organising and condensing that knowledge into testable laws and theories' (Burns et al. 2003, P. 185). The definition of science has been extensively debated in literature, and the word 'science' has a contemporary meaning much wider than that of 'pure science' (Shamos 1995). Casadevall and Fang (2016, P. 1) define revolutionary science as 'a conceptual or technological breakthrough that allows a dramatic advance in understanding that launches a new field and greatly influences other fields of science'. Lett (1997, p. 44) emphasises the objectivity of science, stating that it is 'an objective, logical and systematic method or technique for acquiring synthetic propositional knowledge'. He also assumes that absolute objectivity exists in science. However, because attaining absolute objectivity is impossible in any real scenario, science cannot be claimed to be absolutely objective; rather, its objectivity has to be elaborated in the relevance of human beings Lett (1997), who are

unable to understand perfectly the objectivity of science but can use science as a frame of reference for establishing objectivity.

Erickson (2016) states that current societies are surrounded by science and view everything from the perspective of science. In addition, science plays an important role in understanding the way various aspects of life function in a society. For example, science helps societies analyse various issues, helping to identify their root causes, which eventually helps determine possible resolutions for them. According to Rörsch (2014), the pace at which science has progressed in various fields has not been the same or consistent, accelerating and decelerating at various times.

This speed depends upon the science field; poor practices in some fields have slowed their progress, as can still be observed today. In contrast, other fields, including astronomy, physics and molecular biology, are progressing at a fast pace, bringing about public awareness and changes in societies. Renn (2015) suggests that observation of the history of science supports the statement that it can be considered an integral part of cultural practices rather than separate from them. However, Cooper (2012) states that the history of science demonstrates that its development is influenced mainly by the economic need for new products, which spurs researchers to develop the techniques required to develop them.

Driscoll et al. (2011) state that the physical and social sciences play important roles in maintaining sustainability worldwide. In particular, the sciences have helped societies to change the way humans' daily lives function in terms of their daily activities. However, Driscoll et al. (2011) also argues that the interface between science and society needs to be strengthened and that achieving this requires activities that promote public engagement and result in the distribution of science through several media, which will help to build diverse audiences. Meanwhile Rull (2014) underlines that science plays a major role in shaping the societies' futures and that therefore, they value the practical implementation of scientific knowledge as a way to improve their living standards. The most common example of the positive effects of science on societies is clean energy. Godin and Doré (2004) note that science also affects societies by contributing to their economic growth by increasing productivity, profits and market share and by creating jobs.

2.3 What is Science Communication?

Science communication has been a major area of journalism for decades (Bucchi and Mazzolini 2003). In science communication and the associated news stories, the relationship between scientists and communicators is essential to making scientific knowledge accessible to the general public. Ashwell (2016) notes that the concept of science communication evolved

after the concept of communication. This concept of communication notes that it refers mainly to the exchange of information between two or more persons or groups using a communication medium, or channel. Similarly, the concept of science communication refers mainly to the exchange of science information between two or more persons or groups.

In support of the above theories, Meyer (2018) notes that the development of science communication is an important phenomenon that has helped societies develop and create opportunities for informed-debate and rational-based public policy. Over time, science communication, accompanied by an increase in public relations professionals, has grown into a profession that aims to disseminate to societies the most fundamental knowledge regarding scientific facts (Meyer 2018).

According to Stilgoe et al. (2014), one significant problem associated with the differences in development of science and society is the public's limited awareness and knowledge of scientific facts that can help ease their lives. The growth in science communication has increased the public's level of engagement with science developments. The literature argues that acquiring relevant science knowledge has increased the opportunities of non-experts and even of the public to find solutions to common problems identifiable in their daily lives. In addition, the increase in science news has promoted criticism regarding societies' political and cultural issues.

Highlighting the significance of science communication to societies, Claussen et al. (2013) explore the digital channels, including social media, on which photographs and videos related to science news can be shared, making science knowledge accessible to wider segments of societies. The significant growth of social media sites, including Facebook, Twitter and other blogging sites, has helped to spread science news to large segments of societies. In addition to raising public awareness related to science knowledge, the growth of science communication helps to bridge societies' knowledge gaps regarding scientists' contributions to development (Claussen et al. 2013).

2.4 Science Communication Models

Contributions to science communication are classified into four models, which Lewenstein (2003) describes as: deficit, lay expertise, contextual and public participation. Other researchers have identified other classifications, including the dissemination model -often called the deficit model- (Gregory and Miller 1998, Littlejohn and Foss 2010), the dialogue model (Trench 2008, Cooperrider and Srivastava 2017) and the participative model (Marshall and Wickenden 2018). These are:

2.4.1. The Deficit Model

One of the key concepts here is the so-called deficit model. Briefly, the deficit model sees scientists as experts who hold knowledge and the public as lacking in capabilities in the sciences (Lévy-Leblond 1992, Trench 2008). The past belief that the public lacks knowledge contributed to this model (Sturgis and Allum 2004). If the public is provided with enough data about modern science and technology to overcome this 'knowledge deficit', it can view science as beneficial (Dickson 2005).

According to Sturgis and Allum (2004) the deficit model implies that science communication flows in only one direction, with scientists producing information and the public receiving it. Messages are disseminated to the public, and no feedback is received from it. This model of science communication sees communication as being initiated at the point when the source sends the information and as being completed when the audience receives it in an appropriate, understandable format. However, this model of science communication is only half complete, as it does not provide for the audience's response.

Former Minister of the British Labour party Lord Sainsbury pronounced the 'demise of the deficit model and also warned that the end of the deficit model does not mean there is no knowledge deficit...many communications about science will still mainly be about passing on the latest scientific knowledge' (Miller 2001, P. 137-138). Furthermore, Sturgis and Allum (2004) note that many criticisms of the deficit model are in many ways valid but do not problematise the model sufficiently to justify scrapping it entirely.

Indeed, it has been noted that the deficit model is still the default choice in many areas of science (Trench and Junker 2001). In addition, Trench (2008) states that 'the deficit model survives as the effective underpinning of much science communication. A legitimate case can be made for retention of a dissemination model in certain circumstances'.

2.4.2. The Dialogue Model

Dialogue has been defined as 'the exchange of ideas, opinions, beliefs and feelings between participants—both speakers and audience. It is listening with respect to others and being able to express one's own views with confidence' (Davies et al. 2009, p. 343). As this definition implies, the dialogue model of science communication differs from the deficit model in that it is more comprehensive and provides for a partnership between the two participants in the communication: the scientists and the public. The dialogue model has been defined as a 'two-way, interactive and participatory' process that includes the valued aspects of mutual respect, humility and trust (Reid et al. 2018, p. 123). According to Trench (2008), in the dialogue model, 'science is communicated between scientists and their representatives and other groups,

sometimes to find out how science could be more effectively disseminated, sometimes for consultation on specific applications'.

Davies et al. (2009) point out that dialogue is valuable for several reasons. First, it helps to actively engage the public in science discussions. Second, dialogue is more reactive and gives more participants an extended chance to actively participate and contribute. Third, the format of a dialogue event has the potential to promote many different types of learning. Finally, the dialogue model can have effects at the individual level rather than the institutional one, and on the individual level, dialogue is the starting point that motivates participants to engage, whether as speakers or listeners. In contrast, Durodié (2003) argues that the dialogue model is problematic because some scientists might try to make science more accessible to the public even if that means telling the public what it wants to hear.

2.4.3. The Participation Model

This model, which focuses on the activities that contribute to sharing and therefore to confidence in science policy, has emerged in reaction to the importance of social trust to political disputes about issues regarding science and technology (Lewenstein 2003). According to Joss (1999), public participation is a phenomenon in decision-making and public policy regarding science and technology.

Trench (2008) notes that in the participation model, communication about science takes place among various groups, based on the belief that all can share and benefit from the results of deliberation and debate. Trench adds that the participation model differs from the deficit and dialogue models in that it represents a three-way, multidirectional model in which communication takes place in both directions between scientists and the public and also among the public itself, while in the deficit and dialogue models, communication is linear and one-way or two-way, respectively.

2.5 Importance of Health and Technology

In addition to this taxonomy is important also to acknowledge the media as a primary source of health information (Martinson and Hindman 2005) as it contributes in raising awareness and disseminating knowledge. Hence, we need to consider health communication as a type of science communication that aims to serve individuals and communities by delivering health-related information that can improve health outcomes. Health communication has been defined as 'a multifaceted and multidisciplinary approach to reach different audiences and share health-related information with the goal of influencing, engaging and supporting individuals, communities, health professionals, special groups, policymakers and the public to

champion, introduce, adopt or sustain a behaviour, practice or policy that will ultimately improve health outcomes' (Schiavo 2013, P. 7).

Overall, health and technology are the types of science news most frequently published in Arabic newspapers (Al-Qafari 2009, Al-Saber 2012, Alyan 2012). Science communication regarding health and technology is a vital priority in Arab countries, which are considered as developing countries and in need of education in many areas, of which health and technology are two of the most important.

2.6 Science in the Muslim World

The Arab world is situated in a large geographic area and includes many countries in Asia and Africa. The word 'Arab' is a term used to describe a group of people who share the same language and certain other identifying characteristics including religion although certainly Islam is not the only one present. Hence, the term 'Arab' is often used synonymously with 'Islam' despite the fact that Islamic countries are not necessarily the same countries as Arab ones and they include instead many others such as Indonesia, Iran, Malaysia and Pakistan, to name just some. However, the terms 'Arab' and 'Islamic' are often used to mean more or less the same thing or else they are combined into the expression 'the Arab-Islamic world' (Yildiz 2018, P. 5). For Hoyland (2002, P. 2), 'Arabia signifies the steppe and desert wastes bordering on the territories of the states and principalities of Egypt and the Fertile Crescent'.

Despite these various descriptions and expressions, many historians and scholars acknowledge the significant contribution of Muslims to the contemporary world (Falagas et al. 2006). In fact, humanity enjoys much of its modern-age development in various fields, including medicine, astronomy, mathematics and others, because of the early scientific observations and works of several Muslim and Arab scholars and scientists, including al-Khwarizmi (Ajwa et al. 2003), who is known as the father of algebra, and ibn-Sina, who is considered the founder of early modern medicine (Gohlman 1986).

Dallal (2010) argues that before the birth of the Islamic religion in the seventh century, the Arabs did not have science. He dates the emergence of what he describes as 'the Islamic scientific culture' to the 'translation movement', which occurred during the ninth century (Dallal 2010, p. 10). Dallal indicates that all historians of Islamic science agree that the beginnings of Islamic science originated with this translation movement, of which translation and learning about the earlier scientific and philosophical works of important civilisations, including Ancient Greece, were important parts. Dallal also suggests that in the Middle Ages, Muslim societies were involved with pure science and knowledge in ways not seen before or again until the

developments of the current era. Dallal's argument is that the number of scientists and science books produced at that time are unequalled by those of any other time or civilisation.

Nasr and De Santillana (1968) argue that there are elements of Chinese science in Islam, especially chemistry, which might indicate contact between Muslims and this science. However, they note that greater influence from China came in later centuries and in the arts and technology rather than the sciences. Similar to Dallal (2010) remarks about benefiting from older civilisations, Nasr and De Santillana describe the ancient sciences of the Mediterranean peoples as being the starting point of the arts and sciences in Islam. That heritage, in particular the knowledge and philosophy of the Greeks, was translated into Arabic by famous translators, including Hunain ibn-Ishaq and Thabit ibn-Qurrah (Nasr and De Santillana 1968). Many works by Greek authors in nearly all areas and fields of knowledge were translated into Arabic.

The same view is shared by Chaney (2016), who argues that there was a strong translation movement after 750 CE, at the time of the Abbasid Caliphs, who sponsored this movement. Most science books were translated into Arabic. Chaney stated that 'This translation movement coincided with and served as a catalyst for the explosion of scientific output that occurred in the Islamic world over the following centuries' (Chaney 2016, .p 6). This period witnessed important scientific achievements and advances in fields that included astronomy, mathematics, medicine and optics (Kennedy 1970).

Masood (2017, p. 43) believes that the 'boom in translation' during the time of the Abbasid Caliphs was compatible with the teaching of the prophet Muhammad 'to seek knowledge everywhere, even if you have to go to China'. Masood (2017, p. 44) adds that Baghdad, the capital of the Islamic empire at the time, was the centre stage for this movement and that translators were highly paid. He believes that this began slowly at the time of the caliphate of al-Mahdi (775–85) and Harun al-Rashid (786–809) and flourished in the time of al-Mamun. Ancient treatises and books from Greece, Persia, India and even China were brought to Baghdad to be translated into Arabic.

The translation movement was one that led to later developments and advances in many scientific fields and other areas. Collectively, these advances are known as the 'Islamic Golden Age', a name bestowed by the 'Orientalist' movement (Said 2003 [1978]). Renima et al. (2016) argue that there is no agreement among historians on the exact beginning and end of the Golden Age. According to them, it was a process rather than a specific period. However, that time was known for important events, including the establishment of the Bait el Hikma (House of Wisdom) in Baghdad in the second half of the eighth century. Scientifically speaking, the Golden Age witnessed important breakthroughs and advances. For example, in mathematics, important developments included the decimal place value system, decimal fractions, the first systematised study of algebra (named for the work of al- Khwarizmi, a scholar of the House

of Wisdom) and other developments in geometry and trigonometry (Van Sertima 1992). By the end of the eighth century, the Abbasids applied the decimal system and invented ‘Arabic’ numerals. They were the first to use the zero, which facilitated operations in a highly remarkable way compared to that of Roman numerals (Renima et al. 2016). The poet Omar al-Khayyam (1048–1131 CE) is another example of the important influence of Muslim scientists at that time. He was a theologian who wrote important studies that helped to establish the principles of algebra, which formed part of the Muslim mathematics that was later passed on to Europeans (Allard 1997).

In addition to mathematics, astronomy was an area in which Islamic Golden Age scientists made their contributions particularly useful for navigation and discovery. According to Renima et al. (2016), Muslim scholars renewed the interest in this field of knowledge and added to the heritage and contributions of other civilisations. They also note the support for scientific efforts by the Abbasid rulers, as exemplified by Caliph al Ma’mun, who built an observatory within the framework of the House of Wisdom. The results and achievements of the House of Wisdom were so great as to influence Byzantine, European and Chinese astronomy (Rāshid and Jolivet 1997).

In addition, alchemy, or early chemistry, is another field that grew during the Golden Age. Rāshid and Jolivet (1997) explains alchemy by stating that people of the time believed it possible to transform other matter into gold using an ideal agent called an ‘elixir’. Jabir ibn Hayyan (721–780 CE), a very famous scholar of alchemy, studied the compositions of minerals and their transformations. In addition to other well-known Muslim alchemists, ibn-Hayyan developed many processes and reached important findings that served as the basis for modern chemistry.

2.7 The Role of Islam in Science

The relationship between science and religion is not a new topic of study but instead has for long attracted human interest. In fact, most religions have had serious discussions about science, and Islam is no exception. Many consider that Islam has had a positive relationship with science. Several Qur’anic verses indicate the importance of learning and acquiring knowledge. Yusoff et al. (2011, p. 56) indicate that the Qur’an stated, ‘Say: Are those who know equal to those who know not? It is only men of understanding who will remember’. They argue that in addition to the many Qur’anic verses highlighting the importance of science, many narrations and hadiths from the Prophet Muhammad offer additional encouragements to Muslims (2011). The meanings of these teachings remind Muslims of the importance of searching for knowledge and that doing so is an obligation and duty of all Muslim men and women.

Nevertheless, there is far from agreement around science and the Qur'an. Some believe that the two are compatible while others do not. Barbour indicates four categories of relationships between science and religion: contradiction and conflict; independence; interaction, or dialogue; and unity and integration (Yusoff et al. 2011, p. 54). Accordingly, such classification is useful to a scholar proving his or her point, and the same could be said about the relationship between science and the Qur'an. In addition, they refer to Qur'anic verses that have scientific references, including one that describes the mountains as stabilisers. This is accepted by, for example, El-Naggar, the author of the book The Geographical Concept of Mountains in the Qur'an, which claims that there are no contradictions between the explanations of mountain formation contained in scientific studies and those contained in the Qur'an.

In addition, Na'ik (2001) declares, 'The scientific evidences of the Qur'an clearly prove its divine origin (…) and the Qur'an contains a complete code of life for the individual and society'. He plainly believes in the compatibility of science and the Qur'an. His book The Qur'an and Modern Science, Compatible or Incompatible, provides many examples in which Qur'anic verses refer to phenomena that were later proved by scientific research and experiments. On the astronomical front, he discusses verses that proved that the Earth is circular at a time when people thought that it was flat. According to Na'ik (2001), the verse about the alternation of day and night is a clear indication that the Earth is circular and not flat or any other shape.

However, Guessoum (2008) argues that the idea of science in Islamic studies is not clear and does not have a definite meaning, as the word that is used to refer to science in Arabic, 'ilm', did not have the same significance that it has today. He adds that some orthodox Muslim scholars go as far to indicate that the definition of science should include 'religious sciences' as well as natural sciences (2008, p. 416). But, not all scholars have the same view. Some argue that there is a clear difference between 'science' and 'ilm', with the latter meaning knowledge in general rather than only science. Guessoum (2008) briefly explores one disagreement among scholars about the meaning of the word 'ilm'. The object of this disagreement is whether the contemporary significance of science matches the old Islamic meaning of 'ilm'.

Regardless of the controversial nature of the definitions of the terms and the various dimensions and aspects of science in Islam, the Qur'an encourages and motivates Muslims to think and reflect from inside themselves about their external world and their beings (Dallal 2010). Seeking knowledge is in line with the Qur'an and Islamic teachings because this knowledge is evidence of God's creation and brilliance. In addition, Dallal (2010, p. 113) argues that certain types of knowledge are considered 'collective religious obligations'. Besides fulfilling the obligations of praying, giving alms and fasting, Muslims are asked to have enough skilled people in each field of knowledge. For example, each Islamic community

should have enough physicians, teachers and those skilled in the other indispensable areas of life (Dallal 2010).

Masood (2017) also emphasises the important role of Islam in encouraging and supporting the pursuit of knowledge. By referring to the fact that the Prophet Muhammad often highlighted the importance of good health and urged people to seek medical treatment, Masood clearly shows Islam as a religion in favour of science, learning and acquiring knowledge.

Afridi (2013) notes that Islamic teachings through the Qur'an place much importance on searching for knowledge and learning. Ancient Muslim scholars were very much convinced that there is a duty and a divine instruction to be absorbed in science. Afridi makes a very important reference to the fact that the Qur'an begins with the word 'Read', followed by verses that state that God taught humans what they did not know and verses that speak about knowledge (Afridi 2013).

2.8 The Achievements of Muslim Scientists

After all the interest in the scientific and cultural works of other important civilisations and their translations into Arabic, it is natural that many Muslim and Arab scholars and scientists achieved brilliant, significant discoveries and made contributions in all fields of knowledge. Several were able to seal their names in history permanently after reaching unprecedented findings in most scientific branches and disciplines.

For example, Masood (2017) argues that although the legacy of Islam in early times may be controversial regarding its contributions to the various areas of science, in mathematics, Islamic scientific contribution is not small nor a subject of disagreement. He notes that the numbers used the world over today in all areas of daily life are called 'Arabic numerals' because they were developed by Muslim scholars speaking and working in Arabic.

In addition, algebra, a mathematics discipline developed by al-Khwarizmi, is considered one of the most useful tools in mathematics, facilitating our lives and forming the basis of most scientific disciplines. al-Khwarizmi is regarded as one of the most famous figures of Arab mathematics. His efforts in clarifying the Indian numbering system—which later became known as the Arabic system of numbers when al-Khwarizmi passed it on to Europe—are regarded as one of the most important contributions to humanity. Afridi (2013, p. 49) also discusses this mathematician's contributions, arguing that the words 'algebra' and 'algorithm' derive their names from this, and adds that some of al-Khwarizmi's books were translated into European languages and used in European universities until the sixteenth century as principal text books.

Despite his important work, al-Khwarizmi is not the only famous mathematician in Islamic history. According to Masood (2017), in eleventh century Egypt, Hassan ibn al-Haitham was

known as one of the scholars who created the basics of the integral calculus used to measure areas and volumes. His work and books on geometry, especially analytical geometry, number theory and the link between algebra and geometry, are also recognised by Europeans as having great significance (Afridi 2013).

In addition, among the Muslim scientists who left their mark on the world of mathematics, Omar al-Khayyam is highly regarded. In the early eleventh century, this scientist was able to calculate the number of days in a year. Masood (2017) notes that his calculations were very close to the contemporary calculations achieved by modern tools, which include radio telescopes and atomic clocks. al-Khayyam is also well known for his interpretation of Euclid's geometry theories.

Furthermore, mathematics was not the only scientific area in which Muslim scientists made great developments. The discipline of physics attracted their equal attention and interest. Afridi (2013) maintains that unlike the Greeks, who relied more on theoretical and philosophical understanding and analysis of the natural sciences, Muslims relied instead on experimentation to understand physics. For instance, Muslim scientists were the first leaders to understand the nature of sound and acoustics. They were the first to realise that bodies affect sounds and that these sounds move through the air in the form of waves. In addition, they led in dividing sounds into various categories.

With regard to physics, al-Beruni, a Muslim physicist, was able to identify the specific density of 18 types of stone (Afridi 2013, p. 50). He also calculated the ratios between the densities of gold, silver, lead and bronze, among other metals. Afridi also notes that Mansour al-Khāzini was an unparalleled physicist, particularly in the areas of dynamics and hydrostatics. His theories, among them the Theory of Obliquity and Inclination and the Theory of Impulse, were applied by schools and universities in the field of kinetics until the modern era (Afridi 2013).

Important Muslim scientists and scholars worked in nearly all areas and disciplines, and it is beyond the scope of this review to include them all, but in addition to the aforementioned, there are two important areas in which Muslim scientists did wonderful jobs: chemistry and medicine.

In chemistry, several famous scientists have been mentioned by historians, of whom Jabir ibn-Hayyan appears to be one of the most influential (Masood 2017). He was well known for important contributions in alchemy, which he explored extensively, seeking to go beyond transmuting other metals into gold.

Medicine is definitely another field on which Muslim scientists left their mark, including such scholars as ibn-Sina, al-Razi and al-Baitar, who cannot be overlooked worldwide, especially by medical students or others interested in the field. For instance, ibn-Sina (980–1073) is regarded as one of the greatest Muslim doctors. Known to the West as Avicenna, ibn-Sina's famous book, Al-Qanun fi al-Tibb, was commonly used in Europe as a textbook for more than

70 decades (Afridi 2013). His contributions in pharmacology and public health are well recognised, including his ability to determine the communicable nature of tuberculosis and some other diseases.

Another famous Muslim physician, al-Razi also known as Rhazes, is known for his medical achievements and for continuing the works of scientists before him and for improving their classification systems. Masood (2017, p. 159) states that in this respect, he 'emphasised the need for proof by experimentation, and refined the raw processes of distillation, evaporation and filtration'. According to Afridi (2013), al-Razi was appointed several times as the head of hospital in Baghdad. In addition, his achievements included developing a treatment for kidney and bladder stones and being among the first doctors to assess the side effects of therapies by applying them to animals.

2.9 Conclusions

We could go on in providing references to the history of Islam's engagement with science. However, it is enough for now to establish that there is nothing inherent to this religion's history that precludes it from fostering the quest for scientific knowledge or embracing fully the scientific method. In this sense, Islam is not in itself an obstacle neither to science communication or science in general. On the contrary, if one considers history and a variety of theological interpretations, one would need to acknowledge that there has been a supportive tradition in these societies in relation to knowledge-seeking through evidence by the many religious texts encouraging learning and teaching knowledge, that resonates today. Arab societies are predominantly religious in nature. However, they also are nation-states born from the drawing of boarders and the clash of interests of Empires. They are hybrid formations that reflect a variety of forces that over the years have defined culture and politics. Furthermore, the way Islam is understood today by many in these societies is a very modern phenomenon (Gray 2007, Sayyid 2014).

There is ample evidence that the Arab world wants not only to eradicate illiteracy but also to engage with science in more comprehensive ways. Even in very closed regimes, the overall engagement with science is prolific and so the initiatives to make all its citizens more engage with science in general. Yes, journalism as a political institution faces important restrains in its professional autonomy and challenges are very present in relation to the ability of individual reporters to cover effectively science. However, this cannot be attributed to religion but instead understood as a complex setting forged by history, politics and culture.

Chapter 3 Arab Science Journalism

3.1 Introduction

Journalism in the Arab world has been focussing mostly upon reporting the continuing diplomatic crises and wars in the region (Pintak and Ginges 2008). Issues such as the Israeli occupation of Palestinian territory, the growing tensions with Iran and around human rights violations in the region capture the attention of both reporters and academics studying journalism in the Middle East. In many ways, it broadly reflects societies that often go through political unrest and which constantly face security issues. It is, therefore, not surprising that so little attention has been paid towards other areas of news reporting, particularly to science journalism, which seems not to be a popular field in the Arab world among news media outlets, nor has it received sufficient attention from scholars.

So, the question remains as to why should we, given the above context, pay attention at all to this particular newsbeat? The answer comes down to two facts. Firstly, that science as a whole is quintessential to the modernisation of societies that hold political institutions strongly defined by religious and cultural context. Secondly, that science journalism is in itself central in creating links between these societies and the pursuit of knowledge. This is not to say that science journalism deserves attention because of its potential to help modernise society -although it played an important role in helping professionalise and modernise news institutions and news values in the Global South (Lugo-Ocando 2018) but to underline the role it can play in helping the Arab world develop a type of journalism that can serve its people well within existing circumstances and contexts in the region.

So, let us start by pinpointing that the multiple challenges that this particular newsbeat faces today, including the shortage of competent science journalists in most Arab countries, should not be solely attributed to aspects such as religion and culture. Instead, we should acknowledge how the imposition of modernity as a legacy of colonialism and the Cold War also helped generate the types of tensions and limitations that science journalism faces today in the Arab World. Moreover, given the actual historical legacy of the role of science in these countries. Needless to remind ourselves that in the Middle Ages when Europe had relegated science to a dark corner, it was the Arab world, in the height of Islam, that actually kept technology and science alive and allowed the knowledge transfer from the ancient world into Europe while also creating new contributions that fuelled the Renaissance and later the Enlightenment (Masood 2017).

The need to historicise this discussion has become a necessary dialectical exercise in the present, given the preconceptions and quasi-axiomatic assumptions around science communication in the Arab world. This need for contextual history is also one that allows us

to understand science journalism in the region, not only as a post-colonial construction that intends to mirror the West (Schudson 1978), but as a political institution in its own right that has a long and rich history of science communication that dates back centuries and that over the years has linked these societies and knowledge in ways that would take many centuries for Europe to reach. It is not my intention, of course, to romanticise either religion or cultures of the past but to show how the imposition of modernity by means of colonial rule and the Cold War - particularly in the aftermath of the dissolution of the Ottoman Empire, had an equal stake in creating the problems that science journalism in the Arab world confronts today (Lewis 1980, Vorderstrasse 2014, Levy-Aksu et al. 2017).

In light of the above discussion, we need not only to provide some history of science journalism in Arab countries -incorporating link between Islam and science- but, additionally, to explain the context in which present political institutions in the Arab world, including journalism, are a reflection of history, politics, cultures and disruptions created by modernity itself while acknowledging why this matters to the present and future of science journalism in the region.

3.2 The Emergence of Arab Science Journalism

Despite the fact that it developed along with other newsbeats in the Arab nations, science journalism grew more modestly and slowly than other newsbeats in the region. It started with science publishing in a time in which ‘science in general was dominated by books and not journals’ (Kuhn 2012). One of its first recorded manifestations was the Bulaq printing press. Established in 1821 in Cairo, it made a significant contribution to the popularisation of science. It ran until the middle of the nineteenth century, publishing nearly 100 books, which helped disseminate important works among the general public. It was followed by Al-Waqa'i' al-Misriyya, which in 1828 effectively became the first magazines devoted to spreading science in the Arab world (Sidqi 2009, p. 177).

The first attempt at scientific news in the press began with the Egyptian newspaper Al-Ahram in the 1950s, which published some scientific subjects and translated scientific news (El-Awady 2009). This news was presented by Egyptian journalists, most notably Fawzi Sheiti and Mahmoud Abdul Aziz, who had the scientific stories translated from English and French to Arabic. In 1954, Salah Jalal, the pioneer of modern scientific journalism, started a new school in an Al-Akhbar newspaper based on simplifying science to educate the community. He then moved to Al-Ahram in the early 1960s and formed a team of scientific editors in collaboration with Mohamed Hassanein Heikal, editor-in-chief of Al-Ahram (Badran 2014).

In 1980, the first Egyptian Association of Scientific Writers and Editors was established, a group that included all scientific editors, media outlets and writers concerned with the issue of simplifying science. The society, headed by Salah Jalal, conducted studies on the role of

scientific media in Egypt and investigated ways the media could improve the development of scientific culture in Egyptian society. Then, in 1993, the first association of environmental writers and editors, chaired by the journalist Salama Ahmed Salameh, was established (Badran 2014). The association included the editors responsible for coverage of the environment at Al-Ahram and other Egyptian newspapers and magazines, and it aimed to shed light on pressing environmental issues at the local and international levels.

More recently, several organisations have begun to be established in order to support science journalism. One of them is the Arab Science News Agency, exisitng in the form of an electronic portal on the World Wide Web. It is managed by the Arab Science and Technology Foundation (ASTF), in association with the Technical Magazine. The project was launched in the form of an electronic portal on the Internet on the 28th of October, 2008 on the sidelines of a conference on the prospects of scientific research in the Arab world, which was held in the city of Fez in Morocco. Among its most prominent objectives was to bring old scientific news from various fields in the Arab world to the Arab citizens in particular, in a clear and easy Arabic. However, the agency faced some difficulties, such as the scarcity of Arab scientific media outlets possessing both the media talent and the scientific background, as well as the problem of the Arabization of terms by journalists (Hamwi 2009).

Another organisation is the Arab Science and Journalist Association (ASJA) which is a regional Arabic, non-profit network that aims to develop the field of science and technology in the Arab world through developing the scientific Arabic mass media and its role in the fields of technology and science. There are also other organisations worth mentioning, such as the World Federation of Science Journalists (WFSJ), which is another programme aiming to develop Arab science skills.

Overall, the Arab world nowadays presents a sophisticated institutional framework for how science journalism operates. This framework includes, as we have seen above, several organisations that support and educate science journalistic practices across the region. These institutional frameworks are the result of history and politics, which - to be fair - have also defined the rest of these societies as is the case for each of the countries I have included in this study.

3.2.1. Science Journalism in Egypt

Until recently, and despite years of colonial and military rule, the Egyptian press was considered by many to be more progressive than other Arab newspapers, particularly in its ability to engage with important issues and develop newsbeats. Part of the reason for this, is that it merged successfully a tradition of ‘street discussion’ (Saber 2013) and an adaptation of the colonial press to its own context.

With regards to the scientific press, according to some authors, Egypt has passed through four historical stages (Saber 2013). The first stage, also known as the functional stage, was the period from the First World War until the late 1920s and represented the childhood of Egyptian scientific journalism. The reporting of science in general newspapers, such as Al-Ahram, was functional and did not enter into criticism or analysis, nor was it considered a tool for education or enlightenment.

The second stage was one of prosperity and the emergence of the critical trend. It developed from the 1930s until the end of the Second World War and represented a period of prosperity for the scientific press in Egypt. During this time, a number of cultural and scientific newspapers were published that, in responding to the interest of the Egyptian public, used science to address culturally relevant questions. In this sense, publications led by reformers such as Salama Moussa and Ismail Mazhar abandoned the scientific commitment to neutrality towards the social, health, political, and cultural problems of Egyptian society (Saber 2013). This was in a way a return to the Islamic legacy, which promoted a critical engagement with science in the broader context of challenges in society.

During this period, the scientific press expressed progressive ideas that brought it into conflict with the reactionary and conservative forces in Egyptian society at that time. This conflict led to the disappearance of these newspapers by the end of this period and other newspapers which survived the backlash preferred not to enter into such battles. Moreover, the intellectuals who carried the banner of spreading scientific thinking among the public withdrew from the press a legacy that even today helps partially explain the reluctance of many scientists in the Arab world to engage with the media.

The third stage was one of intellectual regression and repression. During the post-World War II period, from the mid-1940s until the early 1950s, scientific journals were battered by the changes that affected most Egyptian intellectuals. It was during this period that the scientific publications of Mazhar and Moussa came to an end, and the situation returned to one similar to the first stage of infancy. The hindering of the Egyptian scientific press during the 1940s was the direct result of stricter laws, censorship, and the circumstances of the war. Although some Egyptian intellectuals also blamed the public, which seemed to have abandoned them in their battles for Enlightenment (Saber 2013).

The fourth stage or ‘survival stage’ came last and reflected the post-War II and Cold War political landscape. During this period, science publications in Egypt continued to engage with societal issues and problems but by then had toned down criticality or cultural and social engagement between science and society. In exchange for preservation and continuity, they abandoned the intellectual and philosophical aspect of their scientific presentation, and once again went back to performing a straightforward science dissemination function. At the same time, newspapers dedicated to the cultural significance of science ceased to be published and

critical engagement with knowledge and its relevance to society disappeared. The general press became 'responsible' for the introduction of science to the public but in a way that lacked the depth and the philosophical and theoretical aspects that the cultural magazines had once offered.

In this stage, scientific topics became increasingly practical and decontextualized. For instance, science news favoured topics such as astronomical phenomena related to weather conditions and scientific discoveries. In doing so, science journalism in the Arab world followed suit with its western counterparts and became all about 'practical links to daily life' as a way to gain relevance (Nguyen and McIlwaine 2011). Science news became, therefore, 'objective' and deprived of meaning and relevance to societies for which knowledge has historically been a way of challenging power structures.

I argue that this conundrum was not only a product of the new political landscape but also a direct result of 'westernisation'. By this I mean, that by embracing the notion of objectivity in order to survive, not only science journalism became stripped of its intellectual and critical philosophical context that once allowed it to be a part of change and reform in the region. In addition, the professionalisation of science journalism translated into sidelining scientists as intellectuals in the public and media spheres, something that in the past Islamic societies had allowed but that the new rulers did not. Hence, the emergence of editors of scientific journalism with little or no academic backgrounds in the fields of natural and applied sciences or who are unable and unwilling to take science to society as a space for wider discussion cannot be seen just as an isolated issue but needs to be assessed as a greater historical problem in these societies.

3.2.2. Science Journalism in Kuwait

In addition to the lack of scientific news, especially in Saudi Arabia and Kuwait, there is also a scarcity of research related to scientific journalism in these two countries. As was the case of other Arab countries, the beginning of the scientific press in Kuwait was very modest (Alyan 2012). Several other factors contributed to the delay in the development of the scientific press in Kuwait, which include an underdeveloped educational system and a lack of economic resources, as well as a delayed national independence (Badran 2014). In the last decades of the twentieth century, the media in Kuwait followed the global trend towards the allocation of media to suit the interests of different segments of society, especially in the fields of sport, economics, and culture. In this context, scientific writing in the Kuwaiti media has begun to appear in the scientific sections of daily newspapers. For example, the Kuwaiti daily Al-Rai ran a weekly page dedicated to the environment in 1995, but the page was suspended a year later. The daily Al-Qabas ran a two-page environmental supplement entitled "Our Environment,

Our Lives." The scientific pages of the Kuwaiti papers dealt primarily with technology and agriculture (Alyan 2012).

According to Badran (2014), science journalism is rare and low quality in the State of Kuwait for several reasons. These reasons include a lack of interest in science in Kuwait compared with economic, sports, and cultural news. The late establishment in the country of scientific institutions or research centres concerned with theoretical and applied sciences also plays a role. In 1990, specifically after the Iraqi invasion, officials in Kuwait felt that there was a need for a new philosophy in the internal media, where the restrictions on the newspapers were reduced and the policy of openness and dealing with the international media became a new vision (Badran 2014).

3.2.3. Science Journalism in the Kingdom of Saudi Arabia

The publication of scientific news in Saudi Arabia, as with the other Arab countries, had a modest start (Al-Qafari 2009). The history of the Saudi press dates back to 1924, when Umm al-Qura, the first Saudi newspaper, was published. In its early stages, the Saudi press faced many physical, cultural and social difficulties. At the beginning of the 1950s, the press was the press of individuals. By the end of the 1950s, the merger phase was introduced as newspapers were encouraged to merge with each other. This stage continued until 1983, when the system of press institutions was promulgated. There was a paucity of scientific news that coincided with the Saudi press at the beginning, specifically with regard to spreading awareness and education about some of the diseases that were prevalent at the time (Al-Qafari 2009). After a period, interest in scientific news increased in the Saudi newspapers through its publication, such as stories concerning health, the environment, and information technology, in addition to following up on scientific conferences. Currently, there are scientific pages in some Saudi newspapers produced on a weekly basis as well as reports on the subject of science.

Al-Qafari (2009) study about science media in Saudi Arabia found that some Saudi newspapers allocated daily or weekly pages to publishing scientific news and many other Saudi newspapers published either regularly or irregularly. Only 20 per cent of all news articles fall into the category of scientific news. Health news, at more than 60 per cent of scientific news, dominates the other topics. There are no specifically scientific sections in Saudi newspapers, but the scientific editor is responsible for other sections of the newspaper. The Saudi press is not concerned about the qualifications or training of scientific journalists, who have little experience: there are no specialists in scientific writing. Saudi newspapers rely on freelance editors from outside the newspaper who edit scientific news. Journalists writing scientific news are not expected to abide by quality standards. Nevertheless, the presentation

of scientific news tends to be simple and easy for readers to understand, which is characteristic of the Saudi press.

The current context of journalism in the Arab world reflects history, politics, and cultures created in the past. Non liberal regimes in Arab countries impose tight control over the media through draconian regulations and censorship (Rugh 2004, Mellor 2005, Sakr 2007). In doing so, these governments not only aim to control freedom of expression to ensure that what is published and broadcast to the public is in line with the government's objectives (Sakr 2007, Mellor 2011) but also to silence any alternative voices to the official narrative by undermining the individual ability of journalists to perform their work independently.

Likewise, events are often exploited by the authorities in the Arab world to restrict press freedom. For example, after the September 11, 2011, terrorist attacks in New York and Washington DC, many emergency and antiterrorism laws were enacted along with other vaguely defined pieces of legislation that provided these governments with the power to limit the publication of news and commentary that may be considered a threat to national harmony (Rugh 2004). Despite the political change in Egypt, the media has continued to be mostly a mouthpiece of the government (Bebawi 2016).

Politics is considered the most important factor affecting the media in the Arab region (Hamdy 2013). Despite this, many Arab newspapers still largely depend on governmental funding (Rugh 2004), and they and their owners are deeply dependent on subsidies, government advertisements and particular contracts that make up the economy of these organisations. For example, in Egypt, the government can put economic pressure on private newspapers via its agencies and the organisations they control — such as publicly-owned enterprises — that contribute a great deal to these newspapers' revenues. Moreover, the Egyptian government controls the Supreme Press Council, which determines the distribution of advertising (Rugh 2004). Consequently, some newspapers may be compelled to give up their credibility and accuracy in the transmission of news, especially with regard to science news.

The problem of weak science journalism in the Arab world is a historical one. In the past, there was no interest in science journalism in the manner required by governments and newspapers in addition to the lack of interest of some members of the public in science journalism to the present day. Science journalism in Arab societies remains weak in terms of producing science news, and most of the science news published in Arab newspapers is taken from the Western media and international agencies (Al-Qafari 2009). The reasons for the weakness of science journalism in the Arab world are many; they include the lack of specialised journalists, the scarcity of science journalists and the general lack of knowledge about science (Al-Qafari 2009, El-Awady 2009). Politics and religion play a part, but it is the reasons stated above that really underpin the limitations and constraints of science reporting.

3.3 Problems of Arabic Science Journalism

Having established that science journalism has roots in the Arab world, it is of the utmost importance to investigate the current state of science journalism in the Arab world in general. Overall, as we have seen here, the Arab scientific press suffers deficiencies in several aspects. There is minimal scientific content. The volume of scientific information that appears in the Arab media is slight, if not negligible when compared to the reporting of scientific information worldwide, and when considered in light of the size of the Arab media establishment (El-Awady 2009). Specialized scientific publications either do not exist or are so few they could be counted on the fingers of one's hands. Though Egypt is one of the largest countries in the Arab world, the space its daily newspapers and weekly or monthly magazines allocate to science is small, and often the Arab reader puts off turning to the scientific pages or skips them altogether (Mehran 2018, p. 101).

The credibility of scientific news is also one of the problems facing science journalism in the Arab world. Mahmoud (2018) study on public attitudes towards the credibility of scientific and technological news in Egyptian newspapers and electronic media found that science and technology news is found to be less credible on average than other types of news, though electronic newspapers are perceived as more credible than printed newspapers.

Another obstacle facing science journalism is a more general matter. Several media outlets are owned by the state. Consequently, many journalists offer coverage that is uncritical of governmental output. This can be clearly seen, for instance, in Egypt's coverage of the outbreak of the swine flu. As a result of a presidential decree, all the pigs of the country were killed, even though there was no evidence of the virus in these animals. Before the epidemic hit the country, Egypt's Minister of Health at the time, Hatem El-Gabaly, asked people to perform prayers and take university exams in open spaces rather than in the mosques. Uncritical reporting of these policies by Egypt's media resulted in unnecessary fear among the general population (El-Awady 2009).

Because of the absence of studies and surveys identifying the level of scientific awareness among the public, those working in the field of scientific media are addressing an audience that they know nothing about (Abu Haseera 2018, p. 85). Besides the problems of quality and quantity, scientific journalism must contend with the confusion between science and religion, as well as the associated spread of superstition and false science (Saber 2013, p. 192).

The journalists involved also possess weak science backgrounds. The practitioners of scientific journalism in the Arab world suffer from poor professional performance. As Sidqi (2009, p. 26) discusses, this weakness is manifested in several ways. For instance, Arab journalists are unable to read scientific material in foreign languages, and they do not have the ability to translate it into Arabic. Scientific articles written by journalists are unclear and not

simple enough to be understood by non-specialists. These matters are complicated by other factors. These include poor command of English, scarcity of scientific sources in Arabic, limitation of the information available and a weak contribution to international events. What is worse is that some journalists and those involved in scientific fields in the region seem to trust the Internet and regard it as a reliable source of information (El-Awady 2009).

Moreover, poor editing of these articles, as well as exaggerations based on underestimating the intelligence of the reader, cause them to become boring and longer than they need to be. The reader's confidence in the scientific news found in newspapers is weakened by the use of non-scientific sources and by how quickly the stories are produced. Journalists are not fully supported by their organisations in investigating and publishing stories beyond politics and sports. Also, it is difficult for reporters lacking professional skills to find good local experts and scientists willing to inform them (Lublinski et al. 2014). Journalists who regularly cover science, health, environment, and technology in Africa and the Arab world face a number of difficulties, such as the lack of elementary resources for journalistic research and the existence of newsroom environments that are not always supportive of specialised reporting (Lublinski et al. 2014).

Historically, the Islamic religion has played a major role in the Arab region. Indeed, the vast majority of the population in each Arab country embraces Islam and is thus influenced by the religion's rituals. Analyses of the Arab media must always consider the role of Islamic culture (Rugh, 2004). In addition, as Mellor (2005) points out, the Islamic religion plays a fundamental role in defining journalistic practices in Arab countries. There are assumptions in the West that the Arab world in general and its press in particular have problems with freedom of expression because the Arab world follows the Islamic religion (Merskin, 2004). These assumptions suggest that the solution to the problems in the Arab press is to abandon the Islamic press (Lind & Danowski, 1998).

Of course, one must acknowledge that the Islamic religion plays a key role in influencing journalistic practices because the jurisprudence and institutional framework in the Arab nations derives from it. The argument goes that news reporters are limited in their actions and constrained in their deontology by the effects of the moral impositions deriving from institutionalised faith.

Journalists in Arab countries may be afraid of a religious backlash, especially from religious leaders, who have great influence, even on the rulers of states, and therefore these journalists do not publish, and sometimes even hide, information on certain sensitive topics. Awad (2010) suggests that Islam has affected the Saudi government through its religious leaders, whose power stems from their role in legitimising or delegitimising the government's political acts by issuing fatwas, or 'religious rulings'. Consequently, Arab newspapers are prone to pressures from religious leaders when disseminating news (Al-Kahtani 1999).

Religious leaders influence Arab governments, which then produce legislation that incorporates further restrictions on what journalists can say and do. They exert a major influence on journalistic practices in the Arab world. Sometimes this effect is negative. The influence of these leaders on public opinion regarding issues relating to the interior, especially in Saudi Arabia and Kuwait, extends to closing newspapers as well as prosecuting and fining them. Thus, newspapers sometimes try to avoid clashing with religious leaders by declining to publish some information. The journalist is the weakest link in the newspaper and may be fired, fined or even imprisoned to satisfy religious leaders. Thus, we find that journalists always take into account the reactions of religious leaders before reporting information.

There are a number of assumptions in the West about the Arab world's press. As I explained before, limitations on freedom of expression are often attributed to Islam (Merskin 2004). This assumption is common among some Western voices, which suggests that abandoning religion and embracing secularism will enhance these societies' ability to bring about modernity (Lind and Danowski 1998, Lewis 2009). However, these views are far from subtle and lack the understanding of the deeper and more complex context of history and politics that we have discussed here. Bringing Enlightenment to the Arab world is often assumed as breaking the separation between religion and science. Hence, somehow reproducing the history of Europe in the Middle East. However, the problem with this assumption is that for centuries the Enlightenment was imposed upon the Arab world through colonialism and military interventions.

The support for particular political regimes, the military interventions and the creation of the state of Israel in 1948 have become both an effort by the West to impose modernity in the region and a destabilizing force that has hindered the development of more stable political institutions. The radicalisation of religious and political fanaticism, as the aftermath of the 2003 Iraq US-led invasion showed, is more the result of a backlash against modern imposition than of connections to the original Islam. The problem, therefore, has never been Islam but how the backlash of history in the region created the grounds for authoritarianism. Islam, on the contrary, has a rich history of engaging with science. As then US President Obama, in his June 4, 2009 speech in Cairo, highlighted, this religion has made important scientific and intellectual contributions to civilization,

> *It was Islam that carried the light of learning through so many centuries, paving the way for Europe's Renaissance and Enlightenment. It was innovation in Muslim communities that developed the order of algebra; our magnetic compass and tools of navigation; our mastery of pens and printing; our understanding of how disease spreads and how it can be healed (Ofek 2011, p. 3).*

The problem is more how the West tends to interpret religion in the rest of the world through the lenses of its own secular/religious dichotomy. Since in the West the Enlightenment in Europe is interpreted as a revolt against religion, it is believed that this dichotomy must be also definitive in other societies. This essentialised assumption sees the divorce between Church and state as fundamental for human rationality. Unlike Christianity, however, especially in the medieval ages where religion was manipulated and used to serve the interests of the priests and the clergy as well as fighting science (Van Engen 1986), Islam always encouraged the scientific quest for knowledge (Masood 2017). The European Enlightenment, on the other hand, was interpreted by Immanuel Kant - who later became very influential in the philosophy of Western journalism- as the moment that Europe acquired adulthood and left behind ignorance,

> *...man's emergence from his self-imposed immaturity. Immaturity is the inability to use one's understanding without guidance from another. This immaturity is self-imposed when its cause lies not in lack of understanding, but in lack of resolve and courage to use it without guidance from another. Sapere Aude, 'have courage to use your own understanding', that is the motto of enlightenmetnt(Kant,2013,p1).*

Indeed, most scientific thinkers in Europe in the Middle Ages were limited by religion and their work and efforts were directed to serve the purpose of proving God. Many scholars were restricted in challenging the positions that the Catholic Church had adopted on issue (which is why Galilei, Nicolaus Copernicus and Giordano Bruno clashed with it). They had to refer only to religious sources, such as the Bible and the book of the Church Fathers. In other words, they were limited by the confines of the religious circle and the authority of the priests (Lindberg 1980). Scientists were not able to consult the sources they desired, and their freedom of research was constrained. In this sense, the Christian religious authority at those times hampered the progress of science and created obstacles for researchers, especially when knowledge threatened the interests of the priests and challenged their authority and power.

On the other hand, Islam encouraged science and scientists because it never had a position on the natural world other that it was created by Allah. It supported the quest for knowledge and valued scholars and researchers because this did not threaten its centrality in society. In this respect, Muhammad 'Abdu -one of the famous thinkers of the reformist movement- believes that Islam and modernity are compatible (Najjar 2004). The idea of the existence of God is already decided, and there is no discussion among Muslim scholars and scientists about it, unlike the Christian scholars and scientists of the Middle Ages in Europe who had to go against a whole explanation of the natural world -i.e. that the sun gravitates around the earth- to which the Church was fixed into. To be sure, in the Dark Ages science in Europe had

to confine itself to Rome's worldview. It meant bowing rationality to religious and political power, something that scientists in Islam had not to face. Islam encouraged thinking and exploring beyond religion and did not tie scholars to refer only to the existence of God (Van Engen 1986) despite having a similar eschatology to Christianity. However, contrary to the Catholic church, Islam was a decentralized faith which did not impose a dogma on the natural world.

Today's flaws in scientific journalism in the Arab are not as Orientalists and apologists for colonial rule under the guise of civilization would want us to believe a result of religious imposition but of predetermined agendas set by history and politics (Fatih 2012). Contemporary Orientalists nevertheless persist on an image of Muslims and Arabs as irrational blinded by faith. They not only ignore the influence of imperial powers but they praise it as a modernizing force rather than recognizing the damage it inflicted in these societies and others around the Global South (Sayyid 2014, Tharoor 2018).

They also obviate that the European Enlightenment was imposed upon the Arab world in parallel to conquest and colonialism (Losurdo 2014). Having said that, Al-Tahtawi, the pioneer of 'tradition of Enlightenment', was influential in transferring the liberal thought of the French Enlightenment to his Egyptian compatriots and he believed that Islam does not contradict the values of enlightenment and reform (Najjar 2004). According to some observers, the Enlightenment as a political project was imposed on Islamic societies' particular ideologies linked to modernity and liberalism. Domenico Losurdo (2014) reminds us that the history of the Enlightenment, as a political project, with its appealing promises of progress and freedom for the European white man of the North, is one that also comes with a heavy baggage of slavery, imperialism and colonial rule in the Global South. Indeed, this is one of the reasons for the backlash in the 20th century in the Arab world against modernity.

Several religious and non-religious scholars have shed light on this problem of imperialistic manipulation and false accusations of Islam being against the values of modernity and development, often hidden under the cloak of political and colonising goals. In other words, religion itself, without manipulation and biased interpretation, is in tandem with the principles of the pursuit of knowledge and scientific development. Therefore, the problem lies in the understandings and interpretations of the religion and the way it was employed to serve certain goals and agendas. It is clear in the light of unbiased and objective investigation of the relation between science and Islam that this religion is not hostile to illuminating and progressive ideas regarding the quest for knowledge (Di-Capua 2015).

3.4 Improving Science Journalism

It is worth noting that any possible improvement to science journalism will be conditioned by the political, cultural and religious context. Hence, the main question is Western normative aspirations for journalism should be expected for places such as Egypt, Saudi Arabia, and Kuwait. This might not be possible in the current political context. Therefore, there may be a need to reassess professionalism for scientific journalism in a way that that allows reporters in these countries to produce true, engaging, and critical news stories, while taking into consideration the fact that there will be operating within constrains and limitations (Ayish 1998).

Regardless of the normative aspirations, it is clear that there is much work to be done in order to improve the performance of scientific journalism in the Arab world. Journalists themselves are in need for specialization when it comes to covering science. There is a need of knowledge and skills that can contribute to the development of the news beat as to make it more accurate, comprehensive and critical (Mbarga et al. 2012). In addition, financial support should be provided by governments and organisations to encourage and motivate science journalists whose goal is to promote and transfer scientific information to the public and then to raise awareness in society regarding scientific topics (El-Awady 2009).

Another solution is to create a database that helps scientific journalists access sources of information anywhere in the world to verify data integrity. Furthermore, enhancing and improving the relationship between journalists and Arab scientists is helpful. Likewise, providing the resources and material will enable the journalists participating in scientific journals to search for scientific information correctly, which can be advantageous.

3.5 Conclusion

This section has examined the question of science journalism in the Arab world in the context of its history and political landscape. Given the divisive and debatable nature of the relationship between religion and science in general, particular attention has been paid to distinguish between the conceptualisation of religion itself and the way it is interpreted or understood by different parties. Despite some common points between Christianity and Islam, the historical development and evolution of each religion and the interactions of their followers were different. Most notably, Islam did not fight science and scientists the way it was fought in Europe in the Dark Ages, especially by the Catholic Church.

This does not mean that Muslim-majority countries did not witness manipulation of the religion for political gains and power purposes. In fact, Muslim societies experienced in some cases greater challenge than Christian-based societies. But these challenges derived from history and politics, which gave way to complex political systems that oscillate between modernity and tradition but that at the end reflect structures and system that in many ways have been inherited from a colonial past and that persisted in a Cold War era in which the super power struggles for energy and resources in these lands.

Contrary to common assumptions, Islam as a religion encourages the quest for scientific knowledge and respect for science. If it stands today as an obstacle for reason, it does so under the light of modernity, which created a series of backlashes that created the conditions for abuse and misunderstandings around faith. In this chapter I have intended to provided a summary of these debates around faith and the secular, while using this as the background to explain how this influence the emergence of science journalism in the Arab world. In doing so, I have also tried to also equally discussed the major problems and obstacles facing science journalism in the Middle East while providing some ideas as to how to improve the situation of science journalism as part of my theoretical explanatory framework. Something which I am to test and explore in the following chapters.

Chapter 4 Methodology

4.1 Introduction

This chapter introduces the research methodology used in this study to explore the arguments developed in the theoretical explanatory framework presented in both the introduction and the literature review. In so doing, it looks at empirical evidence to assess assumptions, ideas and arguments under the lenses of deductive logics and reason. Hence, the methodology was developed with the theoretical context in mind so as to explore issues and areas that can inform and address the key research questions.

To do this, I applied various research strategies and collected data, which I later triangulated. The overall purpose was to understand how journalists engage and use statistics to report science news in the Arab media and to understand the challenges and opportunities they face in these countries (Egypt, Saudi Arabia and Kuwait), in the wider context of science communication. I am therefore explaining how this research is designed to address the research questions.

As I describe in the work itself, this was just part of a dialectical exercise to explore the greater issue of journalists' engagement with the dissemination of science and communication in the Arab world.

4.2 Research Methodology

The key research question of this study is: 'How do science journalists in three countries in the Arab region—Saudi Arabia, Kuwait and Egypt—engage with and use statistics when reporting science news, and what does analysis of this tell us about the professional autonomy of science reporters in relation to science communication in illiberal political systems'?

To answer this question, I analysed the cases of Saudi Arabia, Kuwait, and Egypt as they represented significant yet distinctive segments of the Arab population in that region. The idea was to offer a clearer understanding of the use of statistics by editors and journalists in the Arab region when writing science news by exploring the ways in which science journalists in these particular countries gather data and statistical information to articulate science news.

I then triangulated quantitative and qualitative data as a way of: "gathering information pertaining to the same phenomenon through more than one method, primarily in order to determine if there is a convergence and hence, increased validity in research findings" (Denzin 2012, p. 81). I was aware that triangulation may not be appropriate for all research aims, however, as Jick (1979) points out, it has important benefits:

Firstly, triangulation allows researchers to be more confident in their results; secondly, it can stimulate the creation of inventive methods, new ways of capturing the problem to balance with conventional data-collection methods; thirdly, it can lead to an enriched explanation of the research problem; fourthly, it can lead to the synthesis or integration of theories; triangulation may also help to the deviant or off-quadrant dimension of a phenomenon. Finally, it may also serve as the critical test by virtue of its comprehensiveness for competing theories (Jick 1979).

Following other similar research projects in this field, I managed to integrate both quantitative and qualitative data in my work, such as semi-structured interviewing and coding. The main reason for using triangulation in this study was because this approach allowed me: "the development of various pictures of the same phenomenon and provide a broader view" (Trumbo 2004, p. 420). Using statistics in science news needs to be analysed accurately, so triangulation was essential to this study: it can help to increase the accuracy of science news through methods such as expert panels and content analysis, and also create methodological richness and overcome potential biases. In addition, triangulation could contribute to a broader answer to the research question. In this study, triangulation was essential to analysing how statistics are used in science news and how journalists engage with statistics to articulate their news. The data was collected through analysis of newspapers, semi-structured interviews conducted with science journalists and editors, close reading, and an expert panel.

4.3 Research Questions (RQs)

The main research question of this thesis is, 'How do science journalists in the Arab region - Saudi Arabia, Kuwait, and Egypt - engage with and use statistics when reporting science news, and what are the key challenges and opportunities they face in doing so in terms of communicating science to the public?'

However, this is also broken down into more specific subsidiary questions, as follows:

1. How do journalists engage with statistics to articulate science news in the Arab region?
2. How do science journalists in the Arab region access statistics when reporting science news?
3. Do the statistics used by science journalists comply with principles of validity and reliability?
4. Do journalists use statistics effectively to communicate science?
5. What are statistics used for when articulating science news?

6. What are the identifiable capabilities in terms of education, training, experience and background that science journalists display when working with statistics?
7. What are the key factors impacting upon journalists' work in relation to using statistics in science journalism?
8. What challenges and opportunities do science journalists in the Arab region face when using statistics?
9. What is the purpose of science journalists and editors using statistics in science news?
10. What are the similarities and differences between scientific journalists in Arab countries (Egypt, Saudi Arabia, and Kuwait) in their use of statistics?

4.4 Research Design

Research designs were defended by Creswell (2013, p. 295) as: 'types of inquiry within qualitative, quantitative, and mixed-methods approaches that provide specific direction for procedures in a research study'. It contains analysis, data collection and interpretation. Generally, this was the scheme I used for carrying out the research. It has been argued that quantitative designs are extremely structured whereas qualitative designs are more flexible (Creswell 2013). In this study I used mixed-methods design because it allowed for a better incorporation of quantitative and qualitative research. I also chose it to overcome any challenges that might come from just adopting one approach.

Content analysis close reading was used in the study to understand how Arab journalists use and engage with statistics when articulating science news. Also, I used a control group to compare how journalists use statistics between Arab news and western news to identify whether or not the level of journalists in Arab countries was better or worse than that of western journalists. An expert panel in the use of statistics was used to comply with the principles of validity and reliability and to determine whether or not statistics were used effectively to communicate science news. Semi-structured interviews were conducted with science journalists to examine and understand, in detail, how journalists in the Arab region deal with statistical data when they report science news. The purpose of the interviews was to explore the difficulties or opportunities which these science journalists faced in their journalistic practices.

4.5 A Mixed-methods Approach

A single-method research design is not adequate to understand how science journalists in the Arab region engage and use statistics to report their science news. Therefore, to fully

understand the work of these science journalists, more than one research method was needed. According to Creswell (2014, p. 2), using a mixed-methods research design, with both quantitative data and qualitative data, provides a better understanding of the research problem than from just using one form of data alone.

According to Venkatesh et al. (2013), mixed-methods research is the gathering, analysis, and explanation of both qualitative and quantitative data within a study. Through combining quantitative and qualitative research methods in the same study, rich insights can develop into several phenomena of concern that cannot be fully understood using only a quantitative or a qualitative method (Venkatesh et al. 2013). Moreover, mixed-methods research may provide more valid inferences (Lund 2012, p. 157). According to Hesse-Biber and Leavy (2010, p. 279): “the combination of two different methods can create a synergistic research project in which one method enables the other to be more effective. Together, both methods can provide a fuller understanding of the research problem”.

As this study attempted to highlight several aspects regarding the use of statistics in science news among journalists, the mixed-methods approach has been deemed the most appropriate for this study, given the nature of individual journalists, the distinctive dynamics taking place in the newsroom, and the specificities of Arab societies.

4.6 Cross-national Comparison

The study was conducted across three Arab countries: Egypt, Saudi Arabia and Kuwait. These countries were chosen for several different criteria. They have the least freedom of the press, according to Reporters without Borders (RWB 2017). They have non liberal regimes, which control what journalists report; something that might affect the use of statistics in newspapers. An atmosphere for good journalism might not be present in these countries because of the political and cultural systems that dominate them. Many Arab countries, such as Syria and Somalia, come at the bottom of freedom of the press lists. These countries were not chosen because of instability or conflicts, or lack of data. On the other hand, some Arab countries have more freedom, such as Tunisia and Lebanon. My research did not cover these countries, but covered the outcome of science communication in Egypt, Saudi Arabia and Kuwait, because research has been done in countries where freedom of the press and expression exist, but not about statistics in science news in non-western countries where newspapers are under the control of the state.

Another reason is that these three countries are considered the best in the Arab world when it comes to spending in the science fields (Naush 2015). Researching science communication would help uncover how spending on science in these countries is reported in newspapers. My research brings awareness of and draws attention to the problems from the political and

cultural systems that dominate these countries. Conflict between Islamic movements and modernist movements is apparent and might affect the use of statistics in journalism. Therefore, these countries need a good science communication process.

The study was conducted across three different Arab countries, so it could carry out cross-national comparison. Elliot et al. (2016) define cross-national comparison as: “a set of techniques in which multiple nation states play a role as units of analysis. The researcher chooses the national units, aiming for contrast on certain features, whilst having others in common.” According to Bryman (2012), using this type of research might provide deeper understanding and insight into the phenomena.

The study examined the differences and similarities among Arab newspapers regarding the use of statistics by science journalists. There were some issues in relation to the cross-national comparison, which included intervenient variables that can also play a role in dealing with statistics in science news, such as the issue of freedom of journalism.3

4.7 Data Collection: Fieldwork Frame and Sampling Process

This study began with a review of the literature and an analysis of news content related to statistics from a specified set of organisations and individuals. This provided an initial understanding of the use of statistical data by scientific journalists in the Arab region and the nature of the relationship between journalists and sources of statistical information. The newspaper media archives that were visited in Egypt, Saudi Arabia, and Kuwait were those of: Al-Ahram, Al-Masry Al-Youm, Al Riyadh, Okaz, Al-Qabas, and Al Rai.

The research was undertaken in two stages. The first stage included content analysis, close-reading, and an expert panel, while semi-structured interviews were held in the second stage.

4.8 Data Sources and Analysis

The study collected science news in the sample study newspapers via the archives of those newspapers, which included science news within the chosen period. The analysis of quantitative data was carried out mostly using SPSS software, to process the dataset generated by the study in order to explore issues such as frequency, correlations and linear regressions, among others.

Data analysis is a process that transfers raw data into usable data. Data analysis has been defended by Hatch (2002, p. 148); according to him, data analysis is: a systematic search for meaning. It is a way to process qualitative data so that what has been learned can be communicated to others. Analysis means organizing and interrogating data in ways that allow researchers to see patterns, identify themes, discover relationships, develop explanations,

make interpretations, mount critiques, or generate theories. It often involves synthesis, evaluation, interpretation, categorization, hypothesizing, comparison, and pattern finding. It always involves what Wolcott calls “mind work”. Researchers always engage their own intellectual capacities to make sense of qualitative data.

The overall strategy was that each research strategy looked to address a particular question set in the methodology. In so doing, I was able not only to triangulate different aspects of the overall inquiry, but also to contrast and complement a variety of aspects, such as explanatory corollaries to initial observations. This allows journalists, for example, to reflect and comment on my findings about their own work.

4.9 Types of News

The study was conducted on science news, especially health technology news, from the Arab region. This is because heath news makes up the largest component of science news coverage in the Arab region newspapers. For instance, in Saudi Arabia, health issues dominate science news with a publication rate of 80%. Technology issues are at 18%, while environmental and agricultural issues were covered very rarely (Al-Qafari 2009, p. 199). In Egypt, health news is the most common news representing 36% of all science news (Al-Saber 2012). In Kuwait, health news is commonly considered more interesting than other science news as can be seen by the allocation of special health news pages in daily or weekly editions (Alyan 2012). Kuwaiti journalists covering health and scientific issues tend to be more accessible as this is often perceived as a non-political and neutral news beat that allows for self-reflection.

4.10 Content Analysis

The study looked at the newspaper content in three Arab countries (Egypt, Saudi Arabia and Kuwait). It analysed science news (health and technology news) from a quantitative viewpoint by checking the frequencies of the variables. It sought to provide valuable data on how Arab journalists engage and use statistics to articulate science news. The objective was to provide discourse on an overall amount of 32 variables such as: types of statistics, types of source reliability and interpretation, among others, for the purpose of obtaining a picture of how numbers are used in scientific news.

Content analysis was the first method used in this study, to examine whether the use of statistics in science news by journalists and editors is positive or negative. It looked at the content of science news by using content analysis on samples from the set of Arab newspapers. Neuendorf (2016, p. 10) defines content analysis as: “summarising quantitative

analysis of messages that relies on the scientific method (including attention to objectivity, inter-subjectivity, a priori design, reliability, validity, generalizability, replicability, and hypothesis testing) and is not limited as to the types of variables that may be measured or the context in which the messages are created or presented''.

'Quantitative newspaper analysis' was another name of content analysis, according to Krippendorff (2004, p. 7-8). In his book: *Content Analysis: An Introduction to its Methodology*, he pointed out that: 'several factors influenced the transition from quantitative newspaper analysis, which was largely journalism driven, to content analysis: analysts began to employ new statistical tools borrowed from other disciplines, especially from survey research but also from experimental psychology, and content analysis data became part of larger research efforts and so content analysis no longer stood apart from other methods of inquiry'.

Krippendorff (2004, p. 5) pointed out that: "quantitative newspaper analysis seemingly provided the needed scientific ground for journalistic arguments and led to the development of many valuable ideas". Content analysis can create foundational data, especially for research studies which lack information. For example, in Maier (2002) study about numbers in the news, he used content analysis to determine the extent to which journalists depend on mathematics to articulate the news.

This study examined and assessed whether journalists and editors used or misused statistics in science news through the four elements of: validity, reliability, absence and interpretation. Furthermore, it explored how science journalists accessed statistical sources for science news, by collecting a sample of science news stories that include statistical information from the newspaper sample study. The sample provided data to explore the ways that statistical information was used and presented in science news, and thus this will allow me to answer the research sub-questions No. 1 and No. 2 and to partially answer sub-questions No. 3 and 5.

In so doing, this study examined how statistical information is articulated in science news, which can provide information about how journalists and editors use statistics. It examined whether the statistics used are suitable to the narrative of the science news and whether they have been made sufficiently accessible by the journalists and news editors. This can, therefore, help us to answer research sub-question No. 3.

Overall, the purpose of the research strategy was to answer the main question by presenting further explanation of how Arab journalists use and engage with statistics when articulating science news. However, there is a scarcity of knowledge of how Arab journalists use and interpret statistical information when they produce science news stories.

4.10.1. Sampling

The sample is a systematic method for selecting a representative sample of a large population. Sampling, according to Krippendorff (2004, p. 84): 'allows the analyst to economize on research efforts by limiting observations to a manageable subset of units that is statistically or conceptually representative of the set of all possible units, the population or universe of interest'. The sample should be representative with the conclusions of the whole population analysis match. Through analysis of a representative sample it can then be said to describe the population.

Six daily newspapers from the Arab region were selected for this study, which are based in the sample countries. The decision to choose these countries was due to their similarities and the overall urgent need to develop science communication as a priority in these societies. The newspapers selected for this study were: Al-Ahram, Al-Masry Al-Youm, Al Riyadh, Okaz, Al-Qabas, and Al Rai. The selection of these newspapers was based on multiple criteria. However, the first criterion is that they have the highest circulation in their countries (Table 1). Al-Masry Al-Youm is considered the most popular newspaper in Egypt with 180,000 copies sold daily in 2011 according to Dubai Press Club (DPC 2015).

The second criterion is the interest in science news shown by these newspapers. Al Riyadh and Okaz have a high coverage of science news (Al-Qafari 2009). In Egypt, Al-Ahram is considered the newspaper that is the most interested in scientific news (Al-Saber 2012). The interest that these newspapers have in covering science news could lead to better reporting of science news than that of other newspapers, which do not have the same interest in science news.

The third criterion is the type of ownership of these newspapers, whether governmental or private. The Al-Ahram newspaper is owned by the Egyptian government while Al-Masry Al-Youm is privately owned. It is possible that ownership status could impact access to data for newspapers in the Arab region. The final criterion is the freedom of the newspapers. In Kuwait, newspapers have greater freedom of expression than in other Arab countries (RWB 2017), which may play a role in the accessibility of data and the use of statistics in science news. Because of that, the Al-Qabas and Al Rai newspapers from Kuwait were chosen, as shown in the following table:

Newspaper Name	Country	Circulation Figure (Copies per issue)
Al-Ahram (The Pyramids)	Egypt	700,000
Al-Masry Al-Youm	Egypt	180,000 (Dubai Press Club, 2015, p.29)
Al Riyadh	Saudi Arabia	170,000

Okaz	Saudi Arabia	147,000
Al-Ray	Kuwait	65,000
Al-Qabas	Kuwait	60,000

Table 2. Circulation figures of some of the Arab newspapers (Rugh 2004, p. 61; 173)

4.10.2. Newspapers from Egypt

Al-Ahram is Egypt's largest news organization and the publisher of the Middle East's oldest newspaper, the daily Al-Ahram, which has been in circulation since 1876 (Ahram, 2017). Al-Masry Al-Youm is a privately-owned daily Egyptian newspaper which started publishing in 2004 (Almsry Alyoum, 2017). It is the most popular newspaper in Egypt (DPC 2015).

4.10.3. Newspapers from Saudi Arabia

Al Riyadh is a daily newspaper in Saudi Arabia which started publication in 1965 and is owned by the Al-Yamamah Press Establishment. It has 58 branches in Saudi Arabia and around the world (Alriyadh, 2017). Okaz is a daily newspaper that has been published by the Okaz organisation since 1960 (Okaz, 2017). It is also one of the most read newspapers in Saudi Arabia with more than one million readers (Al-Ghamdi 2009) and is published in western Saudi Arabia.

4.10.4. Newspapers in Kuwait

Al-Qabas is a daily Kuwaiti newspaper published by Dar Al Qabas Publishing and Distribution Company in Kuwait City. Al-Qabas was launched in 1972 and is owned by Kuwaiti merchant families (Al-Qabas, 2017). Al Rai is a daily newspaper established in 1961. It is owned by the Al Rai Media Group and is one of the most popular newspapers in Kuwait (Alrai, 2015). It is perhaps important at this point to explain why I have chosen to work with print media instead of online or broadcast media, given the global trends towards convergent and digital media. For one, the print media in most Arab countries remain, despite falling sales and strict government control, primary definers of the news agenda in those countries. They might not have audiences as large as some broadcasters but they continue to set the framework of discussion about not only the subject of debate, but also in what terms. On the other hand, print media is also transitioning online so any findings continue to be valid across the board. Finally, and perhaps no less importantly, the archives of newspapers were far more accessible to me, and given the limitations of resources and time, this was an important consideration that I had to consider when deciding which type of media outlets to choose.

The study selected the years 2015 and 2016, which were chosen for several reasons. Firstly, they were the most recent and the easiest to access. Secondly, these years were interesting

ones for science because there were many important scientific discoveries around the world. For instance, in health and technology-related news, several treatments and techniques were discovered and invented. Some of these treatments saved lives, such as the dengue fever vaccine; diabetes drugs that reduce cardiovascular disease and reduce the rates of preventable deaths; new drugs for heart failure, and the mobile stroke unit. Finally, Arab countries in 2016 spent $5.31 billion on science research, considered to be the highest spending in history. Also, in 2015 Saudi Arabia spent over $42.6 billion on the health sector, now making it one of the central areas in its economy.

The sample text for this research included all health (public health, policy health and disease) and technology (software applications and machines) news stories in the aforementioned newspapers between 1 January 2015 and 31 December 2016. Regarding the scope of the research, which aimed to understand how journalists use statistical data to articulate science news in the Arab region, the article selection criteria specified that the articles needed to contain statistical data, so all health and technology articles that did not contain statistical data were excluded.

4.11 Codes

According to (Krippendorff 2004, p. 84): ‘coding bridges the gap between unitized texts and someone's reading of them, between distinct images and what people see in them, or between separate observations and their situational interpretations’. Coding was used in this study to group different aspects included in the science news stories and convert those into quantitative data. This was done: ‘in order to handle larger blocks of verbal material in a statistical way, (it seems necessary) to reduce the variety of alternatives that must be tabulated’ (Miller 1951, p. 95). The study used coding largely to highlight frequencies. The coding design in this study was designed to facilitate analysis of science news that contained statistical data. The following 32 categories were established to answer both the main question of the study and the sub-questions as well:

1	Article number	
2	Page number	First, middle, or last
3	Article title	
4	Date of publication	
5	The newspaper	Newspaper’s name
6	Word number	Number of words in the article
7	Statistical type	The appearance of statistics
8	The producer	Who produces the science news?
9	Journalist’s name	If the producer of the article is the newspaper, is the journalist’s name presented?
10	Gender	The gender of the journalist
11	News type	The type of science news (health or technology)
12	Main topic	The main topic of the article
13	Journalistic genre	Journalistic genre of the article: hard news story or beat reportage
14	Statistics type 2	Type of statistics presented the article (descriptive or inferential)
15	Statistics type 3	Type of statistics presented in the article (numerical data or categorical data)
16	Visual data	Does the article contain any graphical data?
17	Visual data 2	If yes, which type of graph?
18	Verification	Is there any mention of missing data/partial statistics?
19	Sources 1	What is the main source of the statistics?
20	Sources 2	Source provenance
21	Sources 3	How many statistical sources are cited?
22	Reliability 1	Is the source of statistics in the article reliable?
23	Reliability 2	Does statistical reliability follow adequate mathematical and statistical procedures?
24	Validity	Is the use of statistics coherent with the topic?
25	Absence	Is statistical information absent which could have a role in supporting the journalist’s claim in the article?
26	Interpretation 1	Are the statistics in the article interpreted?
27	Interpretation 2	Are statistics interpreted in a correct way?
28	Geographic coverage	International/foreign or national/local/domestic
29	Statistical claim	What is the statistical claim?

30	Timeliness	Time passed between the statistical release and the publication of the article
31	News value	Are the statistics used in the news story to: produce/substantiate/contextualise?
32	Function	Main function of statistics in the news story

Table 3. Variables that guided the manual collection of code sheets

It is important to note that the present study particularly emphasises health and technology news, which is defined as including health news and technology news. The study divides health news into three categories: (1) public health stories, which describe common problems influencing health or public safety; (2) health policy stories, which describe the systems that affect access to the healthcare market; and (3) disease health stories, which present new information on diseases and treatments. Technology news is defined as news related to software applications and machines.

The study depended on inter-coding reliability, where used as standard of measurement. It was considered essential to carry out content analysis and has largely been used by academic researches. Wimmer and Dominick (2013, p.59) pointed out, that inter-coding reliability: 'used to assess the degree to which a result can be achieved or reproduced by other observers'. For example, this means that two people can use the same measurement tool and get an estimate of the same result. Doing inter-coding reliability is important to achieve a high quality and accuracy of research findings. To achieve this I trained a PhD student who has experience in the same field of using statistics and journalism and he did an assessment of 10% of the sample of all 32 variables. I used Krippendorff's alpha (KALPHA) test which showed the results from 0.81 to 1.00.

4.12 Close-reading Rhetorical Structural Analysis

This study undertook close-reading as a qualitative approach. Brummett (2009, p. 3) who has written a book about close-reading ('Techniques of Close Reading') defined close-reading as: "mindful, disciplined reading of an object with a view to deeper understanding of its meanings". This study examined content via close-reading to assess the ways that statistics are presented in science news. Close-reading took place after content analysis in order to collect information that allowed us to focus on some points.

I carried out a detailed analysis of the findings from the close-reading stage, using the Rhetorical Structure Theory on twelve (n=12) articles, two from each newspaper, ten related to health issues and two to technology (Al-Ahram, Al-Masry Al-Youm, Al Riyadh, Okaz, Al-Qabas, and Al Rai.) This research strategy aimed to present an overview of text organisation, particularly in how statistical data is used in the articulation of texts, by paying attention to

relations and accuracy and rigor and also to the criteria that this research relies on to assess the use of statistics, which are: validity, reliability, interpretation and absence of statistical data in the text. The analysis aimed to reveal the accuracy and rigor (or lack of it), within science articles by answering the following question: How are statistics used in the science articles? The data collected from content analysis, close-reading and expert panel approaches could provide a background (information) for the questions that journalists were asked in the semi-structured interviews.

1	Health	AL-Rai	11 April 2016	Cancer disease index in Kuwait to rise	Omar Alas
2	Health	AL-Rai	29 January 2016	Kuwait has the highest obesity rate among Arab nations and the second-highest rate globally	Kuna
3	Health	Al-Qabas	18 August 2015	Sleep disorders hurt the heart	Fouad Salama
4	Health	Al-Qabas	17 May 2016	Beware of childbearing after the age of forty	N/A
5	Health	Oqaz	2 November 2015	A lack of Vitamin D threatens women with 12 diseases	Hussein Hazazi
6	Health	Oqaz	22 March 2016	Women are wiser than men	Wkalat
7	Health	Al-Ahram	5th April 2015	'Joshar' rare disease affects 25% of births	Abeer Fouad
8	Technology	Al-Ahram	17 January 2016	New revolution on the 'barcode' segments	The newspaper
9	Health	AL-Riyadh	3 March 2016	Obesity is linked to 'poor memory'	The newspaper
10	Technology	AL-Riyadh	11 April 2016	A device that awakens the lower back muscles and removes pain	The newspaper
11	Health	AL-Masry AL-Youm	6 June 2016	Women with migraines are more likely to have heart disease	Reuters
12	Health	AL-Masry AL-Youm	18 July 2016	Obesity may be caused by 'brain dysfunction'	Muhammed Mansour

Table 4. Details of articles analysed in close-reading method

4.13 Expert Panel

The study adopted the use of an expert panel as a qualitative method. The purpose of using this method was to examine the accuracy of the journalists in using statistics in science news. Choosing this strategy was useful for several reasons. It provided some background on the use of statistics by science journalists in Arab countries. The method also helped in formulating

questions that journalists were to be asked in semi-structured interviews. By interviewing specialists, it was also possible to examine the accuracy of science news in terms of how statistical information is used. Together, these applications of the expert panel method helped to answer sub-question number 3 (Do the statistics used by science journalists comply with principles of validity and reliability?) and number 4 (Do journalists use statistics effectively to communicate science?).

Expert panels: “provide a forum in which leading experts in a given field are invited to share their experiences and thoughts” (Galliers and Huang 2012, p. 122). This study’s expert panel consisted of five specialists, one from the field of statistics, one from technology and three from health. A total of 25 science news articles from the sample-study newspapers were divided among the specialists, so that each specialist read five articles before being interviewed. Then, each panellist was interviewed to ascertain their opinion about the news they read. In the interview, they were asked to evaluate the accuracy of the science news regarding the statistical information. Also, they were asked about the validity of the science news and to give recommendations, thereby providing information to answer sub-questions numbers 3 and 4.

Code	Discipline	Role
INT01	Statistics	Research Fellow in Applied Health (University of Leeds)
INT02	Technology	Postdoctoral research fellow (University of Leeds)
INT03	Health	Consultant in Cellular Pathology (St James's University Hospital)
INT04	Health	Senior Fellow in Emergency Medicine (Leeds Teaching Hospital)
INT05	Health	Consultant Neuropathologist and Lecturer (University of Leeds)

Table 5. Codes used for analysis of interviews with experts

4.14 Semi-structured Interviews

The last method we used was semi-structured interviews. This strategy aimed to demonstrate and complete the results of the content analysis, close-reading and expert panel. Semi-structured interviews with science journalists were undertaken to examine and understand, in

detail, how journalists in the Arab region deal with statistical data when they report science news. The purpose of the interviews was to explore the difficulties or opportunities, which these science journalists faced in their journalistic practices, in order to answer research sub-questions numbers 6−10. An interview is: “a method of data collection in which one person (an interviewer) asks questions of another person (a respondent) (…) conducted either face-to-face or by telephone” (Whiting 2008, P. 35).

According to Birmingham and Wilkinson (2003, p. 44) interviews can provide the researcher more of an insight into the importance of what is happening. Researchers use qualitative interviews when they want to gain in-depth knowledge about experiences or phenomena from participants (DeMarrais 2014, p. 52). Semi-structured interviews can help previously unknown information to emerge because participants have the opportunity to speak freely (O'Keeffe et al. 2016) p.1913). A semi-structured interview is a qualitative method that combines a predefined set of open questions, with rapid dialogue with the chance for the researcher to discover exact subjects. Interviews with participants are particularly beneficial for obtaining information behind journalists’ experiences.

Essentially, there are three kinds of interviews: semi-structured, structured and unstructured. It has been argued that although there are great differences in style and tradition, all semi-structured interviewing has certain common characteristics (Mason 2002). Edwards and Holland (2013, p. 3) noted that: (1) The interactional exchange of dialogue (between two or more participants, in face-to-face or other contexts); (2) A thematic, topic-centred, biographical or narrative approach where the researcher has topics, themes or issues they wish to cover, but with a fluid and flexible structure; (3) A perspective regarding knowledge as situated and contextual, requiring the researcher to ensure that relevant contexts are brought into focus so that the situated knowledge can be produced. Meanings and understandings are created in an interaction, which is effectively a co-production, involving the construction or reconstruction of knowledge.

In this study, we chose a semi-structured method because it is a: ‘form of interviewing that has some degree of predetermined order but still ensures flexibility in the way issues are addressed by the informant’ (Dunn 2000). The study carried out recorded semi-structured interviews with journalists to gather data about how journalists selected their sources and why they chose those sources when they wrote science articles that include statistical information. Through the semi-structured interviews, the study explored the difficulties or opportunities which science journalists in the Arab region faced when accessing statistical information. The study used the interviews to assess the quality of science journalists regarding the use of statistics in their reporting by looking at the three aspects of education, training and journalistic experience. In addition, these interviews allowed exploration of the issues that can positively or negatively impact journalists and editors using statistics in science journalism. After that,

the study could carry out a comparison between Egypt, Saudi Arabia, and Kuwait to answer research sub-question 10.

4.14.1. Interviewing Sampling

In terms of the carrying out semi-structured interviews, I gathered information from eighteen (n = 18) journalists, who were from six Arabic newspapers from three Arabic countries: Saudi Arabia (Al Riyadh and Okaz newspapers), Egypt (Al-Ahram and Al-Masry Al-Youm newspapers) and Kuwait (Al-Qabas and Al Rai newspapers). I selected three journalists from each newspaper (one editor and two journalists). I selected the journalists who write about science news in general and specifically health and technology news stories. The science journalists and editors were contacted to participate in the study. The study adopted the University of Leeds ethical standards regarding the safeguarding of data and ethical requirements. Specifically, the study did not reveal journalists' names and their information stayed confidential.

Code	Newspaper	Journalist's Role	Gender
#INT01	Al-Ahram	Science editor	Male
#INT02	Al-Ahram	Science journalist	Male
#INT03	Al-Ahram	Science journalist	Female
#INT04	Al-Masry Al-Youm	Science journalist	Male
#INT05	Al-Masry Al-Youm	Journalist	Female
#INT06	Al-Masry Al-Youm	Science editor	Male
#INT07	Al Riyadh	Editor	Female
#INT08	Al Riyadh	Journalist	Female
#INT09	Al Riyadh	Journalist	Male
#INT10	Okaz	Journalist	Female
#INT11	Okaz	Editor	Male
#INT12	Okaz	Journalist	Male
#INT13	Al-Qabas	Science editor	Female
#INT14	Al-Qabas	Journalist	Male
#INT15	Al-Qabas	Journalist	Male
#INT16	Al Rai	Journalist	Male
#INT17	Al Rai	Journalist	Female
#INT18	Al Rai	Editor	Male

Table6. Codes used for the analysis of the journalists' interviews

4.15 Ethical Considerations

The study followed the ethical framework set by the University of Leeds regarding safeguarding data and ethical requirements. The research has been approved by the Ethical Committee of the University of Leeds. It included the completion of informed consent forms. The participants were informed about the purpose of the research as well as the process of the project. Furthermore, because it may require the disclosure of sensitive political views, they were given the right to voluntarily join the study as well as to refuse to participate, or to quit at any moment. The study ensured the anonymity of the journalists interviewed and their information and details were kept confidential. The data produced during this study was protected by being stored in the University of Leeds server, and by the way it was stored following guidance and clearance from the IT team regarding data protection procedures.

4.16 Conclusions

This chapter has described the design research questions and methods that led to the entire study. It has also mentioned how qualitative and quantitative methodologies were used and why these methods were chosen as the best methods to answer the question of how journalists engage and use statistics to report science news in the Arab media and to understand the challenges and opportunities that journalists face in these countries in the wider context of science communication.

I have benefited from the methods I have used in gathering information (analysis of evidence, in-depth reading, interviewing and experts) as well as discovering more details when I delved deeper into each approach. In addition, in this study we used a panel of experts which is almost unused in the field of journalism, (unlike the rest of the other methods which are more widely used). This curriculum has given me information that is not only in the field of study and research, but also in correcting and adding valuable scientific information, whether in the health or technological field, which I obtained through my meeting with experts in addition to the results obtained from these experts in relation to the use of statistics by journalists in scientific news.

There were some difficulties in interviewing some journalists, especially with regard to gender, and more specifically in relation to Saudi women journalists. All the Saudi women journalists I interviewed had to be done over the phone, even though they were aware I was in the same city where they were working. Future research in these countries might find similar challenges. The position of women in society in relation to the context of the religious and cultural is a

tricky issue when it comes to any methodology of researching in these countries. The religious or cultural side of these women journalists may have a role in their not being interviewed face-to-face.

In terms of obtaining a sample of newspapers, some Arab newspapers were more accessible than others. For example, Kuwaiti newspapers were easier to access through their websites, where copies were free; by contrast, for both Saudi and Egyptian newspapers, access was difficult because the information was archived and required a fee.

Doing research in Arab media is an increasingly important task particularly in the light of changes in the region. One of the experiences of doing this research was that I have to utilise a variety of methods to reach knowledge, which is tricky but at the same time rewarding and I hope that contributes to future research.

Chapter 5 Findings

5.1 Introduction

Let me start by reiterating my main goal when setting out to do this fieldwork, was not only to understand how and why journalists use statistics when articulating science news but also to use this as a dialectical exercise in order to explore the epistemology of science news reporting in more general terms. Hence, I have triangulated a series of research strategies in my methodology in order to compare practices across different newsrooms and countries, while making sure that variables such as gender and politics were present in my sample and overall analysis. All this to provide a more comprehensive picture of what happens on the ground in relation to the news reporting of science in the Arab media.

Although this chapter presents the analysis of the data gathered during the field work for this research project in order to shed light upon the way statistics are used when articulating science news by Arab reporters, it also provides useful data to contextualise this analysis within the broader theme of science reporting. Therefore, although this chapter's purpose is to answer the main research question of the study - How do science journalists in the Arab region - Saudi Arabia, Kuwait, and Egypt - engage with and use statistics when reporting science news, and what are the key challenges and opportunities they face in doing so in terms of communicating science to the public?, - it also allowed me the chance to deconstruct and critically assess professional practices in journalism in that region when it comes to the science newsbeat.

To explore these questions, I have developed a multilevel approach and triangulated a set of research strategies (see Methodological Chapter 4) which allowed me to gather data from three different countries. Overall, the findings show that there are important issues and problems regarding the communication of science and statistics in general in that part of the world. Secondly, it suggests that these issues and problems arise mainly from two factors; the lack of 'professional autonomy' (Waisbord 2013)) and absence of capabilities (knowledge and skills).

To explore these findings, this chapter is structured into six sections. The first one describing the findings resulting from the content analysis of science news including statistical data, which allows me to answer several of the research sub-questions such as; No. 1. How do journalists engage with statistics to articulate science news in the Arab region? No. 2. How do science journalists in the Arab region access statistics when reporting science news? and, No. 3. Do the statistics used by science journalists comply with principles of validity and reliability? 5. What are statistics used for when articulating science news? The second section allows me

to describe and interpret the findings that came from the control group method which analysed science news. In so doing, it allows me to find out whether Arab journalists use numbers better than their counterparts in the West or not. The third section focuses on carrying out a close-reading analysis of sampled science news and therefore helps to address sub-questions 1, 2 and 3. The fourth section focuses on the results that came from the findings of an expert panel, which provides information to answer sub-question numbers (3) and (4) - Do journalists use statistics effectively to communicate science?

The fifth section examines the issues using semi-structured interviews carried out with Arab science journalists. It provides important answers to sub-questions 6,7,8,9 and 10 - What are the identifiable capabilities in terms of education, training, experience and background that science journalists display when working with statistics?, What are the key factors impacting upon journalists' work in relation to using statistics in science journalism?, What challenges and opportunities do science journalists in the Arab region face when using statistics?, What is the purpose of science journalists and editors using statistics in science news?, What are statistics used for when articulating science news? And, what are the similarities and differences between scientific journalists in Arab countries (Egypt, Saudi Arabia, and Kuwait) in their use of statistics? The final - and sixth - section provides a general conclusion derived from the fieldwork.

5.2 Content Analysis

This section sets out in tables and graphs the descriptive statistics used to identify the percentages and frequencies of all thirty-two collection points involved in this study. SPSS was used to analyse the data. The content analysis was carried out using the inter-reliability code, where used as a standard of measurement. In so doing, a PhD student who has experience in the same field of using statistics and journalism was trained and he did an assessment of 10% of the sample on all 32 variables. I used Krippendorff's alpha (KALPHA) test which showed the results from 0.81 to 1.00.

Overall, the results of the content analysis showed the occurrence of statistics used in science articles published during the years 2015-2016 by newspapers from different parts of the Arabic world: Al-Ahram (Egypt), Al-Masry Al-Youm (Egypt), Al Riyadh (Saudi Arabia), Okaz (Saudi Arabia), Al-Qabas (Kuwait) and Al Rai (Kuwait). It highlights several trends that can be discerned from the frequencies of, and correlations between, the types of news, gender, sources, the number of statistics, who presents the statistics, and other relevant factors. The main purpose of using this method was to answer the main research question.

The content analysis helped me to examine how journalists engage with statistics in order to articulate science news in the Arab region and how science journalists in the Arab region access statistics when reporting science news. In doing so, it allowed me to explore if the way they use statistics complies with the general principles of validity and reliability set by experts (statisticians and scientists) and, overall, if journalists use statistics effectively to communicate science (in order to bring transparency, accountability and accessibility to the issue being reported in science).

From the general results, it is worth mentioning three main findings here: Firstly, that there is an exaggerated reliance on official statistical sources, secondly, that there is a widespread use of unknown statistical sources (around 25% of the statistical sources used in the scientific news). Thirdly, the scarcity in the use of visual data in science news stories in Arab newspapers despite ample evidence of this being a factor in making this type of news accessible to the public. The coding used 32 categories, which were established to answer both the main question of the study and the sub-questions as well.

5.2.1. Initial Findings

The findings of this study show that in total, the Saudi newspapers Al Riyadh and Okaz published more science news than Egyptian and Kuwaiti newspapers. Out of 932 articles analysed, 409 were published in Saudi newspapers. Kuwaiti newspapers came in second with 334 articles and finally Egyptian newspapers with 189 articles. Saudi newspapers published more than twice as many science news items than the others and included far more statistical information than did, for example, Egyptian newspapers.

This is an interesting finding given existing preconceptions around the treatment of science in the news in these countries. My first impression is that far from being relegated, the use of numbers in science reporting is far more present that I was expecting in countries where contextual issues (politics, religion and culture) would suggest otherwise (because of tight regulation and censorship). The results of this fieldwork have also the merit that it informs the discussion around professionalism, deontology and professional autonomy in the region as I will be discussing later on.

In this sense, and as a clear example to be discussed later on in more detail, the findings show that although Saudi newspapers published nearly half of the overall articles (therefore indicating a larger attention towards science in general as a newsbeat), this did not mean that the stories published in the former newspapers were necessarily ‘better’ when it came to the use of statistics in science news (something that suggest variable quality standards in relation to professional practice). In other words, these types of findings allowed us to open a serious discussion in relation to what it is to offer an accurate or critical use of the numbers in the

context of science reporting (hence, suggesting the need to review both professionalism and professional autonomy in journalism). Moreover, despite the fact that the Egyptian press was in last place in the number of science news items published in the selected period - those that included statistical data - it was far more professional in the use of statistics as the qualitative findings suggest.

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Al-Qabas	154	16.5	16.5	16.5
	Oqaz	101	10.8	10.8	27.4
	Al-Riyadh	308	33.0	33.0	60.4
	Al-Rai	180	19.3	19.3	79.7
	Al-Ahram	104	11.2	11.2	90.9
	Al-Masry Al-Youm	85	9.1	9.1	100.0
	Total	932	100.0	100.0	

Table 7. Newspaper Frequencies (Source: author's data)

If we look more closely at each newspaper, the results show that Al Riyadh, with 33%, came first in publishing science news which contained statistical information. Al-Rai came in second with 19.3%, followed by another Kuwaiti newspaper, Al-Qabas, with 16.5%. After that was Al-Ahram with 11.2%, then Oqaz with 10.8%. Al- Masry Al-Youm was last with 9.1%. Although a Saudi newspaper came first, this does not necessarily mean that other Saudi newspapers are in an advanced position. For instance, the findings showed that Al-Riyadh came in first with 308 articles, three times more than Oqaz, which came second-to-last with 101 articles.

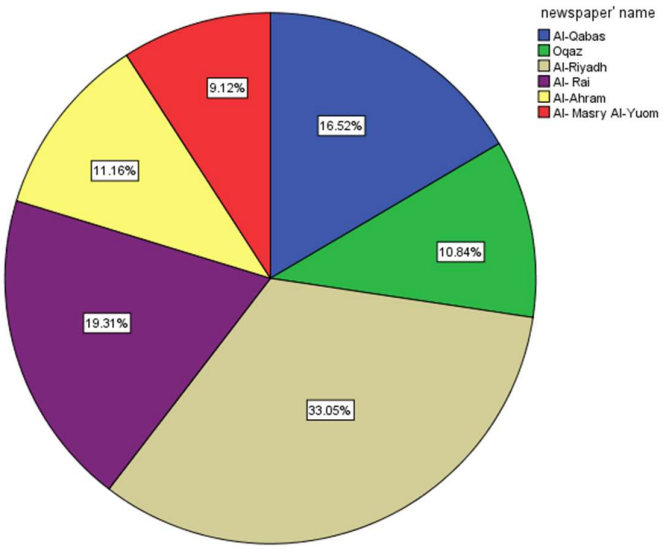


Figure 2. (Source: Who Publishes More Stories with Statistics: - Author's Data)

The study also highlights that the coverage of science news in Arab newspapers is not homogenous even within the same country; for instance, among Saudi newspapers, Al Riyadh published 308 articles, while Oqaz published less than a third of that with 101. Hence, the uneven use is not only between countries but also within newspapers in the same country itself. This suggests that the degree to which news media outlets pay attention to science has to do more with organizational dynamics and cultures than with national trends. This is a particularly significant finding, in my view, as it suggests that researchers looking at issues around professionalism and professional autonomy in journalism pay careful attention not only to media systems (Hallin and Mancini 2011), but also to individual news organizations as units of analysis.

5.2.2. Science News Producers

This study showed a distinct gap between the amount of news involving statistics among the different providers of stories in the newsroom. Reporters working for the newspapers produced 687 articles out of a total of 932 science articles, more than three times what the international agencies provided, which came in second with 193 articles. This is an interesting finding given the fact that it is often assumed in this region that science news is mostly provided by external agents (news agencies, freelancers, public relations, press releases, etc.).

This, however, supports Brandao (2016) and Bucchi and Mazzolini (2003) suggestions that most science news is actually produced by journalists working in the newsroom. The results also showed that the national news agencies of Saudi Arabia and Kuwait produced just 41 science articles, which suggests that they engage far less with science news when compared to how many stories journalists in Arabic countries, especially Saudi Arabia, dedicated to the field of science. That 11 out of 932 science news stories came from unknown content providers is also an interesting finding given issues around trust and the increasing use of public relations materials to fill the gaps in the newsroom (Lewis et al. 2008).

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	The newspapers	687	73.7	73.7	73.7
	Nation agency	41	4.4	4.4	78.1
	International agency	193	20.7	20.7	98.8
	unknown	11	1.2	1.2	100.0
	Total	932	100.0	100.0	

Table 8. Science news producers (Source: author's data)

Table 8 shows that 687 of out the total of 932 articles were produced by staff writers working in the newspapers. From this, 73% of the articles were clearly produced by the newspapers themselves as they had the journalists' by-line. The other 27% were published without a name and one might assume that they came from public relations departments or other unidentified sources, which had an interest in advancing the particular story. However, again, further research is needed around this and rationales remain speculative at this stage.

Nevertheless, the fact that more than two-thirds of science news that includes statistical data published in Arab newspapers were locally produced by Arab journalists is truly remarkable and to some extent unforeseen. This because it means that there is a great deal of added value to the collective public knowledge of science in the region being produced by local journalists. It also goes to challenge the belief that journalists in this part of the world do not tend to engage with statistics and suggests that local journalists actually deal with statistics far more than anticipated and that they play a greater role than international news agencies or other providers of science news. This is a very positive challenge to prevalent assumptions around Arab journalism and the way it reports science that deserves to be underlined.

5.2.3. Journalistic Genre of the Article

In addition to this, the findings underscore the fact that science news reporting in Arabic newspapers is mostly present through the genre of 'hard news'. This is not surprising as according to Rudin and Ibbotson (2002, p. 52), hard news is the most widespread genre in news stories. My study supports this as I found that almost 98% of science news that includes statistical data came in the form of hard news, while just 2.3% of such articles came in the form of beat reportage. This suggests that the majority of science news is produced by events, press conferences, or press releases. Patterson (2000, p. 3) defined hard news as:

''Coverage of breaking events involving top leaders, major issues, or significant disruptions in the routines of daily life, such as an earthquake or airline disaster. Information about these events is presumably important to citizens' ability to understand and respond to the world of public affairs''. That prevalent use of hard news is indicative of other aspects in terms of reporting practices. Firstly, it suggests a more day-to-day coverage that follows events - as indicated above - rather than setting its own agenda. In other words, it suggests that in this group of countries in relation as to 'what to talk about' in science, journalists tend to follow and not to lead. It also denotes a far more descriptive rather than analytical and critical approach towards the news.

However, its prevalent use also may suggest that journalists can present statistical data without bias or manipulation as the genre relies on the notion of 'objective and unbiased reporting' (Schudson and Anderson 2009). The use of hard news as a genre also suggests that it is done during the (same?) day, hence it implies pressures of time. This means that journalists have less time to process statistics in the stories, and this lack of time can be expected to contribute to more mistakes.

However, as the evidence here suggests, most mistakes in science news reporting do not come from the journalists themselves, but rather from the press releases of organisations featured in the reporting, which has also been found to be the case in other countries (Autzen and Weitkamp 2018). Nevertheless, with less time to fact-check numbers and analyse them properly there is an increasing likelihood that these mistakes will just be passed on to the public.4

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Hard news	911	97.7	97.7	97.7
	Beat reportage	21	2.3	2.3	100.0
	Total	932	100.0	100.0	

Table 9. Journalistic genre of the article (Source: author's data)

My findings additionally highlight that the statistics featured in science news come largely from external sources. Looking at each newspaper independently, we can see that both Al-Riyadh and Al-Ahram produced science news in the form of hard news only, while other Arabic newspapers produced different percentages of both hard news and beat reportage. Over 81% of beat reportage news came from the Kuwaiti newspapers Al-Qabas and Al-Rai; Al-Masry Al-Yuom came in next with 14.2%; and finally, in last place, was Oqaz, with nearly 5% of science news in the form of beat reportage.

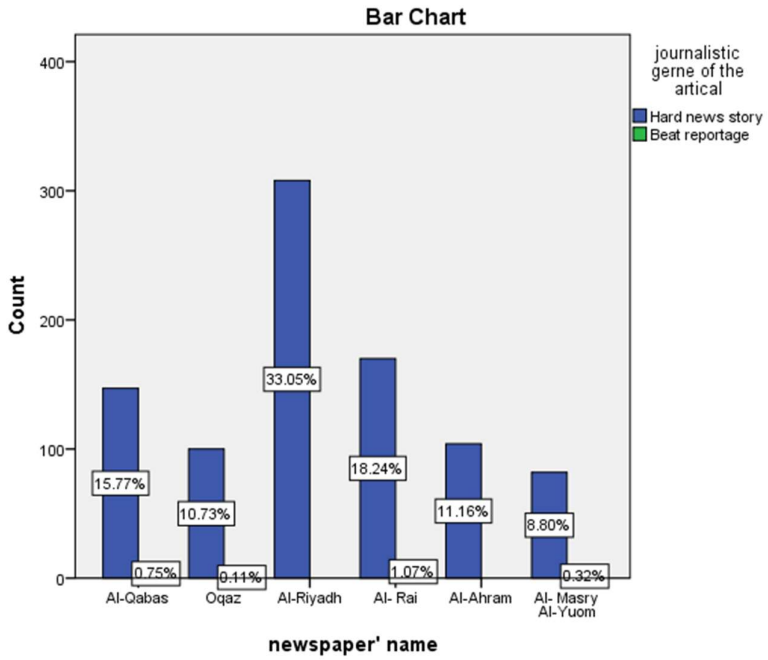


Figure 3. (Source: author's data)

5.2.4. The Type of Science News

An interesting tendency evident in the findings was the clear gap between the types of science news (health and technology news) that included statistical data. Most science news that included statistics, over 94%, was health news, while nearly 6% was technology news. This finding supports Brandao (2016) and Weitkamp (2003) findings; both agreed with Bucchi and Mazzolini (2003) argument that health takes the highest percentage with biology articles.

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Health news	879	94.3	94.3	94.3
	Technology news	53	5.7	5.7	100.0
	Total	932	100.0	100.0	

Table 10. The type of science news (Source: author's data)

In terms of which newspapers published more health or technology news, Al-Riyadh was in first place in publishing stories about both areas, with 308 out of 932 science articles. The second and third places were held by the Kuwaiti newspapers Al-Rai and Al-Qabas, with 180 and 154 articles, respectively. Al-Ahram came in fourth place with 104 articles, then Oqaz with

101 articles. In last place came Al-Masry Al-Yuom with only 85 articles. Generally, there are close percentage scores between newspapers from the same country in the publication of science news; in Saudi Arabia, however, there is a vast difference between Riyadh and Oqaz in the dissemination of science news, with Riyadh producing three times more than Oqaz (308 compared to 101). It is therefore to be expected that Riyadh will produce more statistical errors than other newspapers in scientific news.

		Health news	Technology news	Total
Newspaper name	Al-Qabas	150	4	154
	Oqaz	87	14	101
	Al-Riyadh	292	16	308
	Al-Rai	169	11	180
	Al-Ahram	102	2	104
	Al-Masry Al-Yuom	79	6	85
Total		879	53	932

Table 5. Cross-tabulation of newspaper name and type of science news (Source: author's data)

One notable finding evident in Table [12] concerns where different types of science stories appeared within the paper. In no newspapers did the technology news occur on the front page, but these were instead found largely in the middle section (45 articles) or in the last pages (8 articles). This suggests that if news concerns technology, then it most likely will not be published on the first page of Arab newspapers. On the other hand, that health news was of greater interest to journalists was clear because these stories appeared across all pages (first, middle, last) at different percentages.

		Health news	Technology news	Total
Page number	First page	33	0	33
	Middle pages	783	45	828
	Last page	63	8	71
Total		879	53	932

Table 12. Cross-tabulation of science news and page number (Source: author's data)

5.2.5. The Main Topic of Science News

This study found that Arabic newspapers were mostly focused on publishing health news, specifically news related to disease; more than half the science news which included statistical information, nearly 54%, concerned disease [Table 13]. This suggests that Arabic countries

suffer from a number of diseases, and the use of statistics can convey this reality with impartiality.

	Frequency	Per cent	Valid per cent	Cumulative per cent
Public health	358	38.4	38.4	38.4
Health policy	23	2.5	2.5	40.9
Diseases	496	53.2	53.2	94.1
Machines	44	4.7	4.7	98.8
Computer software	11	1.2	1.2	100.0
Total	932	100.0	100.0	

Table 13. The main topic of the article (Source: author's data)

Public health news came in second with 38.4%. This could be a result of focusing on news concerning diseases, and it suggests the role that newspapers play in Arabic societies in preventing the spread of disease. Indeed, because they are closely aligned with governments in the region it is the case that they would follow official agendas towards disseminating health campaigns and therefore prone to publish related material supporting these efforts. This last point is particularly the case in light of the large amounts that Arabic countries, especially Saudi Arabia, spend in the health sector and suggests not only the role of government officials in shaping the news agenda in science but also the influence that advertisement and investment in professional communication (PR) has in doing so too, something that has been highlighted by authors in other countries (Briggs and Hallin 2016).

On the other hand, news related to health policy does not receive the same level of interest; this is clear from the low percentage of such stories, which constituted just 2.5% of the total. Technology news appears to be of less interest to Arabic newspapers than health news; there was a clear gap between public health, in second place at 38.4%, and machines at only 4.7%. This, in my view, suggests that health news reporting tends to be more about supporting official communication efforts than about scrutinizing policy and therefore playing the role of watchdog in society. Thus, rises the issue of professional autonomy (or the lack of it) in relation to the reporting of science in this part of the world.

In relation to technology, the Arab media does not seem to keep pace with the more global media coverage. Indeed, news relating to computer software came in last place of the news coverage with only 1.2%; and is far from keeping up with technological developments, especially in the digital industry.

5.2.6. Using Statistics in Science News Types

		Do the statistics used in the news story:			
		Produce?	Substantiate?	Contextualise?	Total
The type of science news	Health	567	264	48	879
	Technology	23	16	14	53
Total		590	280	62	932

Table 14. Cross-tabulation of science news and news value (Source: autor's data)

As seen in the findings, the majority of the science articles, 590 out of the total of 932, used statistical data to produce the stories, suggesting that statistics were an important factor in the production of these stories. On the other hand, using statistics to substantiate the stories came in second place with 280 articles, while using statistics to contextualise the stories came in last place with only 62 articles. From these findings we can infer that science reporters tend to use statistics supplied by officials to articulate stories - hence, follow an agenda - rather than incorporate these numbers to enhance a story they already have (i.e. set the agenda). This use of statistics as an 'end' rather than as a 'means' in the production of science news confirms the earlier more general findings in the area of health where news stories are 'supplied to' rather than 'produced by' journalists.

The table above indicates that statistics were used to substantiate both health and technology stories at the same percentage of 30%. While using statistical data to produce both types of story was the leading purpose in varying proportions (64.5% in health news and 43.3% in technology news), using statistics to contextualise the stories was in the last position. However, technology news was five times more likely to use statistics for context than health news (26% compared to 5%) mainly because, one might assume, technology is far less politicalized than health (that dominates the sample).

Another important observation relates to the main function of using statistical data in the news stories of Arab newspapers. In this sense, the findings show that over 92% of the articles use statistics to make the story accessible because they illustrate and elucidate the story. In other words, Arabic journalists use statistics to simplify science news. On the other hand, just 2.3% of the articles use statistics to highlight relevance for society and 4.9% of the articles use statistics for other functions, which mostly suggests the lack of capability to add a critical interpretation of the numbers when producing the stories (so they tend just to limit themselves to present the numbers in the story and fail to extract additional meaning from them).

5.2.7. On the Use of Sources

The study additionally examined the number of statistical sources that were cited in science articles as a way of assessing, in quantitative terms, the degree of interest that journalists evince in obtaining accurate information, triangulating this information and contrasting statistical data as a source with other statistical sources; something that is a normative requirement in journalistic practice (Soloski 1989, Manning 2001). Indeed, as Manning (2001, p. 55) has observed,

> *The pressure of news deadline and the importance of obtaining information rich in news values encourages a dependency upon official sources, whether they be government departments or sources associated with parliaments. All these institutions are likely to be newsworthy precisely because they are powerful and have affected on daily lives of news audience in innumerable ways.*

With regards to this, the content analysis presented here highlights that in more than half of science articles in Arab newspapers (521 of the 932) the statistical information came from official sources. This confirms the high dependency of reporters upon official narratives and perhaps reflects also the lack of professional autonomy in performing the normative aspiration of watchdog (although to corroborate this last we need further research).

In these countries, official sources provide most of this type of information and, consequently, the public are more expose to it than from other sources. Not surprisingly governments often pass their own agenda through by using these sources, especially when coverage turns to politics or the economy (Khazen 1999, Mellor 2011). In addition to this it is also often the case that the statistical information issued by the official sources may be incomplete, either intentionally or unintentionally, thus compromising further the right of citizens to opportune, transparent and critical information regarding their own society.

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Official statistics	521	55.9	55.9	55.9
	Non-official statistics	178	19.1	19.1	75.0
	Unknown	233	25.0	25.0	100.0
	Total	932	100.0	100.0	

Table 15. The main source of statistics (Source: author's data)

On the other hand, it is worth highlighting that 'unknown' sources came in second place, encompassing 25% of science articles. The fact that there is a high percentage of statistics

that are not properly sourced or attributed to a particular official institution or organization might indicate either that it is assumed that the reader knows the source or that it is actually reproduced from a press release. In any case, there seems to be a perception among journalists that the statistics are legitimate in themselves as their nature implies an 'objective' nature (as I have discussed previously).

In relation to this last point, Desrosieres (1998) points out that statistical information is indeed often considered a news source in itself and has a sort of 'innate' legitimacy for the audiences as it has set itself up as a reliable science discipline. To be sure, and as Lugo-Ocando and Brandão (2016, p. 4) note, "Statistical data are widely considered by journalists as one of the most prominent legitimising tools in the construction of news." Hence, it is often the case that journalists fail to cite sources. These findings support those of Lugo-Ocando and Brandão (2016), which showed that unknown sources, at 41.5%, represented the second most common type of statistical sources.

Finally, on this particular point, non-official statistics, such as those from non-governmental organizations, came last on the list. This confirms the argument that journalists in this newsbeat lack a critical stance with regard to how they use and engage with numbers, which - as suggested by the same data set - is due to a lack of capability and of professional autonomy.

Overall, these findings support the common belief that journalists tend to rely on official sources to produce their news stories (Manning 2001, Lewis et al. 2008, Goldacre 2009).

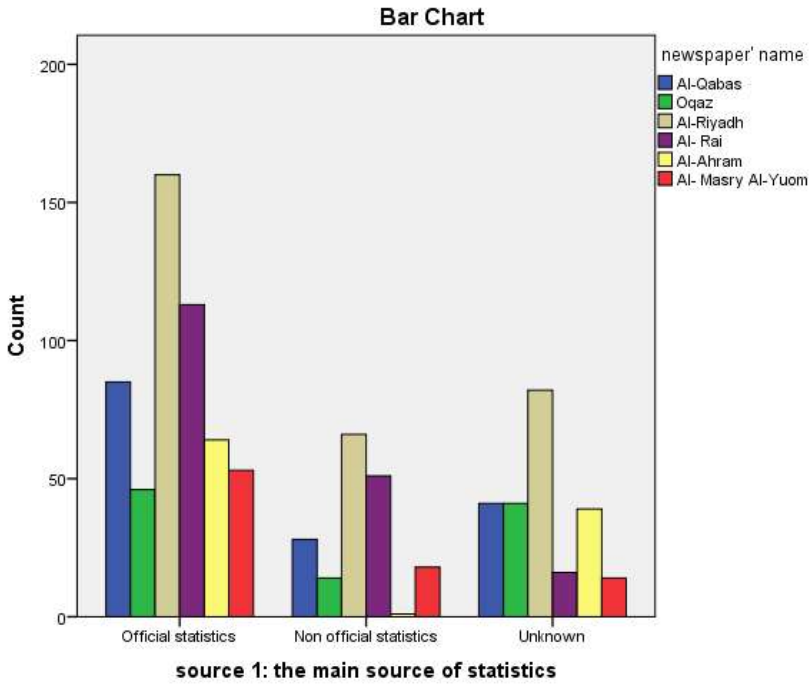


Figure 4. **The main source of statistics (Source: author's data)**

To be sure, the bar chart above shows that, in terms of which type of statistical source newspapers used more, Al-Riyadh was first in using official sources, with 17% articles; then, with 12% and 9% articles respectively, were the Kuwaiti newspapers Al-Rai and Al-Qabas; the Egyptian newspapers Al-Ahram and Al-Masry Al-Yuom had 6.8% and 5.6% , respectively. Although the Saudi newspaper Al-Riyadh was in first place, another Saudi newspaper, Oqaz, was at the end of the list with 4.9% articles. In terms of using unknown sources, Al-Riyadh was again first, with 8.7% articles; second place was shared between Oqaz and Al-Qabas, with 4.3% for both. Closely following these two was Al-Ahram, with 4% articles, and in last place were Al-Rai and Al-Masry Al-Yuom, with 1.7% and 1.5% articles, respectively. Unofficial sources were used by all newspapers at different percentages; however, it is notable that Al-Ahram only used unofficial sources in one article, which could mean that it is the newspaper most likely to depend on official or unknown statistical sources.

The same findings do counter, however, the initial assumptions that all Arab governments exercise the same degree of influence, pressure and censorship or that the way journalists operate within the constraints of Arab societies is homogenous. Yes, most Arab newspapers tend to behave as mouthpieces of the government but I found important dissidence among them and critical voices that actually reach the public. Many Arab journalists reporting science quote statistics from unofficial rather than official sources and this is an increasing trend as I was able to observe. This practice reflects an increasing degree, despite important setbacks, of professional autonomy; something that many journalists worldwide tend to aspire to achieving (Hanitzsch 2011).

It is important to remind ourselves that, as Sjøvaag (2013, p. 155) has observed, professional autonomy “is restricted at the political, economic and organizational levels of news production, negotiated at the editorial level and exercised at the level of practice.” Thus, autonomy is “a fluid concept that is continually adjusted to manage the daily task of reporting the news.” Nygren (2012, p. 78) divided journalists’ professional autonomy into two levels. The first, internal autonomy, is ‘autonomy for journalists in their daily work in relation to the media organization’. The second level, external autonomy, is ‘autonomy of the profession as a group and power in society’.

			Official statistics	Non-official statistics	Unknown
The type of science news	**Health**	Count	509	153	217
		% within the type of science news	57.9%	17.4%	24.7%
		% within source 1: the main source of statistics	97.7%	86.0%	93.1%
	Technology	Count	12	25	16
		% within the type of science news	22.6%	47.2%	30.2%
		% within source 1: the main source of statistics	2.3%	14.0%	6.9%
Total		Count	521	178	233
		% within the type of science news	55.9%	19.1%	25.0%
		% within source 1: the main source of statistics	100.0%	100.0%	100.0%

Table 16. Types of science news cross-tabulated with the sources (Source: author's data)

According to Table 16, which cross-tabulates the main sources of statistical data with the type of science news, the majority of health news used official sources, employing them in nearly 58% of 879 health stories. In technology news, official sources were used only in 22.6% of 53 stories perhaps also reflecting that it is an area dominated by the private sector. Non-official sources were used in technology news more than health news; 47.2 % of technology stories used them compared to 17.4% of health stories. This percentage of using non-official sources in technology news might also raise the concern of over-dependency on private corporate interests. A specific concern is that most sources related to, or working in the field of technology, are not official but they tend to be produced or supplied by the private sector through either companies or private corporate guilds. Finally, unknown sources were used in both health and technology news at relatively close rates (with technology at 30.2% and health at 24.7%). This percentage figure for both health and technology news suggests a very worrying tendency, as it signifies that more than a quarter of science news derives from unknown sources.

One important aspect to infer from this is that the lack of professional autonomy due to a high dependency on official and corporate sources highlights a greater issue; the fact that scientists do not talk to journalists but that instead it is a communication process that is highly mediated by professional communication, mainly public relations and strategic communication (Anderson et al. 2005, Bauer and Bucchi 2008).

5.2.8. Sources from Science

In Table 17 we can see that 'original' scientific sources - produced and mediated by scientists themselves - were first in this category, representing more than one-third of the sources of statistics in science news. This is an interesting result because statistical data coming from scientific sources (as opposed to government institutions or officials), such as universities and journals are more legitimate as they are produced - one might assume - with the intervention of the scientist and/or the scrutiny under a peer-review process in the second place. Though Bucchi and Mazzolini (2003) suggested a while ago that there is a lack of direct participation by the scientific community, our findings in the Arab world show that at least in this part of the world there is at least an 'indirect' participation by scientists in the production and dissemination of scientific statistical data.

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Government source	199	21.4	21.4	21.4
	Original scientific source	293	31.4	31.4	52.8
	Organisations and others	210	22.5	22.5	75.3
	Not mentioned	230	24.7	24.7	100.0
	Total	932	100.0	100.0	

Table 17. Source 2: Provenance (Source: author's data)

On the other hand, statistical data derived from sources which are not mentioned in the story came in second place, occurring in nearly a quarter of the articles. This suggests not only an over-reliance on press releases but also a lack of critical engagement with this data from the part of the journalist who fails to fact-check the statistics. Meanwhile, only 22.5% of the statistical data came from organisations which have an official relationship with statistical information such as the World Health Organisation.

		Male	Female	Total
Source 1: the main source of statistics	Official statistics	287	48	335
	Non-official statistics	89	3	92
	Unknown	72	35	107
Total		448	86	534

Table 18. The main source of statistics and gender (Source: author's data)

Gender in the Arab world has been a central dimension of any type of analysis in media and journalism studies (Sreberny 2000, Al-Malki et al. 2012). A closer analysis of the findings in Table 18 indicated that male journalists used official sources in 64% of the 448 articles they wrote, which was more than female journalists, who used official sources in nearly 56% of their 86 articles. There might be a gender dimension determining 'trust in' and 'engagement

with' official sources (which in these countries tend to be also male) by journalists but further research is needed in order to explore this argument further.

Non-official sources were also used by male journalists five times more than female journalists (19.9% compared to 3.5%), who tended to rely more on the use of unknown sources more often than male journalists (40.7% compared to 16%). From this data, it might seem that male journalists tend to engage more in fact checking than their female counterparts when dealing with statistics. However, we must highlight the fact that female journalists in Arab societies face greater challenges in accessing sources in general, something that is relatively easy for men in these societies.

5.2.9. Regarding the Number of Sources

The results of this research clearly showed that the majority of science articles that contain statistical data, 885 of 932, use a single source (Table 19). This supports Lugo-Ocando and Brandão (2016) finding that journalists in considerable numbers tend to rely upon one single source when reporting numbers, something that suggests they might not sufficiently question the information they are provided. This lack of critical evaluation represents an area where Arab science journalists need to improve.

The fact that the numbers of Arab and western reporters who rely on a single source are similar suggests a convergence in the practices of both groups. In all my sample, only 4.4% of the articles used two sources of statistical data, something that goes against the principle that journalists should test "the information against known facts or other sources" (Frost 2015, p. 69). Indeed, triangulating more than one source could help journalists seek out different perspectives and allow critical comparison of sources, a useful feature, according to one reporter, "because otherwise you would have been hooked into competing anecdotes" (Ettema and Glasser 1998, p. 78). This is not to say that a high percentage of single-sourced stories is bad in itself, particularly when the source is reliable and accurate but to highlight that when just six (6) science articles out of 932 cited more than two statistical sources one would have to accept that there might be a problem of transparency and criticality in the reporting of this newsbeat. As Howell and Prevenier (2001, p. 69) point out,

'Journalists should not rely on one source only, but on many, so that they can construct their own interpretations about the past by means of comparison among sources by sifting information contained in many sources, by listening to many voices'.

Indeed, triangulating and checking news sources by contrasting different data should be a given routine, particularly as it is vital in achieving transparency. As Frost (2015, p. 72) points out, 'Unfortunately, virtually all news sources, by their very nature, provide information that is distorted, either because of pressure of time or resources or because of a deliberate desire to deceive'.

		Frequency	Per cent	Cumulative per cent
Valid	One source	885	95.0	95.0
	Two sources	41	4.4	99.4
	More than two sources	6	.6	100.0
	Total	932	100.0	

Table 19. The numbers of sources when mentioned (Source: author's data)

This analysis, however, is not even across subjects. Different areas of science news present also different numbers of sources consulted. For example, in the majority of cases in health and technology journalists referred to one single source to provide statistical data. The two types were very close to each other; nearly 95% of health stories and 96.3% of technology stories depended on one source. Among types of science stories using two sources, health news was at 4%, a higher percentage than technology news at 3.7%. An interesting result is that only health news used more than two sources; however, at 0.6%, the rate was very low. Technology news did not use more than two statistical sources for any story.

		One source	Two sources	More than two sources	Total
Type of science news	Health	834	39	6	879
	Technology	51	2	0	53
Total		885	41	6	932

Table 20. The type of science news and number of sources mentioned (author's data)

In addition to this, the Table below shows a link between the number of sources and the size of the article. The expectation might be that the longer a science article is, the more sources it uses. However, this study suggests instead that there is only a minor correlation between the size of the article and the number of sources that provide statistical data (so size in this case almost does not matter).

		The number of sources are mentioned	Number of words
Source3: the number of sources are mentioned	Pearson Correlation	1	.173**
	Sig. (2-tailed)		.000
	N	932	932
Number of words	Pearson Correlation	.173**	1
	Sig. (2-tailed)	.000	
	N	932	932

Table 21. Correlation between the numbers of sources (author's data)

5.2.10. The Reliability of the Sources

The findings presented in Table [21] indicate that nearly 26% of the sources which provide statistical data are unknown. This is a finding that somehow suggests that some statistical data cited in science news should be subject to further scrutiny. This ratio also threatens the credibility of statistics in the public mind as previous research has shown that anonymous sources tend to have a negative impact on readers' perceptions of credibility (Sternadori and Thorson 2009). Indeed, as Sternadori and Thorson (2009, p. 63) suggest, 'It is also possible that the use of anonymous sources without sufficient explanation is interpreted by readers as a sign of journalistic incompetence, which in source credibility theory is another reason to assign lower credibility to a source'.

Newspaper journalists may fail to cite the sources of their science articles for several reasons. For example, the omission of a source may be a simple matter of forgetfulness. However, it is also possible that a lack of scientific experts in Arab countries may lead journalists to accept any source, whether known or unknown, without making sure the provided information is correct. On the other hand, over 74% of the sources of statistics were transparent, a fairly good percentage considering the lack of access to sources and the scarcity of scientific journalists in Arab newspapers.

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Yes	692	74.2	74.2	74.2
	No	240	25.8	25.8	100.0
	Total	932	100.0	100.0	

Table 6. Reliability of cited sources (Source: author's data)

Table 22 below shows which pages of the newspaper feature stories that cite unknown sources indicating that the majority, 215 out of 240, occurred in the middle sections. Although the first page of the newspaper is the most important, especially in Arab countries, there were five occurrences of articles with unreliable statistical sources on the first page, denoting a lack of editorial and fact-checking standards. That mistakes such as this manage to appear even on the front page not only reflect something about the way journalists deal with statistics but also about more general sloppiness in the newsroom. This is important to note because the front page of a newspaper serves as a way for readers to establish their understanding of the importance of the newspaper as a whole and to assess its credibility.

		First page	Middle pages	Last page	Total
Reliability: Is the source of statistics in the article reliable?	Yes	28	613	51	692
	No	5	215	20	240
	Total	33	828	71	932

Table 7. Reliability of statistics cross-tabulated with page number (Source: author's data)

The Table below indicates that inferential statistics were used more often than descriptive statistics (with 450 and 242 articles, respectively). However, there was a very weak negative correlation (-0.085) between the type of statistics and article reliability; some inferential statistics used by a number of journalists relied on articles that did not identify their sources. This could mean that transparency is not a concern for some journalists; they do not check the information they use, instead accepting statistical data from any source, whether it can be identified or not.

		Reliability: Is the source of statistics in the article reliable?		
		Yes	No	Total
Statistics type	Descriptive	242	87	329
	Inferential	450	153	603
Total		692	240	932

Table 8. Reliability of statistics cross-tabulated with source (Source: author's data)

Furthermore, the findings found that there was a relation between the reliability of sources and geographical coverage (international versus national stories). It showed that the sources of statistics were identified more often in covering international news science stories than in covering national news (with 370 articles compared to 322, respectively). On the other hand, there was a negative correlation between the reliability of an article and its geographical coverage (corr=-.169); this indicated that reliable sources for statistics were used more frequently in the coverage of international science news than in national science news. That the use of statistical sources in international science news is presented more transparently than in local science news suggests the difficulty journalists in Arab countries face in accessing the best quality of statistical data.

5.2.11. Regarding Statistics' Claims

This finding in Table 24 showed that the majority of the science articles, 73.7%, used stand-alone statistics; there was a clear gap between the number using stand-alone statistics and the rest. Stand-alone statistics appeared nearly three times as often as simple comparison, which was in second place with 26%. This use of statistical data in science reporting confirms Long (1995) findings that the majority of science stories in newspapers do contain some elements of scientific explanation.

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Stand-alone statistics	687	73.7	73.7	73.7
	Simple comparison	242	26.0	26.0	99.7
	No clear claim	3	.3	.3	100.0
	Total	932	100.0	100.0	

Table 9. The nature of the statistical claim (Source: author's data)

This high percentage of stand-alone statistics in the sample suggests that it is journalists' preferred method of dealing with statistical data. However, statistical information presented in this way can be difficult for readers to understand. The finding that most Arab journalists rely on stand-alone statistics also suggests that they may not take a sufficiently critical approach to the sourcing of their stories.

5.2.12. Concerning Verification

Many researchers and experts point out that most science news is not accurate and that journalists should take more care when dealing with data (Long 1995, Goldacre 2009, Seale 2010). This seems to be the case even more if it involves statistics, as their role in looking for the truth obliges them to verify their information and its sources (Shapiro et al. 2013, p. 657). The purpose of the question about verification is to establish whether the journalist checked the accuracy of the statistical data because this can affect the accuracy of the news either positively or negatively.

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Yes	95	10.2	10.2	10.2
	No	837	89.8	89.8	100.0
	Total	932	100.0	100.0	

Table 10. Verification: Mention of missing statistics (Source: author's data)

According to Table 25 above, nearly 90% of the articles do not verify the sources of the statistical data they include. Within this study, verification refers to the journalistic practice of checking statistical data against other sources, such as university and journal publications, or by consulting with scientists to assess the accuracy of the statistics. Accuracy is a significant index of ethics. As Keeble (2008, p. 13) noted, “there is a strong ethical commitment among many journalists towards accuracy and truthfulness in their reporting.” This standard of accuracy was not achieved by the journalists whose work was examined in this study. In only 10.2% of science stories did the journalist verify the sources of the statistics used; this percentage is too low to support the idea of general accuracy in science news.

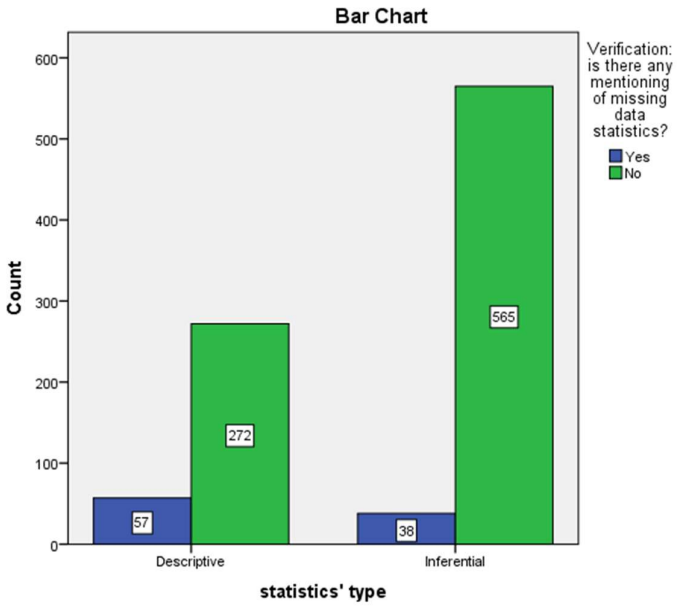


Figure 5. Verification of missing statistics crossing statistics type1 Descriptive, inferential (Source: author’s data)

When looking into verification and statistics type1 (descriptive, inferential), the findings showed that 57 articles which included descriptive statistics mentioned missing statistical data, while more than 38 articles which included inferential statistics mentioned missing statistical data. A positive correlation (corr=.174) indicated that mentioning missing statistical information was somewhat more linked to descriptive statistics than inferential statistics. That is to say, not mentioning missing data was to some extent coupled with the inferential statistics. The use of descriptive statistics and the mentioning of missing statistical data by journalists may arise from the difficulties of accessing statistical sources, whether local or international. The inexperience of dealing with statistics among Arab journalists may also lead to their choice of descriptive statistics.

		Verification:	Geographical Coverage
Verification: is there any mention of missing data statistics?	Pearson Correlation	1	.126**
	Sig. (2-tailed)		.000
	N	932	932
Geographical Coverage	Pearson Correlation	.126**	1
	Sig. (2-tailed)	.000	
	N	932	932

Table 11. Verification and geographical coverage (Source: author's data)

Furthermore, the findings showed a relationship between verification and geographical coverage. The positive correlation between mentioning missing statistical information and geographical coverage (corr=,126) indicated that a greater chance of not mentioning missing data could be seen in national stories than in international stories; however, this chance was still low. This finding may be expected in light of the difficulty of access to the sources of statistics, as most scientific news is sourced from Western countries.

5.2.13. Gender of the Journalists

This study looks at how gender relates to the use of statistics by journalists, given the fact that in Arab countries there are distinctive elements -such as religion, culture, politics and education- that tend to hinder access of women to education and a professional career. As many studies highlight, the socialization of gender can create structural differences in the way men and women are educated and approach mathematics and numerical skills in more general terms (Hyde et al. 1990, Spencer et al. 1999, Lindberg et al. 2010).

Although social differences between men and women might have emerged in ancient times, social stratifications of opportunities for women were particularly exacerbated in the past two hundred years in particular regions of the world (Hasso 2000, Stearns 2015). In Arab societies this situation has persisted despite the fact that women have increasingly assumed more challenges and greater roles. In the media industry, there has been a significant improvement in women's empowerment (Ross and Carter 2011) but they still lag behind in terms of participation and assuming editorial responsibilities (Skalli 2006, Khamis 2013). In fact, even in countries where women play a great role in public life "women's voices, experiences and expertise continue to be regarded by news industries as less important than those of men" (Ross (Ross and Carter 2011, p. 1148). There is a substantial gender gap evident in various types of news; this is especially true of political reports, where only 16 per cent of people who feature are women, a decrease of 3 per cent from 2010 (GMMP 2015).

Regarding the news coverage of health science, there is also a gap between women and men, with women making up just 35% of those who feature (Ross et al. 2018, p. 825). In Arab

newspapers, the situation is similar, as the findings shows that only 16% of newspaper articles were written by female journalists. Interestingly, this shows that there is no great divergence between Arab newspapers and Western media in the lack of science female journalists.

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Unknown	398	42.7	42.7	42.7
	Male	448	48.1	48.1	90.8
	Female	86	9.2	9.2	100.0
	Total	932	100.0	100.0	

Table 12. Gender of the journalist (Source: author's data)

Table 27 above shows that of most science news that includes statistical information, 48%, was produced by men, five times more than female reporters. This finding emphasizes the male dominance of Arabic newspapers, a reflection of the culture which, for a number of reasons, tends to favour men over women. The position of women in these countries is suggested by the fact that just 9.2% of the science articles were written by female journalists. Table 28, on the other hand, indicates that no female journalists produced technology news in any newspaper leaving it all to their male counterparts. The correlation between the type of science news and the gender of the journalist is notable as well; female journalists are overall far less likely than their male counterparts to cover technology news. However, more than 16% of all health news stories were written by female journalists. While this percentage is better than that of technology news, it is still comparatively low.

		The type of science news		
		Health	Technology	Total
The gender of the journalist	Unknown	355	43	398
	Male	438	10	448
	Female	86	0	86
Total		879	53	932

Table 13. Gender cross-tabulated by type of science news (Source: author's data)

As to the question of which newspaper featured more science news produced by female journalists, the findings from Table 29 below suggest that the Al-Ahram newspaper was in first place as women wrote 54 science articles for that paper, compared to 40 by men. Al-Ahram was in fact the only newspaper for which female journalists wrote more science articles than male journalists. This might be due to greater social openness in Egypt, where women have been allowed to practise journalism for a longer time compared to other Arab countries. Al-Qabas came in second place, with 26.4% of the science news written by women, followed by Oqaz with 6.2%. The percentages were close at Al-Riyadh, Al-Rai and Al-Masry Al-Yuom, with 3.7%, 3.65%, and 3.1%, respectively.

Despite contemporary developments in Saudi society, specifically in regard to women's rights, which has recently seen important advancements, the percentage of female-published science news compared to male-published news was very low (3.7% in Al-Riyadh and 6.2% in Oqaz). This disparity is consistent with most Arab newspapers. Mellor (2010, p. 207) points out that,

Despite the abundant opportunities for female Saudi journalists, it is still conjured and superficial rather than a reflection of genuine change in women's status inside the kingdom.

These findings suggest the need for a much larger discussion around modernity and gender in the Arab world and to what degree is it possible for women to push forward boundaries and challenge traditional roles assigned to them in these societies. To be sure, women in Arab societies face many difficulties and limitations, especially in the field of journalism, even as some have started to fade away. For example, until relatively recently, Saudi Arabia's media schools in universities were restricted to men but in the past few years there have been a series of J-schools for women established in that Kingdom and they have now become widespread among Saudi universities (although there continues to be gender segregation in this respect). Regardless of this relative progress, the need to empower women in journalism in Saudi Arabia and other Arab countries still faces crucial challenges. One of them is the lack of adequate economic incentives, such as maternity pay and childcare, for women in the media industry (Mellor 2011, p. 219) but which are in effect also challenges faced by many poor women in the West.

		Male	Female	Total
Newspaper's name	Al-Qabas	39	14	53
	Oqaz	30	2	32
	Al-Riyadh	169	10	179
	Al- Rai	108	4	112
	Al-Ahram	40	54	94
	Al- Masry Al-Yuom	62	2	64
Total		448	86	534

Table 14. Gender of the journalist Cross-tabulation (Source: author's data)

Overall, the participation of female writers in the creation of scientific news within Arabic newspapers is low; the exception to this trend is the Egyptian newspaper Al-Ahram. This may confirm the cultural impact on gender in the region. Even among newspapers in Egypt, which is more liberal in terms of women's rights, there is no homogeneity between the number of female journalists and male journalists. For example, at Al-Ahram, over 57% of the journalists who produced science news were women, while at Al- Masry Al-Yuom, only 3% of science news was produced by women.

5.2.14. Statistics Types

It is important to analyse the type of statistics to assess the ability of interpretation. Both descriptive and inferential statistics make distinctive contributions to the way that journalists and readers understand the world. For instance, in the case of crime, authors have discussed how inferential and descriptive statistics contribute to the way that an audience builds the social reality around the deviation (Lugo-Ocando 2017). Therefore, the ability to make a distinction between inferential or descriptive statistics is vital in “comparative reasoning” (Pfannkuch et al. 2010).

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Descriptive	329	35.3	35.3	35.3
	Inferential	603	64.7	64.7	100.0
	Total	932	100.0	100.0	

Table 15. Type of statistics (Source: author’s data)

The Table above shows that both inferential and descriptive statistics are used in science news; however, inferential statistics, in 64.7% of all articles, were used more often than descriptive statistics, which occurred in 35.3% of the articles. Although inferential statistics were used in most science news stories in Arab countries, some of the literature suggests that their use is not prevalent in the health field because it seems that doctors tend to possess only a slight knowledge of them (Allison et al. 2000, Fowler et al. 2013).

This finding is also contrary to Martisini (2018) finding that descriptive statistics are used in the health field more than inferential statistics but of course that can be explained by the distinctive geographical nature of both of our research projects. Indeed, the disparity in these findings suggests that there is a divergence in the practices of Arab and western journalists in terms of the types of statistics most used in health reporting.

The percentage of inferential statistics used in the reportage of health news was much higher (67.9%) than it was in the reportage of technology news (11.3%). An interesting correlation is evident between the types of science news and the type of statistics (descriptive and inferential statistics). A significant negative correlation ($r=-0.275$, p-value<001) indicated that health news tended to include inferential statistics, while technology news was more likely to include descriptive statistics. This point will be given more attention by means of the close-reading method and interviews with journalists. It can be said, however, that the nature of the news beat in a way defines the nature of the statistics used.

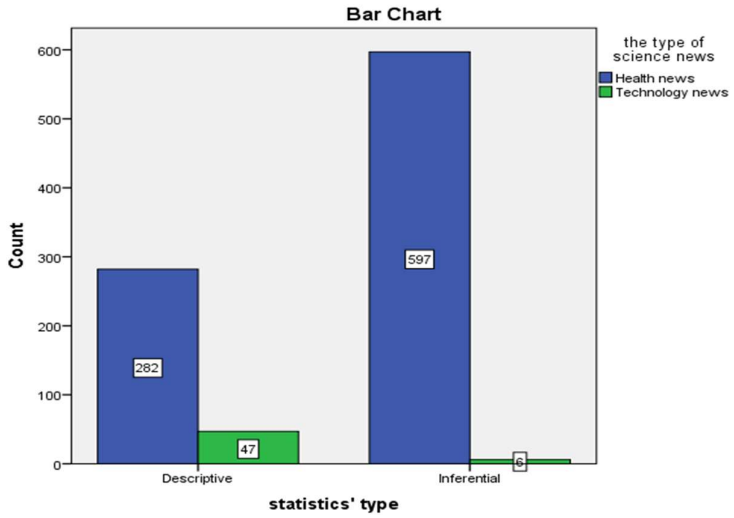


Figure 6. Statistics type

As can be seen from Table 31 below, over 77% of statistical data in science news is numerical data, while nearly 23% of the articles included categorical data. This finding is interesting because of the nature of some fields of science studies. It provides a better understanding of statistical data-building processes in the news.

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Numerical data	720	77.3	77.3	77.3
	Categorical data	212	22.7	22.7	100.0
	Total	932	100.0	100.0	

Table 16. Statistics type2 (Numerical-Categorical) data (Source: author's data)

Furthermore, the findings showed that there is a relation between statistics type1 (descriptive-inferential) and statistics type2 (numerical-categorical) data. A significant positive correlation (corr=.245, p-value<.001) indicated that categorical data tend to be used more in inferential statistics, while numerical data tend to be used more in descriptive statistics. This finding is related to the fact that interpretation is easier and more versatile when categorical data acts as its basis.

The findings also showed a negative correlation between the type of science news and statistics types (numerical and categorical) data. In technology news, numerical data is more likely to occur. On the other hand, health news used categorical data more than technology news did; this might be because it is relatively easy to find several variables for comparing such characteristics as gender, countries, diseases, etc. However, numerical data occurred more often than categorical data, with 668 and 211 articles, respectively.

		The type of science news	Statistics type 2
The type of science news	Pearson Correlation	1	-.122**
	Sig. (2-tailed)		.000
	N	932	932
Statistics type 2	Pearson Correlation	-.122**	1
	Sig. (2-tailed)	.000	
	N	932	932

Table 17. Type of science news and statistics type2 (Source: author's data)

5.2.15. Regarding Timeliness

Statistics are published at different times according to the official sources that provide them (monthly, quarterly, semi-annually, or annually). The issue of the time of publishing statistical information is a point disputed by both authorities and journalists and over the years some authors (Lugo-Ocando and Brandão 2016, Martisini 2018) who have suggested that even though journalists often argue that time pressures are often to blame for some of the mistakes made by news reporters when processing this data, there is no conclusive evidence really that this is the case. Timeliness therefore is considered to be a sensitive matter regarding the news reporting of statistics and it is continuously reviewed by people who deal with numbers (Chibnall 2013, Blanes and Kirchmaier 2018). It is therefore vital to evaluate the time that has passed between the statistical release and the publication of news that includes it. Equally important is the evaluation of the time that has passed between the research fieldwork and the statistical release. An understanding of this will allow for a sense of how useful the information remains.

		Frequency	Per cent	Cumulative per cent
Valid	Less than 3 months	272	29.2	29.2
	More than 3 months	35	3.8	32.9
	Unknown	625	67.1	100.0
	Total	932	100.0	

Table 18. Time passed between release and publication (Source: author's data)

The results in Table 33 above show that the majority of science news, 67%, makes use of statistics which do not indicate time either of collection or release to the public. This suggests a lack of transparency and accountability with the readers and that journalists are not doing all they can to verify the validity of the statistics they use. On the other hand, the percentage of scientific news containing statistical information is less than 3 months old and was the

second most common type with 29.2% while nearly 4% came from statistical information more than three months old.

Almost 98% of science news that includes statistical data came in the form of hard news, as shown in Table 9, which is not surprising given that not only is this the most prevalent genre used in the reporting of science statistics - as I established before - but also because in many cases, coming from official sources, they would be prepared as part of a communication strategy set to be deployed on specific dates.

The fieldwork also shows that is the case and that in the majority of science articles, over 63%, used statistical data to produce the stories.Therefore, we can assume tentatively that most science stories used statistics no greater than three months old. Further close reading and interviews with journalists - carried out in the next section - allowed me to confirm this assumption.

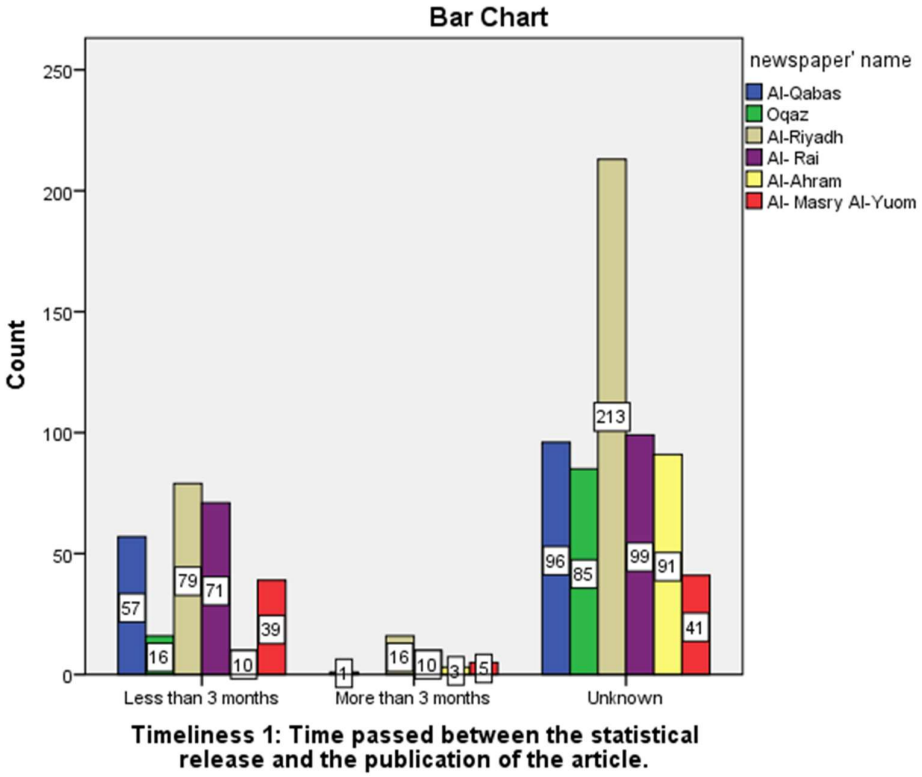


Figure 7. Timeliness: Time between release and publication (Source: author's data)

The figure number 7 above shows that *Al-Riyadh* published 213 articles in which the time between the release of the statistical data and the publication of the articles was unknown, by far the most. The gap between *Al-Riyadh* and the rest is clear because the numbers of the newspapers in second, third, fourth and fifth places were close to each other (Al-Rai, 99; Al-

Qabas, 96; *Al-Ahram* 91; and *Oqaz*, 85). *Al-Mesry Al-Yuom* came in last with 41 articles. For articles published less than three months had passed after the release of statistical data, Al-Riyadh, with 79 articles, was again in first place, followed by *Al-Rai* with 71 articles; Al-*Qabas* with 57 articles; *Al-Mesry Al-Yuom* and *Oqaz* with 39 and 16, respectively. *Al-Ahram* came in at the end of the list with only 10 articles.

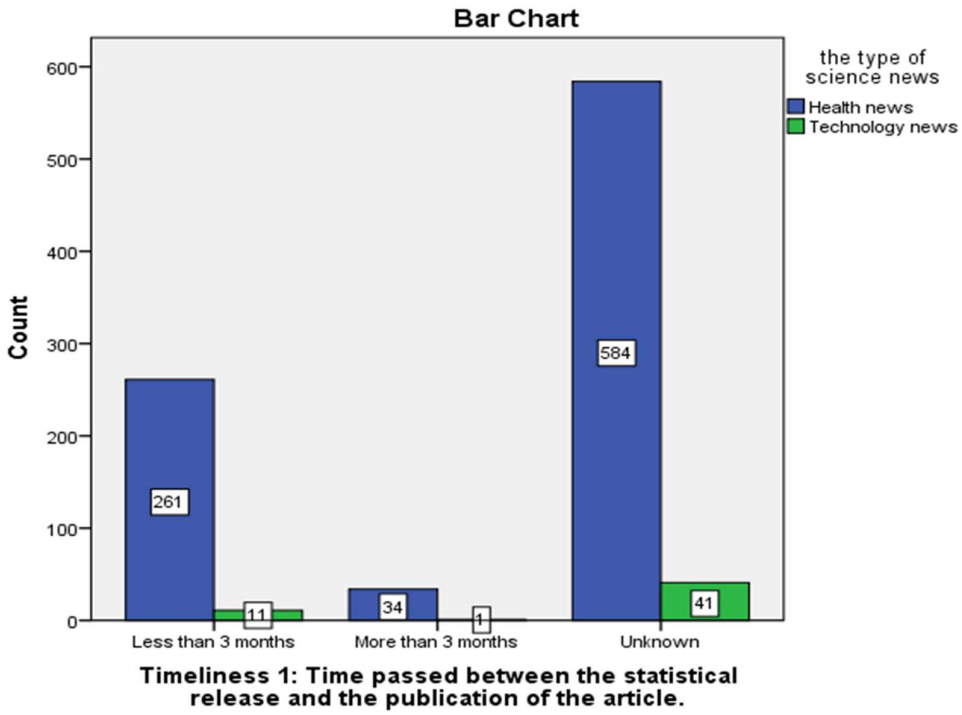


Figure 8. Timeliness: Time passed between the statistical release and the publication

Looking closely at the type of news in relation to the time between the statistical release and the publication of the articles, it seems that the majority of health articles, 584 out of 879, used statistics of unknown age, while 261 health articles used statistics less than three months old. The majority of technology news, 41 out of 53 articles, also used statistics of unknown age. One technology article contained statistics more than three months old, while 11 technology articles used statistics less than three months old.

5.2.16. Presentation of Statistics

In this study, the appearance of statistics in science news was divided into the three categories of explicit, implicit and a combination of both. These categories reflect how journalists deal with statistical data. The findings in Table 34 below show that most science news, 536 out of 932 articles, presented both explicit and implicit statistical data. This result could mean that

statistics in science news published by Arabic newspapers often appear in the form of explanations and comments.

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Explicit	353	37.9	37.9	37.9
	Implicit	43	4.6	4.6	42.5
	Both	536	57.5	57.5	100.0
	Total	932	100.0	100.0	

Table 19. The appearance of statistics (Source: author's data)

However, 42% of the science articles still include only statistical information implicitly. Again this is a weakness in journalistic practices as it limits transparency and accountability for the reader and might undermine many of the journalists' claims around the story as their absence obscure possible arguments made in the story.

On the other hand, technology news did not use implicit statistical data alone in any Arab newspapers. Technology articles used instead explicit and implicit statistical data together in 22 out of 31 cases. Explicit statistics were the most used in technology news at more than 58%.

In health news, explicit and implicit statistical data appeared both separately and together in different percentages. In 58% of health news, the two types both appeared; explicit statistical data alone came in second place, appearing in 36.6% of articles, followed by implicit statistical data alone, which appeared in just 4.9% of articles.

5.2.17. On Data Visualization

Visualisation of data has a role in making information more readily accessible to readers. It attracts attention, and can often convey information more efficiently than many words can. Visualizations of data, usually in the form of charts and diagrams embedded within a text, have been used to support news stories and provide additional evidence or related details (Segel and Heer 2010). Moreover, Gray et al. (2012, p. 191). point out that,

> *Data visualisation merits consideration for several reasons. Not only can it be strikingly beautiful and attention getting—valuable social currency for sharing and attracting readers—it also leverages a powerful cognitive advantage: fully half the human brain is devoted to processing visual information. When you present a user with information graphic, you are reaching them through the mind's highest bandwidth pathway. As well as designed data visualisation can give viewers an immediate and profound impression and cut through the clutter of a complex story to get right to the point.*

The findings in Table 35 showed an interesting and obvious gap regarding the use of statistics in visual information. A high percentage of science articles, nearly 99%, do not use any visual information. This supports Al-Qafari (2009) findings of a lack of interest among journalists in embedding graphics into scientific news. This is an unexpected result because of the significant role that visual elements can play in simplifying and delivering information in ways that make it understandable for readers. Visual statistics are very important in facilitating the delivery of information; for several reasons, this is especially true for an Arab audience. More than twenty per cent of the Arab population suffers from illiteracy (UNESCO 2013). Further, the enormous amounts of money spent by a number of Arab countries in the field of science would seem to support an easy delivery of scientific information to readers there.

Statistics type 3: Does the article include graphs?

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Yes	15	1.6	1.6	1.6
	No	917	98.4	98.4	100.0
	Total	932	100.0	100.0	

Table 20. Articles featuring graphs (author's data)

This is not a problem exclusive to Arab countries but one that also occurs in the West. Brandao (2016) findings showed that 86.7% of science news stories do not present any visual data. This issue may also reflect cultural limitations of technological media convergence. Journalists must think differently in the new media world, one in which audiences are changing very quickly; they should be aware that it is important not only to produce content, but also to create the environment in which content can be consumed (Hall 2001). Along these lines, what this data highlights is that newspaper journalists in Saudi Arabia, Kuwait, and Egypt are thinking in much the same way as journalists elsewhere who describe lower important to visual data.

When the newspapers are compared in terms of the use of visual data, in Table 36 the percentages were the same or very close to each other. Oqaz was first with only 4 articles; then all Al-Riyadh, Al-Rai and Al-Ahram with 3 articles each; and finally, Al-Qabas with 2 articles. It is notable that that Al- Masry Al-Yuom used no visual data in its coverage of science news; this might suggest that journalists at this newspaper are more likely to face more difficulties than other journalists in interpreting the statistical data.

		Does the article include graphs?		
		Yes	No	Total
Newspaper name	Al-Qabas	2	152	154
	Oqaz	4	97	101
	Al-Riyadh	3	305	308
	Al- Rai	3	177	180
	Al-Ahram	3	101	104
	Al- Masry Al-Yuom	0	85	85
Total		15	917	932

Table 21. Articles featuring graphs cross-tabulated by newspaper (Source: author's data)

The findings reveal that visual data was used in science news in only 1.6% of the articles; this result is, of course, disappointing and may reflect a lack of interest on the part of journalists. Just three types of visual information were used in the articles: table, bar chart and pie chart. The pie chart, with 8 occurrences, was the type most frequently used to present statistical information with visual data; the table came in second place with 4 articles; and the bar chart appeared in 3 articles. That visual data was used in just 15 of 932 articles could suggest that journalists lack the knowledge of the role that each type plays in reinforcing and simplifying statistical information.

5.2.18. Geographical News Coverage

The geographical coverage of science news can play a crucial role in determining whether the news is accurate or not. There are several reasons for this, including the nature and origin of the main source of news and varying levels of scientific expertise, especially between developed and developing countries. The expectation is, especially these days, that developing countries use material and content produced by organizations operating in industrialized nations to provide science-related news. Furthermore, in the Arab region, journalists covering science have little or no access to news sources as often, such sources simply do not exist (Mahmood 2008). These countries also face the greatest challenge to reporting science news, and this is the scarcity of science journalists themselves (Al-Qafari 2009). Another factor is the lack of statistics education among journalists (Alhumood et al. 2016, Ibnrubbian 2016).

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	International	544	58.4	58.4	58.4
	National	388	41.6	41.6	100.0
	Total	932	100.0	100.0	

Table 22. Geographical coverage (author's data)

The results in Table 37 above indicate a reversal of expectations. Although more than half of the science news, 58.4%, derived from international sources, local coverage of the articles was somewhat similar at nearly 42%. Based on the challenges mentioned above that face journalists in Arab society, including their inability to deal with statistics, this suggests that science news in the region's newspapers may not be entirely accurate and may offer less useful explanations and fewer comments.

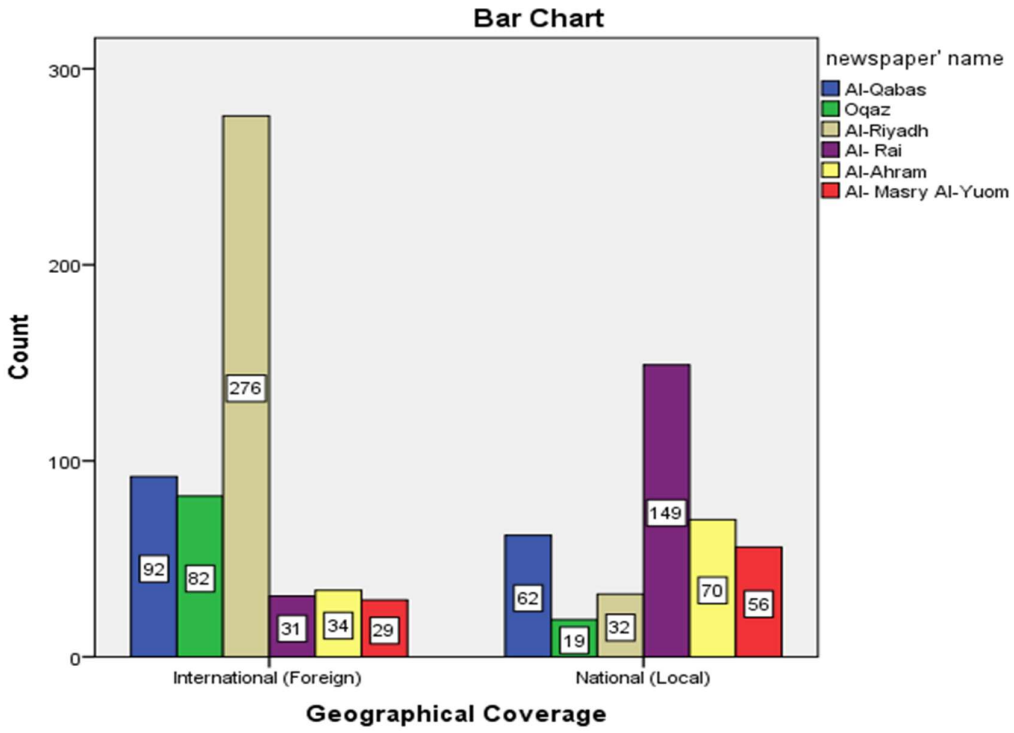


Figure 9. Geographical Coverage

The Bar Chart above shows that, in terms of science news that included statistical data, Al-Riyadh published far more international than national stories, with 276 and 32 articles, respectively. The quantity of international science news it published suggests that Al-Riyadh may be more accurate and better in dealing with statistics than other publications. Al-Qabas and Oqaz also published international science news more than national science news; Al-Qabas published 82 international stories and 62 national ones, while Oqaz published 62 international stories and 19 national ones. Even so, these papers are not at the same level as Al-Riyadh in publishing international science news. Conversely, Al-Rai, Al-Ahram and Al-Masry Al-Yuom published national science news more frequently than international science news. Al-Rai was in first place in this category with 82.8% of 180 articles. Of Al-Ahram's 104 articles, 67.3% were national, and of Al-Masry Al-Yuom's 85 articles, 65.9% were national.

Based on these findings, Al-Rai, Al-Ahram and Al-Masry Al-Yuom are more likely to misuse statistical information than papers in which international stories are dominant.

		The type of news	Geographical coverage
The type of science news	Pearson Correlation	1	-.142**
	Sig. (2-tailed)		.000
	N	932	932
Geographical coverage	Pearson Correlation	-.142**	1
	Sig. (2-tailed)	.000	
	N	932	932

Table 23. Correlation between geographical coverage and the type of news (author's data)

The Table above shows that there is a relation between geographical coverage and type of science news. A significant negative correlation (corr= -0.142, p-value<.001) indicates that health news concerned international areas somewhat more than it did national areas, however, technology news tended to be national. This focus on international health news has several possible causes. One is that national science news is less accessible than international science news as a result of obstacles to the access of statistical data and sources in Arab countries. This limited access may suggest a lack of transparency in those countries. For the most part, Arab newspapers have served their regimes (Nötzold and Pies 2010, p. 60). This tendency necessarily limits the freedom of these newspapers to access information. Some Arab newspapers are issued from abroad in order to avoid the restrictions applied by the government; these papers have better access to information than newspapers published in the Arab countries (Mellor 2011, p. 61).

The focus of Arab newspapers on diseases prominent in Arab countries, such as diabetes, high blood pressure, heart disease, and hepatitis, can be considered both national and international in focus, for these diseases are also common in other countries. Newspapers cover global trends in their spread and treatment, as well as western scientific advancements in the medical field.

5.2.19. The Length of the Science Articles

Table 39 below shows the frequencies of the sample sizes which are presented to the readers. The findings showed that 78% of the articles present statistical information in a small area, defined as less than a quarter of a page. That this occurs so regularly might suggest that Arab journalists are unable to provide additional context to their stories. One of the most significant criticisms that academics have made of journalism is the lack of context in news stories (Brandao 2016). This problem arises in the area of science news that includes statistical data. An expectation of journalists is that they present various viewpoints as a means of providing

the interpretations and contextual understanding necessary for comprehensive news stories (Dimitrova and Strömbäck 2009, p. 75).

The brevity of science articles in the newspapers surveyed in this study suggests that Arab journalists seem unable to provide a meaningful and comprehensive context for each story; something that would bring about additional criticality and provide additional interpretation. One indication of this, is the size of the news articles, which are mostly written in 'hard news' style. One can fairly assume that the length of each news item containing statistical information is indicative of the ability of reporters to contextualise and discuss these numbers beyond the data and press release provided by the source. In fact, most science news which contains statistics in Arab newspapers falls into the category of hard news might limit the interpretation of statistical data, making it difficult to contextualise and elaborate upon the relevant statistics.

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	<0.25	727	78.0	78.0	78.0
	0.25 > 0.5	172	18.5	18.5	96.5
	0.5 > 0.75	28	3.0	3.0	99.5
	0.75 > 1	5	.5	.5	100.0
	Total	932	100.0	100.0	

Table 24. Number of word frequencies (author's data)

Analysis of the number of words cross-tabulated with geographical coverage showed that the number of words used in science articles was to some extent higher in national than in international stories (corr=.171). This could mean that difficulties arose for Arab journalists in accessing statistical data related to international coverage, while proximity allowed them better access to national data.

5.2.20. Interpretation of Statistical Data

In theory, statistics should be used to facilitate and clarify a news story more comprehensively, in addition to helping the journalists themselves to be more accurate in the writing of the story. Therefore, the statistical data should be simplified, first interpreted by journalists who then write articles that become easily interpreted by readers. As part of the 'interpretative' community to which Zelizer (1993) refers to, the interpretation of the world out there provides meaning for audiences. In this sense, the findings indicate that the majority of the statistical data was interpreted in science news and that this was the case with nearly 97% of the articles. In other words, at least in regards to this, journalists in the Arab world seem to be complying with the normative expectations around who they are and what they do.

Interpretation: Are the statistics in the article interpreted?

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid.	Yes	902	96.8	96.8	96.8
	No	30	3.2	3.2	100.0
	Total	932	100.0	100.0	

Table 25. Interpretation of statistics (author's data)

In this study, the interpretation of statistical data refers both to the interpretation of the statistics and also the use of statistics to add value to the news stories. Though a high percentage of the science news including statistics includes some interpretation, this does not mean that this interpretation by journalists is necessarily a critical interpretation that adds value. Journalists do not subject science statistics to the same level of scrutiny to which they subject other news beats, such as politics and economics. The fact that nearly 97% of the articles include interpretation suggests an important opportunity for improvement, because this impulse to interpret could serve as a means to encourage journalists toward developing interpretations of a higher quality.

Only 3.2% of the science news articles lacked interpretation. Notably,40 articles that were interpreted were interpreted incorrectly. This is a relatively small percentage when compared to all the science articles that were interpreted. This may run contrary to the expectation that Arab journalists have a weakness in dealing with statistics in science news. However, better accuracy can be gained through the expert panel method, which provides a sense of how accurately journalists interpret statistical data and how correct they are in the news they produce.

By looking deeply into the articles that did not interpret statistical sources, the Bar Chart below shows that over 60% of the 30 articles that were not interpreted came from unknown sources. Of the remaining 12 articles that were not interpreted, half came from official and half came from non-official sources.

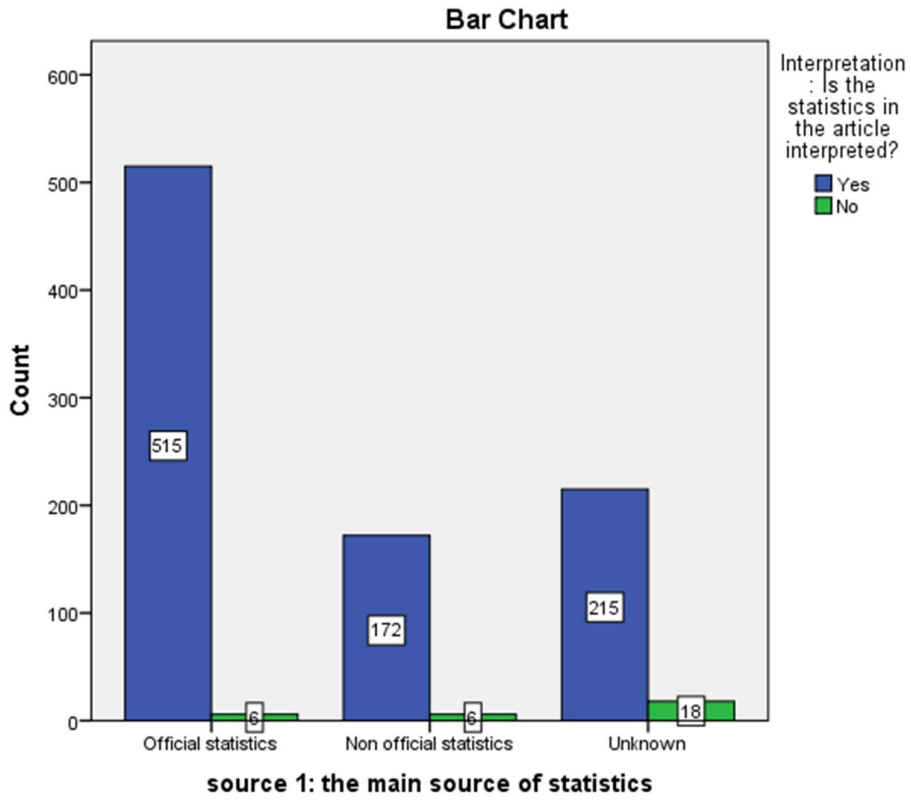


Figure 10. Sources

The findings also indicated a relationship between the interpretation of statistics and their validity. There was a positive correlation between interpretation and validity (corr=.241), which suggests that incoherent statistics used in science news pose a challenge in their interpretation. Another correlation the findings revealed was that between the interpreted statistical data and the reliability of statistical sources. The resulting positive correlation (corr=.129) indicated that using reliable articles as sources for statistics produced statistical results that lend themselves to interpretation.

5.2.21. On Statistical Reliability

As I have discussed before, it is important to follow adequate mathematical and statistical procedures to enhance the reliability to science news by choosing a representative sample or suitable test that offers ways in which this can be done. News that does not consider these procedures could be reporting unreliable statistics.

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Yes	829	88.9	88.9	88.9
	No	103	11.1	11.1	100.0
	Total	932	100.0	100.0	

Table 26. Statistical reliability (Source: author's data)

As seen from the Table 41 above, nearly 89% of articles followed adequate mathematical and statistical procedures and only 11.1% did not.

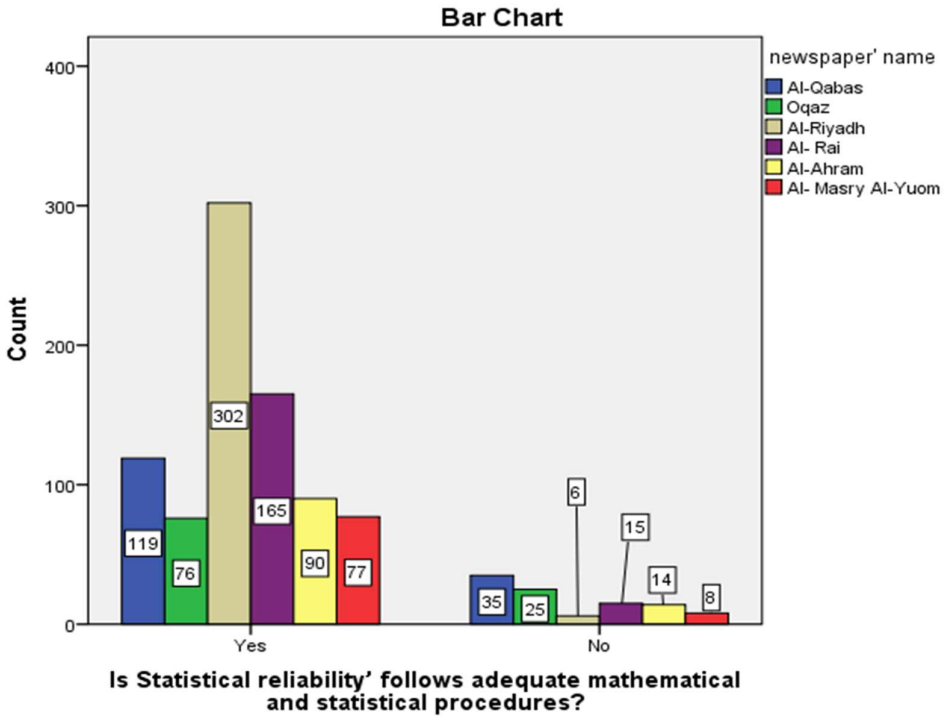


Figure 11. Following adequate statistical procedures

The Bar Chart above shows interesting findings regarding the science articles which followed adequate mathematical and statistical procedures, especially those from Arab newspapers. Al-Riyadh, with 308 articles, was in first place in publishing science news, and was also best in terms of following statistical procedures. The analysis shows that 98.1% of science news published by Al-Riyadh followed the statistical procedures correctly. This finding was not expected because of Arab journalists' inadequacy of dealing with statistics. In second place was Al-Rai with 91%, and then Al-Masry Al-Yuom with 88%. On the other hand, Oqaz and Al-Qabas were the Arab newspapers least able to deal with statistical procedures orrectly; they obtained percentages of 24.8% and 22.7% Al-Qabas, respectively. These findings underline different levels between Arab newspapers in terms of following statistical procedures.

However, Al-Riyadh was by far the best, based on the volume of articles published and in following statistical procedures. These factors may be a result of the high percentage of international science news published by Al- Riyadh [Geographical coverage- Figure 9].

			source: the main source of statistics			
			Official statistics	Non-official statistics	Unknown	Total
Does statistical reliability follow adequate mathematical and statistical procedures?	Yes	Count	496	157	176	829
		% within: does statistical reliability follow adequate mathematical and statistical procedures?	59.8%	18.9%	21.2%	100.0%
		% within source: the main source of statistics	95.2%	88.2%	75.5%	88.9%
	No	Count	25	21	57	103
		% within: does statistical reliability follow adequate mathematical and statistical procedures?	24.3%	20.4%	55.3%	100.0%
		% within source: the main source of statistics	4.8%	11.8%	24.5%	11.1%
Total		Count	521	178	233	932
		% within: does statistical reliability follow adequate mathematical and statistical procedures?	55.9%	19.1%	25.0%	100.0%
		% within source: the main source of statistics	100.0%	100.0%	100.0%	100.0%

Table 27. Statistical reliability and procedures (Source: author's data)

When considering the science articles that followed adequate mathematical and statistical procedures in relation to the statistical sources that they used, the findings showed that just over 55% of the articles that did not follow these procedures came from unknown sources. This could confirm that journalists simply trusted the statistical information they found rather than checking it, especially when it came from unknown sources.

The second greatest number of articles that did not follow adequate statistical procedures came from official sources; this group represented 24.3% of 103 articles. This was unexpected

because one would expect that official sources would be more accurate and valid than other sources. Instead, these sources had the lowest rate of accuracy and validity (20.4%), which is concerning as most journalists rely on these sources to produce their stories.

Furthermore, following adequate mathematical procedures can lead to an improvement in the validity of statistical data. The findings showed a relationship between following procedures and the validity of statistical data. In this study, the use of coherent statistics for the topic of interest was positively linked to following adequate mathematical and statistical procedures, since the resulting correlation was positive (corr=.279). Following adequate mathematical and statistical procedures also led, to some extent, to interpretable statistics within the articles, since the resulting correlation was positive (corr=.246).

Another correlation evident in the findings was that between following adequate mathematical procedures and the absence of statistical data; there is a moderately negative correlation (corr=-.450) between these factors. This result indicates that the absence of statistical information that supports the journalist's claim in the article was very likely due to using inadequate methods of statistics.

5.2.22. Absence of statistical data

Is there statistical information absent which has a role in supporting the journalist's claim in the article?

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Yes	138	14.8	14.8	14.8
	No	794	85.2	85.2	100.0
	Total	932	100.0	100.0	

Table 28. Missing information (author's data)

The presence of statistics in news stories enhances the journalist's claims and helps to explain the news in a way that delivers information to readers better than news without numbers. If a journalist claims a certain thing and this assertion requires supporting statistics, then the absence of statistics greatly affects the accuracy and validity of the news; the lack of statistics may call the full story into question. As Table 43 above shows, more than 86% of the articles included statistical data which supported the journalists' claims. However, nearly 15% of the articles did not include such information. This may suggest that some journalists were not careful about checking the statistical data related to their science articles and this contributed to the inaccuracy of the stories.

		Is statistical information absent which has a role in supporting the journalist's claim?		
		Yes	No	Total
The main source of statistics	Official statistics	36	485	521
	Non-official statistics	25	153	178
	Unknown	77	156	233
Total		138	794	932

Table 29. The main source related to missing information (Source: author's data)

Table 44 above shows that more than half the articles lacking statistical data supporting what they said came from unknown sources; this was the case with 77 of 138 articles. Non-official sources were the best because they had just 25 articles, the lowest number, in this category; official sources came next with 36 articles.

		Reliability	Absence
Reliability: Is the source of statistics in the article reliable?	Pearson Correlation	1	-.314**
	Sig. (2-tailed)		.000
	N	932	932
Absence: Is there an absence of statistical information which could support the journalist's claim in the article?	Pearson Correlation	-.314**	1
	Sig. (2-tailed)	.000	
	N	932	932

Table 30. Correlation between reliability and absence of statistics (author's data)

The moderately negative correlation (corr=-.314) between reliability and absence of statistics was a strong indication confirming that relying on unreliable articles as a source of statistics would result in an absence of statistical information having an essential role in supporting the journalist's claim in the article. Another moderate correlation evident in the findings was that between the absence of statistics and the coherent use of statistics. Using incoherent statistics was found to strongly correlate (corr=-.388) with the absence of statistical results that serve a role in supporting the journalist's claim in the article.

5.2.23. Regarding Validity

In relation to the question, is the use of statistics coherent with the topic? We need to observe the following table,

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Yes	878	94.2	94.2	94.2
	No	54	5.8	5.8	100.0
	Total	932	100.0	100.0	

Table 31. Validity (Source: author's data)

In this study, validity means the legitimacy of the claims made about the statistical information presented by the journalists (Lugo-Ocando 2017). Therefore, validity refers to whether the statistical data support what journalists claim. Because it plays an important role in cohesion and accuracy in the news, it is necessary to check the validity of the statistical data. According to Maienschein (1999), it is important to evaluate the validity of not only science in the news, but any information. In analysing science news, it can be seen that over 94% of the articles were valid, while only 5.8% of the articles were not.

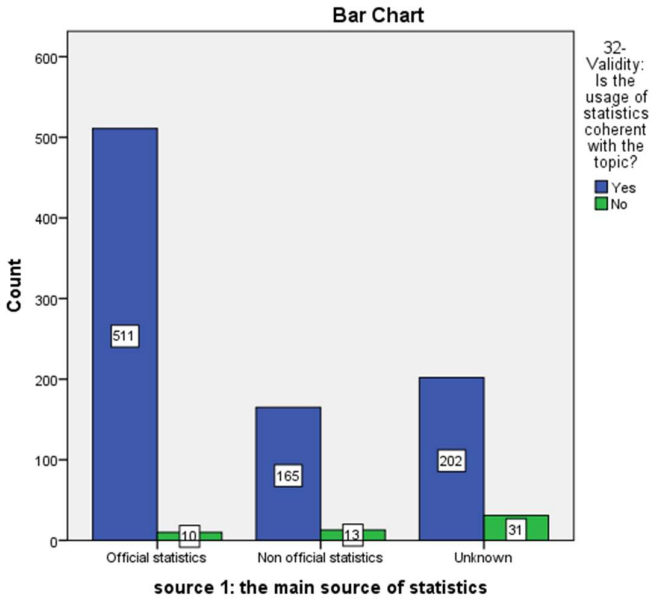


Figure 12. Main sources and validity

More than 57% of the 54 articles that included invalid statistics came from unknown sources. This percentage could confirm that Arab journalists rely on any source available without checking the validity of its statistical information. Other invalid statistical data were divided between official and non-official sources with close rates of 18.5% and 24.1%, respectively.

Moreover, the findings showed that there was correlation between the reliability and the validity of using statistics. Based on the resulting positive correlation (corr=.222), using coherent statistics in the article was linked with to the reliability of an article using a source of

statistics. This could mean that the more statistical information is obtained from reliable sources, the greater the validity of these statistics.

5.2.24. Summary of the Findings

Overall, the findings indicate three primary characteristics of the coverage of science news by Arab newspapers. The first element involves normative aspirations/claims of professional autonomy against reality on the ground. Rather than relying entirely on official sources, many journalists working in media cite unofficial statistical sources in their science news reporting. Nevertheless, the broad picture that we can draw from the findings is an over-reliance rather than an ability to challenge prevalent narratives. However, the fact that there are cases in which reporters seek out authoritative sources beyond the state suggests a desirable degree of professional autonomy and gives some hope for the future (although not without setbacks). The second element involves transparency and accessibility to the sources used to produce news context. In this sense, the findings suggest that overwhelmingly, journalists use a single source, they too often allow the sources to go unmentioned, employ anonymous sources and rarely truly question statistical data or the sources. In fact, as we saw here, statistical sources are either double-checked or triangulated with other sources and that provides an account of events that tends to reproduce prevalent official accounts.

The final element is the ability to provide a meaningful and comprehensive context for each story so that audiences may interpret the information and engage with the subject properly. In this respect, the majority of science news that includes statistical information, 78%, is presented in brief stories that take up very little space on the page. The fact that most science news which contains statistics in Arab newspapers is hard news might limit the scope of interpreting statistical data, as this makes it difficult to contextualise and elaborate upon the statistics in each story.

5.2.25. Control Group

To make sure that my study complies with set standards, it included a control group which consisted of non-Arab newspapers. This control group analysed 10 science news from two British newspapers (The Guardian and The Times). The sample of this science news was chosen randomly. The purpose of using the control group is to compare how journalists use statistics between Arab news and western news to find out whether or not Arab journalists use numbers better than their counterparts in the West. From the results, it seems that the British newspapers are better than the Arab newspapers in terms of the use of statistics in science news. However, this does not mean that there is a large distance between them.

The findings show that all science-related articles in British newspapers contained statistics, while the figure for Arabic newspapers was 73.7%. This was expected for several reasons. One of them is that most science news in the world usually comes from western media. Most of the scientific developments in this era are derived from developed countries. What is noticeable is that most of the scientific news in British newspapers quoted the name of the journalist specialized in scientific news, something which was almost absent in the Arab newspapers. In addition, all science news produced by British newspapers which quoted the journalist's name could indicate that there is an abundance of science journalists compared to the number of Arab journalists who write science news (73.7% of all science news published by Arab newspapers).

The research found that all science news - including statistical data - written by British newspapers came in the form of hard news, while in Arab newspapers, almost 98% of science news included statistical data in the form of hard news and just 2.3% of such articles came in the form of beat reportage. Also, in Arab newspapers the science news appeared across all pages (first pages 3.5%, middle pages 88%, and last pages 70.6%) while in British newspapers, science news containing statistical data was found only in the middle pages.

In Arab newspapers, the majority of the science articles (63.3%), used statistical data to produce stories. Using statistics to substantiate stories came second (30% of all articles), and statistics used to contextualise stories came last (only 6.6% of all articles). On the other hand, in British newspapers 70% of articles used statistics to substantiate stories and the remaining 30% used statistics to produce the stories.

Content analysis revealed that British newspapers obtain statistical data from official sources and non-official sources. Some 90% of science news in British newspapers relies on official sources to obtain statistical data whilst 10% of the articles obtain statistics from non-official sources.

In contrast, Arab newspapers obtain statistics from official, non-official and unknown sources with a different spread of percentages. Statistical information from official sources account for 55% of science articles in Arab newspapers, whilst in second place, 25% came from unknown sources. Non-official statistics, such as those from non-governmental organizations, came last with 19%. These results are expected when we compare western and Arab countries, for several reasons. One of them is the difficulty of accessing the source in Arab countries and another is the freedom granted to newspapers in Arab countries which is much lower than that in western countries and finally, the lack of scientific journalists in the Arab countries. These results could lead to accepting any statistical information from any source, whether this source is known or unknown.

Moreover, most of the official sources used by British newspapers were original scientific sources (universities and science journals) (80% of all articles), while the same sources used

by Arab newspapers accounted for just 31% of all articles. Furthermore, all science news produced by British newspapers mentioned the sources of the statistics. In contrast, nearly 25% out of all articles published by Arab newspapers did not mention the source of the statistical data. This means that, in the context of science news, British newspapers are more accurate than Arab newspapers because the majority of statistical sources came from original scientific sources.

The results of this research also showed that, in both British and Arabic newspapers, the majority of science articles that contain statistical data used a single source. However, in Arabic newspapers using a single source occurred more frequently than in British newspapers [nearly 95% compared with 70%]. In addition, using two sources of statistical data appeared more frequently in British newspapers (30% of all articles), while only 4.4% of articles used two sources of statistical data in Arab newspapers. It may appear that the British newspapers present the statistics more accurately than do Arab newspapers

In terms of the reliability of statistical sources, the findings indicated that, all the sources of statistics in science news published by British newspapers were reliable while, in Arab newspapers, over 74% of the sources of statistics were reliable and nearly 26% of the sources which provided statistical data are unknown. This percentage of unknown statistical sources in Arab newspapers is likely to indicate the sources are unreliable so, British newspapers are more accurate than Arab newspapers in using statistical sources in science news.

Some 60% of all science news articles published by British newspapers used simple comparison statistics compared to Arab newspapers where the figure was 26%. Using stand-alone statistics in science news took place more in Arab newspapers than in British newspapers [73.7% and 40%, respectively]. From the findings we can suggest that British newspapers give more details to their readers than Arab newspapers which leads to better understanding by their readers.

The findings showed that in British newspapers, 60% of science news that includes statistical information was produced by men with 40% produced by women. On the other hand, in Arab newspapers, only 9% of science news was produced by women.

The results show that the British newspapers did not use visual statistics to complete and explain the statistics. In contrast, Arab newspapers used visual statistics by only 1.4%, out of all science articles containing statistical data. This means that there is a great convergence in press practice between Arab and British newspapers in the lack of support of news with visual statistics.

The findings also show that both British and Arab newspapers used inferential and descriptive statistics in science news; however, in Arab newspapers inferential statistics were used more than in British newspapers [64.7% and 50% respectively of all articles]. The use of descriptive statistics was greater in British newspapers than Arab newspapers [50% and 35.35%,

respectively]. Moreover, there is a great convergence in the use of numerical data between British and Arab newspapers. In Arab newspapers, over 77% of statistical data in science news is numerical data, compared with 70% in British newspapers. On the other hand, nearly 23% of the articles included categorical data in Arab newspapers compared with 30% in British newspapers.

The findings show that the majority of science news in both British and Arab newspapers [80% and 67%, respectively], make use of statistics which are of unknown age. On the other hand, the percentage of scientific news containing statistical information less than 3 months old was the second most common type used in Arab newspapers with 29.2% and this percentage is relatively close to the comparative figure in British newspapers of 20%. Some 20% of statistical information in British newspapers from sources more than three months old and this compares with a figure of only 4% for Arab newspapers.

The findings indicated that in British newspapers, all science news presented used both implicit and explicit statistical data which is much better than in Arab newspapers where only 57.5% of all science news presented both implicit and explicit statistics. Some 42% of the science articles still include only explicit or implicit statistical information. This may mean that in British newspapers there are more details regarding statistics and more explanation. In both cases, this percentage causes concern. The use of numbers only may lead to misunderstandings, and the delivery of information to readers may not be successful because of the weakness of journalists in dealing with numbers.

The results highlighted that there is a divergence between British and Arab newspapers in terms of geographical coverage with 80% out of all science stories derived from local news in British newspapers, which is almost two times greater than in Arab newspapers where the figure is 42%. In contrast, in Arab newspapers international news relating to science stories that included statistical data accounted for more than half of the science news, (58.4%), which is nearly three times more than the figure for British newspapers (20%). There are several reasons for this, including the nature and origin of the main source of news and varying levels of scientific expertise, especially between developed and developing countries. The expectation is, especially these days, that developing countries use developed countries as their source of science-related news.

The findings showed that all the science articles in British newspapers presented statistics in short-story form which was somewhat close to Arab newspapers (78% of the articles present statistical information in a ‘small size’, defined as less than a quarter of a page in Arab newspapers). Nearly 19% of the articles in Arab newspapers occupied more than a quarter of a page and less than half a page.

They also underlined that all science news that included statistics in British newspapers was interpreted, whilst in Arab newspapers, the majority (97% of all articles) of the statistical data

was interpreted in science news. Furthermore, all science news which included statistics in British newspapers was interpreted correctly, whilst in Arab newspapers over 95% of the articles were interpreted correctly. There is a preference for British newspapers but there is also a convergence between Arab and British newspapers in the interpretation of statistical data.

The findings indicate that, all science news containing statistical data in British newspapers followed adequate mathematical and statistical procedures which was better than in Arab newspapers, where this applied to nearly 89%, of articles. Put another way, in Arab newspapers, 11.1% of the articles did not follow these statistical procedures.

The findings show that, in British newspapers, all science articles included statistical data which supported the journalists' claims compared to 86% in Arab newspapers. The fact that in Arab newspapers nearly 15% of the articles did not include such information may suggest that some journalists were not careful about checking the statistical data related to their science articles, and this contributed to the inaccuracy of the stories.

In analysing science news which included statistical data, the results shows that all science news included valid statistics in British newspapers which was better than in Arab newspapers which came close, with over 94% of the articles being valid, while only 5.8% of the articles were not valid. Furthermore, nearly 90% of the articles did not verify the sources of the statistical data included in Arab newspapers which was better than British newspapers where all science news produced by them did not verify the sources of the statistics.

5.2.26. On the Comparative Findings

In general, the British newspapers are better than the Arab newspapers in terms of the use of statistics in science news. However, this does not mean that there is a large distance between them; in some variables there was a great convergence between the Arab newspapers and the British newspapers in terms of the use of statistics, such as interpretation of statistics and using numerical data in science news. Moreover, British newspapers are more accurate than Arab newspapers, especially in accessing more reliable statistical sources. Nevertheless, Arab newspapers were better than British newspapers in verifying statistical sources. Evidence in a number of areas suggests that British newspapers, may be superior to Arab newspapers, for example: in terms of journalists' easy access to information and the specialism of scientific journalists who have better capability and greater freedom to express themselves than do Arab journalists.

Finally, I would want to clarify that this comparison was made only with the aim of establishing a proper control group and that any analysis or conclusions are just indicative and speculative

as the sample is not necessarily representative of the wider universe of British newspapers. Therefore, the analysis here is just a way to explore how my own research might compare in terms of equivalent variables and to what degree it is consistent in terms of key indicators.

5.3 Close-Reading Rhetorical Structure Analysis

I used the Rhetorical Structure Theory in the close-reading stage. Certain elements of this theory are suited to the hermeneutic approach I took in the analysis of the articles. I then conducted a detailed analysis of the findings in twelve (n=12) articles: two from each newspaper, (Al-Ahram, Al-Masry Al-Youm, Al Riyadh, Okaz, Al-Qabas, and Al Rai) including ten related to health issues and two to technology. The research strategy presents an overview of the articles' text organisation, particularly the use of statistical data, through the evaluation of the relations, accuracy, rigour and research criteria, the validity, reliability, interpretation and absence of the statistics in the text are also assessed. I will use tree-diagrams to visualise the connections between parts of the texts.

The close-reading analysis in this research aims to examine the coherence of statistical data in science articles for the purpose of partly answering the following research questions: Do the statistics used by science journalists comply with principles of validity and reliability? Do journalists use statistics effectively to communicate science? The close-reading method is just one of several methods which this study employed to answer these questions. The performance of close-reading, a qualitative method, cannot alone represent how statistical data is presented in Arab newspapers; however, combined with other methods, including the use of an expert panel, it can help to address the research questions. It usefully provides a background for the ways in which science news is articulated in Arab newspapers.

5.3.1. On Main Findings

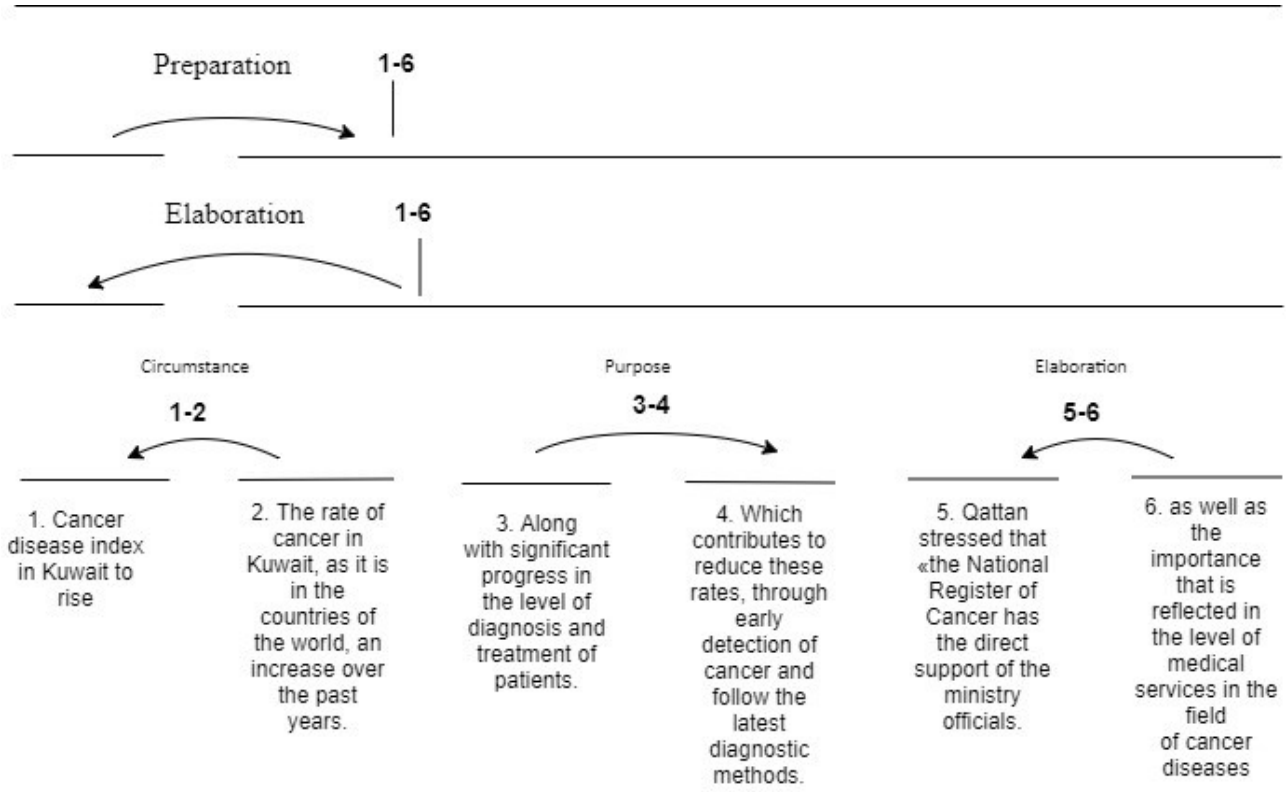
The results suggest two things in most science news stories. (1) Statistical information is articulated in a different way pursuant to the type of science news. Most health news was articulated in three levels of structure, while in technology news were articulated only in two levels of structure, (2) in most health news, which has three levels of structure, this does not mean that a higher level of structure is a guarantee of better coherence in health news, such as in articles [3] and [5] shown below.

1. Cancer disease index in Kuwait to rise (AL-Rai newspaper-Kuwait):

Article No.	1
Newspaper	AL-Rai
Title	Cancer disease index in Kuwait to rise
Author	Omar Alas
Date	11 April 2016
Words	533
Sentences	10
Sentence structure	Cancer disease index in Kuwait to rise. The rate of cancer in Kuwait, as it is in the countries of the world, an increase over the past years. Along with significant progress in the level of diagnosis and treatment of patients. Which contributes to reduce these rates, through early detection of cancer and follow the latest diagnostic methods. Qattan stressed that «the National Register of Cancer has the direct support of the ministry officials. as well as the importance that is reflected in the level of medical services in the field of cancer diseases,
logo	Unit 3
pathos	Unit 1
ethos	Unit 2
paratactic(coordinate)	Unit 1
hypotactic(subordinate)	The rest of the units

Table 32. Breakdown of the AL-Rai article

The first six sentences of the article indicated in Table 1 are articulated in three structural levels. The first level indicates that satellite 1 shapes a preparation for units 2-6. The second level features an elaboration relation between units 2-6 and satellite 1. In the third level of structure, additional information is given to elaborate unit 5 as well as unit 3, which is aimed at unit 4, ‘which contributes to a reduction of these rates. Unit 2 explains the situation of cancer and that it was widespread, not only in Kuwait, but also in the world.



The writer made unit 3, 'Along with significant progress in the level of diagnosis and treatment of patients', serve as the logos. However, a problem arises here: it seems that the message ignores the causes of the rising cancer rates in Kuwait. Unit 1, 'Cancer disease index in Kuwait to rise', represents pathos; Kuwait wants to be seen as a successful state, capable of delivering good health to its people. The first message, then, contradicts this appeal to pathos. Ethos is established in unit 2 with 'The rate of cancer in Kuwait, as it is in the countries of the world, an increase over the past years'. This statement supports the logos expressed in unit 3, notably demonstrating that even science news is associated with elements of control by the government. In the case of Kuwait and other Arab countries, the government always seems to need to say that it is somehow engaged in every issue. The main function of statistics in the first unit is paratactic, while those in the rest of the units are hypotactic.

Furthermore, in the article, the sentence, 'The rate of cancer in Kuwait, as it is in the countries of the world, a rise compared to the past years,' uses implicit statistics to discuss the increase in the incidence of cancer diseases in Kuwait and compares it to other countries around the world. It is assumed that the journalist then supports this claim by identifying the proportion of people in Kuwait infected with cancer over the past years and comparing this statistic with other countries to see whether the ratio is close. However, this statistic was not explained as

expected. The journalist identified the progress in the diagnosis of cancer and suggested that this progress reduced cancer. He stated, ‘There is significant progress in the level of diagnosis and treatment for patients, which contributes to the reduction of these rates, through the early detection of cancer diseases.’ He did not provide evidence using statistics.

The journalist reviewed the government’s progress in the diagnosis of cancer diseases, saying that the government has succeeded in reducing the incidence of cancer. However, this claim may be contrary to the first sentence, which states that cancer is increasing. In addition, the journalist did not support his claim with statistical data. This made the statistical data invalid. In addition, the journalist does not provide statistical information that supports his claim that the cancer risk index in Kuwait is increasing and that diagnosis has contributed to a reduction in cancer incidences.

The article’s statistics are from government sources, which may suggest that the journalists relied on official sources without making efforts to compare this statistical data with data from other sources, such as the World Health Organization.

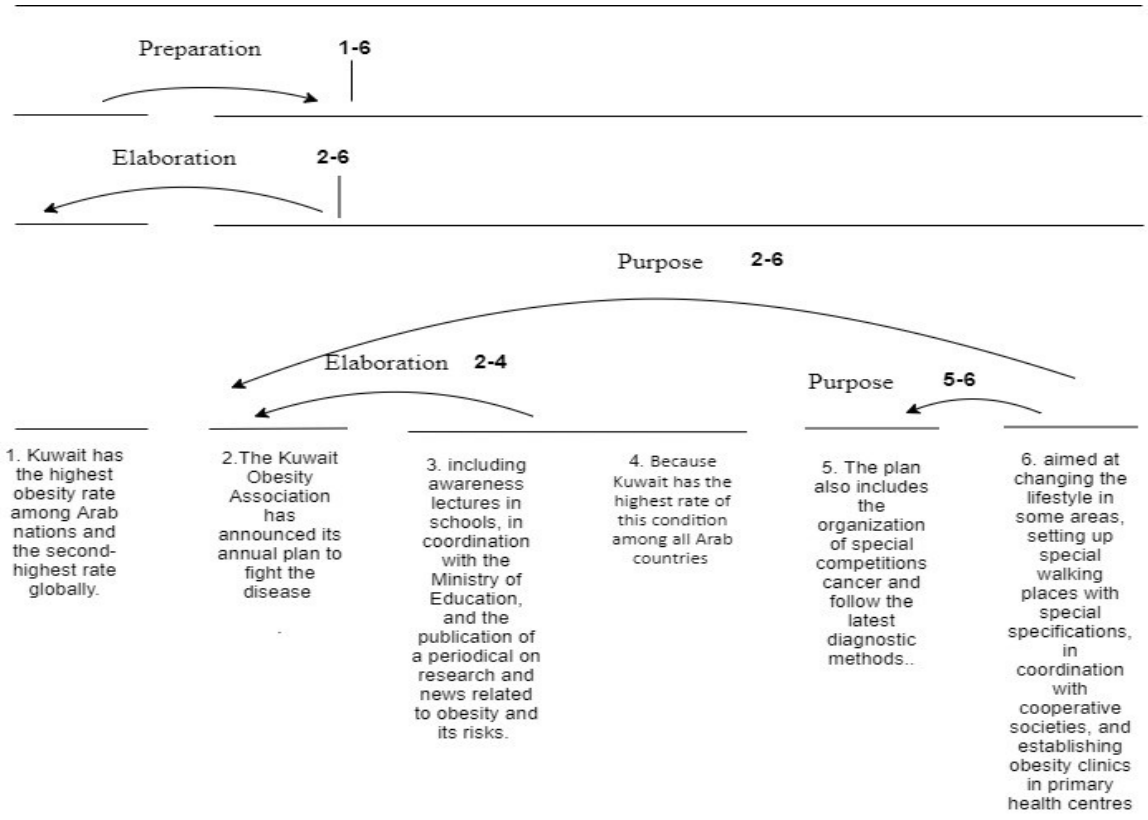
This article is not transparent and does not report the full information, especially since the statistical data was provided by government sources. The article lacks the statistical data necessary to support the journalist’s claim. It also lacks an interpretation of the statistics, which may contribute to facilitating and delivering information to the readers in a way that enables them to better understand it. Finally, the author depended on government sources without searching for additional statistical data. Overall, the three levels of structure are coherent and cohesive in the articulation of the four statistical data points included within the units of the article, and they are also strictly connected.

2. **Kuwait has the highest obesity rate among Arab nations and the second-highest rate globally**:

Article No.	2
Newspaper	AL-Rai
Title	Kuwait has the highest obesity rate among Arab nations and the second-highest rate globally
Author	Kuna
Date	29 January 2016
Words	262
Sentences	6
Sentence structure	1. Kuwait has the highest obesity rate among Arab nations and the second-highest rate globally. 2. The Kuwait Obesity Association has announced its annual plan to fight the disease. 3. …including awareness lectures in schools, in co-ordination with the Ministry of Education, and the publication of a periodical on research and news related to obesity and its risks. 4. Because Kuwait has the highest rate of this condition among all Arab countries. 5. The plan also includes the organization of special competitions. 6. …aimed at changing the lifestyle in some areas, setting up special walking places with special specifications, in co-ordination with co-operative societies, and establishing obesity clinics in primary health centres.
logo	Unit 2
pathos	Units 1 and 4
ethos	Unit 6
paratactic(co-ordinate)	Unit 1 and unit 4
hypotactic(subordinate)	Units 2, 3, 5 and 6

Table 33. Breakdown of the AL-Rai article

The article presents three levels of structure. The first level shows that satellite 1 shapes a preparation for units 2-6. The second level contributes additional information, creating an elaboration relation between units 3-4 and satellite 2. In this same level, unit 6 also serves a similar purpose for units 2 and 5. At the third level, the article goes into more detail, with units 3-6 elaborating satellite 2.



The writer made unit 2 ‘The Kuwait Obesity Association has announced its annual plan to fight the disease’ the logos, or the central idea that the journalist wants to communicate. It seems that the journalist focuses exclusively on future plans, ignoring the important element of the causes for Kuwait’s position as the nation with the highest percentage of obesity in the Arab world. Pathos occurs in both unit 1, ‘Kuwait has the highest obesity rate among Arab countries and the second-highest globally’, and in unit 4, ‘Because Kuwait has the highest rate of this condition among all Arab countries. The element of ethos occurs in unit 6, ‘aimed at changing the lifestyle in some areas, setting up special walking places with special specifications, in co-ordination with co-operative societies, and establishing obesity clinics in primary health centres in co-ordination’. Again, the aim is to build a message that supports the logos in Unit 2. Examination of the function statistics in this passage reveals that units 1 and 4 are paratactic, and units 2, 3, 5, and 6 are hypotactic.

The article lacks sufficient interpretation of the statistics; that is to say, the journalist fails to explain the statistics in a way that contributes to public awareness of the high risk of obesity in Kuwait. It represents an example of a science news story that uses only implicit statistics. Statistical data which could support the journalist’s claim that the obesity rate in Kuwait is the highest in Arab countries and the second globally, is absent. The journalist also failed to check for accurate statistical sources that would confirm the data contained in the article, but instead

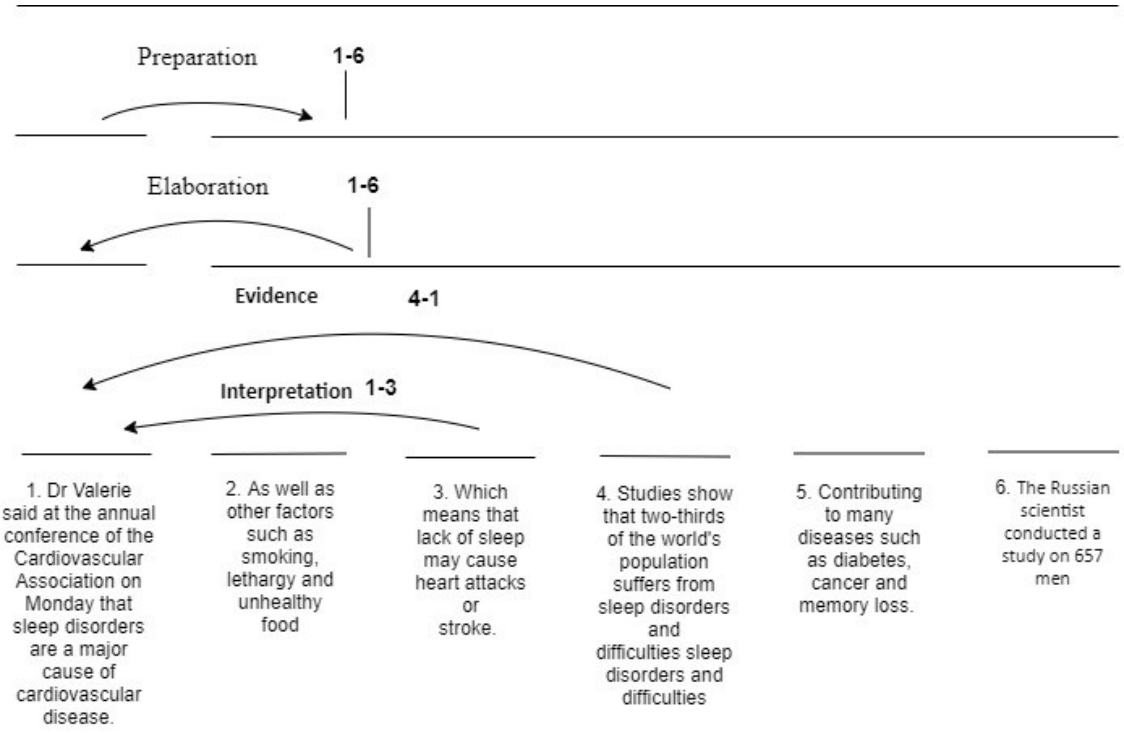
relied on a single statistical source. Good journalistic practice would involve seeking out statistical information provided by government sources as well as the World Health Organisation, rather than relying on non-official sources. Overall, the first six sentences included two statistical points which generally have a sense of coherence.

3. Sleep disorders hurt the heart (Al-Qabas newspaper-Kuwait):

Article No.	3
Newspaper	Al-Qabas
Title	Sleep disorders hurt the heart
Author	Fouad Salama
Date	18 August 2015
Words	788
Sentences	20
Sentence structure	Dr Valerie said at the annual conference of the Cardiovascular Association on Monday that sleep disorders are a major cause of cardiovascular disease. As well as other factors such as smoking, lethargy and unhealthy food. Which means that lack of sleep may cause heart attacks or stroke. Studies show that two-thirds of the world's population suffers from sleep disorders and difficulties. Contributing to many diseases such as diabetes, cancer and memory loss. The Russian scientist conducted a study on 657 men.
Logos	Unit 1
Pathos	Units 3, 5
Ethos	Unit 4
Paratactic (co-ordinate)	Unit 1
Hypotactic (subordinate)	Units 3, 4, 5 and 6

Table 34. Breakdown of the AL-Qabas article

The article presents three levels of structure. The first level shows that satellite 1 shapes a preparation for units 2-6. The second level contributes additional information, creating an elaboration relation between units 1-6 and satellite 2. At the third level, unit 3 ‘Which means that lack of sleep may cause heart attacks or stroke’ was used to interpret unit 1 as well as unit 4. ‘Studies show that two-thirds of the world's population suffers from sleep disorders and difficulties’ was used as evidence for unit 1.



The writer made unit 1, 'Dr Valerie said at the annual conference of the Cardiovascular Association on Monday that sleep disorders are a major cause of cardiovascular disease', the logos, or the central idea. Pathos occurs in both unit 3, 'Which means that lack of sleep may cause heart attacks or stroke' and unit 5, 'contributing to many diseases such as diabetes, cancer and memory loss'. The element of ethos occurs in unit 4, 'Studies show that two-thirds of the world's population suffers from sleep disorders and difficulties'. The main function of statistics in the first unit is paratactic, while those in the rest of the units are hypotactic.

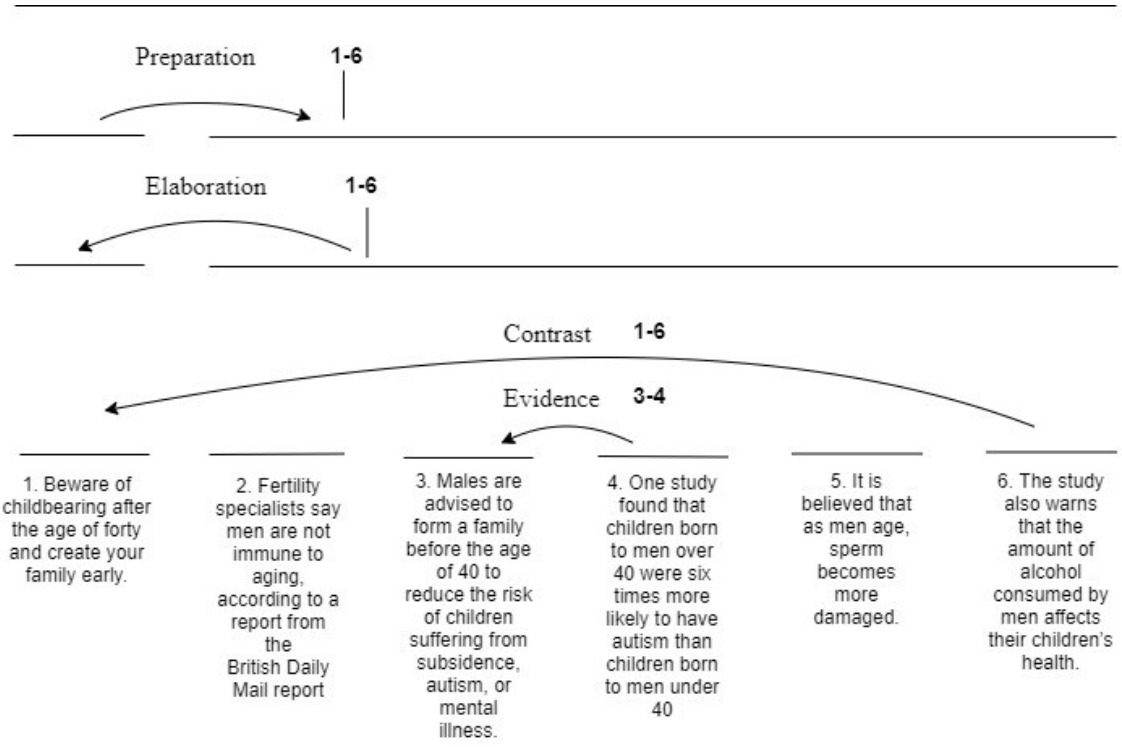
The article contains implicit and explicit statistics about sleep disorders as a potential cause for heart attacks, but, for several reasons, these statistics may not be entirely reliable. First, there is the matter of the reliability of the source of the statistics. For example, unit 4, 'Studies show that two-thirds of the world's population suffers from sleep disorders and difficulties', provides no source for this statistical data. Because no source is identified, readers may question the credibility of this information. The journalist also cites a survey conducted by the Russian researcher on a sample of men within a specific age range, which found that about 63% of the sample have sleep disorders. In this case, the sample is not broadly representative because it was only conducted on men of a specific age and omitted women altogether. That this study is rather old also suggests that these statistics are currently invalid and inaccurate. Overall, the statistics referenced in this article were somewhat inaccurate and were not interpreted in a way that helped deliver the message to readers.

4. Beware of childbearing after the age of forty (Al-Qabas newspaper-Kuwait):

Article No.	4
Newspaper	Al-Qabas
Title	Beware of childbearing after the age of forty
Author	The newspaper
Date	17 May 2016
Words	294
Sentences	10
Sentence structure	Beware of childbearing after the age of forty and create your family early. Fertility specialists say men are not immune to aging, according to a report from the British Daily Mail. Males are advised to form a family before the age of 40 to reduce the risk of children suffering from subsidence, autism, or mental illness. One study found that children born to men over 40 were six times more likely to have autism than children born to men under 40. It is believed that as men age, sperm becomes more damaged. The study also warns that the amount of alcohol consumed by men affects their children's health.
Logos	Unit 1
Pathos	Units 4 and 6
Ethos	Unit 2
Paratactic (co-ordinate)	Unit 3
Hypotactic (subordinate)	Units 4 and 6

Table 35. Breakdown of the AL-Qabas article

The article presents three levels of structure. The first level demonstrates that satellite 1 shapes a preparation for units 2-6. The second level contributes additional information, creating an elaboration relation between units 1-6 and satellite 2. At the third level, in unit 4, 'One study found that children born to men over 40 were six times more likely to have autism than children born to men under 40', statistical data was used as evidence to support unit 3, 'Males are advised to form a family before the age of 40 to reduce the risk of children suffering from subsidence, autism, or mental illness'. At the same level, unit 6 'The study also warns that the amount of alcohol consumed by men affects their children's health was used to show the cause of negative effects on children born when their fathers were past forty in unit 1.



Unit 1, 'Beware of childbearing after the age of forty and create your family early', acts as the logos. Pathos occurs in units 4 and 6. The element of ethos occurs in unit 2, 'Fertility specialists say men are not immune to aging, according to a British Daily Mail report'. The main function of statistics in the third unit is paratactic, while the function in units 4 and 6 is hypotactic.

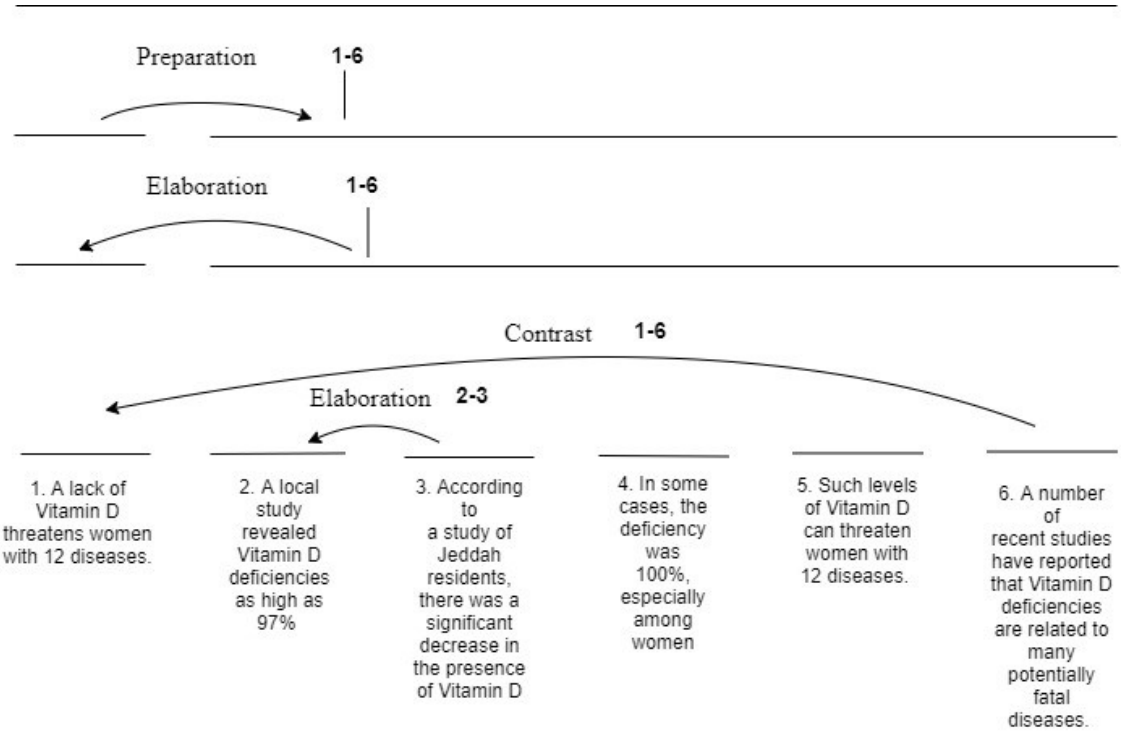
The article contains an implicit statistic in its warning about childbearing after the age of forty. The journalist's reliance on undisclosed statistical sources contributes to the scepticism about the validity of these statistics. The journalist also mentioned several statistics from unnamed studies which support the danger that may be faced by children whose parents are over 40. In addition, the journalist did not support his claim by including statistical data which would allow readers to easily interpret the information. Overall, the article fails to interpret statistical data, which makes them less accurate.

5. A lack of Vitamin D threatens women with 12 diseases (Oqaz- Saudi Arabia):

Article No.	5
Newspaper	Oqaz
Title	A lack of Vitamin D threatens women with 12 diseases
Author	Hussein Hazazi
Date	2 November 2015
Words	132
Sentences	8
Sentence structure	A lack of Vitamin D threatens women with 12 diseases. A local study revealed Vitamin D deficiencies as high as 97%. According to a study of Jeddah residents, there was a significant decrease in the presence of Vitamin D. In some cases, the deficiency was 100%, especially among women. Such levels of Vitamin D can threaten women with 12 diseases. A number of recent studies have reported that Vitamin D deficiencies are related to many potentially fatal diseases.
Logos	Unit 2
Pathos	Units 3, 5 and 6
Ethos	Unit 4
Paratactic (co-ordinate)	Unit 2
Hypotactic (subordinate)	Units 3, 4, 5 and 6

Table **36.** Breakdown of the Oqaz article 1

This article has a three-level structure. At the first level, unit 1, 'a lack of Vitamin D threatens women with 12 diseases' is a preparation for the rest of the units. In the second level, units 2-6 serve as elaborations of unit 1. In the third level are two types of relation. Unit 6 'A number of recent studies have reported that Vitamin D deficiencies are related to many potentially fatal diseases' contrasts with unit 1, and unit 3. 'According to a study of Jeddah residents, there was a significant decrease in the presence of Vitamin D' is an elaboration of unit 2, 'A local study revealed Vitamin D deficiencies as high as 97%'. The writer made unit 2, the logos. Pathos occurs in units 3 and 6. The element of ethos occurs in unit 4. The main function of statistics in the second unit is paratactic, while units 3, 4, 5 and 6 were hypotactic.



While there is statistical information in the article, the statistics lack an explanation that would help with the understanding of their meaning. The article also fails to identify which diseases are caused by Vitamin D deficiency, merely noting that there are 12 such diseases. The source was an unknown study, which may call into question the credibility of these statistics. Also, though the location of the study was identified as Jeddah, the article did not specify the sample number, whether both men and women participated, or the age of the participants. Overall, the statistical data in the article coheres poorly and it is therefore possibly misleading.

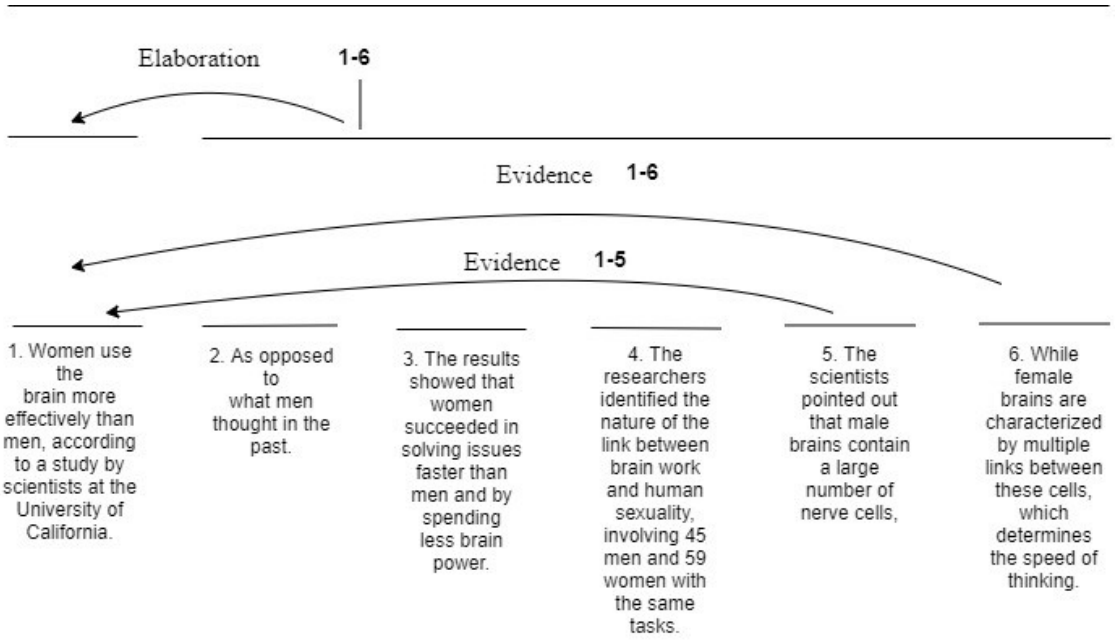
6. Women are wiser than men (Oqaz- Saudi Arabia newspaper):

Article No.	6
Newspaper	Oqaz
Title	Women are wiser than men
Author	Wkalat
Date	22 March 2016
Words	146
Sentences	8
Sentence structure	Women use the brain more effectively than men, according to a study by scientists at the University of California. As opposed to what men thought in the past. The results showed that women succeeded in solving issues faster than men and by spending less brain power. The researchers identified the nature of the link between brain work and human sexuality, involving 45 men and 59 women with the same tasks. The scientists pointed out that male brains contain a large number of nerve cells. While female brains are characterized by multiple links between these cells, which determines the speed of thinking.
Logos	Unit 1
Pathos	Units 3, 4, 5 and 6
Ethos	Unit 2
Paratactic (co-ordinate)	Unit 1
Hypotactic (subordinate)	Units 3, 5 and 6

Table 37. Breakdown of the Oqaz article 2

As we can see from the tree-diagram below, the first six sentences present two levels of structure. At the first level, units 2-6 serve as elaborations of unit 1. In the second level, units 5 and 6, 'While the female brains are characterized by multiple links between these cells, which determines the speed of thinking' and 'The scientists pointed out that male brains contain a large number of nerve cells' were used as evidence for unit 1, 'Women use the brain more effectively than men'.

The writer made unit 1 'Women use the brain more effectively than men' the logos. Pathos occurs in units 3, 4, 5 and 6. The element of ethos occurs in unit 2. The main function of statistics in the first unit is paratactic, while in units 3, 5, and 6 the function is hypotactic.



Overall, the use of statistics in the article is somewhat coherent. However, some of the implicit statistics lack interpretation. Further, the sample used in the study included more women than men, which means that the assertion that women are smarter than men may be incorrect. There is also a difference in meaning between the title and the rest of the article. The title states that women are more intelligent than men, and readers would expect to find information that confirms the title in the story. However, the rest of the article concerns how women use their brains more effectively than men.

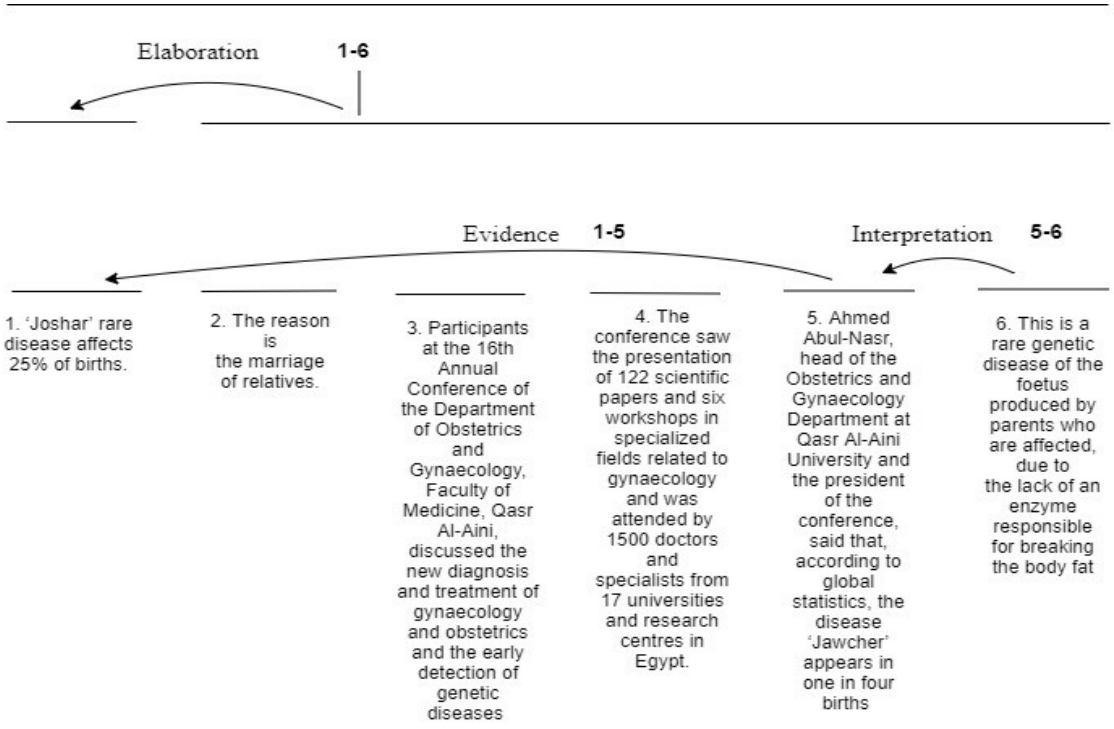
7. 'Joshar' rare disease affects 25% of births. (AL-AHRAM - Egyptian newspaper):

Article No.	7
Newspaper	Al-Ahram
Title	'Joshar' rare disease affects 25% of births
Author	Abeer Fouad
Date	5th April 2015
Words	409
Sentences	19
Sentence structure	'Joshar' rare disease affects 25% of births. The reason is the marriage of relatives. Participants at the 16th Annual Conference of the Department of Obstetrics and Gynaecology, Faculty of Medicine, Qasr Al-Aini, discussed the new diagnosis and treatment of gynaecology and obstetrics and the early detection of genetic diseases. The conference saw the presentation of 122 scientific papers and six workshops in specialized fields related to gynaecology and was attended by 1500 doctors and specialists from 17 universities and research centres in Egypt. Ahmed Abul-Nasr, head of the Obstetrics and Gynaecology Department at Qasr Al-Aini University and the president of the conference, said that, according to global statistics, the disease 'Joshar'appears in one in four births. This is a rare genetic disease of the foetus produced by parents who are affected, due to the lack of an enzyme responsible for breaking down the body fat.
Logos	Unit 2
Pathos	Units 1 and 5
Ethos	Unit 6
Paratactic (co-ordinate)	Unit 1
Hypotactic (subordinate)	Unit 5

Table 38. Breakdown of the Al-Ahram article 1

As we can see from the tree-diagram, there are only two levels of structure in this article. The first level shows units 2-6 as elaborations of unit 1. In the second level of the structure, unit 5 was used as evidence of unit 1; in the same level, unit 6 was used for the interpretation of unit 5. Unit 2, 'The reason is the marriage of relatives' was used as the logos. Pathos occurs in

units 1 and 5. The element of ethos occurs in unit 6. The main function of statistics in the first unit is paratactic, while in unit 6 it is hypotactic.



Both implicit and explicit statistics appear in a number of the first six sentences, including 1, 5 and 6. In general, the statistical data is fairly coherent and cohesive; however, the statistics are not interpreted and therefore readers may not fully understand the information. The statistical source is unnamed, which may lead to doubts about this information. For example, in the first and second units, 'Joshar' rare disease affects 25% of births' and 'The reason is the marriage of relatives', it is asserted that the main reason for the high incidence of the disease is the marriage of relatives, yet no proof is provided.

In the same article there is a contradictory use of statistics. The statement 'Which appears in one in four births according to global statistics' is later followed by 'A study conducted from 2000 to 2014 only detected 78 cases'. The article also neglects to mention how many children were born throughout that period. This article both fails to provide a useful interpretation and contradicts itself in the use of statistics.

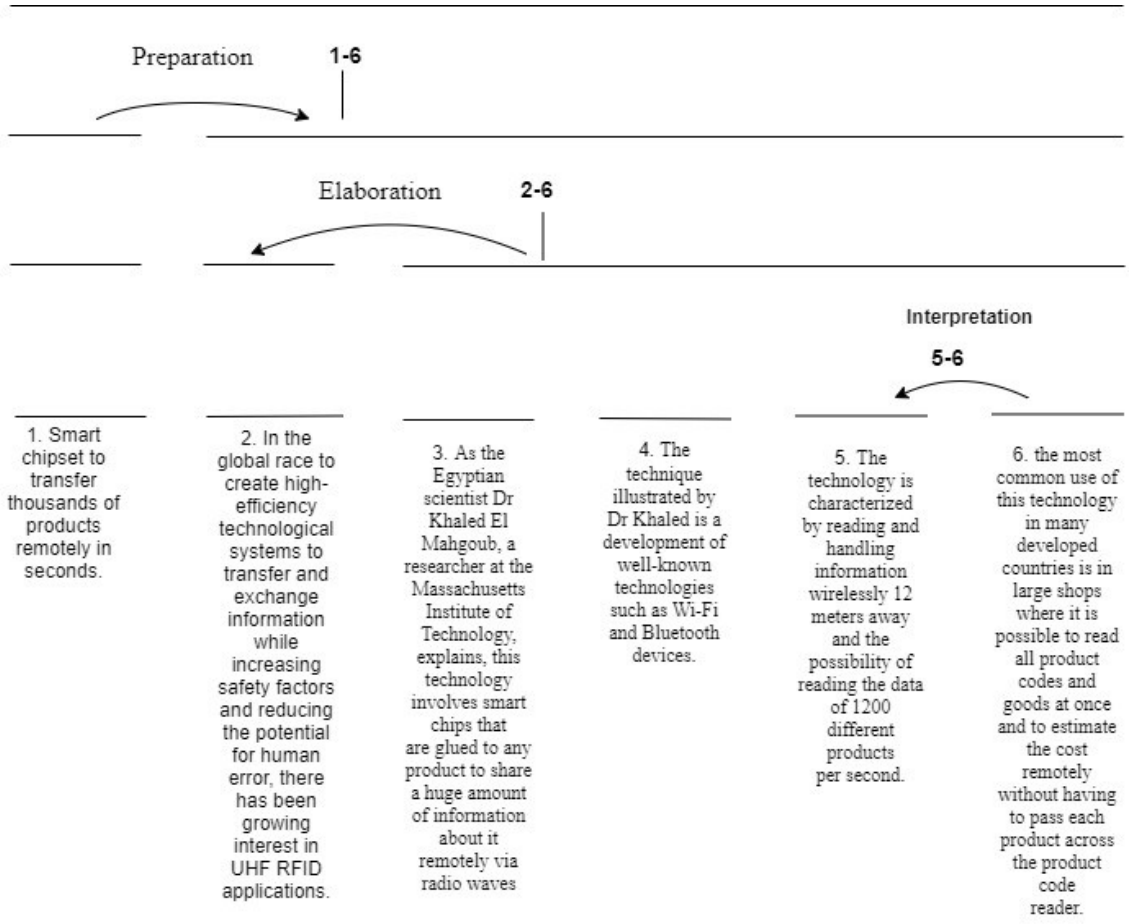
8. New revolution on the ‘barcode’ segments. (Al-Ahram - Egyptian newspaper):

Article No.	8
Newspaper	Al-Ahram
Title	New revolution on the ‘barcode’ segments
Author	The newspaper
Date	17 January 2016
Words	773
Sentences	24
Sentence structure	Smart chipset to transfer thousands of products remotely in seconds. In the global race to create high-efficiency technological systems to transfer and exchange information while increasing safety factors and reducing the potential for human error, there has been growing interest in UHF RFID applications. As the Egyptian scientist Dr Khaled El Mahgoub, a researcher at the Massachusetts Institute of Technology, explains, this technology involves smart chips that are glued to any product to share a huge amount of information about it remotely via radio waves. The technique illustrated by Dr Khaled is a development of well-known technologies such as Wi-Fi and Bluetooth devices. The technology is characterized by reading and handling information wirelessly 12 meters away and the possibility of reading the data of 1200 different products per second. The most common use of this technology in many developed countries is in large shops where it is possible to read all product codes and goods at once and to estimate the cost remotely without having to pass each product across the product code reader.
Logos	Unit 1
Pathos	Units 2 and 5
Ethos	Unit 6
Paratactic (co-ordinate)	Unit 1
Hypotactic (subordinate)	Unit 5

Table 39. Breakdown of the Al-Ahram article2

This science article, an example of technology news, presents a three-level structure. At the first level, unit 1 is a preparation for units 2-6. At the second level, units 3-6 are elaborations

of unit 2, ‘In the global race to create high-efficiency technological systems’. In the third level of the structure, unit 6 is an interpretation of unit 5. Unit 1 was used as the logos. Pathos occurs in units 2 and 5. The element of ethos occurs in unit 6. The main function of statistics in the first unit is paratactic, while in unit 5 it was hypotactic. Overall, the statistical information presented throughout this article was logical and coherent.



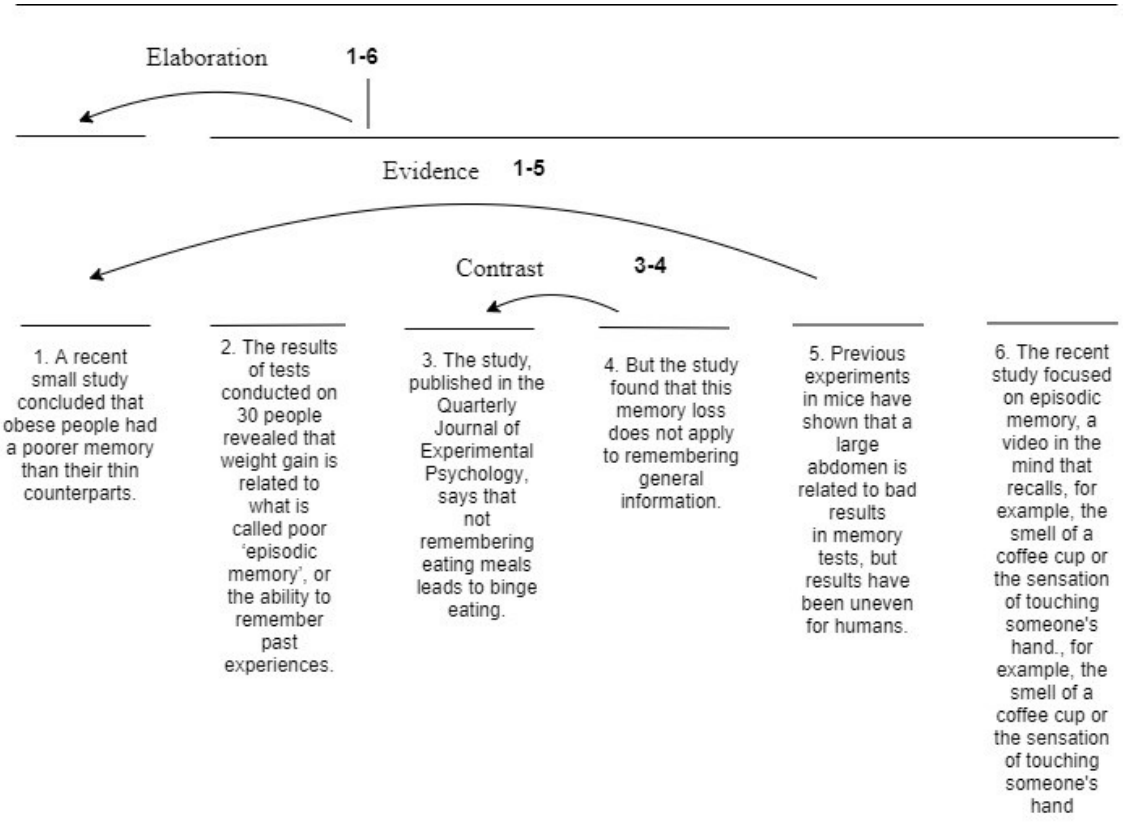
9. Obesity is linked to 'poor memory' (AL-Riyadh newspaper - Saudi Arabia):

Article No.	9
Newspaper	AL-Riyadh
Title	Obesity is linked to 'poor memory'
Author	The newspaper
Date	3 March 2016
Words	276
Sentences	12
Sentence structure	A recent small study concluded that obese people had a poorer memory than their thin counterparts. The results of tests conducted on 30 people revealed that weight gain is related to what is called poor 'episodic memory', or the ability to remember past experiences. The study, published in the *Quarterly Journal of Experimental Psychology*, says that not remembering eating meals leads to binge eating. But the study found that this memory loss does not apply to remembering general information. Previous experiments in mice have shown that a large abdomen is related to bad results in memory tests, but results have been uneven for humans. The recent study focused on episodic memory, a video in the mind that recalls, for example, the smell of a coffee cup or the sensation of touching someone's hand.
Logos	Unit 1
Pathos	Unit 5
Ethos	Unit 3
Paratactic (co-ordinate)	Unit 1
Hypotactic (subordinate)	Units 2, 3 and 5

Table 40. Breakdown of the AL-Riyadh article 1

The beginning of this article presents two levels of structure. At the first level, units 2-6 are used as elaborations of unit 1. In the second level, there were two types of relations. Unit 5 'Previous experiments in mice have shown that a large abdomen is related to bad results in memory tests, but results have been uneven for humans.' is evidence of unit 1, 'A recent small study concluded that obese people had a poorer memory than their thin counterparts'. Unit 4, 'But the study found that memory loss does not apply to remembering general information' contrasts with unit 3, 'The study, published in the Quarterly Journal of Experimental Psychology, says that not remembering eating meals leads to binge eating'. Unit 1 was used

as the logos. Pathos occurs in unit 5. The element of ethos occurs in unit 3. The main function of statistics in the first unit is paratactic, while in units 2, 3 and 5 it is hypotactic.



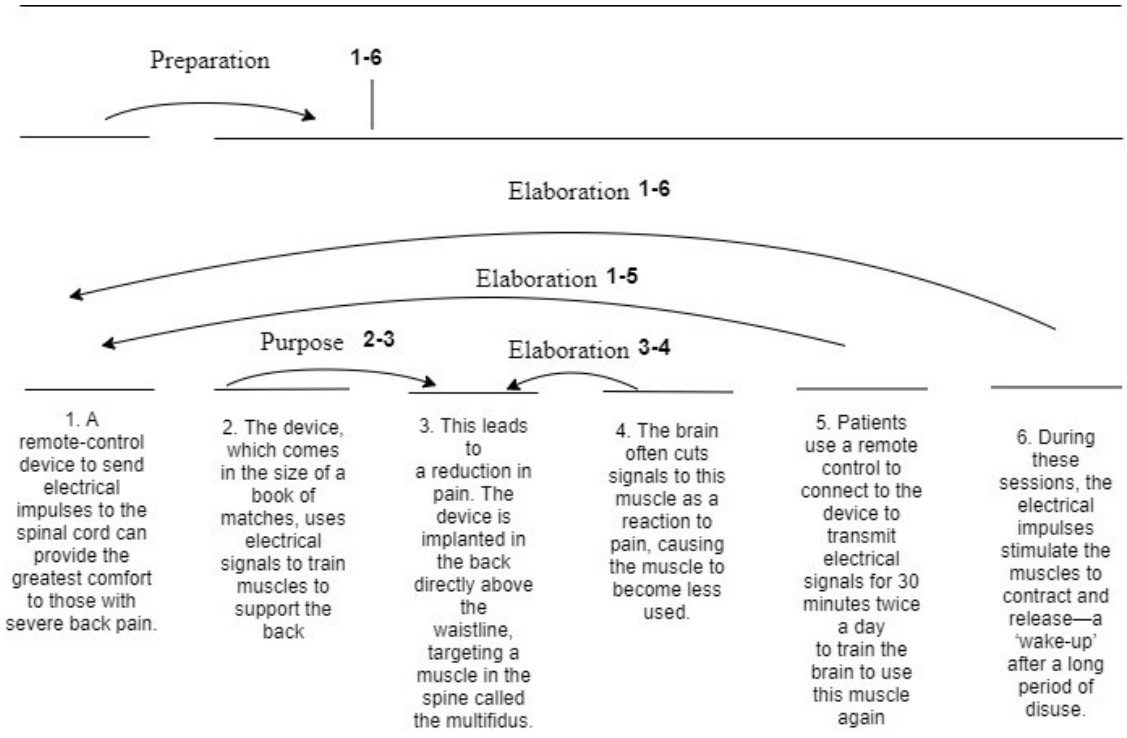
Overall, the article presents statistical points in three units 1, 2 and 5 and they have a sense of coherence. However, the rest of the article is marked by an incoherent use of statistics and by misinterpretation. For example, unit 2 states that the study was carried out on 30 people, but towards the end of the article the sample is said to comprise 69 people. Also, the finding that obese people have a poorer memory than healthy people is somewhat dubious for several reasons. One is that the selected sample included very few participants and therefore cannot be generalized to all obese individuals. Additionally, the study participants included 51 obese and 18 healthy people, and it does not seem correct to make a final determination on the basis of this unequal number.

10. A device that awakens the lower back muscles and removes pain (AL-Riyadh newspaper - Saudi Arabia):

Article No.	10
Newspaper	AL-Riyadh
Title	A device that awakens the lower back muscles and removes pain
Author	The newspaper
Date	11 April 2016
Words	393
Sentences	17
Sentence structure	A remote-control device to send electrical impulses to the spinal cord can provide the greatest comfort to those with severe back pain. The device, which comes in the size of a book of matches, uses electrical signals to train muscles to support the back. This leads to a reduction in pain. The device is implanted in the back directly above the waistline, targeting a muscle in the spine called the multifidus. The brain often cuts signals to this muscle as a reaction to pain, causing the muscle to become less used. Patients use a remote control to connect to the device to transmit electrical signals for 30 minutes twice a day to train the brain to use this muscle again. During these sessions, the electrical impulses stimulate the muscles to contract and release — a 'wake-up' after a long period of disuse.
Logos	Unit 1
Pathos	Units 2 and 6
Ethos	Unit 5
Paratactic (co-ordinate)	Unit 1
Hypotactic (subordinate)	Units 4, 5 and 6

Table 41. Breakdown of the AL-Riyadh article 2

As can be seen from the tree-diagram, the first six sentences of the article have two levels of structure. The first level shows that unit 1 is used as a preparation for units 2-6. In the second level of the structure, there are three types of relations: unit 3 is used as purpose for unit 2; unit 4 is used as an elaboration of unit 3; and units 5 and 6 are used as elaborations of unit 1. Unit 1 was used as the logos. Pathos occurs in units 2 and 6, while the element of ethos occurs in unit 5. The main function of statistics in the first unit is paratactic, while in units 4, 5 and 6 the function is hypotactic. Overall, statistical information is coherent throughout the parts of the article.


Preparation 1-6
Elaboration 1-6
Elaboration 1-5
Purpose 2-3
Elaboration 3-4
1. A remote-control device to send electrical impulses to the spinal cord can provide the greatest comfort to those with severe back pain.
2. The device, which comes in the size of a book of matches, uses electrical signals to train muscles to support the back
3. This leads to a reduction in pain. The device is implanted in the back directly above the waistline, targeting a muscle in the spine called the multifidus.
4. The brain often cuts signals to this muscle as a reaction to pain, causing the muscle to become less used.
5. Patients use a remote control to connect to the device to transmit electrical signals for 30 minutes twice a day to train the brain to use this muscle again
6. During these sessions, the electrical impulses stimulate the muscles to contract and release—a 'wake-up' after a long period of disuse.

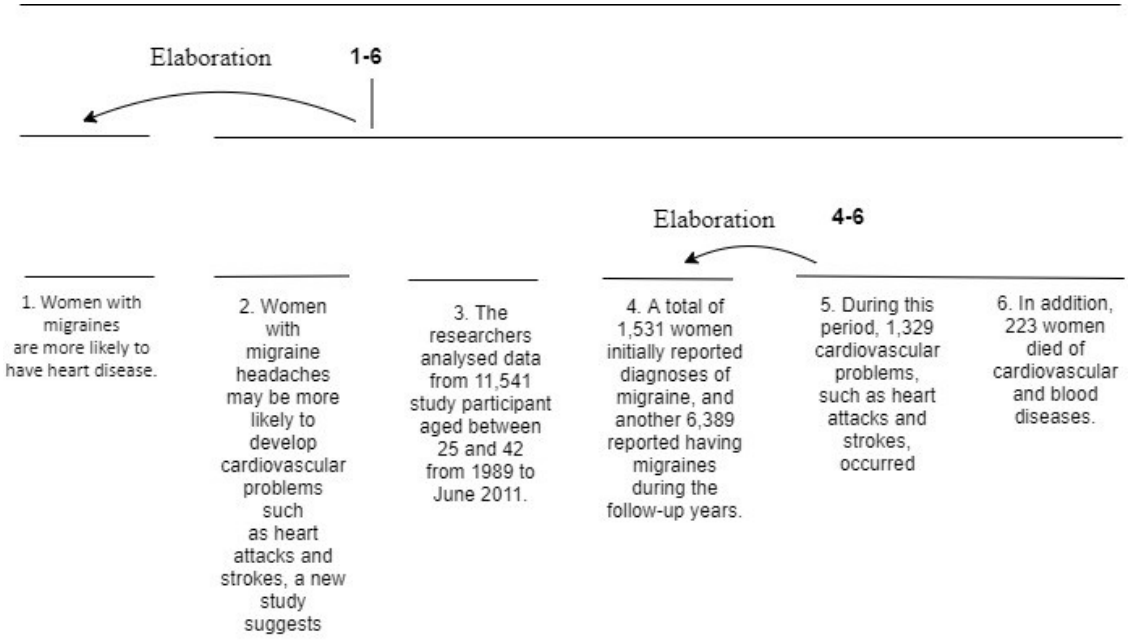
11. Women with migraines are more likely to have heart disease (AL-Masry AL-Youm newspaper - Egypt):

Article No.	11
Newspaper	AL-Masry AL-Youm
Title	Women with migraines are more likely to have heart disease
Author	Reuters
Date	6 June 2016
Words	188
Sentences	10
Sentence structure	Women with migraines are more likely to have heart disease. Women with migraine headaches may be more likely to develop cardiovascular problems such as heart attacks and strokes, a new study suggests. The researchers analysed data from 11,541 study participants aged between 25 and 42 from 1989 to June 2011. A total of 1,531 women initially reported diagnoses of migraine, and another 6,389 reported having migraines during the follow-up years. During this period, 1,329 cardiovascular problems, such as heart attacks and strokes, occurred. In addition, 223 women died of cardiovascular and blood diseases.
Logos	Unit 1
Pathos	Unit 2
Ethos	Units 3, 4, 5 and 6
Paratactic (co-ordinate)	Unit 1
Hypotactic (subordinate)	Units 3, 4, 5 and 6

Table 42. Breakdown of the AL-Masry AL-Youm 1

The first six sentences of the article indicated in Table 57 are articulated in two structural levels. The first level indicates an elaboration relation between units 2-6 and satellite 1. The second level features an elaboration relation between units 5-6 and unit 4. The writer made unit 1, 'Women with migraines are more likely to have heart disease', serve as the logos. Unit 2, 'Women with migraine headaches may be more likely to develop cardiovascular problems such as heart attacks and strokes, a new study suggests', represents pathos, while ethos is established in units 3, 4, 5 and 6. The main function of statistics in the first unit is paratactic, while the function of units 3, 4, 5, and 6 is hypotactic.

Overall, the statistical data used in the first six sentences are coherent. However, they should be explained more specifically by noting the percentage or number of women with migraines and heart disease and comparing it with the total number of women with heart disease.



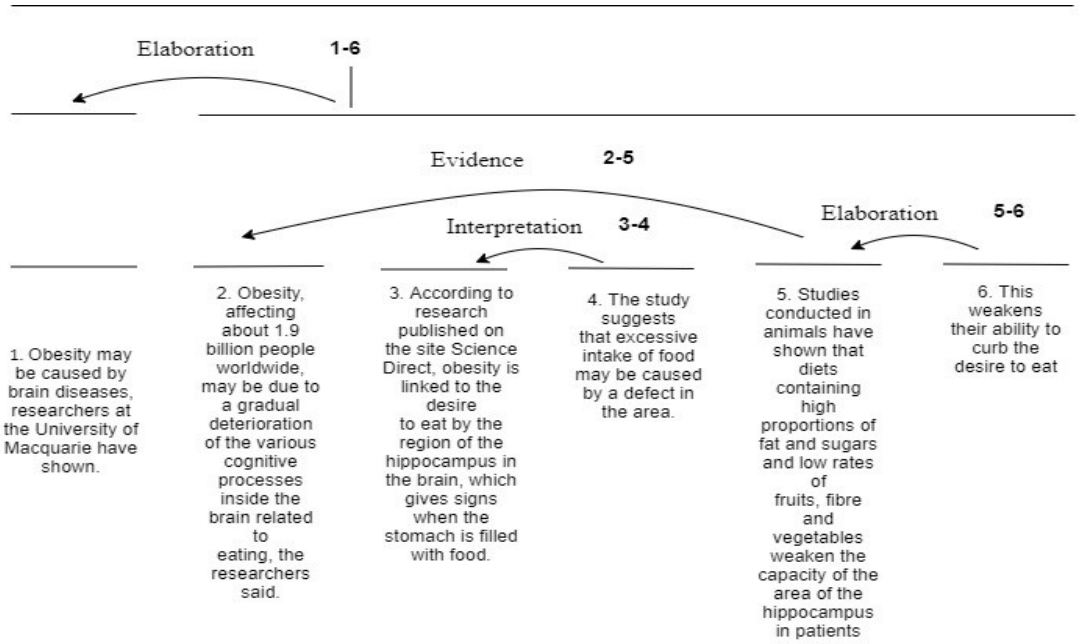
12. Obesity may be caused by 'brain dysfunction' (AL-Masry AL-Youm newspaper - Egypt):

Article No.	12
Newspaper	AL-Masry AL-Youm
Title	Obesity may be caused by 'brain dysfunction'
Author	Muhammed Mansour
Date	18 July 2016
Words	246
Sentences	10
Sentence structure	Obesity may be caused by brain diseases, researchers at the University of Macquarie have shown. Obesity, affecting about 1.9 billion people worldwide, may be due to a gradual deterioration of the various cognitive processes inside the brain related to eating, the researchers said. According to research published on the site Science Direct, obesity is linked to the desire to eat by the region of the hippocampus in the brain, which gives signs when the stomach is filled with food. The study suggests that excessive intake of food may be caused by a defect in the area. Studies conducted in animals have shown that diets containing high proportions of fat and sugars and low rates of fruits, fibre and vegetables weaken the capacity of the area of the hippocampus in patients. This weakens their ability to curb the desire to eat.
Logos	Unit 1
Pathos	Unit 3
Ethos	Unit 2
Paratactic (co-ordinate)	Unit 2
Hypotactic (subordinate)	Units 5 and 6

Table 43. Breakdown of the AL-Masry AL-Youm article.2

As we can see from the tree-diagram below, the first six sentences of the article outlined in Table 60 are articulated in two structural levels. The first level indicates an elaboration relation between units 2-6 and satellite 1. The second level shows three types of relations. Unit 5, 'Studies conducted in animals have shown that diets containing high proportions of fat and sugars and low rates of fruits, fibre and vegetables weaken the capacity of the area of the hippocampus in patients', is used as evidence for unit 2, 'Obesity, affecting about 1.9 billion people worldwide, may be due to a gradual deterioration of the various cognitive processes

inside the brain that relate to eating, the researchers said'. Also, in the second level, unit 4, 'The study suggests that excessive intake of food may be caused by a defect in the area' is used as an interpretation of unit 3, 'According to research published on the site Science Direct, obesity is linked to the desire to eat by the region of the hippocampus in the brain, which gives signs when the stomach is filled with food'. The last relation is that of unit 6, 'This weakens their ability to curb the desire to eat', which is used as an elaboration of unit 5.



The writer made unit 1 serve as the logos. Unit 3 represents pathos, while ethos is established in unit 2. The main function of statistics in the first unit is paratactic, while the function of units 5, and 6 is hypotactic. Overall, the statistical data used in units 2, 4 and 5 are largely coherent and cohesive. However, misunderstanding may arise within the combination of the first and fifth sentences. The first sentence asserts that obesity may be due to brain disease. The fifth sentence includes implicit statistics: 'Studies conducted in animals have shown that diets containing high proportions of fat and sugars and low rates of fruits, fibre and vegetables weaken the capacity of the area of the hippocampus in patients'. Taken together, these passages may convey the incorrect idea that obesity is the cause of brain diseases.

5.3.2. Summary of the Findings

The rhetorical analysis method of close-reading was employed in this study to help to know more on how statistics are articulated in the science news and also for several reasons. Firstly, it supported the methods of content analysis and the use of an expert panel by providing a background understanding of how journalists use scientific statistics in Arab papers. It was also useful in in answering certain sub-questions: Do the statistics used by science journalists comply with the principles of validity and reliability? Do journalists use statistics effectively in communicating scientific ideas? The sub-questions in turn aimed to answer the main research question: How do journalists in the Arab region — Saudi Arabia, Kuwait and Egypt — engage with and use statistics when reporting science news, and what are the key challenges and opportunities they face in doing so? Close-reading also assisted in preparing questions for interviews with Arab journalists.

In general, the results of close-reading suggest that statistics are articulated in two or three levels of the structure of science articles and the relationships of these levels may affect the general coherence of the article. Statistical data were more often used in health news than technology news; statistics were used in the health articles 1, 2, 3 and 4 at three levels of structure, while in the technology news articles 8 and 10, statistics appeared at two levels of structure. However, this does not mean that a higher level of structure is a guarantee of better coherence in health news. For instance, coherence was lacking in health articles 3, 4 and 5, which have three levels of structure, while articles 8 and 10, examples of technology stories with two levels of structure, were coherent in their use of statistical data.

- Most of the articles lacked interpretation of the statistical data they presented that would simplify information, allowing it to be easily delivered to readers; this was obvious in articles 4, 5 and 7. These findings confirm Long's (1995) findings that the majority of science stories in newspapers do not contain some elements of scientific explanation.
- Reliance on anonymous statistical sources in decision-making was evident in articles 2, 3, 4 and 5. Also, articles may rely on official sources as fact without looking for other sources, as was the case with article 1.
- None of the articles used visual information, and this supports Al-Qafari (2009) finding of a lack of interest among Arab journalists in embedding graphics into scientific news.
- Some science articles did not follow adequate mathematical and statistical procedures, as was the case in articles 3, 5 and 6. This practice may lead to manipulation of statistical data, to promoting a journalist's agenda, or to the risk that the meaning of the article will be misinterpreted by both the journalist and the readers. It also suggests that Arab journalists have inadequate skills in dealing with statistical information.

- Some articles provided invalid statistical information, meaning that journalists did not support the statistics they presented; this was the case in articles 4 and 7.

5.4 Expert Panel Findings

5.4.1. Regarding the Approach of the Panel

In this qualitative study, the expert panel method was considered useful for several reasons. First, it provided some background on the use of statistics by science journalists in Arab countries. The method also helped in formulating questions that journalists were to be asked in semi-structured interviews. By interviewing specialists, it was also possible to examine the accuracy of science news in terms of how statistical information is used. Together, these applications of the expert panel method helped to answer sub-questions 3 (Do the statistics used by science journalists comply with principles of validity and reliability?) and 4 (Do journalists use statistics effectively to communicate science?).

Expert panels 'provide a forum in which leading experts in a given field are invited to share their experiences and thoughts' (Galliers and Huang 2012, p. 122). Scientists have stressed that science news needs to be accurate (Murcott 2009, Hansen 2016), and it has been argued that science (and especially natural science) is often poorly reported because of 'non- or under-reporting of important scientific progress, tendency to sensationalism and negativity in wording and in presentation, and inaccurate reporting' (Fjæstad 2007, p. 123).

In the present study, interviews were conducted with five Arabic academic specialists who work at the University of Leeds and still live there. The participating specialists worked in different scientific fields: three in health, one in technology and one in statistics. The reason for choosing three interviewees from the health field was that more than 94% of the science news items analysed here related to health.

Code	Discipline	Role
INT01	Statistics	Research Fellow in Applied Health (University of Leeds)
INT02	Technology	Postdoctoral research fellow (University of Leeds)
INT03	Health	Consultant in Cellular Pathology (St James's University Hospital)
INT04	Health	Senior Fellow in Emergency Medicine (Leeds Teaching Hospital)
INT05	Health	Consultant Neuropathologist and Lecturer (University of Leeds)

Table 44. Codes used for analysis of interviews with experts

A total of 25 science news articles were chosen from the sampled Arabic newspapers (19 health news, 6 technology news). These were distributed among the specialists, each of whom read five articles before being interviewed to ascertain their opinions about the news items

they had read. During the interview, each participant was asked to evaluate the accuracy of the items they had read in terms of the use of statistical information. They were also asked about the validity and reliability of the information, and they were invited to make relevant recommendations.

5.4.2. The Results of the Panel

The key findings from these interviews can be summarised as follows.

1. Statistical data were mispresented in a majority of the items read.
2. In more than half of the items read, statistical information was not used effectively to communicate science.
3. Statistics did not comply with the principles of reliability in 13 out of 25 articles.
4. Statistics complied with the principles of validity in only 7 articles.

In 13 of the 25 articles the participating specialists felt that journalists had presented statistics inappropriately, that is, they did not comply with they did not present statistics in the way an expert would have read, interpreted, explained and communicated the statistics. This has previously been noted as a problem in science articles, as many journalists struggle to engage with, accurately interpret or adequately report numerical data (Maier 2003). The specific form of misrepresentation was found to differ from one article to another, perhaps because journalists do not understand how to present the statistical information in a consistent way or because they simply misunderstand the significance of statistical information. As one example, consider the following review of article 24.

According to the members of the expert panel, this article contains clear falsehoods, and, judging by the use of incorrect statistics, 'the journalist does not know what he is writing about'. As one of the members of the panel pointed out,

> *It is not true that Gaucher disease is widespread in America, Europe, and the Middle East, or that the prevalence of this disease is 5 out of 100,000 births. Where did the journalist find the statistic that 25% of babies are infected with this disease? I do not know, and there is nothing in the article that indicates this ratio. This would mean that of every 4 births, one baby is affected by Gaucher disease (INT05).*

In this case, the members said, the journalist's use of statistics seems to indicate a lack of the necessary statistical skills or knowledge, and the way in which the statistics are presented suggests they are not specialized in that scientific field. This issue contributes to doubts about

statistical information in the news as a whole, aligning with Al-Qafari (2009) view that Arabic newspapers suffer from a scarcity of science journalists.

Such failures in the presentation of statistical data, or indeed the failure to provide any statistical support, impacts on the credibility of journalists and newspapers, as argued in this review of article number [9]:

> *The sentence "Most users will no longer need glasses to read" is the worst in terms of statistics. In this case, the company that makes the product written about may have been responsible for the article, which seems designed to sell; to this end, the statistics were biased and generalized to make the company seem excellent. Readers gain no benefit from these statistical data; for example, the article did not specify exactly what percentage of users will be able to dispense with glasses. I do not know whether the writer—less a journalist than a marketer—was aware of this information. In any case, he presented no additional sources to confirm or refute the assertions made in the article (INT02).*

While the use of statistical data was judged slightly acceptable in 8 of the sampled articles, even these were considered inadequate. According to INT1, it seemed that the journalist who wrote article [2] lacked the capability to process statistical information. The interviewee suggested that this is a problem not only among journalists but even among statisticians themselves in Arab countries.

The use of statistics here is fairly clear, but it is preferable to use a variety of statistics beyond percentages in order to offer a better understanding of the image. The reason this was not done may be that the journalist's ability to use statistics is weak, leading them to avoid some types of statistics:

> *Use of statistics in the Arab world in general is very weak, even among statisticians themselves, who often fail to present their statistical results effectively. Statistics should be summarized in an easily understandable manner for use by different disciplines, including the press (INT01).*

According to all members in the panel, only 4 of the 25 sampled articles were appropriately presented; all of these were health-related. The presentation of statistical data in these four articles differed completely from the others, indicating that the journalists who wrote these articles were well versed in how to process statistical information and were also experienced in science writing. For example, it was pointed out that the journalist who wrote article [23] used medical statistics to measure the prevalence of disease.

The statistics in this article were presented in an excellent way. From the beginning of the article, starting with the headline, the journalist uses statistics in a clear, concise and

understandable manner that supports the story. He presents the diabetes statistics in a way that makes them understandable. His method of displaying medical statistics (37.1 per 100,000 cases) is also excellent. He consistently discusses the number of incidents in terms of 100,000. This approach makes it easy to understand the extent of the disease. The journalist also used precise scientific language (INT05).

In general, however, the present findings suggest that statistics were not used effectively to communicate science in more than half of the science news items analysed by the participating specialists. There were five reasons for this: Firstly, inadequate use and interpretation of statistical data; secondly, inaccurate statistical data; thirdly, statistics were used for marketing purposes rather than for delivery of science information; fourthly, statistics were used to address emotions rather than to convey science; and fifthly, the data were not of relevance to Arabic countries.

Statistics play a key role in delivering science information to help readers to understand social issues (Fioramonti 2014). However, missing data or failure to use them may mean that scientific ideas are not properly delivered, which can have a negative effect on the reader as this reviewer suggests.

Statistical data were not used extensively in this article, although the volume of information it provided is greater than in some other articles:

> *Also the data were not used appropriately, as for example [in the reference to] "Huge Information"; the accuracy of this is difficult to judge, as the statistical information was presented in too general a way, and the science was not well communicated. I would not say that the journalist intended to mislead, but the scientific information was not delivered well (INT02).*

The implicit statistics used without interpretation in several of the sampled articles (e.g. 'six times', 'long battery life', 'the battery is very good') is likely to confuse the reader and fails to deliver the scientific idea. The role of statistics should be to simplify and deliver information to the reader rather than to confuse them. For example, INT05 questioned the meaning of the phrase 'six times'? Does this mean that if a person has six children, one of them will be infected? Or does it mean that, if one person is aged 30 and another is over the age of 40, the former will have no infected children if he has six, or that the sixth child of the person over 40 will be infected?

Statistical information plays a fundamental role in reinforcing the accuracy of science stories, which impacts directly on the quality of the news (Nguyen and Lugo-Ocando 2015, p. 6). For this reason, scientists stress the need for accuracy in science news reporting (Murcott 2009, Hansen 2016). According to Utts (2010), misleading reporting of statistical results is a widespread problem. The present findings highlight the presence of inaccurate statistical data

in the communication of science to the public, which has the effect of misleading readers rather than delivering accurate scientific information.

The statistics the journalist uses in the article suggest that the probability of injury is very large, and in fact this is scientifically incorrect and unproven. The journalist should also have explained what was meant by the words “after 40”, and whether this refers to the ages of 40, 60, or 80.

> *The journalist uses a circular argument, which is also problematic The use of the phrase “more damaged” is correct, but the extent of the damage must be explained. This use of statistics leads to misunderstanding and to the manipulation of the ideas in the article, creating public fear with no scientific evidence (INT05 on article 21).*

In some of the science news items analysed by the specialists, there is evidence that the main purpose of using statistics was for marketing purposes rather than to communicate scientific ideas, as for instance in article [4].

The statistics in this article were used not to deliver science but for the purpose of marketing. While the journalist did not offer his opinion about the mobile phone, he seems to be trying to sell something through the use of these statistical data. Readers of the article want to know the details and advantages and disadvantages of this phone, but in this article, the journalist is promoting it (INT02).

This issue emerged in relation to 6 of the 25 sampled articles [4, 5, 7, 9, 11 and 20]. Interestingly, although three times as many health news articles (19) were analysed, four of these five articles were technology-related while only one was a health news item. These results suggest that the statistical data used in technology news items in Arab countries are controlled by commercial enterprises.

The present findings indicate that statistics were used to address emotions rather than to convey science in three articles [13, 21 and 24], all of which were health-related. Article [24] was seen to use statistical information for marketing purposes by employing emotional language.

It seems to be marketing a particular treatment. He mentions that each syringe costs £10,000 and that the child needs at least 4 injections per week. In fact, the success rate of this treatment is very poor. The claim that 31% of people with Gaucher disease died because of a lack of treatment also suggests to me that pharmaceutical companies may have paid the newspaper or the journalist to market this treatment. The cause of death of that 31% is that the disease itself leads to death; the possibility of healing by any treatment is very poor (INT05).

All such statistics were seen to be used to intimidate people without scientific justification. According to interviewees INT03 and INT05, who are health specialists, many of these statistical data are just wrong. One example was article [13], titled 'Women with migraines are more likely to have heart disease'. The article points out that the research found 15,541 cases, and then said that 17,500 cases have migraine headaches while 6,389 suffered migraine headaches during follow-up. It then noted the number of people who have heart and circulatory problems,

> *The statistics here did not indicate whether participants had heart attacks before they were diagnosed with migraines or after, or whether migraines caused fewer heart attacks. Some migraines are caused by diseases of the blood vessels. Do these diseases cause migraines and heart disease at the same time, or is migraine the cause of heart disease? All of this delivers a message that will confuse ordinary readers. I am sure that some women who suffer from migraine now will think that they might have cardiovascular problems (INT3).*

Interestingly, that article was published on the first page of Al-Qabas (a Kuwaiti newspaper), alongside a news story about ISIS, who also seek to intimidate people in Arab countries and around the world (INT05). This, as suggested by one of the expert panel members, "may indicate that the newspaper does not care enough about scientific news to place it in a special section but uses it only to fill empty spaces".

The findings also indicate that statistical data were not used effectively in some articles because the data were not relevant to Arabic countries. For example, the percentage of alcohol use in article 21 has nothing to do with Arab society, where there is very little alcohol consumption as compared to Western countries.

> *According to INT05, scientific news stories should be relevant to society. In Arab communities, it would make more sense to talk about serious issues such as the use of shisha, a tobacco commonly smoked in the Arab states, which merits wider news coverage.*

Based on the present findings, statistics used by journalists failed to comply with the principles of reliability in 13 of the 25 sampled articles. Statistical reliability depends on two main criteria: appropriate mathematical and statistical procedures (e.g. selecting a representative sample) and appropriate sources. Unknown sources, which have a negative impact on content credibility (Carlson 2011), were used by journalists in 12 of the sampled articles, and the sample was not representative in 5 of the articles. Interestingly, both of the articles that fulfilled these two criteria ([2] and [17]) were health-related.

In some articles, journalists used the phrase 'international statistics' without identifying the source, implying that the source was reliable when this was not the case. Serious mistakes

were also noted in how sources were referred to. For instance, article [21] described the source as a newspaper; this is a misrepresentation, as the American Journal of Stem Cells is a journal. The journalist also used the name Georgetown University to convince readers of the credibility and strength of the cited statistical information; in fact, Georgetown University has nothing to do with this journal (INT05, INT01 made a similar point about article 2).

In the beginning, the statistical source of the information may be unreliable and unknown at the scientific level. Here, suggested the panel members, the journalist should have background information on the classification of the magazine published — whether it is classified as a powerful and reliable journal — as well as confirmation of this source and even another reliable source that supports this study. The sample and selection criteria are very poor, including only 30 persons. In another example, INT03 pointed out that: “While the statistical information in article [17] might be correct, “we would need to know the actual source of the information”.

The source was not mentioned, and the sample of only 300 children is very small in statistical terms. The article did not provide details about the sample, or about when and where the study was conducted. In terms of journalism and science, the article is very weak and not at all professional. The text may be accurate, but it is not supported by statistical evidence, said some of the members of the panel. Because the above articles and their statistics all came from international news items rather than from the Arab world, journalists are more likely to trust them because of the greater scientific progress in western countries. This means that journalists may simply relay the news as it is, without returning to the main source or asking specialists to confirm the reliability of statistical information. Clearly, this is unacceptable journalistic practice.

Validity was another issue raised by the Arabic specialists in the expert panel. For the purposes of this research, the notion of ‘validity’ is taken to refer to the legitimacy of the claims made by the journalists on the basis of the statistical information presented (Lugo-Ocando 2017) that is, whether the statistical data support the journalists’ claims. The findings of the panel indicate that the statistical information as presented was invalid in just 7 of the sampled articles; 6 of these were health-related and one was a technology news item. This may indicate that journalists accept any health news containing statistics without checking validity, which suggests in turn that they are not science specialists.

In article [24], entitled ‘(Gaucher) rare disease affects 25% of births and the reason for marriage relatives’, there is a significant discrepancy between the statistics cited and the journalist’s assertion that this is a rare genetic disease that (according to international statistics) affects 1 in 4 infants. INT05, a practising doctor since 1999, had only encountered one case of Gaucher disease. In the same article, the journalist described the disease as being caused by the lack of an enzyme that breaks down fat in the body:

> *This represents an incorrect transfer of information, as the disease is in fact due to the lack of an enzyme that breaks down fatty sugars. The journalist also reported that Gaucher disease occurs in up to 50% of births in the Delta region and Upper Egypt because of the proportion of relatives who marry; again, this is untrue (INT05).*

In article 14, entitled 'Obesity is associated with poor memory', which was published in Al-Riyadh (a Saudi newspaper) without naming the journalist, it was stated that the relationship between obesity and poor memory was scientifically proven. However, "it would require a great deal of statistical evidence to prove this assertion and to test the information" (INT03). In fact, the statistical data did not prove what was being claimed. The article was translated from The Guardian by Al-Riyadh (and many other Arabic newspapers) and inaccurately reported without returning to the source of the study (the University of Cambridge). Instead, the journalist selected certain paragraphs in a way that rendered the statistical data invalid. According to INT04, "this is not only a problem among journalists; in Arab societies, we are considered consumers but not producers of science, as evidenced by the tendency to rely on any Western source as authoritative".

Based on the sampled science articles and their use of statistics, the participating specialists suggested that statisticians should be seen as important contributors to the process of news editing, whether as official members of the news team or as outside contributors offering the benefit of their expertise. Their comments on scientific articles containing statistical data would ensure that statistics are conveyed to the public in a more appropriate and understandable way. To enable readers to evaluate the statistics used in news items, it was also recommended that journalists should be held accountable for mistakes in presenting statistical information. This public scrutiny might make journalists more conscious of the need to write correctly and to check their data more carefully than before.

The findings highlight the need for Arab journalists to understand the subject matter of any studies they write about and to provide sufficient and appropriate detail to properly convey the significance of the research. This should include identifying essential parts of the research and providing relevant details rather than writing vague and scientifically incorrect articles. A further recommended goal for science journalists is to return to the original study rather than translating accounts that appear in other newspapers. To this end, scientific translators might usefully be employed to assist Arab newspapers to provide statistical information in a simplified and explanatory way that the ordinary reader can understand.

Returning to the need for relevant statistical sources and reliability, it is important to refer to local sources because they are closer to the community, and local researchers can more readily be consulted. For example, if one is writing about schistosomiasis, it makes sense to

ask an expert based in Egypt rather than a specialist at Harvard University because the disease is common there.

The members of the panel recommended that journalists should also refrain from using emotive language — for example, words like ‘beware’ should be avoided. It is also important not to exaggerate; the aim is not to intimidate people but to provide scientific information in order to ensure that information is statistically and scientifically correct. The journalist should conduct research to verify it, allocating sufficient time to checking both data and sources.

In many of these stories, the method of presentation is not scientific. To improve the quality of science news, the central issue must first be introduced clearly, providing the information in a way that makes it easy for the ordinary reader to understand. This is especially true in the Arab world, where ignorance and illiteracy are more common than in some other regions and the use of familiar Arabic vocabulary is important (INT02).

Setting standards for the selection of scientific journalists in Arab countries would help to improve the presentation of science and statistics, especially in sensitive areas such as health. Ministries of information in Arab countries must work to improve the scientific press and to ensure appropriate practices by developing regulations that require journalists (especially those writing medical stories) to accurately reflect current scientific knowledge.

In general, as suggested by the panel of experts, journalists in Arab countries seem to lack statistical training, something that is already highlighted by scholars (Alhumood et al. 2016, Ibnrubbian 2016). The specialists concurred with Wilby (2007) and Nguyen Nguyen and Lugo-Ocando (2015) that journalists need scientific training if they are to write scientific articles and must learn how to deploy statistics in news contexts. Newspapers must also value capable scientific journalists, who must also be allowed adequate time to produce stories that are of use to their readers. Specific pages should be dedicated to scientific and health news rather than as in Al-Qabas, where science coverage of a story using statistics to frighten people may appear alongside a story about ISIS.

Finally, scientific news stories should be relevant to society. This cannot be said of the articles I have read concerning the use of alcohol; in fact, this subject has nothing to do with Arab society, where there is very little alcohol consumption as compared to Western countries. It would be more useful to discuss serious subjects of relevance to Arab communities; for example, the use of shisha, a tobacco commonly smoked in Arab states, merits wider news coverage.

5.4.3. Summary of Expert Panel’s Findings

Overall, the expert panels suggest that statistical data were broadly mispresented in a majority of the items read by them. In 13 of the 25 articles, journalists had presented statistics

inappropriately and statistical information was not used effectively to communicate science in most science news. According to the members of the panel, this seems mainly due to: inadequate use and interpretation of statistical data; inaccurate statistical data where statistics were used for marketing purposes rather than for delivery of science information; by the fact that statistics were used to address emotions rather than to convey science and the data and that these were of no relevance to Arab countries. Moreover, as suggested by the panel, statistics did not comply with the principles of reliability in 13 out of 25 articles. Unknown sources were used in 12 of the sampled articles and the sample was not representative in 5 of the articles. The findings indicate that the statistical information as presented was invalid in seven of the sampled articles.

These results from the expert panel might not be representative nor should we make universal claims from them beyond the sample presented here. However, they are very indicative of key problems faced in Arab countries. They also provide a very insightful analysis of the key issues in science journalism, which confirms some assumptions about the inability of journalists to read, interpret and communicate data and statistics about science in the way it would have been intended by the scientist themselves.

5.5 Semi-structured Interviews

During the utilisation of the last method of collecting data, the semi-structured interview stage, the results of the three methods (content analysis, close-reading and an expert panel) were also used to develop the interviews with Arab journalists; the content being a descriptive framework that explores why science journalists do what they do. This last research strategy, however, has a more explanatory purpose, which was intended to explain the rationale and context of the outputs analysed with previous research methods used in this project.

Therefore, the purpose of using the semi-structured interviews was to examine the previous findings in light of the normative claims, roles and performance of journalists (Mellado 2015). In so doing, the semi-structured interviews allowed me to explore what are the identifiable and answer some of the key questions set here, but from a more explanatory point of view and in light of the previous results.

5.5.1. Regarding Semi-structured Interviews Findings

To answer these questions, I gathered information from eighteen (n = 18) journalists from six Arab newspapers from three Arab countries: Saudi Arabia (Al Riyadh and Okaz newspapers), Egypt (Al-Ahram and Al-Masry Al-Youm newspapers) and Kuwait (Al-Qabas and Al Rai newspapers). I selected three journalists from each newspaper (one editor and two journalists). This access, I must say, has been so far unprecedented as there have been few studies able to access these sources. The composition of this sample of interviewees is as follows,

Code	Newspaper	Journalist's Role	Gender
#INT01	Al-Ahram	Science editor	Male
#INT02	Al-Ahram	Science journalist	Male
#INT03	Al-Ahram	Science journalist	Female
#INT04	Al-Masry Al-Youm	Science journalist	Male
#INT05	Al-Masry Al-Youm	Journalist	Female
#INT06	Al-Masry Al-Youm	Science editor	Male
#INT07	Al Riyadh	Editor	Female
#INT08	Al Riyadh	Journalist	Female
#INT09	Al Riyadh	Journalist	Male
#INT10	Okaz,	Journalist	Female
#INT11	Okaz,	Editor	Male
#INT12	Okaz,	Journalist	Male

#INT13	Al-Qabas	Science editor	Female
#INT14	Al-Qabas	Journalist	Male
#INT15	Al-Qabas	Journalist	Male
#INT16	Al Rai	Journalist	Male
#INT17	Al Rai	Journalist	Female
#INT18	Al Rai	Editor	Male

Table 45. Codes used for the analysis of the journalists' interviews

In this section of the study, the findings of the interviews can be summarised as several points: The first point from the findings is that there were difficulties in accessing statistics by most of the Arab journalists because of official sources. The 'official' source is an obstacle to the journalist getting the statistics for a variety of reasons, either due to fear of the source or of accountability, or due to fear of the reaction of their society. They often publish the positive numbers for their personal purposes. Moreover, conflicting official sources in terms of issuing figures may lead to the transference of inaccurate numbers. The numbers take more than a week (sometimes up to a month) to deliver to journalists, which means that journalists must wait a long time, especially if the source is the official source. Even when the numbers are obtained, they are often old or sometimes unrepresentative of society.

The second point from the findings is that two main internal issues within these Arab newspapers prevented science journalists from dealing with statistical information correctly. The first issue arises from the journalists themselves:

Firstly, the lack of training (in terms of dealing numbers) of more than half of the Arab journalist interviewees: This could be due to the educational backgrounds of Arab journalists as the majority of journalists working in the field of journalism are not specialists in the field but are from different disciplines. Therefore, in addition, some journalists do not hold university degrees or diplomas as high school graduates do. The scarcity of training courses that deal with how to handle numbers in the news stories are another factor. The vast majority of journalists did not undertake courses that were concerned with dealing with numbers, even those of them who did take such courses did not focus on how to deal with numbers. The numbers were instead included as a very small part of the course: The main purpose of these courses was only to develop the skills of journalists in different areas and not to explain how to deal with the figures directly. As a result of the lacking capabilities of journalists in terms of using statistics in Arab newspapers, some researchers and scientists have refrained from dealing with journalists because of the fear that the journalist will transfer statistical information and other information in ways that do not convey accurate information. Secondly, the second issue concerns the newspapers themselves; this is an issue which can be attributed to several factors. The weak financial capacities of the newspapers contributed to the lack of databases for many Arab newspapers. Also, the newspapers did not support the journalist by paying subscription fees to the scientific journals that provided reliable numbers. Owing to the

financial weakness of some Arab newspapers, the publication of some commercial advertisements in the form of scientific news, especially in medical news such as the promotion of pharmaceutical companies for their products, provide numbers that may be inaccurate or incorrect.

The case of the Arab newspapers, according to many of the interviews, highlights that science as newsbeat is –compared to other news beats- often neglected. Several of the interviewees highlighted the fact that few newspapers appoint scientific journalists to write about scientific news. As one of the interviewees pointed out: “Any journalist in the newspaper can write any kind of news, whether it be political, economic, scientific or sport-related. Therefore, we find that the scientific journalists working for Arab newspapers do not exceed a few journalists, which ultimately leads to the negligence of some journalists in terms of them taking foreign scientific news without first reviewing the figures”.

The third point that one can infer from these findings is that there are external systems that influence and limit journalists ability to engage critically and use statistics in scientific news. These include, but are not restricted to, the political systems, religious culture and economics. All of these factors have a role in influencing both the news media outlets and the journalists in terms of their handling of scientific statistical information. The impact of these factors on the use of numbers by journalists or newspapers varies from one element to another. Religion and culture are key factors which directly affect the journalists themselves and they affect female journalists more than male journalists. On the other hand, the political and economic factors have more impact on the Arab newspapers themselves when it comes to them dealing with figures.

5.5.2. Key Finding 1: Official Sources

The findings show that in the three Arab countries (Egypt, Saudi Arabia and Kuwait), journalists covering science have little or no access to official sources which they need in order to obtain statistical data. However, there is a sense of difficulty when it comes to accessing government sources in Arab societies,

> *I rely on anything concerning Saudi Arabia by asking the Ministry of Health of Saudi Arabia, not others, because the World Health Organization is able to receive information from more than one source and this source can be unreliable. I depend on the source who exports the information from the base of the source [INT12].*

Sometimes, blind trust in government sources is negative for a journalist or newspaper, often resulting in a loss of public credibility because of inaccurate figures. Therefore, the journalists should diversify their statistical sources in order to finally obtain reliable figures.

These results coincide with Lugo-Ocando and Brandão (2016): They found that journalists are over-reliant on official sources when producing news stories. This may affect the handling of numbers in terms of checking and verifying the validity of statistical information through other sources. Not all of the data from government sources is valid and reliable (Messner and Garrison 2007).

In many cases, government sources are hesitant and very conservative in disclosing statistical information to journalists, especially when the sources believe that the dissemination of such statistical information will have negative consequences both on the personal level and on the governmental body in which the official works, or even on the community.

> *The issue of numbers in Arab countries is very sensitive because they [the government] are afraid of the numbers being published either in a positive or a negative way, so officials avoid giving figures on some sensitive topics such as AIDS. Unfortunately, in the Arab countries, the numbers are only published where it will serve the government body [INT9].*

This is confirmed by another of the interviewees who pointed out,

> *As a journalist, anywhere I go, the first question I ask should be about a statistic. But there is always a 'blur' among the media and the official sources, such as ministers and research centres in terms of figures. The Ministry of Health only publishes figures if they are positive, such as an increase in visitor numbers or in emergency income. Negative figures are often not published by the Ministry [INT11].*

On the other hand, it is quite different when the statistical information is positive, as the government source believes. The officials, in those cases, will facilitate and speed up the journalist's access to the figures and remove the obstacles that are placed in front of the journalist when the numbers are negative.

As well as the negative impact of some government sources on the Arab countries that is derived from hiding some figures that they believe to be negative, leading journalists publishing scientific news without numbers – or even without the use of sources – may be equally unreliable. The act of hiding numbers may stem from a fear of accountability to the higher authorities or for the purpose of polishing up the official authority's reputation, painting a perfect picture for the community, and portraying a particular official as a successful leader and ultimately helping him or her to reach the higher ranks of the state or the ministry. In the end, the negative figures may be hidden for personal purposes.

There may be an acceptable reason to hide numbers from reaching the journalists, since these figures may affect national security or affect international relations and thus this aspect reflects the common interests of the state with other countries.

The findings also indicted that the lack of co-operation between the ministries in the issuance of figures led to a discrepancy between the statistical information, as each ministry or government sector issued a different set of numbers from the other. As a result of this discrepancy in statistical information, the average journalist became confused, and thus some journalists may now not trust the government sources and instead look for external sources from which to obtain their numbers. However, as a result, as only three journalists – [INT01], [INT06] and [INT13] – preferred external statistical sources from international organisations, two from Egyptian newspapers and one from a Kuwaiti newspaper.

> *Unfortunately, any number issued by the government sector will find a contradiction 'and contain inaccuracies', for example, in the Egyptian Ministry of Health we will find a statistic and when you go to the database of the Cabinet we will find another number on the same subject. We always find inconsistencies in the government figures, so we resort to specialised organisations where the figures issued by them are often accurate and correct [INT06].*

This is not a problem unique to this part of the world, nor of censorship or spin. Indeed, Arab countries are considered to be a part of the developing world, where bureaucratic procedures play a role in delaying the access to statistical information and they take a long time to be available despite no agency intentionally causing the delay. When the journalists go to the ministries – such as the Ministry of Health, to give an example –, they often go through long procedures to reach the government source that has the information they desire, according to the interviewees. Some journalists see the officials as deliberately delaying the delivery of figures because the numbers are not available: As a result, he/she will try to get a hold of the figures regardless. Even if the figures are sometimes available, they are often outdated, which has a negative influence on the credibility of the journalist's numbers. Some other journalists have observed that the government ministries do not care about the statistical aspects of government.

Unfortunately, there is no one who helps in dealing with numbers, especially the source of statistics. When I go to the source of the number and I try to reach the minister, I find that there are many barriers placed by the ministers as the office manager and the official spokesman only highlight the achievements of the ministry, the ministers and of other staff [INT09].

This challenge for the journalists in terms of obtaining figures contributes to the delay in the publication of scientific news and (in this case) the journalist may be held accountable by the newspaper. These factors may reduce the journalist's determination to get the numbers and may consequently lead to the publication of scientific news without figures.

Moreover, even when the journalist receives statistical information through the procedures and complexities established by the ministries, sometimes the figures obtained by the journalist from government sources are not representative of the community, as one journalist mentioned, ‘statistics that the journalist gets from official sources in the Arab community often are not represented and not comprehensive’ [INT03]. This was confirmed by the content analysis findings which showed that 11.1% of the science news (health and technology) did not follow these statistical procedures (unrepresentative sample) [see content analysis section, Table 37].

However, some of the journalists have developed strategies to bypass these obstacles. Sometimes, as pointed out by several of the interviewees, when a particular journalist has difficulty accessing a government source then the journalist reaches the statistical information by tracking the foreign conferences where the government’s sources will be displayed through speech. One journalist from the Saudi newspapers mentioned that he got some figures, specifically from the Ministry of Health, through the minister’s speeches at foreign conferences – still, however, the figures are sometimes inaccurate because of the use of implicit statistics,

> *In fact, we cannot rely on a number because the Ministry of Health, as an example, takes the figures from the letters of the minister who went to the United Nations and also gave his speech. The Ministry avoids giving the exact figure by giving only a percentage and using the words: example, about, estimated and ‘approx’ [INT09].*

Nevertheless, the problem of access to data is a generalised one as exposed by another of the interviewees,

> *Statistics are rare, although unfortunately, statistics are not representative of the whole society. We suffer from the fact that the figures are issued from the mouth of the minister or the media spokesman of the minister [INT03].*

The journalists interviewed, however, have distinctive views of the degree of access to data and sources. Most of them, for example, and regardless of the country, say that the Ministry of Health is better than the other ministries. This is because, they argue, the Ministry of Health tends to issue a monthly statistical booklet and sometimes yearly booklets which are both available on the website of the Ministry alongside many statistics on health-related aspects. The system, however, still needs development and other statistical information to be included.

One of the journalists interviewed for this research project has since moved to the Ministry of Health of his country to help improve the information system.

Other journalists believe that there are many ministries that help the journalists get their numbers quickly and easily without any barriers being placed in front of them. They also point out that if there are difficulties in obtaining the information and the journalists are taking a long time to reach the government source, it is not only the fault of the government sources but also of the journalists themselves. In this sense, they suggest that the journalist should have experience in dealing with the ministers as well as in developing excellent relations with ministers and the rest of the staff working in those ministries. How confident are the officials in the journalists as to whether they will be good at dealing with the statistics or if they will instead distort them inaccurately? All of these things help us understand the concept of the easy access to statistical information, commented one the interviewees.

> *I think that, from my point of view, although I do not know the opinions of other journalists, I think that checking the statistics is not difficult but can be done or can be dealt with simply or easily if you have previous knowledge of the official sources who provided you with the statistics. I think, if there is any ambiguity, I think the statistics can still be consulted and confirmed properly. I think it is easy, simple and not difficult. The effort of those looking for the information will eventually decide whether or not they get it, but statistics always require effort to get because not all statistics are easy to obtain, depending on the confidence of the officials in the journalist and if the journalist is good enough to deal with the statistics [INT18].*

The findings show that in Kuwait there are some government sources using journalists to publish statistical information to gauge the reactions of the public and the officials, where the government source gives the journalist its figures in an oral form and then the journalist publishes the figures. If the public reaction is negative, the source comes out through the media and denies that it gave the statistical information to the journalist.

The journalist, especially in our Arab societies, must obtain documents, not take numbers randomly or orally. The numbers must be in accordance with official letters.

> *There is a term in politics called the 'test balloon'. The test balloon is always used by ministers to test a topic. The minister passes information to a journalist as a source. Thus, after two days, if the minister believes that this information or figure is not positive, the information will be denied. So, the journalist comes out as the liar and there are then claims that the media is false, not the source. I often move away from the source issue. I always look for documented information, taking the figures from the official papers is better than taking the numbers from the words spoken by a minister [INT16].*

Another journalist from a Saudi newspaper who always asks for government sources elects to obtain this information by sending emails, especially when the news contains numbers:

> *As a means of being careful, I aim to receive statistics from the official authorities through an official email because sometimes the official may deny that he or she gave the statistics to the journalist and therefore the official email is my only proof [INT08].*

The subjects of the interview also explained that in Arab countries, if the government source gives the journalist figures and then denies it the next day, there may be strict financial penalties imposed on the newspapers if they have already published the figures which may have negatively affected the reputation of the society or the reputation of the people. In this case, the journalists are considered to be the weakest link and it is they who are forced to pay the fine or sometimes even be put in prison. Accordingly, some government sources use indirect methods in terms of managing the flow of statistical information to the newspapers to achieve the objectives of the ministry, which is the dissemination of solely positive statistical information and, in turn, blocking negative numbers from reaching the journalists. This mode can present difficulties in verifying the accuracy of those figures. One of the interviewees who was from Saudi Arabia mentioned that some ministries, especially the Ministry of Health, control the flow of statistical information to newspapers indirectly:

> *I cannot get information and figures from all the areas of news and health news. The Ministry of Health and other ministries do not provide information and figures to journalists and resort to sending one of their employees, especially from the public relations department, to the newspaper to work part time. This person aims to pass information and positive figures on to the newspaper. The newspaper has to hire these people because, if they do not, they will not achieve the cooperation of those ministries in terms of obtaining information and thus they employ these people to get the scoop [INT09].*

The main goal of a newspaper should not only be to ‘get the scoop’, but there should be a more important goal, which is to maintain their sense of responsibility for the society they write for and inform. The newspapers must assume their responsibilities towards the community and not avoid this by turning a blind eye to the journalists who publish the news and who work for a certain ministry, and who will only improve the image of the ministry by displaying positive numbers and blocking negative numbers.

5.5.3. Key Finding 2: Internal Issues Inside the Arab Newspapers

Internal issues inside Arab newspapers can prevent science journalists from dealing with statistical information correctly, as has been previously established. Several factors include: Arab journalists having a lack of statistical training as well as statistical accessibility. Another factor is that most journalists cannot access accurate numbers due to the lack of data bases provided by newspapers. In addition to that, majority of journalists working in science news are not specialists in this field of journalism, and Arab newspapers do not support them to subscribe to scientific journals that provide reliable numbers. These factors will be explained in more details below with excerpts from the interviews:

One of these factors, is the educational backgrounds of Arab journalists and one that the findings seem to highlight the most. Indeed, the results of the interviews showed that the majority of journalists working in the field are not specialists in the field. Eight of the journalists graduated from media colleges, and only one of them holds a master's degree. Eight of them graduated from different disciplines such as physics, chemistry, radiology, sociology and English, which is remarkable in light of the expert panel's comments given the fact that it is often said that ' if only' journalists had a science background they would do a better job at science reporting. Only two of the journalists did not have university degrees (only secondary certificates) and both of these journalists were from Kuwaiti newspapers.

The interviewees also seem to accept the fact that education and training are crucial and some journalists believe that the employment of journalists without qualifications in the field of journalism contributes to the incorrect handling of statistics:

> *Unfortunately, there are no specialised journalists. Most of the journalists in Saudi newspapers are not journalism graduates [INT09].*

Unfortunately, many journalists are not media specialists, says one of the interviewees, who adds,

> *Therefore, dealing with numbers causes them embarrassment. Cannot explain these figures or explain them to the public in order to convey the real media message [INT16].*

The large number of journalists who graduated from different fields outside journalism and who use statistics to create scientific news, delineate how the Arab newspapers do not seem to care too much about scientific news. Furthermore, these newspapers also do not trust the outputs of the media colleges because of the weakness of the media students, not only in

terms of dealing with numbers but also in their field work, as fourteen journalist interviewees mentioned,

> *There is no doubt that there is a significant lack of awareness of the importance of dealing with figures from media students in Egyptian universities who are still new at work [INT04].*

The interviewees blame this on the background of many of those coming to the newsroom from the universities,

Unfortunately, university students have no background in dealing with numbers as well as in how to write news stories in general [INT09].

The interviewees also express their criticism towards the education system as a whole and question its value in the face of the challenges of journalism practices,

> *Studying alone is not enough. There are many students studying in media colleges, but journalistic practice for a long time is better than studying media. Therefore, journalistic practice helps to give a better understanding of numbers, not just university studies about media and numbers [INT05].*

This belief that the output of media colleges is very weak is not only held by the journalists but also by editors, especially in Saudi newspapers. Khaled al-Malik, Editor-in-Chief of the Al-Jazira newspaper, one of the most important Saudi newspapers, demanded that the media colleges be closed by saying that,

> *The problem with these media schools is that they do not develop and do not deal with the great changes in the media, so we do not find an impact for their graduates. As a result of that, the profession of journalism is dependent on talent from outside of these specialised media schools, without finding an impact for the graduates of these schools (Al-Malik 2019).*

The study showed us that seventeen of the journalists have had more than ten years of experience in the field of journalism and that some had even had thirty years. Only one journalist had less experience than the rest; she had only two years of journalism experience. Experience plays a role in dealing with numbers in the news, not studying media, as some journalists think,

> *Dealing with numbers depends on the experience of the editor because the experience here plays a big role in the process of dealing with the statistics, because the journalist may get statistics but cannot explain or understand them [INT18].*

Experience may be sufficient to deal with numbers in some types of news, but experience alone may not be sufficient when the news is scientific. Creating scientific news requires precision (as does medical news) which can be gained by returning to specialists in the scientific and statistical fields, or even by taking specialised courses in dealing with numbers in the scientific field.

The second factor is the scarcity of training courses that deal with how to handle numbers in news stories. It has been suggested that the background and training of journalists both play a crucial role in allowing reporters to examine and validate claims made on the basis of statistical information in the press (Nguyen and Lugo-Ocando 2015). However, the findings indicated that the majority of journalists did not take courses in dealing with numbers in relation to science news. This findings may reflect that the majority of Arab journalists have no interest in developing their skills, especially in terms of how to deal with numbers. Although I conducted interviews with seven female journalists, none of them had taken any courses related to numbers.

Only four of the journalists took courses in dealing with numbers, [INT1], [INT09], [INT16] and [INT18], two from one newspaper, Al Rai, one journalist from Al-Ahram newspaper and one from the Riyadh. Two of those who took courses did not chiefly focus on how to deal with numbers, but the figures were mentioned as very small parts of their courses and the main purpose of the courses was to develop the journalists' skills in different areas and the courses were not about dealing with the figures directly.

This means that the journalists from the Kuwaiti newspaper (Al Rai) had more interest regarding the development of their skills in terms of dealing with numbers in scientific news than did the other journalists from the Arab newspapers. Interestingly, one of these journalists from Al Rai newspaper – who took courses in dealing with figures – was commended in terms of the accuracy and clarity of statistical information by the experts during one of the news-analysis segments of the expert panel section [see expert panel section]. So, taking courses in handling numbers has a positive influence on Arab journalists, which reflects on using statistics in science news. One of the journalists who took a course in numbers pointed out,

> *Of course, the course helped me to know how to deal with the numbers, giving indications and evidence, especially in the parliamentary and political fields and when testing the attitudes of society [INT16].*

On the other hand, the responses from the journalists who did not take courses in numbers differed in how much they placed importance on, or acknowledged the usefulness of, these courses for journalists when writing scientific news: They all pointed out that having sufficient experience was more important. They felt that there was no time for courses and no need for these courses under the pretext of knowing how to deal with numbers. They claimed that

access to the government sources was sufficient enough and that it reduced the importance of taking those courses:

> *I honestly do not think that taking courses in dealing with numbers will add anything to me, especially since I have about 12 years of experience. I know how to deal with numbers. For me, I think the government sources are enough to ignore the necessity of taking courses in dealing with numbers [INT15].*

Time pressures are not only used to explain mistakes in the newsroom around the use of statistics but also in relation as to why there is not sufficient training,

> *Did not have the chance nor the time to take this type of course because I am working for a television channel in Egypt also. This doesn't leave me a lot of time to take these types of courses [INT04].*

The quotes above reflect the lack of interest of some journalists in developing their skills on handling figures. They further demonstrate that some journalists also believe that once access to the government sources has been established, the figures will be clear and accurate and that they do not need skills to understand how to deal with them. This belief and confidence in the sources in terms of the provision and interpretation of numbers may not necessarily be true but may instead be evidence of poor journalistic skills in dealing with numbers.

Moreover, in Arab countries, there are some statistical sources that do not co-operate with some journalists for several reasons. The most important of these reasons, perhaps, is the fear of those sources that the journalists might misinterpret the numbers. It has been argued that the way in which science news is reported, especially when it comes to the natural sciences, is inadequate because of its 'non- or under-reporting of important scientific progress, tendency to sensationalism and negativity in wording and in presentation, and inaccurate reporting' (Fjæstad 2007, p. 123). Also, scientists have stressed the need for 'accuracy' when dealing with scientific news (Murcott 2009, Hansen 2016). One journalist pointed out that,

> *There are a number of journalists who abused the media profession by writing inaccurate content and you will find that many scientists suffer from the idea of the misappropriation of media content because of the lack of precision, so scientists prefer to avoid the media [INT01].*

The weakness of the journalist's skills in dealing with numbers in scientific news may be an important factor for the lack of co-operation between scientists and journalists in terms of the provision of statistical information.

The results showed that seventeen out of eighteen journalists agreed that not all of the statistical information they received was intelligible. The journalists' handling of the information varies from one journalist to another: Some journalists go back to the source of the statistics

in a basic way and some go to search for alternative sources of statistics, whether from the Internet or from foreign organisations. There are also those who refer to colleagues' work to try and interpret those numbers and some use experts in the field of news.

All the interviewees confirm the importance of numbers in scientific news and also in other branches of the news. Also, the role of the figures is to enhance the credibility of the news segment and help solve, or alert people to, the problems, and help the readers in understanding the decisions that are being made by the decision-makers or even by the public. However, some journalists, if they do not understand statistics, will incorporate the numbers as they are or publish news stories without numbers – this can lead to negative effects on the public through the misunderstanding of these numbers. The reason for ignoring or incorporating numbers without explaining them may be due to poor journalistic skills in terms of interpreting numbers.

> *If I do not understand the figures, I go to the statisticians for them to explain those figures. What do the figures mean? Also, I refer to the statistical source. If I do not understand the number, I will not write the number in the news [INT08].*

The figures may be ignored, unexplained or misinterpreted by the journalists because of their poor skills in dealing with the figures. There may, however, be several other reasons that are not related to the skills of the journalists themselves that account for this problem. One of these reasons is that the manipulation of the figures through highlighting only positive numbers that serve the officials or the ministers, helps the journalists to build on their personal interests with these leaders. One of the interviewees from the Saudi newspaper mentioned that there were journalists who came into the press profession only to achieve their personal goals in terms of the ministers – such as obtaining money or employment in a ministry while keeping his or her job in the newspaper,

> *Unfortunately, there are no specialised journalists. Most of the journalists are not journalism graduates, but some of them are specialised in agriculture and geography. Some of them use the profession of journalism to reach a goal, such as being an employee in a ministry, to look good to the minister or the director in that ministry so that the minister gives him a bonus or leadership position. There are journalists who benefit from the professionalism of the press to achieve special goals [INT09].*

Another journalist noted that courtesy plays a part in the fact that the journalist passes numbers on, even though the journalist is not convinced of the accuracy of those figures,

> *Sometimes the reporter passes inaccurate numbers and information on because*

> *the journalist is forced to pass this information on, either as a compliment to the people or for any other reason [INT11].*

While one journalist believes that the responsibility of attaining accuracy does not lie solely with the journalists, but that the blame is on the scientists themselves and other such specialists in the scientific fields,

> *In some science news we cannot verify the numbers because I do not have a specialist who can confirm the validity of the information; not even some of our specialists in the field of medicine or engineering such as doctors. Some of them are very weak in their specialisation and there are few specialists to begin with [INT09].*

The quote above reflects that there is a lack of trust between the journalists and the experts and that each side has their own argument. This may result in an absence of numbers or the publication of inaccurate numbers. In Arab societies in general, there are experts and scientists and famous people in scientific fields, but their numbers are very few compared to the scientists in western countries.

There are a good number of scientific experts in the Arab world, but the majority are not at the same level as those in Western countries for several reasons, including the lack of financial support by most Arab countries for these scientists, as well as a lack of environmental factors which contribute to the development and motivation of scientists.

On the other hand, the journalists agreed that the credibility, honesty, reliability and accuracy in terms of the publication of figures, both positive and negative, as well as interpreting them correctly, in order to serve the public and not manipulating the numbers for individual purposes, were the most important things that a journalist must do when he/she receives statistical information,

> *As journalists, we must convey statistics that are of interest to people whether this statistic is bad or positive. Publication of the figures for the public is considered to be a form of honesty that must be communicated without changing the facts [INT07].*

In the study, within the content analysis findings [see content analysis section], the findings indicated that over 16% of the scientific news stories that contained statistical data were published through Arab newspapers without mentioning the name of the journalist. It was also found that nearly 26% of the sources of the statistics were unknown. These percentages may be due to the insufficient skills of the journalists in dealing with the figures or it may, in fact, also indicate other elements: This led to the formulation of the question relating to the Arab

journalists regarding the reasons for not mentioning the journalists' names and their statistical sources.

When the journalists feel that they are at risk, and they experience the fear of responsibility when their name is mentioned, or the name of the statistical source is mentioned, they publish statistical data without mentioning the names. One of the interviewees from an Egyptian newspaper said,

> *When I have statistical data or other information that I got from a source, and the source has asked me not to publish this information but the information is very important – which is considered to be the scoop –, in this case the journalist will not commit to the request of the source and then will publish the information without mentioning the name of the journalist or the source of the statistical data [INT02].*

Some journalists, especially those from Saudi newspapers, believe that there is a common protocol among journalists when the news comes from an agency or a public relations department in a ministry or indeed from any government agency. This protocol is to publish the news stories without mentioning the name of the journalist because no effort has been made to obtain information,

> *When a journalist does not write his name on a news item or on a statistical report, this may be due to the fact that this news may be published in all of the other newspapers and the journalist himself did not write the news article in question. We have a protocol in the press that means that if you don't strive to develop the news that you received by email so you don't deserve to put your name on it [INT11].*

When the journalist receives scientific news – especially from public relations departments or different agencies – that contains numbers and then publishes them without names, without making any effort to add information or to verify the accuracy of the figures or even their credibility, this may be explained by the fact that this journalist does not have the ability to verify or handle numbers. As a result, some sources may pass unreliable and inaccurate statistical data on for personal or commercial benefit.

[INT14] and [INT11] point out that when some journalists get inaccurate statistical data and do not provide their name on the article when it is published in a news story, the journalists may fear the consequences of publishing this data – such as being legally prosecuted. This may indicate that journalists tend not to name themselves on scientific news articles in order to hide their weaknesses in dealing with figures.

On the other hand, [INT03] from Al-Ahram newspaper noticed that when the name of the journalist is not mentioned in the news, there is often a certain defect or manipulation of the

figures. Another journalist who was from same the newspaper agreed with [INT03] and he added that the journalist's failure to mention his name on the news item is considered to be negligence and indifference towards the news generally [INT01].

The second issue that can prevent science journalists from dealing with statistical information correctly is that newspapers play a central role in influencing press practices by formulating policies that affect the journalists positively or negatively. The policies of the newspapers differ from one country to another because of several elements such as the level of freedom or the main principles of each newspaper. As Arab countries are developing countries where the level of freedom of expression is low for several reasons such as those stemming from political and cultural aspects, it is normal for Arab newspapers to be affected by this. As a result, Arab newspapers play negative or positive roles in terms of their influencing journalists in how to deal with statistical data. In this study, the findings highlight several aspects that can influence the handling of numbers negatively.

The weak financial state of the Arab newspapers can affect how the journalists deal with numbers. There are several factors that can be caused by the financial weakness of these newspapers, with one of these factors being a lack of funding, leading to a lack of statistical databases. Although databases have a significant role in improving the journalist's press work and providing statistical information and other information, there are a lack of databases in Arab newspapers and even those newspapers which have databases often stock old statistical information.

> *Unfortunately, there is a problem in the Arab newspapers; because of their low budgets they cannot create information centres. So, journalists depend on what they collect from the archive, information which is not considered to be accurate statistics or real indicators of the measurement of opinion in society [INT16].*

Access to data and statistics is at the centre of this issue raised by journalists and other news people, which also is underlined by the lack of databases that journalists can access,

> *When we talk about the scientific newspapers in Arab societies, you find that most (or all) of the countries do not have an information database through which to obtain the statistics [INT03].*

A lack of information centres is not only present within Arab newspapers but a general issue that affects the whole of society. In most Arab countries people suffer from the same problem, even though some Arab countries, especially in the Arabian Gulf, are very rich. This is confirmed by a Saudi journalist who pointed out that journalists really miss the information centres in Saudi Arabia that contain information that is relevant and correct and that relates to

medical fields. He added that often these centres have the information, but the numbers and information are considered to be semi-confidential and they are published only to certain parties and are not exposed to the media [INT11]. Another journalist from a Kuwaiti newspaper, [INT16], said that complaints from journalists about their lack of access to statistical centres, the lack of co-operation from statistical centres and the lack of private study centres were all factors that led to difficulty in obtaining or publishing accurate statistics and numbers. The United Arab Emirates (UAE) may be better than other countries in having a number of good information centres, as [INT13] pointed out. However, lack of information centres in the countries does not justify the newspapers not providing their own information centres and also the journalists should always look for statistical information from anywhere and not rely on the newspaper to provide statistical information for them.

Another factor that can be caused by the financial weaknesses of these newspapers is that the managers of these newspapers do not contribute to supporting the journalists by paying the subscription fees to the scientific journals that provide reliable numbers. One journalist pointed out that,

> *Statistical information can easily be accessed if you are a subscriber to a journal or a process journal and therefore you can simply read it and get the numbers. Of course, participation in scientific journals requires the payment of a large amount. It is always paid by the journalists and therefore it is difficult for the journalist to pay a large amount without the newspaper bearing the subscription fees [INT03].*

The financial resources of most of the Arab newspapers are owned by either Arab traders or governments. The traders will primarily consider how to increase the income of the newspaper. This trend may lead to the acceptance of these newspapers in terms of publishing inaccurate figures within scientific news items that are aimed at promoting a particular company – pharmaceutical companies or other commercial companies.

The general view by the interviewees is that Arab newspapers can have a negative role in dealing with numbers and they have a lack of interest in scientific news in general. This was obvious due to a number of reasons, as follows. Firstly, the Arab newspapers do not care about scientific news as they do for other branches of the news: This is demonstrated by them not appointing scientific journalists to write scientific news. Any journalist in the newspaper can write any kind of news, whether it be political, economic, scientific or sport-related. Therefore, [INT06] mentioned that there were very few dedicated scientific journalists working for Arab newspapers. This finding confirms that the number of scientific journalists is low and that such journalists are rare. Only six out of eighteen journalists are considered to be science journalists and the rest of the journalists are not science journalists. Interestingly, the Egyptian

newspapers came in first place with five science journalists (three for Al-Ahram and two for Al-Masry Al-youm), then the Kuwaiti newspapers with only one science journalist who was a woman, then the Saudi newspapers that did not have any scientific journalists. Moreover, [INT07] pointed out that,

Can you imagine that Al-Ahram, which is considered to be the oldest newspaper in the Arab world, is considered as a model to be followed by Arab newspapers only, where there are three scientific journalists out of twenty-six thousand journalists and the reason for that is that many journalists do not prefer to work in the field of scientific journalism because work in this area requires great effort.

The scarcity of scientific journalists in Arab newspapers has contributed to the fact that any non-specialised journalist can cover scientific news which results in the figures possibly becoming negative and inaccurate.

Secondly, [INT01] mentioned that some Arab newspapers do things that may indicate that these newspapers are not aware of the importance of scientific news: They use science news to fill the newspaper's pages if there is a lack of news. The scarcity of science journalists and lack of interest in scientific news by newspapers. This caused the translation sections in the newspapers to translate scientific news and publish them without further scrutiny. [INT16], from the Kuwaiti newspaper, pointed out that,

> *The Arab newspapers are buying foreign scientific news from the agencies by buying a full sheet of news. The main problem is that these sources provide the press with information and figures which are incorrect and inaccurate in some areas and some of the information and the figures are very old – by up to more than a year [INT16].*

Another journalist from a Kuwaiti newspaper mentioned that:

> *There is scientific news reaching the newspapers through external sources where translation offices, specifically from Beirut, send the news and unfortunately some of these figures are passed on without verifying their credibility [INT13].*

Furthermore, some journalists felt that all scientific news containing numbers that is issued by famous foreign agencies is accurate, especially when foreign agencies have an Arabic version. Only one journalist, [INT02], from Al-Ahram newspaper, mentioned this issue: He said that there was a contradiction within the same news agencies when there was an Arabic version that was issued by the same agency – in these scenarios, there was no interest in the transfer of news and figures as there was in the English versions. He found so many of these mistakes that when he saw these numbers in scientific news stories from foreign agencies

that were published in Arabic, he did not trust the news items and instead he would revert to the more accurate English version [INT02].

According to them, inaccurate translation may lead to the delivery of news and figures that are not relevant to certain communities, especially in Arab societies, and therefore the benefit of the news is reduced in those communities. The results of the expert panel revealed that incorrectly translated western news may present statistical information that is irrelevant to Arab societies. The interviewed journalists explained that several factors may be responsible for this tendency: the translation may have been made without adequately checking the scientific news and figures; a lack of interest in scientific news among the Arab public; and the scarcity of scientific journalists. According to the journalists, all these elements have a role in the findings of translated science news that contains no relevant statistical data. [INT06] and [INT12] pointed out that including figures that come from places outside the Arab world contributes to raising the awareness of science in Arab societies. According to another journalist who feels that the issue is one related to the tendencies of the Arabic reader:

> *You are dealing with a lazy Arab reader who reads the titles but not the content of the articles, because these stories are long, and the scientific terms are not interesting to him. The problem is most evident in science news, because reading is very weak in Arab society. If figures are published, they will be random, and it will not matter whether those figures are relevant to the society or not [INT16].*

Of course, newspapers have many types of readers, often those reading scientific news are experts and specialists, but some ordinary people also like to educate themselves by looking at these kinds of news stories. If the journalist's statement that the public does not read is true, it is his duty to respect the readers by transmitting the numbers that would attract the public to read science news. This can be done by presenting figures related to the community and helping to clarify the story to the public.

On the other hand, the study showed that the majority of Arab journalists (fifteen out of eighteen) mentioned that the newspapers demanded that scientific news stories should contain figures. The interests of newspapers in encouraging journalists to use numbers in scientific news differs from one newspaper to another. [INT11], from the Saudi newspaper, Oqaz, pointed out that the newspaper relied heavily on numbers, especially on the first page, as when you opened the first page you would find that most of the news on it depended on statistical information. Another journalist from an Egyptian newspaper (Al-Masry Al-Youm) said that Al-Masry Al-Youm and its administrational and editorial policies urged journalists to put a number in the main title of the news story.

Furthermore, visualisations of data, usually in the form of charts and diagrams embedded within a text, have been used to support news stories and provide additional evidence or related details (Segel and Heer 2010). Consequently, data visualisation and infographics have become useful tools for journalists, as two journalists [INT12] and [INT04] mentioned: Some Arab newspapers have taken an interest in the infographic and have presented their figures through it, which is a kind of encouragement to use figures and also to clarify them.

The newspaper has a great role in dealing with statistical data through providing the technical aspects (which is done through infographics) which help in delivering the numbers to the public in an easier way for them to understand. Graphics have now become the master of media publishing and the most important thing that is required [INT12].

Currently, infographics have become a major factor in the press in Egypt and in the Middle East. When you have a strong journalistic topic, you will get better infographics that can deliver the information simply. This means that the more infographics that are on the page, the more comfortable and the easier it is for the reader to read [INT04].

However, in the content analysis [see content analysis section Table31], the findings showed a different aspect: They showed an interesting and obvious gap regarding the use of statistics in visual information. A high percentage of science articles, nearly 99%, do not use any visual information. This supports Al-Qafari (2009) findings of a lack of interest among journalists in embedding graphics into scientific news.

[INT03] and [INT12] suggested that this high percentage of science-related news articles not displaying visual information is because the newspapers simply ignore this element and do not care about scientific news that is required of them. [INT12] added that in the Oqaz newspaper, they use much visual data in economics articles, more than in any other type of news story. Three journalists think that newspapers do not play a role in supporting journalists in their use of statistics in science news. Two of the journalists who were from one newspaper (Al Riyadh), [INT08] and [INT09] said the newspaper did not encourage journalists to use the figures by leaving it up to the journalist, who is then responsible for adding numbers or not. The third journalist (from Al Rai newspaper) mentioned that,

> *The newspaper's policy does not always help in the use of numbers because there are numbers that harm the interests of some, whether in the newspaper or outside the newspaper. Therefore, of course, not all the known numbers are published [INT16].*

Here, especially, if the newspapers give the journalists freedom then the journalists should not wait for the newspaper to support them or for the newspaper to explain to them what they need to write in terms of numbers. A good journalist who is highly professional often does not

need to wait for the support from the newspaper in terms of writing good news, especially when the newspaper leaves the journalist with the option of adding numbers or not.

5.5.3.1 Regarding Timeliness

Timeliness is considered to be a sensitive matter, especially with regards to statistics, and it is one of the elements that is continuously reviewed by people who deal with numbers (Chibnall 2013, Blanes and Kirchmaier 2018). The factor of time has a role in influencing the use of figures by journalists, either because of the time constraint required by the newspaper for the journalists to hand over the news at a specific time, or because of the journalists themselves in terms of how they should deal with the numbers in a short time.

The study revealed that the time factor has an effect on journalists in their using statistical information, where the majority of Arab journalists believed that they suffered from time constraints which affected the accuracy and the credibility of their figures. In contrast, only four journalists from the Kuwaiti newspapers and one from the Egyptian newspapers – [INT03] [INT13], [INT14], [INT17] and [INT18] – mentioned that the time factor was not a problem in dealing with numbers for several reasons.

The difficulties faced by journalists when using numbers vary due to the time constraints and also from one journalist to another. Some journalists pointed out that some newspapers obliged journalists to submit the news before the publication period (by no less than one day before) and this was difficult, specifically in terms of scientific news which needed to be accurate. This study confirms that for 67.1% of statistical data (from the content analysis section, see Table 29), no reference to time was mentioned and that 3.8% of the statistics were older than three months. In addition, the time pressure that most journalists suffered from could be the reason for using only one statistical source: This had a very high percentage, with 95% of science news including statistics [see content analysis section, Table 14]. Journalists try to make science news acceptable by using the approximation method when handling numbers or ignoring them:

Of course, time is catastrophic, especially when dealing with urgent news and there are numbers that are updated at any time such as accidents. We also use the approximation method, where sentences are repeated (more or less and almost) when the numbers occur continuously [INT01].

> *We suffer from the time factor not only in dealing with the figures, but in many stories that require accurate information and a carful writing technique and therefore we try to deliver the news before the date of publication if our time is limited. Therefore, the news and figures may be insufficient or not mentioned*

due to the time factor [INT06].

Another difficulty that faced journalists when considering the time factor was the delay in obtaining numbers from their sources. [INT09] mentioned that it took time to obtain or verify statistical information from sources, especially official ones in some Arab countries. So, the publication of scientific news, including figures, is often delayed because of waiting for the numbers from the official sources.

While some journalists, especially those from Kuwaiti newspapers – [INT17] and [INT14] –, have an alternative opinion about time and numbers, they also mentioned that they had no problem with timeliness, as the newspapers did not pressure the journalists to hand the scientific news in fast and that the journalists had the time (up to a month sometimes) to write the article and look for the numbers. [INT14] pointed out that he did not have a problem if the news he had was going to be late by a week as long as he made 100% sure that he had supported it with statistics. He felt that this was better than publishing numbers when he was not sure about their accuracy.

Experience in journalism has a major role in overcoming the handicap of time constraints and dealing with numbers, as is mentioned by [INT03], [INT13] and [INT18],

> *The time factor is not effective when you read a statistic that may require effort to understand its significance, especially when the journalists are at the beginning of the time factor that affects them when dealing with the numbers. But with practice in handling the numbers for a long time, journalists will find that the time factor does not affect the handling of numbers [INT03].*

Moreover, there are journalists who see that the problem is not a lack of time, but rather how they organise their time in order to deal with numbers, as noted by [INT13] and [INT18].

> *I think that time does not affect the correct submission of statistics if you have the experience to deal easily with all the statistics that come from the sources for the news [INT18].*

5.5.4. Key Finding 3: The External Interference

The third point from the findings is that there were external terms that influenced the use of statistics in science-related news by Arab journalists or by the newspapers such as political systems, religious cultures and economics. The impact of these factors varies from one element to another regarding the use of numbers by journalists or newspapers. Both religion and culture are key factors affecting journalists themselves in terms of their usage of numbers, while political and economic factors have more of an impact on the Arab newspapers in terms of dealing with the figures.

The political system has been described by many journalists as a major point of difficulty in terms of obtaining or verifying statistical information. Politics is considered the most important factor affecting the media in the Arab region (Hamdy 2013).The journalists' responses differed depending on the reasons and excuses that were given to journalists from the statistical sources.

Firstly: Four interviewees (three from the Egyptian newspapers and one from the Saudi newspaper), [INT01], [INT02], [INT05] and [INT09], mentioned that the threat to national security was the main reason why the statistical sources invoked confidentiality when they asked for statistical information. Some official sources do not declare figures for political reasons such as national security and therefore the journalists cannot publish or search for the numbers [INT01]. In Arab countries, as a result of the aftermath of 9/11, many emergency and antiterrorism laws were enacted, as well as other vaguely defined pieces of legislation that provided these governments with the ability to limit the publication of news and commentary that may be considered a threat to national harmony (Rugh 2004). Thus, some newspapers avoided the issues of access to information and government control by publishing the papers outside the region (Mellor 2011).

According to [INT09], journalists understand their duty to their homelands better than officials do, and they only disseminate information that serves the country,

> *I know what to write and what not to write. I know. No one can force me to write what I don't want. I want to have a background on the numbers so that I know how to write accurately about matters of national, educational or educational importance to the public. I will not publish figures that harm my country's reputation or affect my community negatively [INT09].*

In line with this result, three journalists from only one country (Egypt) spoke out freely, stating that the political factor affects the handling of numbers in scientific (and other branches of) news. These journalists understood that the freedom of expression and the expression of opinions in that country was greater than in other Arab countries (Saudi Arabia and Kuwait). However, as [INT16] pointed out, the Court of Appeal of the State of Kuwait acknowledged two days previously that the public and journalists were entitled to criticise the politicians harshly.

Moreover, [INT02] added that nuclear security was considered to be a part of national security. He said that he wrote a section on nuclear security and nuclear security was not all the information on this subject in terms of authorised numbers – it was difficult for journalists to deal comprehensively with numbers.

Secondly: The second reason is that the movement of data may initiate a disclosure of the figures because of the common interests that are shared between the state and other countries,

> *There are certain agreements in space, so I, as a journalist, speak about a certain part of the cost of a satellite that the source does not want to mention because there is an element of cooperation with another country, so the source does not want to disclose the numbers and the cost because of confidentiality and relationships [INT02].*

Finally: The political differences within one state. The political differences across Arab societies play a role in influencing the use of numbers in the news in general. A good example of this is the political differences in Egypt where there are many different parties, unlike some of the countries where the system is led by the monarchy, as in Saudi Arabia and Kuwait. The difficulties vary depending on the country itself and the difference in time itself,

> *For example, in the countries where the Arab Spring is, unfortunately, I do not like this term (...) Our circumstances before the revolution and after the revolution mean our circumstances are different because it lies in political differences, so there are certain directives imposed on officials if they do not speak [INT02].*

Despite political change in Egypt, the media has continued to be mostly a mouthpiece of the government (Bebawi 2016) . Egypt experienced the Arab Spring and then a military coup in a short time, and these disturbances and rivalry between political parties and the differences in government within a short time frame – not to mention the change in the laws in order to serve a particular party – resulted in a great impact upon journalists in terms of their usage of figures. The use of statistical information is positively or negatively influenced by both economic elements and newspaper owners in Arab countries. Although some Arab newspapers are funded by the state, most Arab newspapers rely on advertising as a major means of income. In some countries, however, the state plays a major role in reducing advertisements or preventing them from appearing in any newspaper that violates state policy.

For example, in Egypt, the government can put economic pressure on private newspapers via its agencies and related organisations – such as publicly-owned enterprises – that contribute a great deal to these newspapers' revenues. Moreover, the Egyptian government controls the Supreme Press Council, which also determines advertising distribution (Rugh 2004). Furthermore, the ownership of the newspapers may impact on the use of statistics in these countries. For instance, the Al-Ahram newspaper is funded by the government along with other sources, while the Al-Masry Al-Youm newspaper is funded only by private sources (Rabi 2008), while print media in Saudi Arabia and Kuwait are under private ownership (Rugh 2004), yet these newspapers are still dependent to some extent on their governments regarding the governmental funding (Rugh 2004, p. 65;76). These factors have made the newspapers very open and left them scrambling to get a large share of the advertising market. Consequently,

some newspapers may be (forced or encouraged) to give up their credibility and accuracy in terms of the transfer of news, especially with regards to scientific news and figures.

The interviews' findings indicated that the majority of interviewees believed that the Arab newspapers were influenced by economic aspects that affect the use of figures in the scientific news. Also, some journalists mentioned that there were large companies – such as pharmaceutical companies – who pay newspapers to advertise their products and play a role in the passing on of inaccurate figures without scrutiny from the newspaper. One interviewee said that,

> *Let me tell you… the newspaper received health news from an outside source, and it imposed on the newspaper paid advertising from a certain company – this is often done by pharmaceutical companies [INT13].*

The quote above reflects that the pharmaceutical companies have a great ability to control the newspapers through the imposition of their announcements including the numbers that are often integrated without scrutiny from the newspaper or the journalists.

Also, some pharmaceutical companies insist that the same numbers be used in the scientific news, although they are incorrect [INT11].

Furthermore, the findings show that some newspapers publish the announcement of a drug in the form of scientific news (health), and all the statistical information and other information is therefore serving the pharmaceutical company for the purpose of selling this drug. [INT03] suggested that there was a big problem in terms of the confusion between the advertising from pharmaceutical companies and health news. She added that, for example, a few weeks previously, they had heard about a cure for cancer. This was for the benefit of one of the well-known and famous companies.

> *In fact, how many patients in the Arab world who are suffering from cancer would relate to this drug and stop taking their medication and thus lose their lives? The problem is that the study was not scientifically proven, despite the fact that it was published in the newspapers in the form of a scientific news revolution in the treatment of cancer [INT03].*

This observation is confirmed by the expert panel findings that showed that there were a number of health and technological news items that contained statistical data that was used for the purpose of marketing the product, whether it be a drug or a device. Arab newspapers are owned by traders or governments and therefore some traders want profits or pass on some information that would improve a company's reputation or to achieve other personal goals. Therefore, they could have a role in influencing the use of numbers by journalists.

Unfortunately, the owners of these media outlets are traders. They change some figures, and fictional numbers are created to influence the market and the public. This can influence the stock market or the money markets in the Arab world. When newspapers publish a figure, the stock can go up or down, so you find that manipulating numbers is normal for some traders or the owners of some media. Thus, we lack the ethics of the profession in the Arab media, because those who are the media are either governments or traders [INT16].

All these factors have a role in influencing both the newspapers and journalists in their handling of statistical information in science news. It is unfortunate that the press profession is exploited to achieve personal interests and to earn money: This may have a negative impact on the credibility of the newspaper and its responsibility towards society.

5.5.4.1 Religious and Cultural Factors

Culture and religion are important factors affecting people, especially in Arab societies that are considered to be religious communities and have Arab customs and traditions. Religion is considered to be one of the most important categories influencing journalistic practices. Furthermore, the culture among Arab journalists needs to be considered as a wider issue that might affect their ability to engage with and use statistics in scientific news. Indeed, cultural backgrounds affect the journalists' understanding of concepts such as objectivity, neutrality, fairness and bias (Weaver 2015).

The study revealed that the religious and culture elements both have an influence on the Arab journalists in their use of statistics in science news, especially in Saudi newspapers. According to Mellor (2005), Islam plays a fundamental role in defining the journalistic practices in Saudi Arabia and other Arab countries. Two journalists from Saudi Arabia, [INT09] and [INT11], pointed out that there was statistical information that they could not obtain or even publish because of the religious factor, as the source of the figures imagines,

> *Let me say something. In fact, in the health news, at the beginning of the emergence of AIDS in Saudi Arabia, there was a great embarrassment in the extraction of statistics on the number of patients. It was mentioned that the proportion was very low for several reasons. It was critical because we are in an Islamic society and therefore, we do not have such diseases [INT11].*

Unfortunately, the Ministry of Health is silent about diseases, and this disease, AIDS, is a danger to the community.

> *In the past, the number of people with AIDS was 3,000. This figure was unknown in the previous social and religious factors. This figure was revealed, and I am sure that the number has doubled, but there is no source available*

[INT09].

In fact, there may even be some confusion or misunderstanding from the religious groups of people who believe that showing figures on sensitive topics is a negative thing, especially in the media with diseases such as AIDS in Saudi Arabia – which is the heart of Islam because the Kaaba is there. They believe that showing numbers negatively affects Islam because one of the main causes of AIDS is sex that is considered in the Islamic religion as adultery if there is no legitimate marriage to consolidate it.

The journalists and officials of the ministries in Saudi Arabia may be afraid of a religious backlash, especially from religious leaders who have great influence, even on the ruler of the state, and so therefore they do not publish the figures and sometimes even hide some of the figures on certain sensitive topics. Awad (2010), suggests that Islam has affected the Saudi government through its religious leaders whose power stems from their role in legitimising or delegitimising the government's political acts by issuing a fatwa, or 'religious ruling'. Consequently, Saudi newspapers are prone to the pressures from religious leaders when they are disseminating their news (Al-Kahtani 1999). It seems that the role of religious leaders has become less influential recently, especially with the changes that occurred in Saudi leadership. Religion can also play a role in whether illiterate people believe the statistics in science news. There is less interest among illiterate people in scientific news, especially health news and the statistical information it contains. This segment of the audience tends to believe religious people more than scientific news that contains research and correct figures. According to [INT16], there is a lack of awareness in society because of religion and he provided an example of this.

> *When a scientific institution publishes a study on diabetes or a treatment for diabetes, and in contrast an ordinary person claims that he has found an herb which helps in the elimination of diabetes, people find themselves looking for an herb that is promoted by a person who is not competent in the field of medicine, and ignore the science, [because it] seems like it would work better here. This is because the public does not care about studies based on science and will instead rely on an uninformed person, because people believe that this person promotes this idea for no other gain than a reward from [Allah] God [INT16]*.

In fact, the interviewees argue, "there are those who fail to understand religion, which is especially true among the illiterate segments of the population. Furthermore, there are those in the Arab world who exploit religion to make money illegally" [INT16]. For these reasons, one can argue that the role of the journalist is important, as it involves educating people by

presenting the figures in the scientific news in a way that makes them accessible and easily understood.

However, one must acknowledge that culture also has a role in the hiding of statistical information by journalists or the Saudi newspapers, especially when it comes to customs and traditions among tribes who account for the vast majority of people who live in Saudi Arabia. An example is genetic disease, especially in northern Saudi Arabia, specifically due to marriage between relatives. One Saudi journalist mentioned that,

> *It is also known that the northern regions are tribes where the frequent marriage of relatives without awareness of the risks and effects takes place. There are significant numbers in terms of the incidence of genetic diseases there, but we as newspapers cannot easily spread this information by virtue of the customs and traditions of society in Saudi Arabia. The cultural aspect affects the use of numbers [INT09].*

The external factors (political, economic, religious and cultural) differ in influencing journalists' use of statistics in scientific news from one country to another. This study found that politics in Egypt plays a bigger role than in Kuwait and Saudi Arabia in dealing with the figures due to several factors such as political differences and the revolutions that resulted in the Arab Spring. On the economic side, pharmaceutical companies are more influential in Kuwait than in other countries while the cultural and religious factors in Saudi Arabia have had a stronger impact on how journalists deal with figures than in Egypt and Kuwait.

5.5.4.2 Arab Female Journalists and Statistics

Of the 18 interviewees from the newspapers that were part of the study sample, seven were female journalists. Each of these journalists has a bachelor's degree in one of a number of disciplines (law, cardiology, media or the social sciences). Two have higher degrees: one Saudi journalist has a master's degree in journalism, and a Kuwaiti journalist has a PhD in radiology. The high qualifications that these female journalists have are better in comparison to those of male Arab journalists, who have only a bachelor's or a high school degree. Although women journalists hold higher degrees than male journalists, they do not receive any female training courses in dealing with numbers, and this might suggest that they do not have the skills necessary to handle statistical data in science news.

Beyond the basic challenges of obtaining and dealing with figures in science news faced by Arab journalists in general, whether men or women, women face more problems than men. This is especially true in the field of media, even though women's empowerment in the media has improved (Ross and Carter 2011, GMMP 2015). There is a clear gap in the coverage of gender news in different news categories. This is especially true in the case of political reports,

where only 16% of the people featured are women, a decrease of 3% from 2010 (GMMP 2015). In addition, in the coverage of health news, women represent only 35% of those featured (Ross et al. 2018). This was confirmed by content analysis findings that show only 16% of the articles in Arab newspapers were written by female journalists.

This study revealed that, because they are women in Arab societies, women journalists faced difficulties related to the use of and access to statistical information. Saudi women journalists reported that they encountered these difficulties; however, those from Kuwait and Egypt did not. According to Mellor (2011) the empowerment of women in journalism in Saudi Arabia and other Arab countries still faces some challenges, including the lack of economic incentives.

The study showed that all Saudi female journalists who were interviewed had encountered challenges that influenced their ability to use statistical information in reporting science news. All these journalists, [INT07], [INT08] and [INT10], agreed that there were difficulties in obtaining statistical information for both men and women, but, because of cultural or religious factors, the difficulty for women in Saudi society is greater. According to [INT07] and [INT10], while the number of obstacles that women have encountered in the past have become fewer, they still exist,

> *In the past, there were many barriers for women journalists to get the numbers and information in general. These barriers have shrunk and become simpler, but they still exist [INT07].*

> *In the past it was difficult, but now it seems to be a lot easier [INT10].*

The greatest difficulty faced by Saudi female journalists was related to official sources; the source may deliberately delay giving journalists statistical information and sometimes ignores the journalists. [INT10] pointed out that, although in Saudi Arabia there is currently an openness and an awareness of the concept of journalism, there used to be a delay in information being delivered, but it finally arrived. Another female journalist [INT07] who complained about the lack of co-operation by statistical sources said that sometimes the sources do not co-operate with her and do not give her the information she seeks, and often they give her old information. Perhaps the reason that the sources refrain from giving female journalists the figures is that these sources are not convinced of the ability of women to cover the news well (Abdulrahman 2008). However, official sources providing female journalists with old statistics may not represent an unwillingness to work with women. Rather, some governmental sources simply do not have up-to-date statistical information, an issue that poses a problem for male journalists as well.

The comments above from female journalists may suggest that some official sources treat men and women who seek statistical data unequally. Although difficulties in obtaining

statistical information are common for both male and female journalists, that female journalists have more difficulties than male journalists may be related to the role of culture and religion, especially in Saudi Arabia and other Arab countries. According to many scholars, gender is in itself a problem in Arab countries (Abu Samra 1995, Abdulrahman 2008, Al-Mutairi 2009).

Furthermore, [INT07] pointed out that she always tends use to sources that facilitate her access to statistical information rather than those that put obstacles in front of her. Difficulty related to gender in accessing statistical sources may lead female journalists to accept statistical information from other sources, even if it is not reliable or accurate or if the sources are unknown. This was clear in the content analysis findings, which confirmed that female Arabic journalists used unknown statistical sources more often than male journalists (40.7% compared to 16%). [See the content analysis section at Table 19.] From this data, it seems that male journalists are more accurate than female journalists in dealing with statistics. I think this result may reflect the greater difficulties faced by female journalists than male journalists in the Arab world.

The findings from the interviews also show that none of the female interviewees work in technology news. This seems to be the case for two reasons. One is that technology news does not attract female journalists. Another is related to the expectations of newspaper editors. These editors, direct female journalists to write news of all kinds and do not provide any specific guidance for the writing of technology news,

> *We do not have female journalists in Saudi Arabia who specialize in a particular subject. Women tend to work temporarily in a field and then move to another area, depending on the kinds of stories the paper needs [INT07].*

If you were to ask most journalists in the Kingdom, they would say that they have worked in every area – political, social, health, economy; the journalist covers whatever news the editors want them to.

> *For example, I prefer not to cover economics. Technology does not attract me very much. Health is possibly my second choice, but my first preference is the social news that deals with citizens' problems, because I consider the press an amplifier through which the voice of the public is conveyed to the government [INT08].*

Among the Saudi female journalists. I encountered none who covered science. This is confirmed both by the quotes above and by the fact that none of the Saudi female journalists interviewed were science journalists. In fact, there is an overall scarcity of journalists who specialize in the scientific field, including men. In this study, out of 18 journalists, there were only six, two women and four men, who covered science news exclusively. This may indicate

that male journalists are more interested in scientific news than women journalists. The rest of the journalists covered several types of news, including science.

Although the educational qualifications of female Arab journalists are superior to those of their male counterparts, factors such as culture and religion can play a role in negatively influencing women journalists, especially those from Saudi Arabia, in the use of statistical information in science news.

5.5.5. Summary of the Findings

The interviewees expressed that most of the difficulties in accessing numbers is due to limitations and restrictions imposed by official sources. The 'official' source is seen by them as a biggest obstacle for a variety of reasons. Either due to fear of the source of facing a backlash, because of the lack of a culture of accountability, or due to fear of a possible adverse reaction in society. This of course is not a surprising finding considering the illiberal context in which these journalists operate.

In addition to this, there is a perceived lack in the ability among journalists to understand and engage with numbers. The weak financial capacities of the newspapers contributed to the lack of databases for many Arab newspapers. The scarcity of training courses that deal with how to handle numbers in the news stories is another factor.

The time factor has an effect on journalists using statistical information, where the majority of Arab journalists believed that they suffered from time constraints which affected the accuracy and the credibility of their figures. There were external systems that influenced the journalists in terms of them using statistics in scientific news – political systems, religious culture and economics. All of these factors have a role in influencing both the newspapers and the journalists in terms of their handling of scientific statistical information. Women journalists faced difficulties related to the use of, and access to, statistical information, especially in Saudi Arabia because of cultural or religious factors.

5.6 Conclusion

This chapter presented the findings from several methods (content analysis, control group, close-reading, expert panels and semi-structured interviews) in order to answer the main research question : How do science journalists in the Arab region - Saudi Arabia, Kuwait, and Egypt - engage with and use statistics when reporting science news and what are the key challenges and opportunities they face in doing so in terms of communicating science to the public? And in order to provide a structured answer, the main question was divided into 10 sub-questions as follows:

First Sub-question: How do Journalists Engage with Statistics to Articulate Science News in the Arab Region?

The findings showed that the majority of the science articles, 590 out of a total of 932, used statistical data to produce the stories. Using statistics to substantiate the stories came in second place with 280 articles and statistics used to contextualise the stories came in last place with only 62 articles. Also, they found that almost 98% of science news that includes statistical data came in the form of hard news whilst just 2.3% came in the form of beat reportage.

In addition, the findings revealed that the majority of the science articles, 73.7%, used stand-alone statistics; there was a clear gap between the number using stand-alone statistics and the rest. Stand-alone statistics appeared nearly three times as often as simple comparison statistics, which came in second place with 26%. The findings showed that 78% of the articles present statistical information in a small area, defined as less than a quarter of a page of a newspaper. Also, it indicated that more than 86% of the articles included statistical data which supported the journalists' claims. However, nearly 15% of the articles did not include such information.

The results indicated that the majority of science news, 67%, makes use of statistics which are of unknown age. On the other hand, the percentage of scientific news containing statistical information less than 3 months old was the second most common type with 29.2%. Nearly 4% came from statistical information more than three months old.

The findings also indicated that nearly 89% of articles followed adequate mathematical and statistical procedures. However, 11.1% of the articles did not, a circumstance which may lead to easy manipulation of statistical data or to promoting the agenda of a journalist's specific goal or to the risk that the meaning of the article will be misinterpreted by both journalist and readers. The findings showed that over 94% of the articles were valid, while only 5.8% were not, whilst nearly 97% of the articles included an interpretation (of the statistical procedures?).

Second Sub-question: How do Science Journalists in the Arab Region Access Statistics when Reporting Science News?

The study revealed that in more than half (521 of 932) of science articles in Arab newspapers, the statistical information came from official sources, such as governments, universities and science journals which means that journalists rely on official sources to produce their news stories. Also, journalists used unknown statistical sources in science news, accounting for 25% of science articles. Moreover, the results of this research showed that the majority of science articles that contain statistical data, (885 of 932), used a single source whilst 41 articles used two sources and just 6 science articles used three or more.

Third Sub-question: Do the Statistics Used by Science Journalists Comply with the Principles of Validity and Reliability?

The statistics used by journalists for the most part comply with the principles of reliability and validity, especially in the content analysis findings. Conversely, more than half of science news articles analysed by the expert panel did not comply with these principles. The findings showed that nearly 26% of the sources which provide statistical data are unknown; this suggests that some statistical data cited in science news might be unreliable. In addition, it is important to follow adequate mathematical and statistical procedures, such as choosing a representative sample, to enhance the reliability of science news. This can be seen from a high percentage, (nearly 89%), of articles followed adequate mathematical and statistical procedures. However, 11.1% of the articles did not follow these statistical procedures. Furthermore, the expert panel's findings confirmed that statistics did not comply with the principles of reliability in 13 out of 25 articles.

In analysing science news, it can be seen that over 94% of the articles were valid, while only 5.8% of the articles were not. According to the expert panel's findings, from its sample, nearly 29% of the articles quoting statistics complied with the principles of validity.

Fourth Sub-question: Do Journalists Use Statistics Effectively to Communicate Science?

The present findings suggest that statistics were not used effectively to communicate science in more than half of the science news items analysed by the participating specialists. This was because of several reasons: inadequate use and interpretation of statistical data, inaccurate statistical data; statistics were used for marketing purposes rather than for delivery of science

information, statistics were used to address emotions rather than to convey science and the data were not of relevance to Arabic countries.

Fifth Sub-question: What are Statistics used for When Articulating Science News?

In this study, the appearance of statistics in science news was divided into the three categories of explicit, implicit and a combination of both. These categories reflect how journalists deal with statistical data. The findings show that most science news, 536 out of 932 articles, presented both explicit and implicit statistical data. However, 42% of the science articles still included only explicit or implicit statistical information. The findings indicated an interesting and obvious gap regarding the use of statistics in visual information. A high percentage of science articles, nearly 99%, do not use any visual information.

The study also indicated that both inferential and descriptive statistics are used in science news; however, inferential statistics, in 64.7% of all articles, were used more often than descriptive statistics, which occurred in 35.3% of the articles. Furthermore, over 77% of statistical data in science news is numerical data, while nearly 23% of the articles included categorical data.

Sixth Sub-question: What are the Identifiable Capabilities in Terms of Education, Training, Experience and Background that Science Journalists Display when Working with Statistics?

The results of the findings showed that the majority of the Arab journalists working in the field of journalism are not specialists. Eight of the journalists graduated from media colleges and one of them holds a master's degree. Eight of them graduated from different disciplines. Two of the journalists did not have university degrees (only secondary certificates). The findings reveal that there is a scarcity of training courses that deal with how to handle numbers in news stories. The majority of journalists did not take courses in dealing with numbers in relation to science news with only four of the journalists doing so. In terms of experience, the study showed that seventeen out of eighteen Arab journalists have had more than ten years of experience in the field of journalism.

Seventh Sub-question: What are the Key Factors Impacting upon Journalists' Work in Relation to Using Statistics in Science Journalism?

The weak financial capacities of the newspapers contributed to the lack of databases for many Arab newspapers. Also, the newspapers did not support the journalist by paying subscription

fees to the scientific journals that provided reliable numbers. Owing to the financial weakness of some Arab newspapers, the publication of some commercial advertisements in the form of scientific news, especially in medical news such as the promotion of pharmaceutical companies for their products, provide numbers that may be inaccurate or incorrect. Another factor is that Arab newspapers do not appear to give as much support to the area of science as they do for other branches of the news. This is borne out by the fact that they do not appoint science journalists to write about scientific news.

The study revealed that the time factor has an effect on journalists in their use of statistical information, where the majority of Arab journalists believed that they suffered from time constraints which affected the accuracy and the credibility of their figures. Inaccurate translation led to the delivery of news and figures that are not relevant to certain communities, especially in Arab societies.

Eighth Sub-question: What Challenges and Opportunities do Science Journalists in the Arab Region Face when Using Statistics?

The study showed that the majority of Arab journalists (fifteen out of eighteen) mentioned that the newspapers demanded that scientific news stories should contain figures. The interests of newspapers in encouraging journalists to use numbers in scientific news differs from one newspaper to another. An example, the Saudi newspaper Oqaz, relied heavily on numbers, especially on the first page as did Egyptian newspaper (Al-Masry Al-Youm) where it's administrational and editorial policies urged journalists to put a number in the main title of the news story. Some Arab newspapers have taken an interest in the infographic and have presented their figures through it, which is a kind of encouragement to use figures and also to clarify them. On the other hand, Arab journalists faced some challenges when dealing with statistical data. The 'official' source is an obstacle to the journalist getting the statistics for a variety of reasons, either due to fear of the source or of accountability, or due to fear of the reaction of their society. They often publish the positive numbers for their personal purposes. In addition, the findings reveal that there are external systems that influenced the journalists in terms of them using statistics in scientific news – political systems, religious culture and economics. All of these factors have a role in influencing both the newspapers and the journalists in terms of their handling of scientific statistical information.

Ninth sub-question: What is the Purpose of Science Journalists and Editors using Statistics in Science News?

All the journalists confirmed the importance of numbers in scientific news and also in other branches of the news. Also, the role of the figures is to enhance the credibility of the news

segment and help solve, or alert people to, the problems, and help the readers in understanding the decisions that are being made by the decision-makers or even by the public themselves. Most of the journalists agreed that the credibility, honesty, reliability and accuracy in terms of the publication of figures, both positive and negative, as well as interpreting them correctly in order to serve the public and not manipulating the numbers for individual purposes, were the most important things that a journalist must do when he/she receives statistical information.

Tenth sub-question: What are the Similarities and Differences Between Scientific Journalists in Arab Countries (Egypt, Saudi Arabia, and Kuwait) in Their use of Statistics?

The findings indicated that, there are similarities between scientific journalists in Arab countries (Egypt, Saudi Arabia, and Kuwait) in their use of statistics. Most of the journalists tend to use government sources to obtain numbers due to the lack of other sources being available to obtain reliable figures. Also, they shared similarities in suffering from the time factor, which was a problem for them when dealing with numbers. Arab journalists are similarities some factors such as religion and culture are key factors affecting journalists themselves in terms of their usage of numbers.

On the other hand, there are differences between scientific journalists in Arab countries (Egypt, Saudi Arabia, and Kuwait) in their use of statistics, which are:

- In term of taking statistics courses, the study found that Some Kuwaiti journalists seem to be more interested than their counterparts from other Arab newspapers in developing their skills in terms of dealing with numbers in scientific news. For example, two journalists from one Kuwaiti newspaper, Al Rai, expressed such an interest. This indicates that the journalists from this Kuwaiti newspaper expressed more interest in developing their skills in terms of dealing with numbers in scientific news than did the journalists from the other Arab newspapers.(Egypt and Saudi Arabia). The Egyptian newspapers are more interested in scientific news than the Kuwaiti and Saudi newspapers. This was evident by the number of scientific journalists interviewed (5 out of 18), while there is just one scientific journalist in the Kuwaiti newspapers. In the Saudi newspapers, where any journalist can write in all types of news stories, there is no specialized scientific journalist.
- Factors (political, economic, religious and cultural) differ in influencing journalists' use of statistics in scientific news from one country to another. This study found that politics in Egypt play a bigger role than in Kuwait and Saudi Arabia in dealing with the figures due to several factors, such as political differences and the revolutions that resulted in the Arab Spring. On the economic side, pharmaceutical companies are more influential

in Kuwait than in other countries while the cultural and religious factors in Saudi Arabia have had a stronger impact on how journalists deal with figures than in Egypt and Kuwait.

- In terms of gender, although, in this study, seven out of eighteen journalists were female, women have higher and better qualifications in comparison to male Arab journalists who only have a bachelor's or a high school degree. Five of these female journalists have a bachelor's degree in different disciplines. Two have higher degrees: one Saudi journalist has a master's degree in journalism and a Kuwaiti journalist has a PhD in radiology. Despite women journalists holding higher degrees than their male counterparts, they do not receive any female training courses in dealing with numbers, while male journalists fared slightly better with 4 out of 11 of them taking statistics courses. Furthermore, the findings from the interviews also show that none of the female interviewees work in technology news, In the Arab region, although women's empowerment within the media has increased, there are still unequal levels of empowerment between women and men in writing some types of news, especially technology news. In addition, Arab newspapers are not as interested in publishing technology news as other science news, for instance, health news.
- Even within the same gender there are difference among Arab countries (Egypt, Saudi Arabia and Kuwait). This study revealed that, Saudi female journalists were different from female journalists in Egypt and Kuwait in terms of using statistical information because of cultural or religious factors, where the difficulty for women in Saudi society is greater. This was apparent regarding statistical sources inside Saudi Arabia, especially some official sources who sometimes deliberately delay giving journalists statistical information and sometimes ignore the female Saudi journalists.

Chapter 6 Conclusion

The central contribution of this thesis is explaining how journalists use of statistics when articulating science news in Arab countries, particularly in relation to Egypt, Saudi Arabia and Kuwait. The study made use of a triangulation of quantitative and qualitative empirical data from content analysis, close-reading analysis, an expert panel and semi-structured interviews. To arrive at the main conclusion, this study paid particular attention to the role of science journalism, mainly in health and technology news. In this study, a panel of experts was used, which innovative in the field of journalism studies as is not as widely used as other methods.

The first and main thing to point out is that contrary to common assumptions, political and religious constrains have less effect upon journalists' ability to use statistics to report science news than a lack of education and general skills. Yes, reporters covering science in these countries are subject to the broad censorship and self-censorship prevalent in these societies. However, they face fewer restrictions than their colleagues covering other news beats. Yet, news reporting of science remains deeply flawed and uncritical at large. The main drivers for these shortcomings seem to be mostly related to a lack of education and skills around science journalism. This is, however, not a problem that happens in a vacuum but that also seems to be closely related to news audiences' lack of interest in science.

The originality of this study derives from the fact that it embraces a typology of four criteria that helps develop a comprehensive and solid explanatory theoretical framework to analyse this phenomenon. This framework allowed for a structured and comparative examination of the use of, and engagement with, statistics by professional journalists. In so doing, it provides a comprehensive and critical understanding about how journalists engage with numbers in the pursuit of science news in a region of the world where journalism is challenged by contextual elements such as: politics, culture and religion.

In order to deliver a comparative analysis of the state of journalism practice in relation to the use of statistics in the articulation of science news, this study looked at a set of criteria based on: 'absence', 'reliability', 'validity' and 'interpretation' in relation to the presence of data in each story. This is because in the theoretical framework assumes these four notions as crucial in identifying key problems and issues surrounding the use of statistics by news reporters.

By examining the validity, accuracy and reliability of statistics used by journalists and editors and identifying the nature of the sources used by them when engaging with numbers, the study provided a picture of the cross-national similarities and differences that account for the use of statistics by science journalists in Egypt, Saudi Arabia and Kuwait. The overall conclusion and the main findings of this work indicate that the lack of educational skills, professional autonomy and low level of interest in science news are three elements that hinder

the ability of science journalists in the Arab world to deal with statistical information in science news.

To be sure, most of the journalists interviewed for this study are not specialised in scientific news nor do they have any type of particular training regarding engagement with, and the use of, statistics to produce news stories. Therefore, non-specialised journalists write scientific news but they tend to do so while producing stories for other very distinctive news beats. Thus, the content of scientific news may be problematic in terms of accuracy and interpretation as well as credibility and understanding. This study focused on the statistical side of scientific news, which plays a key role in delivering science information to help readers understand social issues (Fioramonti 2014).

The findings show that statistics were not used effectively to communicate science in more than half of the science news items analysed by the participating specialists. There are five reasons for this: 1) inadequate use and interpretation of statistical data, 2) inaccurate statistical data and 3) statistics used for marketing purposes rather than for the delivery of scientific information, 4) statistics used to address emotions rather than to convey science and 5) data of no relevance to Arab countries.

All these results reflect the weakness in the ability of journalists who are not specialised in dealing with numbers in scientific news, in addition to the lack of interest in the scientific aspect of news from newspapers and the reliance on Western media in the transmission of scientific news. These conclusions reflect similar findings in other parts of the world (Wilby 2007, Nguyen and Lugo-Ocando 2015, Alhumood et al. 2016, Ibnrubbian 2016). However, differences were also found in the cases of Egypt, Saudi Arabia and Kuwait, which indicates particular practices that are not necessarily present in Western newsrooms.

In addition to the lack of skills and education regarding science, other issues were identified as additional barriers to providing high-quality science news. Particularly, around the lack of reporters themselves who are dedicated to this news beat. The absence of science news reporters who can remain engaged with science is key in explaining the gaps. In addition, we found limitations around gender and resources. Religion, on the other hand, is a restricting factor but only because of the mix of history, politics and cultures rather than because of faith itself.

6.1 General Discussion

Most of the results of this study agree with those views in the existing literature regarding the factors that affect the use of figures by Arab journalists. As this literature explained, there are obstacles that prevent journalists in general, and Arab journalists in particular, from using

statistics properly when reporting science news (Curtin and Maier 2001, Genis 2001, Maier 2003, Brand 2008, Mahmood 2008, Al-Qafari 2009, Utts 2010, Koetsenruijter 2011, Porlezza et al. 2012, Nguyen and Lugo-Ocando 2015, Alhumood et al. 2016, Ibnrubbian 2016, Lugo-Ocando and Brandão 2016, Cushion and Lewis 2017, Nguyen 2017).

In addition, other factors also play a role, for example, those such as: religious, cultural, political and economic that affect men and particularly those challenges facing women in the Arab region. To aggravate matters, as this study has shown, there is a general lack of interest from the public in scientific news in Arab newspapers (Abu Samra 1995, Rugh 2004, Mellor 2005, Abdulrahman 2008, Al-Mutairi 2009, Al-Qafari 2009, Awad 2010, Mellor 2011, Hamdy 2013, Bebawi 2016) which creates a deficit of science news within the larger audience and undermines the market for science news. As we have mentioned above, there are three main findings, which are: (1) the lack of education skills, (2) the lack of professional autonomy and (3) the lack of interest in science news.

6.2 Education and Skills

One of the main findings of this study is how the lack of skills among Arab journalists in relation to statistics affects their ability to provide sound and comprehensive science news and how this is aggravated by the absence of an educational framework that can address those gaps. This challenges common assumptions around contextual limitations which have argued that it is lack of political freedom and cultural issues around religion that mainly adversely affects journalism in Arab countries. This last might be true for other news beats such as politics and economics but it does not seem the case with science.

I am not for one moment trying to argue that these external factors such as the political system in which reporters operate do not affect their ability to perform. On the contrary, whenever professional autonomy is compromised, journalists are unable to fulfil their normative aspirations. Most evidence suggests that, in this part of the world, it is almost impossible for news reporters to meet basic standards regarding their normative aspiration of bringing about transparency and accountability to power.

However, my fieldwork also underpins that not all news beats are the same. In fact, science and technology are not as heavily regulated and censored as, let us say, politics or economics in the Arab world. Hence, at least in theory, we could expect a greater quality in science news given the fact that reporters working in this beat enjoy more professional autonomy than their peers. Instead, what we see instead are similar gaps, flaws and malpractices as in other more regulated beats. This last point cannot therefore be attributed solely to the contextual limitations.

Education and skills are far more important for journalists' ability to use statistics to articulate science news in ways that are acceptable and understandable by the readers. One important clarification that emerged from the study is the difference between skills and education. It became clear that this dichotomy is central in the formation of journalists and their news cultures. In this sense, skills need to be understood as the ability to do something, while education is a way to be able to interpret and critically think about the world. Journalists who arrive at a newsroom might be very good at 'doing' news coverage but not necessarily at critically thinking about that coverage. This is, as I explored in this study, a persistent problem in the Arab world.

With regard to journalists' use of statistics in the writing of scientific news, although the background and training of journalists play a crucial role in allowing reporters to examine and validate claims made on the basis of statistical information in the press (Nguyen and Lugo-Ocando 2016), the present study reveals that there is a lack of skills in terms of critically understanding and using these numbers to produce news stories. This trait was displayed by more than half of the Arab journalist interviewees. Several factors contribute to this lack of understanding, such as educational background and the scarcity of training courses. This also suggests can help to explain the lack of interest in scientific stories by the newspapers as they tend to prioritise other news beats because the resources to do so are not there and it is easier just to repurpose and publish stories from news agencies.

The good news is that given these results, there is a lot that can be done to improve news coverage of science. Indeed, journalism education has a role in improving professional practices of journalism (Deuze 2005). In this respect, there has been a noticeable development in media colleges in the Arab world in recent years, particularly in Saudi universities, which has increased the number of media colleges despite the limited freedom of press there. However, there is still a lack of provisions in the teaching of statistics and science in those colleges. The lack of statistics teaching provisions is not only present in the Arab world, but also at the global level as there are very few journalism degrees which include statistics as part of the basic curriculum and that tailor these delivery provisions (Utts 2010, Lugo-Ocando 2013, Martin 2016).

This is also the case in the Arab world, where statistics are not perceived as a core area for journalism studies. This lack of educational provision in most of the media schools in the Arab has led to important knowledge and skills gaps. Universities, other educational institutions and newspapers themselves, offer adequate provisions and resources to develop skills and education to improve how journalists engage with statistics.

An additional issue concerns the lack of resources available in the news organisations such as access to database beyond the ones offered by official sources as to improve critical examinations and cross-triangulation with official sources. In some cases this is due to

financial limitations, which prevent media outlets from acquiring, accessing and managing databases independently from governments and external institutions. In others, because there is a lack of interests from publishers and broadcasters to fund these types of resources as they see other priorities.

Of equal hindrance are the internal policies, norms and dynamics of the newspapers themselves, which differ from one country to another. These dynamics determine the level of freedom or editorial procedures that can affect journalists' ability to perform their aspirational role. To be sure, the news organisation, in the case of science news, plays a much greater role in terms of defining levels of professionalism than any external factors. The organizational cultures in many of these daily newspapers is one that is characterised by self-refrain and self-censorship, which prevails when it comes covering any beat.

The findings indicate that current assumptions about the limitations and challenges for journalists in the Arab world do not hold in the case in the science news beat and, that it is instead education, organisational cultures and broader societal dynamics determine the shortcomings of news reporting in this beat. It is, perhaps also important to highlight the argument posed here around religion as this last category has been used to essentialise an explanation for journalistic failures in the region.

Besides the lack of skill in the use of numbers and a lack of education related to statistics in Arabic science journalism, there is also another important factor, as indicated by the study. That is, there is a lack of professional autonomy, which influences using and articulating statistical data. Professional autonomy is considered one of the most influential factors that can either prevent or increase journalists' capability to retain their journalistic professionalism (Waisbord 2013). In the case of science reporting this last also accounts as a contextual limitation; something that has also been observed by a number of researchers in the Arab world (Alheezan 2007, Babaker 2014).

Factors that influence the performance of journalists in the region include the political system, religion and culture, economics and media ownership. Indeed, religion and politics are considered the most relevant categories influencing journalistic practices. Of these two, politics is considered the most important factor affecting the media in the Arab region (Hamdey, 2013). Consequently, when looking at the Arab media, analyses have often been closely involved with non-liberal governments and the role of Islamic culture (Rugh, 2004). In this sense, since the emergence of the press in Arab countries, their governments have continued to be the main funders and owners of mainstream media outlets, and these governments are credited with exercising strict laws against freedom of expression.

Because of this control, Arab media outlets tend to operate under official government guidance and follow authorised editorial policies (Rugh 2004, p. 6), and in so doing, their main role has been to promote government politics (Hamdy 2013, p. 71). Governments can exert economic

pressure on private newspapers via official the agencies and related organisations—including publicly owned enterprises—that contribute greatly to the newspapers' revenues, therefore becoming common forms of inducement by proxy.

In addition, Arab newspapers are influenced by economic aspects that affect journalistic practices and professional autonomy. This influence comes from large companies, including pharmaceutical companies, who pay newspapers to advertise their products and thereby contribute to passing on inaccurate information that is not scrutinised by the newspapers. Poor resources for Arab newspapers contribute to the lack of established information centres, which in turn affects journalists' access to the information they seek. Furthermore, newspapers provide no financial support to enable journalists to access information from documented sources in scientific journals. Finally, Arab newspaper owners are mostly merchants looking for profit, and major commercial companies take advantage of this point in their favour.

Islam is another factor playing a fundamental role in defining the journalistic practices in Saudi Arabia and other Arab countries. For example, in Saudi Arabia and some other Arab countries, newspapers are subject to pressure from religious leaders when disseminating news (Al-Kahtani 1999). This influence by religious leaders on the Arab world's press takes several forms, including reactions by leaders or the public that may lead to newspaper boycotts or fines and even to temporary or permanent newspaper closures. Individual journalists may be labelled as apostates after the publication of information that requires repentance in the understanding of some religious leaders.

Finally, general education can play a role in journalists' performance in the Arab world. A low level of literacy regarding statistics and mathematics has been noted in the Arab region. For instance, in 2015, the Programme for International Student Assessment (PISA 2015) conducted a study of the mathematical skills of 15-year-olds worldwide. Some Arab countries, including Qatar, Lebanon, the United Arab Emirates, Tunisia, Algeria and Jordan, were found to be at the bottom in terms of mathematics and science performance.

Again, just to clarify, my thesis is not suggesting that external factors have no bearing upon the ability of journalists to work independently. On the contrary, professional autonomy in some news beats cannot be exercised at all due to these contextual limitations. Non liberal regimes in these countries impose tight control over the media through draconian regulation and censorship (Rugh 2004, Mellor 2005, Sakr 2007). In doing so, these governments not only aim to control freedom of expression in order to ensure that what is published and broadcast to the public is in line with the government's objectives (Sakr 2007, P. 15, Mellor 2011, P. 164) but also to silence any alternative voices to the official narrative by also undermining the individual ability of journalists to perform their work independently.

There is also little doubt that Arab governments continue today to hold control over the media to varying degrees. Even in the midst of the Arab Spring, there were clear examples that the

traditional cultures of censorship and press control continued to be alive in places such as the Egyptian press under the Muslim Brotherhood. In many of these places, journalist continue to be in a precarious position to exercise professional autonomy. If they transgress particular issues they may end their career, suffer penalties, face prison or even death. Examples of this are abundant in the Arab in the Arab world. Journalists using statistical data to report science also live in the same shadow of fear. If reporters perceive that certain numbers may convey a particular controversial point in the eyes of the authorities they will often refuse to publish it.

However, even in countries like Saudi Arabia, where we do not expect to see journalism practices that fulfil the slightest aspiration of being a watchdog, we should still be able to expect at least some degree of professional autonomy in news beats such as science that has a low level of external regulation and intervention. After all, these numbers in science news reporting are not controversial in the sense that they are mostly factual and also the subjects to which they refer are distant from the political battles that these regimes and their opponents undertake.

However, political constrains to professional autonomy should not bear as much weight in the outputs produced by science reporters. The case of Kuwait, where newspapers enjoy far more freedom (RWB 2017), nevertheless also present important flaws and gaps in the coverage of science. The content analysis indicated similar levels of inaccuracy and misrepresentation of statistics in science news as in other countries. Kuwaiti journalists interviewed for this study were asked about their sources of unknown statistics. In most cases, they complained that the reason for using them was that even this type of news is imposed upon them through press releases and editorial pressures because it is paid for by commercial companies, therefore also limiting any scrutiny of the content of these stories. In fact, pharmaceutical companies have a major role to play in influencing professional autonomy in the Arab world thanks to their powerful role as major advertisers. Moreover, some commercial companies, especially pharmaceutical companies, may exploit this tendency by passing on statistical information that serves the promotion of a commodity without mentioning the source name, which is originally the commercial company. Hence, the study also identified corporate interests as additional element hindering a more comprehensive and critical news reporting of science.

In this sense, this study found that the political economy of the newspapers in the Arab world plays a greater role than the contextual limitations although it might also be strongly correlated with them. This is because many Arab newspapers still largely depend on governmental funding to some extent (Rugh 2004) and they and their owners are deeply dependent upon subsidies, government advertisement and particular contracts that make up the economy of these organisations. Interestingly, as my research indicated, some newspapers present ads in the form of scientific news, whether in health or technology, without even checking and reviewing the statistical information upon which they are based. Overall, there is a weak ethical

framework among journalists who rarely engage with more critical deontological reflections upon what they do.

6.3 Is Not Faith Alone?

Far from common narratives, the Islamic religion and faith are far from being the central problem for these gaps. Islam, on the contrary, not only allows, but calls for, critical thinking. The four main schools of thought in Islamic jurisprudence – Hanafi, Shafi'i, Maliki and Hanbali – are clear evidence of this claim. So why then is critical thinking among Arab journalists in such a state? Again, as became clear in the case of Saudi Arabia, in the case of engagement with statistics in science reporting the problem resides in prevalent organisational cultures within the media landscape and, mostly, with poor educational provision where teachers encourage the shallow preservation and understanding of materials rather than its critical examination (Al Zahrani and Elyas 2017).

However, as the findings also indicate, religious and social backgrounds do influence Arab journalists when dealing with figures in scientific news. What the study shows, however, is that religion does not have as important an influence as some might assume. Religiously speaking, some Saudi journalists might believe that showing certain figures for diseases such as HIV/AIDS, for example, might be a matter of faith. But this is more to do with a misunderstanding of their own faith than of religion itself. Misconceptions about religion also affect the news coverage of other areas such as genetic diseases that occur because of intermarriage between tribes. If, instead, journalists highlighted the real numbers of people with genetic diseases due to marriage among relatives, this might establish controls that would help prevent the spread of these diseases.

In the past, religious leaders have had a role in influencing journalists in dealing with numbers and other information, especially in Saudi Arabia. Awad (2010) suggests that Islam has affected the Saudi government through religious leaders, whose power stems from their role in legitimising or delegitimising the government's political acts. As a result, newspapers have been prone to be subject to the influence and pressure from religious leaders when publishing their news stories (Al-Kahtani 1999). However, this is changing in the light of developments under the new Saudi government, which are summarised in the vision it has drawn up in its plan for a Saudi Vision 2030, where there is an attempt to assert the political power of the government. Some observers have pointed out how religious leaders have lost power and are not as influential in journalism practice as they were before.

6.4 Accessing Statistical Sources

The study reveals that Arab journalists rely heavily on official statistical sources, which was similar to findings in other countries (Lugo-Ocando and Brandão 2016). This result was expected as journalists often rely on sources that are familiar and trusted by them. However, not all of the data from government sources is valid and reliable (Messner and Garrison 2007). In the context of Arab newspapers, statistical sources are considered one of the greatest obstacles that prevent journalists from engaging properly with statistics. There are ways in which official sources in these countries hinder the effective and critical use of statistics by news reporters. One is by imposing bureaucratic procedures that must be followed to reach a particular news source. This can delay the publication of statistics for months to the point that it renders the information useless. Another game played by official sources is to provide old statistics to journalists, such as when the Ministry of Health provides statistics about a specific disease that have not been updated for several years.

The study also suggests that due to difficulties in obtaining statistical information from official sources, the reliability of statistical information might be lost. Some journalists resort to other statistical sources, regardless of whether they are reliable or not. Furthermore, 25% of the scientific news contained figures from anonymous sources. However, as the statistics came from unknown sources on websites, they could be true. Still, known sources are the best evidence to add reliability to the science stories. This ratio of unknown sources may be due to several factors; the inability to obtain statistical information from official sources due to obstacles from those sources which may lead the journalist to try and to obtain any statistical information available, even if it is from an unknown source. In fact, this may lead to uncertainty or unreliability in those unknown sources.

6.5 Dependency on External Providers

Owing to the difficulty of accessing statistical sources, especially those outside the borders of the Arab world and to a combination of contextual limitations and lack of skills, journalists often take scientific news items from international sources, including news agencies and public relations firms. Rather than being the cause of a deficit of sound science news in the region, this practice reflects the region's inability to cover its own science production and knowledge generation. Arab newspapers contain much science news that is translated from western media and originally published in developed countries but that has little or no science news from Arab countries.

Joubert (2007) notes that one reason for this reliance on foreign sources is that in developing countries scientific achievements in universities are rare. Another reason is that because Arab journalists face challenges in finding local experts who have great knowledge and experience, some see local expertise as insufficient and therefore mistrust it. In contrast, journalists are impressed by the science news from western newspapers and think that all science news from western media is reliable.

The great scientific developments in the western world do not justify journalists' total dependence on all foreign sources from that world. Studies have noted that this leads to problems, including poor translation, inadequate understanding of basic scientific processes and failure to effectively relate science to the local context (du Plessis 2008, Massarani 2014). Journalists should emphasise the following practices: (1) searching for local science news and linking it to the world, (2) when reporting international science news, using correct translations and accurate scientific vocabulary and relating it to the local context.

6.6 Women in Arab Science Journalism

Although there has been a significant improvement in women's empowerment in the media industry (Ross and Carter 2011), they still lag behind in terms of participation and assuming editorial responsibilities (Skalli 2006, Khamis 2013). The findings indicate that across all Arab newspapers (Egypt, Saudi Arabia and Kuwait), few female journalists produce technology news, including statistics, leaving those areas to their male counterparts. Despite some openness in places such as Saudi Arabia in relation to the empowerment of women in recent times, greater engagement with the media and, increasingly more women are studying university degrees, there are still very few females in science journalism in general. At the same time, we do see that women work in the rest of the various fields, such as political and economic news as well as Saudi female journalists now entering the coverage of sports news. Not only are there fewer women in science journalism but also they face more difficulties than their male journalists when dealing with numbers. This includes discrimination by some official sources in terms of providing access to datasets and interviews, participation in press conferences and being invited to particular events.

According to some authors, there is the factor of 'gender', which in Arab countries is a central issue (Abu Samra 1995, Abdulrahman 2008, Al-Mutairi 2009). There are challenges for women journalists in Saudi Arabia that their counterparts in Kuwait and Egypt do not face (Mellor 2011). This study confirms this and highlights that, despite continuous developments and some progress, women journalists lag behind their male counterparts. These challenges include discrimination by official sources when providing information or responding to

particular requests. This has led some women journalists to rely on the Internet to obtain figures, regardless of the validity of those figures.

6.7 Interest in Science in Arab Countries

Scientific journalism in Arab societies remains weak in terms of producing scientific news and most of the scientific news published in Arab newspapers is taken from the western media and international agencies. The reasons for the weakness of scientific journalism in the Arab world are many, as we have discussed here, including the lack of a specialised journalist, the scarcity of scientific journalists and the lack of general knowledge about science, as revealed in this study, which agrees with a number of studies on scientific journalism in the Arab world (Al-Qafari 2009, El-Awady 2009). We cannot single out a single a particular reason but can underline the pressing ones, education and skills, which are also the ones that can be effectively be addressed.

One of the greatest problems faced by science journalism in the region, this study found, is the lack of interest in the subject by the wider public. Although far more additional research is needed to understand this point better, in all certainty we could argue that the public is just not engaged as much with science. This lack of a 'news audience' for science also contributes to the lack of investment in the news beat and the weak engagement on the part of the media itself. The findings showed journalists believed that the lack of interest in scientific news exists because readers do not care about scientific news, but rather preferred other news beats such as politics and sports.

However, one of the reasons for the lack of interest in scientific news on the part of readers, I would suggest, might be because the content of the news is not understood. Here comes the role of the scientific journalist, who is trying to convey scientific news in a simple and easy way to readers and to transfer scientific news that is relevant within the community. This confirms the finding of Nguyen and McIlwaine (2011) when they noted that one problem with science news is disinterest on the part of readers who believe that it is not relevant. Therefore, the challenge for science journalists is to make science news relevant to readers. According to Nguyen and McIlwaine (2011) 'the lay public needs a science journalism that can adopt fresh mind-sets and new techniques to make science news relevant to its daily life'. This lack of reader interest has not been written about in the context of Arab countries. It is a key issue suggested by the findings of the present study but not explored in any depth, as it was unexpected. The issue will be explored in future research, as discussed below.

Several factors might play significant roles in decreasing engagement with science, ultimately decreasing public interest in reading scientific news. One such factor is the audience's culture and education level. Statistics show that more than 20% of the Arab world suffers from

illiteracy, and this must be taken into account by journalists writing scientific news. In addition, a lack of studies and surveys identifying the level of public scientific awareness means that those working in the scientific media are addressing an audience about which they know nothing (Abu Haseera, 2018). Unfortunately, Arab newspapers are not as interested in scientific journalism as in other types, which may account for some of the lack of interest on the part of the public. The Arab media contain minimal scientific content, and the volume of scientific reporting is low if not negligible when compared to the volume worldwide and when considered in light of the size of the Arab media establishment (El-Awady, 2009).

The credibility of scientific news is another factor affecting audience interest in science. Although the British public sees scientific news as more credible than other news (Matter 2017), the opposite is found in the Arab world, where Mahmoud's (2018) study of public attitudes regarding the credibility of scientific and technological news in Egyptian newspapers and electronic media found that science and technology news were seen as less credible on average than other types of news. Several media outlets are owned by the state; consequently, many journalists offer coverage that is uncritical of government output (El-Awady, 2009).

Arab journalists are unable to read scientific material in foreign languages, and they lack the ability to translate material in those languages into Arabic. Scientific articles written by journalists are unclear and not simple enough to be understood by non-specialists (El-Awady, 2009). Furthermore, poor editing and exaggerations based on underestimating readers' intelligence cause scientific articles to be boring and unnecessarily long. Readers' confidence in newspapers' scientific news is weakened by the use of non-scientific sources and by the short amount of time available to produce the articles. Journalists are not fully supported by their organisations in investigating and publishing stories other than those about politics and sports. Finally, it is difficult for reporters who lack professional skills to find good local experts and scientists willing to act as sources (Lublinski et al., 2014).

All of the above elements have major effects on public interest in scientific news, especially in the Arab world. The public's lack of education and the government's control of newspapers contribute to the lack of scientific criticism of newspaper content, and newspapers' lack of interest in covering scientific news compared to other types contributes to the public's lack of confidence in newspapers' scientific coverage.

6.8 Future Research

This research is a step towards a better understanding of how to use and engage with statistics in distinctive settings affected by policy, religion, culture and economy. Thus, the study opens

doors for future studies on the use of statistics in science journalism, particularly in the Arab world. This research has highlighted the weaknesses of scientific communication in the Arab scientific press in an attempt to find a solution for developing and improving scientific journalism in the Arab world, in addition to bringing science back to the surface, as it was in the Golden Age of science in Islam.

However, further research is needed to explore the impact of cultural, political and religious factors on articulating science news in Arab newspapers. Each of these elements plays a role, particularly in Arab societies, since most Arab societies are Muslim. The fact that Islam encourages people to engage with science makes it interesting to explore, as well as the influence of elements such as politics, which have power and control, Arab culture within Arab societies and education, which does not rise like other Western countries, despite the availability of financial resources in some Arab countries such as the Gulf States. Some scientific journalists justify the weakness of scientific journalism in Arab societies because the public does not care about it and does not read it at all.

This research has produced a significant body of knowledge on how numbers are used in science news in newspapers, specifically in Arab regions, including journalists' use of statistics. However, the study has mostly considered this as a structural issue in relation to the professional practice of journalism in these countries. What my study did not do is to consider the power and influence of corporate lobby groups in relation to professional autonomy and science statistics in the news. Moreover, as some researchers have already highlighted, the problems are generated by undue corporate interference in science reporting (Gandy Jr 1980, Briggs and Hallin 2016). Hence, another issue that could be considered is the impact of commercial medical companies on journalists' use and review of statistical information in health and technological news.

Because Arab societies are developing countries and therefore have a high rate of illiteracy, the barriers that hinder the use of statistics should be removed by allowing easy access to such statistical information. One solution is to make statistics more accessible and understandable, especially when using statistics via the media to benefit the public. For example, using visual communication techniques for statistics and science is now possible due to the development of infographics in newspapers. It would be interesting to explore how to use visual statistics in the delivery of information to the public in Arab newspapers as well as to determine the impact of this change on their readers. Another solution is establishing national committees for statistics in Arab countries to allow easy access to statistics, such as the National Statistician's Data Ethics Advisory Committee (NSDEC), which was established to advise national statisticians that access, use and share public data for research and statistical purposes on its ethical use for the public good.

This study suggests that journalists are influenced by many factors, such as cultural aspects or personal interests and compliments and these factors have impacted how they deal with numbers. Research on ethical implications can be conducted on how these implications might influence journalists when they are using statistics in science news in Arab countries. This study confirmed that there are issues related to ethics, such as compliments between journalists and statistical sources and also between journalists and commercial companies. Therefore, it is crucial to carry out a deep reflection on the limits by which statistics can be used by journalists for the public good.

Journalists in the Arab world have limited access to information services that could help them do a better job in reporting science. This study reveals that journalists are limited by a lack of financial base that could help them access international organisations and scientific journals that provide official and reliable statistics. There is also a scarcity of databases that could facilitate the work of journalists in dealing with figures. This is an aspect that also needs additional attention.

One area that also needs more research is the news audience; the present study did not explore why the news audiences in the Arab world do not engage with science news. How and why news audiences read and understand statistical data is a project in its own right. Recognising readers' capabilities to understand science news may require exploring this topic from a different angle. The study found that audiences seemed not to be interested in science news and that this affects the ability of journalism as a political institution to develop a more comprehensive and critical reporting of science. Hence, it will be interesting to explore further the causes of this disinterest. Through future research, will allow a better understanding of why the public in Arab countries –which has such a rich and robust history of science in its own culture- does not engage sufficiently with science news nowadays. This is the task for my future work.

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Appendix 1

Ethical Approval

The Secretariat
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UNIVERSITY OF LEEDS

Abdullah Alhuntushi
School of Media and Communication
University of Leeds
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Faculty of Arts, Humanities and Cultures Research Ethics Committee
University of Leeds

13 August 2020

Dear Abdullah

Title of study	**How Arab journalists engage and use statistics to report science: the case of statistics in science news in Saudi Arabia, Kuwait and Egypt**
Ethics reference	**PVAR 17-032**

I am pleased to inform you that the above research application has been reviewed by the Faculty of Arts, Humanities and Cultures Research Ethics Committee and following receipt of your response to the Committee's comments, I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	Version	Date
PVAR 17-032 ethical application2-3-2018.pdf	3	02/03/18
PVAR 17-032 participant form.pdf	3	02/03/18
PVAR 17-032 consent form.pdf	3	02/03/18
PVAR 17-032 risk assessment.pdf	3	02/03/18

Please notify the committee if you intend to make any amendments to the information in your ethics application as submitted at date of this approval as all changes must receive ethical approval prior to implementation. The amendment form is available at http://ris.leeds.ac.uk/EthicsAmendment.

Please note: You are expected to keep a record of all your approved documentation and other documents relating to the study, including any risk assessments. This should be kept in your study file, which should be readily available for audit purposes. You will be given a two-week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at http://ris.leeds.ac.uk/EthicsAudits.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to ResearchEthics@leeds.ac.uk.

Yours sincerely

Jennifer Blaikie
Senior Research Ethics Administrator, the Secretariat
On behalf of Prof Robert Jones, Chair, AHC FREC

CC: Student's supervisor(s)

Appendix 2: Code Sheet

1- **Number of Article**:
2- **Page number**: [1] the first page, [2] middle pages, [3] last page.
3- **Headline**:
4- Date of Publication :
5- **Newspapers' Name:** [1] Al-Qabas, [2] Okaz, [3] Al Riyadh, [4] Al Rai, [5] Al-Ahram, [6] Al-Masry Al-Youm.

6- Number of words in the article:
[1] <0.25 [2] 0.25 > 0.5 [3] 0.5 > 0.75 [4] 0.75 > 1

7- The appearance of statistics:
[1] Explicit [2] Implicit [3] Both

8- Who does produce the science news?
[1] The newspaper, [2] nation agency,[3] international agency,[4] unknown.

9- If the producer of article is the newspaper then, is the journalist's name presented?
[1] Yes [2] No

10- The gender of the journalist:
[1] Male [2] Female

11- The type of science news:
[1] Health news [2] Technology news

12- The main topic of the article:
[1] Public health [2] Policy health [3] Disease health [4] Machines,
[5] Computer Software.

13- Journalistic genre of the article:
[1] Hard news story [2] Beat reportage

14- What type of statistics is presented in the article?
[1] Descriptive [2] Inferential

15- What type of statistics is presented in the article?
[1] Numerical Data [2] Categorical data

16- Does the article contain any graphical data?
[1] Yes [2] No

17- If yes, which type of graph?
[1] Pie chart, [2] Bar chart, [3] Table.

18- Is there any mentioning of missing data/partial statistics? (Verification).

[1] Yes [2] No

19- What is the main source of the statistics?

[1] Official statistics, [2] Non-official statistics, [3] Unknown.

20- Source provenance:

[1] Government source.
[2] Original scientific source (university/journal).
[3] Organisations and others.
[4] Not mentioned.

21- How many statistical sources are cited?

[1] One source , [2] Two sources, [3] more than two sources

22- Reliability: Is the source of statistics in the article reliable?

[1] Yes [2] No

23- Is Statistical reliability follows adequate mathematical and statistical procedures?

[1] Yes [2] No

24- Validity: Is the usage of statistics coherent with the topic?

[1] Yes [2] No

25- Absence: Is there statistical information absent which has a role in supporting the journalist's claim in the article?

[1] Yes [2] No

26- Interpretation: Are the statistics in the article interpreted?

[1] Yes [2] No

27- Are the statistics interpreted in a correct way?

[1] Yes [1] No

28 - **Geographical Coverage**:

[1] International (Foreign) [2] National (Local)

29- Statistics Claim: What is the statistical claim?

[1] Stand-alone statistics, [2] Simple comparison, [3] No clear claim

30- Timeliness 1: Time passed between the statistical release and the publication of the article

[1] Less than 3 months, [2] More than 3 months, [3] Unknown.

31- News value: Are the statistics used in the news story to:

[1] Produce, [2] Substantiate, [3] Contextualise.

32- Main function of statistics in the news story
[1] To explain the phenomena and make the story accessible.
[2] To highlight relevance for society.
[3] Other functions.

[1] I am perfectly aware that sport news also tends to be a beat full of numbers and statistics, particularly in baseball and cricket, to name some. However, incorporating statistics in these news beats does not necessary bring additional transparency or accountability nor is it is necessarily required. Different countries, for example, have different approaches towards the incorporation of statistics in their reporting of sport. Even the news coverage of politics is somehow uneven in terms of reporters' engagement and use of statistics.

[2] Arab countries are divided between Asia and Africa; however, they still have many similarities in terms of religion, language, tradition, and clothing. According to The World Bank (2015), the population of the Arab countries is almost 390.2 million. Arab society is considered to be religious and most Arab people are Muslims (Kalliny et al., 2018). The other common religions in these countries are Christianity and Judaism. The Christian religion is considered to be the second most common religion in the Arab region with 12 million Christian Arabs (Dalrymple, 2014).). The country with the most Christian Arabs is Egypt, with 8.9 million (BBC, 2011).

[3] For example, according to Reporters without Borders (2017), Egypt and Saudi Arabia are among the worst countries in regard to freedom of the press, with Saudi Arabia ranking 168 and Egypt ranking 161, while Kuwait is considered to be in a better position with a ranking of 101 out of 180 countries in their 2017 world ranking. This contrasts with other countries in the region despite their own negative records in this respect. Another issue is the level of spending on science research in these countries. For instance, Saudi Arabia is ranked highest among Arab countries in terms of spending on science research, with $1.8 billion of the total $5.31 billion that all Arab countries spend on science research (Manjoumi, 2016), while Egypt spent nearly $363 million on science research (Al-Jazeera, 2015). Finally, the ownership of the newspapers may impact on the use of statistics in these countries. For instance, the Al-Ahram newspaper is funded by the government along with other sources while the Al-Masry Al-Youm newspaper is funded only by private sources Rabi, A. (2008). The relationship between the style of Egyptian newspapers and the freedom to express public opinion. The 14th Conference of the Faculty of Media: Media between freedom and responsibility Cairo.

. The education of journalists is provided via media schools in these countries; those schools may play a role in dealing with the statistics needed to articulate science news. For instance, in Egypt, the school of media in Cairo University is considered the oldest college in the Arab region, established in 1939; the first schools of media in Saudi Arabia and Kuwait were opened in 1972 and in 1980. The kind of funding media schools in these countries receive could influence the capabilities of journalists. Kuwait has a public media school, which was funded by the government (Kuwait University) and has only one private media school (Department of Communication and Media) in the American University of Kuwait. Similarly, Egypt has more than 15 public schools of media in universities (e.g., Cairo University, Al-Azhar University, October 6 University); also, it has several private media schools in universities such as the American University of Cairo and Ahram Canadian University. On the other hand, in Saudi Arabia, there are only public media schools in eight universities including King Saud University, Imam University, and King Abdulaziz University. There are statistics courses taught in some Arab media schools, especially in Egypt and Saudi Arabia. These courses are only an introduction to statistics in general; such courses exist in universities such as Cairo University, Al-Azhar University, King Saud University, and Imam University. Science media as a basic course is found in two universities: Cairo University and King Saud University. It is also found as a small part of a main course titled 'Specialised Press' in places such as King Abdulaziz University and Beni Suef University) All these aspects (e.g., the type of the university, type of course) may affect the capabilities of journalists when dealing with statistics.

[4] One important aspect to highlight at this point - and that helps to explain some of the pitfalls we will see later in this chapter - is the fact that the release of statistics in Arab countries is heavily regulated and censored, at least compared to other countries. This is because these governments tend to impose a high degree of censorship on the distribution of certain information. While in countries such as the United Kingdom, the release of statistics to the media and the public is now also regulated by the UK Statistics Authority in order to guarantee consistency and transparency Martisini, A. (2018). Journalism, statistics and quality in the news. school of medai and communiction university of leeds. **PhD**.

. It is not done so in terms of censorship as all the figures do get out (something that is additionally supported by the Freedom of Information Act). However, this is not the case in the Arab world as 'regulation' often means 'censorship'. Although in science reporting one would expect that there would be a more lenient treatment in the regulation and dissemination of statistics, it is important to remind ourselves that journalists often do not have access to the data nor are they free to disseminate it as one might expect in other societies.