

Emerging Communication Technologies and Public Health Information Dissemination

Dan Dumbrell

Faculty of Health Sciences

The University of Sydney

“A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy”

Declaration of Originality

I declare that all research and content presented in this thesis is my own, with reference to other findings and work clearly cited. In line with university guidelines, all publications contained within this thesis are as myself as lead author/majority of contribution to these papers.

Publications with my previous primary supervisor (Professor Robert Steele) were published under the banner of The University of Sydney. I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged.

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Abstract

Health promotion is a critical constituent of the public health system. Its primary objective is the empowerment of individuals and communities in the interest of positively influencing health behaviours and outcomes, thereby improving overall quality of life and decreasing consequences of poor health. One of the main ways in which successful health promotion is achieved is by the dissemination of relevant health information to certain individuals and communities. As health costs around the world rise to match the demands of an increasing and ageing global population, such delivery of cost-effective public health information is explored.

The relatively recent advances in communication technologies have led to the development of social digital platforms (Web 2.0), with unprecedented opportunities for the extensive dissemination of relevant health information. The widespread uptake of these SNS presents a novel platform for public health promotion and management that can verily overcome the issues faced by current public health initiatives while reaching global populations of health consumers.

Using a top-down approach, this thesis aims to provide an exploratory study and analysis of the current landscape of health information communication across SNS, primarily through the public platform Twitter. The research will address literature gaps in this cross-disciplinary field of health and communication sciences found for various SNS user-types, analyse and characterise the types of health information being disseminated across such platforms, as well as examine the use of such platforms during real-life public health events.

The findings of the following work contribute to the limited evidence in this novel field of research. Government policy makers, Web 2.0 platform developers and various health-involved entities can utilise outcomes from this thesis to address limitations of online public health-related communication insofar as they can assist with: a) advising plans for better engagement of information disseminated during health events; b) developing future applications and Health 2.0 technologies that are appropriate for limited or disadvantaged groups; c) identifying information dissemination strategies for authoritative health bodies and organisations to effectively reach targeted populations.

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- Steele, R., & Dumbrell, D. (2012, December). Putting the public into public health information dissemination: social media and health-related web pages. In *Proceedings of the 17th Australasian Document Computing Symposium* (pp. 135-138). ACM.
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- Dumbrell, D., & Steele, R. (2013). The changing nature of health information dissemination through the role of social media. In *Applied Mechanics and Materials* (Vol. 411, pp. 110-114). Trans Tech Publications.
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Chapter 1. Introduction and Overview

1.1 Public Health Promotion

Public health is an important and effective branch of both health and social sciences that affect many individuals, communities, and proportions of certain populations. As a general definition, ever since its foundation public health remains as "the art and science of preventing disease, prolonging life and promoting health through the organised efforts of society... focusing on the entire spectrum of health and wellbeing, not only the eradication of particular diseases" (Acheson, 1988). Over the years there has been both a political and social shift from traditional healthcare delivered on a case-by-case individual basis, to the focus of delivering health promotion and disease prevention to a wider community. In reality, public health is a complex, many-faceted and ever-changing field that requires constant research, assessment, and evaluation; and as such work presented in this thesis will address the information-based "promotional" aspect of public health.

Health promotion is a key aspect of public health, which focuses on the empowerment of individuals and communities to increase control over and positively influence health behaviours and outcomes. International health bodies, governments, and communities agreed upon the significance and necessity of health promotion in 1986 at the First International Conference on Health Promotion (World Health Organisation, 2016). The signed agreement, titled the Ottawa Charter for Health Promotion, outlined five action areas: i) Build Healthy Public Policy, ii) Create Supportive Environments, iii) Strengthen Community Actions, iv) Develop Personal Skills and v)

Reorient Health Services toward prevention of illness and promotion of health. The strategies that were agreed upon for the improvement of health promotion to fulfil these five action areas were i) advocate, ii) enable and iii) mediate. Advocate refers to the making all dimensions and conditions more favourable to encourage health. Enable refers to the equity within health and the empowerment of individuals and communities to achieve the best possible quality of life within their socioeconomic and holistic health status. Mediate refers to the collaboration of sectors and organisations to achieve health promotion as effective as possible within communities. Whilst these action areas and strategies to fulfil areas of health promotion remain relevant much has changed throughout the years with advancements in technology, communication means, and the roles of entities within the field of public health.

As previously stated, the following research in this thesis explores the informational aspect of health promotion (i.e. information sharing, communications, media campaigns) rather than investigation of the clinical aspects and initiatives of public health (e.g. interventions/treatments/trials, mass vaccinations, cancer screenings). Through various initiatives, public health promotion has a role of empowering communities through educating, providing knowledge and raising awareness of specific health issues that affect individuals, communities and targeted or whole population groups. This consequently leads to positive improvements in overall population health (e.g. lower rates of morbidity and mortality and a heightened quality of life) through factors such as the reduction and prevention of communicable and non-communicable diseases. Through the promotion and delivery of appropriate messages and information from various sources, such as government bodies and health-related

organisations, public health initiatives are currently the most vital yet cost-effective means of influencing population health and behaviour positively.

The effectiveness of public health promotion and initiatives can be attributed to various factors, such as the source and type of the health information, the quality of the information being shared, the appropriateness to the targeted audience or community, the effect this information has on said audience, as well as the various media and communication channels in which this information is being disseminated through. There have been previous efforts to research health information dissemination within a broader online community, though such research has suggested that these online-based initiatives act as a supplement, rather than a replacement to other communication channels (Noar & Head, 2011). With the introduction of the Internet, a quantitative and qualitative method of measuring public health information communication can be more readily utilised. In addition to this, the exponential growth and uptake of social media systems over the previous decade provides an appropriate and relevant platform to analyse: the type of information that is being disseminated, the flow of information between entities (e.g. the source, end user, message sharers etc.) and the level and quality of interaction between users. These emerging technologies subsequently provide the foundation for such a contemporary and novel area of research.

1.2 Social Networking Sites (SNS)

Social media are digital tools, programs and websites that allow users to create, review, disseminate and receive information. As quite a recent phenomenon, social media has gained

significant ground over the last few years and is currently ingrained in modern-day society. In fact, over the past decade, reported social media use amongst all Americans has increased from 5% of in 2005 to 69% in 2016 (Pew Research Center, 2017). Examples of online social media sites are Wikipedia (www.wikipedia.com) and Tumblr (www.tumblr.com), both examples of websites where large amounts of content can be generated, published and viewed by the online population. Social networking sites (SNS) fall under the umbrella term of social media and are online-based systems that allow various users, such as individuals, organisations, companies, government bodies, and celebrities to create, share and receive content and information with other users. Globally it has been reported that a median of 76% of Internet users access SNS (Poushter, 2016), which translates to approximately 2.7 billion, people worldwide (Internet Live Stats, 2016b). These sites are primarily focused on communication, relationships, and (as the name states) networking. There are a plethora of these systems currently available that targets various audiences with different purposes and requirements. Some examples of the uses of current popular SNS are:

- Connecting and keeping up-to-date with friends, relevant people and communities, for example Facebook (www.facebook.com) and Baidu (www.baidu.com)
- Communicating with users via visual media through the use of photos and short videos, for example Instagram (www.instagram.com), Vine (<https://vine.co>) and Snapchat (www.snapchat.com)
- Occupational and professional networking, for example LinkedIn (www.linkedin.com)
- Following relevant topics, trends and up-to-date news and information, for example Twitter (www.twitter.com)

Most of these platforms were initially developed to allow participation in social networking through online and digital means, though they have evolved to provide an important function in the creation and dissemination of large amounts of relevant information (e.g. news, education, health issues, warnings, etc.) to targeted populations. Whilst this plethora of readily-accessible information can play a beneficial role in knowledge management and communication throughout modern society, the content type, accuracy and credibility of such information should be further explored as a growing number of differing sources become involved with its generation and dissemination (Li & Suh, 2015).

1.3 Twitter

Twitter is a popular SNS with approximately 320 million monthly active users as of the third quarter of 2016 (Statista, 2016), which accounted for approximately 9% of total Internet users worldwide (Chaffey, 2016). The functionalities and features of Twitter make it a very unique yet appropriate SNS for research purposes; one of the major features being that the default settings for Twitter are public. Users of Twitter communicate via tweets, which are short posts or microblogs limited to a maximum of 140 characters that are broadcast to the Twitter feed. Due to the nature of this platform, any user can discover another users' publicly disseminated tweet in the Twitter feed, however as there are on average approximately 6,000 tweets posted every second (Internet Live Stats, 2016a) the chance of finding specific information is usually difficult without certain parameters.

Twitter provides several functionalities and abilities that can be utilised to assist with the customization and direction of relevant information to a user. Firstly, all users on Twitter are able to "follow" any other user with a public profile with the click of a button. Following an account on Twitter results in that accounts' tweets to be automatically directed to the following users' Twitter feed, similar to a subscription. The more accounts a user follows (or subscribes to), the more information they receive via their Twitter feed which is populated with a chronological list of tweets from these followed accounts. Unlike Facebook or LinkedIn where users must approve invitations to socially connect, the act of following a user on public Twitter is immediate and does not require prior approval from the followed user. Therefore users are able to customize the information they receive by following (or unfollowing) users and accounts of interest or relevance according to their changing needs and requirements. This conversely means that users can also be followed if they create information (through tweets) that is of interest or relevance to other accounts. Twitter users may also "like" tweets to show endorsement or approval of the information that has been shared.

Twitter users are also able to forward tweets posted by another account, an act known as retweeting. Retweets play an important role in communication throughout Twitter, as they are community-driven propagations of information that the retweeting user finds important to share with their followers. They are also important in understanding the influence of certain accounts, as well as the significance of the disseminated information in various contexts. Twitter users can customize the information they send and receive by using hashtags when tweeting or searching. Hashtags are words or phrases that are preceded by the hash symbol (e.g. #thesis, #universityofsydney, #stress) and are used to categorise specific topics of interest or discussion.

For example, a user wanting to find information on diabetes can search "#diabetes" in the Twitter search function, which will result in a list of tweets that contain the specific hashtag. The use of hashtags has been found to produce viral information spread regarding various social movements and news events (Wang, Liu, & Gao, 2016) and are thus an important aspect of information communication on Twitter.

These unique characteristics of Twitter may possibly explain why there is such a proliferation of information throughout the platform, as Twitter is seen as a less personal, more convenient and timely manner of open communication. Previous studies have shown that Twitter users share information as they are more motivated by factors such as learning, self-efficacy, and reputation (Oh & Syn, 2015; Syn & Oh, 2015). These factors are less represented amongst users of other SNS platforms. Whilst Twitter has been the most highly ranked SNS platform for personal, workplace and educational learning (Center for Learning and Performance Technologies, 2016), much is still needed to be researched when information communication is applied to a health-related context. Therefore, this thesis will employ the aforementioned functionalities of Twitter and various approaches to carry out research within this field.

1.4 Social Media & Health Promotion

Health 2.0 is a term that has been commonly used throughout literature and research in the field where interactive and social Web 2.0 platforms are applied in the context of health (Belt, Engelen, Berben, & Schoonhoven, 2012). Web 2.0 is an umbrella term that encapsulates the progression of the Internet from only static Websites to social media and SNS. The relevance of Health 2.0 is

appropriate when discussing this overlap of discipline areas, especially in the context of an increasingly health-conscious and digitalised society. As previously outlined, the three strategic prerequisites of health promotion are i) advocate, ii) enable and iii) mediate. SNS fulfill these prerequisites in the following general ways:

i) Advocate: refers to the making of all dimensions and conditions more favourable to encourage health.

SNS provides an equal platform to users accessing health information. The interface and functionalities of such Web 2.0 technologies encourages an environment of information communication of various types of information. Whilst not directly affecting biological factors of health, users are able to find up-to-date information (and connect with similar individuals and communities) in relation to their specific health condition/issues. The open-access nature of the medium also provides a basis for qualitative and quantitative research due to the vast amounts of publicly available data present across SNS, whereas previously such content has been too complex or costly to explore (Ullrich, 2008).

ii) Enable: refers to the equity within health and the empowerment of individuals and communities to achieve the best possible quality of life within their socioeconomic and holistic health status.

The information contained throughout SNS is open, free, and equally available to users on these sites who have access to the Internet, regardless of the other factors of the physical and geographical environment they are in. Whilst access to health information via SNS is dependent

on access to technology (such as a computer/laptop/phone and the Internet), this direction of health promotion overcomes current major discriminators of access to healthcare, such as cultural issues, geographical location and cost. This is especially true considering the penetration of the Internet, with approximately 3.6 billion users, or 48% of the global population reported as being connected online (Internet Live Stats, 2016b). Also as previously mentioned, those sharing information on Twitter do so as they are motivated by learning and efficacy, factors that have been found to contribute largely to empowerment with relation to those using such platforms for health purposes (Magnezi, Bergman, & Grosberg, 2014).

iii) Mediate: refers to the collaboration of sectors and organisations to achieve health promotion as effective as possible within communities.

Health 2.0 requires users of Web 2.0 relevant programs and technologies to create, send, disseminate, analyse and receive information. For health promotion to be effective there must be a requirement of different online entities (i.e. individuals, organisations, government sectors) to collaborate and communicate with one another. Whilst SNS have established users, the type of health information found throughout these technologies should be explored to better understand the role of these online entities. These basic prerequisites, when applied to the context of health-related SNS use, demonstrate the appropriateness of this medium for health promotion and why further research is required to provide evidence-basis for continued and more effective use of such platforms in the future.

The potential of social media-driven health information dissemination is a significantly increasing area of importance. This can be attributed to various and consistent barriers, such as geographical location and the lack of health funding and access to resources (Hausdorf et al., 2008; Jacobs, Bigdeli, Annear, & Van Damme, 2012; Garcia-Subirats et al., 2014) that affect the delivery and exposure of current forms of health information to certain sub-groups within the global population. Such barriers can potentially be alleviated, bypassed or overcome through the utilisation of digitalised platforms. As more individuals, organisations and communities turn to these systems to create, share, disseminate or collect health information, this raises questions on the various aspects of the nature of public health information such as:

- How has health information dissemination transformed over the years?
- What are the types of information currently present on SNS?
- What health-related content are users sharing and disseminating?
- What are the roles and characteristics of users on these sites?
- What are the limitations faced by low-level and non-users of these platforms?
- How are these SNS used for public health promotion and public health-related events?

1.5 Justification of Research and Aims

There are numerous challenges that are faced in both national and international health sectors. One of the major challenges facing public health promotion in the 21st century is that of the growing population, which is currently 7.4 billion people and expected to reach approximately 10 billion by 2050 (United Nations Department of Economic and Social Affairs, 2015). With larger numbers of people relying on health services and health care facilities, this causes a rise in

expenditure for the health sector in an attempt to supplement the increasing demand. This consequently increases the costs associated with health delivery to patients and consumers, which as previously noted have been found to already be one of the major barriers of access to healthcare. Another issue alongside the growing population is the increasingly ageing population, whereby older adults as a group are becoming larger proportions of communities and countries. Due to declines in fertility and improvements in longevity, the numbers of older adults (aged 65 or older) are expected to more than double in proportion from 8% to 16-20% by 2050 (National Institute on Aging, 2011; United Nations Department of Economic and Social Affairs, 2015). Older adults in general have experience more chronic health issues and have lower uptake of Web-based platforms and online communication sources, and in addition to widening inequalities and global economic crises these are major challenges for public health in the twenty first century (World Health Organisation Regional Office for Europe, 2016). For these aforementioned projections, trends and imminent issues, there is a necessity to explore alternative methods to address the delivery of global health through prevention (i.e. promotion of information and empowerment) rather than treatment (i.e. GP, specialists, hospitals) as these challenges put further strain on the global healthcare sector.

It has been estimated that approximately 90% of the data in world today has been created in the past 2 years, which can be attributed to the uptake and incremental use of SNS (IBM, 2017). With the volume of health-related data available through such platforms, research into this cross-disciplinary area will broaden understanding of the current landscape (Kass-Hout & Alhinnawi, 2013). The purpose of this thesis is to examine and analyse identified issues of the current situation of public health information in the wider (and growing) Health 2.0 initiative. Research

will address how our current digitalised society has changed the way health information has been disseminated, as well as the effect SNS platforms have on user interaction with this information. Due to the multi-faceted aspects of public health promotion and the plethora of SNS available, the primary focus of the following research will centre on health information dissemination and public health promotion through Twitter. This novel area of research is made possible by social media platforms that allow us to readily observe health-related communication. With the help of these technologies we can:

- Collect, classify and examine the types of health information that is currently being disseminated through such SNS
- Explore the many facets of modern day public health / health promotion and add knowledge to the current state of Health 2.0
- Observe the interaction of users on these social media systems to health information, and uncover the barriers to certain user groups (i.e. older adults) from using these SNS
- Analyse information being distributed and shared during health campaigns or outbreaks, as well as the various roles of entities involved with these real-life situations

As a result of the novel area of this research, there are many gaps in the knowledge of this relationship between social media and health information dissemination. These gaps are necessary to address as SNS are currently considered as one of the major channels in which a large proportion of the Internet-using public attains their health information. In addition, this thesis can be used as an example of big data analysis and provide a strong foundation for further research and development of systems that contain similar capabilities that involve a rich plethora of data. For policy makers and health promotion strategists, this medium is also a low-cost and

user-oriented way to spread health information that is important and relevant. The outcome of this research is to add value to future planning, strategy and policy relating to health information dissemination through such media, especially with the growing population and increasing costs of global healthcare. There is an imbalance of evidence-based findings and understanding in this area in comparison to the uptake, use, reach and potential effect of SNS, hence why further investigation is necessary to fill gaps in the literature. In light of the multi-faceted aspects of social media and public health, it would be exhaustive to address all major issues and gaps identified within these areas. This thesis, rather than addressing specific issues, will instead address an array of identified issues through case studies of such platforms. The current issues that surround social media and health promotion are identified from the review of literature (in the following chapter).

Therefore the aims of the research contained in this thesis are:

- 1) To develop a comprehensive understanding of the current landscape of health-related use on Twitter, including the roles of users such as health organisations and the type of health information they are disseminating.
- 2) To investigate the characteristics of what makes certain health information more “popular” and more likely to be shared via these platforms.
- 3) To better understand the phenomenon of self-dissemination networks found on online social sites, and how this applies to health-related usage and information exchanged.
- 4) To explore the issues of why certain sub-groups, such as older adults, use such SNS minimally, or not at all, and address the consequences and concerns surrounding these levels of use.

- 5) To study international public health events and uncover significant trends and features of SNS-based communication and information-related responses to offline occurrences.

1.6 Structure of Thesis

This thesis is structured in a top-down manner, where each of the following chapters addresses the various components of Health 2.0 that have knowledge gaps. Chapter 2 presents a review of the literature of the current landscape of public health promotion and SNS platforms, identifying knowledge gaps in the aforementioned components of this system (e.g. information shared, user types). Chapter 3 summarises the methodology undertaken in the subsequent chapters, presenting a conceptual framework that has emerged and providing justification of the research design used. As there are various methods utilised throughout this thesis for the purposes of each chapter, Chapter 3 also further details how data collection and analysis was achieved throughout the thesis. Chapter 4 opens by providing an overarching view of how health communication has evolved over time. This chapter also illustrates the current model of public health information dissemination, identifying how this information is transferred and communicated between different types of entities. Chapter 5 then builds on this previous chapter by exploring a substantive dataset of health organisations and the health information created and shared by these organisations. It also categorises this health information into condition and message type, illustrating the current situation of Health 2.0 through an organisational context.

Tweets that were categorised as “public health” related in Chapter 5 are further analysed in Chapter 6. This chapter explores information that is passed-along (through analysis of retweeting

rates), and semantically analyses highly disseminated tweets to uncover characteristics amongst successfully shared public health information. Chapter 7 investigates the authoritativeness of such health information being shared through such SNS platforms. Through use of the program PageRank, the chapter analyses the Weblinks present in health-related tweets and discusses results in relation to health information quality, rates of sharing and dissemination networks. Chapter 8 follows on to explore a population group that has been found to have one of the lowest levels of use of such platforms (older adults). The chapter analyses a sample of older adults and their SNS perceptions and uses, as well as qualitatively explore reasons and themes as to why this group has such minimal use in the context of privacy. This chapter investigates one of the various barriers faced by population groups that would otherwise benefit from the plethora of public health information in the context of current and future global health environments as discussed in earlier chapters. Chapter 9 and Chapter 10 then explore case studies of real-life public health events. Chapter 9 examines the activity surrounding one of the largest global health campaigns, World Health Day, and the type of users and information that was shared during this event. Chapter 10 explores online reaction to the Zika Outbreak Public Health Emergency of International Concern (PHEIC) announcement, and similarly to Chapter 9 also analyses user roles, actions and information disseminated. Both case studies add further knowledge and evidence to the landscape of Health 2.0. Finally, Chapter 11 discusses the important findings of all previous chapters with reference to the research aims, providing guidelines for public health officials when using SNS platforms and concluding with suggestions for future research direction in this novel area of study.

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Chapter 2. Literature review

The literature review was carried out through the University of Sydney Library Database (and linked-to academic publication sites), Google Scholar and Google Search. Keyword searches were performed on words and phrases such as “public”, “health”, “promotion”, “online”, “social media”, “Health 2.0”, “Twitter”, “information communication”, etc. with publications relevant to the research aims and purposes saved on the referencing program Zotero (<https://www.zotero.org>).

The purpose of the literature review was to build a case for the use of SNS for health-related communication and promotion, and subsequently explore gaps in this cross-disciplinary area that required further investigation. To build a foundation for the research in this thesis, initial sections of this review will analyse literature that involves the use of past media for public health information dissemination, followed with the justification of how characteristics of current online platforms (specifically Twitter) fulfil health promotion and communication methods. The literature review also details previous methods in which data has been mined (e.g. tweet collection, hashtag filtering) for health-related research. Due to the multi-faceted nature of SNS, the literature review (in line with the purpose of this thesis) explores the various types of users utilising these platforms, what type of health information these users are currently communicating and how this applies to real-life events. Latter sections of the review focus on exploring differences in use between these user types, including reasons why certain user groups do not use such platforms. The literature review concludes by exploring studied public health events, gaps in the literature of such work and the relationship these events have to the aforementioned users and SNS platforms.

2.1 Previous platforms for public health information

Health 2.0 is a growing demand that fulfils the delivery of health information where offline sources are sometimes limited. Online public health promotion also plays a role in supplementing existing traditional sources of information, such as primary and secondary health care workers (e.g. doctors, nurses, allied health staff etc.), traditional media based campaigns (e.g. television, billboards, pamphlets), and other individual/community entities. There have however been issues with access to offline health information communication, from patients not primarily seeking via their health practitioners (Armstrong, Gillespie, Leeder, Rubin, & Russell, 2007; Ettel, Nathanson, Ettel, Wilson, & Meola, 2012) to demographical issues such as geographical location restricting access to health information coverage (Fox & Rainie, 2000). Further to this, the growing price of global health care and health management over the years (Flaer, Younis, Hussain, & Malow, 2008; Das & Das, 2009, Nale, 2013; Cook, 2016; Volger & Vitry, 2016) puts certain groups, such as those with lower socioeconomic status, at risk of having no access to health information (Kelley, Su, & Britigan, 2016).

Previous findings have uncovered that more and more people are turning to traditional mass media to seek such information (Brodie, Kjellson, Hoff, & Parker, 1999) in addition to health awareness campaigns propagated through such platforms (Brodie et al., 2001; Montagne, 2001). Thus it would be of significance to observe if such propagation translates through social media, especially with the increasing number of health sites and online health communities around the world (McMillan, 2001; Usher, 2011; Samadbeik, Ahmadi, Mohammadi, & Saravi, 2014; Nath, Huh, Adupa, & Jonnalagadda, 2016). In addition, with the increasing spread of mobile technology

there subsequently comes a growing proportion of people using SNS for health, which benefit those who do not have privately paid or ready access to healthcare (Prestin, Vieux, & Chou, 2015). This widespread uptake of digital platforms and formation of global communities also provides the rationalisation of using SNS as a foundation to carry out the research for this thesis as they become a) saturated with large amounts of readily available and accessible data and b) further ingrained in our current society and the area of health.

Prior to the Internet and modern day communication sources, and even still in less developed countries and areas, public health information research occurred via offline systems. One common method of research and investigation was to establish surveillance systems through structured channels and established authorised entities that were utilised to capture responses and relevant data. Whilst effective in execution, these methods captured data through costly, manual and time-consuming means (i.e. paper, telephone based, face-to-face surveys, etc.) (Pena, Perez, Melendez, Kallestal, & Persson, 2008). There have been many successful attempts to create offline communities to address community health issues, one such initiative being that of the creation, development and implementation of public health nurse roles to facilitate the practice of population-based health research (Halbert et al., 1993). Whilst these and many similar models were the standard for the previous few decades, technological developments have allowed for more effective ways of health research and promotion through online means through data collection of relevant information, with much less associated costs and effort.

Prior studies have uncovered the potential effectiveness and reach of Internet-based public health interventions across a range of conditions and population samples (Bennett & Glasgow,

2009) however most research regarding public health interventions have been mainly via static health education websites (Freeman & Chapman, 2008). With the introduction of technologies such as SNS, this presents a novel area of potential research where the Internet takes on a more social and interactive-based aspect, one that has previously been lacking. SNS also provide a platform where the information that is being disseminated is in modes other than text, with the dissemination of media-based information such as images (e.g. health infographics, trend graphs), audio (e.g. podcasts) and video (e.g. patient education) that can effectively reach users who have certain physical or cognitive impairments (Adams, 2010). The research contained in this thesis is assisting to redevelop the concept of health information with the level of interaction and deep communication provided by SNS, particularly as these platforms continue to become more utilised with all modes and forms of health-related communication (Love, Himelboim, Holton, & Stewart, 2013; Zhang, Xie, Tang, & Lai, 2014; Hether, Murphy, & Valente, 2014; Himelboim & Han, 2014).

The need and demand for online public health information has increased and is now an acceptable and valid method of searching for relevant health information (Alpi, 2005). This is especially the case today as there have been findings that suggest that a majority of people first search the Internet for health-related information prior to consulting a health professional (Hesse et al., 2005). The type and quality of health information present on the Internet has been less explored than other sources and forms of information due to the contemporary nature of websites and systems present on this medium, with the amount of research varying from country to country. Due to constantly changing individual and global demographics, as well as the shifting patterns of certain health and disease, and the current static nature of public health

models, there needs to be a far more flexible form of health promotion which reflects the context of modern times (Smith, Orleans, & Jenkins, 2004).

The significance of Health 2.0 research can be attributed to its rapid and largely global uptake in a relatively brief amount of time. In fact, there are a reported 2.3 billion active social media users in the world today (Statista, 2016), which translates to approximately 31% of the current global population of 7.4 billion. There are many facets of health information communication via SNS without supporting evidence-based research, thus with a significant proportion of the global population of online users already using these digital platforms, further work must be done to uncover gaps in literature. The acknowledgement of previous (and still current) platforms of public health information are important to the ultimate purpose of this research into Health 2.0. These offline health promotion and public health-related studies have recommended for future direction of research to focus on larger scale, web-based information dissemination, and the development of networks through the use of readily available medium and expertise that will lead to broader health information communication for users to effectively impact and change health behaviours and issues globally.

2.2 Social Networking Sites and Characteristics of Online-based Health Information Dissemination

As previously stated, Internet-based searching and communication of health information is occurring at significant levels. One of the major recurring risks for users seeking and utilising health information they find online (or shared from other sources) however is the quality or

credibility of this information (Bernhardt, Lariscy, Parrott, Silk, & Felter, 2002). For example, it was found that some websites of health-related organisation and bodies (e.g. hospitals) did not contain up-to-date or credible information, and only minimal online interaction occurred with patients (Maifredi et al., 2010). This may be one of many factors that explain why a greater number of people and users of digital platforms are turning to more social forms of online communication for relevant information, with one of the most currently common online activities found to be communicating about health on SNS (Prestin et al., 2015). With this ever-increasing number of adults who use the Internet as a first source of health information, further study on the quality and type of information spread via these sources is necessary. Use of available online quality measures, such as Google PageRank to judge the importance of Web links present in tweets, is thus considered in this thesis.

In a recent review of literature on health-related social media use, the authors founds that most frequently reported health topics were sexual health, diabetes, flu/H1N1 and mental health, (Moorhead et al., 2013). Research on the comparisons of users seeking health information online however found that communication varied amongst different disease types but not public health information as a general sense (Magnezi et al., 2015). Previous studies have examined the characteristics of health information seekers rather than the characteristics of the sources of this information or even the characteristics of the disseminated information itself (Miller & West, 2007; Koehly et al., 2009). This identifies several gaps in current literature that are required to be filled, such as the research of other health topics how they are communicated. Further to this, the characteristics of SNS disseminated health information should also be captured and analysed to build a more complete representation of the current state of communication via these platforms.

Mining historical data from SNS, have been recognised as the future of public health communication analysis (Sundararaman, Pargunarajan, & Ramanathan, 2016). Due to the open and public nature of disseminated information, relevant metrics of communication that were previously complex to collect can be readily captured either via manual means or with sophisticated data mining programs. Examples of such metrics can be characterising the type of information being disseminated via messaging and shared hyperlinks, or how many times a piece of information has been shared. In addition, users sending information via social media are able to be geographically located from information parsed from their user profile, or with GPS location indicators. Location information is found to be more accurate and especially beneficial for the SNS Twitter, where reliable location information can be found for about 15-17% of users (Burton, Tanner, Giraud-Carrier, West, & Barnes, 2012). The mentioned examples of data that can be collected and analysed through SNS provide a foundation for online ecological research in health communication and health promotion that is both comprehensive and more rigorous. This research also allows us to build on current academic knowledge and further understand the relationship of SNS and health within varying contexts in our modern society (Moran et al., 2016).

The uptake of Internet and SNS usage differs by country, thus findings based on this research are currently more representative of more connected areas of the world, with countries in the Americas, Europe and Asia-Pacific having more Internet and SNS penetration compared to countries in Africa and Central Asia (Chaffey, 2016). Nonetheless there is future potential of applying such findings to regions lacking such technology as the push to a more digitalised world

becomes attainable. Many issues raised in previous literature with regards to implication on research for health promotion can be solved through utilising the available created systems and datasets that we can now find throughout social media. The study of SNS-based health information dissemination is also important to not only provide evidence-based knowledge to users of these platforms, but to contribute to national and international health policy making as mainstream media and government bodies frequently view these sites (Kovic, Lulic, & Brumini, 2008).

2.3 Health Promotion Settings and Social Networking Sites

Over the years there has been an increasing trust of using SNS for certain purposes, such as providing support that lead to enhancing self-efficacy in the real-life management of certain health issues (Oh, Lauckner, Boehmer, Fewins-Bliss, & Li, 2013). Self-efficacy is essential as an outcome of good quality and influential health information as it translates to the user performing real life health behaviours to reach certain health goals. An example of this would be a user receiving information about preventing germ spread online and subsequently washing their hands as a result of this efficacy-related information. Previous studies have suggested Twitter to be an effective tool of promoting self-efficacy, or in other words a viable set of communication and information processes that enable the participant to make an informed choice, during such events like natural disasters and terror attacks (Wukich & Steinberg, 2013). Aspects of this concept will be explored within this thesis to better understand the characteristics of efficacy-related health information on SNS. Further to this, it would be of interest to observe if findings

are consistent with current literature when applied to a public health or various different health promotional contexts and settings.

The use of SNS has been raised as a platform for health communication and promotion, however due to the novel nature of these settings there has been a proportionally smaller amount of research and large ambiguity of this area compared to other areas of medical and healthcare (Loss, Lindacher, & Curbach, 2014). Whilst it has been identified that the characteristics of settings for health promotion are generally followed by SNS, these have not been thoroughly explored due to the many-faceted areas of health and health promotion (e.g. campaigns, outbreaks, etc.). The features that were found to be applicable to social networking sites were that it "offered social context and social interaction, being an integral part of everyday life, allowing pursuit of various personal professional or leisure time aims and activities, displaying an organisational structure and policies, whilst partly applicable was basing on shared values, norms, sanctions and/or a code of conduct, influence on health and well-being, permanence and or consistency". The main characteristic of health promotion setting that did not apply to SNS was the aspect of being a geographical locus and having no physical boundaries. This may illustrate how these technologies have evolved aspects of the health promotion model that were previously seen as unfeasible. As such public health-related research through this medium can potentially uncover findings that lead to changes in the current public health promotion model.

2.4 Twitter as a Tool for Public Health Research

Having only been introduced to the Internet for approximately a decade since launching in mid-2006, Twitter is viewed as a relatively unexplored resource for conducting health science research (Yoon, Elhadad, & Bakken, 2013). Twitter is a free, public and open-sourced social media platform with many capabilities and characteristics that allow for data to be mined and analysed on a large and ethical scale. This is why it has been identified as an appropriate setting for to undertake health science research with big data (Finfgeld-Connett, 2015). Many of the previous research into Twitter and health information dissemination and public health promotion utilised various available and customized software, such as Twapperkeeper (Vickey, Ginis, & Dabrowski, 2013), ViBE (Hingle et al., 2013), Twitter4J (Kim, Seok, Oh, Lee, & Kim, 2013), followerwonk (Hajar, Clauson, & Jacobs, 2014), to collect large amounts of relevant data. As Twitter contains a large amount of historical data spanning over nearly a decade since its commencement, research is generally carried out according to certain parameters like date (King et al., 2013) with selective or random sampling of certain users by health topics (Hanson, Cannon, Burton, & Giraud-Carrier, 2013; Park, McDonald, & Cha, 2013; Robillard, Johnson, Hennessey, Beattie, & Illes, 2013). The methodology of the following research contained in this thesis will combine both cost-effective automated programs for data mining and manual coding and categorising of random samples collected.

Twitter has been found to potentially serve as a powerful communication tool for public health information dissemination, however previous research has not address the quality of the health information present amongst such social networking systems (Bartlett & Wurtz, 2015). There

have been Twitter studies that have involved the collection and analysis of specific health issues such as antibiotics and tooth pain (Scanfeld, Scanfeld, & Larson, 2010). Conversely there are minimal studies within the literature that involve the classification of different health issues from a sample of tweets to provide a landscape of the current health information state of Twitter. It would be of interest to examine the different types of health information present in a specific Twitter population, and classify these into generalised and specific groups (as well as the type of tweet collected).

Twitter is also an appropriate platform to carry out health promotion/communication research due to the presence of well-known health bodies found throughout the site (e.g. The World Health Organisation or WHO). The span of such a global body has further extended its presence and reach due to well-established and monitored global and regional-specific SNS accounts, thus not limited by geographic location and increasing online user access to information from a credible source (Carillo-Larco, 2012). To capitalize on this established and reliable source of information, case studies regarding health campaigns and outbreaks presented within this thesis will be with connection to the WHO. By attaching research attributable to a well known, governing, professional and highly expertise organisation, the outcomes of this research can present more reliable and authoritative evidence-based findings (Alnemer et al., 2015).

The research conducted throughout this thesis uses big data mined from Twitter. As such, there are assumptions for carrying out research through this medium, as well as assumptions for the results drawn from this collected and analysed data. Contrary to previous research identifying anonymity as a benefit for health communication via SNS (Eysenbach, Powell, Englesakis, Rizo, &

Stern, 2004), Twitter's functionality and foundation is of a public nature that allows for user information (i.e. demographics) and communication to be more readily captured. A limitation thus of Twitter is that extremely sensitive or personal matters are minimally discussed in such public ways, which should be acknowledged when both analysing results and forming discussion from data collected throughout this thesis. The results presented therefore represent a community that encapsulate the population of Twitter users, that may vary slightly to other forms of social media with different communication methods due to the functionalities of Twitter.

The study of health-related Twitter usage will also inadvertently produce outcomes that will address the phenomenon of "health information scanning" (which is different to health information seeking). Due to the brief and 140 character-limited micro-blogging nature of the platform, users can receive information via scanning and rapid browsing of their Twitter feeds (Niederdeppe et al., 2007). Whilst the research in this area has been minimal, health information scanning has been found to be more beneficial than health seeking for certain conditions like cancer (Kelly et al., 2010). In addition, some research areas presented in this literature review have been found to impact health information scanning, for example age (i.e. older adults) being negatively associated with information scanning. Examining roles of emotion and content (i.e. semantics) in information scanning can potentially fill gaps in literature regarding the characteristics of individuals who scan and those who seek during health-related events (Ruppel, 2016). Therefore findings from this thesis can potentially be adapted and applied to the developing framework of this phenomenon.

2.5 The Role of Hashtags for Online Communication

Whilst the use of hashtags was not introduced to SNS until 2007, as of mid-2016 upwards of 1.5 billion individual pieces of health information had been tweeted, with approximately 12,000 hashtags (Symplur, 2016). The importance of using hashtags is that they act as a self-filtering mechanism to exclude irrelevant signals and data present in these SNS, as previous studies have found that between 5 and 20% of signals are "relevant" to a specific conversation when mining for all health event-related data without hashtag parameters set on the online search (Denecke et al., 2013). Thus it would be beneficial to utilise specific hashtags as part of the methodology, increasing the proportion of relevant data captured and thus being analysed during certain health events.

To capture specific data relevant to the area of research, some chapters within this thesis involve the collection and analysis of hashtags. There have been consistent findings that using hashtags in Twitter creates online communities, especially within the context of health and health-related areas. There have been many recommendations of the use of hashtags in certain professions such as nursing (Moorley & Chinn, 2014) and general medical practices and health organisations (Knapp & Baum, 2015) to drive patient-provider and workplace communication and relationships. The focus of the research in this thesis however is not to build on these established hashtags and communities, but to explore novel and new health issues and communities more relevant to the general public (i.e. public health promotion) to fill gaps in the literature. The collection of a dataset of tweets by hashtags can be seen as a beneficial way of capturing a more global sample of users and information by involving those with geographical and language

differences into the same topic or point of interest (Pavalanathan & Eisenstein, 2015), and thus producing more applicable outcomes.

Studies in the past have indicated that conducting retrospective research using hashtags are feasible due to the historical nature of these SNS (Volovyk & Topachevskyi, 2014). Whilst health hashtags (i.e. #health) have been collected and analysed in the past, these have usually been carried out within shorter timeframes, with data being too generalised to ascertain reliable patterns and findings (Donelle & Booth, 2012). Previous work have found that that a limitation of collecting data with certain health-related hashtags on Twitter is that tweeting activity is influenced by certain events thus skewing results. However rather than using hashtags to track and predict certain health events, this thesis will differ from previous research by utilising historical data mined from Twitter to capture and analyse information from pre-meditated, controlled and anticipated offline events.

Previous literature has raised some implications of using health-related hashtags for research, such as the reluctance of users to disclose certain health information due to the public nature of platforms, different uses and meanings of hashtags (i.e. same use of the hashtag does not mean same thing for content analysis) and non-directional nature of communication through this medium (i.e. to the public rather than in few cases person to person) (Xu, Chiu, Chen, & Mukherjee, 2014). In addition, it should be noted that users using hashtags have been found to increase their followers and engagement more than two times than those who do not use hashtags (Martin, Lavesson, & Doroud, 2016), so results produced from hashtag-mined data may be skewed due to users tweeting with hashtags being more active and having a larger presence

on Twitter. Hashtags however are a novel aspect of health information communication that warrant further exploration, as the approach of analysing hashtags rather than other metrics of influence on SNS (e.g. followers, likes) may uncover trends/findings of both users and content that are not present in non-hashtag related communication (Cha, Haddadi, Benevenuto, & Gummadi, 2010).

2.6 Users of Social Networking Sites for Health-related Purposes

2.6.1 Individuals

The need to explore aspects of public health information on social media platforms and their users is driven by the need to advance questions already present in past literature. The more society becomes digitalised with advancements in technology, the more accessible public health information becomes to SNS users. Further advancements in technology create larger differences and disparities between offline public health information and online health information. Past literature had identified characteristics that discriminate between those who seek public health information offline, and those who do so online (Cotten & Gupta, 2004). SNS however provide the opportunity for online users to interact with people of the same community and target group, as well as foster the sharing of content and information through messaging and links (Thackeray, Neiger, & Keller, 2012). Now with the significant levels of global social media uptake, this brings an entirely different aspect and set of factors in how different individuals interact with online information.

This research produced in this thesis will build on previous findings of health-related users of social media. Success of health promotion from a user-oriented perspective has found that various characteristics, such as regular posting, individualised interactions, posing questions and uploading multimedia material, produced more successful engagement (i.e. more influential communication) in sex health promotion (Veale et al., 2015). Future research directions of similar studies have also outlined the need for identifying best strategy for engagement in health, as well as classifying types of users and identifying differences in content sharing of these categories. This thesis will research several case studies of health information communication via SNS to observe any differences in characteristics of user types during larger scale information dissemination events, such as campaigns and outbreaks.

2.6.2 Organisational

The literature surrounding organisation-related social media use for health communication has produced conflicting outcomes. There have been recent findings of health organisations' use of Twitter for health promotion that show that specific organisations are more likely to report organisation-related topics rather than personal health-related tweets (Park, Reber, & Chon, 2016), whilst other findings suggest that local health departments tweet more about personal health than the organisation itself (Neiger, Thackeray, Burton, Thackeray, & Reese, 2013). In addition, it has been previously indicated that whilst organisations and more authoritative sources of information are involved during emergency scenarios (e.g. natural disasters and terror attacks), there is a limited level of engagement found throughout the SNS (Wukich et al., 2013). These findings exemplify the need for further research surrounding the characteristics and roles

of organisations in online-based health information dissemination. These discrepancies amongst findings however are not unusual, due to variations in demographics and situational contexts of any offline or online sample being examined. Further research on the type and condition of health information would be beneficial to provide more consistency when explaining these knowledge gaps of the health-related content tweeted by organisations through SNS.

Park et al. (2016) carried out analysis on 16 USA-based health organisational Twitter accounts, examining the ratio of tweets to retweets and the proliferation of other media (e.g. hyperlinks, hashtags, multimedia) embedded in these tweets. There was bias present in the sample of accounts as organisations with well-known reputations were only selected for the study, however the methodology of analysing SNS characteristics of health-related organisation can potentially shed light on the activity and roles of these tweeting entities. Not-for-profit organisations have been found to tweet more health literacy messages than other groups found on Twitter (Park, Rodgers, & Stemmler, 2013) however their level of fundraising and donation-related activity on SNS remain unclear (Sisler, 2012). Several studies have also quantified the level of engagement, activity or general online presence of health-related entities on Twitter (Bhattacharya, Srinivasan, & Polgreen, 2014; Harris, Choucair, Maier, Jolani, & Bernhardt, 2014a) without however analysing the disseminated health information (i.e. condition or issue) being relayed and communicated in detail. In addition, the various categories of organisations (e.g. for profit, not-for-profit, government) are an area of research interest to address how differences in organisation models, strategies, capacities, governance features and external pressures (Nah & Saxton, 2012) affect their respective health-related SNS. Consequently there has not been a

comprehensive analysis of a both organisational types and the health information these entities disseminate on a large national scale, which this thesis will investigate.

2.6.3 Disadvantaged groups – Older Adults

One important aspect to address when studying SNS is certain groups that do not use or have barriers to access social media and the relating health information. This thesis must also address the digital divide found in users and non-users of SNS for health information communication. Despite the increase of digital information resources, there is a growing digital divide suggesting people can be deprived of adequate access to health information because of factors such as age, income, location and education (Bawden & Robinson, 2009). Studies have found that those in more rural, and less developed countries, have lower levels and more implications of social media engagement (Gilbert, Karahalios, & Sandvig, 2010; Duggan, 2015), whilst a recent review of Web 2.0 health interventions found few programs targeted to the needs of these disadvantaged groups (Chou, Prestin, Lyons & Wen, 2013). Individuals using the Internet for health information have been found to already have higher levels of health literacy, as well as a positive association between specific health information knowledge they were searching for and health literacy in that specific area of health (Sarkar, Schillinger, Lopez, & Sudore, 2011). User attitudes toward information positively predicted behavioural intentions to engage in intended information sharing, thus a positive feedback cycle occurs where those who are more health literate and positively interacting with online-based health information partake in more positive health behaviours (Crook, Stephens, Pastorek, Mackert, & Donovan, 2016). Many previous studies produce findings that cannot be generalised across non-user population groups due to a)

only analysing specific areas of health (e.g. cardiac health in older adults) and b) not taking into account the impact technology literacy that also affect access for these groups.

Twitter has been found to be patients' preferred choice of social media platform for health knowledge management and advice, with approximately 60% of patients using social media using Twitter as their primary platform (Antheunis, Tates, & Nieboer, 2013). One of the main motives found was "to stay updated on the new developments in healthcare" (p. 428) whereas the main barrier for not uptaking any health-related information communication via these platforms was due to privacy concerns. Further to this there research has suggested that even those who do not use the Internet for health information have been found to receive information through offline means, thus showing that if these barriers are identified, explored and addressed more non-users will be able to have direct access to relevant health information (Ayantunde, Welch, & Parsons, 2007; Massey, Lavesson, & Doroud, 2016). The systematic review also identified that one of the gaps that needed to be addressed by future research was the impact of social media for health communication in specific population groups. However to thoroughly research the issues surrounding all minority and limited access groups with regards to health information, SNS use and the combination of both areas, would be extremely extensive and thus the largest (older adults) minority group identified was chosen to be studied for this thesis.

There have been few studies of the demographics of users of social media who use the platforms for health-related purposes (Sadah, Shahbazi, Wiley, & Hristidis, 2015). In addition to this, there has been less research on the characteristics and demographics of those who do not use these platforms for health, due to information being not readily available on some platforms (e.g. age).

One of the most underrepresented groups, especially when compared to their growing global population numbers and proportions, are older adults aged 55 and over (Sadah et al., 2015). Whilst older adult groups that were 65 and over were found to more readily use health websites (i.e. mainly drug review websites) than social media, they still represented the lowest overall users of Internet for health purposes. Older adults however are potentially able to better manage their health through SNS, as health information content found through these platforms are easier to understand for most users and thus requires lower health literacy (Gibbons et al., 2011). Therefore due to the availability and advancements of health information it would be of interest to outline both the benefits and also examine the barriers and issues surrounding the lack of uptake with older adults and these platforms.

As one of the lowest users groups of SNS, older adults and their relationship to social media has not been comprehensively explored. The majority of studies in health-related SNS use involved participants that fell within the age group of 11-34 years old (Moorhead et al., 2013). Due to the increasingly digital nature of society, the growing proportion of older adults in the world, and the ability of SNS to provide information for chronic diseases largely affecting this group, there is a need to research and draw evidence-based findings of issues preventing older adult uptake of SNS. It is important to note that as the burden of chronic disease continues to grow in both developed and low- and middle- income countries, Internet access and use for health information and communication will become increasingly important to preventing, treating, and managing these chronic conditions (Jadhav, Wu, Sheth, & Pathak, 2014).

One of the practical implications raised by a study of health users of social media in healthcare and their associated motives and barriers raised the issue that “future studies on social media use in health care should not disregard participants’ underlying motives, barriers and expectations regarding the (non)use of social media” (p.431) (Antheunis et al., 2013). Further to this point, non-users or users with low levels of SNS use are minimally studied and analysed in the literature as research tends to focus on active users of such platforms. Therefore an area within this gap of knowledge would be to study the barriers faced by this group of non-users to overcome future non-compliance as the world and health information communication become more digitalised. Therefore this thesis will also address older adults who are non-users, as previous research that recruits older adults who are already online users of SNS, thereby increasing the knowledge in literature of a group that has not yet been fully explored.

2.7 Public Health Events and Changing Communication Models

The use of social media has been identified as a novel and immediate way of monitoring events and overcoming time delays for reacting to currently occurring events, for example, terrorism, natural disasters, and health events. Twitter has been identified as one of the more active SNS when it comes to event-related sources of information, due to its immediate, public and up-to-date nature (Denecke, 2015). Although the area of research is increasing within this field, Twitter has been a comparatively unexplored resource with its potential to address challenges in conducting health science research during public health events (Yoon et al., 2013). SNS are the platforms that allow online entities to form bonds and share relevant information during important offline public health-related events. Two important types of public health events

identified in the literature that are explored in this thesis are a) public health campaigns and b) public health outbreaks.

2.7.1 Public Health Campaigns

The importance of studying SNS-based public health campaigns is the potential of achieving similar positive outcomes of current offline interventions. For example, the implementation of prevention campaigns has been found to be cost-effective for global health settings especially with low-income and middle-income countries (Marseille et al., 2014). Such interventions have been centred on traditional integrated prevention campaigns (IPC) that involve face-to-face real life contact (e.g. vaccines, condom provision) between users and health consumers. Previous research has hypothesised that SNS can be used to supplement such offline health-related actions through the empowerment of users and increasing the level of participation of such campaigns through targeted information dissemination (Mankoff, Matthews, Fussell, & Johnson, 2007; Laverack, 2013; Apatu, Alperin, Miner, & Wiljer, 2013). Therefore more work is required to uncover the framework of large-scale online campaigns that are run through SNS-based platform, to provide further understanding of the appropriateness of this medium for such health information dissemination.

There has been minimal research on health campaigns run by largely credible sources (e.g. health organisations and government sources) through online medium. Previous studies have examined the roles of authoritative health information entities using the Internet as a marketing platform for public health promotion. One such example was the successful and cost-effective campaign

run by the Canadian Health Network. The campaign relied heavily on self-disseminating users (mainly individuals) to drive traffic (via email) to a health-related website (Gosselin & Poistras, 2008). Several key factors behind the self-dissemination of information that drove this effective online campaign were identified. Viral marketing was used to exploit pre-existing social networks to produce increases in awareness of the campaign. Users who had a sense of providing a social benefit to the community, enhancing their own self-worth as well as a desire for social interaction, could also explain this phenomenon of self-dissemination (Hennig-Thurau, Gwinner, Walsh, & Gremler, 2004). Due to the more personalised nature of email, users were more likely to pass on and forward messages from friends and acquaintances as there was an implicit level of credibility due to these pre-existing relationships (Chiu, Hsieh, Kao, & Lee, 2007). Jokes were also forwarded the most often via email during these campaigns (Phelps, Lewis, Mobilio, Perry, & Raman, 2004). Whilst this indicated the potential of person-to-person online public health information dissemination, the idea that this would also be reflective of social media platforms cannot be assumed due to the differences outlined earlier on capabilities and characteristics of this medium. In addition, there was a limited foundation for further content analysis due to the static nature of websites and the inability to directly (and readily) measure if this information is passed along dynamically within a user's online or offline social network. As SNS are inherently more public platforms, it would be valuable to draw comparisons between such previously explored online health campaigns with Twitter-based health campaigns, analysing aspects like self-dissemination, pass-along information features and the content/semantics of this forwarded information.

Whilst the potential of Twitter as an opportunity for public health campaigns have been realised (Wehner et al., 2014), there has not been a large-scale analysis of such social media driven campaigns. A study of information dissemination of maternity care quality through social media used retweets and mentions as a measure of "customer conversion" on Twitter (Huesch, Galstyan, Ong, & Doctor, 2014). The results from that particular research found that the Twitter run campaign found less reach and engagement than both Google Search and Facebook, with one limitation of the study being the niche and private area of health covered (i.e. maternity-related information). Harris et al. (2014b) studied the online response of users to an electronic cigarette campaign that was disseminated via Twitter prior to the offline vote of a public health policy. This "online response to offline/real life events" could be applied and studied for both public health campaigns and outbreaks, rather than repeating the numerous previous studies that look for online trends to or only track conditions. This thesis would also like to build on the methodology of these campaign-related studies, to compare trends of tweets and SNS activity over time to capture the full response and reaction to an offline planned event (e.g. announcements). Similarly, as health outbreaks occur, online campaigns can take note of the strategies employed to increase the reach of information and adapt them to develop effective dissemination and behaviour outcomes.

2.7.2 Public Health Outbreaks

Prior research of SNS has involved the tracking of certain health issues or diseases via Twitter, such as the flu, cigarette smoking, and dental pain (Chew & Eysenbach, 2010; Signorini, Segre, & Polgreen, 2011). Although these studies illustrate the useful role of Twitter in real-time data

collection, and some cases the prediction of such health issues, there are various other aspects of public health information that need to be explored. For example, while Twitter outbreaks have the potential to predict rates of spread in society (Prieto, Matos, Alvarez, Cacheda, & Oliveira, 2014) there has not been an analysis of user responses and SNS activity to a health outbreak announcement on a global scale. These are important areas of communication research, as they allow for further understanding of the relationship between offline and online health communication in modern times.

It has also been found consistently that users in more rural areas, or coming from a lower socioeconomic background tend to participate less in online health communication (Prestin et al., 2015). Whilst previous health outbreak papers have tracked the spread of infection/disease in more developed communities, such as the flu (Nagar et al., 2014; Lamb, Paul, & Dredze, 2013; Chew & Eysenbach, 2010), it would be of interest to observe recent global health outbreaks and how their related announcements affect less developed communities. Further research in this area can explore how health communication is affected by varying diseases or different demographics. Due to factors such as limitations to health access and lower levels of online information technology, less developed communities have more offline ways of health-related information dissemination during outbreaks. For example, with the 2014 Ebola Outbreak, communication and collaboration of issues such as vaccine candidates and clinical trials were carried out through a regulatory forum (The African Vaccine Regulatory Forum) which involved various numbers of global committee members and organisations. Future directions of this could involve such collaborations through readily available online medium (Akanmori & Bellah, 2015) as communities become more digitally connected.

Past research on recent outbreaks, such as the Bird Flu Outbreak, have focused on examining if health information present on social media could translate to offline means and help users respond to a crisis appropriately (Vos & Buckner, 2016). The authors of this paper also identified differences between sensemaking (i.e. information that provides updates, developments and trends with regards to a crisis/outbreak) and efficacy (i.e. information regarding an effective response to a crisis/outbreak and the ability of users to act on that response) messaging through Twitter, and found that efficacy-related tweets were minimal. Sutton, League, Sellnow, and Sellnow (2015) also found that in a public health crisis that involved a flood and water contamination, a low proportion of messages sent by governmental organisations contained efficacy information. In addition, several studies of the 2009 H1N1 outbreak focused on public sentiment in response to the outbreak rather than if these messages were of a sensemaking or of an efficacy nature (Chew & Eysenbach, 2010; Signorini et al., 2011). Drawing from the findings of these studies, it would be of importance to observe if the efficacy-related information is as consistently low during global outbreaks. In addition, it would also be of interest to see how premeditated offline events (e.g. emergency health announcements) affect communication during an outbreak to further add to the literature and refer back to health campaigns disseminated via social media, if this is also the case.

There have also been social media-driven public health interventions that have shown to disseminate health information that is of a low or inadequate standard or inaccurately targeted (Sullivan & Green, 2016) thus research into the response to an international outbreak will assist in understanding whether SNS are an effective medium for targeted global health

communication. Another area where there are gaps in the literature is the issue of health information variations that are being disseminated via SNS. With health-related information on general search engines, there has found to be a mixture of both high and lower quality health information, especially the lower quality of results found in social health issues (Kitchens, Harle, & Li, 2014). Previous findings have revealed cultural variations in online health information seeking, although with the same study also finding there was no cultural differences in the level of trust in more expertise-based sources (Mano, 2014; Song et al., 2016). Whilst this study shows there is trust in certain health sources, it also brings up the variations that are expected when analysing online health activity amongst those in different countries, especially when dealing with continent specific issues that should be taken into account with each chapter.

2.8 Conclusion

This literature review has revealed some significant issues that are further explored in subsequent chapters. It should be reiterated that due to the novel and multi-faceted nature of health and communication, not all potential areas could be studied; rather this thesis investigates important aspects where large knowledge gaps exist. Twitter has been reported as a preferred tool for learning, education and health knowledge management, and thus is a SNS platform with publicly available information upon which research can be carried out (i.e. historical data and sampling with parameters). The review of literature uncovers that the types of health information present throughout SNS platforms have not yet been rigorously explored, especially in comparison to other online health sources such as static Web sites. Due to the nature of SNS

platforms, further analysis can also be performed on various aspects of health information (e.g. quality of links being shared, how this information is being shared, level of dissemination, etc.).

There are also gaps in literature regarding the characteristics and presence of health organisations and user groups across SNS platforms, as well as the health information these various groups disseminate and interact with. Further to investigating these user groups, the literature review revealed that there is a lack of knowledge about why some groups (e.g. older adults) make limited or no use of SNS platforms, previous studies having focused on younger age groups. These aforementioned areas of research (i.e. types of health information, communication and interaction, differentiation of user types) can be applied to real-life cases. Global public health events, such as established health campaigns and outbreak announcements, have not been closely studied through SNS platforms although they are two major aspects that underpin health promotion. Therefore it would also be of interest to capture community data using similar methods (i.e. hashtag parameters) and analyse such events to compare and contrast these different, yet significant, areas of public health communication. Exploring such aforementioned aspects of SNS-based health promotion uncovered in the literature review will increase knowledge and further add to this novel landscape of Health 2.0.

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Chapter 3. Methodologies

Twitter was the main SNS from which data was collected and analysed for the following publications. The advantage of mining Twitter data was due to the platform's many research-desirable features such as the:

- Public and historical nature of tweets that were able to be collected
- Concise nature of posts (140 characters maximum) which contains minimal free-text compared to other SNS platforms
- Ability to capture and access further linked to relevant websites and information
- Ability to self-filter and track relevant topics through the use of hashtags
- Profiling of users into categories based on provided demographic and descriptions.

As identified in the literature review, there have been various options and programs explored for collecting and sampling data from SNS and Twitter (e.g., followerwonk, ViBE, TwapperKeeper, Twitonomy). The methodology of the research contained in this thesis utilised various approaches when collecting Twitter and participant data. These approaches were dependent on the purpose of the chapter or publication, with cost-effective automated programs for tweet mining, questionnaire administration and manual means of collecting and analysing specified samples being considered. It should be reinforced (prior to the discussion of methods) that the following research surrounding Twitter does not focus on physician-to-patient communication of health information, or the offline health behaviours of users due to data availability issues pertaining to patient confidentiality and authorship concerns (Vance, Howe, & Dellavalle, 2009).

3.1 Research Design

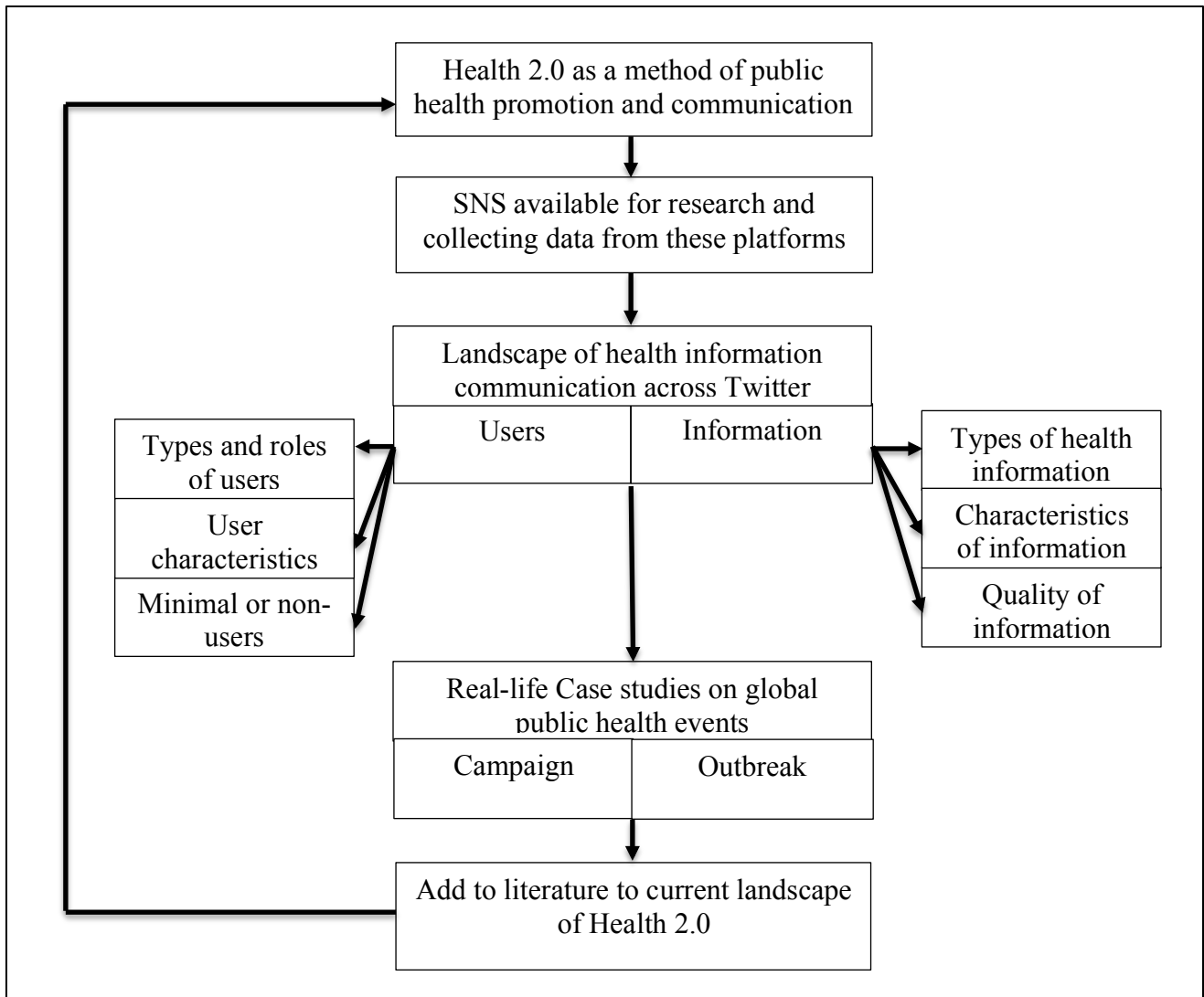


Figure 3.1 Conceptual framework of the thesis research direction and outcome

Figure 3.1 shows the conceptual framework that had emerged from the literature review to address the main aims of this thesis outlined at the conclusion of Chapter 1. To explore the multi-faceted nature of health promotion and communication technologies, a top-down approach was undertaken where this overall system was broken down into various components, with research

conducted on more specific areas to produce findings that ultimately contribute toward filling identified gaps in literature pertaining to the current landscape of Health 2.0. Due to the differences in areas being explored throughout the framework, the methodology used to collect and analyse data in this thesis was adapted to achieve certain aims and will be discussed in more detail in the following sections.

The various methods of collecting data from Twitter for academic research have previously been detailed in a comprehensive systematic review of related studies (Zimmer & Proferes, 2014). This paper found that not all authors included the exact number of tweets collected, the number of users these tweets came from or how such data was obtained. This thesis will thus be transparent when capturing Twitter data to avoid such oversights. The authors also found that the most common forms of data collection and analysis through Twitter was the use of various online programs or manually capturing data through searches and user feeds. Content analysis and the coding of types of information involve manually reading a substantial number of postings being shared. Although practically more time and resource consuming, the literature suggests that human coders are more proficient at coding information than available automated coding software (Graham & Wright, 2014). In addition, coding topics and sentiments of comments provides a landscape of the research context, in this case, health information communication across Twitter, and helps with analysis and discussion of user-created data (Thelwall, 2014). This is why coding and content analysis of tweet information through this thesis was performed manually.

Methods of tweet type comparisons (e.g. retweets vs. original tweets) and the different ways of categorising information contained within the text of a tweet in various occupation movements have been studied within the political context, exemplifying the relevance of content analysis through SNS (Garcia-Albacete & Theocharis, 2014). When analysing information shared through social media platforms, there is also the option of cross validating with various other online sources or functions. Whilst the text within a tweet may not provide enough information for categorisation, there is the option of analysing linked-to Websites to overcome this potential flaw in the research design (Kass-Hout & Alhinnawi, 2013). The quality of disseminated information can thus be taken into account when analysing health information on SNS, with various online programs able to assert or calculate the authoritativeness of linked-to Websites.

Previous research into online users has consistently collected information such as the frequency and volume of posting, text of messages disseminated, usernames, further personal information (e.g. occupation) and interactions of participants with information dependent on the SNS platform (Graham & Wright, 2014). Researchers have found that automated programs may not find certain pieces of user-related information, such as the geographical location of a user. Thus the use of manual methods of scanning available data (e.g. user profiles and descriptions) will increase the completeness of datasets and the validity of research undertaken and provide a more accurate representation of Twitter users and communities. With regards to qualitative-based research of SNS platforms, the most commonly used approaches involved collecting data from people through interviews, surveys and focus groups (Snelson, 2016). The surveys used in such studies were found to be predominantly quantitative, though in some cases with the introduction of open-ended questions the research design changed to a mixed methods form

(Van Zoonen, Vis, & Mihelj, 2011). Content analysis was the most commonly used approach to analyse such mixed-method studies, with themes identified in the content being a popular approach, and a sequential explanatory design (i.e. quantitative analysis followed by qualitative analysis) has been used similarly to that of Debatin, Lovejoy, Horn, & Hughes (2009) to deepen understanding of survey results of privacy perceptions of such platforms.

The systematic review by Zimmer and Proferes (2014) also found that most previous studies collected datasets of over 100,000 tweets, which was taken into consideration when performing analysis of the public health case studies. Suggested methods of hashtag data collection and approaches to event detection on Twitter have been to analyse the volume, retweets, and Weblinks of hashtag-related tweets. Whilst many studies chose to capture tweets within certain date parameters using Application Programming Interface (API) and online aggregators, hashtag filtering has been found to have the potential to uncover issues relevant to a global community (i.e. not just local samples) during real-life public health events and thus will be used to better collect relevant data. As referenced in the literature review, mapping trends and event detection through social media data has been explored in a multitude of disciplines. Collecting data from SNS will contain a higher level of noise to signal ratio than edited online texts. Hashtags have been found to be an effective method of filtering conversation to a specific topic without ruining the integrity of the data, and are therefore used to capture event information more relevant to the context of the topic of study (Jungherr & Jurgens, 2014).

3.2 Methods used for Chapters 4 to 7

These chapters involve research based around the collection of organisational account-related data from Twitter. For data mining purposes, a manual approach was adopted after determining that automated mining programs did not provide the necessary functionalities for the purposes of the publications, such as:

- i) Finding accounts by broad topic area (e.g. health)
- ii) Identifying automatically if an account was health-related
- iii) Categorising if an account was associated with an organisation or with an individual user, and classifying this account accordingly
- iv) Distinguishing accounts by origin (i.e. country)

To find health-related organisation accounts on Twitter, a three-step process was utilised. First, a search for relevant accounts was carried out via the Twitter search function via the website (www.twitter.com), using a combination of health-related keywords (e.g. 'health', 'doctor', 'diabetes' etc.). The second step was to identify any relevant Twitter accounts via health-related keywords on the Google search engine (e.g. terms like 'health organisation Australia', 'dementia Australia Twitter' (and similar) would be searched for). The third step involved scanning the Twitter feed and followers of already identified accounts to detect any more relevant users that had not been found with the prior two steps. The collected organisations had to meet a set of pre-defined criteria and parameters for the purpose of this specific work, which was set to ensure a substantive sample of users were collected but also that this dataset was practically feasible to manually analyse within time and resource constraints:

- i) Nationality: Self-declared home location is Australia or is a known or deducible Australian-based user
 - i. Exclusion criteria: Accounts that were organisationally based outside of Australia
- ii) Representativeness: Accounts represent government health bodies or health organisations (with the link to a relevant website provided in account description)
- iii) Content of tweets: Accounts must have at least one health-related tweet or provide links to health articles
- iv) Activity: Accounts are currently active, as we defined as having tweeted in the month of February 2012
 - i. Exclusion criteria: Accounts that were considered inactive, that is not having tweets in February 2012
- v) Number of followers: The number of Twitter followers for any given account was set to a minimum of 150

When all relevant (and possible) accounts were collected, all tweets disseminated by these accounts during the month of February 2012 were manually analysed and categorised according to:

- i) Health condition or area (if the tweet was health-related) for example, condition-specific tweets about 'skin cancer advice' and 'breast cancer research' were categorised under the umbrella health condition area of 'cancer'
- ii) Type of information regardless of health-related or non-health related tweet, for example, tweets about 'skin cancer advice' were categorised as 'public health advice'

and tweets about 'breast cancer research' were categorised as 'research and project' type

Any hyperlinks present in tweets were followed to their source, with subsequent categorisation being based on the content contained on the linked-to page. In addition, tweets were also categorised according to the way they were disseminated on Twitter (i.e. retweets and mentions). Manual methods of tweet categorisation were also chosen due to analytics tools identified not having the capabilities of categorising tweets into complex concepts for the purposes of this work (e.g. 'public health advice', 'children-related', 'infectious diseases-related', 'fundraising', 'organisational news', 'advertising', etc.). Categories of health conditions were created from the prominent area being conveyed through the tweet, whereas categories of the type of information were coded with regard to the delivery/tone of the tweet. For example, the tweet "#HeartMyth Being active means high-intensity exercise #HeartFact Just walking for 30 mins a day can cut #heartdisease risk by 50%" would be categorised as disseminating "heart" health-related information and due to its delivery would be "public health advice" type of tweet. In general, Twitter analytics tools cannot provide analysis of tweet content based on concepts and semantics within the text of tweets. These analytics tools also did not contain capabilities to examine in-depth the Web pages linked-to by hyperlinks present in tweets, hence further necessitating the manual approach adopted. All data collected was inputted into Microsoft Excel and analysed using the statistics program SPSS v22.0.

3.3 Methods used for Chapter 8

Due to the research in this thesis surrounding limited and non-user groups of SNS, the methodology of the work in Chapter 8 differs from the other chapters that involve Twitter-based data collection.

To recruit voluntary participants, this research was advertised through several mediums (e.g. local newspapers, local radio, magazines, senior clubs, Senior Card mailing lists). There were 230 individuals who initially responded to these advertisements. These individuals were given further screening via a telephone interview that asked relevant questions about general demographics and living arrangements, computer literacy/access, current Internet and social technology use, type of impairment (i.e. vision or hearing) as well as current perceived level of isolation. After this screening process, 150 participants who met the inclusion criteria (i.e. 55 and over, indicating high levels of isolation, no or low level of existing use of social technologies, access to a computer with Internet) were selected to take part in this project. 127 of the recruited participants were from the Sydney metropolitan area, whilst 12 participants were based in Port Macquarie and the remaining 11 from north Lake Macquarie. Consent forms were mailed out to participants detailing the background, purpose and process of the research project, training sessions, and data collection. All participants participating in this research project had given consent through these forms.

Training sessions were held between June and August 2012 with each participant undergoing similar training via two three-hour sessions held a week apart. The first session focused on

Twitter and Skype and the second focused on Facebook (which was allocated more time due to the larger amount of settings and functions when compared to the other two social media technologies). The sample of 150 individuals was divided into groups of approximately 10 people for these training purposes due to room size and participant availability. These training sessions were administered in various locations (according to where participants were based):

- i) Sydney-based training sessions were held at (and run by) the Australian Seniors Computer Clubs Association (ASCCA) based in Town Hall
- ii) Port Macquarie-based training sessions were held at the Port Macquarie-Hastings Library in Port Macquarie
- iii) North Lake Macquarie-based training sessions were held at the Westlakes Seniors Computer Club in Lake Macquarie

Prior to the commencement of each training session, all participants were administered questionnaires (attached in Appendix A of this thesis) that included questions about demographics, experiences with technology and social media, as well as experiences in relation to real-life social networks and quality of life. Also administered to participants were relevant guides/notes to assist with each training session. Participants were given the opportunity and assistance to sign up with these social media technologies after a brief introduction and demonstration of how they worked. The rest of the session was spent going through basic characteristics, functions and setting of each application. Seven groups were comprised of between 3 to 7 participants who had indicated that they would like to participate in initial focus groups that were carried out at the conclusion of their 2nd (and final) training session. These participants had consented to be audio-recorded when filling out consent forms, and this was re-

iterated again prior to the focus group recording. The semi-structured focus groups asked open questions such as: experiences with the social technologies, aspects of these applications and perceived benefits, and conversations were facilitated by the interviewer to keep in-line with the discussion topics. The interview guide can be found in Appendix B of this thesis.

After the conclusion of the final training session, there was a six-month period (August 2012 – January 2013) in which participants were given the opportunity to voluntarily use the technologies learnt if they so wished. Technical support was also available through assistance from ASCCA in relation to computer or online issues encountered. At the commencement of this trial period, participants were contacted via email that follow-up data collection was to occur. Post-questionnaires (with reply paid envelopes) were mailed to those who had not participated in initial focus groups. All post-questionnaires were identical to pre-questionnaires however they also included questions on experiences of these social media technologies during the trial period. Those in initial focus groups were contacted to organise session times in which they were to both complete a post-questionnaire as well as partake in a follow-up one-hour focus group. At the commencement of the research project, 110 participants completed the final questionnaire with data from this questionnaire (73% return rate), with retrieved data from these questionnaires entered into Excel and analysed using SPSS. Free-text and worded responses were entered into Microsoft Excel spreadsheets separately to quantitative data, whilst audio data from the pre and post focus groups were transcribed. Recurring themes were identified through open coding of qualitative data, and these themes were reviewed and defined to avoid repetitive overlap.

It should be noted that for the purpose of this chapter, the collected qualitative data was analysed specifically around items surrounding the issues of privacy. Responses to some survey questions regarding offline connections and real-life experiences/interactions were not reported as they are unrelated to the aims of this chapter which explores why certain groups made minimal to no use of SNS and address the consequences and concerns surrounding these levels of use. Whilst the survey also collected quantitative data relevant to offline health behaviours for a multi-purpose research project, the aim of this chapter was not to explore changes to offline behaviours (e.g. changes in social isolation or quality of life). Rather it addresses identified gaps in the literature of why groups such as older adults make minimal to no use of SNS platforms in light of perceived benefits to such groups in a health context. Uncovering these key issues further assists in uncovering one area of the multi-faceted landscape of Health 2.0.

All necessary ethics clearances for the study were obtained from the University of Sydney Human Research Ethics Committee, Protocol Number: 12431 (Appendix C). In addition, the participant consent form has been attached in Appendix D.

3.4 Methods used for Chapters 9 & 10

The methodology of capturing Twitter data in the final two publication chapters differ from initial methodology present in Chapters 4 to 7, due to the research requiring the primary collection of tweet data rather than collecting account data. As such it was deemed appropriate to utilise an automatic mining program that could collect specific historical data with set parameters. From the literature review, the use of hashtags for self-filtering data collection was

identified as a feasible method for the following research. After searching online for potential options, the online program tool Hashtracking (www.hashtracking.com) was utilised to mine hashtag-specific historical data from Twitter. The web-based program allows for customers to collect, track, save and export hashtags found throughout Twitter over an indefinite amount of time.

Hashtracking captures real-time data by collecting tweets containing specific hashtags, which in the case of the following studies was set to #worldhealthday (campaign) and #Zika (outbreak). For data relating to the study of World Health Day (April 7th 2014), data collection was carried out over the course of a few days, commencing at midday on April 6th 2014, and ending at midday on the 9th of April 2014. Data pertaining to the Zika Virus Public Health Emergency of International Concern (PHEIC) announcement was collected for one week, starting from the commencement of the day of the announcement (1st February 2016 at 00:00 GMT) and concluding on the 7th February 2016 (23:59 GMT). Hashtracking provided basic report generation, as well as the ability to export the collected data, which was analysed using Microsoft Excel and SPSS. This data was analysed in terms of temporal distribution, numbers of tweets, levels of engagement, account participation, account reach, numbers of participants, retweeting behaviours and frequency, amongst a number of other characteristics. The process of data collection was automatic and self-filtering, with spam filtering set to the highest level to avoid unnecessary tweets from being included in the final analysis.

Further to this, a random sample of tweets was collected in the #Zika outbreak study for deeper semantic and content analysis of the users and tweets. To determine the appropriate sample size

of tweets required to analyse to significantly reflect the population, a sample size calculator was utilised (<https://www.surveysystem.com/sscalc.htm>). By setting the confidence level at 95% and using a standard confidence interval of ± 3 , a significant sample size of tweets was set for this study, and that sample size was applied to the week-long collection of tweets in which a random sample was pulled from. The collected tweets and related Twitter users were retrospectively collated and exported to Excel and SPSS programs for further analysis, with the Twitter profiles of the users who being manually mined for further information (e.g. demographics, user type). Further details of the processes in this methodology are detailed in Chapter 10.

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Chapter 4. Social Media's Role in the Changing Model of Health Information

Dissemination: A Review

4.1 Foreword

Prior to analysing big data mined from SNS, the question arises as to how social media has established itself as being one of the largest current platforms of online information dissemination. The context, methods and media through which health information is disseminated have evolved drastically over the previous few decades. Prior to the Internet, information was primarily disseminated to people via means of traditional mass media, for example by print (i.e. newspapers, posters/pamphlets) or broadcast (i.e. radio, television). With the invention of the Internet in the 1980's and the establishment of the user-friendly World Wide Web in 1990, a non-traditional system of easily accessible information through digital websites and hyperlinks was available. This shifted the flow of information, whereby previously information was directly delivered to people, users were now able to seek and readily access information through these systems. Whilst the shift to an online medium provided a foundation in which information flowed freely between a variety of different entities, these still involved static Web pages and hyperlinks with little social or human-based levels of interactions.

Technical literacy within societies grew as more individuals, communities and organisations became familiar with the use of the Internet/World Wide Web. In addition to this, the increase of access to information and public health initiatives led to increasing levels of health literacy amongst populations. Further advancements in online-based communication methods

contributed to the development and proliferation of more social-based interactive information communication sites to supplement various users, resulting in the phenomenon that is currently known as social media. All these factors have directed to the current model of health information dissemination (i.e. Health 2.0), and provide the basis for potential research in the areas of health and communication. Chapter 4 examines this evolution of health information dissemination and the roles of the entities through the previous few decades, as well as provide models to illustrate these changes over time.

The following chapter is derived from the publication: Dumbrell, D., & Steele, R. (2013). The changing nature of health information dissemination through the role of social media. In *Applied Mechanics and Materials* (Vol. 411, pp. 110-114). Trans Tech Publications.

4.2 Abstract

Traditional forms of health information dissemination have previously involved a few key organisations originating health-related information and disseminating this to clinicians and the community. This information was typically disseminated via private, formalised and non-digital (offline) interactions between health information sources (HISs) and clinicians and consumers. With the development of the Internet, health information dissemination began to occur via an online medium, leading to changes with greater availability of Web-based health information. With widespread uptake of the Internet by worldwide users, this has led to many virtual communities and networks for information creation and sharing, or what is now referred to as social media. The recent mass adoption of social media has led to many more parties, both

organisations of varying types, and individuals, participating in public health information dissemination. This has also led to new forms of sharing health-related information and the transformation of interactions within and between relevant entities, particularly involving a greater role for individuals. In this paper we review how organisations and individuals are now using social media for sharing health information, and from this suggest various models to describe the interactional changes from traditional to contemporary health information dissemination, as well as the new emerging roles and forms of interaction for health information dissemination. In addition, we also address the various issues that arise with these changing models.

4.3 Introduction

The nature of health information creation, dissemination and sharing has changed substantially in recent years. Traditionally, there has been a range of offline media by which health information has been disseminated in the pre-Internet era: from physical means such as billboards, print advertisements and writings; to public service announcements and mass broadcast media (such as health campaigns delivered via television). Advances in technologies have expanded the ways in which information can be created and shared, as modern day Internet-based approaches now see health information being driven by the Web (Berland et al., 2001) and now additionally by social media systems (Steele & Dumbrell, 2012). The Web has already created a medium in which a greater number of organisations can upload and share relevant health information, and also impacted consumers and patients via their engagement with such a pool of accessible health-related information and entities.

More recently, social media has provided a new way in which health information can be disseminated and shared (Scanfeld, Scanfeld, & Larson, 2010). The use of social media from an organisational perspective has transformed health information dissemination from distribution by a few centralised and large distributors to sharing and originating information from organisations of varying types and sizes. Social media also provides a foundation that significantly increases the role of individuals in relation to dissemination and sharing of health information. In this way, health information dissemination has become more interactive and digitally-based – with both organisations and individuals able to create, share and pass evaluation/judgement on relevant health-related information and Web documents.

The purpose of this paper is to analyse and review the various changes to the nature of health information dissemination due to the characteristics of social media, such as: peer-to-peer communication, information evaluation, and the ability to create self-organising dissemination networks. This paper will also introduce a model to examine how organisations and individuals are currently using social media for health and public health information dissemination, as well as introduce and compare previous and emerging models of health information retrieval and dissemination involving these entities and their evolving/adapting roles due to the emerging forms of communication technologies.

4.4 Traditional Offline Health Information Dissemination

Prior to the Internet and Web, health information dissemination involved very few key entities and a more limited number of interactions. Key, large sources and distributors (such as health

bodies and public health organisations, typically within government or government agencies) had the role of creating, publishing and disseminating this information. Figure 4.1 illustrates the roles of such health information sources (HISs), clinicians, and individual health information consumers. As can be seen, there were relatively simple and more stratified interactions between such entities. Health information usually flowed in one direction from key HISs bodies or organisations that would generate this information, outwards to relevant receiving parties. These relevant parties, particularly clinicians, would utilise this information and share this with individuals (e.g. patients) who consulted with them. HISs may in some cases have passed health information to individuals directly (e.g. via public health campaigns), and these individuals may have potentially passed this on to others (although the extent of sharing and the subsequent interaction with the information could not be easily measured). The sizes of HISs and the patient-base of various clinicians varied, and thus determined the number of health consumers they would each reach with this information.

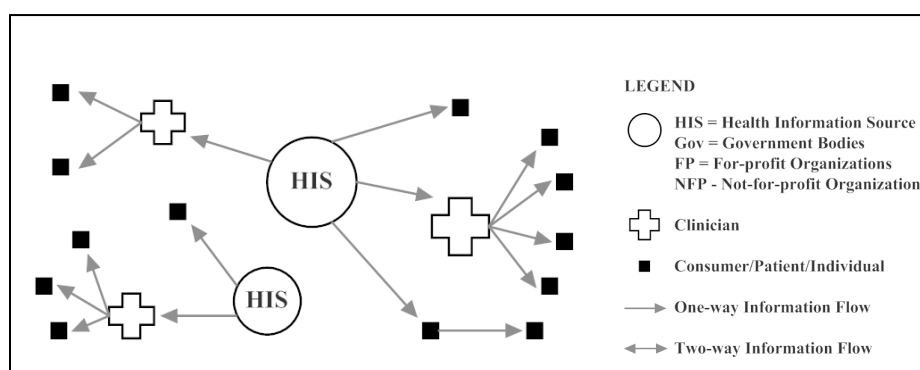


Figure 4.1 Health information dissemination and retrieval prior to the Internet

In this offline model of health information dissemination there have been found to be social barriers to access (Dobransky & Hargittai, 2011). It has been identified that there have been

many other barriers to health information access in this pre-Internet era such as cost, geographic location and literacy (Eng et al., 1998). Hence this is why information technologies, such as the Internet, are a suggested medium for promoting health and preventing disease. It was also indicated that mass media (such as television and newspapers) were probably more cost-effective and appealing to those who could not or cannot or do not wish to attend face-to-face clinics.

In this pre-Internet era, the medium by which health information was communicated was non-digital (i.e. word-of-mouth, print, posters/billboards, radio and television). Widespread health information was disseminated via strategies such as mass media programs and national campaigns. One of the most common forms of campaign was in relation to smoking cessation. Researchers found that whilst print (self-help manuals) were the least effective for cessation, with the introduction of mass media this became more effective (Flay, 1987). In addition, with the further introduction of social support (such as help groups) alongside mass media, smoking cessation was found to be more successful.

Another study also found that whilst AIDS-related health information was successfully delivered to large proportions of a sample in India (mostly via television), only a smaller proportion of the sample had discussed this information with offline social support (Chatterjee, 1999). However, despite these low levels, an increased exposure to relevant information led to an increased likelihood of consumers to discuss this with their offline social networks.

Various models had been suggested in this pre-Internet era for successful health information dissemination leading to actual and positive behaviour changes. Flay, DiTecco and Schlegel (1980) found that the most important aspects of health promotion by HISs were by:

“presentation and repetition over long time periods, via multiple sources, at different times (including “prime” or high-exposure times), by multiple sources, in novel and involving ways, with appeals to multiple motives, development of social support, and provisions of appropriate behavioral skills, alternatives, and reinforcement (preferably in ways that get the active participation of the audience)”.

Whilst various HISs have followed similar guidelines to disseminate certain health information, the level of interaction by the consumer is quite simplistic due to them mostly receiving information in a uni-directional manner. Consumer feedback and evaluation can be extremely powerful for health information dissemination, as it has previously been seen that consumer feedback may have prevented ineffective (Capalaces & Starr, 1973), wrongly targeted (Hanneman & McEwen, 1973) or even campaigns that acted to enable/instigate substance abuse (Kinder, 1975). However prior to the flexible communication methods provided by the Internet, consumers would have had to provide feedback by writing and posting letters, attending public forums or using the telephone – all methods that have a higher barrier to communication (i.e. time and cost-ineffectiveness). Therefore, whilst a novel and developing concept, the open platform that social media provides for data to be communicated has changed the way information flows.

More recently, has led to issues such as public health 'scares' due to the misrepresentation and dramatization of health risks by HISs (Bomlitz & Brezis, 2008).

4.5 The Web and Health Information Dissemination

With the introduction of the Web, health information was now made available by more parties, however this information was not “pushed” to consumers. Instead an individual determined the specific type of information sought and this was searched for and retrieved (Cline & Haynes, 2001), typically utilising a search engine. If and when this information was found, it may have been shared with other consumers and individuals – however the extent to which this information was distributed, the type of consumer it reached and the interaction with the information, again has not been readily available. In addition, the interaction between consumers and organisations, consumers with each other, or the consumers with the information found would not have been publicly accessible nor would there be any knowledge of the feedback on the different types of information that were distributed. Figure 4.2 illustrates this previous Web-enabled model of health information dissemination.

In this model of health information dissemination however, individuals are able to become health information creators themselves, and can upload information creating a two-way flow via the Web/Internet (i.e. both sharing and retrieving information). Those sharing or retrieving information (or both) can also pass this along to other individuals, although as with the model in Figure 4.1, the extent of offline sharing could not be easily measured. The number of people finding the information online however can be determined by “hits” on websites, which can be

used to identify the success of specific pieces and types of health information dissemination. In addition, the proliferation of HISs expanded from the previous model to represent the growth of organisations and bodies with a Web-presence generating or providing information. This can be attributed to both the greater ease of use of this medium for organisations and individuals to become information providers, and the medium's popularity with the public for the retrieving of detailed information at-call.

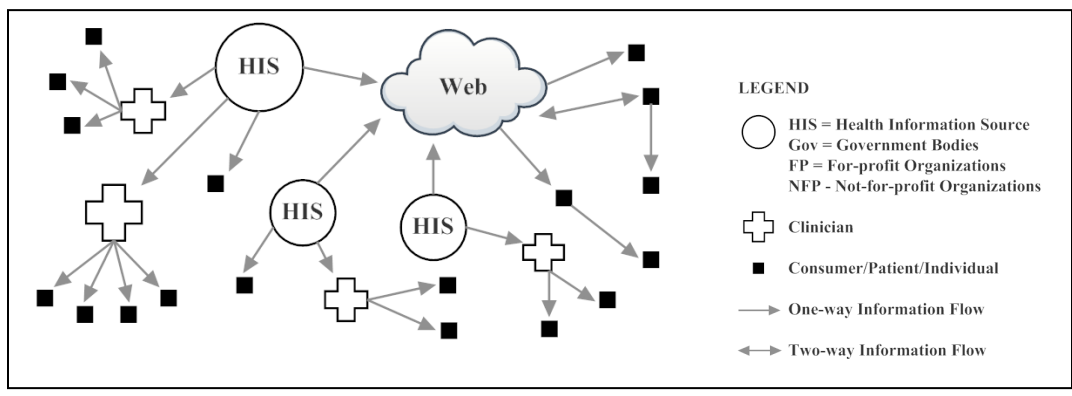


Figure 4.2 Health information dissemination and retrieval prior to Social Media

However it has been found that online health information retrieval via these methods (i.e. search engines) may not be as successful due to various factors. One of these major factors is the retrieval method by consumers, and the type of terminology used when searching for health information. A previous study has found that there are significant mismatches between the consumer terminology and the terminology of the health information that consumers searched with (Zeng, Kogan, Ash, Greenes, & Boxwala, 2002). Berland et al. (2001) in addition found that using simple search terms to look for health information was not efficient, as less than one quarter of links led to relevant content on a search engine's initial page. Another study also found

similar sub-optimal results with consumer search techniques (Eysenbach & Kohler, 2002), however when assessing the quality of the information provided the participants responded that the information source was important. The introduction of query recommendations has been shown to significantly improve rates of successful queries and retrieval of health information by consumers (Zeng et al., 2006). This has improved the flow of health information (and success in retrieving this information) from Web sources to the consumer through this medium.

As recently stated, the quality of available digital health information is an issue when taking into account the various sources this medium of the Web introduces. Many previous studies evaluating health information for consumers on the Web have suggested that quality is a problem (in relation to accuracy, completeness, readability, design, disclosures and references) whilst other studies have found quality to not be a problem (Eysenbach, Powell, Kiss, & Sa, 2002). Researchers have also investigated the automatic analysis of Web pages returned from general online searches (Price & Hersh, 1999) and using various instruments and criteria (Charnock, Shepperd, Needham, & Gann, 1999) as some of the few explored methods to judge and retrieve high quality health information. Many of these quality evaluative tools however have unclear findings in relation to reliability and validity (Sheppard, Charnock, & Gann, 1999). There can also be content quality issues on the Internet within information about specific health conditions, with Ahmed, Sullivan, Schneiders and McCrory (2011) finding variability in the standards of concussion-related Web sites. Conversely, previous analysis of breast cancer-related Web sites found that there were no significant differences in content quality between pages with differing rankings (Meric et al., 2002). These studies reflect the responsibilities of the HISs to provide consistent, deliverable, content-relevant and readable information to the public. With the

digitalisation of health information, it has been suggested that health care providers should work to create accurate and thorough online material (Bichakjian et al., 2002). In addition, this reflects the changing relationship between clinicians and health consumers, with clinicians playing a further role to help consumers by having a more active role in recommending and directing them to comprehensive and accurate Web sites. The proliferation of health-related Web sites also reflects the need for clinicians to assess themselves and educate others on the accuracy of specific online information.

A study investigating the characteristic differences between online and offline health information consumers found that both groups reported reliance upon health care professionals as a reliable and main source of health information (Cotton & Gupta, 2004). However there has been a change in dynamics in the relationship between the health consumer and the clinician. Whereas once health information flowed one-way from clinicians to individuals (i.e. patients) during face-to-face offline interactions, consumers are now actively seeking out further information from the Internet on their own personal health conditions/concerns (Hu, Bell, Kravitz, & Orrange, 2012). This presents a shift of information flow where the individual brings information retrieved from online community groups and resources to the clinician, which consequently affects the way in which both parties interact with one another face-to-face in a positive way from the consumer's perspective (AlGhamdi & Moussa, 2012). There has been previous research that suggests that more and more individuals are retrieving online health information as initial points of reference, even though it was identified that physicians were the most highly trusted information source to patients (Hesse et al., 2005). It was also found that these individuals rarely used the Internet to communicate with the physician or physician's office, choosing to rather have face-to-face

communication. In addition, the Internet was also ranked as the second most trusted source of health information (after physicians), although there were differences in trust amongst various demographics.

There have also been suggested discrepancies with online users, with aspects such as socio-demographic characteristics and type of health information being searched for determining seeking behaviours of Web documents (Rutten et al., 2012). In addition, Web-based health information dissemination presents new challenges to the consumer. Whilst the Internet is an open platform that a vast majority of the developed world's population may access, there are differences amongst users that determine the type and quality of health information that is being retrieved. For example, technical skills (i.e. computer/Web experience) which were not relevant when retrieving information in offline methods, can determine the quality of information being accessed via the Internet and thus lead to a different type of barrier that is being presented by this medium (Feufel & Stahl, 2012).

Through health dissemination on the Web, one aspect that creates further quality issues is the larger role of interaction by individuals. Using the Internet as a medium for health information source also further increases the number of consumers being able to retrieve and access this information (as shown in Figure 4.2). This has been found to be due to a variety of factors such as: the widespread adoption of the Internet, the generalizable/translatable language used, the anonymity when retrieving sensitive information across age-groups and condition-specific populations (Borzekowski & Rickert, 2001; Mitchell, Ybarra, Korchmaros, & Kosciw, 2013). In addition, health consumers (who previously had very little role with the generation of health

information prior to the Internet) are able to upload their own health information to the Internet and become HISs themselves.

In addition to the changing role of health information dissemination from an offline to an online medium, there also are the ever-changing ways health consumers interact with information they find. As stated previously, through this medium the individual becomes further involved with health information and knowledge management rather than just being fed information from HISs. Previous research by Mager (2012) has shown how the relationship between user information preference and search engine capabilities (i.e. pre-filtering information) have actively shaped and transformed the type of interaction the consumer has with online health information. Not only do online health consumers actively search and retrieve information relevant to their needs – through this method individuals are able to be selective of the type of information they interact with and thereby pass judgment (i.e. evaluation) on Web documents based on perceived quality.

4.6 Social Media and its Impact on the Flow of Health Information

With the introduction of social media, there has been a further increase in the use of information technologies to both deliver and share health information and public health information. From this, a new and emerging model of health information dissemination is introduced (Figure 4.3). The large, key distributors that were previously the main creators and publishers of this information are now accompanied by many other organisations undertaking this role as well. The characteristics of these organisations differ to those previous sources/distributors as they come from various sectors with varying purposes and objectives (e.g. NFP and FP organisations).

These organisations are able to specialize in specific health-related information domains and thus a specific consumer, instead of previously where there were fewer and often-broader HISs distributing health information. In this new medium providing connectedness, various organisations are also able to interact publicly with one another whereas previously this type of communication typically occurred more privately (and did not involve health consumers to such an extent).

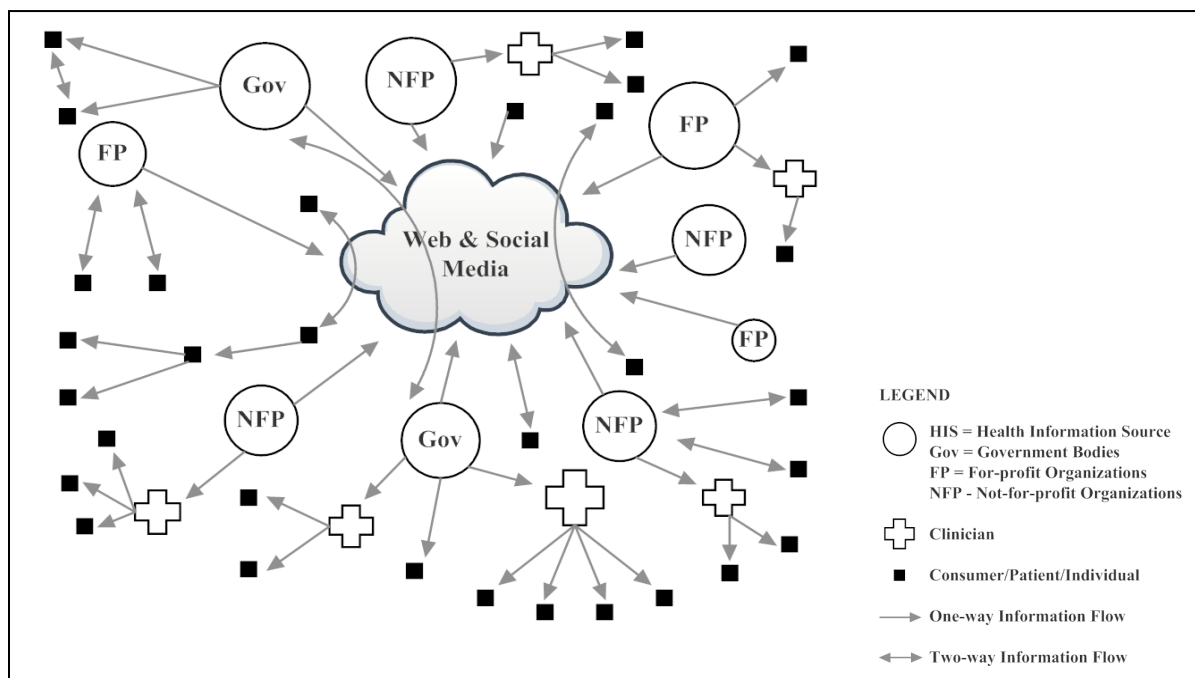


Figure 4.3 Emerging model of health information dissemination and retrieval via Social Media

This period of technology communication has been accompanied by an increase of different groups using the Internet (and social media technologies). For example, more than half of older adults are currently connected to the Internet and more than a third use social media technologies such as Facebook (Zickuhr & Madden, 2012). In addition, these groups that

previously had low interaction with the Internet and Web-based information, or who had been classified as solely consumers, have started to become digital content producers themselves (Waycott et al., 2013). Individuals who were once solely information retrievers can push their own content outwards to the web, for other consumers and HISs to directly or indirectly receive. This presents great opportunities for HISs, for example they can observe the type of information that is being shared (i.e. providing feedback about what type of information they are putting out is being shared). However this also presents certain issues in quality of information, especially with inaccurate health information being shared amongst peers (who may take this information as fact). It has already been observed how misinterpreted, or even false information, can be propagated extremely quickly through these social media due to the sharing ability of such systems (e.g. celebrity death rumors through Twitter), and hence this is one concern that must be addressed.

Whilst there are further relationships and multi-directional flows of information in this complex model of health information dissemination (Figure 4.3), so too is presented the issue of information quality as more and more individuals are able to create, recommend and share their health information. The nature of social media further emphasizes the growing role of the individual with regards to information interaction. However as previously emphasized, the issue of information quality with consumers now acting as HISs. Previous research has examined adoption of these technologies by clinicians, finding that unprofessional content and breaches of patient confidentiality occurred (Muhlen & Machado, 2012). Due to these individual-related issues, future uses of social media with regards to health should have guidelines and quality measures when creating and sharing certain information.

A major change in the nature of public health information dissemination is the growing role of consumers (Chou, Hunt, Beckjord, Moser, & Hesse, 2009). Social media provides an open platform in which these individuals are able to interact with organisations, the information that is being disseminated, as well as with each other. Therefore the information flow in this model between various entities is both a mixture of one and two-directional. Consumers of public health information are able to spread specific information being directly pushed towards them, onwards to other people they are connected with online. By doing so, these individuals create an online network of self-organised information dissemination where relevant health information is shared between consumers who are interested in that specific area of health information. This also increases the range and reach of the health information posted by organisations. Individuals (and organisations alike) can also act as filters of health information by evaluating and passing judgment on Web documents and choose to either pass them on, save them for personal use, do both actions, or neither.

A benefit of using social media applications for health dissemination is that HISs are able to quantitatively assess what type of information is being shared, saved, or simply received. These various types of interactions have the potential to provide feedback to both organisations and key distributors of this public health information, and thus more can be understood in relation to the most effective forms and ways to disseminate this type of information. This model shows a much higher level and frequency of interaction due to the capabilities within social media technologies. The nature of social media also suggests the possibility of the development of future software tools to “optimize” public health information dissemination on a community-

wide basis so that such information is reaching the relevant audience and with sufficient frequency.

An advantage of social media based health information dissemination is a larger reach to a more specific audience. It has been previously seen in public health-related parenting interventions that these forms of delivery (alongside television and written materials) were much preferred by the targeted audience (i.e. parents) when compared to home visits, therapists and group sessions (Metzler, Sanders, Rusby, & Crowley, 2012). Another aspect of social media is that it can create self-organised information dissemination networks between users (Steele & Dumbrell, 2012). This is a process that allows for relevant information reaching targeted individuals/consumers, where: 1) older adult users selectively choose health information sources customized to their health consumer needs; 2) these health information sources create and/or “push” relevant information to these users; 3) the users receiving this information evaluate this information and decide whether or not to pass-along or share this with other peers; 4) these peers receive this information being pushed towards them and may also perform similar actions on this information as well as refer back to the original source (if they are not already subscribed); and 5) health information sources receive feedback on the health information they have pushed out (e.g. characteristics of successfully disseminated information, information type with regards to health-area and delivery). These communities have been seen to contribute to positive health benefits in real-life (Ba & Wang, 2013).

4.7 Conclusion

In this paper we have described how the development of the Web and then social media technologies has changed and is continuing to change the nature of health information dissemination. While originally such information was sourced from fewer and larger organisations and there was more one-way communication, social media is creating a more richly connected, sophisticated, health consumer-centric health communications network, also leading to a greater variety of types of participant organisations and entities.

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Chapter 5. Twitter and Health in the Australian Context: What Types of Information are Health-related Organisations Tweeting?

5.1 Foreword

The previous chapter explains the ways in which health information dissemination has evolved over time. The significance of current SNS provide the foundation for this research, as previous platforms of information dissemination outlined did not contain capabilities and functionalities that allow for such readily available and accessible data collection. Consequently by presenting and publishing these findings, much needed knowledge is added to this novel field of research. Chapter 5 details current research on the state of health information dissemination through the SNS Twitter, focusing on health promotion via social media in an Australian and organisational context.

Prior to the published work contained within this chapter, there had been minimal research conducted that categorised and analysed the types of users and health information present on SNS. Publications in the area of online health focused on non-social aspects of the Internet, for example Web searches and access of information via websites (Jadad & Gagliardi, 1998; Eysenbach & Kohler, 2002, Spink et al., 2004, Law, Mintzes, & Morgan, 2011). Many findings had suggested that the Internet was saturated with health information with many turning to such sources to retrieve information (Wu & Li, 1999; Eysenbach & Kohler, 2003; Eaton, 2012), however whether these findings were reflected by SNS in addition to the types of information being communicated through these platforms were inadequately explored. In addition to this, the

emphasis of existing SNS-based research conducted addressed issues regarding the end-user (i.e. individuals and patients), rather than exploring the sources that were creating and disseminating this health information. Consequently it was decided that the foundation of the framework of this thesis was to explore health promotion through Twitter via a top-down approach, whereby the sources of such communication of information (identified as health-related organisational or government bodies) would initially be explored and analysed. The justification for this was to fill the previously identified gaps in literature by:

- i) Identifying these groups within a specific context
- ii) Capturing a sample that was as substantive and representative as possible
- iii) Collecting the information disseminated by these groups
- iv) Analysing and categorising the types of health and non-health related information contained within these tweets

The following chapter is derived from the publication: Dumbrell, D., & Steele, R. (2013, January). Twitter and health in the Australian context: What types of information are health-related organisations tweeting?. In *Proceedings of the 46th Hawaii International Conference on System Sciences* (pp. 2666-2675). IEEE.

5.2 Abstract

There has been a rapid uptake of the use of online social networking services, and more recently their usage for health-related communication is also being researched and trialled. Twitter, a widely used micro-blogging service, has significant potential for the communication and sharing

of up-to-date health information particularly with health consumers. In this paper a sample of 114 Australian health-related organisations' Twitter accounts were identified, that matched inclusion criteria of a significant number of followers and activity. The 114 accounts' micro-blog postings over a defined period of time were systematically analysed, with a total of over 4,700 tweets retrieved, examined and manually categorised. This work analyses Australian health-related micro-blog usage both in terms of health condition areas and types of micro-blog postings, including explanatory discussion of the outcomes and provides a case study in relation to retweeting of public health advice tweets. The work contributes to the literature by providing insights into the characteristics of community-wide health information dissemination via social media.

5.3 Introduction

Internet-based social networking and social media services have important capabilities that can support their potential utilisation in health communication. As of late 2011 social networking services (SNSs) were accessed by 90% of the 15.7 million Australians currently online (comScore, 2011). SNSs also accounted for the largest share of total online minutes of people using the Internet (20.8%) (comScore, 2011). Further suggesting the role of social networking, characteristics such as one-to-many interaction and their social and engaging aspects (Steele, 2011) make SNSs potentially powerful tools for health-related communication.

Evidence has shown that in recent years, providers of health information and health consumers have increasingly utilised SNSs. In a survey of nearly 23,000 people in the United States, 18% of

respondents said they utilised Twitter, a free social-based micro-blogging site, for health information (National Research Corporation, 2011). Twitter, the widely used micro-blogging application, is currently recording a substantial 1.8 million Unique Australian Visitors (UAV) per month as of April 2012 (Cowling, 2012). These are important statistics to consider as they equate to significant proportions of Australia's total population and highlight the current reach and relevance of social media applications.

Twitter's capabilities include supporting the ability of users to disseminate real-time information, including in some cases, news events before mainstream/traditional media. A non health-related example of this is the response, and subsequent information dissemination, by civilians following terrorist attacks (Cheong & Lee, 2011). Health-related research involving Twitter, such as the systematic examination of sexual health promotion via SNSs (Gold et al., 2011) found that Twitter had lower rates of inactivity in the previous month (14%) when compared to Facebook (22%) and MySpace (79%). These examples evidence the capabilities of instant and up-to-date micro-blog information dissemination. This paper will investigate the role of Twitter as a medium of health information dissemination in Australia, focusing on health-related organisations posting information and the types of and quantity of information being communicated by these organisations.

Various sources and reports have found that the average number of followers for a given Twitter account has fluctuated between 27 and 300 followers (RJMetrics, 2010; Kagan, 2011). The term 'follower' in a Twitter context describes any user that subscribes to another Twitter account. By doing so, that 'follower' will receive real-time tweet updates; which are text-based posts of up to

140 characters long, composed by the accounts they are following. Our work described in this paper involved identifying Twitter accounts of a number of Australian health-related organisations and companies with active Twitter accounts. Accounts were categorised by the nature of the Twitter user and the number of followers that that user currently had. Each individual tweet was also analysed and categorised according to the nature of the health information it contained.

The ultimate purpose of this paper is to describe in detail and provide better understanding of how Twitter is currently being utilised by health-related organisations in Australia. By doing this, insights are gained to better understand the role of social media in health care information dissemination on a community-wide basis. Findings in this paper can also be used in comparison with other national or global health micro-blogging usage findings.

5.4 Background: Twitter and health

The utilisation of social media and Twitter for health communication is relatively new due to Twitter's relatively recent widespread uptake, but the service is anticipated to continue to emerge as one of the most used applications worldwide (Bennett, 2012; Twitter, 2012). Twitter has been explored as a population health-tracking mechanism, where for example researchers tracked public concern during the swine flu pandemic alongside the actual disease activity in the United States (Signorini, Segre, & Polgreen, 2011). The results of the study demonstrated that Twitter traffic could effectively estimate the disease activity of swine flu in the US in real-time; providing up-to-date health information to researchers, authorities, and users of the SNS. Similar

studies were also carried out in relation to the 2010 Haitian cholera outbreak (Chunara, Andrews, & Brownstein, 2012) as well as the analysis of symptoms and medication usage in the US (Paul & Dredze, 2011).

Further research has examined how micro-blogging is used to make health information available to users with specific health interests, including how more sophisticated filtering can allow users to obtain more targeted health condition specific tweets (Steele & Min, 2012). Previous Twitter-related studies have also explored the sharing of information related to specific health conditions such as concussion (Sullivan et al., 2011). This involved analysis of concussion-related tweets to investigate different themes (i.e. 'news', 'sharing personal situation' and 'inferred management') and where this concussion-related information has been disseminated. Epilepsy-related information dissemination via Twitter has also been studied (Mcneil, Gordon, & Brna, 2011) where researchers analysed and coded tweets into specific categories to describe the type of epilepsy-related information that was being tweeted. These studies demonstrated that accurate health information could be disseminated via Twitter, but also found a minority of tweets sampled were actually informative.

A previous cross-sectional study of SNS use amongst the Society for Assisted Reproductive Technology (SART) members highlighted the growing influence of social media in relation to health-related issues and communication (Omurtag, Jimenez, Ratts, Odem, & Cooper, 2012). Various clinics within the organisation had their online websites evaluated and it was found that social networking was mainly used by health-related bodies to provide information to consumers (31% of the time), rather than consumers asking for information (5% of the time). However, they

also demonstrated that in addition to providing health information, SNS included many other types of information such as advertising (28%), support (19%) and irrelevant chatter (17%). Other research articles have examined Twitter and smoking cessation (Prochaska, Penchmann, Kim, & Leonhardt, 2011) or Twitter and dental pain (Heavilin, Gerbert, Page, & Gibbs, 2011). While such studies as above have been limited to specific health areas, our work analyses health-related Twitter usage on a nation-wide basis and across all health areas for that region.

As such this paper looks to provide new insights into how Twitter is being used for health information dissemination on a community-wide basis including sectoral differences and to provide a snapshot of a nationwide use of Twitter by health organisations. This provides a step to better understand the nature and scale of social media-based health information dissemination.

5.5 Methodology

5.5.1 Identifying relevant twitter accounts

A manual approach to identifying and categorising health-related accounts and tweets was adopted and necessitated for the following reasons. After considering various Twitter analytics tools such as Twitonomy, TweetVolume, TweetStats amongst others, it was established that they did not provide the necessary functionality for region-wide, domain-wide or “tweet meaning”-based data capture and categorisation. For example, available tools do not have functionality to:

- Find accounts by broad topic area (e.g. health)
- Identify automatically if an account was health-related

- Categorise if an account was associated with an organisation or with an individual user
- Distinguish accounts by sectoral origin

These tasks were essential aspects in the identification and subsequent data collection process for this research work - therefore the manual approach described below was required and adopted.

Relevant accounts were found via a three-step process. First we conducted a search for accounts through the Twitter website (www.twitter.com) search function with a combination of health-related keywords such as 'health', 'doctor', 'cancer' etc. to find relevant Twitter accounts meeting the criteria we defined in Table 5.1. Second, further Twitter accounts were identified via searches of more specific health-related keywords using a combination of Twitter and the search engine Google (www.google.com). For example if dementia accounts were identified on Twitter but were not Australian, the term 'dementia Australia Twitter' (and similar) would be searched for. Third, the Twitter feeds and followers of the identified accounts were examined to uncover further relevant users, who were then also selected to be part of the study if they met the study inclusion criteria.

Table 5.1 Inclusion criteria

Inclusion Criteria	Definition
Nationality	Self declared home location is Australia or is a known or deducible Australian-based user
Representativeness	Accounts represent government health bodies or health organisations (with the link to a relevant website provided in account description)
Content of tweets	Accounts must have at least one health-related tweet or provide links to health articles
Activity	Accounts are currently active, as we defined as having tweeted in the month of February 2012
Number of followers	The number of Twitter followers for any given account was set to a minimum of 150

Twitter accounts that represented health bodies, organisations or companies in Australia were included if they met the inclusion criteria (Table 5.1). According to the criteria, the identified accounts should have 150 or more followers and were required to be currently active, which we defined as having tweeted in the month of February 2012, as inactive accounts on Twitter are not automatically deactivated. Excluded were accounts that were considered inactive, that is not having most recently tweeted in the previous month (February 2012), as well as accounts of individual users and accounts of organisations outside of Australia. The study identified and compiled a substantive sample of the current health-related organisational Twitter users meeting

these criteria in Australia. This specified manual identification approach and process was chosen, given the challenges of identifying Twitter accounts via the Twitter search function (Section 5.7).

This process identified 114 accounts that were subsequently categorised according to sector: government, for-profit (FP) and not-for-profit (NFP). All February 2012 individual tweets from these 114 identified accounts were then also manually analysed and categorised based on health condition areas (Table 5.2) and the type of tweet (Table 5.3).

5.5.2 Examining individual tweets

Each of the 114 account's details and health-specific tweets from February 2012 were thoroughly read and categorised according to:

- The health-related condition or area being tweeted in a given tweet (Table 5.2)
- The general type of information being tweeted in a given tweet, regardless of specific health condition/area (Table 5.3)
- For any tweet that contained a hyperlink, this hyperlink was followed and the indicated page examined, and the subsequent categorisation was based on the tweet's content and the content of the linked-to page.
- Also included in the categorisation of a given tweet were all of its retweets and replies, if any, so that conversational aspects were also taken into consideration.

Individual tweets were grouped and generalized according to similarities for specific health-related conditions and type of tweet identified. The first form of categorisation undertaken was

in relation to health condition area - for example, condition-specific tweets about 'skin cancer advice' and 'breast cancer research' were categorised under the umbrella health condition area of 'cancer' (see Table 5.2). To provide another dimensional view of the collected data, health-related tweets were also categorised according to the type of tweet (independent of health condition area that the tweet pertained to). Referring to the above example, tweets about 'skin cancer advice' were categorised as 'public health advice' and tweets about 'breast cancer research' were categorised as 'research and project' type tweets (see Table 5.3).

For this aspect of the methodology we also identified that current Twitter analytics tools did not provide the capabilities of categorising based on any complex concepts such as 'public health advice', 'children-related', 'infectious diseases-related', 'fundraising', 'organisational news' or 'advertising' to name a few. As such, manual categorisation by a researcher (as was utilised in this work's methodology) was required. In general, current Twitter analytics tools cannot provide analysis of tweet content based on concepts and semantics within the text of tweets. These analytics tools also did not contain capabilities to examine the Web pages linked-to by hyperlinks present in tweets, hence further necessitating the manual approach adopted.

5.6 Twitter accounts by sector

There were 114 identified Twitter accounts that fit our inclusion criteria included for analysis. The total number of users following all identified accounts totalled to 207,993, which meant the average number of followers per account was approximately 1,825. Neither the uniqueness nor the nationality of each follower was investigated, so Twitter users following multiple accounts

were potentially not excluded from the identification process. The total number of tweets of all 114 accounts was 95,819 and the average number of total tweets per account was 841. From the Twitter feeds of these accounts, 4,787 tweets from the month of February 2012 were identified, and this was the set of tweets we analysed and categorised based on health condition (Table 5.2) and tweet types (Table 5.3) for this study.

It was generally found that in most cases health information was given out as Website hyperlinks to relevant sources (i.e. media releases, reports, blogs, official web sites, etc.). Hyperlinks were working and valid at time of checking, with an exception of 0.5% of tweets providing links that were either broken or in a foreign language. Tweets that did not provide any health information were classified under the 'non health-related' category. Non health-related tweets were categorised similarly to the Pear Analytics study (Pear Analytics, 2009), falling under sub-categories such as:

- Conversational; for example tweets that simply thanked other users for retweeting information or communication about non health-related issues (e.g. the weather) were identified as under this category.
- Any news or development that was not obviously health-related (e.g. building a new apartment).

The Twitter accounts themselves were categorised (and analysed) accordingly into three different sector categories that represented the type of user behind the actual account: government bodies, for-profit (FP) organisations and not-for-profit (NFP) organisations.

5.6.1 Government body accounts

Twitter accounts that were identified as belonging under the category of government bodies were those whose Twitter description provided a Web link to their corresponding governmental site (i.e. ending with .gov.au). In total there were 16 government Twitter accounts meeting the inclusion criteria identified. These accounts had a range of 506 to 6660 followers, and a 2,347-follower average for this category, the highest average number for the three sectors.

On average, Government Twitter accounts had approximately half the total tweeting activity when compared to all 114 accounts in the sample, with an average of 448 total tweets per government account compared to the sample average of 841 total tweets per account. In the month of February 2012 only 417 (or 8.7%) of total tweets from our sample, came from government Twitter accounts. This was equivalent to an average of 26 tweets per government account, which was far less than the average number of tweets from all the accounts analysed (the sample average number of tweets being 42). Although there were a smaller average number of tweets, when compared to the accounts sampled, government accounts disseminated less non-health related information with only a total of 28 non-health related tweets found from government Twitter feeds in February 2012.

5.6.2 For-profit organisation accounts

27 Twitter accounts were identified under this category representing FP health-related organisations associated with and currently operating within Australia. With an average of 953

total tweets per account, this category had a larger average number of tweets than the sample average, with approximately 100 more total tweets per account in this category than the total sample average. However, despite tweeting twice as much on average in comparison to government accounts during the month of February (with 52 tweets per account) this category was identified to have the lowest number of average followers, with a mean of 1,153. The FP organisations identified also had a smaller minimum (180) and maximum (4,858) number of followers than the government accounts.

The reason for the low average number of followers when compared to the other sectors may be explained by the study by Sillence, Briggs, Harris and Fishwick (2004). The participants of the study were more likely to reject sites they considered promotional or sales-based; that is, the idea that consumers least trusted organisation-run sites that contained large amounts of commercial self-promotion. In our study, only 3.5% of tweets of health-related, FP organisation accounts in the month of February were considered promotional or selling-related tweets, but this was still the largest proportion of this tweet type within any sector category. This may potentially be why FP Twitter accounts have a lower average number of followers.

5.6.3 Not-for-profit organisation accounts

There were 71 Twitter accounts identified in the search representing NFP health-related organisations within Australia that met our inclusion criteria, representing nearly two-thirds of the 114 identified health-related organisational accounts. This sector had a much higher average following than their FP counterparts, with 1,975 average followers per account. Due to the large

number of Twitter accounts within this category, there was both a large range between the minimum and maximum number of total tweets (28 to 6,021) and total followers (166 to 25,117). In the month of February 2012, tweeting activity was nearly identical to the sample average, with a 42 (rounded) average per NFP account.

As mentioned, the Twitter accounts of the NFP organisations accounted for a majority of the sampled tweets, with 2,956 tweets during February. One of the reasons for the large amount of activity was that NFP Twitter accounts contained far more fundraising and condition awareness-related tweets (e.g. Teal Ribbon Day for Ovarian Cancer awareness) than for any other sector, with 30.8% of all NFP tweets in February coming from these areas. This was an anticipated result, as NFP organisations are typically constantly involved with fundraising, donations and charities for specific conditions and target groups. Specifically, the number of tweets for NFP fundraising (361 or 12.2%) was also substantially larger, especially when compared to government bodies (4 tweets or 0.08%) and FP accounts (23 tweets or 0.48%).

5.7 Categorising individual tweets

In 5.7.1 we describe categorisation of the sample of tweets based on health-related condition areas (Table 5.2), and in 5.7.2 we described categorisation based on tweet types (Table 5.3). Note, the data from both tables come from the same set of health-related tweets from the 114 identified accounts, but the tables provide complementary views of the sampled tweets. Also note, both tables do not include the 997 non-health related tweets that were identified and

categorised during analysis (the total number of tweets for both tables comes to 3,790 instead of the total sample number of 4,787).

5.7.1 Health conditions and health-related areas

Analysis of the sample found a distribution of Twitter health-related activity across a range of conditions. Table 5.2 summarizes the top 28 health-related conditions and areas that were tweeted in February 2012. The top 28 health-related areas accounted for 3,790 (79.1%) of total tweets in February 2012. The number of tweets in each category ranged from a minimum of 3 to a maximum of 2,157 over the identified health-related areas.

The area with the highest number of tweets (accounting for 56.9% of health-related activity) contained non-condition specific health information, for example the progress of the federal health reform or developments in the pharmaceutical sector that did not specify a certain condition. In absolute numbers there were 2,157 identified tweets from the sample that dealt with such health information in a general sense, rather than related to a specific health condition.

When considering the absolute number of tweets, it can be seen that the government accounts contributed the least towards health-related Twitter activity. Compared to their total of 417 tweets in February 2012, however government accounts actually contributed the most in proportion of health-related tweets to the amount tweeted with 93.0% (or 388) of government tweets identified in the most common health-related areas.

There is a substantial variation in the proportion of tweets for a given condition area coming from different organisation sector categories. For example, FP organisation tweets are dominant in the maternity, pharmaceutical and dental areas whilst NFP tweets are dominant in cancer, disability, indigenous (general), mental, kidney/renal, osteoporosis/arthritis, vaccine and vision health areas. These variations in tweets may be explained by the reason that some of the areas FP accounts provide a majority of tweets for may potentially be health-related areas that have larger amounts of commercialism or potential profits to be made, such as selling pharmaceutical products, or advertising dental as extra added costs on health insurance. Conversely, this may also reflect the issue that NFP accounts deal with health condition areas that usually have funding from the government or require fundraising (e.g. cancer, disability). Government accounts were more proportionally dominant in the areas of infectious diseases and organ donation.

Table 5.2 Summary of health-related areas tweeted

Health-related areas	Organisation tweets			
	Gov	FP	NFP	Total
Addictive substances	16	26	47	89
Allergies	0	3	2	5
Cancer	5	54	145	204
Children	0	8	5	13
Dental	3	20	8	31
Diabetes	4	9	61	74
Disability	0	0	49	49
Elderly	1	11	6	18
Gender	1	1	3	5
Male	0	3	0	3

Health-related areas	Organisation tweets			
	Gov	FP	NFP	Total
Female				
Heart	1	23	27	51
Indigenous (general)	1	7	79	87
Infectious diseases	12	11	9	32
Injury	3	12	1	16
Lifestyle				
Fitness	15	15	10	40
Nutrition	45	91	87	223
Maternity	3	30	7	40
Mental health	29	69	218	316
Neurology / Geneology	0	7	10	17
Non-condition specific	231	571	1,355	2,157
Obesity	0	9	10	19
Organ donation	14	5	12	31
Osteoporosis / arthritis	0	1	22	23
Pharmaceutical	1	48	10	59
Renal / Kidney	0	1	20	21
Respiratory	0	1	6	7
Sexual	2	12	26	40
Sleep-related health	0	8	9	17
Vaccine	1	14	66	81
Vision	0	1	21	22
Total	388	1,071	2,331	3,790

While it should also be noted that most major condition areas are present to some extent in the Twitter activity, the proportions were somewhat surprising. There were a relatively small

number of tweets for some widespread and significant conditions or health-related areas affecting Australia. The National Health Priority Areas (NHPAs) initiative by the Australian government has identified health conditions and areas contributing significantly to the morbidity and mortality rates of the population. Asthma, arthritis and musculoskeletal conditions, injury prevention and control and obesity are four of the eight current NHPAs (Australian Institute of Health and Welfare, 2011) that are under-represented in the identified sample of tweets. Asthma and respiratory disorders ranked as the lowest Twitter communicated NHPA with only seven tweets found across government bodies and other health-related organisations, whilst arthritis and musculoskeletal conditions, the most active of these under-represented categories included only 23 tweets.

Obesity, being a lifestyle disease, is an area that can benefit from the dissemination of quality information via social media, although only 19 obesity-related Tweets were found. However it should be noted that there were a further significant number of tweets in areas that could have a positive bearing on obesity, which was the lifestyle category including fitness and nutrition, with a combined number of 263 tweets. In addition, the results of the Twitter analysis indicate potential opportunities for further obesity-related micro-blogging activity by government and NFP accounts, especially considering the widespread current and future epidemic in Australia.

The four mentioned under-represented NHPAs had a total of 65 identified tweets in February 2012. Combined, these conditions contributed to only 1.7% of health-related tweets. Considering that these areas are considered of national importance, these numbers were notably low especially when compared to the other four of the eight NHPAs: cardiovascular health (51

tweets), diabetes (74), cancer control (204) and mental health-related tweets (316). Tweets in these four NHPAs accounted for approximately one-sixth (17.0%) of the 3,790 health-related tweets identified in February 2012, with NFP organisations contributing more than two-thirds (70.0% or 451 tweets) of the 645 tweets in these areas. In fact, mental health and cancer-related tweets were the most tweeted about health condition-specific areas in the overall sample, with a raw total of 520 tweets (13.7% of all identified health-related tweets in February 2012) between these two health conditions.

An opportunity based around a target group is that of Twitter-based health communication with indigenous users and communities. This category appears to be currently significantly under-represented in health Twitter activity. Tweets about indigenous Australians were both extremely low from government and FP organisations (1 and 7 tweets respectively), however when examining NFP organisations it was found that tweets about indigenous Australians and their health issues averaged at 1.1 per NFP account during the month of February 2012.

5.7.2 Types of tweets

Table 5.3 was compiled from the same sample of tweets collected for the study and analysed for Table 5.2. This table however provides another dimension by separating the identified tweets into the type of health information being provided, as a complement to Table 5.2, which categorised the tweets by health condition.

The table indicates that Twitter is already being well used for public health awareness and public health advice dissemination with 42.3% of health-related tweets in February coming from these two areas. This is an anticipated beneficial function for micro-blog postings. Also of interest is the finding that the greatest absolute numbers of public health (403) and awareness (549) type tweets are from NFP accounts. However in terms of proportion for a sector, government tweets are most dominated by public health advice with more than one-third (36.9%) of their health-related tweets being categorised as public health advice-related, indicating the current use of government Twitter accounts to deliver health advice to consumers. In addition, awareness plus public health advice tweets combined accounted for approximately half (48.2%) of government health-related tweets. It should be noted that both FP and NFP accounts had substantial numbers of awareness and public health advice posts also.

The figures for research and project-related tweets suggest that government categories could potentially utilise Twitter more extensively for research and project announcements as 24 research and project-related tweets is quite a low number considering the government handles a large proportion of health research funding in Australia. The figures also suggest low-use by government accounts for disseminating health policy news (15 tweets) in comparison to other account categories (32 tweets for FP and 22 tweets for NFP organisations). Similarly, policy development and its issues are dealt with significantly by the government and its respective bodies hence there is a potential opportunity for government to tweet more directly about this type of health information.

Table 5.3 Types of information tweeted

Types of Information	Organisation tweets			
	Gov	FP	NFP	Total
Advertisizing	0	11	12	23
Ambulance updates	75	0	1	76
Awareness	44	239	549	832
Competitions	16	3	46	65
Conferences & events	12	38	164	214
Fundraising	4	23	361	388
Funding	4	8	21	33
Insurance	3	28	42	73
Jobs & Career	7	48	83	138
Medical workforce	5	65	40	110
Motivation & support	8	9	42	59
Organisational news	26	232	396	654
Policy	15	32	22	69
Promotional	2	38	56	96
Public Health Advice	143	226	403	772
Research & Project	24	71	93	188
Total	388	1,071	2,331	3,790

The organisational news type suggests that FP organisations are selectively active, even when compared with NFP organisations, in disseminating organisational news. FP accounts have 21.7% of their health-related tweets dedicated to providing organisational news (news about the activities of that organisation), whereas NFP organisations tweeted a slightly lower percentage of organisational news as a proportion of their health-related tweets (16.9%). These figures coincide proportionally to the number of promotional tweets by FP (38 or 3.5%) and NFP (56 or

2.4%) accounts compared to their overall number of health-related tweets. Governmental accounts tweeted respectively significantly less for both types of information. Hence, providing further organisational news from government accounts also represents an opportunity for a form of further engagement between government organisations and health consumers.

Fundraising-related tweets alone contributed to approximately 8.1% of the total number of tweets identified in February. Unsurprisingly, most of these types of tweets (361) came from NFP organisation Twitter accounts. Throughout the analysis, Twitter was identified to be a frequent way for NFP accounts to communicate about fundraising. This medium can potentially be extremely cost-effective for NFP organisations, especially when considering the costs of developing, promoting and advertising through various traditional media. The use of Twitter or social media for fundraising also has the advantage of potentially reaching a more interested and targeted audience for the specific health area of fundraising.

As mentioned, government bodies also have several potential opportunities when considering the sheer amount of non-health related tweets found throughout other categories of Twitter accounts in the month of February 2012. Government Twitter accounts could tweet more, as they would be able to promote more accurate and direct updates on current health developments and policy within the Australian community and thus potentially increase the quality of health information communicated via Twitter. It is also interesting to note that none of the government accounts identified had been verified by Twitter. Verifying is a process carried out to establish the authenticity of identities on Twitter, so other users could identify true accounts (as there can be multiple accounts of the same organisation/group). If government accounts were verified then

this would also brand them as more trustworthy and could lead to increases in follower numbers. The usage seen in the Australian context indicates differences in dissemination characteristics and levels between different health condition areas, different organisational sectors and different types of information. Of future interest will be similarities and differences seen between the Australian results and those found elsewhere and globally.

Capturing and analysing the data in this study provides a further step towards more fully understanding what types and quantities of health information are being disseminated and how widely throughout a community as a whole. For effective or even optimized health information dissemination, the following aspects are critical: relevant health messages reaching the relevant target groups; the number and frequency of such messages; and the nature of dissemination and sharing of these messages by social network members. The analysis in this paper provides a step to understanding this overall dissemination by health organisations in the Australian context of health information via Twitter. Building from this categorisation, the next steps include analysing more closely the set of followers receiving and disseminating such messages (of given health condition areas and message types) and further consideration of how targeted and effective this dissemination is. A powerful characteristic of social media for health information dissemination is the ability to analyse who health information is reaching, and this implies the availability of analytic approaches to improve the quality and optimization of this dissemination. As such these results and further analysis of retweeting are also an input to developing software tools and applications for measuring the effectiveness and targeting of social media health information dissemination across the community.

5.8 Case study: 'public health advice' dissemination and interaction

We analysed interaction in relation to information dissemination in terms of retweets for the specific tweet type of 'public health advice'. NFP accounts had 176 of their 403 public health advice tweets retweeted. This was the largest raw numbers of retweets in the entire sample. More than two-fifths of public health-related tweets were retweeted (176 out of 403, or 43.7%). FP health-related organisations had the smallest raw number of retweeted public health advice (84) as well as the smallest proportion (37.2%) considering 226 of their tweets in February 2012 were considered public health-related. Out of all three-health sectors analysed, FP organisations had the smallest proportion of their health-related tweets that were retweeted/disseminated.

The government health-related Twitter accounts we identified were found to be the most successful in disseminating health information to the public. Of the 143 government disseminated public health-related tweets identified in February 2012, 99 were retweeted. Approximately 70% of government public health-related information was disseminated amongst Twitter users during February 2012.

We also observed tweet interaction-related characteristics having an impact on the level of dissemination. Observed common characteristics of highly retweeted tweets included: actionable, had health information that one reading could 'act' upon; time relevance, related to temporal events e.g. floods; perceived health risk, acute need for others to know creating a possible obligation to share; and a personally-directed style of language.

This suggests that the sector of a tweeting organisation may impact the level of Twitter-based public health advice dissemination, along with the specific content of a tweet and also writing style used in tweets. Further understanding these factors affecting breadth of dissemination is also critical in understanding health information dissemination in general. This will also be an input into designing software tools and applications to support targeted and effective public health advice information sharing.

5.9 Limitations

One of the major issues found during the initial search for accounts was the unspecific nature of the Twitter search. The search function of Twitter returned very general findings and the Twitter Advanced Search did not provide usable information in relation to the needed aspects of our searches. For example, we used the terms 'Australia hospital' to search for Twitter accounts representing Australian hospitals. Whilst the search did produce a few hospital entities, they were scattered infrequently throughout the many accounts and users that resulted from the search. Further, searches returned many non health-related, yet popular accounts within the Australian context (e.g. Australia Zoo). Consequently, many of the Twitter accounts were found through related users or the search engine Google.

As mentioned in previous sections, a limitation for this report is that the list of health-related Twitter accounts identified may not be fully exhaustive due to these challenges of Twitter search. Therefore, this paper does not intend to provide an exhaustive scope of the current Twitter health-related activity in Australia, instead it provides as substantive as possible sample of

organisational accounts meeting the inclusion criteria. The approach of examining connected accounts, either followers or followees, added to the thoroughness of identification.

Also, the method used whereby Tweets were analysed from only the month of February in 2012 would not provide a fully representative sample of the extent of Twitter activity, especially with accounts of organisations that would be more active in certain periods of the year (e.g. the Movember Twitter account being more active around the month of November and having many fewer tweets in the earlier months of a year between fundraising events).

5.10 Conclusion

This paper describes and analyses the Twitter activity of various Australian-based health organisation accounts in the month of February 2012. Specific criteria were utilised to identify and include active accounts that represented government, FP and NFP accounts based in Australia. The analysis and categorising of tweets was carried out in two dimensions: based on health condition (i.e. cancer, mental health), and the type of information being tweeted (i.e. fundraising, public health advice, organisational news) and a case study in relation to the retweeting of public health advice tweets is provided. Future work involves analysing the recipients of such tweets of various categories to gain further insights into the reach (extent of dissemination), effectiveness of targeting and frequency of coverage with health messages. This work is also a step towards further understanding of dissemination for the development of software tools and applications to improve or optimize the coverage and targeting of health information sharing and dissemination across a community.

Amongst the interesting findings, it was observed that the three sectors disseminated proportionally different kinds of information in terms of health condition and message type. Surprisingly, some NHPAs were under-represented, and these included asthma, arthritis and musculoskeletal conditions, injury prevention and control and obesity. In addition, public health advice and awareness tweets were the most prevalent type of health information disseminated, for example accounting for almost half of government tweets and making up more than two-fifths of all health-related tweets identified. There were also significant sectoral differences for other major types of tweets, for example a prevalence of fundraising tweets by NFP health-related organisations and significant use for disseminating organisational news by FP and NFP accounts. Common characteristics of highly retweeted public health advice tweets were also observed in the case study.

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Chapter 6. What are the Characteristics of Highly Disseminated Public Health-related Tweets?

6.1 Foreword

Chapter 5 had identified the Twitter-based health organisations within the Australian context, as well as the types of health-related and non-health-related information that was being disseminated by these sources. From the literature review carried out in Chapter 2, an area of significance that required further research was the investigation of the types of public health information found through these SNS that are being tweeted by organisations. Also of further interest is the characteristics of such highly disseminated information, which provides the foundation for exploration for this section of this thesis. Chapter 6 explores the novel research of these characteristics through analysis of the identified public health tweets in the previous chapter. The purpose of such investigation is to uncover what could not be readily measured by prior platforms of information dissemination; evidence-based results of why certain health information is passed along by online users more than others, as well as the number of times this information is passed along. The ability to collect and analyse public health information through SNS also allows us to classify such information according to observed characteristics. Further to this, by comparing the retweeting results of different organisation types identified, the findings from this chapter can contribute to review of digital strategy and online policy/practice changes for more successful content spread across a variety of user groups. This area of research is significant for health-related organisations as social media-based information dissemination becomes more widely used (and expected) from such entities.

The following chapter is derived from the publication: Dumbrell, D., & Steele, R. (2012, November). What are the characteristics of highly disseminated public health-related tweets?. In *Proceedings of the 24th Australian Computer-Human Interaction Conference* (pp. 115-118). ACM.

6.2 Abstract

Unlike traditional mass media, peer interaction between individuals is of critical importance in the dissemination mechanisms for social media. There is emerging interest in the possible novel application of social media in disseminating public health information or messages. In this paper, we analyse tweet and retweet behaviour in the context of Australian public health-related micro-blog posts to provide preliminary insights into the characteristics of widely disseminated tweets (including characteristics of retweeting accounts). In this way we also consider the nature and role of human computer-mediated interactions in affecting the level of dissemination of Twitter-based public health message.

6.3 Introduction

Twitter, a widely used micro-blogging service, has characteristics and capabilities that make it a useful tool for information dissemination. The convenience and immediacy of providing information in 140 characters or less has presented many novel and potentially beneficial approaches for dissemination to large numbers of active users. Twitter's application to public

health has recently been considered (Steele, 2011), although mostly in the areas of health surveillance and illness tracking (Achrekar, Gandhe, Lazarus, Yu, & Liu, 2011; Sadilek, Kautz, & Silenzio, 2012). For this paper, we looked specifically at accounts of Australian health-related organisations utilising Twitter and analysed the characteristics of their public health advice dissemination. This paper investigates an example of how organisations are using social media to achieve communication and public outreach, in this case within the Australian public health context.

Health dissemination in Twitter involves retweeting, the act whereby a user ‘forwards’ or shares a tweet posted by another user to their followers (and so on). In this work we measure dissemination in Twitter by the number of retweets a certain health tweet receives, and also take into consideration the number of followers of retweeting accounts. For example, if a certain message was retweeted four times by four different users, then the reach of that particular health information would be the sum of the number of followers of those four users. Therefore, a tweet that has been retweeted numerous times would generally have a higher dissemination compared to a tweet with a smaller number or no retweets.

The purpose of this paper is to examine various public health advice tweets, and analyse and interpret their characteristics and dissemination across the Twitter network. Comparisons of tweet dissemination and retweeting activity will also be made within and between three different sectors of health-related organisations: government, for-profit (FP) and not-for-profit (NFP) organisations. Common characteristics of highly disseminated health information will also be

discussed, with potential opportunities and insights identified for current and future related research.

6.4 Related work

Throughout the literature there has been few papers directly measuring the broad extent of tweeting activity and tweet dissemination, especially health-related tweeting activity in Australia. A study investigating characterization of the tweeting habits within different countries found that identified active Twitter accounts in Australia had 11.73% of their tweets retweeted in the year 2010 (Poblete, Mendoza, & Jaimes, 2011). However, that particular study did not focus on health-related content, analysing the sentiment component of tweets (i.e. levels of 'happiness') using an algorithmic approach rather than considering the complex semantic content of tweets.

An important factor in dissemination on Twitter includes the tendency of a tweet to be retweeted. Cha, Haddadi, Benevenuto and Gummandi (2010) found that Twitter accounts with a large number of followers had many one-to-one interactions (i.e. followers were directly communicating with them), and retweeting was a more suitable way of representing influence of a user beyond a one-to-one interaction domain (i.e. community interaction and dissemination). Therefore, they suggested that the most influential users were those who had more of their tweets retweeted and mentioned, rather than judging the influence of an account based on number of followers.

As mentioned, measuring the reach or dissemination of a certain tweet can also involve identifying the retweeting accounts and their number of followers. Kwak, Lee, Park, and Moon (2010) found from their dataset of 41.7 million user profiles and 106 million tweets that any retweeted tweets reached an average of 1,000 users – regardless of the number of followers of the original tweeting account. They suggested that quality, timeliness and coverage were factors of disseminated tweets to be further researched.

The human aspects behind the Twitter accounts however should not be disregarded as the language used within tweets may influence how they are responded to (Quercia, Ellis, Capra, & Crowcroft, 2012). The authors found that in terms of retweeting, users or accounts considered influential (or highly retweeted) would express emotions that were common to individuals, thus creating a sense of community. They also suggested that using negative aspects of languages drew more retweets, and was a characteristic of highly retweeted (influential) users. Our paper will focus on organisations that tweet, which also raises the question of whether this is different to individual use investigated in previous literature.

This paper considers a set of retweeted public health tweets of various active Twitter health accounts in Australia (with varying amounts of followers) to determine common characteristics. This is a preliminary study with interesting implications for further research in issues and aspects of effective health information dissemination.

6.5 Methodology

Relevant Twitter accounts were identified and selected via a three-step process. First, through utilising the Twitter search function, accounts were found by searching health-related keywords (e.g. “health”, “doctor”, “cancer”, “heart” etc.). Further accounts were identified in the second step via searches using Google (www.google.com), such as typing in “dementia Australia twitter” and similar phrases. Third, already identified Twitter accounts’ feeds and followers were examined to find further relevant users. All accounts had to meet inclusion criteria, that is: active in the month of February 2012, having 150 or more followers, and representing health-related bodies or organisations based in Australia.

The manual approach to identify and analyse accounts was chosen after considering available Twitter analytics tools such as Twitonomy or TweetVolume for example. The reason for this chosen manual methodology was that these Twitter analytics tools did not automatically identify health-related accounts, could not process complex concepts such as a ‘public health-related’ tweet, nor did they provide an effective method of examining and summing the followers of retweeting users (reach).

We reviewed the Twitter feeds of each of the identified accounts for public health-related tweets posted during February 2012. Public health-related tweets (and their respective hyperlinks) were those we defined as delivering health advice to those reading the tweet, whilst providing enough information for a consumer (or reader) to potentially use to change any relevant aspect/s of their current health behaviours. Therefore, tweets that were public health-related were not

merely awareness-related (i.e. “tomorrow is world cancer day”) as this type of tweet did not contain information that would indicate change in health behaviour, rather it just raised awareness of an upcoming event or occasion. From our criteria, only tweets that were categorised as public health-related were expanded. The number of retweets for each tweet was captured, as well as the types of users retweeting the information (e.g. government, FP/NFP organisations, and individuals). The total number of followers for retweeters of each public health advice tweet was also calculated, to demonstrate the reach of the tweet (i.e. how many accounts on Twitter would potentially receive it).

6.6 General characteristics of sectors

From the methodology outlined, a total of 114 health-related Australian organisation Twitter accounts were identified for this paper. The identified Twitter accounts were categorised into three sectors – government (16), FP (27) and NFP (71) organisations. Out of these 114 accounts, it was identified that 12 government accounts, 13 FP accounts and 42 NFP accounts had public health-related tweets that were retweeted – resulting in a total of 67 identified accounts that had some retweeting of public health information.

When looking at the 67 identified accounts with retweeting, government and FP accounts had a similar total number of followers with 30,605 and 25,547 respectively. When looking at the average number of followers per account however, it could be seen that government accounts had a larger average follower number (2,550) than FP accounts (1,965). Comparing public health advice tweet dissemination, both government and FP accounts had similar raw numbers of the

total number of followers their tweets were retweeted to, with 241,320 for government accounts and 223,444 for FP accounts. Though again when considering averages, government accounts were more powerful at disseminating public health advice to other Twitter users with an average of 19,877 Twitter users seeing retweeted tweets. FP accounts had an average reach of 17,103 users per account. Therefore, from the identified sample, public health advice tweeted by government accounts was shared with nearly 2,800 more users throughout Twitter (per account) when compared to the tweets from FP accounts.

Across the whole 114 identified health-related organisations, 772 public health tweets (retweeted and non retweeted) were identified, with a total of 359 of these tweets retweeted. NFP accounts had 176 public health advice tweets that were retweeted. This was the largest raw number of retweets in the sample. This could probably have been due to the fact that during February 2012, NFP organisations recorded the largest raw number of public health-related tweets (403 out of the total 772). Therefore, more than two-fifths of public health-related tweets (176 out of 403, or 43.7%) made by NFP were retweeted by other Twitter users. FP health-related organisations had the smallest raw number of retweets (84) as well as the smallest proportion of retweeted public health advice (37.2%) considering 226 of their tweets in February 2012 were public health-related. Out of all three-health sectors analysed, FP organisations had the smallest proportion of their health-related tweets that were retweeted/disseminated.

The government health-related Twitter accounts we identified were found to be the most successful in disseminating health information to the public. Of the 143 government posted

public health-related tweets identified in February 2012, 99 were retweeted. That is, approximately 70% of government public health-related information was retweeted amongst Twitter users during February 2012. In fact, if taking into account the number of Twitter accounts per sector, it could be seen that although government accounts had the lowest raw numbers of total public health tweets, they recorded on average a higher reach of followers with their public health advice (as they recorded higher retweet rates).

6.7 Retweeting accounts

It is also interesting to note that government accounts did minimal retweeting of public health advice tweets in comparison to FP and NFP accounts. Overall, government accounts made up only 44 of the 890 (or 4.9%) retweeting accounts identified, which was the lowest of the three sectors. More than half of the retweets from government accounts (23) were actually public health tweets from the health-related government Twitter accounts identified. These numbers not only show how government accounts have low retweet numbers (potentially due to selectiveness), but also that they tend to retweet information from other government bodies rather than from FP and NFP organisations.

On the other hand, accounts that represented various individual users (i.e. non organisation or non group-based bodies) recorded the highest proportion of the 890 retweeting accounts, with 561 or 63.0% of identified public health information retweets being from individual users. NFP accounts had retweeted public health tweets only 88 times, and FP accounts were found to have a higher rate of retweeting activity at 125 FP retweeting accounts identified. The remaining 72

retweeting accounts were ambiguous as to whether they were associated with organisations or individuals, and hence were classified as 'other'. These numbers are interesting, as they show low activity of government Twitter accounts when it comes to retweeting public health advice – but illustrate the high proportion of interaction of individual users who disseminate this kind of information.

6.8 Characteristics of highly retweeted tweets

We manually examined the public health advice-related tweets (retweeted and non-retweeted). As an example, Table 6.1 provides a list of the top 10 most retweeted public health tweets – we limit to showing this example set for space reasons. The list was compiled by retweet frequency according to absolute number (e.g. if a tweet was retweeted 5 times and another was retweeted 7 times the latter was considered more retweeted) rather than relatively (i.e. compared to the number of followers that specific account had) as during the analysis we discovered there was a large overlap between these two measurement metrics. We then identified the common and shared characteristics of these oft-retweeted tweets.

Through manual analysis of the identified retweeted tweets, the following characteristics are identified and initially posited as possible characteristics conducive to public health advice tweets being retweeted.

6.8.1 Actionable

A majority of the highly retweeted tweets contained health advice that was actionable. We defined actionable tweets as those that had information one reading could ‘act’ on to alter their current health behaviour or habits in the real world. For example, the tweet about sleep hygiene provides tips on how to “improve the tranquillity of [one’s] bedroom & improve on sleep”. This is actionable as the consumer would be able to act on the provided information to alter their sleeping environment and thus their sleep-related health. Another example – “health & safety tips from Dr James Smith for those cleaning up in flood affected areas” – also promotes similar actionable advice to those cleaning up affected areas by providing information that decreases potential health risks.

Table 6.1 The 10 most retweeted public health-related tweets from study sample

Tweet	Retweets	Sector
#Tip: Kids who have a #pet before the age of three are less likely to develop pet #allergies. http://bit.ly/xxnftQ	40	FP
Fact file: #Crohn's disease and ulcerative colitis are two of the best known types of inflammatory bowel disease. #IBD http://bit.ly/wLnwQR	18	FP
Sleep hygiene - what’s that?!! Helpful tips on how to improve the tranquillity of your bedroom & improve on sleep here: http://ow.ly/97GpT	17	NFP
Identifying your strengths can help you feel good about yourself & are important for resilience & wellbeing! Start now: http://ow.ly/9cYtM	15	NFP
Today we launched #fatfreetv guide. Find out what your child’s daily TV junk	14	NFP

ad intake is by visiting http://www.fatfreetv.com.au		
Health & safety tips from Dr James Smith for those cleaning up in flood affected areas: http://tinyurl.com/7b9w4jq #bigwet #floodassist	14	GOV
#HeartMyth Being active means high-intensity exercise #HeartFact Just walking for 30 mins a day can cut #heartdisease risk by 50%”	11	NFP
Do you know if your loved ones want to be an organ and tissue donor? Feb 19-26 is DonateLife Week http://www.donatelife.gov.au #organdonor	11	GOV
Do your loved ones know if you want to be an organ and tissue donor? Feb 19-26 is DonateLife Week http://www.donatelife.gov.au	11	GOV
If you or a person close to you are remembering a loved one, here are some tips on helping someone experiencing grief http://ow.ly/9lIdi	10	NFP

6.8.2 Time Relevant

In the example of the flood-related tweet (see Table 6.1), the tweet, albeit useful, would not be generalised to the public as it was directed specifically to those affected by the Queensland floods of early 2012. Many of the tweets that were highly retweeted were found to have significant time-relevance. This matches the nature of Twitter, as it is able to provide up to date information on events or topics of timely interest. Similar characteristics can be seen in the tweets about “going back to school” as well as during certain events (e.g. organ donation-related public health information around DonateLife Week, two in the top 10). Therefore, highly retweeted public health advice often is time-relevant leading to larger dissemination of up-to-date information to following Twitter accounts.

6.8.3 Perceived Health Risk

The retweeted tweets that were highly disseminated also included many that had high perceived health risks. The perceived acute health risks could have been environmentally-related (i.e. retweeting information about the floods) or they could have been lifestyle-related health issues (e.g. “#HeartMyth Eggs are bad for heart health #HeartFact Eggs are v nutritious...” or “...assoc between consumption of sugar sweetened drinks and excessive weight gain...”). These tweets were disseminated due to the retweeting accounts finding significance in the sharing of such health information. A hypothesised possible factor of why these tweets are most retweeted can be due to the retweeting user having a feeling of social obligation associated with the tweet subject matter. This raises the interesting possibilities of a potential relationship between group/population values and norms and the operation of dissemination in social networking systems. Another possible reason is that individuals may want to gain influence through concerted efforts of retweeting tweets with a perceived health risk.

6.8.4 Personally-directed Style

The highly retweeted tweets analysed not only have contextual and relevant characteristics, they also display stylistic attributes that possibly affect their level of dissemination. We found highly retweeted tweets were often written in a personally-directed manner, for example using direct references to the reader such as “...stand up for your health...”, “if you’re affected by #floods...” or asking personal rhetorical questions such as “having a baby?...” or “...want to be an organ and

tissue donor?...". This may explain why individuals did the majority of retweeting, as the public health tweets may have felt more personal to an individual rather than an organisation.

6.9 Future Research Implications

The paper presents various possible implications for future research. Areas of potential future research may be the investigation of the relative contribution to dissemination of tweet content, the originating account and sector. Further, is characterizing the distribution curve for dissemination of public health advice and other health-related tweets. Finally, and interestingly, the tweet characteristic of 'perceived health risk' suggests possible links between population value norms and dissemination.

6.10 Conclusion

In this paper we have analysed the retweeting of organisation-posted public health advice tweets in Australia during February 2012. The results demonstrate differences related to sector and a number of common characteristics of highly disseminated tweets have been identified. Government accounts were found to be most successful in having their public health information posts disseminated. However, they also retweeted the least amount of public health information when compared to FP and NFP accounts. On the other hand, individual users were found to retweet such information the most. It was identified that common characteristics amongst highly disseminated public health-related tweets were that they were actionable, time relevant, contained a high perceived health risk and were written in a personally-directed style. This

paper thus provides initial insights into the complex interactions of human and computer components implicit in social media communications systems.

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Chapter 7. Putting the Public into Public Health Information Dissemination: Social Media and Health-related Web Pages

7.1 Foreword

One of the important areas of research outlined by the literature review was that of the quality, credibility and trustworthiness of health information present on online sources. With reference to Chapter 5, although static Web sites have existed far before SNS, the credibility of health information present amongst these sources is still under constant scrutiny and examination due to the differing levels of quality that have been found through these sources. This can be attributed to a variety of factors, such as the sheer number of health sites and information found (i.e. typing health into the search engine Google brings up 3.4 billion search results), the frequent creation of new Web-pages containing health information and the updating of older information sources as health-related research uncovers further knowledge in this field.

Research from the previous two chapters has identified that a large proportion of health-related tweets on Twitter contain hyperlinks. As such, the following chapter builds on previous work and explores the novel aspect of measuring the authoritativeness of hyperlinks present in the sample of collected public health retweets. The subsequent analysis of these tweets will increase the knowledge surrounding certain attributes pertaining to successfully shared information. For the purpose of this research, Chapter 7 will involve research utilising an online function called Google Pagerank that measures the importance of a Web site.

The phenomenon of self-organising information dissemination groups will also be discussed, where users of a particular online community on a SNS pass judgement on a piece of information. This process of public peer review of information can be equated to retweeting, favouriting or liking a certain piece of information on Twitter. This phenomenon is again made possible by the capabilities of SNS platforms, where peer-reviewing of health information can be quantitatively assessed due to the measurable actions of users. The information contained within this chapter can be used as a basis for user-driven quality assurance research, as well as provide more knowledge in the field of relevant information dissemination to targeted users through such interactive platforms. This is especially important as more users turn from search engines to SNS for health information and managing health conditions (Hawn, 2009; Jones, 2009, National Research Corporation, 2015).

The following chapter is derived from the publication: Steele, R., & Dumbrell, D. (2012, December). Putting the public into public health information dissemination: social media and health-related web pages. In *Proceedings of the 17th Australasian Document Computing Symposium* (pp. 135-138). ACM.

7.2 Abstract

Public health information dissemination represents an interesting combination of broadcasting, sharing, and retrieving relevant health information. Social media-based public health information dissemination offers some particularly interesting characteristics, as individual users or members of the public actually carry out the actions that constitute the dissemination. These

actions also may inherently provide novel evaluative information from a document computing perspective, providing information in relation to both documents and indeed the social media users or health consumers themselves. This paper discusses the novel aspects of social media-based public health information dissemination, including a comparison of its characteristics with search engine-based Web document retrieval. A preliminary analysis of a sample of public health advice tweets taken from a larger sample of over 4700 tweets sent by Australian health-related organisation in February 2012 is described. Various preliminary measures are analysed from this data to initially suggest possible characteristics of public health information dissemination and document evaluation in micro-blog-based systems based on this sample.

7.3 Introduction

The role of the Internet in enabling document retrieval and dissemination has led to vast changes in the past 15-20 years. Relatively recently, searches for certain types of information were (and still are) usually done via search engines resulting in the ranked presentation of the algorithmically calculated most relevant Web documents. With the introduction and development of social media platforms however there has been some change in the discovery and retrieval aspects of Web documents. Public health information dissemination involves communication of disease prevention and health promotion information through organised efforts. While a majority of Web-based public health information dissemination and retrieval has been done via search engines, it has been found that relevant public health documents were not always successfully located and disseminated via search engines due to the query behaviour of the user (Yang, Winston, Zarro, & Kassam-Adams, 2011). The novel approach of utilising social

media for public health information dissemination and retrieval has recently been explored (Paul & Dredze, 2011). The rapid and widespread uptake of social networking sites (SNSs) such as Twitter allows for the sharing of public health-related information to result in more up-to-date information dissemination due to the instantaneous and 'push' nature of the application.

Twitter, a widely used micro-blogging service, has characteristics that make it a useful tool for information dissemination and retrieval, such as instantaneous 'tweeting' (postings of 140-character limited updates), 'retweeting' (forwarding of other users' tweets) and the ability to publicly interact with other users and their tweets. Unlike the case with search engines, documents in Twitter are discovered via embedded URLs in received tweets. When dealing with public health information dissemination via Twitter, there are a number of objectives and goals that are beyond simply retrieving relevant documents that match queries based on information retrieval metrics. These co-occurring objectives include: the aim of widespread dissemination of quality health information; dissemination to targeted groups and individuals so that the information is reaching those it is relevant to; achieving 'push' communication with the ultimate goal of positively affecting the health behaviour of recipients; involving users with cognate interests to interact and communicate; as well as providing up-to-the-minute information.

The purpose of this paper is to provide a preliminary overview of micro-blog-based public health information dissemination and its novel document retrieval and evaluation characteristics. A preliminary experiment to examine relationships between public health advice retweeting behaviour and the nature and authority of the Web pages pointed to by embedded URLs in public health advice tweets is described and results presented.

7.4 Background

URLs that are embedded in tweets represent Web links to documents that can provide the user with lengthier health-related information (usually summarized or suggested in the tweet itself). A recent study by Cui et al. found that from an analysis of one million tweets, 29.1% contained URLs (Cui, Zhang, Liu, & Ma, 2011). However after further examination it was found that over half these URLs were 'spam' related. On the other hand, a study examining public health-related tweets by Australian health organisations found that a large majority of public health-related tweets included URLs and that they were also genuine (i.e. non-spam and contained appropriate information as described in the tweet) (Dumbrell & Steele, 2013). These characteristics of tweets embedding URLs for public health document dissemination and retrieval suggests the value in further research into social media-disseminated public health documents. Throughout the literature reviewed, evaluation of public health messaging in micro-blog applications such as Twitter (and more generally social media) has not been thoroughly explored. There have been various temporal estimation methods and models introduced for information retrieval and document rankings when compared to traditional media (i.e. newspaper articles) (Efron & Golovchinsky, 2011). Document and data ranking (by Web search) has recently been explored when taking into consideration the social aspects of SNS like Twitter and Facebook (Khodaei & Shahabi, 2012). The authors of the study proposed a ranking system based on the characteristics and communicative relationships between SNS application users as well as the actions these users performed on Web documents. A form of socially-based Website review was introduced called tagging, where end-users place a content and quality label on a particular document on a

topic of interest. These types of technologies (Mayer et al., 2011) used on various websites can also be seen on Twitter, whereby a user can perform various actions (e.g. retweeting and favouriting) to provide both dissemination and opinions/evaluation of the content of the document (or tweet).

7.5 Social Media-Based Public Health Information Dissemination

There are a number of inter-connected and diverse characteristics of social media-based public health information dissemination. In terms of dissemination, such systems could be considered to represent a distributed health information dissemination network with the network topology and routing depending upon the 'self-organising' activities of the human members of the social media network. This self-organising aspect of social media is present via users first manually choosing which accounts to follow, based on their preferences for what information and accounts are of interest and relevant to them, and also in choosing from various possible actions including forwarding or retweeting when receiving a health-related micro-blog post. We identify novel aspects specific to social media-based public health information dissemination to include: user role in document dissemination, public review and evaluation, known and targeted recipients, impact of population values and user-initiated content.

User role in document dissemination: Users are actually forwarding and hence are the parties disseminating public health information or Web documents. When users receive information that they find interesting or useful, they may retweet the microblog post including any embedded link referring to a Web document.

Public review and document evaluation: Actions taken in relation to the public health information received from other accounts is also a source of evaluative information. By carrying out such actions as retweeting or favouriting, users are also passing a form of judgment and evaluating the type, quality and/or relevance of the tweet and any document referred to. For example, favouriting a document may be making an indication about the relevance of the public health information based on the needs of the particular user, whereas retweeting may suggest that there is some value in that piece of public health information for followers to benefit from. These issues will be further explored in Section 7.7 via the preliminary experiment, analysis and results described.

Known and targeted recipients: Another significant characteristic of social media-based public health dissemination is that the recipients (at least the receiving accounts) of any given piece of public health information can be known. One of the challenges with mass media-based public health dissemination is that it can be hard to establish who has received a given message or how successfully targeted it is. Such capabilities in social media suggest the ability to analyse and optimize dissemination in detail across the population and also create software and analytic tools to measure and optimize public health information dissemination via social media.

Impact of population values: Social media-based systems also include interplay between community interests and values, and what and how broadly information is disseminated. For example in the study by Dumbrell and Steele (2012) the issue of acute health risk indicated in

tweets, and hence its possible relationship to feelings of social obligation, was identified as a characteristics of highly retweeted tweets.

User-initiated content: Varied types of users are also able to generate their own health information and micro-blog postings (whether this is accepted or not is based on various factors, such as user perception of the authority or interest of that piece of information). This example identifies another aspect of Twitter-based public health dissemination, whereby accepting and interacting with certain users and documents involves establishment of an informal 'network of human trust' as part of that information dissemination.

7.6 Social Media vs. Social Engines

As stated, traditional forms of Internet-based access to public health information are often through the use of search engines. This could be broadly considered to be a 'pull'-based approach, where the user would discover and request information from various sources, and in this case public health Web documents. However with the introduction of SNS, the users of these services share information as the means for these documents to reach other individuals. While SNSs like Twitter support the sharing of short textual messages, they are very commonly utilised to direct others to Web pages and documents by providing a URL. Twitter is a good example of a SNS that incorporates a 'push'-based approach (see Table 7.1), where specified, relevant and up-to-the-minute health information is pushed to users. This may suggest the relevance of social media-based public health dissemination where health behaviour modification is aimed for. The criterion used to determine the resulting documents seen by users varies between the two

systems. Search engines base their results on the user’s query and identify the most relevant and authoritative pages based on those query words.

Table 7.1 Comparison of Web-based public health information dissemination systems Social Media Search Engines

	<i>Social Media</i>	<i>Search Engines</i>
<i>Mode</i>	‘Push’	‘Pull’
<i>Temporal</i>	Most recent	Various times
<i>Ranking/ evaluation</i>	Manual/ human selected	Algorithmic
<i>Interaction</i>	Community and peer-based	Individual-based
<i>Document description</i>	Manual by micro-blog poster	Automated/ anchor text-related
<i>Documents disseminated</i>	Changing rapidly	Relatively constant for a given query
<i>Documents received</i>	Relevant to a topic & topic personally selected	Relevant to a query
<i>Web coverage</i>	Limited to documents shared	More comprehensive

In Twitter however, discovered documents are based on the type of account the user chooses to follow, and hence the quality and content of the public health information is dependent on the tweeting users being followed. This inherently includes some form of manual evaluation being done by the mass of users (see Section 7.7) implicit in the sharing and dissemination activities. Social media is well suited to providing up-to-the-minute information. Up-to-the-minute information is well-suited to public health for various reasons and scenarios, such as epidemic outbreaks, health warnings, natural disasters and environmental information updates to name a few. Another of the major differences between social media and search engine systems is the

level of interaction with a public health Web document or information. Due to the open environment of Twitter, there are many mechanisms for peer feedback.

7.7 Preliminary Analysis of a Sample of Public Health Retweets

In the dissemination of public health advice via Twitter, there are a number of ways in which the broad populations of users inherently provide some form of evaluation of that information.

7.7.1 Preliminary Analysis of Sample

As part of a broader study described in Dumbrell and Steele (2013), all tweets by health related organisations in Australia meeting threshold criteria of at least 150 followers per account and having been sufficiently recently active, were collected and manually analysed for the month of February 2012. There were 114 identified health-related organisation accounts meeting these criteria, and these accounts produced 4787 tweets during that month. These 4787 tweets were also categorised as being of various 'types' including for example: public health advice, organisational news, advertising, fundraising, conference and event, amongst various others. In this paper we limit our consideration to just the sub-set of these tweets that were public health advice tweets. Across the whole 114 identified health-related organisations, there were a total of 772 (out of the overall total of 4787 tweets) public health advice tweets (retweeted and non retweeted) sent in February 2012. A total of 359 of these public health advice tweets were found to have been subsequently retweeted at least once. The identified Twitter accounts were also categorised into three sectors – government (16), for-profit (FP) (27) and not-for-profit (NFP)

(71) organisations. For this paper we were interested to gain preliminary insights into the relationships between public health information retweeting behaviour, and the Web documents pointed to by embedded URLs within the public health advice tweets, and also other preliminary characterizations of public health social media usage in terms of this sample. Of the 359 public health advice tweets sent in February 2012, that were retweeted, 329 of these retweeted tweets contained a URL (91.6%). Notably, this is substantially higher than the proportion of retweeted tweets in general, which contain embedded URLs (56.7%) (Zarrella, 2009).

All 359 tweets were ordered in terms of number of times they were retweeted. The most retweeted was retweeted 40 times, the top 25 tweets were retweeted seven or more times, the next 94 tweets were retweeted between three and six times inclusive and the remaining 240 were retweeted one or two times. The Web pages indicated by the embedded URLs were manually inspected to determine the source of their content. The tweets that either did not include an embedded URL or for which this link was no longer functioning were excluded from this analysis. In the most highly retweeted group (seven or more times) there was some evidence of high authority for the information source of the linked-to Web pages: 40% were from leading NFPs such as the Australian Red Cross, Cancer Council NSW, the Heart Foundation etc.; 25% from government departments and 20% based on input/ content from Professors. The second set of tweets considered were those retweeted three to six times inclusive. In this case only 31% of Web pages indicated by these tweets were from NFP organisations, a slightly lower percentage indicated government site pages (23%), a much lower percentage were from Professors (1.5%) and a small percentage (6%) had as their source international journal articles. The third set, retweeted only once or twice showed again a decrease in NFP Web pages (26%), a decrease in

government content pages (18%) and a decrease in Professors as sources of the Web page content to 1%. Interestingly there was an increased and relatively large proportion of pages in this group that used as their information source international journal articles (20%). The above shows high authority sources such as government, well-recognized NFPs or Professors, as the sources for the content of indicated Web pages, being more prevalent for more highly retweeted tweets. On the other hand it also shows high authority sources such as international journal articles being more prevalent amongst lower retweeted tweets, counter to the possible overall trend of the embedded URLs within more highly retweeted tweets indicating pages with more authoritative information sources.

As an alternative analysis, to gain a simple measure of the 'authority' or 'quality' of the Web pages indicated by embedded URLs, the Google PageRank of each of the indicated Web pages (and of their domain name resulting from removal of the directory path from the end) were retrieved via the Google toolbar. Various averages of these PageRanks were then calculated. Tweets from the retweet set were excluded in this analysis if they did not include a URL, had a URL but it was no longer functioning or no PageRank was available for that URL. For the most retweeted group (retweeted seven or more times) the average PageRank for the indicated Web pages was 4.25, for the set of tweets retweeted three or more times, the average was 3.9 and for the set of all tweets retweeted at least once the average was 3.38. In relation to the domain names for the top group of retweeted tweets the average domain PageRank was 6.52, for tweets retweeted three or more times, the average domain PageRank was 6.39 and for the set of all retweeted tweets the average domain PageRank was 6.05. While these averages suggest that a higher PageRank was present on average for the URLs in more retweeted tweets, there was a low positive correlation between

PageRank and retweet count with only $r=0.16$, with significance value of $p=0.01$. In considering other factors with possible correlation with high retweeting, interestingly the number of followers of an account did not show a strong correlation with number of times retweeted with $r= 0.243$ and significance value $p=0.000$. Also there was a moderately strong negative correlation between total number of tweets sent from an account and PageRank of embedded URLs, $r= -0.614$ with $p=0.000$. Other analysis of the sample data provides some preliminary insight into those doing the retweeting and hence carrying out the possible evaluative actions. In general, accounts of individuals were the most active retweeters: individual accounts retweeting numbers outnumbered government accounts retweeting for example by a ratio of ten-to-one. This suggests the large role of individuals in providing the document evaluative information. Finally, if a user refers to another on Twitter via the @ symbol, this is considered a 'mention'. There were only 51 instances of mentions in our sample of 359 retweeted tweets.

7.7.2 Discussion

The low r value for the correlation between PageRank and retweet number may be a result of various other factors impacting retweeting such as the actual semantic content of tweets, PageRank not being an appropriate measure of the quality or authority of public health information or possibly there being little linear relationship between page authority and retweet number. Previous work has also shown a not very high correlation between PageRank and the quality of health information (Griffiths, Tang, Hawking, & Christensen, 2005). The low r value of account follower number in relation to number of retweets is interesting in that it suggests that it is not just number of individuals receiving a tweet that drives numbers of retweets, which might

be naively hypothesized, but it suggests that characteristics intrinsic to the content of the tweet may be more important in affecting the level of retweeting. The negative correlation between number of tweets and PageRank of embedded URLs suggests accounts sending many tweets are not tweeting URLs with high authority as indicated by PageRank. Previous research has found that retweets contained a significantly larger percentage of embedded URLs when compared to regular tweets (i.e. URLs have a strong relationship with retweetability) (Mayer et al., 2011), (56.7% and 19.0% respectively) (Dumbrell & Steele, 2012). From our sample, it may possibly be hypothesized that in relation to public health advice tweets the inclusion of URLs is more common and have even greater importance to achieve dissemination.

7.8 Future Research

While public health social media networks may potentially create powerful ‘self-organised’ dissemination networks the effectiveness of these dissemination networks for public health needs to be further investigated. Much further work is required to determine how effective retweeting and evaluative actions are in identifying and rewarding quality or relevance of public health Web pages or micro-blog posts. An immediate future step would be a more sophisticated measure of authority or quality of health information provided. Related questions include: does such dissemination and evaluation implement a “wisdom of the crowd” behaviour?; does the self-organised nature effectively route documents to individuals who are better qualified to evaluate these documents? There are a far broader range of future research questions also. How effectively are public health tweets reaching target audiences? Given information on who are the social media recipients is available, related to this, what can be determined about a user from

their connection network and postings? How well are users able to identify the relevant accounts to follow? Finally, in relation to healthcare, are users actually changing their health behaviour as a result of receiving such information? To answer such questions, further analysis and discussions surrounding community and online data with relation to real-life health situations will shed further knowledge on this complex area of SNS-based public health communication.

7.9 Conclusion

This paper has considered the novel characteristics of social media-based public health information dissemination. A preliminary study has considered the relationship between retweeting frequency and the authority or quality of the Web pages pointed-to by tweets and other preliminary dissemination characteristics. Future related directions of research are also identified.

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Chapter 8. Privacy Perceptions of Older Adults when Using Social Media Technologies

8.1 Foreword

The previous chapters have identified several key factors of Twitter-based health information dissemination that make it a viable SNS platform for health information research, public health promotion and information dissemination in current and future contexts. There are however many further gaps in knowledge to be filled, due to the multi-faceted nature of this novel relationship between human-based online communication and health information. Whilst there has been research in the area surrounding online user activity, an area of importance identified in the literature were low-level and non-users of such platforms. The importance of studying groups that minimally use SNS for health information communication is to fill in current knowledge gaps by exploring the issues and reasons behind this. Due to the already identified potential of SNS to manage and positively affect health, in both literature and work within this thesis, research surrounding low levels of use should be similarly analysed. Considering the incremental spread of digitalised societies, the growing number of sources of online information, the rising cost of primary healthcare and the increasing amount of health conditions that are preventable and manageable via public health means; minimal to non-users of SNS will be further disadvantaged with regards to health information access and communication. Findings from this research can thus address issues faced by these groups and suggest suitable actions and strategies to break down these barriers.

The literature review in Chapter 2 had identified older adults as the largest group of non-users of online sources of communication, and this trend is expected to continue proportionally with the ageing global population. Also identified in the literature review were privacy concerns as one of the major barriers to SNS use for health-related communication. Thus the following chapter explores the privacy perceptions of older adults when using social media technologies. The outcomes from this study can provide more evidence-based research in the knowledge gap surrounding low-level and non-users, in addition to providing direction for initiatives and interventions to positively affect this population in terms of SNS-use and indirectly health information management via these platforms.

The following chapter is derived from the publication: Dumbrell, D., & Steele, R. (2015). Privacy Perceptions of Older Adults when Using Social Media Technologies. In M. Tavana, A. H. Ghapanchi, & A. Talaei-Khoei (Ed.), *Healthcare Informatics and Analytics: Emerging Issues and Trends* (pp. 67-83). Pennsylvania, USA: IGI Global.

All necessary ethics clearances for the study were obtained from the University of Sydney Human Research Ethics Committee, Protocol Number: 12431.

8.2 Abstract

Social media technologies represent an emerging and promising means by which older adults can access health and community information, engage in peer-to-peer information sharing and also potentially decrease social isolation. Privacy concerns however have been consistently identified

as a barrier for older adults' use of the Web and social media technologies. We have conducted a preliminary study involving 150 older adult participants, aged 55 or over, with 80% of these participants being aged 65 or over, investigating their use and perceptions of social media technologies. The trial involved first providing the participants with brief training in three common social media technologies; Facebook, Twitter and Skype.

We carried out a quantitative analysis of the differences in use and privacy perceptions in relation to the three technologies introduced. Our results showed that for the older adult participants, Skype was considered the most secure technology in terms of privacy. Facebook was considered the second most secure in terms of privacy and Twitter was considered the least secure in terms of privacy. In comparison, Facebook was the most highly used social technology; Skype was the second most used, and Twitter the least used by the older adult trial participants. We also carried out a qualitative analysis of participant's free-text responses, in relation to their privacy perceptions about the social media technologies. This led to the identification of five broad recurring themes within which were also identified twelve sub-themes. Overall there were significantly varying perceptions in relation to privacy for these systems, and the subjective decisions as to how individuals chose to use them or believed they should be used, played a role in the participant's views. Overall the results are promising in terms of the potential to address and overcome privacy concerns to enable older adults to further utilise these technologies for improved mental, physical and social health. Implications are also discussed for future research and usage within the older adult community.

8.3 Introduction

Social media technologies, such as Facebook and Twitter, have experienced widespread uptake by users worldwide since their relatively recent introduction as platforms for online peer-to-peer communication and information sharing. More recently, the utilisation of social media technologies for health information dissemination has been explored (Steele, 2011) and it has been found that social media postings do refer to many types of health-related information (Dumbrell & Steele, 2013). According to recent reports such as Zickuhr and Madden (2012), there has been a large increase in the proportion of older adults (aged 55 and over) that are adopting social media technologies and using them as a means of socially connecting with others. In addition, with the ageing population of the world (and thus Internet users), it can be noted that the use of these media for older adults to access health information can potentially provide benefits in relation to physical and mental health and general well being for individuals.

Whilst there are many potential benefits that could result from the use of social media, there are issues that must be explored that possibly affect older adults' willingness to use these technologies. One of these major issues is concern about privacy, which has been consistently identified as a barrier for older adult use of the Internet and social media systems. These privacy concerns have also been investigated with online users and the access and sharing of digital health information (Fink & Beck, 2013; Park, 2013). In addition, the recent revelations of Web-based breaches of privacy, as well as the development of laws in relation to online privacy, can potentially affect the perceptions and uptake of use of these technologies by older adults.

Therefore further research must be carried out to uncover the specific reasons for the concerns and barriers affecting use.

In this chapter we describe results from a study that was carried out to identify and analyse the effects of introducing social media technologies to an older adult participant sample group (aged 55 and over). The broader goal of this study was to consider whether or not the use of these technologies had any impact on the levels of social isolation and loneliness of older adults. With this as an underlying context, the purpose of this chapter is to explore and analyse the privacy perceptions of these older adults when using Twitter, Facebook and Skype within this study. The study was carried out involving 150 older adult participants, who were free to use these different technologies during a six-month trial period after they were provided with initial training. Quantitative data was gathered from the pre and post questionnaires, and results such as security perceptions and usage rankings of the respective social media technologies were identified. From the qualitative data collected from both questionnaires and the focus groups, recurring themes were identified, and sub-themes within these themes were also identified. These themes and sub-themes are also compared to the existing literature to assist in analysing our findings as well as to identify current gaps in knowledge on this area.

8.4 Background

It is believed that technology usage and adoption amongst older adults will continue to grow, as the majority of baby boomers have already used computers (Harkin & Huber 2004), and are also likely to have more exposure and experience with information technologies. However previous

studies indicate that the older the individual, the less likely they are to have interest and experience in using computers (Brosnan, 1998; Billipp, 2001; Czaja & Lee, 2001). Moreover, it has been found that older adults are likely to experience fear and anxiety when interacting with computers (Ellis & Allaire 1999). However it is envisioned that the future older generations may not experience the same level of anxiety and fear that current older generations experience as many baby boomers already have experience with technologies before their retirement. For example, many of them have already used computers and email due to the prevalence of technologies in today's environment, and those below the retirement age and still working are likely to be influenced by the use of new technologies in their workplace (Harkin & Huber, 2004). Recently it has been found that half of adults aged 65 and older are now online, and one in three of these online users are on social networking sites such as Facebook (Zickuhr & Madden, 2012).

A previous qualitative study (Steele, Lo, Secombe, & Wong, 2009) was conducted upon a group of senior participants, aged between 65-85 as an exploratory investigation of their perceptions, attitude and concerns towards wireless sensor network technologies in terms of their application to health care. It was found that while older adults perceive sensor networks as a viable solution enabling "ageing-in-place", their acceptance towards a technology was mainly based on its cost and their ability to interact with that piece of technology. Some of our previous findings, in particular those that provide an indication on factors determining an older adult's acceptance of technologies, were considered in designing this study.

The perceptions in relation to online privacy and related issues have been found in previous studies of older adults and Internet use. Gatto and Tak (2008) found that there were varying

levels of mistrust experienced by older adults when using sites like Google, Yahoo, and health-related Web sites. These privacy issues caused many older adults to avoid activities on the Internet that required personal information, as well as question the trustworthiness of retrieved information from these sites.

8.5 Methods

This investigation made use of an analysis of the previous literature, then surveys and focus groups to collect and subsequently analyse data from participants drawn from the older adult population. The research project was advertised in local newspapers, local radio, magazines, local seniors clubs and other community groups, as well as sent to the large Senior's Card (a purchase discounts card issued by State and Territory governments) mailing list. Initially, approximately 230 individuals responded to these advertisements. A further screening telephone interview was carried out on these initial individuals, asking relevant questions about various factors such as: computer literacy, current use of social media technologies, access to the Internet, living arrangements, vision impairment and level of social isolation. From these individuals, 150 participants were selected to be a part of the research project. The selected participants were those: matching the 55 and over age requirement, indicating higher levels of isolation, living in their own home / not a seniors facility, with no or the lowest levels of existing use of social technologies, and those indicating they had access to a computer with Internet either at home or from a public facility.

Participants were recruited mainly from the Sydney metropolitan area but also from two regional locations where training in the technologies could take place. Following this screening-based selection, Sydney-based participants formed the majority with 127 participants, and with other participants coming from the two regional locations, north Lake Macquarie (approximately 150kms from Sydney) having 11 participants and Port Macquarie (approximately 380kms from Sydney) providing 12 participants.

Participants were divided into groups of approximately 10 people for training sessions. Each group would attend two three-hour training sessions, typically the sessions a week apart – the first teaching Twitter and Skype and the second teaching Facebook. At the commencement of the first session, participants were given a questionnaire asking them basic demographic details (e.g. age, gender, living arrangements), current experience with technology and social media sites, as well as questions in relation to loneliness, current social networks and quality of life. Participants were given the opportunity and assistance to sign up, after a brief introduction and demonstration of the potential uses, on each social media application. The instructor then went through basic functions and settings of each application following a written guide that was also provided to participants. The allocation of time required to teach the different applications was set by researchers, as it was considered that Facebook would require more time due to the larger number of settings and functions compared to Twitter and Skype.

Seven groups were comprised of participants who had indicated that they were also willing to participate in an initial focus group. These participants were notified and had consented to be audio recorded when filling out consent forms, and were again reminded of this by the

interviewer before the commencement of the focus group recording. Sydney-based training sessions were held at the Australian Seniors Computer Clubs Association (ASCCA) in the Sydney CBD, Cooranbong-based training sessions and focus groups were held at Westlakes Seniors Computer Club in Lake Macquarie, and Port Macquarie-based training sessions and focus groups were held at the Port Macquarie-Hastings Library in Port Macquarie.

After the final training session, there was a six-month period (August 2012 – January 2013) in which participants were given the opportunity to trial the use of these applications. It was reiterated to participants that it was not compulsory to use all (or any) of the applications and it was up to their personal desire to use them. During this period, participants could also request technical assistance from ASCCA in relation to any computer or online issues encountered. At the end of this trial period, participants were contacted via email that follow-up data collection was to occur. Participants in initial focus groups were contacted to organise session times in which they would complete a post-trial questionnaire and partake in a follow-up focus group. Post-trial questionnaires were mailed to the remaining participants. 110 participants completed the final questionnaire, with retrieved data from these questionnaires entered into Excel and analysed using SPSS.

Free-text and worded responses were entered into Microsoft Excel spreadsheets separately to quantitative data. A researcher manually transcribed the pre and post focus groups. Recurring themes of this collected qualitative data were identified as each participant's qualitative response data was analysed systematically.

8.6 Findings

Participants were asked about their view of the relative privacy of the three social media platforms. Skype was identified as the overall “most secure” technology in terms of privacy with a majority of respondents (78%) finding it the “most secure”. Only 14% and 8% of respondents who ranked Skype’s security found it as the “second most secure” and “least secure” application respectively. Although an overwhelming proportion of the sample considered Skype as the most secure application in terms of privacy, it was identified as only the second most used technology. From those who did use Skype, approximately half responded that they used it the most during the six-month trial period. 31% of respondents who used Skype said that it was their second most used application, with the remaining 19% using Skype the least of the three social media technologies. 28 participants chose not to use Skype.

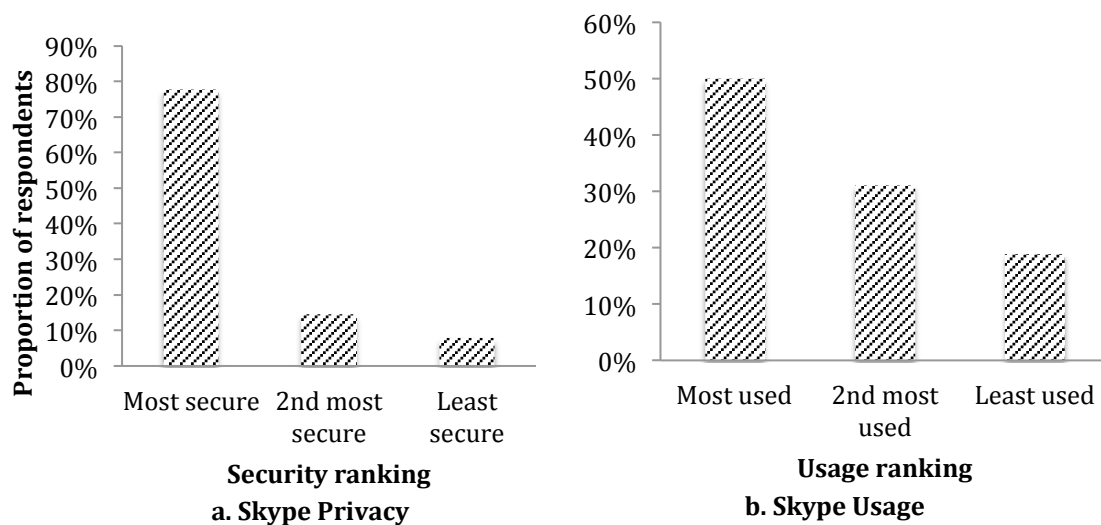


Figure 8.1 Skype Privacy Perceptions and Usage Level

Facebook was considered the “second most secure” in terms of privacy. Only 26% of participants who used Facebook responded that it was the “most secure” in terms of privacy. A slightly larger proportion of respondents (36%) identified this social technology as the “second most secure” with the remaining respondents (38%) ranking it as “least secure” in terms of privacy. Although Facebook was perceived to be significantly less secure than Skype, participants ranked it as the “most used” technology during the six-month trial period with 57% responding with this. Smaller proportions of users ranked Facebook as the “second most used” (29%) and “least used” (14%) social media application. Facebook also had the highest rate of adoption amongst the older adult sample, with only 20 participants choosing not to use this platform.

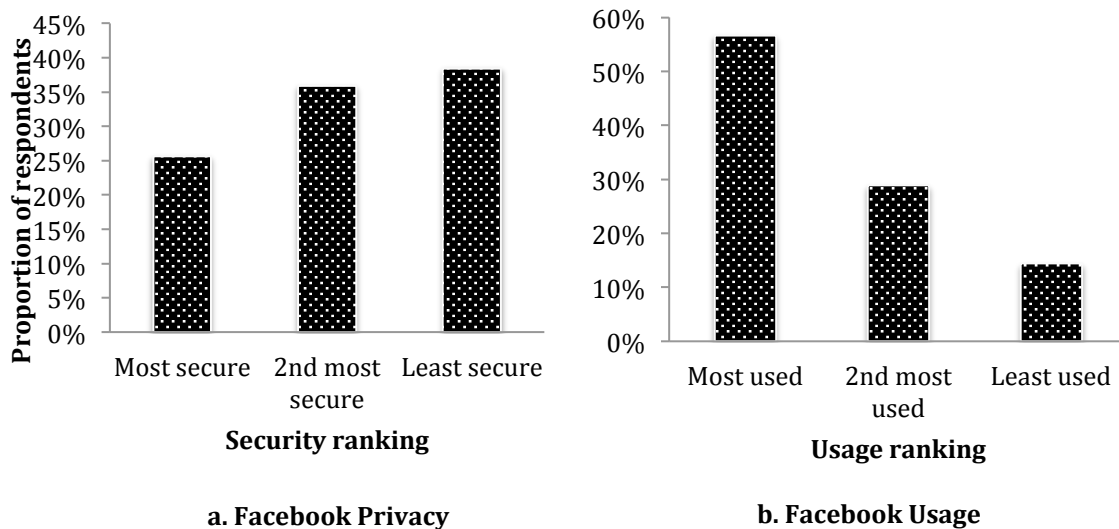


Figure 8.2 Facebook Privacy Perceptions and Usage Level

Twitter was both perceived to be the least secure in terms of privacy, and was the least used social media technology. A mere 6% of respondents ranked Twitter as the “most secure” in terms of privacy, and nearly half (49%) identified this social media technology as the “least secure” in

terms of privacy. With regards to usage, 41 participants chose not to use this social media technology during the six-month trial period. When looking at those who did use the Web-based platform, only 5% ranked it as the “most used” technology of the three available. 27% identified it as the “second most used”, whilst the majority (68%) used this platform the least of the three platforms.

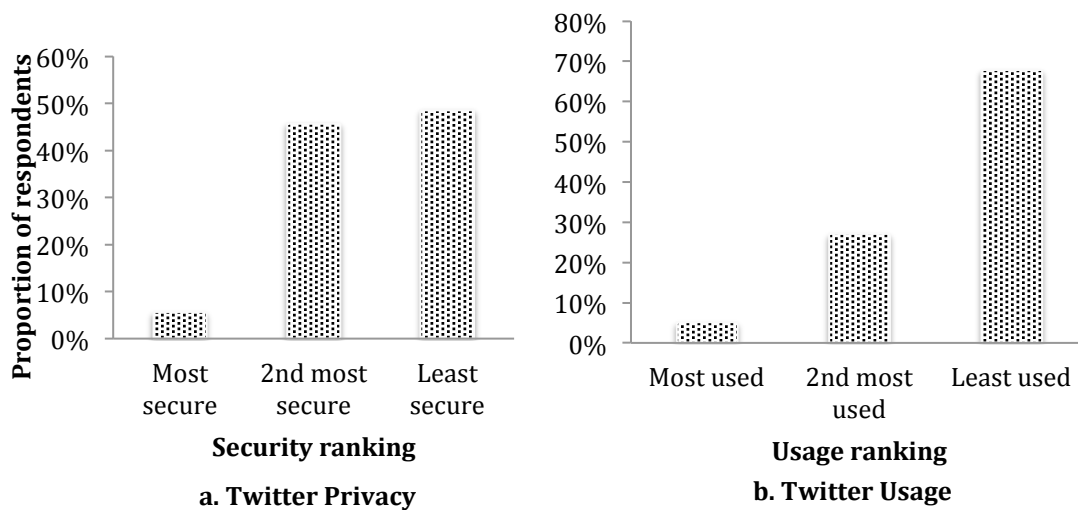


Figure 8.3 Twitter Privacy Perceptions and Usage Level

There were differing views in relation to the three platforms when comparing the technologies within each question. When asked to rank the social media technologies participants thought were the most, second most, and least secure, an overwhelming majority considered Skype as the most secure in terms of privacy (Figure 8.4b). Overall, Facebook was considered the second most secure in terms of privacy whilst Twitter was considered the least secure in terms of privacy. However when asked to rank their use of social media technologies in the six-month trial period from most to least used, Facebook was found to be the most highly used (Figure 8.4a). The

second most used application was Skype, and Twitter was the least used by the older adult trial participants. It is interesting to note that whilst there were some concerns about the use of Facebook in terms of privacy, it was the most used social media technology overall. In addition, the results from these sections of the questionnaires raised further questions such as: why Twitter had very low levels of adoption?, why Twitter ranked the lowest in terms of perceived privacy?, why Skype was seen as the most secure but was the second most used technology?. These questions are further considered based upon the qualitative analysis of the free-text responses of the trial participants described in the Discussion section.

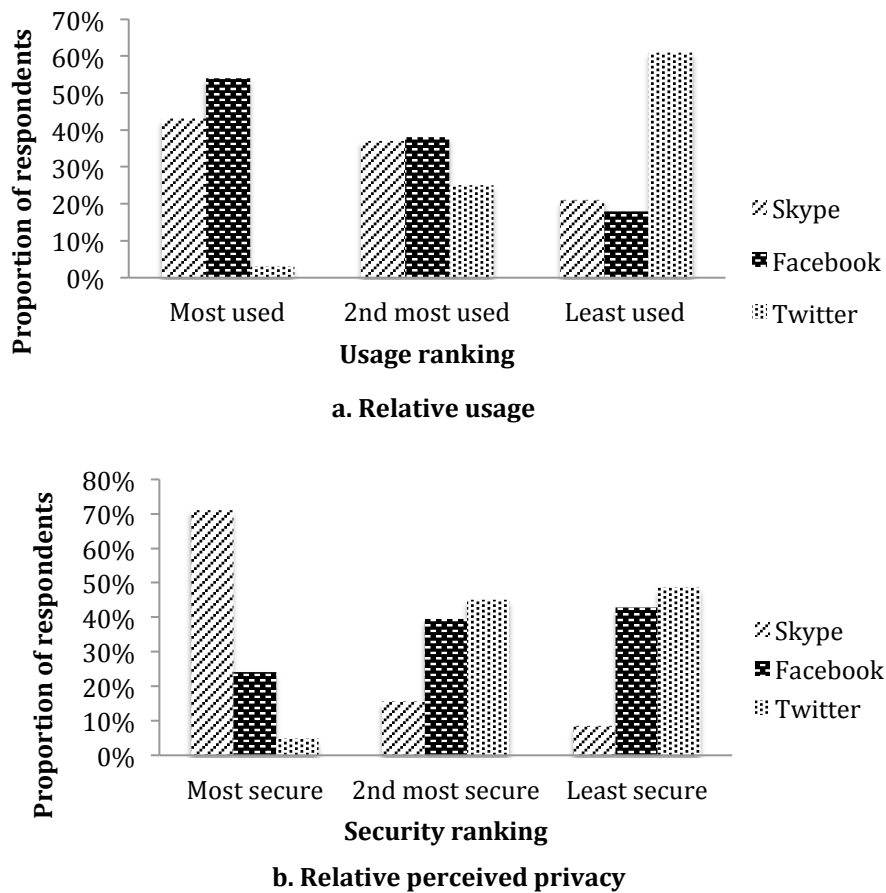


Figure 8.4 Relative Privacy Perceptions and Usage Levels

In carrying out a qualitative analysis of the open-ended survey questions we identified five broad themes in relation to the social technology privacy perceptions of the older adult trial participants: (i) user control; (ii) openness of the social media system; (iii) chosen mode of use; (iv) user interface issues; and (v) external factors. These will be further discussed, in conjunction with the quantitative results, in the Discussion section.

8.7 Discussion

As seen in the quantitative findings section, the three social media technologies used had varying privacy perceptions and levels of usage. In addition, various themes were identified from the collected qualitative data from free-text questionnaire responses and focus groups responses. These five themes and a total of twelve sub-themes are now described and discussed.

8.7.1 Theme One: User Control

User control featured in various ways in numerous participant responses. This broad theme encompassed two major sub-themes that dealt with different types of control that participants indicated affected their perception of privacy when using the technologies: control of settings and control of online contacts.

Control of Settings

A common sub-theme was the level of control of the privacy settings of the social media system, and its apparent positive effect upon perceived privacy. Facebook was considered to have the most settings to control privacy, and possibly surprisingly this led to it being perceived as superior in terms of privacy than Twitter, which had minimal such settings. Participants' responses about Facebook-related privacy settings and why this led them to consider it private included comments such as:

"Because you can change your settings"

"Can use settings to make it very secure"

"I feel I have more control and safeguards in place to feel safe using this medium. My age group are still wary of the information available to others"

Whether such settings were understood, used or appreciated also seemed to have led to divergent views as to the privacy of the social media technology. Participants who saw the use of Facebook settings as a key priority for controlling their privacy also found them to be a governing factor in using the social media technology:

"If settings not used considered to be too open "too in your face for me"

Previous studies (Shapira, Barak, & Gal, 2007) have shown that positive feelings may be caused by a sense of control and independence when older adults are using the Internet.

There was also a view that the number of privacy settings on Facebook may have overwhelmed some participants, and hence why some may have ranked the application as the least secure of the three. This raises the issue that having more settings in some cases can instead lead to a negative reaction in terms of privacy, as the complexity of these may act as a deterrent to using them and hence remove the positive impact of improved privacy via use of settings. In addition, Facebook settings that are constantly changing also create an issue of unpredictability and less confidence in relation to user control of privacy:

“[Facebook] least secure as complicated to setup security filters and facebook operators/program unreliable as often changes features (unpredictable)”

However when looking at the social media technology Twitter, it could be suggested from participant responses that the lack of settings was seen as a negative for protecting and controlling user privacy as they:

“Can be passed on - no control”

Control of Online Contacts

In addition to the control of settings, another recurring sub-theme from participant responses in relation to control was that of control of online contacts. The general theme seen throughout the qualitative data was that the more control of online contacts reflected positively on perceived

privacy, as opposed to the previously discussed varying levels of settings control leading to divergent views. When looking at control of online contacts in Skype, it could be seen that the high level of control over whom individuals could accept as a contact, not having to respond to unsolicited contacts, as well as who could find and request a certain individual to be a contact, were possible positive factors in why Skype was seen as the most secure social media technology compared to the others:

“Can limit to just family for example”

Previous research by Brandtzaeg, Luders and Skjetne (2010) found that older adults also identified having too many friends as an issue with Facebook. The inability of individuals to control what information people in their network shared and published about them (without deleting or unfriending them) was also an issue as they felt there was no control over their own personal information. When considering Facebook and Twitter, the participants in our study thought that these social media technologies did not provide as much control when compared to Skype. For example, the number of unwanted or less familiar online contacts that could be linked and pushed to that individual, was recognized by the participants in relation to these applications.

8.7.2 Theme Two: Openness of the social media system

Openness refers to the degree to which the finding and contacting of new contacts is supported or encouraged via the social media system. Two recurring sub-themes that were identified under

this broad theme were the autosuggesting of contacts, and the privacy linked to communicating with already known people.

Auto-suggesting of Contacts

Auto-suggesting of contacts was an implicit and non-configurable characteristic and capability of both Facebook and Twitter. This involved suggesting to an individual, contacts to connect with, using entered details (i.e. name, date of birth, email address) or already established online connections (i.e. mutual friends). This was generally seen to have a negative effect on perceptions of privacy, which may have contributed to why participants saw Skype as the most secure technology (as Skype only suggests to users if they would voluntarily like to find online contacts via their email address). In relation to Facebook, auto-suggesting of contacts was seen as a greater infringement on privacy, as participants were concerned about the auto-suggestion of acquaintances and unfamiliar online contacts:

“had only just connected and unwelcome faces from the past appeared”

There was also confusion as to how the social media technology knew which people to suggest to them, and this raised the questions as to the type of information that was being used to suggest these contacts:

“I felt personally exposed to potential 'friends'”

When considering the auto-suggesting of contacts on Twitter, there was not as much concern in relation to privacy as seen in relation to Facebook. This may have been due to the characteristics of Twitter to suggest organisations, companies and celebrities to follow based on personal preferences and hobbies (e.g. knitting, scrabble) rather than suggesting potential online contacts that were/might be real-life connections.

Privacy Linked to Communicating with People Already Known

Skype was perceived as the most secure social media application by a majority of the participants. This is surprising in some regards, as the common means of communication via Skype is more personal (and thus risky) than compared to communication via Facebook and Twitter (i.e. audio and video chat via Skype versus uploading photos and posting for Facebook and Twitter). This however can be possibly attributed to both the lack of openness of Skype (i.e. minimal auto-suggesting of contacts and adding people you already know details of in real life) as well as the one-to-one means of communication that occurs.

As social media technologies often promote a degree of openness, previous researchers have suggested that older adults may feel more comfortable sharing information with recipients that they are able to select from a list of actual names, rather than having previously defined groups (Lehtinen, Nasanen, & Sarvas, 2009).

8.7.3 Theme Three: Chosen Mode of Use

It was found that the chosen mode of use for each social technology often differed between the various participants (i.e. not all participants used the social media technologies in the same way as each other). The way certain participants used these applications actually altered their respective privacy perceptions for each technology. Sub-themes that were identified under this theme were: anonymity capabilities, perceived normative mode of use, and one-to-one versus one-to-many.

Anonymity Capabilities

Anonymity (or using pseudonyms) has been previously found to facilitate participation in online computer-mediated learning environments (Yu & Liu, 2009) as it creates a more equitable and safe basis for an online user to share and receive opinions and feedback (Guardado & Shi, 2007). Of interest in our study, is the impact of an anonymity capability on privacy perceptions and participation in the use of social media technologies. The word 'anonymous' was repeatedly used in responses of participants when asked about the usability of Twitter. This is because Twitter allows one to use a Twitter 'handle', which is a term that simply means a username (which does not have to reflect in any way the user's real name or identity). This was seen as a positive amongst participant perceptions of privacy, as many felt safer being able to remain anonymous and still using the social media technology:

'Needed a pen name'

'You only use a secret name'

'Using a username made me feel comfortable'

Whilst this was seen as one of the strong positives for privacy in relation to Twitter, in contrast this social media technology was overall perceived as the least private when compared to Skype and Facebook. This is an interesting finding, as both Skype and Facebook provide far less anonymity than Twitter, yet they were still perceived as more secure. This underscores that it was the user's chosen mode of use that was significant in relation to perceived privacy – many of the other trial participants appear not to have conceived that they could remain anonymous and so there was a generally low view of Twitter's privacy.

In addition, it can be said however, that anonymous participation may only occur if users are confident their identity will be protected (Richardson, Zorn, & Weaver, 2011, p. 326), and that although Twitter can be anonymous, there may be a lack of confidence by users that the technology will protect this anonymity.

Perceived Normative Mode of Use

As suggested, there were variations in both the participants' perceptions of privacy as well as how they used each social media technology. Users in some cases felt their privacy to be protected via recognizing and choosing the option to use the media for information gathering and receipt, rather than for the posting of their own information and content. This sub-theme also relates to the anonymity capabilities of Twitter, as rather than providing personal details and

sharing of one's own information, some participants chose to use this open platform as an information-gathering source:

'I do not have to disclose any details and can still enjoy reading comments'

'Used only to read other comments'

In stark comparison however, those who saw Twitter as mainly a medium for sharing information and self-posting, had perceptions that postings would be open to the public which led to significant privacy concerns:

"Twitter is last, all tweets are in the public domain so you have no choice in who reads your information"

This can be compared to respondents who identified and opted to use the technology solely or largely for the receipt of information – this appears to have hence led to a more favorable conception of Twitter's privacy. Whether this is applicable to Facebook and Skype is not as clear, as both these social media technologies require some sort of two-way interaction (i.e. post and read) when compared to the type of interaction provided by Twitter (i.e. able to read, don't have to post).

One-to-one versus One-to-many

There are various modes of communicating via these social media technologies. Communication can be done on a one-to-one basis (i.e. private/direct messaging on Facebook and Twitter, one-to-one chat and video calls on Skype) or a one-to-many scale (i.e. posting a micro-blog post or 'tweet' on Twitter, updating one's status or uploading a photo on Facebook, participating in conference calls on Skype). Participants did not see the communication through Skype as an issue for privacy, and were even open to the use of video cameras, which may have been why it was ranked as the most secure technology because of its "one to one" or "personal" nature:

"Because its one to one"

"Personal"

Although the one-to-one means of communication on Facebook and Twitter were made known to participants, a majority of responses focused on the one-to-many aspect of these technologies. Some participants found issues with what they posted being able to be shared with friends of friends (if statuses or photos were shared by their friends). Although others seemed to acknowledge that this was a risk of posting on Facebook, and embraced the one-to-many communication that the application provided:

"Its all there for all to see! I admit though I use it the most!"

Whilst direct messaging was understood by some users to add privacy, the public nature of Twitter and the micro-blog post were a concern. More so than Facebook, participant perceptions of Twitter and the one-to-many nature of public posting negatively affected the perception of privacy of those that chose to use Twitter for sharing information. The terms 'follow', 'followers', and 'following' used on this application was also an issue that affected perceptions of privacy amongst the older adult participants:

"Don't much like the concept of followers or following or being in public domain online"

8.7.4 Theme Four: User Interface Issues

The design and interface of social media technologies is important for functionality, usability, and generalizability. However many older adults found various issues with these interfaces, and thus this affected their perception of the applications' security in terms of privacy. The two sub-themes found within this broader theme were: the effect of perceived familiarity of the technology and issues with the changing of interfaces.

Perceived Familiarity of the Technology

A sub-theme that was positively associated with privacy perceptions was the perceived familiarity of the social media technologies. Pfeil, Zaphiris and Wilson (2009) investigated the needs and preferences of older adults in relation to online support. One technical issue that was brought up was the unfamiliarity of the Web-based technology for support, with most participants

in that study stating that they would rather use a telephone or meet face-to-face. In our study, it can be seen that there was a relatively high uptake of Skype as a communication technology, even though it is a Web-based application. However, when analysing participant responses about Skype, it was suggested that the application tended to be perceived to have similarities to the telephone, and this appeared to lead to less privacy and security concerns.

“Skype is most secure, as it works like a phone”

This may suggest another possible reason as to why Skype was perceived as the most secure social media technology of the three, as aspects of the application can be perceived to be more familiar to older adults (e.g. calling, answering, speaking directly to the other person by the telephone) whereas the other two communication abilities provided by Facebook and Twitter (i.e. posting) are less similar to traditional communications. However this familiarity with technology may have had a carry-over effect – as participants used video chat on Skype, and because this function was also available on Facebook, this may have made Facebook seem more familiar than Twitter (which might also be a factor as to why Facebook ranked as the second most secure technology).

Changing Interface

There were issues found with the constant re-designing and re-invention of both the look and the functionality of the social media applications. As with the perceived familiarity issue affecting privacy perception, changing interfaces may be a greater problem potentially for older adults.

Not only may this make these social media technologies harder to adapt to and use, but these changing interfaces may also raise privacy concerns for older adult users. Facebook was one of the technologies that provided the greatest issues with changes to interfaces even during the training period, where some participants had signed up with Timeline (a newly introduced Facebook design) and others had signed up with older interfaces. Those who had signed up with older interfaces had to change over to Timeline during the six-month trial period, and this change of interface may have caused a negative impact on privacy perception as well as use:

“I was just getting to understand Facebook when they changed the format. I have rarely used it since.”

However some participants acknowledged that some of the changes made by Facebook (such as in the account and privacy settings) were reflective of the social media technology responding to potential threats by providing options for better and more suited security protections. The changing interfaces of various social media technologies are not the only interface issues that have been identified by previous work. However it can be seen in previous studies that older adults may find support to overcome usability problems if they see benefits of the platform to meet their needs (Fuchsberger, Sullner, Moser, & Tscheligi, 2012). Therefore future studies may focus on the effect of technological support on older adult perception of privacy.

8.7.5 Theme Five: External Factors

There were also external factors that affected the perception of privacy identified by the responding participants. Unlike the first four broad themes, these external factors did not deal with the interactions between the social media technologies and the older adults, but rather the effects upon other outside influences that may have affected both use and privacy perceptions of these applications. The three identified sub-themes within this category were: mass media effect upon perceived possible privacy concerns, the level of training (if any) for older adults as well as the views about the social media companies themselves.

Mass media effect upon perceived possible privacy concerns

Social media technologies have had various negative media and press releases about various privacy issues and breaches of such applications (Boyd, 2008; Humphreys, Gill, & Krishnamurthy, 2010). This was reflected by the responses of the older adult participants, whom had expressed varying levels of suspicion with recent privacy-related events reported on by mainstream media. The recurring concern for using any social media technology that required individuals to provide personal information was that this information would be “leaked” for all to see:

“Seems like the entire world knows about you if not careful”

This sub-theme of our study is similar to various results found by previous literature.

Level of training or experience (if any)

The level of training and experience of participants within the sample may have also impacted on their perceptions of social technology privacy. Those with less understanding of social media sites and technology in general may have possibly found functions such as privacy settings more difficult to use. This can also be attributed to personal experience with the social media technologies – as those with more (or more rewarding/positive) experiences with these applications may have perceived a higher level of trust and a lower level of resistance in relation to privacy perceptions. One participant identified the following for resistance to using Facebook and the eventual acceptance of the social media technology with further use and experience:

“Many students resisted social media (Facebook) because of privacy, bullying and lack of knowledge on how to operate it... all students are now Facebook devotees”

The Pew Research Center’s Internet and American Life Project (Madden & Smith, 2010) released a report about online reputation management. It was found that 20% of older adults aged 65 and older (and 25% of older adults aged between 50 and 64) took steps to limit the amount of personal information available to them online. However when compared to the 44% of younger users aged 18 to 29 (and the 33% of those aged 30 to 49), it can be seen that there is a significant proportion of these older adults that either do not bother enough to, or do not know how to, limit the amount of personal information available about them online. As the privacy concerns of older adults in relation to using the Internet and social media technologies have been consistently raised throughout past literature as well as this study, we can suggest that the reason for not

limiting personal information can possibly be attributed to the lack of training or experiences of older adults on these applications, especially when compared with some of the younger user cohorts.

Views about social media companies

Another sub-theme that affected privacy perceptions of these technologies were the participant's views about the perceived motives of the social media companies themselves. Many raised issues as to where the information they posted was going, as well as why these applications asked them to fill in their real name and details (like date of birth). One of the major concerns was that of sharing photographs of family and friends:

"Something I'm worried about what Facebook will do with my information + photographs"

8.8 Implications

The research carried out provides various implications for health information delivery within older adult communities. With an ageing population comes a greater number of ageing-related health conditions, which can potentially be supported via online health information interventions. As previously identified, the proportion of older adults adopting social media technology is increasing rapidly. By identifying older adult privacy perceptions when using social media technologies, this paper can help to address the various issues that need to be considered when developing and maintaining interventions through such interfaces.

One major implication is that, with regards to health information interventions, there have been no studies observing the impact of social media technologies on specifically older adult communities. Although there have previously been studies about social media technologies and chronic health conditions relevant to the older adult community (e.g. dementia and diabetes), there must be further research specifically considering older adults due to the various, and perhaps differing, privacy perceptions as outlined above. A better understanding of older adult privacy concerns can also have benefits in improving older adult adoption of other health information technologies (Steele, Min, & Lo, 2012) that can potentially have particular benefits for this demographic.

8.9 Conclusion

From the study, of the three introduced social technologies, it was found that older adults perceived Skype as the most secure in terms of privacy. This was followed by Facebook as the 2nd most secure, and Twitter as the least secure in terms of privacy. The perception of privacy and privacy protection in relation to these applications may have possibly affected the older adult's use, as Twitter was the least used during the six-month trial period by a significant margin. However perceived benefits of use may have been a suggested reason as to why Facebook was the most used (followed by Skype as the second most used). There were various recurring themes seen within the older adults' responses with regards to privacy perceptions and their experiences with social media. After analysing the qualitative data gathered from questionnaires and focus groups, five broad themes were identified: (i) user control; (ii)

openness of social media system; (iii) chosen mode of use; (iv) user interface issues; and (v) external factors. Within these themes, twelve sub-themes were also identified and we have discussed these to consider possible reasons for such privacy perceptions and concerns amongst older adults.

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Chapter 9. #worldhealthday 2014: The Anatomy of a Global Public Health Twitter Campaign

9.1 Foreword

As noted in the literature review, there are two main types of public health events explored in this thesis. Chapter 9 presents a case study into a global health Twitter campaign propagated by the authoritative and international peak health body the World Health Organisation (WHO). With the ever-increasing uptake of SNS and reach of the information communicated on these platforms to people around the world, a significant, cost-effective and powerful tool by which online health campaigns and interventions can be delivered presents itself. On top of this, as seen in earlier chapters, the propagation of such information from self-disseminating individuals can be further explored via these campaigns; that utilise “people power” to spread relevant information rather than solely rely on the uni-directional push of information from large health information sources.

Previous online health campaigns have been minimally explored in this context due to the novel nature of this area of communication and health science. Whilst research has been carried out on email and static web-based (Gosselin & Poitras, 2008; Reed, 2009; Lim et al., 2012; Jalleh, Anwar-McHenry, Donovan & Laws, 2013) campaigns, the capabilities and functionalities of public SNS platforms present a greater foundation for investigation. As such, quantitative analysis will be carried out to calculate the reach, engagement and participation of such an online event. Content and qualitative analysis of successfully shared tweets and the roles of various categories of user types will be explored to build on findings of Chapters 5 and 6. This novel area of research

contributes greatly to SNS-based health campaigns, providing relevant entities (e.g. government bodies and health-related organisations) outcomes regarding dissemination strategies through an alternative and cost-effective opportunity of public health promotion.

The following chapter is derived from the publication: Dumbrell, D., & Steele, R. (2015, January). #worldhealthday 2014: The Anatomy of a Global Public Health Twitter Campaign. In *Proceedings of the 48th Hawaii International Conference on System Sciences* (pp. 3094-3103). IEEE.

9.2 Abstract

Public health campaigns aim to positively affect health-related behaviours and/or raise awareness of specific health conditions, risk factors or issues. These campaigns have traditionally relied upon various mechanisms, such as: mass media distribution, information propagation by individuals, involvement of stakeholders, and recruitment of ‘celebrity’ advocates. More recently, microblogging platforms such as Twitter have also been increasingly utilised for public health campaign delivery. This is a relatively recent phenomenon and so is not yet well understood or studied. In this paper we examine a case study of a global Twitter-based public health campaign, namely that involving the use of the #worldhealthday hashtag during and surrounding the 2014 World Health Day, April 7th 2014, involving a data set of over 160 million tweet deliveries. The various characteristics of this public health campaign within this contemporary medium are explored via utilising software tools that enable the capture and summarization of Twitter information flows.

9.3 Introduction

Social media and microblog systems provide a promising new medium to deliver truly global public health campaigns. The use of Twitter, and particularly the use of public health campaign-specific hashtags, has emerged relatively recently and spontaneously over the last number of years. A hashtag is an identifier preceded by the '#' symbol used in Twitter microblog posts. The inclusion of this allows for the categorisation, association and searching for of microblog posts that are about that particular subject (e.g. #worldhealthday indicates tweets about or related to World Health Day). As this is a new public health information dissemination platform, there has been relatively little formal study of the properties, characteristics or 'anatomy' of these microblog-based public health campaigns. Therefore the purpose of this study is to capture, examine and analyse data and characteristics specifically related to the online aspect of a public health campaign, to gain better understanding of such a social media-propagated phenomenon. In this paper we study the prominent global health campaign, World Health Day, and how this was manifested in terms of Twitter-based dissemination, in the case of this event on and surrounding April 7th 2014.

9.4 Background

Previous public health-related campaign research has explored the impact of knowledge awareness and effect of campaigns addressing specific issues such as mental health (Livingston, Tugwell, Korf-Uzan, Cianfrone, & Coniglio, 2013), HIV (Stekler, Baldin, Louella, Katz, & Golden, 2013) and tobacco use (Terry-McElrath et al., 2013). However these types of studies analysed

these campaigns from an audience-perspective, such as exploring the impact of the health message on its audience, and did not track other aspects of the campaign, such as full reach across a social networking sphere, general dissemination trends, sources of information, the type of highly disseminated information and the engagement of and extent of information sharing. This study will attempt to address these various aspects of an online public health campaign, rather than focusing on the perspective of the end-user.

Little existing research has been carried out in relation to microblog-based public health campaigns specifically, however the potential of such platforms for health campaigns (Rosenberg, Barnes, Bauman, & Bull, 2013) and health promotion (Loss, Lindacher, & Curbach, 2014) have been recognized due to developing technology allowing for online communication to be more interactive. There have been recent studies in relation to other Twitter-based public/government interactions (such as natural disasters and emergency situations) (Chatfield, Scholl, & Brajawidagda, 2014), but not specifically in relation to health-related campaigns. The general characteristics of the public's engagement in health-related tweeting behaviour via microblog systems have been previously described (Dumbrell & Steele, 2012; Dumbrell & Steele, 2013a). However this study aims to fill a gap in the literature by exploring contemporary health campaign delivery, and provide quantitative data and analysis of such a public health campaign the details of such having been previously relatively unexamined.

9.5 Methodology

We utilised the Hashtracking Web application (www.hashtracking.com) to capture data for this study. This tool captures real-time data by tracking tweets containing specific hashtags, which in the case of this study was set to #worldhealthday. To capture data during the campaign day itself and any substantial data surrounding World Health Day (April 7th 2014), data collection was carried out over the course of a few days, commencing at midday on April 6th 2014, and ending at midday on the 9th of April 2014. Hashtracking provided basic report generation, as well as the ability to export the collected data, which was analysed using Microsoft Excel and SPSS. This data was analysed in terms of temporal distribution, numbers of tweets, levels of engagement, account participation, account reach, numbers of participants, retweeting behaviours and frequency, amongst a number of other characteristics.

We also examined various aspects and quantifiable measures of the #worldhealthday campaign in three hour blocks. This was carried out to allow examination of how characteristics such as engagement, participation and measures of types of content distribution varied throughout the course of the campaign. The data collection period of microblog posts containing the hashtag #worldhealthday was set to between midday 6th April 2014 and midday 9th April 2014. The intention for this was to collect specific campaign related data and trends during, before and after World Health Day (7th April 2014). As the Hashtracking account's time zone is set to that of Eastern Australia, all dates and times reported throughout this document are in Australian Eastern Standard Time (AEST), with corresponding East Coast US times given in some cases. A

point of note is that Eastern Australia is 'earlier' than most of the world with regards to time zones.

9.6 Overview of #worldhealthday data

The 2014 #worldhealthday campaign data captured resulted in over 163,170,000 'timeline deliveries' during the days surrounding World Health Day (Figure 9.1). By timeline deliveries, it is meant the total number of possible times recipients of microblog posts could have seen posts containing that hashtag. 16,966 unique accounts (contributors) posted 25,379 tweets, which were received by approximately 93,227,000 unique individuals (reach) (Figure 9.2). There were on average approximately 5.9 tweets per minute containing this specific hashtag over the entire sampling period (between midday 6th April 2014 and midday 9th April 2014).

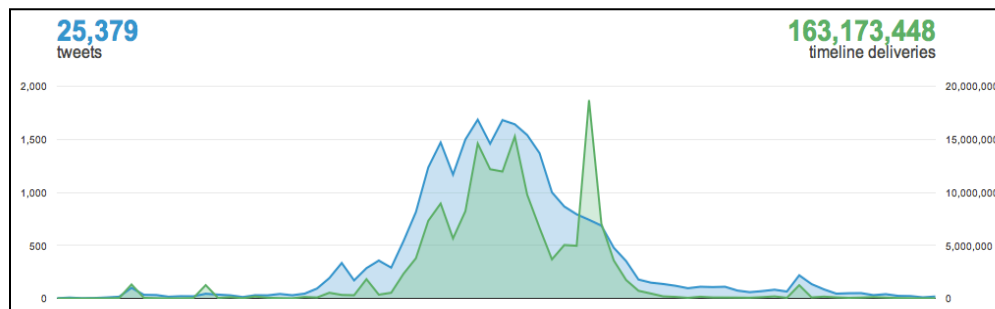


Figure 9.1 Number of tweets and number of timeline deliveries

These figures demonstrate that a public health campaign via Twitter can have a large reach to a broad audience (over 93 million unique accounts). More importantly, these figures also show that with close to 17,000 unique contributors, such public health campaigns are no longer only restricted to information dissemination by just a few large public health organisations, and

instead involve a very large number of other entities (Dumbrell & Steele, 2013b). As can be seen by both Figure 9.1 and Figure 9.2, the pattern of tweets, timeline deliveries, contributors and reach showed a broadly symmetrical pattern around World Health Day on the 7th April, however with a longer drop-off tail following the day itself in comparison with the days preceding. In addition, unusual peaks in timeline deliveries and reach can be seen within the broader main peak around World Health Day, and a number of much smaller peaks can be seen preceding and following the day itself. These phenomena will be discussed in later sections.

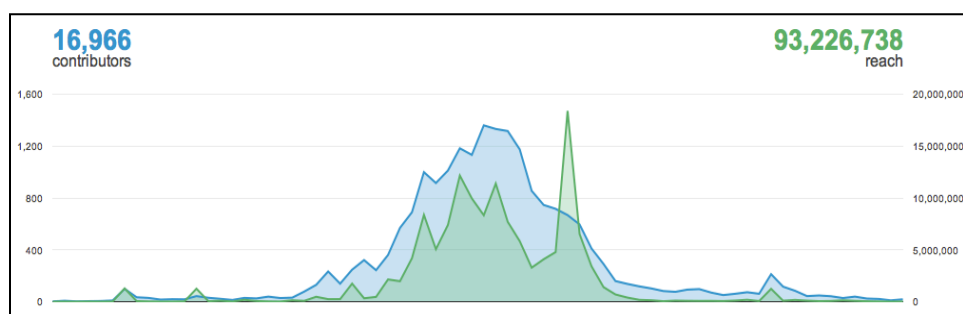


Figure 9.2 Number of contributors and number of unique individuals reached

52.35% (or 13,285) of all tweets collected with the hashtag #worldhealthday also contained other hashtags (we refer to these as co-occurring hashtags). The most prevalent of these was #just1bite (the focal message of World Health Day 2014, which relates to vector-borne diseases), with 6.7% of all collected tweets containing this co-occurring hashtag. #health (5.1%) and #malaria (2.7%) were second and third respectively. However there were other campaign-unrelated frequently co-occurring hashtags, such as #childrenofsyria and #assadwarcrimes. In relation to the words within tweets, the most commonly occurring in this set of over 25,379 tweets included expected words such as 'health', 'today', 'happy', 'day', 'people', 'diseases', 'bite', 'mosquitoes', 'vector-borne', 'threat', 'protect' and 'dengue'.

9.6.1 Tweets and contributors

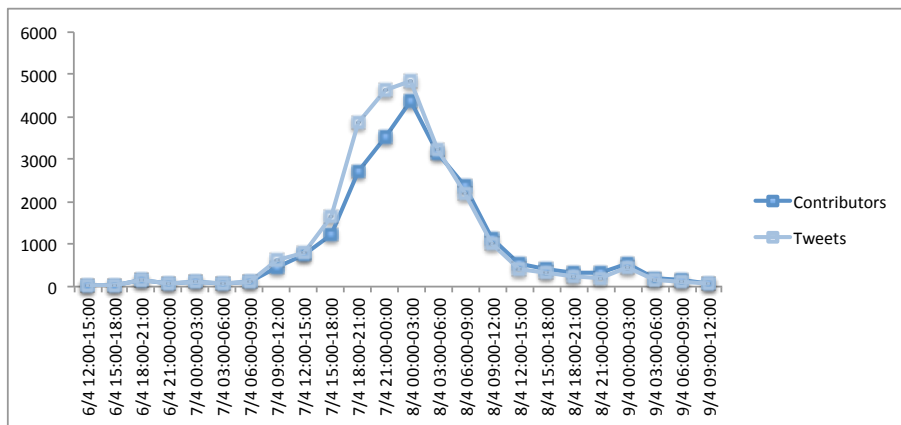


Figure 9.3 Number of tweets compared to contributors

Figure 9.3 graphically demonstrates the number of contributors, versus the number of tweets containing the hashtag #worldhealthday, in 3 hour periods throughout the data collection period surrounding World Health Day 2014. The contributor number in Figure 9.3 represents unique contributors within each 3-hour block. Again in total, there were 16,966 unique contributors during the whole data collection period that posted 25,379 tweets over the entire period. The minimum number of contributors and tweets occurred as expected in the periods substantially before and after the World Health Day, whilst the maximum number was in the period between 12am and 3am on the 8th of April 2014. This reflected a time period of morning to early afternoon on the 7th of April in the United States of America (e.g. 10am – 1pm on the East coast, 7am – 10am on the West coast). As illustrated by Figure 9.3, both the number of contributors and tweets followed a relatively similar pattern through the entire course of the data collection period, although there are a noticeable larger number of tweets compared to contributors during

the period of 3pm (7th April) to 3am (8th April) (the 1am - 1pm period 7th April on the US East coast). This means that between these times, contributors/accounts were more actively tweeting, mentioning or retweeting per account than compared to relative activity during other times.

9.6.2 Deliveries and reach of campaign

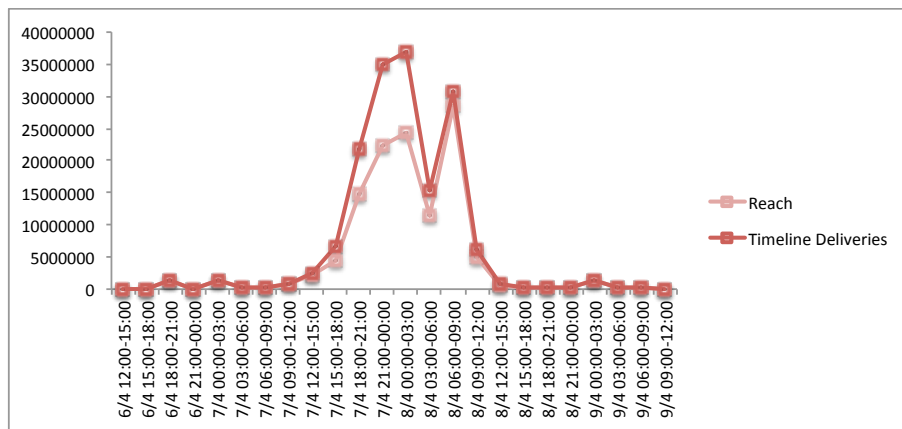


Figure 9.4 Number of timeline deliveries vs. unique accounts reached

Timeline deliveries are the total number of possible times tweets reached a user, whereas reach is the number of unique accounts receiving tweets (thus, unlike timeline deliveries, reach does not count a same account twice). For this reason, timeline deliveries were consistently higher than reach in every 3-hour block across the entire sampling period. As can be seen in Figure 9.4 however, there were various instances where timeline deliveries and reach were similar to one another. Similar to Figure 9.3 there seemed to be a larger number of timeline deliveries compared to reach between the hours of 3pm (7th April) and 3am (8th April) (the 1am - 1pm period 7th April on the US East coast). This reinforces the higher activity of contributors tweeting within this period (i.e. for accounts tweeting greater than once in this period, their reach would

remain the same but the timeline deliveries would be the reach multiplied by the number of times these accounts tweeted). There was a noticeable dip in reach and timeline deliveries between 3am and 6am on the 8th April (1pm – 4pm 7th April US East coast time), whilst as seen in Figure 9.3 there were still relatively high levels of tweeting during this period. This suggests that accounts tweeting during this period had on average relatively lower numbers of followers. There was then a further spike in the number of accounts delivered to and reached in the 3-hour block of 6am – 9am on the 8th of April (4pm-7pm 7th April US East coast time). This phenomenon will be explained in a later section.

9.7 Engagement and participation

Data for the whole campaign period shows interesting characteristics in relation to engagement and participation. Engagement refers to the way in which contributors chose to interact with the campaign via the types of tweets that were posted, whereas participation refers to the number of contributors and their relative scale of contribution during the period of data collection.

9.7.1 Engagement

In relation to engagement, more than one-third (35.14%) of the total 25,379 tweets were original tweets (Table 9.1). The remainder of the microblog posts were ‘mention’ tweets (MTs), which are tweets that refer to another user account using the @accountname syntax, or retweets (RT) which are previously posted tweets that are forwarded or shared by an account. 4.09% of the total tweets were MTs - this is considered a measure of “conversational” activity within the

#worldhealthday Twitter campaign. In addition 60.77% of tweets were retweets, demonstrating that the most common type of tweeting activity was the forwarding of original information already posted by another account. The combination of MTs and retweets (64.86%) were approximately two-thirds of all tweets captured, and this emphasizes the significant engagement between individuals during such a public health campaign utilising social media whereby original information is pushed towards others by many accounts (rather than there being only a few key accounts sending information). This also displays the advantage of this novel medium by which public health campaigns can be delivered, whereby it is possible to quantitatively assess the extent of information being generated compared to the information being shared.

Table 9.1 Engagement

	Amount	Percentage
Original tweets	8,918	35.14%
Mention tweets	1,039	4.09%
Retweets	15,422	60.77%
Total tweets	25,379	100%

The majority of tweets across all captured micro-blog posts fell under the category of ‘retweets’. Retweeting is the process where an account shares or forwards original tweets from other users to their followers, and this process hence leads to additional dissemination of information. For this public health campaign, it is interesting that nearly 61% of activity came from retweeting (Table 9.1). In fact, retweets were nearly double the number of original tweets present in the sampled data – meaning that for every original tweet, it was on average shared nearly twice as many times to other followers/audiences. Another functionality of Twitter is the ability to post

'mention tweets', where another account is 'tagged' in a tweet via using the @accountname syntax (i.e. to communicate with these users directly such as providing relevant information or answering/asking questions). Only a small proportion (4.09%) of tweets contained mentions within them. These results highlight the capabilities of Twitter and the potential research of future public health campaign delivery, where relevant information can be quantitatively captured and analysed to consider how information is being shared between members of the population.

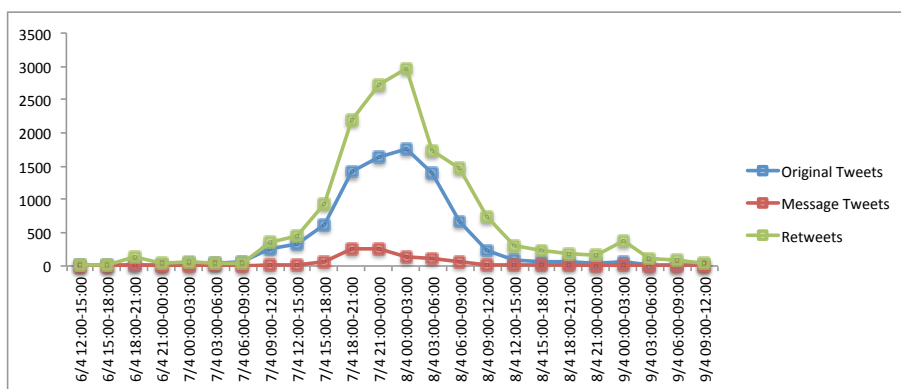


Figure 9.5 Engagement

The type of tweeting activity in terms of engagement as it varied throughout the sample period is also displayed in Figure 9.5. The amount of retweeting was consistently higher than both original tweets and message tweets throughout the campaign. A pattern can be seen, whereby starting at 9am on the 7th of April (7pm 6th April, US East coast time) retweeting becomes increasingly noticeably higher compared to the other two categories of tweets. This trend continues, with some perturbations, for the remainder of the sample period.

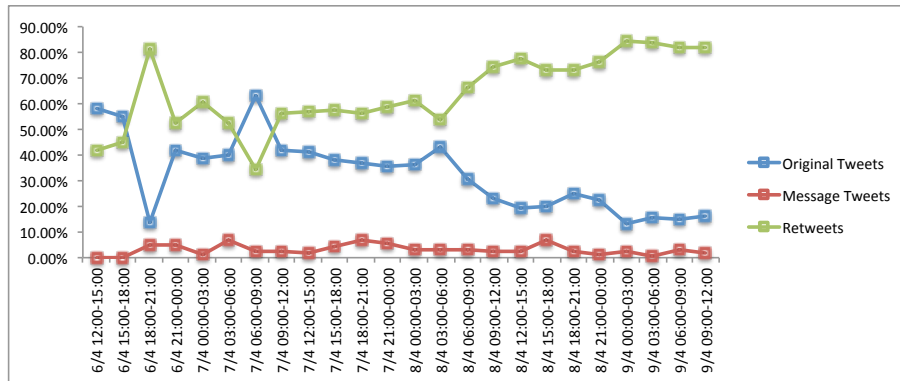


Figure 9.6 Relative engagement

Characterizing engagement in terms of the relative percentages of original tweets, retweets and mention tweets during each period of the overall sample period, provides a more detailed view of engagement. Mention tweets remained quite consistent as a proportion throughout the sample period (Figure 9.6). The period between 6pm and 9pm on the 6th of April (4am to 7am, 6th April, US East coast time) shows the largest proportional peak of retweets, which coincides with the lowest proportional dip of original tweets. When analysing the transcript during this time, there was found to be 135 total retweets, 23 original tweets and 8 MTs. From these 135 retweets however, 118 of these were of the World Health Organisation’s tweet responding to a Twitter user (@MrChrisGoh) who had shared an image of a World Health Day-related art display at London Heathrow Airport (i.e. “Thx, seems to be 1st picture of our #WorldHealthDay site” @MrChrisGoh: Get to know the little vampires! #just1bite <http://t.co/Uz2AkPmem3>”). This is an interesting phenomenon, as it shows how individuals are able to interact with large organisations (such as the WHO) through such platforms; as well as showing how these campaign-generating organisations can utilise these individuals to further propagate their message. In addition, this also shows how offline items (in this case a physical painting at Heathrow) can be linked to, and drive, sharing and communication via online media, thus further

increasing the audience of public health dissemination during such campaigns. In relation to this spike in retweeting engagement from 6pm to 9pm on the 6th of April, retweeting proportions nearly doubled (and original tweets were down by 40%) from the previous 3-hour block.

The proportion of original tweets was higher than retweets in two different time periods: from 12pm to 6pm on the 6th of April (10pm-4am 5th/6th April US East coast time), and from 6am to 9am on the 7th of April (4pm-7pm 6th April US East coast time). It is interesting to note that these also occur in the earlier stages of the campaign and data collection. The spike of original tweets that occurs in the second of these two time periods is quite interesting as this was the final time original tweets outnumbered retweets in the entire sample period. 74 of the 117 tweets during this timeframe were original tweets. 25 of these original tweets had similar messages, stating that April 7th was to be World Health Day. In fact, 23 of these 25 tweets were like the following: "April 7 World Health Day #WorldDay <http://t.co/2Hua9HdiZy> #WorldHealthDay #Just1Bite" - which linked to a site called World Days Info which provides information on a wide variety of upcoming national and international day events. Other original tweets identified were those stating simply that "today" (11 tweets) or "tomorrow" (7 tweets) was World Health Day.

The overall trend across the campaign and sample period (Figure 9.6) is that the proportion of original tweets versus retweets shows a decreasing trend as time passes, despite the rate of tweeting originally being low, rising rapidly during the peak of the event and later becoming low again. This overall trend is interrupted only by the mentioned spikes particularly the ones occurring during the earlier stages of the event.

9.7.2 Participation

Participation showed a large number of unique participants but also a highly skewed distribution. Figure 9.7 shows the trend of participation by three specific groups: the top 20 tweeting accounts, the next 80 contributors and those outside the top 100 accounts. The top 20 accounts (as ranked by number of tweets posted) accounted for 6.00% of all tweets (that is an average of 76 tweets per account). The next 80 accounts contributed a further 5.74% of all tweets (approximately 18 tweets on average for each of these accounts) and the remaining accounts accounted for 88.25% of all tweets. Table 9.2 summarizes the relative participation of these three groups of contributors. This indicates that the vast majority of accounts (the 16,866 outside the top 100) on average contributed approximately 1.3 tweets per account. This demonstrates the influence individuals can have on such public health campaigns. In addition, these results show how campaign-related information can be rapidly propagated to a large audience, when considering vast numbers of contributors outside the top 100 tweeters as well as the high number of tweets sent by a few accounts such as those in the top 20.

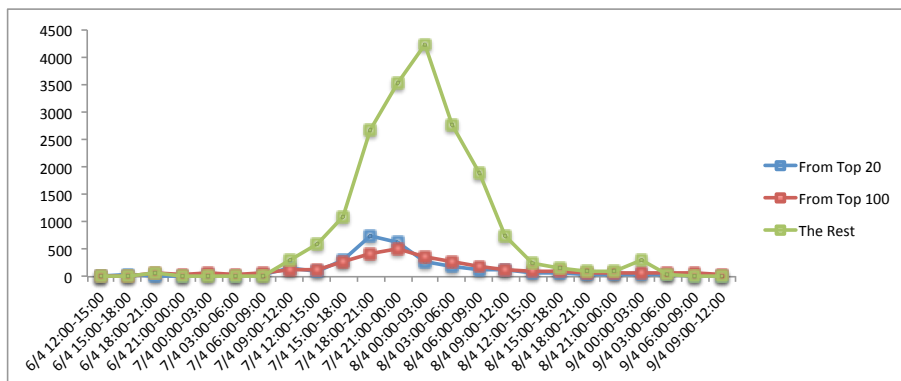


Figure 9.7 Participation of contributors

Table 9.2 Relative participation of contributors

	Amount	Percentage
Top 20	1,524	6.00%
Top 100	1,458	5.74%
The rest	22,397	88.25%
Total tweets	25,379	100%

Further indicating the skewed distribution of tweeting activity and the impact of individuals in the dissemination of campaign-related information, the account that tweeted the most during the sample period tweeted 503 times using the hashtag #worldhealthday (account @sosweet196). The second most frequently tweeting account (@AshaLama85) tweeted 142 times using the #worldhealthday hashtag. It is noted that approximately half of the top 20 tweeting accounts were individuals without (publicly known) health backgrounds and with no identified direct association with World Health Day.

9.8 Content distributed

9.8.1 Tweets containing links

Of the total of 25,379 tweets sent, 10,874 (42.85%) contained links/URLs to Web pages (Table 9.3). The highest number of links present in tweets was during the 3-hour block on the 8th of April from 12am to 3am (10am-1pm, 7th April, US East coast time) (Figure 9.8). This also corresponds with the period of the greatest number of tweets and unique contributors (Figure

9.3). However in most cases during the sample period, tweets without links were more numerous than those with links. Previous research has found that a high proportion of the tweets of health organisations include URLs (Steele & Dumbrell, 2012). Table 9.4 provides information on the most commonly distributed linked-to Web pages, which is an indication of what types of information were most commonly being distributed within the campaign. This linked-to information can be considered to be ‘in-depth’ information, as these are Web pages that were referred to, in comparison with the text within tweets themselves that is limited to only 140 characters.

Table 9.3 Proportion of tweets which linked to Web pages

	Amount	Percentage
Tweets w/ links	10,874	42.85%
Tweets w/o links	14,505	57.15%
Total tweets	25,379	100%

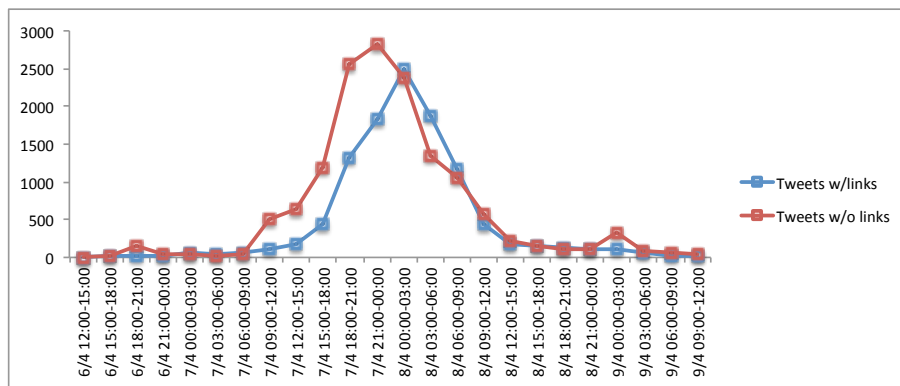


Figure 9.8 Number of tweets with Web-links

We analysed the top 15 disseminated URLs from the collected data. The analysis showed the interesting characteristic of some frequently distributed content not being directly relevant to

the 2014 World Health Day. This shows a potential lack of precision in how the distribution of information occurs through such social media campaigns. This also highlights that such campaigns are inherently not completely controllable by the originating organisation(s), due to the propagation of information being carried out by various independent individuals and organisations. For example, the most highly disseminated URL in the collected dataset in terms of number of retweets related to 'golden rice' a genetically engineered variety of rice that is designed to address Vitamin A deficiency. However, the URL is to a Greenpeace article and this article is in fact critical of golden rice. The second most highly disseminated URL is a petition in relation to promoting all to have access to affordable medicine. And for example, the fourth most highly disseminated URL is an article from the World Economic Forum titled 'How can humans bite back at mosquitoes?', which is directly relevant to the World Health Day 2014's theme, namely tackling vector-borne diseases.

Another widely distributed URL was a Travel Magazine article titled '10 Natural Remedies for Travellers', which appeared twice in the list of top 15 URLs (which may have been due to slight variations within the URLs). Nevertheless, the majority of the top 15 most disseminated URLs were directly about World Health Day or topics related to its specific theme in 2014, namely vector-borne disease. It is also interesting to note that quite a number of these highly disseminated Web pages contained further links for donations. This shows that through this medium, other health organisations may benefit by becoming involved in the campaign by actively tweeting and targeting an already involved audience of this large-scale campaign. Similarly, previous social media-related public health campaigns have resulted in significant fundraising-related activities (Dumbrell & Steele, 2013a).

Table 9.4 Top 15 disseminated URLs

URL	Source	Times shared
http://www.greenpeace.org/international/Golden-Rice/#food	Greenpeace	292
http://accessourmedicine.com	Mindset Foundation	271
https://www.healthiergeneration.org/live_healthier/	Alliance for a Healthier Generation	267
http://forumblog.org/2014/04/world-health-day-fight-against-malaria-mosquitos/?sf2489185=1	World Economic Forum	222
http://www.virgin.com/richard-branson/world-health-day	Virgin	187
http://www.youtube.com/watch?feature=player_embedded&v=LutGFrwysRI	World Health Organisation	107
http://www.thetravelmagazine.net/i-4966--10-natural-remedies-for-travellers.html	The Travel Magazine	100
http://www.globalfundforwomen.org/what-we-do	Global Fund for Women	75
http://www.slideshare.net/CiscoBusinessInsights/mobilizemag-healthcare-and-mobilityand-new-advancements-lead-to-better-patient-care	CISCO	70
http://www.wateraid.org/uk/what-we-do/the-crisis/health?utm_source=twitter&utm_medium=referral&utm_content=what_we_do_health&utm_campaign=world_health_day	WaterAid	66
http://www.thetravelmagazine.net/i-4966--10-natural-remedies-for-travellers.html	The Travel Magazine	65
http://edition.cnn.com/2014/04/07/opinion/world-health-day-beating-diseases/index.html	CNN	63
https://www.facebook.com/media/set/?set=a.727397897305596.1073741868.154163327962392&type=1	World Health Day	58
http://www.unwomen.org/en/news/stories/2014/4/women-living-with-hiv-in-ugandas-slums	UN Women	56
http://www.oxfam.org/en/grow/pressroom/pressrelease/2014-04-07/emissions-must-be-cut-if-we-are-to-tackle-hunger	Oxfam International	52

9.8.2 Tweets containing media

Table 9.5 Proportion of tweets with media

	Amount	Percentage
Tweets w/ media	5,884	23.18%
Tweets w/o media	19,495	76.82%
Total tweets	25,379	100%

A little less than a quarter (23.18%) of the 25,379 tweets contained embedded media such as images or video (Table 9.5). With over 17.8 million timeline deliveries, an image of a mosquito being held in a transparent container was the highest media item potentially seen by those it was pushed to. The most highly retweeted image (303 times) however was a picture of a child drawing a cartoon (relating to ‘art therapy’ for Syrian children). This reinforces how the content disseminated may not always be focused on the campaign topic, but the campaign can be used to disseminate information to an already established audience by including #worldhealthday in posts. In addition, three of the four most highly retweeted tweets were written in a language other than English, a further indication of the global nature of such a microblog-based campaign.

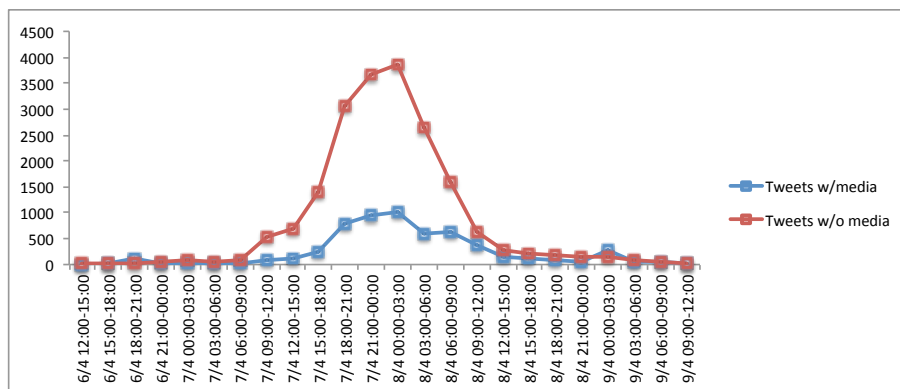


Figure 9.9 Number of tweets with media

9.9 Popularity and celebrity

From the collected data, there were interesting patterns in relation to the impact of high profile organisations and individuals that contributed to the campaign. 'Popularity' may be defined by the level of interaction of an account, and can be measured by the total number of MTs plus retweets. By this measure the most popular account was the World Health Organisation account itself (@WHO) with 2,563 MTs and 349 retweets (Table 9.6). Although this account was classified as the most popular, it only sent 8 tweets (that included the #worldhealthday hashtag) in total during the sample period and ranked 11th for the number of retweeted tweets alone. This demonstrates the impact of perceived authority of an account on subsequent tweeting activity (particularly engagement) of others. This is also an interesting finding - although the WHO did not have the highest number of tweets or retweets, the organisation had the highest number of MTs and thus was the most referred to account during the data collection period. This finding may also possibly demonstrate the importance of both offline and online presence, with contributors identifying the campaign with the originating organisation.

Other accounts that ranked high in terms of this measure of popularity included: celebrities and well-recognized individuals (Richard Branson, David Bisbal), well-known organisations (Greenpeace, USAID Global Health, UNICEF), popular health-related accounts (Dr. Ryan Thamrin, Blog Doktor) and bodies/accounts that were relevant to the campaign (such as Apollo Hospitals, the account description of which indicates it is related to integrated healthcare in India). Also in the top 10 however was an account predominantly in Arabic that based upon its account

description could have been related to the ‘General Intelligence Department’. This again exemplifies the international reach of such a public health campaign, and how Twitter can provide an open platform for global communication in such situations.

Table 9.6 The top 10 most popular accounts

Account	MTs + RTs	MT	RT
WHO	2912	2563	349
Apollo Hospitals	2108	1298	810
Richard Branson	1002	525	477
David Bisbal	964	501	463
Greenpeace	634	321	313
dokter Ryan Thamrin	589	298	291
UNICEF	575	311	264
USAID Global Health	563	310	253
جهاز المخابرات العامة	552	277	275
BlogDokter	535	282	253

Table 9.7 presents the top 10 accounts that had the broadest reach in relation to microblog posts with the hashtag #worldhealthday. The reach represents the number of unique accounts that received or will receive a direct post from an account (i.e. the number of followers a specific account has is an equivalent measure of that account’s reach). In our sample period, the greatest reach was in fact achieved by the well-known public figure Bill Gates (@billgates). Whilst Bill Gates sent only one tweet, he had over 15,500,000 followers at the time of data collection. This achieved the highest total reach (and timeline deliveries) by one account during the whole one week period studied. In fact as seen in Figures 9.1 and 9.2, the tweet by Bill Gates created a

prominent spike in timeline deliveries and reach during the declining phase of the World Health Day event. This single microblog post may also have been a factor in contributing to further discussion toward the later stage of the campaign (thus creating a longer drop-off tail than compared with the days preceding the World Health Day). The third highest reach was achieved by another well-known individual, Sir Richard Branson (@richardbranson), who sent only three tweets but had over 4,000,000 followers. This shows the high impact in a microblog system of high profile individuals, which has also been considered previously (Dumbrell & Steele, 2013a) with their distribution capacity often exceeding that of large and prominent organisations. The World Health Organisation (@WHO) for example at the time of data collection had approximately 1,200,000 followers, and even with the 8 tweets they had sent throughout the campaign, still had less timeline deliveries than the single tweet by Bill Gates.

Table 9.7 The top 10 accounts with the highest reach

Account	Followers (Reach)	Timeline Deliveries	Tweets
Bill Gates	15552222	15552222	1
David Bisbal	6281311	6281311	1
Richard Branson	4021687	12064644	3
UNICEF	2639275	2639275	1
Pau Gasol	2530231	2530231	1
The Guardian	2089335	2089335	1
World Economic Forum	2071890	4143694	2
CNN International	1947806	1947806	1
Farah Khan	1272577	3817539	3
WHO	1198342	9576739	8

It should be noted that every one of the top 10 reach accounts in Table 9.7 had been ‘verified’ (i.e. the process carried out by Twitter to confirm a user’s account as authentic); whereas six accounts in the top 10 most popular accounts (Table 9.6) were verified. As per previous work (Dumbrell & Steele, 2013a), the impact of ‘celebrity’ tweeters was shown to be high. This yet again provides an indication that microblog distribution channels are not as evenly balanced or ‘democratic’ as may typically be assumed. It also shows that there may not be a direct link between the reach of these celebrity tweeters and their popularity (similar to level of engagement). Although @billgates ranked first in terms of reach, he did not appear in the top 25 in terms of popularity (engagement). On the other hand @richardbranson appeared third in terms of reach, but also appeared third in terms of popularity (engagement).

Table 9.8 The accounts originating the 10 most retweeted tweets

Account	Number of times tweet retweeted	Timeline deliveries
David Bisbal	479	317399
جهاز المخابرات العامة	316	861200
World Economic Forum	292	15799813
dokter Ryan Thamrin	288	80185
UNICEF	279	369139
Richard Branson	270	367554
Greenpeace	192	262448
Time to Change	163	137816
Bukhari and Muslim	151	364037
Quran in English	136	497575

This may be also explained by analysing the semantic nature of their tweets. Bill Gates single tweet was actually a retweet “RT @davos: How can humans bite back at mosquitoes? <http://t.co/CRCWXnaMej> #worldhealthday #wef <http://t.co/sDngkybt7S>” from the World Economic Forum, which was not original content from himself. On the other hand, Richard Bransen tweeted information about his company Virgin and their work related to the campaign “From healthcare to motorbikes: This #WorldHealthDay, meet an inspiring Kenyan entrepreneur <http://t.co/465EWId3zW>” and “How entrepreneurs & business are tackling healthcare in rural Kenya <http://t.co/465EWId3zW> @WHO @christian_aid #WorldHealthDay”, as well as tweeting an interactive petition “For #WorldHealthDay, I declared medicine must be affordable for everyone. Sign to add your voice: <http://t.co/iSy80E714t> #accessourmeds”. These tweets were the 18th, 12th and 6th most retweeted tweets respectively. Similar to previous findings, influence of an account can not necessarily be judged simply on the number of followers a user has, rather on other factors such as level of community interaction and level of retweeting (Cha, Haddadi, Benevenuto, & Gummandi, 2010).

Finally Table 9.8 suggests the dissemination power of an account in the public health campaign is not simply a matter of reach (number of direct followers) or number of mentions or retweets. Table 9.8 lists the accounts from which the 10 most retweeted tweets originated. A tweet from the World Economic Forum (WEF) whilst being only the third most retweeted and WEF ranked only 7th in reach, had a number of timeline deliveries (including those from retweets) that was over 18 times greater than the tweet with the second most timeline deliveries. This may also suggest the dissemination power of organisational accounts, that amongst their not insignificant numbers of followers may have many other significant organisational followers and famous

individuals as followers who may also retweet their content e.g. Bill Gates being one example in the case of WEF.

9.10 Discussion

The World Health Day 2014 Twitter campaign demonstrates a mixture of large and small organisations, famous individuals and many other members of the population contributing in a complexly interconnected distribution of (largely) public health-related information. Despite the large participation of over 17,600 unique accounts, it can be seen that individuals and organisations with well-established real-life and online presences have a large influence on the propagation of such campaign information. It could also be argued that through a different medium (such as television or print), these public health campaigns may not have involved such a large array of individuals or organisations in the dissemination of information.

It should be noted that with over 93 million unique accounts being reached that the reach of such a campaign is immense, but also that with there being approximately 17,600 unique contributors, the overall balance is still heavily on the side of receipt of information rather than generation/distribution of information. However this does also show a hitherto unseen number of individuals and organisations engaged in public health information dissemination in comparison with mass media campaigns. Another noticeable characteristic of the #worldhealthday campaign via browsing the full tweet transcript, is that there are very few informal or 'humorous' tweets. For this campaign, the tweeters concentrated on disseminating information, and commenting on the World Health Day. This might be expected given that the topic of World Health Day and

vector-borne diseases is a serious one, but the lack of informal or 'trivial' content is also at odds with some perceptions of the types of information that can be disseminated via Twitter.

Although mention tweets were 4.09% (or 1,039 tweets) of the entire sample, this was still a substantial subset of the entire sample. Mention tweets are important as they represent the direct communication and interaction between specific and identifiable accounts. Unlike reach, mentioning accounts in a tweet represents an attempt to communicate with a specific account/individual. It should be noted that the World Health Organisation account was mentioned 869 times from the 1,039 mention tweets (here referring just to mentions that occurred not within a retweet) – meaning that this account was mentioned in the vast majority (80%) of all mention instances. This makes the @WHO account the 'conversational hub' of the campaign and demonstrates that it was the account that the largest number of individuals recognized as the account they wished to directly communicate with. This does suggest the role of offline knowledge, in affecting the behaviour of those participating in a micro-blog-based public health information campaign.

The campaign can be considered to have raised public health awareness, but a future research challenge is to further quantify this level of awareness raising. In addition, a further challenge is to understand how this widespread distribution of information may have affected behaviour or actions of recipients.

9.11 Limitations

As this study utilised the hashtag #worldhealthday to capture data, tweets relating to the campaign but not using this hashtag would not have been included in our sample data (e.g. the phrase “World Health Day” may have been excluded by using these parameters). However, this was justified as creating filters based on words such as “World” “Health” and “Day” may have led to the inclusion of data irrelevant to the specific campaign. Therefore, the use of the hashtag may have ignored possible relevant tweets about the campaign, but would also have assisted in the filtering out of unrelated data.

Another limitation was that the data collected was only from Twitter. As this campaign is widespread across various other social networking sites, such as Facebook and Instagram, our sample does not include data from these systems. However we do not claim that our research involves the collection and analysis of online World Health Day data across all online media, but just across one of the most predominantly used networks for these types of campaigns

9.12 Conclusion

Due to the relatively recent and novel role of micro-blogging technologies in public health information dissemination, little has been studied about such public health campaigns in terms of temporal patterns, engagement, participation, information propagation and user characteristics. World Health Day is a well-known annual public health event, which has only recently (alongside various other campaigns) made use of online applications such as Twitter to spread its

message(s). Our study has explored various characteristics of this campaign such as the number of users contributing and being reached via the campaign, engagement and participation of users, the type of content distributed, and the effect of ‘celebrity’ tweeters on such a campaign. Notable results were not only the wide reach of the campaign, but also the extent of engagement and participation by individual entities to propagate information using the #worldhealthday hashtag. In addition, the influence of larger organisations and well-known public figures upon the dissemination displayed that the most ‘popular’ accounts were more campaign-relevant thus had more interaction, whereas accounts with the highest reach could generate very large dissemination with minimal tweeting due to their large online following. Also consequently through the utilisation of emerging applications such as Twitter, campaigns (such as the 2014 World Health Day) can now be quantitatively analysed and further understood, which may potentially change communication strategies of future public health campaigns.

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Chapter 10. The Effect of a Public Health Emergency of International Concern

Announcement: The Twitter Landscape during a #Zika Virus Outbreak

10.1 Foreword

The work presented in Chapter 10 follows on from the previous chapter of research in the area of public health events. The following study investigates the Twitter reaction to a Public Health Emergency of International Concern (PHEIC) announcement by the WHO regarding the Zika Virus Outbreak. Whilst many previous studies outlined in the literature review have tracked rates of disease during health outbreaks, such as minor outbreaks like the flu to large outbreaks like Ebola, none have ever specifically studied the online SNS-based response to an announcement of international concern. Similar to research of the online health campaign, this public health outbreak-related investigation involves the collection of hashtag data surrounding the event. Further analysis is performed on a random sample pulled from the one-week data collection to uncover certain trends of content shared and user characteristics in response to this announcement. The importance of the following research is to provide a landscape of the use of SNS-related information dissemination during such an event, addressing content-related outcomes and trends as well as comparing results to already investigated event-related data. Findings produced will address gaps in knowledge regarding online responses to offline announcements of international concern. Outcomes from this chapter may assist authoritative and peak government bodies and organisations in charge of such announcements to better handle responses, and by determining the best-practice of dissemination of information during similar events.

The following chapter is derived from the publication: Dumbrell, D. (2016). *The Effect of a PHEIC Announcement: The Twitter Landscape during a #Zika Virus Outbreak*. Manuscript submitted for publication in Journal of Health Communication (1st Dec 2016).

10.2 Abstract

The World Health Organisation (WHO) announces Public Health Emergency of International Concern (PHEIC) when a health crisis or disease has the potential to spread to significant global populations. On February 1st 2016, a PHEIC announcement was made concerning the virility and incremental spread of the Zika Virus. Previous literature has not explored an online response to such an announcement, thus the main purpose of this study was to collect hashtag-related Twitter data and analyse trends and characteristics pertaining to this response. 307,982 tweets with the hashtag #Zika were collected from the day of the PHEIC announcement (1st February 2016 at 00:00 GMT) and concluding one week later on the 7th February 2016 (23:59 GMT). A random sample of 1,063 tweets and their respective accounts were pulled from the collected data, with both user profiles and disseminated information being categorised and analysed in more detail. Significant findings of tweet content include the low amount of efficacy-related information being shared, the rapid decline of announcement-related conversation and the response of authoritative information to this declination during the week-long period. With regards to users, this research found a proliferation of individual accounts, a low-level of government/organisation-related accounts, and an online reflection of the geographical offline of the Zika Virus rather than actual Twitter uptake. Outcomes of this study can be utilised to inform

government policy and online strategy for relevant and effective information dissemination in future responses to such announcements of global concern.

10.3 Introduction

The communication of important international health issues has changed vastly over many years with the evolution of media platforms; from early print mass media such as newspapers and billboards, to broadcast media via the radio and television, to online and digital means through the development of the Internet. In recent times, a phenomenon known as Web 2.0 has occurred where Internet users have become creators, peer-reviewers and disseminators of information through social networking sites (SNSs). These sites are digital platforms where users form relationships and participate in such information communication. One such example of a SNS is Twitter, which has multiple capabilities and functions that allow for the qualitative and quantitative analysis of health information communication

Twitter is a micro-blogging program that involves public communication via posts called tweets. Tweets are limited to characters of 140 or less, and thus require users to be succinct or utilise hyperlinks to further websites to expand on the information provided by the tweet. Twitter is also known for its use of hashtags, words or phrases preceded by the hash symbol that identify and categorise tweets into specific topics (e.g. #Twitter, #health). Hashtags are an important aspect of Web 2.0 communication, allowing users to filter information and discuss issues that are of relevance. Users of Twitter are able to forward other users' tweets, an action called retweeting, which is a form of public acknowledgement and approval. Due to the 313 million active global

users on Twitter (Statista, 2016a), tweets are constantly being disseminated with information surrounding certain issues being updated almost immediately, thereby making this SNS appropriate for such research.

The World Health Organisation (WHO) was set up as a result of the formation of the United Nations in 1948. The organisation was established to act as the key/peak professional body whereby health concerns and issues on a global scales were identified, analysed, discussed and acted upon. As a result, the organisation is seen as an important global communicator of health and has authority on issues such as determining appropriate action to global health issues such as outbreaks. When a health outbreak or crisis has a potential global reach, the WHO declares a Public Health Emergency of International Concern, or a PHEIC. Recently the Zika Virus disease has raised international concern due to its rapid spread through parts of North and South America, islands of the Pacific and parts of Asia. The virus is mostly spread by mosquito bites but can also be spread by saliva and semen, causing a fever and more seriously microcephaly in unborn babies of infected mothers. On February 1st, 2016, the Zika Virus pandemic was declared as a PHEIC.

The purpose of this paper is to explore the response to a PHEIC announcement on an online and global scale. Due to the international nature and widespread uptake of the platform Twitter, immediate reactions and information spread relating to the PHEIC announcement of the Zika Virus could be more readily captured and analysed. Whilst outbreaks such as the 2004 Swine Flu Pandemic and 2014 Ebola Epidemic have warranted a PHEIC declaration, online responses to these have been relatively unexplored within literature. Thus it would be of interest to identify

variously unexplored trends pertaining to such an international event, as well as analyse characteristics of user and information/content disseminated in the sample of tweets captured.

10.4 Literature Review

There are various methods and sampling strategies that have been attempted with big data analysis of health issues on SNS (Xu, Wang, Jia, & Wang, 2015). Community sampling of datasets was found to deliver the best performance in terms of preserving the distribution of tweets across users, and thus retweeting and information dissemination activity. The choice to collect a sample of tweets that only contain the hashtag #Zika is a novel approach to community sampling, where the community is not from a certain city but the online social community that is discussing this outbreak. This also exemplifies the advantage of SNS-based and online research where a more globalised proportion of data can be captured, especially when compared to stratified/physical community sampling where limitations like demographics and geographical locations apply.

One major issue raised during the sampling process of large datasets throughout social media is that of unclean data (e.g. spam) being collected and included in some analysis, affecting findings and outcomes drawn from such research. To address this issue, the program selected to be used in this study is able to detect and filter out potential spam (thus self-cleaning dataset). The use of hashtags as parameters to collect relevant Twitter data for research has also been explored (Morstatter, Pfeffer, Liu, & Carley, 2013). Findings from this study uncovered potential bias when using the Twitter Streaming API, especially during hashtag analysis collected through sampling.

Therefore the hashtag method/program was utilised to have minimum impact on tweeting distributions (by retaining key characteristics of the population) in addition to reducing the data required to perform analysis on, especially as the Zika Virus outbreak and subsequent announcement classify as a large tweeting event.

Previous studies that have examined response to the Swine Flu outbreak have found that whilst users actively seek information in relation to the health issue, this becomes less common as the pandemic progressed (Tausczik, Faasse, Pennebaker, & Petrie, 2012). Similarly, another study that observed Ebola related Internet searches and Twitter data found an average time of 3 days between the first tweet regarding the disease to becoming disinterested with the online communication surrounding Ebola (Towers et al., 2015). Taking into consideration these findings, a longer time period of data collection was selected to see if similar levels of disinterest occurred from the significant event of the PHEIC announcement of the Zika Virus. It would also be of interest to observe and categorise content relating to the virus being disseminated and how these content categories respond to the announcement.

Odlum and Yoon (2015) was also a study that involved the collection and analysis of the content being disseminated during the 2014 Ebola outbreak. The authors showed that tweeting increased drastically from baseline levels as a response to certain events, such as infection spread to a new country or official messages from important government figures. The study however did not capture the response to the PHEIC of Ebola, nor tweets in languages other than English. The authors also found that most public concern tweets were about health information seeking (i.e. sensemaking), whilst health education and efficacy tweets were minimal. Efficacy-related

information is important in educating and empowering individuals to act on certain health issues, thus it would be of importance if this lack of efficacy information is reflected with the event of the PHEIC announcement.

A recent report has outlined the reaction to Zika Virus outbreaks over a 3-day period (Fu et al., 2016). The following themes were identified from the content: societal impact, organisational and public response, pregnancy and microcephaly, transmission routes and case reports. It would be of interest to examine if there are unidentified themes/content with a longer data collection period, and if this is affected by the PHEIC announcement. The rate of tweeting from different types of users should also be studied to produce a broader landscape of the communication of #Zika on Twitter. The findings from this study can be used as a blueprint when researching information communication during future disease outbreaks or emergencies.

10.5 Methodology

Data was mined from Twitter using the Hashtracking program (www.hashtracking.com). The web-based program allows for customers to collect, track, save and export hashtags found throughout Twitter over an indefinite amount of time. For the purpose of this study, the hashtag #Zika was collected for analysis. Data were collected for one week, starting from the commencement of the day of the PHEIC announcement (1st February 2016 at 00:00 GMT) and concluding on the 7th February 2016 (23:59 GMT). These times were chosen due to the discrepancies of the times of the PHEIC announcements found through traditional media sources.

The objective however was to ensure that data collection commenced prior to the announcements, hence there was allowance for noise in early stages of data collection.

307,982 tweets were collected over the week-long period of the initial Zika PHEIC announcement by the WHO. To determine the appropriate sample size of tweets required to analyse to significantly reflect the population, a sample size calculator was utilised. By setting the confidence level at 95% and using a standard confidence interval of ± 3 , it was determined that the significant sample size of tweets we required for this study was 1,063 from the population of 307,982 tweets (using the sample size calculator from <https://www.surveysystem.com/sscalc.htm>). We then assigned each tweet a number according to their chronological order of appearance (i.e. the earliest tweet was coded as "1" and the last tweet was "307,982"). A random number generator then produced 1,063 unique integers between 1 and 228,822 (inclusive), and the numbers generated that corresponded to a tweet were grouped together for further analysis.

The process of data collection was automatic and self-filtering, with spam filtering set to the highest level to avoid unnecessary tweets from being included in the final analysis. The collected tweets and related Twitter users were retrospectively collated and exported to an Excel document for further analysis, with the Twitter profiles of the users who had tweeted the 1,063 tweets being manually mined for further information (e.g. demographics, user type).

10.6 Results for #Zika

During the one-week period of data collection, there were 307,982 total tweets that were found to contain the hashtag #Zika (Figure 10.1). This was on average about 44,000 tweets per day, 1,833 tweets per hour and 30 tweets per minute. The frequency of tweets was also reflected in the dissemination and engagement found when tracking this hashtag, with approximately 6.5 billion timeline deliveries occurring across the week. Timeline deliveries, whilst not a count of unique accounts who actually received/saw disseminated information, is a metric that represents the total possible number of times users were exposed to tweets containing the #Zika hashtag. For example, if an account with 2 million followers retweeted two tweets containing the hashtag #Zika, this would count as 4 million timeline deliveries.

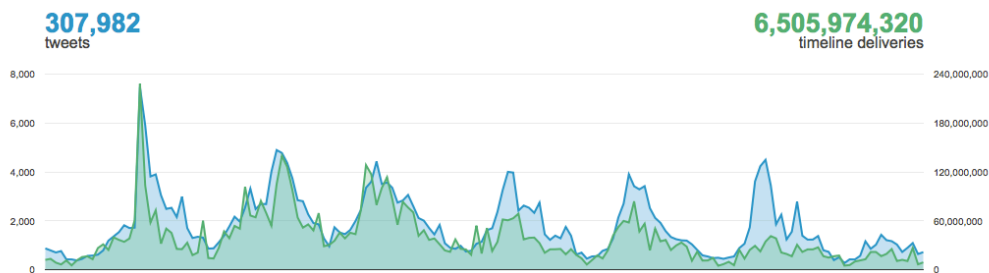


Figure 10.1 Overview of Tweeting Activity and Timeline Deliveries

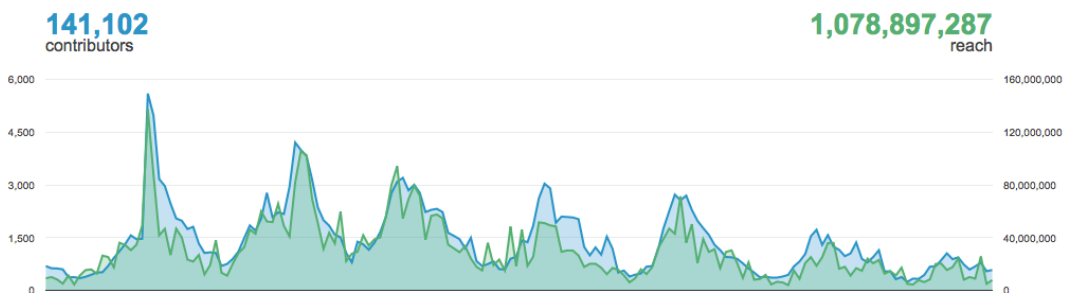


Figure 10.2 Overview of Contributors and Reach

There were also 141,102 unique Twitter accounts that had tweeted using the hashtag #Zika during this period (Figure 10.2). This shows that interest and activity surrounding this hashtag was high. The total collected tweets reached approximately 1.08 billion non-unique followers, which is significant considering both the number of existing accounts, and even more so when considering the current global population of 7.4 billion. The use of this hashtag during this period was emphasized by the announcement by the WHO that the Zika Virus was a PHEIC, which may explain the cause of a very large and rapid dissemination event.

As can be seen in both Figures 10.1 and 10.2, there was a large spike that occurred at approximately 18:00 GMT on the 1st February 2016, reflecting the immediate reaction to the WHO press release of the PHEIC announcement for the Zika Virus. This exemplifies the immediacy of such social networking systems, as several large online media sources around the world reporting the PHEIC at various times after this from 18:30 GMT to 18:30 GMT the day after (Grenoble, Almendrala, & Schumaker, 2016; RT International, 2016; ABC News, 2016; Henderson, 2016; The Hindu, 2016). Also shown in the Figures are the gradually decreasing numbers of contributors to this conversation and the users this information is disseminated to occurring after the announcement. However the frequency of tweets with the hashtag #Zika rises daily to approximately 4,000 after the initial announcement-related peak.

Table 10.1 Communicative categories of tweets

	Number	Percentage
Original Tweets	80,889	26.3%
Retweets	221,674	72.0%
@Mention Tweets	5,419	1.8%
Total Tweets	307,982	100.0%

Table 10.1 presents the breakdown of the three communicative categories of tweets mined throughout the week-long collection. More than one-quarter of the total tweets in the one-week period were original tweets, whilst less than 2% were mention or message tweets (i.e. tweets that included another user’s Twitter handle that signifies either a direct response or inclusion of an account to the information contained within a specific post). 72% (or 221,674) of all tweets were categorised as retweets, which were original tweets that were forwarded and shared amongst the sharing users’ followers. Therefore a vast majority (nearly one-quarter) of the collected tweets with the #Zika hashtag around the PHEIC were opinions, messages and certain health opinion that were passed on from either followers of a user who posted an original tweet, or those active in the Zika Virus discussion. This shows that the evaluative or peer-review nature of Twitter played a large role during the event, whereby users publicly pass judgment on whether or not certain tweets are satisfactory enough to disseminate to other users.

Table 10.2 Participation from top users as a proportion of the sample

	Number	Percentage	Average Tweet per user
Top 100	16,173	5.3%	162
The Rest	291,809	94.7%	2

Over 5% of tweets came from the top 100 tweeters, which totaled to 16,173 tweets or approximately 162 tweets per account (Table 10.2). Considering that on average each account had over 2 tweets, the participation from the top tweeters was significant.

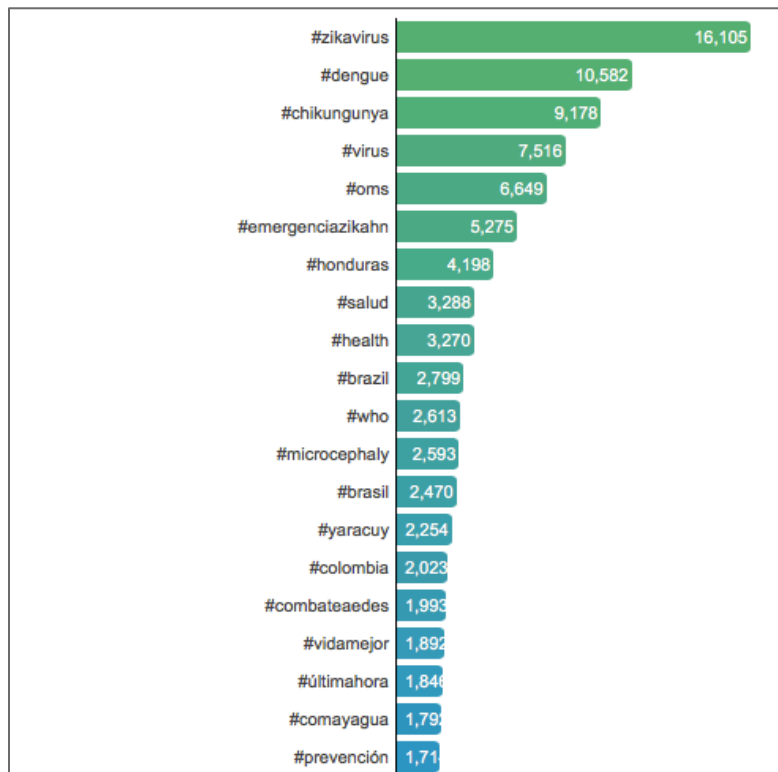


Figure 10.3 Co-occurring Hashtags

53% of all tweets collected with the #Zika hashtag also contained other hashtags. The most common co-occurring hashtag was #zikavirus, followed by #dengue, #chikungunya, #virus and #oms (Figure 10.5). The hashtag #oms and the WHO hashtag (#who), which was 11th on the list, related to organisations that were involved with the announcement of the PHEIC. Other popular co-occurring hashtags were in relation to other diseases transferred by mosquitos, such as

#dengue and #chikungunya. The three countries that also appeared in hashtags were #honduras, #brazil/#brasil and #colombia. Honduras was also highly represented in the collected week-long tweets, due to its national declaration of emergency over Zika virus in response to both the PHEIC announcement and the rising cases of Zika infections, reflected by the hashtag #emergenciazikahn. This suggests that whilst important during and for a brief period after the WHO announcement, the PHEIC took less precedence in the week-long Twitter communication to ongoing/co-occurring issues.

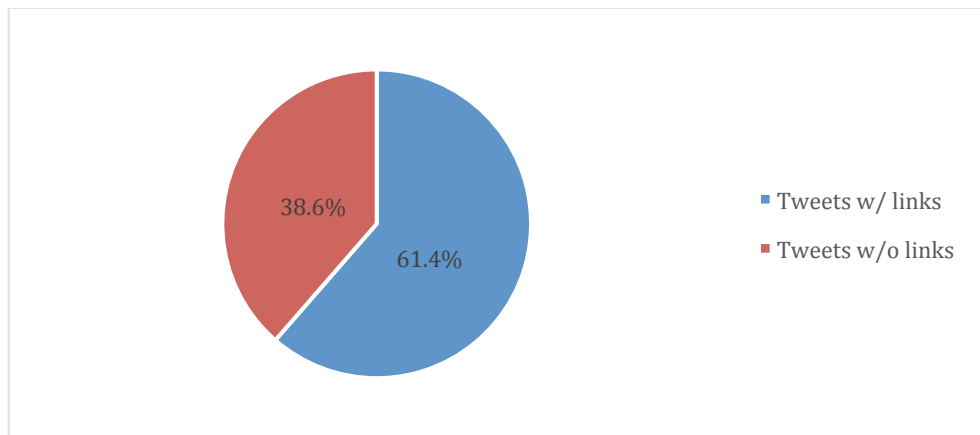


Figure 10.4 Tweets containing hyperlinks

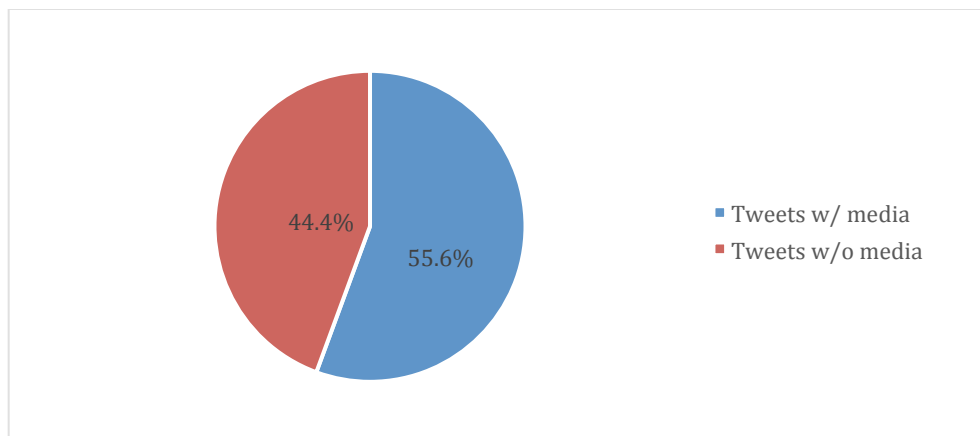


Figure 10.5 Tweets containing media

The number of hyperlinks (that click-through to further Web sites) present in the total collected tweets can be seen in Figure 10.6. Due to the limitation of 140 characters in tweets, hyperlinks are an important source of more in-depth information for users. Previous findings have also indicated that tweets with hyperlinks are more likely to be retweeted (Mayer et al., 2011; Steele & Dumbrell, 2012), which may be one aspect as to why there were such a large number of retweets with links. Approximately 61% of tweets contained hyperlinks to further information. This is a larger proportion than the number of tweets that contained photos, videos or other media (Figure 10.7). Approximately 56% of tweets relating to the Zika Virus during the week disseminated some form of media, which like hyperlinks can also be a further source of information (e.g. photos of cases, etc. etc.).

10.7 Analysis of Random Sample

As outlined in the methodology, a random sample of 1,063 tweets and their respective accounts were collected and analysed. Profile data was manually mined from these accounts and tweets were also manually categorised according to certain parameters/metrics. Approximately 72% of these tweets came from individual accounts, whilst 9% came from online media accounts. Government and organisation-related accounts had a low representation within the sample, making up 2% and 3% respectively. Peculiarly, 12% of the accounts within the random sample had been suspended or deactivated. 14% of these accounts were users from a health-related background.

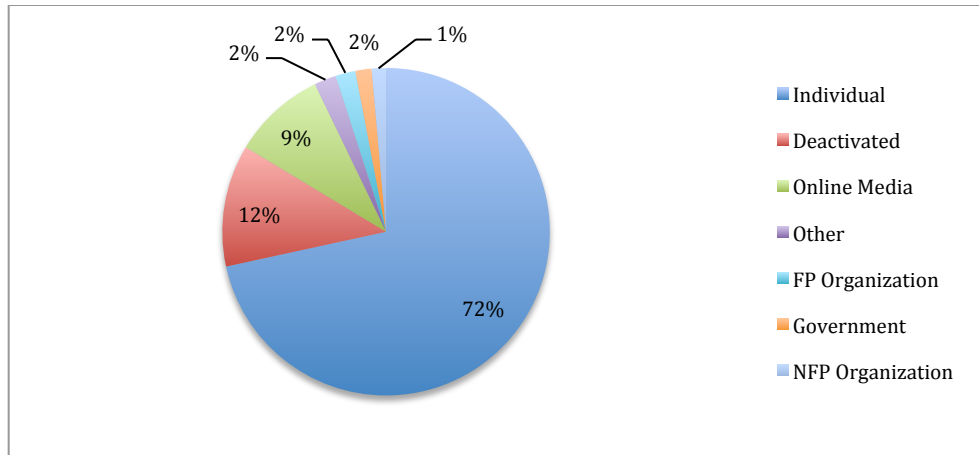


Figure 10.6 Types of Accounts in Random Sample

The random sample of tweets collected was representative of the week-long data collection, with similar proportions of the types of tweets when compared to Figure 10.3 (Table 10.3). Figure 10.7 illustrates the trend of the types of tweets found throughout the sample captured, and as seen the number of retweets far outweighs the number of original and mention tweets being disseminated. The Figure however shows the decreasing number of retweets throughout the week long sample, whilst original tweets and mention tweets only slightly fluctuate. This illustrates that the number of users forwarding original information gradually decreases during the week following the PHEIC announcement. However there was a larger proportion of links present throughout the tweets in the random sample compared to the week-long collection (88% compared to 61%) (Figure 10.8). This may show the slight limitation of automatic mining programs, where the strict algorithms set to collect URLs and links contain parameters that do not govern manual examination processes.

Table 10.3 Communicative categories of tweets in Random Sample

	Number	Percentage
Original Tweets	273	25.7%
Retweets	773	72.7%
@Mention Tweets	17	1.6%
Total Tweets	1,063	100.0%

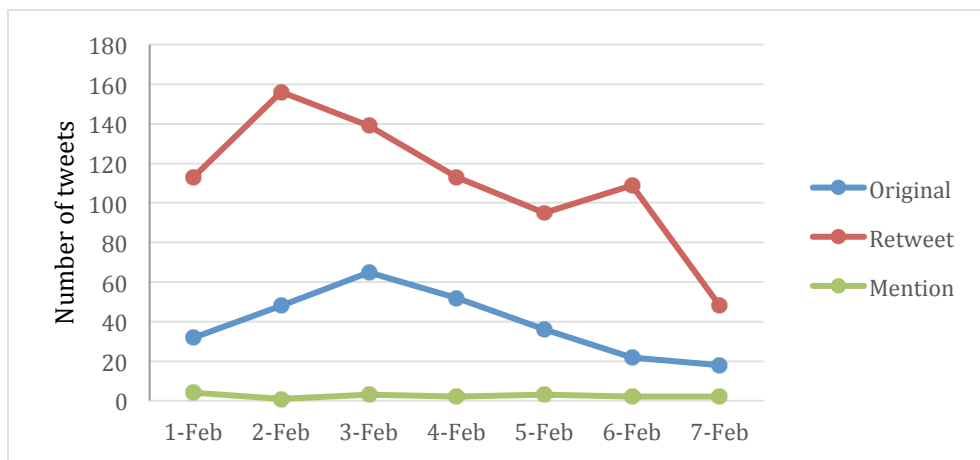


Figure 10.7 Trend of Tweets in Random Sample

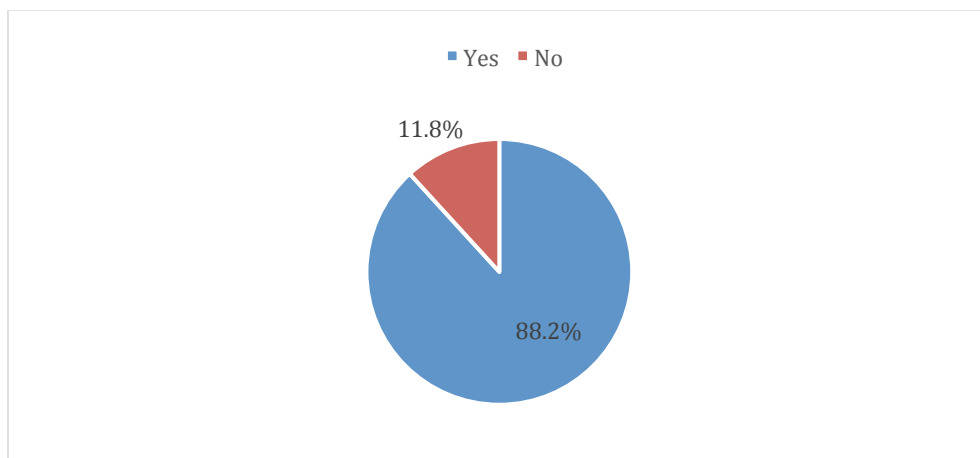


Figure 10.8 Tweets containing hyperlinks in Random Sample

The tweets collected from the random sample were thoroughly analysed and manually categorised for consistent and semantic accuracy. In line with the CERC Framework, which addresses the communication process that occurs during stages of a crisis (Veil, Reynolds, Sellnow, & Seeger, 2008), two types of information necessary in early stages of crisis, sensemaking and efficacy, were mined. Sensemaking tweets contain information that allow users to make sense of the health emergency (Weick, 1995) for example, “RT @johnspatricc: New Zika virus cases confirmed in Houston area #Zika <https://t.co/kUYI9SoXIj>”. Efficacy tweets on the other hand provide information for users to act on, encouraging self-efficacy and appropriate response (Reynolds & Quinn, 2008), for example “RT @BetterNation_MY: Please seek medical attention if you have these symptoms. Stay safe and healthy! #Zika <https://t.co/X305wpD0Ny>”. It was found that 83% of the tweets in the random sample were sensemaking, 7% were efficacy and 8% contained information that were both (Figure 10.9). 2% of tweets could not be classified in either or both categories. The sensemaking tweets had information regarding government and community response, country status and spread of Zika, general disease information, PHEIC and campaign updates. Efficacy tweets were mainly regarding advice about combatting mosquitos, pregnancy advice and Zika, prevention actions, symptoms and potential treatments (Figure 10.10). A further breakdown of specific tweet content can be found in Figure 10.13.

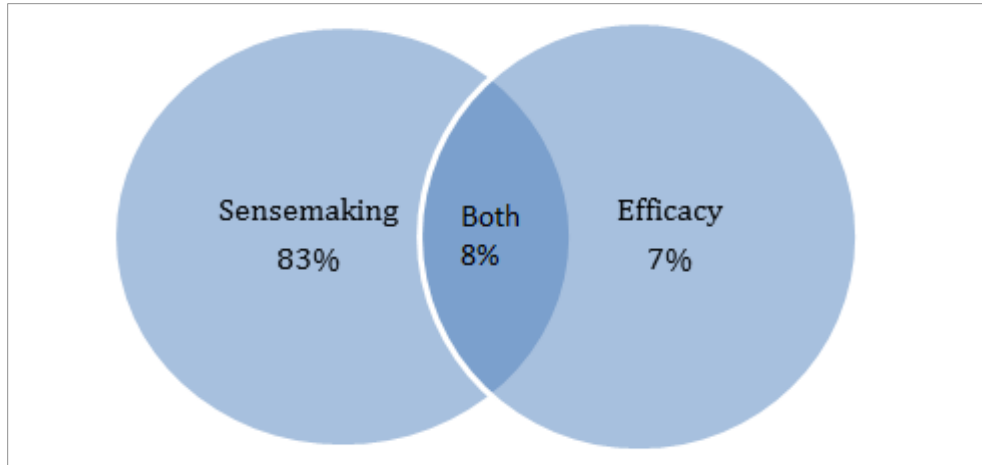


Figure 10.9 Sensemaking vs. Efficacy Tweets in Random Sample

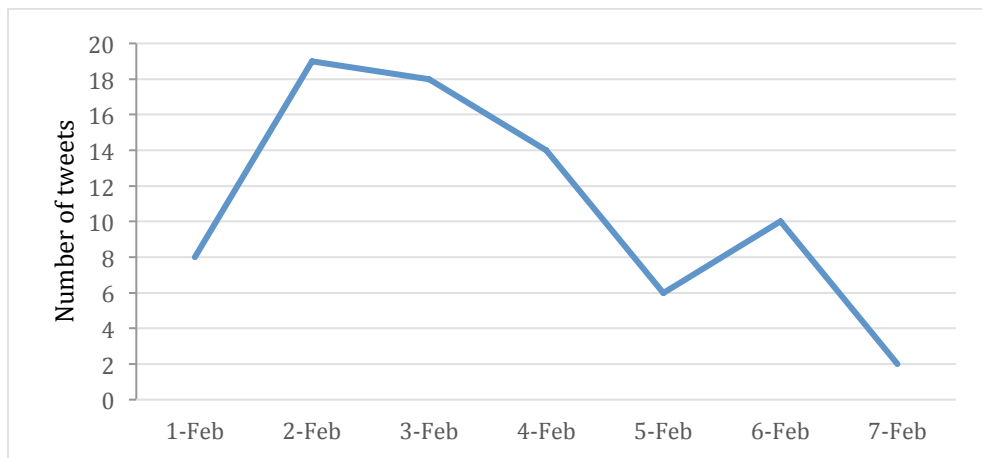


Figure 10.10 Efficacy Tweets in Response to PHEIC

Figure 10.11 shows the breakdown of the languages used in the random sample of tweets. More than half of the random tweets (55%) collected were written (and linked to) information that was in Spanish. A further 35% of the tweets were in English, with the next most predominant languages present being French (4%), Portuguese (2%), Italian (1%) and German (1%). This can be implied that the spread of Zika information through Twitter reflects the impact and spread of the Virus through predominantly Spanish speaking countries, and coincides with the popular co-

occurring hashtags of South/Central American countries in Figure 10.3 as well as the first case found in Spain during the week-long data collection.

When collecting profile data however, 425 of the 1,063 (or 40%) accounts did not provide location data or this could not be deduced from the information present on their Twitter page (Figure 10.12). From the remaining users that had location data, the top 5 global areas that tweets came from were North America (36%), South America (28%), Europe (15%), Central America (6%) and the Caribbean (6%). This however does not represent the countries with the most Twitter users worldwide, (Statista, 2016b), showing that response to a health crisis (and the issues that occur with it) reflect the offline communities it affects.

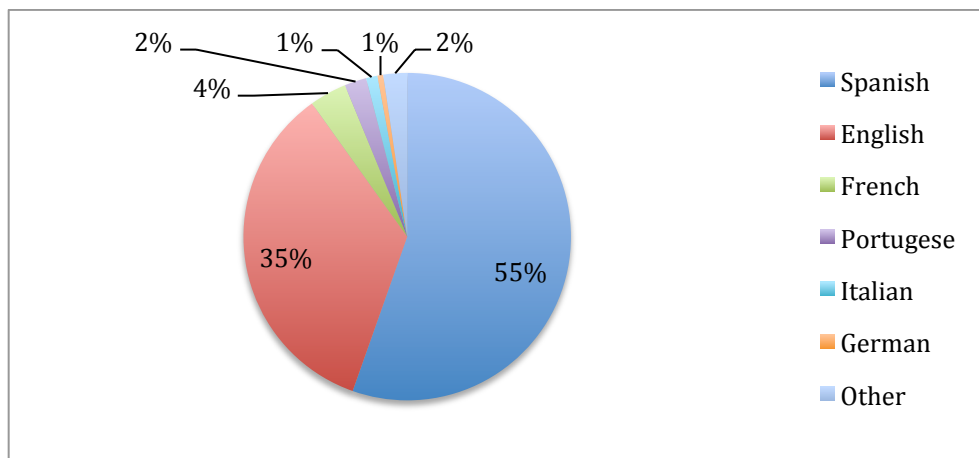


Figure 10.11. Language of Tweets in Random Sample

With regards to the tweet content, the most predominant topic that was disseminated was that of the spread of the Zika Virus (16% of the random sample conversation) (Figure 10.13). The next highest topics were of government responses to the disease (13%), general disease information (11%) and with regards to the prevention of Zika (9%). Tweets about the PHEIC contributed to

9% of the analysed tweets, again reinforcing the findings from the collected co-occurring hashtags (Figure 10.3) that the actual announcement did not take precedence in the online discussion after the initial PHEIC in a week-long period. Least represented topics were those regarding data access and research, jokes, opinion pieces, advertising and events, all of which contributed a total of 4% to the disseminated information.

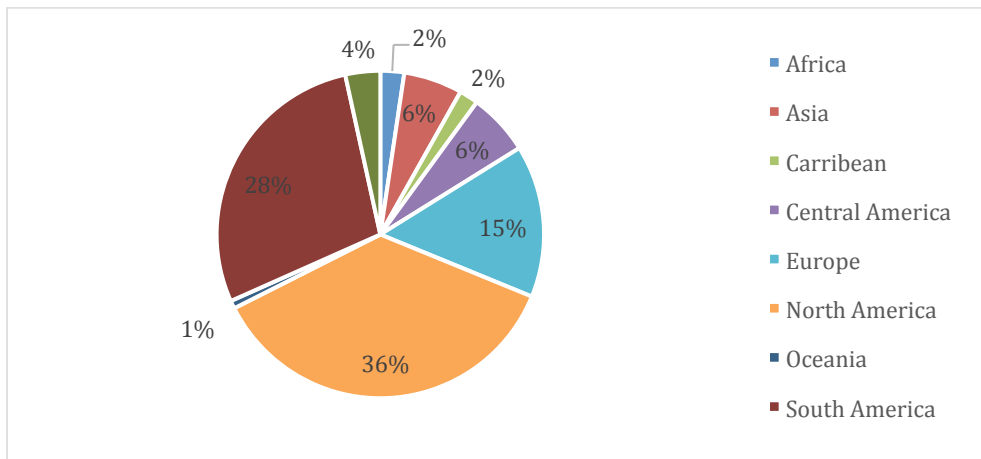


Figure 10.12. Continental Location of Accounts in Random Sample

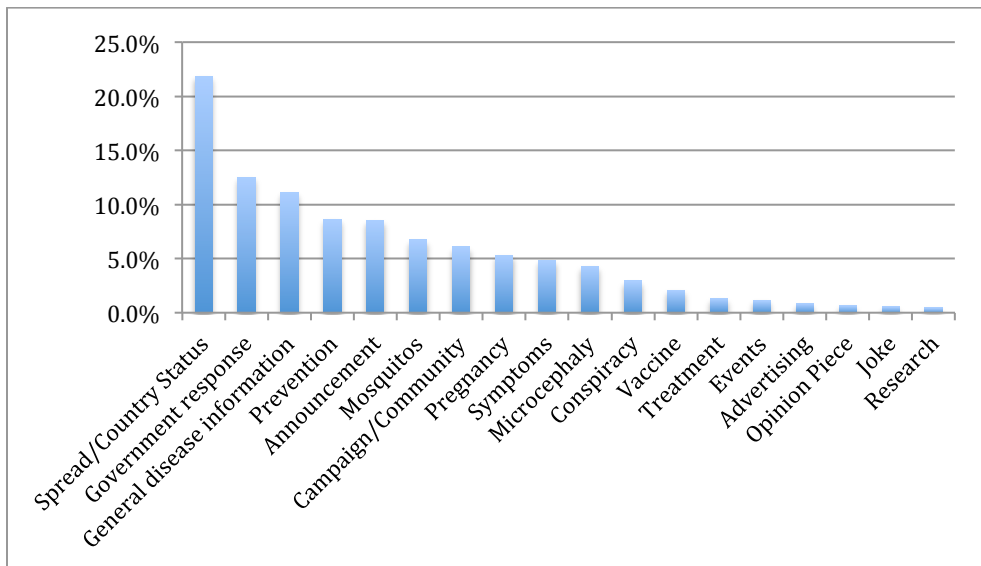


Figure 10.13 Tweet Content in Random Sample

When looking closer at the trend of the announcement content throughout the week, it can be seen that this was in fact reflective and relevant of the PHEIC announcement made on the 1st February (Figure 10.14). There was a peak of announcement-related tweets on the 1st of February (the day of the PHEIC), decreasing 32% on the second day, 71% on the third day and 95% on the 4th of February, where small fluctuations are present till the end of the data collection. It is interesting to note that during the decrease of the frequency of the announcement-related content, statistics regarding the spread of Zika and country statuses, government response-related tweets and general disease information simultaneously rose together (Figure 10.15). Further to this, campaign and community response-related tweets rose later in the week (whilst other topics decreased in frequency of tweets) and peaked on the 6th of February. This trend is relevant and interesting as it shows how the top-level response to the announcement (e.g. government, spread/country status) occurs prior to a lower level reaction (e.g. local campaign/community response).

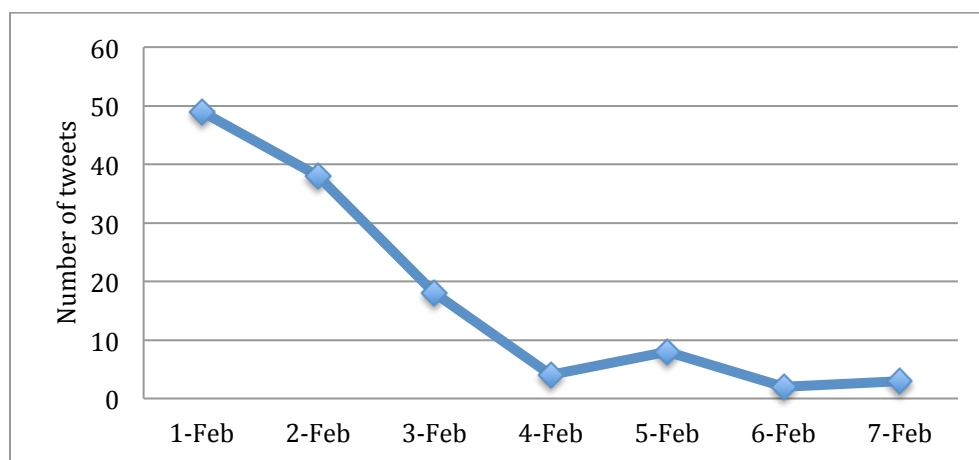


Figure 10.14 Trend of Announcement-Related Tweets in Random Sample

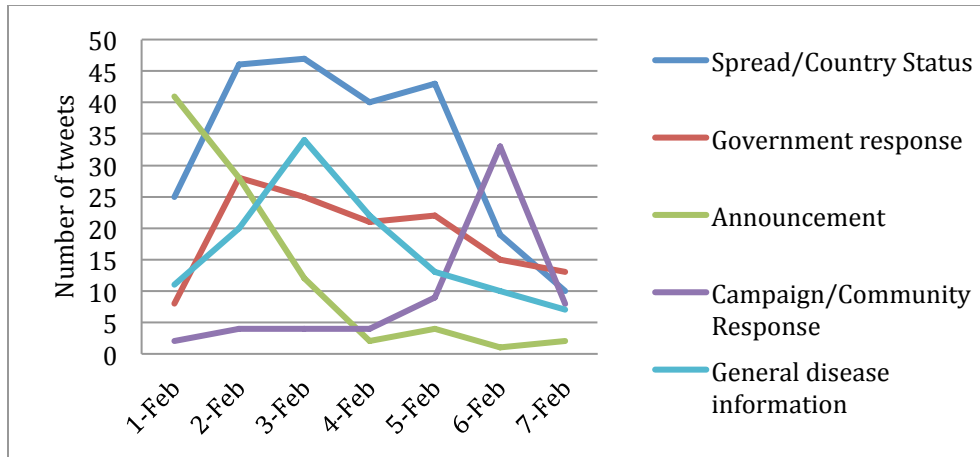


Figure 10.15 Trend of Tweet Content in Random Sample

10.8 Discussion

This research was carried out to observe the unexplored area of the effect of a PHEIC announcement on the subsequent online response. The findings that were presented in the results section involve both a general analysis of the entire week-long data collection, as well as a deeper analysis of a random sample of tweets. The following section discusses significant findings, as well as building on areas of interest as directed by previous studies in the field.

Nearly three-quarters of the users who tweeted during this period were classified as individual accounts, whilst online media, organisation and government-related accounts represented 9%, 3% and 2% respectively. As per previous research that involves categorising Twitter users in the context of health, accounts that represent individuals are usually found to make up the majority (Dumbrell & Steele, 2015). This should however exemplify the importance of the role of non-individual users and especially the information they disseminate. Previous studies have shown there is a plethora of health-related organisations scattered throughout the social networking

site Twitter, however during outbreaks and crisis they are outmatched by the tweets from individual accounts and may be a reason as to why there are less efficacy-related tweets being disseminated amongst users. This also brings up the need for government and organisation-related accounts to push out a vast amount of relevant and timely information, especially as they are effective (influential) at disseminating public health advice over other types of information. Nonetheless, there is a large increase of tweets with the hashtag #Zika as a response to the PHEIC announcement, and illustrates how offline health media situations causes online reaction. This also exemplifies the need for online information to supplement and positively affect these offline health outcomes.

When categorising the tweets according to the early stages of a crisis (using the CERC framework), it was found that 83% of the tweets were sensemaking-related, 7% were of an efficacy nature and 8% contained both forms of information (Figure 10.9). Previous work surrounding the global health outbreak of the H7N9 bird flu virus flu found larger proportions of sensemaking information and significantly lower levels of efficacy information and tweets containing both forms of information in their sample of collected tweets (88.3%, 1.7% and 0.6% respectively). This may be due to the difference in nature/context of the respective viruses, whilst the data collection from Zika was during its PHEIC announcement there was no PHEIC announcement for the Bird Flu Virus due to its early geographical and contagion containment. PHEIC announcements may cause a push to larger amounts of efficacy information being tweeted to reassure/control fear and panic response amongst the public, which is contrary to the finding of the previous study suggesting that Twitter did not provide a forum for efficacy information. In addition, the PHEIC was a pre-planned announcement and thus it could be argued that more

efficacy information could have been disseminated due to the “preparedness” of all parties involved with this, rather than respond to the announcement (as shown in Figure 10.10). Future studies should consider categorising tweets utilising this framework to uncover further results of sensemaking and efficacy information communication during health events.

Although this was the week of the PHEIC Announcement by WHO, the number of tweets relating to this announcement contributed approximately 9% to the conversation. The findings also showed that over the period of only a week, information dissemination relating to this PHEIC announcement decreased immediately after the first day and reaching very low significance within a 96-hour period. As shown in Figure 10.15, there is a trend towards tweets relating to government response, spread and country status being rapidly disseminated the day after the announcement, whilst tweets with general disease information rising and peaking 48 hours after the day of the announcement. Therefore this research found that tweets relating to the PHEIC announcement were not disseminated as frequently as other content during the week-long period, however caused content to be disseminated accordingly to address this announcement.

There were more categories of content found in the random sample of the #Zika-related conversation. As previously identified in the literature review, Fu et al. (2016) carried out a study to observe the reaction to Zika Virus outbreaks over a 3-day period (outside of the PHEIC announcement). The following themes were identified from the content: societal impact, organisational and public response, pregnancy and microcephaly, transmission routes and case reports. Pregnancy and microcephaly-related contributed to 9.6% of the random sample found in this research, which was approximately half that as found by the 3-day study by Fu et al. (2016).

However there was a significantly larger proportion of spread/ country status-related content disseminated during the PHEIC, with 22% of tweets being this compared to the 8.1% of case reports during non-PHEIC Twitter conversation. This shows how offline situation, such as the PHEIC announcement, impacts on the content of the tweet being disseminated in a particular sample – introducing further ones with the announcement (as opposed to baseline data)

Previous work has analysed the online aspect of global health campaigns run by WHO to analyse and observe data and trends (Dumbrell & Steele, 2015). In the sample of campaign-related tweets collected there were found to be less hyperlinks present (43% vs. 61%), less retweets (61% vs. 72%) and more original tweets (35% vs. 26%) disseminated. The spread, number of contributors and information dissemination of the health campaign was comparably less (94,800,000 reach, 17,613 contributors, 26,566 tweets) than the outbreak. This may be due to a variety of factors, such as the specificity of the hashtag (e.g. #worldhealthday), most tweets being in English (i.e. targeted response) and the urgency or importance of the health issues (campaign vs. outbreak). In addition whilst the health campaign was also in relation to vector-borne diseases, these lower frequencies of reach, contributors and tweets may exemplify that online campaigns require to be more inclusive to spread to relevant communities and can use the examples provided regarding a health outbreak to better target content to relevant audiences.

10.9 Limitations

Due to the context of the PHEIC and the period of data collection, it should be reinforced that the findings presented do not represent a typical or standard response to such outbreaks as

presented in previous literature. As seen in the findings, the announcement caused the #Zika hashtag to peak from “normal” levels of appearance on Twitter. Further to this, data was collected for a set period of one week with some data prior to the announcement being captured due to discrepancies of the time of the announcement through various media sources. The purpose of this research however was not to simply repeat similar studies of tracking a disease, but rather to examine and analyse this response to the PHEIC announcement.

The use of hashtags, whilst self-filtering, also excludes potentially relevant information to the Zika Virus that either used other hashtags or tweets that did not use hashtags at all, or used other hashtags to convey Zika information. This however was combatted by also collecting week-long data for similar hashtags (e.g. #ZikaVirus), using the more used and popular hashtag to capture a larger sample. In addition the coding and categorisation of tweet content was achieved via manual methods, thus raising the issue of coder reliability. However to overcome this issue, the dataset of captured tweets for the random sample underwent two rounds of coding, with differing categories identified and further scrutinized for final coding.

10.10 Conclusion

The research in this paper examines a previously unexplored online response to the 2016 PHEIC announcement of the Zika Virus. The data mined from the SNS Twitter has been analysed and categorised for various factors relating to both user characteristics and disseminated information relating to the hashtag #Zika. Major findings have uncovered a lack of efficacy-related information being disseminated in response to the announcement, as well as the relatively short

period where the announcement is no longer central to the Twitter discussion surrounding the outbreak. Future direction of research within this area can be to compare other responses to announcements or outbreaks to add more findings to gaps in the literature within this field. It would also be of interest to observe and analyse campaigns in relation to such outbreaks to uncover further cost-effective and widespread ways to positively address such situations. This research is also important to advise both policy makers and influential Twitter accounts of the online landscape of SNSs, in addition to providing a foundation for strategy and policy making in relation to information being disseminated during such an event.

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Chapter 11. Findings and Discussion

11.1 Summary of Findings

This thesis has uncovered previously minimally unexplored characteristics of health-based SNS users. The following is a summary of findings from the chapters of this thesis that will be discussed in more detail in the following section. Compared to FP and NFP organisation accounts, government accounts were found to disseminate health information less frequently. These government accounts had (on average) larger numbers of followers as well as significantly larger proportions of their disseminated information classified as being health-related. Health information disseminated by government accounts was more engaging to online health communities and individuals, as information from government accounts was shared more frequently than information created by FP and NFP organisations, with FP organisations having less of their health information being passed along. It had been found that those who retweet health information the most were individual users, followed by FP, NFP then government accounts. From these findings, it can be determined that the lower average number of followers and the less authoritative a SNS user category is, the more likely users in that category are to pass along rather than create health information. On the other hand, the more authoritative and engaging a user category is, the more likely it is to create health information that is more successfully shared regardless of tweeting frequency.

These user-type findings were reinforced when analysing the importance of disseminated health information, where information that was highly retweeted had a higher average PageRanks as

they pushed users to websites representing authoritative sources like government bodies, NFP organisations and health professionals. These authoritative websites were less represented as retweet count (i.e. sharing) and average PageRank decreased. This thesis also found a weak correlation between the number of followers of an account and the number of retweets that account received, which suggested that retweeting activity was not simply driven by the raw number of followers of an account and that other factors, such as the authoritativeness and reputability of an account and the perceived trustworthiness of information, drove engagement on these SNS. On top of this, there was a moderately negative relationship between the number of tweets an account issued and PageRank, which indicates the potential of low-tweeting authoritative accounts (e.g. government bodies) and their potential for further engagement.

A minimal to non-user group identified in the literature was that of older adults. After learning about and using Twitter, Skype and Facebook, this group found Twitter to be the least secure in terms of privacy. This may explain why it was also the least used platform of the three as privacy had previously been identified as a major barrier to uptake for various user groups. Five themes were drawn from qualitative analysis of survey responses and focus groups of these older adult participants included: user control, the openness of social media systems, chosen mode of use, user interface issues and external factors. These themes were identified as recurring privacy-related issues contributing to older adults' minimal to non-use of such SNS. 90% of older adult respondents agreed that SNS was affordable, with 100% having access to the Internet from their home or community facilities. It appears therefore that addressing privacy themes when designing platforms could potentially increase uptake and retention of SNS for health-related purposes for these groups.

With regard to the type of health-specific information found throughout Twitter, cancer and mental health communication were the most frequently disseminated conditions by health organisations and government bodies. There were other condition-specific areas where tweeting could be improved to match actual national initiatives (e.g. asthma, dementia). Approximately one-fifth of tweets by identified health organisations on Twitter were not health-related, although when looking specifically at health-related tweets there were a vast spread of conditions being disseminated. Twitter is being well utilised for public health-related information dissemination with a significant proportion of the collected tweets being categorised as public health advice and health awareness. Health information that was most successful in being passed along contained similar characteristics, identified as being: actionable, time relevant, having a perceived health risk and composed in a personally-directed style.

Both the Zika PHEIC announcement and the World Health Day campaign were large scale public health events, which occurred in the Twitter landscape. The tweeting rate in response to the PHEIC announcement was five times more frequent than that of the campaign-related communication, and approximately five times more followers received Zika-related information across the averaged time period. Although there were nearly four times as many users contributing information per second in response to the PHEIC, both events found that there were many contributors of information that reach vast numbers of users. There was more retweeting found in both these public health events than in comparison to the earlier research of baseline tweeting by health organisations, potentially showing the larger engagement of such real-life events. Other contributing factors for such widespread activity may have been attributed to the

authoritativeness/ trustworthiness of originating sources of information, as well as the appropriateness of Twitter-based information dissemination in such situations.

Although having less absolute reach than other involved accounts, the WHO account achieved the greatest numbers in terms of information passed along and mentions, thus reinforcing conclusions from earlier chapters that the number of followers does not automatically equate to a proportionate engagement with information being created. The collected campaign dataset contained fewer hyperlinks than the outbreak-related sample, and this was reflected with less comparative retweeting of campaign-related information. This could be due to announcement-related tweets containing more characteristics of highly disseminated health information as previously identified in earlier findings (i.e. actionable, time relevant, having a perceived health risk and of a personally-directed style).

Many of the highly shared tweets in the campaign sample related to fundraising for organisations, reflecting the earlier findings of NFP organisations utilising such platforms for cost-effective health-related fundraising initiatives. Through content analysis of tweeting it had been identified that there was a low proportion of health-related efficacy information being disseminated during the Zika announcement. Tweeting activity was however not biased with relation to geography, as the breakdown of users did not coincide with current Twitter usage statistics and thus implied that information dissemination in such events is driven by offline relevance and engagement of the situation. SNS disseminated information in relation to the outbreak was almost immediate when compared to current popular news sources, some

reporting the PHEIC announcement 30 minutes to a day after it was made which further emphasised the reactive nature of Twitter.

11.2 Discussion of Findings

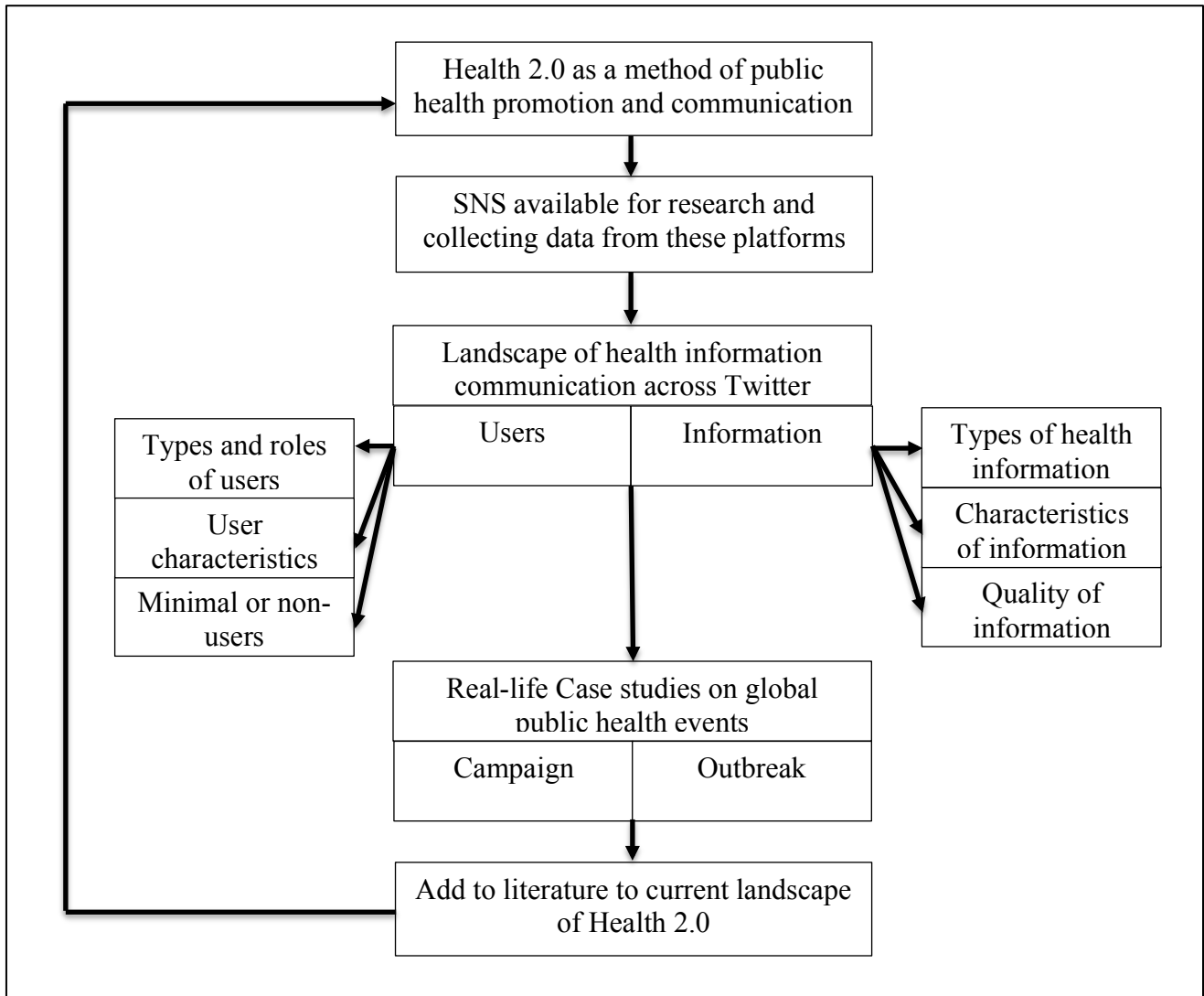


Figure 11.1 Conceptual framework of the thesis research direction and outcome

This section provides a detailed discussion of the thesis findings, taking into account the five research aims outlined during Chapter 1 (listed below as subsections from one to five) and the structure of the conceptual framework initially presented in Chapter 3 (Figure 11.1).

- 1) To develop a comprehensive understanding of the current landscape of health-related use on Twitter, including the roles of users such as health organisations and the type of health information they are disseminating.

The research presented in this thesis adds much value to the novel area of online, social and public health communication. In the context of online organisational entities and their roles on social media, this thesis contains analysis on a substantive sample of health-related Twitter accounts in Australia, an area that prior to this work has been relatively unexplored especially on SNS. Of the 114 identified health-related organisational accounts, it was found that 16 of these represented government bodies, whilst 27 of these represented for-profit (FP) organisations and 71 of these being categorised as not-for-profit (NFP) organisations. Although the majority of accounts collected in this sample were NFP organisations (62%), government-related accounts had higher relative reach than their counterparts, with an average of 2,347 followers per account. In addition, these identified government accounts were found to have a lower average of total Twitter tweets (448) and tweets during February 2012 (26) compared to that of FP and NFP health-related organisations. This suggests that whilst government bodies have the potential to reach more people per account, they tend to not disseminate information as frequently as their organisational counterparts. As it was also found that a 93% of tweets disseminated by these government bodies were of a health-related nature, this exemplifies the underutilised potential

of Twitter-based government bodies to push more authoritative and relevant health-related information to a larger number of following users. It can be suggested from these findings that government health officials could further benefit from the authoritative nature of their SNS presence and become more active by pushing out relevant and high-quality information to engaged users.

On the other hand, although tweeting twice as much as government accounts during the month of February, FP accounts had the lowest average number of followers at approximately 1,153 per account. The findings drawn from the collected sample suggest that FP accounts have lower numbers of followers and reach despite their higher tweeting activity. This can potentially be attributed to their reputation of being “untrustworthy” as health-sources due to their commercial and profit-based nature, which is consistent with previous findings with regards to profit-based online health sources such as websites (Schlesinger, Mitchell, & Gray, 2004; Silence, Briggs, Harris, & Fishwick, 2006). By examining sectoral differences throughout Twitter and the type of information each category disseminates, the findings in Chapter 5 present a snapshot of a nationwide use of this SNS by government and health organisations. The significance of these findings is that both health users and researchers of current SNS can be more knowledgeable when exploring the landscape of health information (e.g. condition or area) that is present on such platforms. FP organisations can also potentially increase their followers and engagement by attempting to establish protocols of liaising with more authoritative figures or pushing information from “trustworthy” sources. Future work surrounding the area of health-related sectors on SNS can categorise health information dissemination by organisational types in

different countries for comparative purposes, in addition to examining certain health-related bodies (i.e. government) in more detail.

With the manual categorisation of tweets by health condition outlined in Chapter 5, the question of “what type of health information is present on SNS?” can be explained via evidence-based means. The 114 organisations identified in the above sample had tweeted a total of 4,787 tweets in the month of February 2012, and these tweets were captured, categorised and analysed according to the content contained within these tweets, as well as the information found in the linked-to pages. 79% (or 3,790) of these tweets were found to contain health-related information. More than half of these health-related tweets were not condition-specific. In addition to this, the analysis of the tweet sample found significant discrepancies between the proportions of condition-specific tweeting by organisations, especially when comparing the proliferation of this information to national priority areas. Cancer and mental health tweets were the most disseminated condition-specific areas of health, contributing to 14% of the health-related tweet sample. On the other hand, further areas considered a priority by the Australian Government by the National Health Priority Areas Initiative (NHPAs) (Australian Institute of Health and Welfare, 2016) were far less represented. Asthma, arthritis and musculoskeletal conditions, injury prevention and control are four NHPAs that made up less than 2% of the health-related tweeting sample. Referring to the earlier conclusions drawn from the tweeting activity of government accounts, these findings suggest that information relating to such low represented health conditions can be further disseminated through an increase in focused tweeting by these government-related accounts.

A major contribution to the area of SNS use is the finding that Twitter is being well utilised for public health advice and health awareness information dissemination, with 42% of health-related tweets from the collected sample in Chapter 5 containing this type of information. In addition, nearly half of the collected health-related tweets from government accounts fell under these categories of public health advice and health awareness, with 43% of FP organisation and 41% of NFP organisation health-related tweets also categorised under this type. Further to this, NFP accounts were found to be substantially using SNS for fundraising, with 15% of their health-related tweets falling under this category. The results demonstrate that Twitter can be an extremely cost-effective method of raising funds in the context of health, especially when considering the significantly larger costs of implementing fundraising strategies through traditional mass media (i.e. advertisement campaigns on television and radio) (Farrelly, Hussin, & Bauer, 2007). Future research in this area should compare the costs, reach and outcomes of such traditional media-based fundraising campaigns compared with SNS-based campaigns to provide further evidenced-based data exploring the comparative benefits (and possible limitations) when using these novel platforms.

As identified initially in Chapter 5, 772 of the collected health-related tweets were categorised as public health advice types. 359 or 47% of these tweets were retweeted, thus subsequent analysis of this sample of retweets was carried out to address the second research aim: to “investigate the characteristics of what makes certain health information more “popular” and more likely to be shared via these platforms”. 176 of the retweets in the sample were posts originating from NFP accounts. When looking at organisation-specific tweeting it was calculated that more than two-fifths of public health-related tweets (i.e. 176 out of 403, or 43.7%) made by NFP organisations

were retweeted by other Twitter users. In addition, it was calculated that FP accounts not only contributed the least amount of public health advice information to the retweeted sample (84 of 359, or 23%) but also had the smallest proportion of their public health advice information being passed along compared to NFP and government bodies. Of all three-health sectors analysed, FP organisations had the smallest proportion of their health-related tweets that were disseminated by other users of SNS, with 37% of these types of tweets being retweeted. This finding may suggest that FP accounts need to disseminate more public health advice-related information to increase both followers and engagement via retweets.

Government accounts were found to tweet the largest proportion of public health-related tweets compared to NFP and FP organisations. Further to this, of the 143 government posted public health-related tweets identified in February 2012, nearly 70% were retweeted. Thus government accounts on this SNS were found to be the most successful in disseminating health information to the public that evoked engagement through retweeting. Although government accounts had the lowest raw numbers of total public health tweets when compared to FP and NFP organisations, they recorded on average a higher reach of followers with their public health advice, as they recorded higher retweet rates and as previously found have a higher average number of followers per account. This finding emphasizes the role of government accounts in public health information dissemination and reinforces their potential of further engagement and influence through increased activity on modern SNS platforms. This research surrounding health organisations, users and the types of information being disseminated by these entities adds to the landscape of health-related Twitter usage, and similar research in different contexts (e.g.

countries outside of Australia, international health bodies) can also further add to this novel area of importance.

- 2) To investigate the characteristics of what makes certain health information more “popular” and more likely to be shared via these platforms.

The 890 accounts that had performed the retweeting of this public health information were also identified and categorised in Chapter 6 to shed light on the propagators of such information with this emerging model of health information communication (Figure 4.3). Government accounts only made up 5% of these retweeting accounts, with NFP and FP accounts contributing 10% and 14% towards the retweeting of this public health information. Accounts that were identified as representing individual users were the largest propagators of tweets, with 63% of identified public health information retweets being from individual users. Interestingly from these results, it can be seen that the fewer average followers a category of user have, the more likely that category of user is likely to retweet (i.e. government accounts retweeting the least, individuals retweeting the most). Further to this point, the finding in which more trustworthy sources of health information retweet less than other accounts of varying degrees of authoritativeness should be further explored, especially with regards to identifying certain user/ account characteristics that can be attributed to this phenomenon.

The retweeted public health-related tweets identified were also semantically analysed during the manual categorisation process. As a result, these successfully shared tweets were found to have the following characteristics with regard to the information contained within them:

- i) Actionable
- ii) Time Relevant
- iii) Perceived Health Risk
- iv) Personally-directed Style

These characteristics are also relevant and consistent with findings in the following chapters concerning public health events. By understanding the characteristics of successfully passed-along tweets, SNS-based accounts can utilise findings contributed by this thesis to create and push health information that will further engage other users. Public health officials can use this new knowledge to create messages that will be more readily disseminated to reach and engage with a wider audience, whilst also increasing the likelihood that high-quality health information is being successfully shared.

- 3) To better understand the phenomenon of self-dissemination networks found on online social sites, and how this applies to health-related usage and information exchanged.

The importance of the quality and credibility of online health information has been explored throughout the literature, with current and relevant issues being outlined in the literature review. Online information quality is one of the many aspects that require consideration in the context of health communication, as misinformation or bad quality information can negatively affect subsequent offline health behaviours. With regards to SNS this is extremely worrisome due to the rapid propagation and large reach (i.e. virility) of certain pieces of information that can potentially affect a large number of individuals and communities, and thus cause widespread

negative health behaviours. The work presented in this thesis provides a potential method to analyse the credibility or importance of health information (and sources of this information) propagated through Twitter through the use of Google Pagerank, whilst also addressing the aim of better understanding the phenomenon of self-dissemination networks found on online social sites, and how this applies to health-related usage. In addition, through the manual analysis of tweets in various chapters, the work contained within this thesis indirectly provides an explorative overview of the credibility of health information present throughout Twitter and several aspects of SNS-based health communication (i.e. by organisations, by individuals, during public health campaigns and outbreaks).

SNS involve a large number of users disseminating information. With regards to Twitter, a phenomenon of “self-organising” networks was uncovered during the research in this thesis where users:

- i) Manually selected accounts or topics to follow based on their information preferences
- ii) Actively interacted with these accounts and topics by performing actions such as tweeting, retweeting, mentioning, favouriting or liking relevant information
- iii) Directly and indirectly interacted with other users who had similar connections or interests, thus forming information-based networks

This is an interesting phenomenon as these global online health communities are found to seemingly form via such means, through specific interests or topics, without prior offline connections or direct means of communication. Further to this, the phenomenon of self-organising networks is a significantly unique aspect of SNS, as information communication diverges from traditional online means and sources due to the changing roles of users and the

push-nature of these platforms. For example, users accessing health information via search engines will type in a specific query, which identifies the most relevant and authoritative pages based on pre-set algorithms. On SNS however, users select which accounts they want to receive their information from, and these accounts post information that is pushed directly to the following users. Consequently, the quality and content of information received by users on SNS are dependent on the accounts the user follows. Therefore there is an inherent need for peer evaluation of information by users before it is passed along to other users within these self-organising networks.

The sample of 359 retweeted public health advice tweets was further analysed for the purposes of the related research in Chapter 7. It was found that 92% (or 329) of these retweeted tweets contained hyperlinks that linked-to more detailed information, a significantly larger proportion than found in the previous literature of non-health tweets (Zarrella, 2009). These retweeted tweets were separated into three representative sets, those with seven or more retweets, those that had between three and six retweets, and those with one or two retweets. When examining tweets that were retweeted seven times or more, it was found that a majority of these directed users to sites with high authority, with 40% of these sites leading to NFP health organisations, 25% to government departments and 20% to professional individuals. These proportions of NFP, government and professional individuals as sources of linked-to information decreased when analysing information that had been retweeted three to six times (31%, 23% and 2% respectively) and dropped even further when considering the tweets that had been retweeted once or twice (26%, 18% and 1% respectively). This finding suggests that the entities behind these linked-to sources of information are more prevalent amongst highly retweet tweets, and

thus have larger influence and engagement that promotes user-driven dissemination. This thesis also suggests that retweeting accounts found these sources to be more appealing and credible in the context of health, thus passing such information along to their connections and networks.

Further to this, the 329 retweeted public health advice tweets also had their hyperlinks analysed by Google Pagerank to gain an understanding of the measure of the quality of these Web-pages and provided information. The average PageRank for the group containing seven or more retweets was 4.25, with their domain PageRank averaging 6.52. For the set of tweets retweeted between three and six times this average dropped to 3.9 and 6.39 respectively and for the lowest retweeting group (one to two retweets) this Pagerank average decreased further to 3.38 and 6.05 respectively. The study found a low positive correlation between PageRank and retweet count ($r=0.16$, $p=0.00$), a weak correlation between followers of an account and retweet count ($r=0.243$, $p=0.00$) and a moderate negative correlation between the total number of tweets sent from an account and PageRank of embedded hyperlinks ($r=-0.61$, $p=0.00$).

The low r value between the numbers of followers an account has and the number of retweets of information posted by an account suggests that it is simply not just measurable reach (i.e. the raw number of followers an account has) that drives retweeting activity. This finding proposes that characteristics intrinsic to the content of the tweet may be a more significant factor in affecting the level of retweeting, which exemplifies the difference between engagement and reach on social-based platforms. The PageRank results also found that whilst there does not seem to be a relationship between the level of authoritativeness of information and the number of times it will be passed along, there is a moderately strong relationship between accounts that tweet less

and higher PageRanks amongst their shared information (and vice versa for accounts who tweet more having lower PageRanks). This corresponds with findings from Chapter 5, as government accounts that are considered authoritative sources of information on SNS were found to tweet on average less than their organisational counterparts. Conversely, accounts that represent individuals who are active tweeters and retweeters may push significantly larger proportions of information that is less authoritative, as generally, individuals are less selective on what to pass along as they are not governed by occupational policy and a strategic SNS framework; whereby this is the case with government bodies and organisations.

The aforementioned set of findings illustrates how established reputability, trustworthiness and authoritativeness of certain entities affect their roles in health information communication. The results also show that rating tools like PageRank reflect on the authoritativeness of the user account through analysis of the health information shared. As there has not yet been an agreed standard to measure the quality of online health information, using authoritativeness as a measure can be a potential tool to fulfill this current gap in the Health 2.0 landscape. Future studies addressing the quality of health information found on SNS should utilise various other measures of quality, such as clinician feedback, to not only compare results of quality outcomes but also assess and benchmark the appropriate use of similar programs to PageRank to judge this information. Nonetheless, results from these findings show the potential of SNS use for health information due to such metrics presented through these programs and add value to the area of quality assurance through SNS-based information dissemination. Further to, this work illustrates to SNS users the benefits of utilising such quality controls within self-organising health networks

found throughout these platforms, to more efficiently engage with others and better assess online content in a health context.

- 4) To explore the issues of why certain sub-groups, such as older adults, use such SNS minimally, or not at all, and address the consequences and concerns surrounding these levels of use.

Low-level to non-use of SNS is a critical area of exploration for this thesis. With the spread and uptake of online platforms of communication such as SNS, there also comes an increase of health-related information present on these sites. As previously identified, many current users of SNS utilise this medium as primary sources of health information, even prior to contacting their health practitioners (Hesse et al., 2005). In this way, SNS-based health communication can be seen as a potentially novel and cost-effective way to manage health and promote positive health outcomes/behaviours, especially with the rising cost of healthcare. By identifying and examining the issues of low-level and non-use amongst certain population groups, findings from this thesis can potentially inform policy and strategies to authoritative bodies to address and thus improve the delivery of health to communities, whilst lowering costs to individuals using these services and promote a more positive method of managing health and their related outcomes.

One major barrier to the uptake of health-related information communication via SNS platforms was identified in the literature review as “privacy concerns”. Chapter 8 of this thesis analysed the privacy perceptions of the largest (and fastest growing) groups of non-users of SNS, older adults. Whilst Skype and Facebook were platforms included in the study, the following discussion will

primarily focus on the results and findings for Twitter to keep consistent with the purpose of this thesis. After taking classes on the basic functions and settings, participants in this study were asked about their view of the relative privacy of these three SNS. Twitter was perceived to be the least secure SNS of the three, with approximately 49% of respondents ranking this as the “least secure” of the three. 41 participants chose not to use this SNS during their 6-month trial even after learning about the functionalities of the platform. On top of this, Twitter ranked highest for the “least used” of the three platforms, with 68% of those who did use these SNS ranking it as last in terms of usage. These findings show the low uptake of Twitter by older adults, even when compared to the already minimal online and SNS-based uptake by this group as outlined in Chapter 2. To address the privacy concerns affecting this low and non-usage of Twitter, qualitative data through the free-text in the survey (provided in Appendix A) and focus groups were collected, transcribed and analysed to further explore this identified major barrier.

Five broad themes (with twelve sub-themes) in relation to SNS privacy perceptions of the older adult trial participants were identified through qualitative analysis of survey questions:

- i) User control
 - a. Control of Settings
 - b. Control of Online Contacts

From the survey questions it was found that other SNS were considered more secure than Twitter due to the level of control over privacy settings. Twitter has minimal privacy settings due to its open and public nature, minimal user profile information and simple interface. Participants also identified comprehensive privacy settings to be a key influencing factor for the use of SNS,

which may explain why they found Facebook more secure than Twitter. Various reasons that were captured to reflect this were that participants “...can use settings to make it [Facebook] very secure” and “I feel I have more control and safeguards in place to feel safe using this medium. My age group are still wary of the information available to others”.

From their responses, participants suggested that the lack of settings on Twitter was seen as a barrier to use, due to information being able to be readily “passed on” with “no control”. Previous chapters however have highlighted this as a positive characteristic of Twitter in the health context, whereby self-organising dissemination networks form according to interests and topics. In addition to this, the inability to control online contacts was also seen as a barrier to use, which was also a reason as to why both Skype and Facebook were considered more secure than Twitter. Therefore, the public nature of Twitter, where any user can follow a public users’ account, is a negative factor in the low-level and non-use of such SNS. The inability of individuals to control what information people in these networks disseminated was also an issue as older adults felt this translated to a lack of control over their own personal information. Compounding on this finding, previous research has also suggested that having too many contacts as an issue with SNS use (Brandtzaeg, Luders and Skjetne, 2010) which may also explain why this lack of user control affects this groups’ uptake of more open SNS platforms, and thus Twitter for health purposes.

- ii) Openness of the social media system
 - a. Auto-suggesting of Contacts
 - b. Privacy Linked to Communicating with People Already Known

Auto-suggesting of contacts occurs on various SNS that automatically connect users with others immediately after sign-up based on established email lists and interests. This was seen to have a negative effect on privacy perceptions and thus usage of SNS, with older adults noting they *“had only just connected and unwelcome faces from the past appeared”*. This also caused confusion amongst older adult participants who did not grasp the concept of this function, and having suggestions of real-life contacts pushed to them caused privacy concerns, for example: *“I felt personally exposed to potential ‘friends’”*. As Twitter mainly suggests accounts to follow based on interests and topics of personal preferences rather than offline contacts, there was not as much concern surrounding this SNS with regards to auto-suggesting. Previous research has suggested that older adults may feel more comfortable sharing information with recipients that they are able to select from a list of actual names, rather than automatically being included in a defined group (Lehtinen, Nasanen, & Sarvas, 2009). These findings alongside the outcomes of previous research may be used as a justification to SNS developers to modify interface and standard functions of such platforms to dynamically adapt to older adult groups, thus alleviating such concerns and retaining this user base.

- iii) Chosen mode of use
 - a. Anonymity capabilities
 - b. Perceived normative mode of use
 - c. One-to-one vs. one-to-many

Twitter was repeatedly referred to as an “anonymous” form of SNS, due to the ability to create impersonal accounts through the use of a handle that does not necessarily need to reflect the users’ real-life details. Many users felt this anonymity was a positive: *“using a username made me*

feel comfortable” and *“you only use a secret name”*. This finding is contrary to the survey responses where Twitter is seen as the least secure SNS amongst the three tested. It has previously been suggested that anonymous participation may only occur if users are confident their identity will be protected (Richardson, Zorn, & Weaver, 2011, p. 326), and while Twitter can be anonymous, there may be a lack of confidence by users that the technology will protect this anonymity. Further education and training surrounding the settings and functions of SNS may address these privacy concerns more effectively, and thus increase the minimal uptake and use of such systems.

Some users felt their privacy to be protected when using these SNS for the primary purpose of accessing and gathering information, rather than disseminating information. For example as one participant stated, *‘I do not have to disclose any details and can still enjoy reading comments’*. However with regards to the low-level to non-users of Twitter, the open and large information disseminating nature of this platform again led to privacy concerns surrounding posting and interaction: *“Twitter is last, all tweets are in the public domain so you have no choice in who reads your information”*. In addition, the one-to-many interactions of Twitter also negatively affected privacy perceptions for those choosing to use this SNS to disseminate information, *“Don't much like the concept of followers or following or being in public domain online”*. These qualitative findings suggest that older adults tend to minimally, or not use, Twitter as they are fearful of public means of communication. Future studies can further explore these concerns and if they differ based on how SNS are used by these low-uptake groups (e.g. for specifically information gathering, for specifically connecting with others, etc.).

- iv) User interface issues
 - a. Perceived familiarity of the technology
 - b. Changing interface
- v) External factors
 - a. Mass media effect upon perceived possible privacy concerns
 - b. Level of training of experience (if any)
 - c. Views about social media companies

A major finding in the study of privacy barriers to SNS use in older adults was that of familiarity with the technology. Skype, as a communication technology, had more similarities with technology older adult users were familiar with and this was why it was considered the most secure platform *"Skype is most secure, as it works like a phone"*. SNS platforms that require posting are less similar communication methods amongst older adult groups. Changing interfaces and functionalities that occur frequently throughout SNS also raised privacy concerns, *"I was just getting to understand Facebook when they changed the format. I have rarely used it since."* In addition to this, external factors, such as the negative press surrounding SNS use were also found to contribute to privacy concerns and non-use, with older adult participants expressing concerns regarding media reports regarding breaches in such platforms, for example *"seems like the entire world knows about you if not careful"*. Further to this, participant perceptions of the motives behind these SNS also raised privacy concerns. The common issue raised regarding this was where the information they provided and disseminated was going, *"something I'm worried about what [SNS] will do with my information"*. However older adults have been found to overcome usability problems if they see benefits of the platform to meet their needs (Fuchsberger, Sullner, Moser, & Tscheligi, 2012). Therefore future studies may focus on the effect of technological

support on older adult perception of privacy, in addition to developers of such platforms to introducing functionalities to SNS that are more familiar with such groups that may aid in increasing uptake.

In addition to this, one positive finding was that nearly 90% of respondents in the sample either agreed or strongly agreed that the social media technologies were affordable to use. This may have been due to a combination of a few factors, namely these social media technologies being free to sign up to and use, as well as the finding that 94% of respondents stating that they already had Internet access at their place of residence (with the minority 6% still being able to access free Internet in public places such as libraries and senior homes). Although this may have been an expected result, it is promising in context of previous research that has found older adults as having greater affordability concerns and cost being outlined as a barrier for use of SNS (Choi & DiNitto, 2013).

Privacy and online concerns will always be a significant barrier when engaging certain groups and communities (e.g. sensitivity of topics, technological literacy levels etc.) (Witzel, Guise, Nutland & Bourne, 2016). The knowledge gained from this specific research aim can be used by public health officials and researchers to customise online social-based platforms in the delivery of health information to such groups. Whilst the research carried out focused on the relatively unexplored area of privacy and older adults on SNS platforms, findings can be transferrable to other “hard to reach” population groups. Rural-based, socioeconomically disadvantaged and lower technological and health literate communities share similar characteristics (e.g. lower levels of education, lower average income, less access to health facilities due to geographical

isolation etc.). Therefore exploring issues of minimal to non-use of such platforms and utilising findings to appropriate existing Health 2.0 initiatives will benefit these aforementioned communities, especially when compared to more advantaged (or “easier to reach”) counterparts. Addressing one of the major barriers to use (in privacy) and by using these identified themes explored in this thesis, public health officials can better design initiatives (i.e. future SNS platforms, applications, online programs) to deliver effective health promotion to these hard to reach population groups. Whilst it is difficult to ascertain that SNS-based health promotion can overcome all aspects of health, acknowledging issues such as barriers to use is a step in the right direction to fulfil expected limitations.

This area of research contributes to one of the aims of this thesis to explore the issues of why certain sub-groups certain sub-groups, such as older adults, use such SNS minimally, or not at all, and address the consequences and concerns surrounding these levels of use. This was done via the analysis of older adults (i.e. one of the largest identified non-users of SNS) and their privacy perceptions (i.e. one of the largest identified barriers to SNS use) of such platforms, with these areas drawn from existing population statistics, trends and literature. Whilst the research contained within this chapter differs methodologically from other chapters, it cannot be emphasized enough that without users the proliferation, effectiveness and uptake of SNS both for general and health-related utilisation cannot be fully realized and adopted; conversely affecting individuals within such minimal-use groups through inadequate access to health information and relevant self-organising communities. Therefore the analysis of such data, as well as further work in this area with similar groups, is paramount to address the issue of limited SNS use amongst

such groups as health information communication and public health promotion continues growing alongside our digitalised society.

- 5) To study international public health events and uncover significant trends and features of SNS-based communication and information-related responses to offline occurrences.

The study of international public health events and their “significant trends and features of SNS-based communication and information-related responses to offline occurrences” is an important aim of the research contained within this thesis. Significant public health events can involve those that are campaign-related or outbreak-related. As funding and resources of health sectors and certain health areas undergo reform (Fritzell & Lundberg, 2007; Esser & Bench, 2011, Wu, 2016), efforts such as public health campaigns require more cost-effective methods of delivery to affected global communities. The use of SNS platforms in the delivery of such campaigns is a novel area of interest, due to the potential (and calculable) reach of health information and engagement of various users (as shown in previous chapters). By providing evidence-based research of public health events, this thesis contributes findings that can be utilised to inform policy and determine the strategy for top-level entities (e.g. national and international health organisations, government bodies) in the management of such events.

Chapter 9 explores the online activity of the 2014 #worldhealthday campaign run by the World Health Organisation (WHO), which was found to have a significant dissemination of information during data collection across a 3-day period. Tweets containing the hashtag #worldhealthday were mined via the Hashtracking program, with these tweets having over 163 million timeline

deliveries and approximately 93 million accounts “reached”. It should be reiterated that this measure of reach counts all followers of a tweeting account, regardless of whether they actually receive the information disseminated or not, thus the value represents the number non-unique followers that could have potentially received such information. During this period of data collection, there were 25,379 tweets disseminated by 16,966 Twitter accounts. These numbers alone reflect the evolution of public information dissemination described in Chapter 4, where public health information dissemination is no longer restricted to a few large sources but involves a wide variety of other entities with more information being pushed multi-directionally than in previous models of health-related communication.

With relation to the tweet engagement of the campaign, more than one-third (35%) of total tweets were original tweets, with 61% of the sample composed of retweets and 4% being mention tweets. The number of retweets nearly doubled the number of original tweets, meaning every original tweet was shared almost twice as many times to other accounts. In fact, the number of retweets and original tweets were increasing at similar rates early in the campaign until 9am GMT on the 7th of April, where the number of retweets began increasing at higher rates than original tweets. This is because, without original tweets, there would be no information to pass along and thus these trends uncover times where user-propagation is significant during such events. There is also a larger proportion of retweets presented in this campaign-related sample than that of the public health related tweets identified in Chapter 5, where only 47% of public health advice tweets were found to be retweeted. This potentially shows the larger engagement of campaign-related data, with possible more trustworthy sources of information from authoritative accounts being more highly disseminated (similar to the

Chapter 5 findings of government and NFP health organisations having their information more frequently retweeted) and the effectiveness of individual users who propagate such information.

The proportion of original tweets was greater than retweets during the announcement and commencement of the #worldhealthday campaign. Approximately half of the top 20 most actively tweeting accounts represented individuals without known health backgrounds, and thus shows the importance of individual user-propagated information during such events. However as found in previous chapters, account activity, reach and engagement did not necessarily correlate during SNS-based information dissemination. For example, when measuring the impact of “popularity” it was found not only that the WHO was the most popular account, with their tweets being retweeted and mentioned the most, they had only tweeted 8 times during the collected sample with the hashtag #worldhealthday. Similarly, it was found in earlier chapters that there was a moderate correlation between more authoritative sources of information and lower tweeting activities, as well as government accounts tweeting less frequently about public health advice but having a majority of this information passed along. Whilst the WHO account was ranked 10th for reach, it still achieve the greatest engagement of all accounts and thus reflects previous findings that it is not just the amount of followers an account has that drives this information propagation (Cha, Haddadi, Benevenuto, & Gummadi, 2010; Bakshy, Hofman, Mason, & Watts, 2011). The WHO account was mentioned in 80% of all mention tweets collected, thus demonstrating it was a) a recognized campaign-related account and b) that users were attempting to directly communicate with this organisation.

In addition, the top 10 most popular accounts were found to include celebrities, well-known NFP organisations and popular health-related entities. In terms of reach, the account that achieved the highest number of followers reached was of the well-known public figure Bill Gates (@billgates). Whilst the verified account representing Bill Gates only tweeted once, by having over 15 million followers this tweet was by far the largest reach of an account during the entire data collection period. Regardless of reach, the @billgates account was not significant in terms of engagement, with lower levels of mentions and retweets of the piece of disseminated information thus consistent with findings throughout this thesis with regards to reach compared to engagement. The next two accounts with the highest reach were also well-known individuals, David Bisbal (@davidbisbal) and Sir Richard Branson (@richardbranson). This illustrates the responsibility of such popular accounts and celebrities during public health events, due to their large following where the information they create or share can be vastly disseminated through the Twittersphere, even regardless of content. These findings of popular accounts can also contribute to the strategy of future SNS-based health campaigns, where those behind certain campaigns can recruit and utilise celebrities with large numbers of followers to increase the reach of more important information. This thesis suggests that a future “best practice” strategy of SNS health campaigns should utilise these celebrities to pass along government or reputable organisation-created information to further increase content engagement, rather than have popular accounts provide their own opinions or information that may not be as authoritative in the context of health.

43% of the tweet sample collected during the #worldhealthday campaign contain hyperlinks that link to further information on Web pages, which was far less than the 61% found for the #Zika

PHEIC announcement in Chapter 10. When examining the content contained in the most popularly disseminated links, it was found that the information varied to the actual message of the health campaign, which was about raising awareness around vector-borne diseases. This highlights that through such platforms, with the interaction of various entity-types with vast amounts of information, campaigns are inherently not completely controllable as they involve the propagation of information by these different user types who have various intentions. For example, a FP organisation may see this campaign as an opportunity to promote mosquito repellent products, whilst an individual may only pass along information if it were relevant to how the message directly affects them and/or their community. It was also found that a number of highly disseminated hyperlinks contained information regarding donation, illustrating the potential of SNS-based health campaigns for a cost-effective way of fundraising similarly to the findings of Chapter 5 with the proliferation of fundraising-related tweets amongst health organisations. The research findings of SNS-based health campaigns contribute to evidence-based decision-making, planning and management of future targeted campaigns. In addition to this, government involvement and policy regarding such delivery of online-based campaigns can be updated as they become more prevalent amongst our digitalised society, with further initiatives of researching actual changes in health behaviour and comparisons to offline campaigns.

Chapter 10 details the study of another public health event involving the online response to the 2016 Zika Virus Outbreak. A Public Health Emergency of International Concern (PHEIC) announcement was made by the WHO regarding the pandemic outbreak of the disease on the 1st of February 2016. A similar methodology to the study of the #worldhealthday campaign was

applied to the data collection phase, by capturing hashtag-related data from the online response to this PHEIC announcement for subsequent analysis. Tweets containing the hashtag #Zika were captured on the day of and the week following this announcement. During the week-long data collection, 307,982 tweets were collected from 141,102 contributors of this information. This was an average of 30 tweets per minute, compared to that of the campaign that was calculated to be approximately 6 tweets per minute. Thus the rate of dissemination of outbreak-related information was seen to be approximately 5 times more frequent than that of the campaign-related tweeting across the respective data collection periods. The larger frequency of outbreak-related communication was also reflected in the number of users participating, with 20,157 users on average per day (14 users per minute) tweeting about #Zika, compared to that of 5,655 users per day (4 users per minute) for campaign-related communication. This reflects the findings in Chapter 6 of the characteristics of highly disseminated health information; where content that is Actionable, Time Relevant and a Perceived Health Risk are more successfully shared and passed along. Whilst these characteristics can also be applied to the nature of highly disseminated tweets in the #worldhealthday campaign, the communication related to the public health outbreak is far less pre-planned and more reactive which may explain such a response.

The large number of contributors and frequency of tweets were also reflected in the general dissemination figures, with 6.5 billion timeline deliveries and 1.08 billion non-unique followers reached with this #Zika-related communication in the week. In addition, whilst tracking these rates of dissemination and reach, it could be seen that a large spike occurred at 18:00 GMT on the 1st February 2016, reflecting the immediate reaction to this PHEIC announcement. As it was identified in the chapter that various large media sources reported this announcement at later

times, this thesis shows how Twitter can be used to accurately pinpoint significant incidents in such public health events more immediately than other offline and online media sources. This Zika-related tweeting sample also contained very high levels of retweeting, with 72% of all collected tweets being passed along at least once. This was a larger proportion than that found in the campaign-related study. The remaining 26% of the captured sample were original tweets, with the final 2% falling under the category of mention tweets. With relation to the findings of Chapter 5, it was found that 47% of all public health advice tweets were retweeted, with this level of retweeting differing between organisational sectors. The larger proportion of retweets found in both campaign and outbreak-related communication can be the effect of more individuals participating during these public health events due to the nature and characteristics reflecting that of highly disseminated information as outlined in Chapter 6 (Actionable, Time Relevant and a Perceived Health Risk). In other words, the forwarding of information increases as the characteristics of highly disseminated information are fulfilled by such events. Approximately 61% of tweets contained hyperlinks to further information, which was greater than the 43% found in the campaign-related sample. This reflects the findings of Chapter 7, where higher disseminated or retweeted information in the #Zika outbreak sample contains more links to other pages than the #worldhealthday campaign-related sample.

To explore in detail the content present in this week-long data collection, a random sample of 1,063 tweets were pulled for further analysis. This sample size was determined from the 307,982 tweets captured with a 95% confidence level and a ± 3 margin of error. Utilising the methodology from earlier chapters, profiles and tweets were manual categorisation and analysed according to required metrics (i.e. location, language, type of information, etc.). The majority of these tweets

(72%) came from individual accounts, 9% were categorised as online media accounts with lower representations of government and organisation-related accounts (2% and 3% respectively). 83% of the tweets disseminated by this random sample of users were classified as sensemaking, 7% were efficacy-related, 8% contained both types of information and 2% could not be classified in either category. Efficacy information was based around the prevention of the spread of the Zika Virus, such as mosquitos, pregnancy advice and potential treatments. This is of interest as it has been found that efficacy-related tweets are underrepresented in previous literature surrounding online health information (Sutton, League, Sellnow, & Sellnow, 2015; Vos & Buckner, 2016), however should be more disseminated due to it being more authoritative in nature. It should also be noted that efficacy-related information have similar characteristics of highly disseminated tweets as identified in Chapter 6. One suggestion for the lower proportion of efficacy-related information found throughout the sample is the underrepresentation of government and organisational accounts in this random sample. Thus for further proliferation of such information during public health outbreaks, future strategies can involve a) the creation of more authoritative health accounts on SNS and b) the requirement for existing authoritative accounts to tweet more efficacy-related information that can be passed around due to their existing influence and engagement.

A previous concern of big data analysis of Twitter health samples is the bias toward countries that have a higher uptake of SNS and more users on Twitter (Chaffey, 2016). The study on the #Zika PHEIC announcement however illustrated this was not the case, with tweeting rates reflecting countries being affected by the health issue and not simply dominated by countries with higher uptake of the SNS. Approximately 60% of the random sample provided location data,

and from this it was found that the top 5 global areas of tweeting activity were North America (35%), South America (28%), Europe (15%), Central America (6) and the Caribbean (6%), proportions that do not reflect the global rankings and proportions of Twitter usage (Statista, 2016). Findings from this thesis thus contribute that response to a health crisis reflect offline communities, and thus Twitter-based research surrounding global health issues should have minimal concern with regards to tweeting bias, especially when exploring issues of such immediate concern.

The content contained in the random sample of tweets were also categorised. Tweets relating to the actual PHEIC announcement only contributed to 9% of the random sample, with conversation peaking on the first day of data collection (during the actual announcement) and almost linearly decreasing by 95% by the fourth day. During this four day decrease of announcement-related content, it was observed that content relating to general disease information, the status of involved countries and government responses to the virus simultaneously rose. This is a significant finding that illustrates the information-related response to the announcement, where such data relating to the Zika Virus is immediately propagated in order to reassure, educate, update and rationalise online users to the current offline situation. The contributions and findings of this work can be used by government, health organisations and authoritative bodies to better prepare, engage and respond to future health outbreaks by the dissemination of similar relevant, efficacy-based information through these SNS. It can be argued that public health events that involve dissemination of information would not have such large reach and engagement through different medium (television or print), especially when taking into account the cost-delivery ratio. Such novel areas of research involving SNS and big data analysis thus provide the

foundation for future public health information communication and promotion with our changing digital and health-related contexts.

Previous research suggests that social media use by many community-based organisations is uni-directional, with health information being tweeted less than promotional information in some cases (Ramanadhan, Mendez, Rao, & Viswanath, 2013). However utilising the various findings of this thesis, the following guidelines are suggested to increase engagement and indirectly increase the proportion of good quality health information being disseminated throughout the Health 2.0 landscape. These guidelines can not only lead to an increase in general engagement during normal periods of SNS-based communication, but will also ensure that controlled information from trusted sources can be more effectively disseminated and shared during national and international public health events:

- Answering user questions: Health organisations should be directly responding to questions and viral information being shared, either to dispel incorrect or untruthful information or to keep the community updated on situations. In both public health events studied, only a minute fraction of collected tweets mentioned other users (2% and 4% in the campaign and outbreak studies respectively). Whilst not suggesting that all individuals are to be directly answered, appearing concerned and engaged (through directly responding) whilst pushing out messages may increase engagement and reputation. Furthermore, interacting with high profile users (e.g. celebrities, politicians) will also increase the reach of the message being delivered.
- Tweeting more efficacy-related health information: As discussed in the analysis of the Zika Outbreak data, only 15% of tweets had some form of efficacy-related information

contained within the message. Efficacy-related information has been found to influence offline health behavior and decision-making (Magnezi, Bergman, & Grosberg, 2014), thus public health officials and communication officers for organisations can push more of this information out during public health events. In addition, combining these findings with the discovered characteristics of highly shared health information from Chapter 6 (actionable, time relevant, contained a high perceived health risk and were written in a personally-directed style), will further ensure that higher quality, relevant and important information are more frequently disseminated throughout SNS platforms.

- Using relevant hashtags: As found in both public health samples, over half the captured tweets contained more than one hashtag (i.e. co-occurring hashtags). Hashtags are an effective way to be involved in specific topics of communication, and especially in Twitter where there is a 140-character limit on posts, using relevant hashtags can strategically spread messages to larger audiences with minimal input. In addition to this, the use of hashtags can benefit specific causes identified in Chapter 5 and 9, such as fundraising for certain charities or spreading awareness through campaigns. The use of relevant hashtags in delivering health information can also benefit users receiving information to effectively filter this information with minimal noise, creating self-organised health networks that effectively route documents to individuals who are better qualified to discuss and evaluate these documents (as suggested in Chapter 7).
- Tweeting more Weblinks: Public health officials should be disseminating more information that contain links that push users to associated Websites. As found by previous literature, approximately 30% of tweets contain URLs, although over half of these lead to spam (Cui, Zhang, Liu, & Ma, 2011). Through the analysis of various collected

datasets across this thesis, it has been demonstrated that health-related tweets have a higher proportion of links than those not related to health, and health tweets that contain links are passed on at a higher frequency than tweets that do not contain links. It should be noted that by sharing links to more authoritative sources, this could also potentially increase the frequency of dissemination as found in Chapter 7. Therefore to increase engagement with users, those creating health information should post more Weblinks from authoritative sources and ensure their message is more effectively communicated.

- Controlling direction of conversation: In addition to the above guidelines to increase engagement, public health officials can also fulfill roles to counteract certain groups attempting to push their own agenda and health information that is not evidence-based (e.g. anti-vaccination movements, anti-GMO groups, practices mistakenly regarded as being based on scientific method or “pseudoscience”). Being attentive of the conversation at hand, monitoring the online activity of these anti-health groups, and implementing strategies like searching for popular results of a hashtag and engaging with the discussion of such groups can help control the direction of harmful (or hijacked) health conversations.
- Tailoring health information and interventions: From this thesis we can ascertain that users will disseminate or share health information created by health organisations, or during certain events, that is relevant to them and do so more frequently when this information is from an authoritative source. The future direction of SNS-based health promotion is to now involve these audience members with tailored programs relevant to their needs. Not only will this achieve the issues present in modern day context, but will also progress research from exploring online engagement to investigating how these

messages truly affect offline behaviour (Neiger, Thackeray, Burton, Giraud-Carrier, & Fagen, 2013).

11.3 Strengths and Limitations

One of the major limitations of the research design can be attributed to the novel nature of the area of study. As quite a recent phenomenon, the literature surrounding Health 2.0 is minimal compared to other disciplines of health sciences (e.g. exercise and nutrition) and traditional areas of media and communication. As previously mentioned, there has yet to be an agreed standard of data collection, with certain aspects of analyses of Twitter data being varied (e.g. automatic coding, manual coding, semantics and meanings). Therefore the methods used throughout this area of study differ dependent on the resources available and the perceived aims of the research being carried out. This thesis overcomes this limitation by applying lessons learned from literature to set achievable methodology and parameters that ensure as substantive as possible samples are captured and analysis is relevant to fulfil chapter purposes.

The novel nature of this cross-disciplinary area of study is also conversely a strength of the thesis. Due to the characteristic of Twitter being a public social platform, especially when compared to more private SNS like Facebook, large amounts of data are readily available for research purposes. On top of this, the ethical considerations and implications surrounding collection and analysis of such big data are less problematic due to the information having been published to the Internet at large (Zimmer & Proferes, 2014). Whilst there are still reasonable

ethical concerns surrounding the use of SNS to carry out research on biomedical data (Mittelstadt & Floridi, 2016), the studies within this thesis emphasise the health information being disseminated rather than the health status or condition of the user. Whilst access to such information may change with the introduction of stricter privacy settings or legislation, this thesis has taken the opportunity of utilising the vast amount of available data for ethically appropriate research.

One of the major strengths of the research design is that it investigates, on a whole, the important aspects of Health 2.0 and builds on what is currently known. Even from the initial publications of earlier chapters, these SNS platforms have grown rapidly in uptake, with information being disseminated across such platforms at an exponentially increasing frequency. These methods of communication are well and truly ingrained in modern day society, and thus similar evidence-based research must be carried out to ensure effective strategic decision-making occurs. In addition to this, the growing number of health applications and social-based online interventions to manage user health emphasises the importance of such areas of study (Grist, Porter, & Stallard, 2017; Bardus, van Beurden, Smith, & Abraham, 2016). Whilst the multi-faceted complexities of such a system can be a limitation to focused research, it has been reinforced that this thesis explores significant areas of interest where there are knowledge gaps in the literature. For example, studying health organisations in-depth as users, emphasising older adults as a minimal-using population group, and investigating two of the most significant recent public health events as case studies, all ultimately contribute to the current Health 2.0 landscape.

Following on from the above, there has been some question as to the true capabilities of using SNS platforms for health purposes and health research. Previous authors have suggested there are high expectations of social media tools that need to be decreased in the context of providing effective health communication and promotion (Nocker, Siegert, Tmse, Quast & Howner, 2014). However, it can be argued that with regard to non-sensitive topics and health events of interest (as shown in this thesis and other studies), health information is disseminated on an extremely large scale and when used effectively can supplement healthcare and chronic health management. Thus rather than disregarding such platforms of communication, further studies to uncover aspects of the landscape of Health 2.0 and correlating to real-life behaviour outcomes will shed more light on this novel area of research.

11.4 Conclusion and Future Work

The model of health information dissemination via social media platforms has evolved from previous models of communication, where information flow was unidirectional and the medium was of a static nature, to the current state of multi-directional and dynamic dissemination through widely utilised and rapidly expanding means. Whilst these SNS are currently ingrained in our way of life, as more individuals and communities join these SNS and turn to online sources for health information, further evidence-based research is necessary to provide a foundation for effective public health communication across such platforms.

Due to the relatively recent introduction of SNS as a means of communication and health information dissemination, future research can focus on longitudinal studies as social media ages

and becomes further established. Further studies can also involve the measure of actual health behaviour outcomes in relation to longitudinal SNS-health information dissemination, such as health management groups of fitness or chronic illnesses (e.g. arthritis) and their respective outcomes. An area of potential significance suggested by work contained in this thesis is the comparison of similar offline and online run campaigns, comparing delivery, reach and cost-effectiveness, especially with the growing area of mobile health technology. In addition, more research should be done to analyse the quality of health information across all platforms of SNS, for potential filter development of low quality or misinformation through these sites. Findings from this thesis should also provide a foundation to further address certain groups with minimal or no usage of such sites, an important area of focus as digitalisation of the global society continues.

The findings discussed in this thesis all contribute to issues faced in our current society of widespread digitalisation. As more and more people utilise such social online platforms, there is the need for more evidence-based outcomes in an area of such high use and uptake. In addition to this, issues that have been identified in current and predicted trends have been the rising cost of global healthcare and the increasing and ageing global population. This thesis contributes to such issues by exploring SNS-based public health information dissemination as the need to supplement health delivery with a cost-effective alternative becomes more and more necessary. Further to these trends, this thesis also addresses one of the major barriers to SNS use (privacy) of certain individuals and communities (older adults) who can potentially benefit from such health delivery the most.

The current literature in this area, whilst not as sizeable as more well-defined and longstanding health science disciplines, is growing due to the increasing focus of e-health and social-based online communication. As such, the work contained within this thesis also contributes to the currently unexplored or minimally understood gaps within this knowledge area of health and SNS-based communication. Outcomes have explored the lack of findings with regard to types of health information present online through SNS platforms, identified the previously unexplored characteristics and roles of health-related organisations and government bodies on such dynamic setting, analysed public health run campaigns by largely credible sources on such social-based sites, addressed the use of hashtag-related research from anticipated events rather than reactive events (i.e. campaigns and announcements), to name a few. In a general sense, the work from this thesis reinforces the appropriateness of SNS for the communication and information dissemination of global health-related issues, in addition to contributing knowledge to the phenomenon of health information scanning on these novel platforms. By uncovering reasons of low-level and non-use of certain groups, the roles and features of users on these SNS, the characteristics and types of information being disseminated and case studies of public health-related events through these platforms, the findings discussed in this research will contribute to a wider understanding of this interdisciplinary field of emerging communication technologies and public health information dissemination, as it grows with the digitalisation of society and health issues affect global communities.

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Appendix A

Appendix A is the final version of the survey used to collect data from older adult participants for the research undertaken in Chapter 8.

PART A. DEMOGRAPHIC DETAILS

Q-A1. Age (fill in):

Q-A2. Marital Status (choose one):

- Single Never married Married or partnered
 Separated or divorced Widowed

Q-A3. Living Arrangement (choose one):

- Live alone Live with others

If living with others, please indicate number of others in household and specify (e.g. wife, son, partner, etc.)

Q-A4. Postcode (fill in):

Q-A5. Are you currently (choose all):

- Working Volunteer work Retired
 Acting as a carer Other (please specify)

Q-A6. How would you rank your computer usage abilities? (choose one)

- Very limited Limited Average
 Above Average Excellent

PART B. EXPERIENCE WITH TECHNOLOGIES

Q-B1. Internet Access Location (choose one):

- Private internet access (e.g. home) Public internet access (e.g. library)

If using public Internet access, please specify access location here (e.g. community library)

Q-B2. Did your Internet Access Location (public or home usage) change during the trial?

- Yes → if so specify which month you changed this
- No

How frequently do you use the following technologies on average currently (please tick the most relevant option per row):

	Technology	Never	Once a month	Once a week	More than once a week	Daily
Q-B3	Computer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B4	Internet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B5	Email	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B6	Online purchase	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B7	Twitter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B8	Skype	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B9	Facebook	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q-B10. Please provide an estimate of your overall average hours/week of computer usage:

During the trial Prior to starting the trial

Q-B11. Please provide an estimate of your average hours/week of Email usage:

During the trial Prior to starting the trial

Q-B12. Please provide an estimate of your average hours/week of Twitter usage:

During the trial Prior to starting the trial

Q-B13. Please provide an estimate of your average hours/week of Skype usage:

During the trial

Prior to starting the trial

Q-B14. Please provide an estimate of your average hours/week of Facebook usage:

During the trial

Prior to starting the trial

The following questions ask how you feel about social media tools. Please choose the answer that appears most appropriate.

	Questions	Strongly Disagree	Disagree	Agree	Strongly Agree
Q-B15	Social networking sites are easy to use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B16	The interaction provided by social networks would be a factor in enabling me to live independently at home for longer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B17	How others might perceive me was a factor in how I used the social media technologies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B18	The use of social networks has, to some extent, improved my quality of life.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B19	Social networking sites help me feel less isolated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B20	Social networks help me to be more connected and involved with the community.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B21	I consider social media to be affordable for me to use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B22	I felt the social media systems used, allowed me to adequately protect my privacy.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B23	I would continue to use social media after this trial project ends.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B24	The use of social media led me to have extra face-to-face social interactions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q-B25. Please rank and discuss below which of the three social media applications (Skype, Twitter, Facebook) you thought was the most (1), the second (2) and the least (3) secure in terms of privacy.

Please tell how much, if at all, the social networking sites have helped you do each of the following things in the last six months.

	Questions	A lot	Some	Only a Little	Not at all
Q-B26	Become more involved with groups and organisations you already belong to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B27	Become involved in new groups and organisations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B28	Connecting with family or relatives	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B29	Connecting with old friends and/or schoolmates	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-B30	Connecting with new people or new friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q-B31. How many connections (friends or followers) do you have for your social networking sites? (Number of connections: Twitter (Following, Follower), Facebook (Friends), Skype (Contact list))

Media Connection Type	Not Used	Number of connections
Twitter: Number of people you are following	<input type="checkbox"/>	
Twitter: Number of people following you	<input type="checkbox"/>	
Facebook: Number of Friends	<input type="checkbox"/>	
Skype: Number of Contacts	<input type="checkbox"/>	

Q-B32. Rank your use of social media technologies in the last six months ('1' for most used, '2' for second and '3' for the least used, or 'X' for never used). Please describe the main reasons for the rank provided.

	Rank	Reasons
Skype		
Twitter		
Facebook		

Q-B33. What are benefits of social media technologies (select all relevant to you):

- To keep in touch with family and relatives
- To keep in touch with friends
- To meet new people and make new friends
- To find information
- To share information
- For entertainment (e.g. music, videos, etc.)

Please describe other benefits if not listed and which technology provided these benefits?

Social media	Other Benefits

Q-B34. Did social media technologies influence your daily or social life in the last six-month period?

- Yes, please describe how
- No, please describe reasons why

Q-B35. If you joined in any other social media (e.g. LinkedIn, Pinterest) in the last six months, please specify the service name and describe reasons you have used their services?

Q-B36. If you have had any problems or concerns in using the social media technologies during the last six-month period, please describe these.

Q-B37. Who did you contact most frequently using the social networking technologies for the last six-month period? (Please type '1' in the box for the most frequently contacted people, '5' for the least frequently contacted people, and 'X' for people not contact):

- | | | |
|--|---|--|
| <input type="checkbox"/> Family, Children, Grandchildren | <input type="checkbox"/> Friends | |
| <input type="checkbox"/> Other Relatives | <input type="checkbox"/> Club or Group-related people | <input type="checkbox"/> Work-related people |

If not listed, then please specify here

Q-B38. On average, how often did you contact the most frequently contacted people in Q-B37 via social networking technologies in a month? (Choose one):

- | | | |
|--|---|--------------------------------------|
| <input type="checkbox"/> Daily | <input type="checkbox"/> Several times a week | <input type="checkbox"/> Once a week |
| <input type="checkbox"/> Several times a month | <input type="checkbox"/> Once a month | |

Q-B39. Which social network technology did you use to contact the people most frequently in Q-B37? Please rank '1' for most used, '2' for 2nd and '3' for the least used, or 'X' for never used.

- | | | |
|--------------------------------|----------------------------------|-----------------------------------|
| <input type="checkbox"/> Skype | <input type="checkbox"/> Twitter | <input type="checkbox"/> Facebook |
|--------------------------------|----------------------------------|-----------------------------------|

Q-B40. Did the use of these technologies during the trial lead to any monetary savings? If so, describe.

--

Q-B41. For the purpose of research output, we would like to quantify the number of your connections you made through the social media during the trial. If you could please provide your user names for the social media, thank you. The user name is different from your email address for Twitter.

Twitter:		Facebook:	
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PART C. SOCIAL EXPERIENCE

The following questions ask how you feel about real-life interactions with people around you. **Please choose the answer that appears most appropriate.** If you are unsure about which response to give to a question, the first response you think of is often the best one. (Including friends or contacts through social media or not including – discussion required)

	Questions	Never	Rarely	Sometimes	Often
Q-C1	I feel in tune with the people around me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C2	I lack companionship.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C3	There is no one I can turn to.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C4	I do not feel alone.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C5	I feel part of a group of friends.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C6	I have a lot in common with the people around me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C7	I am no longer close to anyone.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C8	My interests and ideas are not shared by those around me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C9	I am an outgoing person.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C10	There are people I feel close to.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C11	I feel left out.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C12	My social relationships are superficial.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C13	No one really knows me well.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C14	I feel isolated from others.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C15	I can find companionship when I want it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C16	There are people who really understand me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C17	I am unhappy being so withdrawn.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C18	People are around me but not with me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C19	There are people I can talk to.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-C20	There are people I can turn to.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q-C21. If you do feel socially isolated, what do you believe are the reasons for this? Please list (up to) the top 4 reasons in the box below, starting with the most significant reason (1) to the least significant reason (4).

1.

2.

3.

4.

Q-C22. If you do feel socially isolated, are you trying to actively take steps to cope with social isolation? Choose the relevant option and please specify ways or reasons in the box below:

Yes, describe ways you are actively trying to cope with social isolation below

No, describe any reasons if there are, for this

Please specify here:

PART D. SOCIAL INTERACTIONS

	Questions	None	1 or 2	3 to 5	6 to 9	10 or more	Unknown
Q-D1	How many close <i>friends</i> do you have, people that you feel at ease with, can talk to about private matters?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-D2	How many of these close friends do you see at least once a month?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-D3	How many relatives do you have, people, that you feel at ease with, can talk to about private matters?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-D4	How many of these relatives do you see at least once a month?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-D5	Is there someone available to you whom you can count on to listen to when you need to talk?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-D6	Is there someone available to give you good advice about a problem?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-D7	Is there someone available to you who shows you love and affection?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-D8	Can you count on anyone to provide you with emotional support (talking over problems or helping you make a difficult decision)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-D9	Do you have as much contact as you would like with someone you feel close to, someone in whom you can trust and confide?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q-D10. Do you participate in any groups such as a senior centre, social or work groups, religious connected groups, self help groups, or charity, public service or community groups?

- No – *Go to Part E.*
 Yes – *Go to Q-D11*
 Unknown

Q-D11. About how often do you go to the above meetings or services?

- Never or almost never
 Once or twice a year
 Every few months
 Once or twice a month
 Once a week
 More than once a week
 Unknown

PART E. QUALITY OF LIFE

The following questions ask how you feel about your quality of life. **Please choose the answer that appears most appropriate.** If you are unsure about which response to give to a question, the first response you think of is often the best one.

Q-E1. How is your health in general? (Choose one):

- Poor

 Not so good

 Fair
 Good

 Very good

The following questions ask about how much you have experienced certain things in the list.

	Questions	Not at All	A little	A moderate amount	Very much	An extreme amount
Q-E2	How much do you enjoy your life?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-E3	To what extent do you feel your life to be meaningful?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-E4	How well are you able to concentrate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The following questions ask about how completely you experience or were able to do certain things in the last four weeks.

	Questions	Not at All	A little	Moderately	Mostly	Completely
Q-E5	Do you have enough energy for everyday life?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-E6	How well are you able to get around?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	Questions	Very dissatisfied	dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
Q-E7	How satisfied are you with your ability to perform your daily living activities?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-E8	How satisfied are you with your capacity for work?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-E9	How satisfied are you with yourself?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	Questions	Very dissatisfied	dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very satisfied
Q-E10	How satisfied are you with your personal relationships?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-E11	How satisfied are you with the support you get from your friends?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	Questions	Never	Seldom	Quite often	Very often	Always
Q-E12	How often do you have negative feelings such as blue mood, despair, anxiety, depression?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-E13	How often do you have visits from community support services (e.g. home care service)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

(NOTE: If you don't use public transport or if you don't have your own car/vehicle, then please tick '0 day/week'.)

	Questions	0 day/week	1-2 days/week	3-4 days/week	5 or more days/week
Q-E14	How often do you use public transport?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q-E15	How often do you use your own car/vehicle?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Appendix B

Appendix B contains the interview guide used for the focus groups of older adult participants for the research undertaken in Chapter 8.

Connecting Older Adults – Post Focus Group Interview Guide

General instructions:

Raise the general discussion topics to encourage discussion. Can raise the more specific questions, as/if discussion dries up. Should cover all **broad topics**, but may not cover each individual question.

Importantly: mainly encourage speakers by asking them to continue or elaborate on the points they make, and asking the rest of the group, “is this what you have found also, or any other views?” etc.

Introduction

- *Introduce yourself*
- *“This focus group has been created in an attempt to gather your general thoughts and impressions of the training course and the social networking applications you have been introduced to.”*
-
- *“I will be raising a few discussion topics and asking a few questions to the group, so feel free to speak openly amongst yourselves as this is all anonymous and in no way will comments made here be identifiable to you”*
- *“All have agreed to be audio-visual recorded for the focus group.”*
- *“Lastly, I would really like to encourage all of you to participate because we would like all your opinions to be heard”*

General

- *What do you think of social networking technologies in general?*
- *Are the technologies complex or easy to use?*
- *Which one was the easiest and why?*
- *Which do you expect to use the most?*
- *How do these forms of networking compare to others you may use in your daily life (e.g. email, telephone)?*
- *Are there any suggestions or changes you would like to see to any of the applications we went through?*

Benefits

- *Do you expect any benefits for social interactions or networking?*

- *Do you see any potential of social networking to increase interaction with people you know already, or for meeting new people?*
- *Do you think using those technologies will be a positive for your day-to-day life?*

Concerns/difficulties

- *Were there any specific concerns when using these applications over the trial period (e.g. social, privacy)?*
- *Did you have any difficulties with the technologies?*
- *Do you have any concerns?*
- *Which areas or applications did you have the most difficulties with?*
- *Are there concerns about the quality of interaction social networking provides?*
- *Would there be any barriers to your use during the 6 month period?*

Privacy

- *What do you think privacy in these applications?*
- *Which application do you think is the most secure? Least secure?*
- *If any concerns in relation to privacy, what are they?*

Appendix C

Appendix C contains the ethical approval letter for the research undertaken in Chapter 8.



RESEARCH INTEGRITY
Human Research Ethics Committee
Web: <http://sydney.edu.au/ethics/>
Email: ro.humanethics@sydney.edu.au

Address for all correspondence:
Level 6, Jane Foss Russell Building - G02
The University of Sydney
NSW 2006 AUSTRALIA

Ref: PB/PE

27 May 2010

Professor Robert Steele
Discipline of Health Informatics
Faculty of Health Sciences
Cumberland Campus - C42
The University of Sydney
Email: robert.steele@sydney.edu.au

Dear Professor Steele

Thank you for your correspondence dated 10 May 2010 addressing comments made by the Human Research Ethics Committee (HREC). The Executive Committee of the HREC, at its meeting of 25 May 2010 considered this information and approved the protocol entitled "Connecting Older Adults: Can the usage of information communication technologies enrich an older adult's social relationships and prevent social isolation?"

Details of the approval are as follows:

Protocol No.: 12431
Approval Period: May 2010 to May 2011
Authorised Personnel: Professor Robert Steele
Professor Anita Bundy

Documents approved:
Participant Information Statement (Experience In teaching computers to older adults)
Version 1.1 – 10 May 2010
Participant Information Statement (Questionnaire/Focus Group) Version 1.0 19 November
2009
Participant Consent Form (focus group) Version 1.0 19 November 2009
Participant Consent Form (Interview) Version 1.0 19 November 2009
Advertising flyer
Self-Report Questionnaire
Focus Group Questions

The HREC is a fully constituted Ethics Committee in accordance with the National Statement on Ethical Conduct in Research Involving Humans-March 2007 under Section 5.1.29.

The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Research Involving Humans. N.B. A report on this research must be submitted every 12 months from the date of the approval, or on completion of the project, whichever occurs first. Failure to submit reports will result in the withdrawal of consent for the project to proceed. Your report will be due on 31 May 2011, please put this in your diary.

Deputy Manager Human Ethics
Ms Marietta Couinho
T: +61 2 8627 8178
E: marietta.couinho@sydney.edu.au

Human Ethics Secretariat
Ms Portia Richmond T: +61 2 8627 8171 E: portia.richmond@sydney.edu.au
Ms Patricia Engelmann T: +61 2 8627 8172 E: patricia.engelmann@sydney.edu.au
Ms Kala Retnam T: +61 2 8627 8173 E: kala.retnam@sydney.edu.au

AMN 18 211 913 486
CHICCO 002824

Chief Investigator / Supervisor's responsibilities to ensure that:

1. All serious and unexpected adverse events should be reported to the HREC within 72 hours for clinical trials/interventional research.
2. All unforeseen events that might affect continued ethical conduct of the project should be reported to the HREC as soon as possible.
3. Any changes to the protocol must be approved by the HREC before the research project can proceed.
4. All research participants are to be provided with a Participant Information Statement and Consent Form, unless otherwise agreed by the Committee. The following statement must appear on the bottom of the Participant Information Statement: *Any person with concerns or complaints about the conduct of a research study can contact the Deputy Manager, Research Integrity (Human Ethics), University of Sydney on +61 2 8627 8176 (Telephone); + 61 2 8627 8177 (Facsimile) or ro.humanethics@sydney.edu.au (Email).*
5. Copies of all signed Consent Forms must be retained and made available to the HREC on request.
6. It is your responsibility to provide a copy of this letter to any internal/external granting agencies if requested.
7. The HREC approval is valid for four (4) years from the Approval Period stated in this letter. Investigators are requested to submit a progress report annually.
8. A report and a copy of any published material should be provided at the completion of the Project.

Please do not hesitate to contact Research Integrity (Human Ethics) should you require further information or clarification.

Yours sincerely



Associate Professor Philip Beale
Chair
Human Research Ethics Committee

Appendix D

Appendix D contains the participant consent form for the research undertaken in Chapter 8.



Discipline of Health Informatics
Faculty of Health Sciences

ABN 15 211 513 464

PROFESSOR ROBERT STEELE
Chair and Professor of Health Informatics
Head of Discipline, Health Informatics

Room M309B
C42 – Cumberland Campus
The University of Sydney
NSW 2006 AUSTRALIA
Telephone: +61 2 9036 7368
Facsimile: +61 2 9351 9672
Email: robert.steele@sydney.edu.au
Web: <http://www.sydney.edu.au/>

PARTICIPANT CONSENT FORM

I,[PRINT NAME], give consent to my participation in the research project

TITLE: CONNECTING OLDER ADULTS PROJECT

In giving my consent I acknowledge that:

1. The procedures required for the project and the time involved have been explained to me, including any inconvenience, risk, discomfort or side effect, and their implications, and any questions I have about the project have been answered to my satisfaction.
2. I have read the Participant Information Statement and have been given the opportunity to discuss the information and my involvement in the project with the researcher/s.
3. I understand that being in this study is completely voluntary – I am not under any obligation to consent.
4. I understand that my involvement is strictly confidential. I understand that any research data gathered from the results of the study may be published however no information about me will be used in any way that is identifiable.
5. I understand that I can withdraw from the study at any time, without affecting my relationship with the researcher(s) or the University of Sydney now or in the future.
6. I understand that I can stop the interview at any time if I do not wish to continue, the audio and/or video recording will be erased and the information provided will not be included in the study.

I understand that I can stop my participation in the focus group at any time if I do not wish to continue; however as it is a group discussion it will not be possible to exclude individual data to that point.

7. I also consent to:
- | | YES | NO |
|--|--------------------------|--------------------------|
| • Attending a follow-up one hour focus group at the end of the study, involving audio or video recording | <input type="checkbox"/> | <input type="checkbox"/> |
| • Attending a half hour focus group on the day of initial training, involving audio or video recording | <input type="checkbox"/> | <input type="checkbox"/> |
| • Complete a questionnaire before and after the six month trial | <input type="checkbox"/> | <input type="checkbox"/> |

.....
Signature

.....
Please PRINT name

.....
Date