Title: **Updating the Determinants of Health model in the Information Age**

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Abstract

In 1991 Dahlgren & Whitehead produced a highly influential model of the determinants of health that has since been used by numerous national and international public health organisations globally. The purpose of the model is to enable interventions that improve health to be addressed at four key policy levels. It is not a model of health or disease; instead the model is structured around health *policy* decision-making. However the model needs an update, since it was devised there has been a digital revolution that has transformed every aspect of: human life, our cities, society and the fundamental principles upon which the global economy operates. Using a systematic literature review, the article examines the impact of Information and Communication Technologies (ICT) on the determinants. ICT has given rise to a new '*Information Age'* that is implicated in many of the major global health issues today. Addressing contemporary health issues requires intervention at the level of ICT, particularly as health communication online is central to the delivery and dissemination of public health policies.

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Introduction

The article examines the need for an update to the determinants of heath model, devised by Dahlgren & Whitehead in 1991. The original Dahlgren & Whitehead

model is structured into four policy-levels for public health interventions. Since this date, there has been a digital revolution that marked the end of the Industrial Age and the dawn of the Information Age. The health model needs an *update*. The use of the word '*update'* has a double meaning. Firstly it is meant literally, to bring this important model into the 21st century and to incorporate the massive changes caused by the digital revolution. Secondly *update* is the term used in computing to mean an updated or newer version of the same product. In this context, the Dahlgren & Whitehead model is being updated to respond to the new digital context. The new determinants of *Health Model 2.0* should enable policy-makers to effectively engage with the affects, byproducts and outcomes of the Information Age on human health. The article examines what is meant by the Information Age more specifically, before going on to evidence the implications that Information and Communication Technologies (ICT) have on the determinants for human health. Finally, justification is made for establishing a new level to the model to reflect the need for public health policy-makers to effectively engage with the digital world.

The Determinants of Health Model 1.0

Dahlgren & Whitehead's (1991) article "*Policies and Strategies to Promote Social Equity in Health"* is a hugely influential document; it has been cited over a thousand times, backed by the World Health Organisation, and is regularly referenced by National and Local Health Authorities, and Public Health bodies globally (Bambra et al., 2010; ESRC, 2015). The most commonly cited part of the document is a diagram that provides a conceptual framework that maps out the "*Main Determinants of Health"*. The diagram organizes various determinants of health into four distinct categories that relate to public health 'policy levels'. The primary value in the

diagram is in its stated purpose to *"suggest quite distinct levels of intervention for health policy-making"* (Dahlgren & Whitehead, 1991, p. 11). This function of the model is intended to enable public health agencies to target all relevant policy levels when addressing a specific health issue. The diagram is not merely a helpful simplification for the conceptualization of health determinants; but specifically organised for interventions to promote positive health and/or reduce illness. In order to address a particular health issue; health professionals need to consider each of the levels in a consistent approach (and to avoid contradictory policies operating at different levels).

Since the publication of the diagram in 1991, there have been fundamental changes in the way society and the economy operates (Cardoso, Cheong & Cole, 2009; Castells, 2002; Castells, 2002; Rainie, & Wellman, 2012; Schmidt & Cohen, 2014; Turkle, 2011). The principal change has been the emergence of Information and Communication Technologies (ICT). There are myriad forms of ICT: social media, massive multiplayer online spaces, blogs, vlogs, virtual learning environments, Skype, avatars, emails, messaging, tweets and many others. The Information Age (*also called the Computer Age or Digital Age*) has been enabled and instigated through the development of wide scale ICT (Webster, 2001). Indeed so profound have these new technologies been that the Information Age has been described as a Digital Revolution; as fundamental as the Industrial Revolution or the Agricultural Revolution akin to marking the paradigm shifts from stone age to iron age etc (Castells, 2011). The Information Age is characterized by society and the economy being structured by the flow of information through electronically processed networks (ibid). In the past 25 years the Information Age has transformed almost every aspect of life: society, culture, politics, education, entertainment, and the global economy

(Castells, 2014). This has resulted in physically different configurations of cities, towns, homes, offices, living rooms, appliances, and devices. Along with these '*material'* changes, there have been even more profound '*immaterial'* impacts on society and behaviours (Bauman, 2013). The Information Age has fundamentally and radically altered how we communicate (and with whom we communicate) and how we behave and live our lives.

The key instrument behind the Information Age is the development of the Internet and particularly the world wide web, which coincidentally began life in the very same year as Dahlgren & Whitehead's paper was published. The world wide web (*www*) was released on the Internet in August 1991 and enables the connection of billions of people globally (Gillies & Cailliau, 2000). This is seen as the watershed moment between the '*Industrial Age'* and the start of the '*Information Age*'. Whilst there had been improvements to computers and intelligent devices before this date, it is the *www* as the platform upon which the Internet works that has been pivotal to the coming of the Information Age. The Internet provides the platform for unprecedented global inter-connectivity. Half the world's population is now connected to the Internet (Broadband Commission for Sustainable Development, 2016). The Internet has impacted on the: economy, society, politics, education and lifestyles.

The economy has been transformed by ICT. Globally the majority of all financial transactions take place digitally. Financial markets increasingly use complex algorithms, replacing human actions in the process. The global economy now functions continuously, with companies electronically distributing their work in various continents so that as the planet turns, business is continuously functioning. Other businesses have replaced humans with robots and/or artificial intelligence (Ford,

2015). The number of new technological developments that impact on society and the economy have been phenomenal and the majority of these are relatively new; Google began in 1996, Facebook in 2004, Twitter in 2006 and yet are now so familiar their names have become verbs. Online shopping has become a global phenomenon. Amazon.com went online in 1995 and is now the world's largest online retailer. The five largest companies in the world are all ICT companies (Oremus, 2016).

It is not just the economy that has been changing. Society has been radically affected in a number of ways by ICT. According to the World Economic Forum, adults now "*spend more time online than doing anything else in their life*" (Woods, 2016; Bloom et al, 2011). Social networking, particularly via Facebook with over a billion users, has transformed the way we communicate with each other. Online communities rather than those based on geography or neighbourhoods are prevalent today. Social media is also radically changing mass media, individuals are able to publish their own views and news; bypassing traditional media such as newspaper or television broadcasting. The CEO of Google describes online publishing as: *'the largest experiment involving anarchy in history'* (Schmidt & Cohen, 2014, p. 4). Technology is even becoming embroiled in politics and democracy and war. Gertz (2017, p. 2) claims that 21st century warfare is being fought online as "*nonkinetic conflict waged in the digital realm*". The Russian government is accused of interfering in the 2017 American election by deploying biased or deliberately incorrect news to try to influence the election (Gayle, 2016). Social media has also been posited as instrumental in the Arab Spring and the subsequent geo-political upheaval (Khonder, 2011). Education is also changing, traditional universities are creating virtual universities accessible online globally. Robots with artificial intelligence are entering the classroom to teach school children. In our cities and homes there is ever increasing connectivity, for example,

cities are becoming ‘smart’ (aka *intelligent cities*) with the everyday life of a city being monitored through intelligent sensors and automatic data collection (Caragliu, Del Bo & Nijkamp, 2011; Dutton, Kraemer & Blumler, 1987; Kitchin, 2014). From large-scale intelligent cities to the smallest scale wearable technologies; the Internet of Things is connecting devices in our factories, offices, cars, homes, living rooms, kitchens, and bedrooms with each other via the world wide web (Gubbi, Buyya, Marusic & Palaniswami, 2013). The Information Age has significantly impacted on human health, directly or indirectly. It is not just that the ‘virtual’ world is where people and society spend increasing amounts of time (and reducing the amount of time spent in the ‘real’ world); but also that the Information Age has radically transformed the physical world and how humans interface, and interact, with it.

The Information Age as a Determinant of Health

ICT is a major determinant of health. The Information Age has transformed society and the economy and in turn it has affected human health. The next section examines some of the principal mechanisms through which ICT impacts on health: physical health, particularly through sedentary lifestyles; mental health and social health particularly through health communication.

Physical health: Sedentary Lifestyles in the Information Age

The Information Age is linked with contributing to increasingly sedentary lifestyles. The WHO lists sedentary lifestyles as one of the biggest health risks the world currently faces (WHO, 2017a). More than eighty percent of the world’s population is not sufficiently active (WHO, 2017b). Sedentary lifestyles are such a risk because they are linked to many health issues such as obesity, which is a contributing factor to

cardiovascular disease, diabetes, and cancer (ibid). These illnesses are some of the biggest health concerns globally and have a significant economic cost, estimated to be two trillion dollars a year (Dobbs et al., 2014). There are many contributing factors towards inactive lifestyles, but ICT plays a significant role in this, both directly and indirectly. The Information Age influences individual lifestyles, but it also is transforming our workplaces, homes, cities, and built environments, which in turn, is reinforcing ICT as a determinant of health. For example; online shopping takes less energy than the practice of physically going shopping; 'traditional' shopping used to involve walking and carrying bags, now shopping merely requires the click of a finger. Furthermore the advent of online shopping has been partly responsible for the demise on the high street - which in turn leads to more sedentary lifestyles as active alternatives are being lost (as well as the implications of failing high streets on communities' wellbeing and social health) (Castells, 2011). The trend is set to increase as '*assisted living'* and the Internet of Things reduces the need for human action whilst artificially intelligent objects act autonomously for society. ICT impacts on almost every aspect of contemporary lifestyles.

Mental Health in the Information Age

Mental health issues are one of the biggest health issues globally (WHO, 2001). The OECD state that one in five adults has a mental illness (Hewlett & Moran, 2014). *"The cost of mental health problems in developed countries is estimated to be between 3% and 4% of GNP"* (WHO, 2003, p. 5). ICT is one of many factors that contributes to the burgeoning mental health issues. Mental health impacted by ICT can result in: sleep disorders, depression, and stress (Thomée, Härenstam & Hagberg, 2011). A systematic review of the effects of ICT on human wellbeing concluded that

there are negative outcomes on mental health: "*increased exposure to harm, social isolation, depression and cyber-bullying*" (Best, Manktelow & Taylor, 2014 p27). However, ICT can also positively contribute to mental health through: "*increased self-esteem, perceived social support, increased social capital, safe identity experimentation and increased opportunity for self-disclosure*" (ibid). Social media for communication and socializing is increasingly imbricated in the construction of personal identity. Communication is a vital human need and society increasingly communicates virtually rather than in the physical world. There are longer-term health implications for individuals and society, particularly for younger generations who have grown up in the Information Age.

Social Health: Communication in the Information Age

Communicating health is now considered one the most important interventions in Public Health policy. "*Health communication is seen to have relevance for virtually every aspect of health and well-being, including disease prevention, health promotion and quality of life*" (Rimal & Lapinski, 2009, p247). Health communication informs communities and individuals on health issues with the aim of intervening to improve health outcomes. Communication on health is increasingly regarded as a determinant of health for individuals and communities (WHO, 2017c). '*Health Communication'* is so important that it has become a discipline and profession itself. However, the field of health communication is still relatively new, i.e. emerging *after* Dahlgren & Whitehead's article. For example, the American Public Health Association did not officially recognize Health Communication as one of its disciplines until 1997 and the American Center for Disease Control and Prevention only began an office for Health Communication in 1996 (Freimuth & Quinn, 2004). Notwithstanding its nascent

emergence, digital dissemination and education online is a core strand of almost all health improvement policies. Action on health nowadays invariably involves the use of ICT: social media, websites and online content. Health communication through ICT is a public health policy intervention in itself.

Social media and online platforms are the most effective means of conveying such information to the widest possible populations in the fastest, cheapest, easiest manner. (Hinton & Hjorth, 2013; Murthy, 2013). Online media can be used to disseminate information about a health issue; most simply as a means of conveying information, but it can also be used to express more complex issues; explaining how to identify and deal with symptoms, self-diagnose, educate, and promote healthier alternative practices (Eysenbach, 2001; Griffiths et al., 2006; Moorhead et al., 2013). Whether through social media, websites, blogs, YouTube or the various other platforms; there is great flexibility as one can use written text, illustration, audio, video, diagram and can be used repeatedly by billions of potential users simultaneously. It is now relatively easy to provide translation to any language and access almost any community in their preferred language. Social media, in particular, can be an effective means through which hard-to-access communities can be reached (White C, Primary Care Commissioning NHS, 2012). Social media also connects individuals, outside of traditional geographic constraints, to other individuals and groups with a global and diverse range of beliefs, knowledge, and opinions (Chen, 2012). This can be effective in changing lifestyles and practices that can be entrenched through closed social networks.

Health communication is particularly germane in an era when so many health problems are lifestyle-based or related to individuals' behaviour; much of this is

easily preventable through adopting alternative practices. For example, overeating is now a bigger health issue globally than under-eating (Bloom et al., 2011). Intervening in under-eating required the actual provision of material goods, such as food (which cannot be delivered online). Whereas the issue of overeating mostly requires a shift in behaviour based on interventions on beliefs and/or knowledge; which can be delivered online effectively. Communication is increasingly important as a means of intervening in the promotion of positive public health and ICT is the platform through which these communications are delivered.

Updating the Determinants of Health Model 2.0

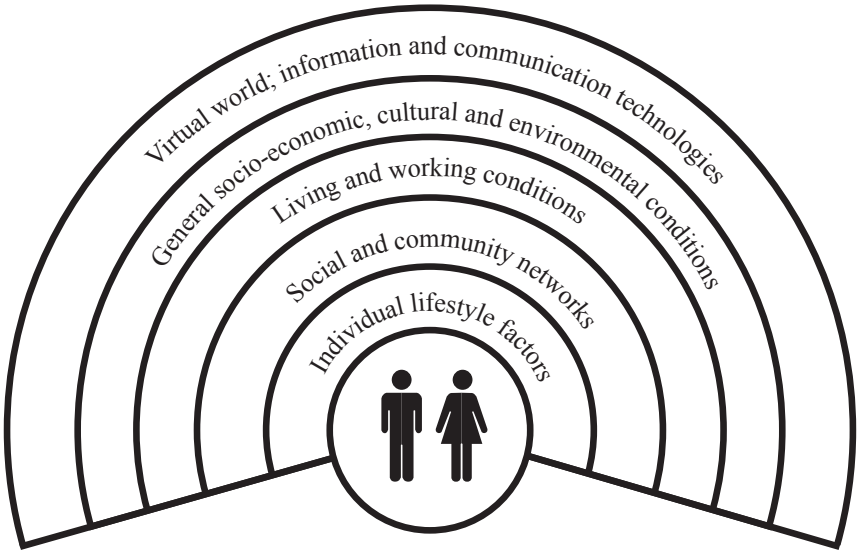

Figure 01: Determinants of Health Model 2.0 with additional ICT sphere.

There are a number of reasons why updates to the determinants of health model need to be incorporated due to the Information Age. Firstly, all contemporary health interventions need to operate at the ICT level because it has such profound implications for the operationalization all of the levels below it. The aim of Dahlgren & Whitehead's model was to identify "*distinct levels of intervention for health policy making*" (1991, p. 11). ICT is a key level for public health policy makers and if a health policy is to be successful, ICT must be targeted (as well as the other four levels). Health promotion directives need to be addressed at multiple levels. W&D's model is scalar: starting with the individual's physical body, then to their personal lifestyle, then to social and civil networks then further out to the next scale of neighbourhoods, offices, factories or agriculture and then to much broader socio-economic context. The next step on this scalar model is to that of the virtual world; something which did not exist in 1991. This ICT update to the Determinants of Health Model highlights the fundamental affect that the Information Age has on human health and for developing public health policy.

ICT operates outside all of the existing levels. A '*virtual'* world exists on the Internet. This is an entirely new world that is being constructed on top of, or additional to, the '*real'* world. The digital world is such a pervasive, all-encompassing and holistic environment; it cannot be chopped up or compressed into one existing level. It is called a virtual world, precisely because it is just that - a new and parallel world to the '*real'* world we also inhabit. The Information Age has created a new virtual world but it has also impacted on the '*real'* world too. It could be said that the 1991 Dahlgren & Whitehead's determinants of health model represents the Industrial Age but an update is required for the Information Age. ICT does not fit neatly into any one of the existing levels described by Dahlgren & Whitehead, yet it is possible to evidence how

the Information Age has influenced the existing levels. The socio-economic context has been fundamentally altered in the last 26 years. For example, in 1991 community networks were predominantly limited by geographical or neighbourhood boundaries, yet in 2017 global communities communicate online. Workplaces have been transformed by operating online; contemporary work is almost unimaginable without the existence of emails or the Internet (Slattery, 2013). Homes have been transformed; mobile technologies have brought the workplace into living rooms and bedrooms blurring the boundaries of home and work. Information technologies have even been incorporated *into* humans, such as electronic pacemakers or hearing aids. Technologies are embedded into almost every aspect of everyday life. Artificial intelligence is transforming how health will be conceived of and delivered in the future (Gretton & Honeyman, 2016). Health provision is already be carried out by ICT, and the future is predicted to be increasingly dominated in this way. For example, robot surgeons are replacing humans in hospital as part of surgical procedures. Assisted living and wearable technologies are considered the most viable long-term strategy for caring for our elderly populations (Golant, 2008). Online doctors (i.e. artificial intelligence) can '*talk'* with patients, with the patients often unaware they are no longer speaking to a human. The virtual world is also increasingly a '*space'* where health experts, policy-makers and health bodies *meet* and engage with their target audience. Numerous tech companies are collating information from wearable technologies to analyse human health on a hitherto unprecedented scale allowing new insights into health populations (Kamerow, 2013). Google and others are using huge computing capacity to develop artificial intelligence to help with the prognosis of illnesses in an attempt to democratize access to health (Armstrong, 2017). ICT pervades each of these levels and has had a paradigm-changing influence.

The Internet is global and independent from control by any single government. The Internet is a truly democratic system in this sense; anyone can contribute, add content as they wish and have a voice. This is both liberating in terms of freedom and agency, but the corollary is concerning precisely because there is little or no control of the Internet content. At one extreme, the Internet is used and abused by terrorists or criminals and very little that can be done about this (Kaplan, 2009; Weinmann, 2006). At the other extreme, the internet can be used to spy or collect data with little oversight (as Edward Snowdon revealed (Greenwald, MacAskill & Poitras, 2013)). Dahlgren & Whitehead's model stopped at the level of national government and international organisations, such as the EU or UN. However, the Internet is arguably outside of any organizations' direct control. The additional of ICT as a new level that operates outside of the controls existing in 1991 reflects the new reality in 2017.

Conclusion

The Determinants of Health Model needs updating to reflect the significant changes to society and the economy since 1991. This is due to the emergence of the Information Age as ICT has produced, directly and indirectly, changes to the determinants of human health. ICT impacts on the physical, mental, and social health of humans. The leading causes of global ill-health are being driven by the conditions imbricated in the emergence of the Information Age. The digital revolution has led to the inception of a new virtual word as well as fundamental changes to the fabric of cities and global socio-economic structures. The virtual world is now so important that we spend more time there than on any other single activity. ICT is not limited to the virtual world or social media; it has also changed the very fabric of our cities, homes, and offices, from laptops and mobile phones to wearable technologies. ICT

needs to be added as a new level to the Determinants of Health Model. The model is structured around policy-levels to ensure interventions to improve public health address the key levels in an integrated way. Contemporary health issues are increasingly characterized by lifestyle choices that lead to ill-health and inequitable health outcomes. Health communication is a key component in any public health intervention and ICT is central to this. This update to the Determinants of Health Model 2.0 is now needed to enable contemporary society to meet the challenges it faces.

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