Readability and Suitability of Online Noise-Induced Hearing Loss Information in English

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Abstract

Purpose: This study investigated the readability and suitability of online NIHL information available in English.

Method: Two search terms ("hearing loss noise" and "noise induced hearing loss") were entered into 19 country specific Google domains. The first ten relevant web pages were included. After removing duplicates, a total of 32 web pages were assessed. Their country of origin, type of organisation (non-profit, commercial, government), and HONcode certification were recorded. Readability was assessed using the FOG, SMOG, and F-K readability formulas. Suitability was assessed using the SAM tool.

Results: Online NIHL information was found to have high readability and only 'adequate' suitability. None of the web pages met the recommended sixth RGL. There was a significant correlation between mean RGL and SAM scores. There was an even distribution of web pages based on region and type of organisation. There were no significant differences in readability or suitability of web pages based on their region or type of organisation.

Conclusions: The effectiveness of online NIHL information is determined by its readability and suitability. Accessible education is an important aspect of the prevention of NIHL. There is a need for the development of readable and suitable online NIHL information to educate individuals about the risks of excessive noise and the importance of protecting hearing.

Table of Contents

List of Abbreviations

ANOVA	Analysis of variance
ccTLD	Country-coded Top-Level Domains
dBA	A-weighted decibel
dB	Decibel
F-K	Flesch-Kincaid
FOG	Gunning Fog Index
FRE	Flesch Reading Ease
HL	Hearing loss
HON	Health on the Net
HPD	Hearing protection device
Hz	Hertz
ICC	Intraclass correlation coefficient
NIHL	Noise-induced hearing loss
RGL	Reading grade level
SAM	Suitability Assessment of Materials
SMOG	Simple Measure of Gobbledygook
URL	Uniform Resource Locator
WHO	World Health Organisation

List of Figures

List of Tables

Chapter 1: Introduction

1.1 Hearing Loss

Hearing loss (HL) is one of the most common chronic health conditions experienced worldwide. The World Health Organisation (WHO; World Health Organisation, 2018) estimates that over 5% of the world's population has a HL that is considered disabling. This is equivalent to 466 million people and is expected to reach 900 million people by the year 2050 (World Health Organisation, 2018).

The effects of HL on quality of life are well-documented. HL adversely affects the functional, emotional, and social aspects of life (Chia et al., 2007; Mulrow et al., 1990). The more severe the HL, the greater the effects on quality of life (Dalton et al., 2003). Even mild HL, however, can cause significant handicap (Mulrow et al., 1990). Individuals with HL have reduced functioning and participation in activities of daily living due to reduced communication (Cacciatore et al., 1999). There is a reduction in their intentional and spontaneous communication which causes feelings of frustration, embarrassment, and loneliness (Scarinci, Worrall, & Hickson, 2008). This leads to social isolation which is experienced both by the individual with HL and their communication partners (Scarinci et al., 2008). This has been linked to cognitive decline and depression (Cacciatore et al., 1999; Loughrey, Kelly, Kelley, Brennan, & Lawlor, 2018).

There are also economic impacts of HL. Adults with HL have higher rates of unemployment (World Health Organisation, 2018). Those in employment are more likely to hold lower levels of employment than individuals without HL (World Health Organisation, 2018). Untreated HL is estimated to cost US$750 million annually worldwide (World Health Organisation, 2018). Treating HL with hearing aids helps to protect against the adverse effects of HL and leads to improved quality of life (Cacciatore et al., 1999). Hearing aids may

also help protect against cognitive decline (Mulrow et al., 1990). However, HL is a widely under-treated health condition (Dalton et al., 2003). It is common for individuals with HL to be in denial (Scarinci et al., 2008) and feel stigmatised (Wallhagen, 2009) by their HL. These feelings, alongside the financial barrier of accessing hearing aids, means that hearing aids meet less than 10% of global needs (World Health Organisation, 2018).

1.2 Noise-Induced Hearing Loss

1.2.1 Pathophysiology

Noise-induced hearing loss (NIHL) is a type of HL caused by high intensity or excessive noise that damages auditory structures (Bohne, 1976). This occurs after repeated exposures to broadband, steady noise over a period of years or a single intense impulse noise (J. D. Miller, 1974; Taylor, Pearson, Mair, & Burns, 1965). It is a permanent but preventable health condition (Sliwinska-Kowalska & Davis, 2012).

The mechanisms that cause auditory damage following noise exposure are numerous and complex (Henderson, Bielefeld, Harris, & Hu, 2006). Noise affects auditory structures both mechanically and metabolically which can result in different types of damage (Henderson et al., 2006). Typically, noise exposure causes destruction of hair cells and damage to the Organ of Corti (Bohne, 1976). The severity of NIHL depends on the extent of damage along the Organ of Corti and other auditory structures (J. D. Miller, 1974). There are differences in damage depending on the intensity and duration of noise (J. D. Miller, 1974).

The outer hair cells are the first structure to be damaged (Bohne, 1976). The outer hair cells at the basal end of the cochlea are the most vulnerable so are damaged first (Henderson et al., 2006). With repeated noise exposure, damage spreads to the inner hair cells, auditory nerve fibres, and stria vascularis (Bohne, 1976). There may also be degeneration of the auditory nerve (J. D. Miller, 1974). Damage to hair cells occurs immediately following noise

exposure but can continue for days (Bohne, 1976). This is because the loss of cells creates gaps in the reticular lamina that allow endolymph to flow into the Organ of Corti (Bohne, 1976). This causes swelling and eventual rupturing of additional cells and nerve fibres (Bohne, 1976).

An intense impulse noise causes mechanical damage to the Organ of Corti, known as acoustic trauma (J. D. Miller, 1974). Acoustic trauma causes intense vibrations that tear the Organ of Corti (J. D. Miller, 1974). It causes structural damage that disrupts the processes necessary for cellular life, leading to rapid cell breakdown (J. D. Miller, 1974). Exposure to lower intensity noise for a longer duration is known as noise-induced cochlear injuries (J. D. Miller, 1974). Chronic noise exposure forces the cells to work at a high metabolic rate over a long period (J. D. Miller, 1974). The metabolic processes necessary for cellular life become exhausted, leading to cell death (J. D. Miller, 1974). The damage caused by noise exposure is irreversible as the specialised cochlear cells do not regenerate (J. D. Miller, 1974). While more recent research has begun to investigate the use of drugs to prevent NIHL (Henderson et al., 2006), the only way to prevent NIHL currently is to reduce noise exposure.

1.2.2 Temporary and Permanent Threshold Shifts

Damage to the auditory system can cause hearing threshold shifts that are temporary or permanent (J. D. Miller, 1974). A temporary threshold shift is when auditory structures recover from noise exposure and hearing thresholds recover (J. D. Miller, 1974). Recovery from a temporary threshold shift can take hours to weeks depending on the intensity or duration of noise exposure (J. D. Miller, 1974). Slow recovery is expected when noise exposure was long in duration or loud in intensity (J. D. Miller, 1974). With excessive noise exposure, there may be both temporary and permanent components to the HL (J. D. Miller, 1974). After the temporary threshold shift component has recovered, there is residual

permanent damage (J. D. Miller, 1974). This is known as a permanent threshold shift (J. D. Miller, 1974).

Greater threshold shifts are produced by noise with an energy concentration between 2 to 6 kHz (J. D. Miller, 1974). The auditory system is most susceptible to noise at 2.4 to 4.8 kHz (J. D. Miller, 1974). Noise below 80 dBA does not cause temporary threshold shifts in the average individual even with long exposure duration (J. D. Miller, 1974). As noise increases above 80 dBA there is risk of temporary and permanent threshold shifts (J. D. Miller, 1974). The greater the noise intensity or the longer the duration, the greater the threshold shift (J. D. Miller, 1974).

1.2.3 Diagnosis

NIHL has a characteristic audiometric pattern (Henderson et al., 2006; Taylor et al., 1965). The first sign of NIHL is elevated thresholds at 4 kHz, with normal thresholds at frequencies above and below (Taylor et al., 1965). This is referred to as a noise notch (Taylor et al., 1965). Most often, the notch begins at 4 kHz but can begin at other frequencies such as 3 or 6 kHz (Taylor et al., 1965). With repeated noise exposure, the noise notch broadens to neighbouring frequencies and thresholds elevate (Taylor et al., 1965). NIHL causes a 40 to 60 dB sensorineural HL and impaired cochlear frequency tuning (Henderson et al., 2006). Over time, the notch may gradually deteriorate across the high frequencies as presbycusis occurs (J. D. Miller, 1974). Tinnitus often accompanies NIHL and can be an early warning sign or indicate susceptibility to NIHL (Lusk, 1997). Individuals who are exposed to ototoxic substances (Henderson, Subramaniam, & Boettcher, 1993) and males (Berg, Pickett, Linneman, Wood, & Marlenga, 2014) are more susceptible to NIHL.

Noise damage to auditory structures is often present before observable threshold shifts are seen in pure tone audiometry (Kujawa & Liberman, 2009). This is because deterioration

in hearing thresholds can continue 20 to 25 years after noise exposure (Taylor et al., 1965). The HL may have progressed before it is noticed by the individual or picked up by pure tone audiometry (McBride & Williams, 2001). The auditory nerve can also degenerate in the absence of damage to the hair cells (Kujawa & Liberman, 2009). Pure tone audiometry is not sensitive to auditory nerve degeneration, so an individual may present with normal thresholds despite noise damage (Kujawa & Liberman, 2009). This makes early detection vital for prevention and management (McBride & Williams, 2001). Diagnosis should focus on a detailed and accurate history of noise exposure in conjunction with audiometric tests (McBride & Williams, 2001).

1.2.4 Occupational NIHL

1.2.4.1 Prevalence

Occupational NIHL accounts for 16% of disabling HL in adults worldwide (Nelson, Nelson, Concha-Barrientos, & Fingerhut, 2005). It is one of the most common occupational hazards (World Health Organisation, 2002, p. 76). The agriculture, mining, manufacturing, and construction sectors have the highest rates of occupational NIHL (Nelson et al., 2005). Specifically, those working as production workers and labourers (Nelson et al., 2005). Occupational NIHL is more common in males than females, most likely because males are represented at higher rates in jobs with the most risk of noise damage (Nelson et al., 2005). Occupational NIHL is also more prevalent in developing countries, possibly due to less comprehensive workplace noise standards and hearing protection programmes (Nelson et al., 2005).

There are greater concerns for individuals with HL who are exposed to occupational noise. They face similar barriers as individuals with normal hearing but with additional concerns about job performance and safety (Morata et al., 2005). They have an impaired ability to hear environmental sounds and warning signals, to communicate with colleagues,

and increased stress and auditory fatigue (Morata et al., 2005). Their reduced functional communicative ability can lead to workplace accidents (World Health Organisation, 2002, p. 76). These consequences of NIHL can also directly impact colleagues of individuals with HL (Nelson et al., 2005).

1.2.4.2 Workplace Noise Standards

In New Zealand and Australia, the workplace noise limit is 85 dBA over a period of eight hours (Standards Australia, 2005). Workers cannot be exposed to noise at 85 dBA for more than eight hours. With every 3 dB increase in noise, the duration of noise exposure must be halved (Standards Australia, 2005). This is referred to as an exchange rate of 3 dBA. So, if noise is increased to 88 dBA then workers' maximum exposure time becomes four hours. This standard differs among countries. In the United States of America, the workplace noise limit is 90 dBA with an exchange rate of 5 dB (Occupational Safety and Health Administration, 1971). Across European countries, the workplace noise limit is 87 dB with an exchange rate of 3 dB (European Agency for Safety and Health at Work, 2003). Workplace noise standards help to minimise the risk of occupational NIHL but do not guarantee prevention of NIHL (Beach, Williams, & Gilliver, 2013). Hearing protection programmes are required when employee noise exposure equals or exceeds the workplace noise limit (Lusk, 1997).

1.2.4.3 Hearing Protection Programmes

Occupational hearing protection programmes include: assessment and control of noise levels, audiometric monitoring of employee hearing, record keeping, employee education and training, appropriate use of hearing protection devices (HPD), and programme evaluation (National Institute for Occupational Safety and Health, 1996). Nelson et al. (2005) reported that implementing hearing protection programmes was effective in promoting education about NIHL and decreasing the incidence of NIHL.

Occupational noise should first be minimized through engineering and administrative controls (Nelson et al., 2005). This involves reducing the generation of noise at the source, blocking its path, protecting workers with an enclosure, or rotating workers in areas of high noise levels to reduce exposure time (Lusk, 1997). Noise that exceeds workplace standards needs to be monitored regularly and employees must be notified about the results (Lusk, 1997). Results need to be presented with interpretation of meaning to facilitate employee understanding (Lusk, 1997).

Employee hearing must be monitored annually by audiometric testing (National Institute for Occupational Safety and Health, 1996). A baseline audiogram should be completed within the first six months of a worker's exposure to noise above the maximum limit (Lusk, 1997). Workers should not be exposed to excess noise before hearing testing to reduce the effects of temporary threshold shifts on the results (Lusk, 1997). Employee noise exposure and audiometric testing need to be recorded (Lusk, 1997).

Employee education and training should be provided regularly (National Institute for Occupational Safety and Health, 1996). This involves education about the effect of excessive noise on hearing, audiometric testing, and HPDs (Lusk, 1997). Employees should be informed about the fit, use, and care of different HPDs (National Institute for Occupational Safety and Health, 1996). This is important as employees are not consistent users of HPDs (Lusk, Ronis, & Kerr, 1995). Lusk et al. (1995) found that the predictors of HPD use are reduced barriers in using HPDs, confidence in the ability to correctly use HPDs, and perceived benefit of using HPDs. Employee education should focus on reducing negative perceptions about HPDs, such as discomfort, and promote the ability to confidently and correctly use HPDs (Lusk et al., 1995). Education is a vital aspect of effective hearing protection programmes as a lack of education about prevention is a major contributor to the prevalence of occupational NIHL (Nelson et al., 2005).

HPDs must be provided by employers when noise levels exceed workplace standards (National Institute for Occupational Safety and Health, 1996). Circum-aural headphones and insert earplugs physically block sound from reaching the cochlea, providing passive protection (Lusk, 1997). Supra-aural headphones do not provide passive protection as they do not physically block sound from reaching the cochlea (Casali & Berger, 1996). For the best protection, insert earplugs should be worn underneath circum-aurals, however, circum-aurals alone provide better protection than insert earplugs alone (Lusk, 1997). Insert earplugs can be custom made to ensure a good fit (Lusk, 1997) and can have vents to reduce attenuation of low frequency sound (Casali & Berger, 1996). Circum-aurals provide greater attenuation at 500 to 8000 Hz while insert earplugs provide greater attenuation at 125 to 250 Hz (Gasaway, 1985).

Passive HPDs can reduce speech audibility when ambient noise levels are less than 80 dB (Casali & Berger, 1996). This is caused by greater attenuation at higher frequencies, which affects speech intelligibility, and less low frequency attenuation which results in the upward spread of masking (Casali & Berger, 1996). While employees are not required to wear HPDs when noise is at these lower levels, if used continuously as recommended, HPDs will be worn in intermittent breaks in noise exposure (Casali & Berger, 1996). The attenuation provided by circum- and supra-aurals can also affect pinna cues which reduces sound localisation abilities (Casali & Berger, 1996). These barriers may reduce HPD use (Casali & Berger, 1996).

To overcome these barriers, some HPDs provide active noise control, by cancelling sound waves of equal amplitude and inverted phase (Casali & Berger, 1996). Active noise cancellation is most effective at cancelling low frequency noise (Lusk, 1997). Practically, this means that low frequency background noise is reduced while allowing wearers to hear the high frequency components of speech and environmental warning sounds (Lusk, 1997). This

feature is important when communication is necessary for work and safety and to promote consistent HPD use (Lusk, 1997). There are also HPDs with communication capabilities and special HPDs for individuals with HL (Casali & Berger, 1996). These provide noise attenuation for high intensity sounds and allow for transmission of speech (Casali & Berger, 1996).

Greatest sound attenuation is achieved when there is correct fit and consistent use of HPDs (National Institute for Occupational Safety and Health, 1996). Manufacturers provide estimates of sound attenuation measured in controlled lab settings, but these estimates are usually higher than what is experienced in workplaces (Lusk, 1997). The amount of attenuation will depend on the frequency of the noise present in the workplace (Lusk, 1997). This means workplaces should evaluate the effectiveness of their hearing protection programmes (National Institute for Occupational Safety and Health, 1996).

1.2.5 Recreational NIHL

1.2.5.1 Prevalence

It is estimated that one billion individuals, aged between 12 to 35 years, are at risk of recreational NIHL (World Health Organisation, 2018). Younger adults are generally exposed to more recreational noise than older adults (Beach et al., 2013). There are no guidelines for recreational noise exposure, so workplace noise standards are used (Beach et al., 2013). It is necessary to consider the cumulative effects of occupational and recreational noise exposure (Williams, 2009).

1.2.5.2 Risk and Prevention

There is sufficient data to confirm that certain recreational activities produce significant noise exposure (Carter, Williams, Black, & Bundy, 2014). These include live music events, live sporting events, nightclubs, children's toys, amplified personal music, and

hunting and firearms (Carter et al., 2014). The levels of recreational noise exposure match noise levels in occupational settings that require the use of HPDs, but the damaging effects of noise depend on duration and pattern of exposure (Carter et al., 2014). Recreational noise exposure is usually less frequent and intense than occupational noise exposure (Carter et al., 2014). There are also differences in the characteristics of the noise. For example, music has greater variation in spectral content and greater spread in intensity over time compared with typical occupational noise (Carter et al., 2014).

There is limited consistent, empirical evidence that confirms the extent of risk of recreational NIHL (Carter et al., 2014). Evidence about the long-term effects of recreational noise on hearing and quality of life is still lacking (Carter et al., 2014). This is because many studies focus on temporary threshold shifts and retrospective study designs from which it can be difficult to draw conclusive interpretations (Carter et al., 2014). There is a need for more longitudinal studies (Carter et al., 2014). In an Australian study by Beach et al. (2013) it was found that average noise levels at popular recreational activities ranged from 84 to 97 dB. They found that 14% of young adults, aged 18 to 35 years, were at risk of recreational NIHL. Only 46% of these young adults recognised that they were at risk of NIHL. This suggests that over half of young adults are unaware of the risk of recreational noise exposure. There is a need for targeted intervention to educate young adults about reducing noise exposure and protecting hearing (Beach et al., 2013). Reducing the risk of recreational NIHL involves identifying high-risk noise exposure, improving legislation about noise exposure, widespread use of HPDs (Sliwinska-Kowalska & Davis, 2012), and educating the public about the risks of recreational noise (Carter et al., 2014).

1.3 Health Literacy

1.3.1 Definition of Health Literacy

Education is an important aspect of occupational and recreational NIHL prevention. For health education to be effective, information needs to match the health literacy levels of readers. Health literacy encompasses a range of skills that are categorised into three levels, according to Nutbeam (2006). First, is functional literacy. This involves sufficient reading and writing skills to function effectively in daily life activities. Second, is communicative literacy. This involves the interaction between functional literacy and cognitive skills with social skills. This means individuals are able to extract information and interpret meaning from different modes of communication. Lastly, is critical literacy. This involves the interaction between advanced cognitive skills with social skills. This allows individuals to use critical thinking skills to analyse and apply new information to have control over daily life activities. Recently, Internet literacy has been identified as another component of health literacy (McCormack et al., 2010). This is the ability and motivation to use a computer and the Internet to obtain, understand, and apply information (Bodie & Dutta, 2008). It requires the ability to navigate search engines and websites (McCormack et al., 2010). Health literacy is dependent on the functional literacy, cognitive skills, and social skills that allow individuals to access, understand, and use information to navigate health care systems and maintain their health (Nutbeam, 2006). These skills allow individuals to make informed health decisions (Kickbusch, Maag, & Wait, 2006).

Low health literacy indicates individuals do not have the skills needed to meet the demands of their health (Nutbeam, 2006). Low health literacy is an indicator of poor functional literacy alongside wider cognitive difficulties, including information processing and memory (Bostock & Steptoe, 2012). Health literacy skills are context dependent (Ishikawa & Yano, 2008). Individuals with high literacy in familiar contexts may have low

literacy in unfamiliar contexts (Joubert & Githinji, 2014). The literacy demands of health contexts are usually unfamiliar and greater than the demands of everyday life (Ishikawa & Yano, 2008). Health contexts are also dynamic, meaning health literacy skills need to be adaptable (Kickbusch et al., 2006). This places greater demands on individuals accessing health information (Kickbusch et al., 2006).

1.3.2 Prevalence of Low Health Literacy

Health care professionals often interact with individuals with low health literacy, so the special needs of these individuals need to be considered (Weiss & Coyne, 1997). Health care professionals cannot assume low health literacy based on the appearance of their clients (Weiss, 2003) or their highest level of education (Davis, Crouch, Wills, Miller, & Abdehou, 1990). Individuals with low health literacy are adept at hiding their difficulties leaving their health care professionals unaware (Weiss, 2003)

In the Adult Literacy and Life Skills Survey (Ministry of Health, 2010), a nationwide measure of the literacy levels of the New Zealand population, it was found that the majority of adults in New Zealand had low literacy. They did not possess the minimum skills required to meet the complex demands of everyday life. Low literacy was significantly higher among Māori than non-Māori. Among both Māori and non-Māori adults, those with low literacy were typically males, individuals above the age of 65 and between the ages of 16 to 18, individuals with a high school level education or less, individuals who were unemployed, and individuals with low socioeconomic status.

Low health literacy levels have been documented worldwide. The majority of adults in Australia, Canada, and Europe also have low literacy (World Health Organization, 2017). In the United Kingdom, approximately one third of adults from the English Longitudinal Study of Ageing had low health literacy (Bostock & Steptoe, 2012). In the 1992 National

Adult Literacy Survey (Kirsch, Jungeblut, Jenkins, & Kolstad, 1993) it was found that approximately 50% of Americans had low literacy levels. A significant portion of these adults were considered functionally illiterate. More recently, the 2003 National Assessment of Adult Literacy (Kutner, Greenburg, Jin, & Paulsen, 2006) found that approximately one third of American adults had low literacy (Kutner et al., 2006). These individuals are only able to understand and interpret simple information.

Certain groups within the population are most at risk of low literacy. These are males, ethnic minorities, individuals who speak English as a second language, individuals over the age of 65 years, individuals with education levels less than high school level, individuals with low socioeconomic status, and individuals who are unemployed (Berkman et al., 2011; Kirsch et al., 1993; Kutner et al., 2006). Low literacy is also more prevalent in individuals with chronic health conditions (Bostock & Steptoe, 2012). This is concerning as the prevalence of long-term health conditions is rising (Bostock & Steptoe, 2012). This means individuals with HL are at increased risk of low health literacy (Atcherson et al., 2014). This also places older adults at risk as they are more likely to have chronic and comorbid health conditions and are high users of health services (Safeer & Keenan, 2005).

1.3.3 Effects of Low Health Literacy

The relationship between low health literacy and poor health outcomes is well-established (Berkman et al., 2011; Ishikawa & Yano, 2008). A systematic review by DeWalt, Berkman, Sheridan, Lohr, and Pignone (2004) found agreement in the literature about the significant relationship between low health literacy and poor health outcomes. Individuals with low literacy were at risk of poorer quality of life, poorer health status, and higher mortality among older adults (Berkman et al., 2011). This is because of the combination of less health knowledge, less motivation for information seeking, and less self-efficacy in health behaviours (Bostock & Steptoe, 2012). Individuals with low health literacy have a

reduced ability to navigate health care systems (Berkman et al., 2011). They have reduced understanding of their health conditions (Berkman et al., 2011), poor adherence to management (Safeer & Keenan, 2005), and less health promoting behaviour (Ishikawa & Yano, 2008). They are less likely to take an active role in their health management but rely on significant others and health care professionals for decision-making (Ishikawa & Yano, 2008).

Low literacy affects all types of communication, including verbal and written (Doak, Doak, Friedell, & Meade, 1998). Individuals with low literacy obtain less from written health information even when information matches their literacy skills (Doak, Doak, & Root, 1996). Their feelings of shame and embarrassment prevent them from making their difficulties known (Parikh, Parker, Nurss, Baker, & Williams, 1996). They are less likely to ask for clarification or to ask for readable written information (Atcherson, Zraick, & Hadden, 2013; Safeer & Keenan, 2005). They are unlikely to bring significant others with them to appointments to facilitate understanding (Parikh et al., 1996). They are unlikely to admit these feelings and difficulties to health care professionals, or even to their significant others (Parikh et al., 1996). They pretend that they understand health information which risks their wellbeing and effectiveness of management (Parikh et al., 1996).

The adverse effects of low health literacy extend beyond that of a single individual (Kickbusch et al., 2006). The ability to take an active role in health care improves the overall health of populations, helps eliminate health inequalities, and reduces the economic burden of health disparities (Kickbusch et al., 2006). It is vital to improve and support the health literacy of individuals.

1.3.4 Improving Low Health Literacy

Improving health literacy involves improving confidence in an individual's ability to act on health information (Nutbeam, 2006). They need to feel empowered to take an active role in their health care (Kickbusch et al., 2006). Improving health literacy, however, cannot rely solely on individuals but also on government agencies and health care professionals (Kickbusch et al., 2006). Health care professionals need to be health literate, so they can communicate effectively and provide appropriate health information (Atcherson et al., 2014). They need to balance the information demands of health care systems with the skills of individuals with low health literacy (Atcherson et al., 2014).

In a study about audiologists' knowledge about health literacy by Atcherson et al. (2013), audiologists had limited awareness of the average literacy levels of their clients and of the readability of written information used clinically. Audiologists have an important role in educating clients and ensuring that those with low health literacy skills can understand complex verbal and written information (Joubert & Githinji, 2014). They need a greater awareness of the impact of health literacy on health outcomes, so they can adapt their communication to match the literacy levels of clients (Atcherson et al., 2013).

Access to readable written health information is a critical component of improving health literacy (Nutbeam, 2006). Written health information that is understandable helps reduce the literacy demands placed on individuals (Nutbeam, 2006). Health care professionals must ensure that individuals understand supplemental written information (Weiss & Coyne, 1997). This can be achieved by writing information at the lowest readability level possible (Weiss & Coyne, 1997). Information also needs to be available in multiple languages as needed (McInnes & Haglund, 2011). Readable health information is especially important for individuals with HL as they are less likely to understand counselling and

educational materials (Nair & Cienkowski, 2010). This can reduce their self-efficacy and result in unsuccessful hearing aid and healthcare use (Nair & Cienkowski, 2010).

1.3.5 Self-Efficacy

Self-efficacy is an individual's belief that they have control over their motivation and ability to successfully achieve desired behaviours (Bandura, 1990). This belief determines whether individuals will engage and persevere in changing their health behaviour (Bandura, 1990). Low self-efficacy creates discrepancies between an individual's knowledge and their behaviour (Bandura, 1990). They are less likely to have the motivation and confidence to engage in positive health behaviour even if they possess sufficient knowledge and skills (Bandura, 1990).

The prevalence of low health literacy and the high readability of health information contributes to low self-efficacy (A. McMullan, Kelly-Campbell, & Wise, 2018). Health information needs to be motivating and informative to increase knowledge and skills about health behaviours (Bandura, 1990). It needs to model behaviours to demonstrate how health knowledge can be translated into efficacious behaviours (Bandura, 1990). In audiologic rehabilitation, patients are often required to make complex behaviour changes (Smith & West, 2006). Health management based on self-efficacy better improves outcomes than interventions that are not self-efficacy based (Smith & West, 2006). Meyer, Hickson, and Fletcher (2014) found that hearing aid self-efficacy could be improved by using best-practice formatting guidelines and recommended readability levels in patient education materials.

Self-efficacy based health information needs to reach a wide range of individuals to have effective social impact (Bandura, 1990). This makes the Internet an important tool for spreading health information. Well-designed online health information has been found to increase self-efficacy (Lee, Hwang, Hawkins, & Pingree, 2008). This is especially important

for individuals with chronic health conditions as they are required to take an active role in managing their health (Marks & Allegrante, 2005). Individuals with chronic health conditions and higher self-efficacy achieve greater quality of life (Marks & Allegrante, 2005).

1.4 Online Health Information

1.4.1 Rise and Role of Online Health Information

The use of the Internet for health information has become increasingly more common (Bundorf, Wagner, Singer, & Baker, 2006; Ritchie, Tornari, Patel, & Lakhani, 2016). The rise of online health information can be attributed to three main factors. First, increased access to and ease of using the Internet (Kontos, Blake, Chou, & Prestin, 2014). Second, the shift towards patient-centred care and shared decision-making which encourages individuals to take an active role in their health care (Joosten et al., 2008; Kontos et al., 2014). Finally, increased provision of online health information by health care professionals (Ritchie et al., 2016).

As the Internet becomes more accessible there is an increasing amount of health information available to individuals. In a survey about Internet use in the United States of America, it was found that approximately half of individuals search for online health information every few months or less (Fox & Rainie, 2002). These individuals are most commonly searching for answers to targeted questions about specific health conditions (Fox & Rainie, 2002). They use this information alongside information from health care professionals to guide decision-making (Fox & Rainie, 2002). Only very rarely did individuals report they used online health information alone to make health decisions (Fox & Rainie, 2002). This shows that online health information has not entirely changed individuals' approach to health care (Fox & Rainie, 2002). The Internet has not replaced traditional methods of accessing health information, but has a greater role and influence in

health decisions (Joosten et al., 2008). The Internet has a role in improving health outcomes (Baker, Wagner, Singer, & Bundorf, 2003).

1.4.2 Accessibility of Internet and Disparities in Use

Despite the rise of online health information, there are disparities in the access and use of the Internet. This is known as the digital divide and is widening with time (Hsu et al., 2005; Kuk, 2002). Even when individuals are given access to the Internet, the divide in Internet use remains (Jackson et al., 2003). Disparities in the use of the Internet reflect health disparities (Atcherson et al., 2014). Individuals who are in most need of online health information are the most likely to experience barriers in accessing and using it (Atcherson et al., 2014). They have less motivation and confidence in accessing online health information (Bodie & Dutta, 2008). These are individuals aged 65 years and older, individuals who are unemployed, individuals with disabilities, and individuals from ethnic minorities (Hesse et al., 2005; Jones, 2009; Lenhart, 2003). These groups are also more likely to have low health literacy (Bodie & Dutta, 2008). This further exacerbates existing health disparities (Richardson & Norris, 2010).

Accessing online health information is more common among females, individuals aged between 30 and 65 years of age, individuals with higher socioeconomic status, individuals with tertiary level education, and individuals who have experience using the Internet (Fox & Rainie, 2002). These findings are supported in the literature (Baker et al., 2003; Bundorf et al., 2006; Hesse et al., 2005; Kontos et al., 2014). Individuals with stigmatising (Berger, Wagner, & Baker, 2005) and chronic (Bundorf et al., 2006) health conditions are more likely to seek online health information. HL is both stigmatising and chronic (Wallhagen, 2009). For stigmatised conditions, the informal nature of online health information makes information seeking less intimidating than seeking advice from health care professionals (Berger et al., 2005). Those with chronic health conditions report that

online health information helps improve their understanding of their health condition and management options (Baker et al., 2003). This is important as individuals with chronic health conditions are required to participate in shared decision-making (Joosten et al., 2008). The shift towards shared decision-making is also seen in audiologic rehabilitation (Laplante-Lévesque, Hickson, & Worrall, 2010).

Disparities in Internet use can be explained by social and demographic barriers (Lenhart, 2003). These include low Internet literacy, low functional literacy, and perceptions that the Internet is too complex and confusing (Lenhart, 2003). Cultural appropriateness is also a barrier. Web pages that are not sensitive to the culture of different ethnicities and older individuals are less likely to be accepted by those individuals (Jackson et al., 2003). Finally, as older adults and those with low socioeconomic status are more likely to take a passive role in their health care, they are also less likely to be motivated to seek online health information (Jung, Baerveldt, Olesen, Grol, & Wensing, 2003). Health care professionals need to provide access to understandable, motivational, and culturally appropriate online health information to overcomes these disparities (Kontos et al., 2014).

1.4.3 Benefits of Online Health Information

The benefits of online health information are dependent on the readability and quality of information (Bundorf et al., 2006). Increased access to online health information alone does not guarantee benefits (Kreps & Neuhauser, 2010). Difficulty finding, understanding, and applying information reduces the perceived benefits of online health information (Bundorf et al., 2006). Due to the broad reach and influence of online health information, information must be effectively designed so that it is accessible to a diverse range of individuals (Kreps & Neuhauser, 2010).

Online health information has a role in influencing decision-making (Jones, 2009). In a survey of Internet use, half of individuals reported that online health information impacts their health decisions, even if only minorly (Fox, 2006). Online health information is perceived as important and contributes to decision-making (Couper et al., 2010). The use of the Internet has also been observed for making audiologic decisions (Laplante-Lévesque et al., 2010). Adults with HL have reported using the Internet to help guide management decisions about hearing aids (Laplante-Lévesque et al., 2010).

Online health information facilitates communication between individuals and their health care professionals to reduce communication gaps (Cherla et al., 2013). Online health information empowers individuals to ask their health care professionals questions and make informed management decisions (Baker et al., 2003; Fox, 2006). It empowers individuals to take an active role in their health care and builds their self-efficacy (M. McMullan, 2006). Online health information supplements but has not replaced information from health care professionals (Couper et al., 2010; Jones, 2009). Individuals report online health information as the most important and influential source of information after health care professional advice (Couper et al., 2010). Health care professionals remain the main and most trusted source of health information (Hesse et al., 2005). Individuals still require guidance from health care professionals to interpret information in the context of their lives and make evidence-based decisions (Haas-Wilson, 2001).

Health care professionals have a responsibility to evaluate online health information (Bylund et al., 2007; M. McMullan, 2006). This allows them to guide individuals to accurate, readable, and culturally appropriate information (F. L. Wilson, Baker, Brown-Syed, & Gollop, 2000). This includes audiologists (Laplante-Lévesque, Brännström, Andersson, & Lunner, 2012). Most individuals accessing online health information do not verify the quality of information (Fox & Rainie, 2002). Those with low health literacy are even less likely to

verify quality (Fox, 2006). It is possible that individuals are accessing poor-quality online health information that affects their well-being (Baker et al., 2003).

1.4.4 Risks of Online Health Information

Individuals searching the Internet for health information are not always able to retrieve relevant information to answer their health queries (Zeng et al., 2004). They may continue searching for information in personal blogs or forums or web pages not intended for consumers (M. McMullan, 2006). This means that they may access poor quality information (Baker et al., 2003) or information that is too difficult to interpret (Eloy et al., 2012). This is concerning as individuals are using online information to guide health management decisions (Berland et al., 2001). Reasons for unsuccessful retrieval of online health information can be attributed to different factors (Zeng et al., 2004). They include frustration by the lack of specific information, an overwhelming amount of information, confusing navigation or organisation of websites, and out of date information (Zeng et al., 2004). Some individuals feel anxious after searching for online health information (Pletneva, Cruchet, Simonet, Kajiwara, & Boyer, 2011).

The potential harm of inaccurate online health information is not as great as the Internet's capacity for providing access to useful health information in an efficient and cost-effective manner (Crocco, Villasis-Keever, & Jadad, 2002). Specific reports of harm due to inaccurate online information are uncommon (Ritchie et al., 2016). This may partially be due to reporting bias as authors are more likely to report on the effectiveness and efficacy of online health information (Crocco et al., 2002). Regardless, the benefit of online health information is dependent on the quality of the information.

1.4.5 Quality of Online Health Information

The biggest barrier to online health information is quality of information (Pletneva et al., 2011). In a systematic review assessing the quality of online health information by Eysenbach, Powell, Kuss, and Sa (2002), there was wide variation in the quality of information. The majority of information, however, was of poor quality. This is concerning as online health information is perceived as trustworthy and important in decision-making (Couper et al., 2010). The disparities in quality could be caused by the lack of required standards for online health information (Eysenbach & Köhler, 2002). Quality of online health information needs to be closely monitored (McInnes & Haglund, 2011). Web developers should adhere to ethical criteria that guide and evaluate online health information quality (Laplante-Lévesque et al., 2012). This may be subject to bias, however, due to reliance on self-assessment (Berland et al., 2001).

1.4.5.1 HONcode Certification

The Health on the Net (HON) foundation created a code of conduct, known as the HONcode, for medical websites. It was created in response to concerns about the quality of online health information (Boyer, Selby, Scherrer, & Appel, 1998). The aim was to standardise the validity of research data and the quality of advice of health information available online (Boyer et al., 1998). Websites that display the HONcode logo uphold the eight principles of the HONcode. Only a small percentage of health information web pages (Boyer et al., 1998) and hearing-related web pages (Laplante-Lévesque et al., 2012) have voluntarily obtained HONcode certification. The HONcode principles are described by Health on the Net (2018) as:

1. Authoritative: medical advice must only be provided by medically trained and qualified professionals.
2. Complementary: information supports and does not replace health care professionals.

3. Privacy policy: confidentiality of Internet users is maintained.
4. Attribution and date: information is cited where appropriate and the date of last modification is displayed.
5. Justifiability: information about treatment and management is evidence-based.
6. Transparency: contact information of web developers is provided.
7. Financial disclosure: financial support is clearly identified.
8. Advertising policy: advertising is stated as a source of funding where applicable.

1.5 Readability

1.5.1 What is Readability

An efficient way to assess the potential comprehension of health information is to predict its readability (Atcherson et al., 2014). Readability refers to how easily written information can be read and understood (Ley & Florio, 1996). It correlates with comprehension, so as the readability of information increases, comprehension decreases (Ritchie et al., 2016). Readability improves when information is written at or below the reading levels of readers and decreases when information is written at higher levels (DuBay, 2004).

Written patient education materials are a vital tool in rehabilitation services (Hoffmann & Worrall, 2004). They allow individuals to comprehend and review information in their own time to reinforce learning (Shieh & Hosei, 2008). To be effective, however, health information needs to be readable (Shieh & Hosei, 2008). Written health information with high readability is especially difficult for individuals with low literacy levels to understand (Shieh & Hosei, 2008). Health information that is not understandable prevents individuals from being active and informed decision-makers in their health care (Meade & Smith, 1991). This applies to online health information which needs to be written at appropriate readability levels (McInnes & Haglund, 2011).

1.5.2 Readability Formulas

Readability can be objectively predicted by readability formulas (Ley & Florio, 1996). These formulas do not predict comprehension but are estimates of the difficulty of written information (DuBay, 2004). This is often reported as a reading grade level (RGL), which refers to number of years of education required for a reader to understand the information (Ley & Florio, 1996). It is widely recommended that health education materials be written at the sixth RGL or below so that they are readable to a large proportion of the population (Doak et al., 1996; Friedman, Hoffman-Goetz, & Arocha, 2006; National Institutes of Health, 2013; Safeer & Keenan, 2005; Walsh & Volsko, 2008). This recommendation is based on the relationship between health information comprehension and increased health outcomes (Berkman et al., 2011; Bostock & Steptoe, 2012).

Readability formulas have been used extensively in health care (Ley & Florio, 1996). Most commonly used for health information are the Gunning Fog Index (FOG), Flesch Reading Ease (FRE), Simple Measure of Gobbledygook (SMOG), Fry, Flesch-Kincaid Grade Level (F-K), and Dale-Chall Formula (Ley & Florio, 1996). There is no universal standard agreement for which readability formula to use (Breese & Burman, 2005; Joseph et al., 2016). However, it is recommended that more than one readability formula should be used as an average RGL gives a more reliable estimate than a single formula (Ley & Florio, 1996). Using more than one formula also accounts for any differences between formulas (Friedman et al., 2006).

While there is good correlation between the scores of different formulas, there are differences in their RGL estimates (Ley & Florio, 1996). This is because they use different variables and criterion scores (DuBay, 2004). Variables include: average word length in syllables, average sentence length in words, proportion of common words, and proportion of monosyllabic or multisyllabic words (Ley & Florio, 1996). Readability formulas have been

validated against certain criterion, usually performance on a comprehension test (Ley & Florio, 1996). The FOG, SMOG, and F-K were validated using the McCall-Crabbs Standard Test Lessons in Reading (McCall, 1979). These are passages varying in reading difficulty with a set of multiple-choice questions. Test scores of students from various grade levels are used to determine estimates of RGL (Wang, Miller, Schmitt, & Wen, 2013). A passage will be assigned to the mean grade at which students can correctly answer a certain percentage of questions (Wang et al., 2013). This means the criterion score indicates the expected comprehension for most readers of a certain RGL for the given material (Wang et al., 2013). Formulas with higher criterion scores will predict higher RGLs (DuBay, 2004). Using higher comprehension scores is especially important for health information (DuBay, 2004).

1.5.2.1 Gunning Fog Index

The FOG was developed by Gunning (1952). It is based on two variables: average sentence length and number of words with more than two syllables for each 100-word sample (DuBay, 2004). It estimates 90% comprehension based on McCall-Crabbs (DuBay, 2004). The FOG is calculated using the following formula (adapted from Gunning, 1952):

$$Grade = 0.4\left(\frac{Words}{Sentences}\right) + 100\left(\frac{Complex\ words}{words}\right)$$

1.5.2.2 Simple Measure of Gobbledygook

The SMOG is based on the number of polysyllabic words in 30 sentences (McLaughlin, 1969). These are words with three or more syllables. It estimates 100% comprehension based on McCall-Crabbs so estimates higher RGLs than other formula (Wang et al., 2013). The SMOG is most suited to assess health information because it has the most consistency of results and estimates 100% comprehension (Meade & Smith, 1991; Wang et al., 2013). It has also been validated for patient education materials (Pichert & Elam, 1985). The SMOG is calculated using the following formula (adapted from McLaughlin, 1969):

$$Grade = 1.0430\sqrt{Number\ of\ polysyllables \times \frac{30}{Number\ of\ syllables}} + 3.1291$$

1.5.2.3 Flesch-Kincaid Grade Level

The F-K is a recalculated formula based on the original FRE formula (Kincaid, Fishburne Jr, Rogers, & Chissom, 1975). The FRE is an estimate of reading ease which is then converted into an RGL (Kincaid et al., 1975). The FRE is based on the number of syllables and number of sentences for each 100-word sample (DuBay, 2004). It predicts reading ease on a scale from 1 to 100 (DuBay, 2004). A score of 30 to 50 is 'difficult', a score of 60 to 70 is 'plain English', and a score of 90 to 80 is 'easy' and corresponds to the sixth RGL (DuBay, 2004).

The F-K does not require conversion, but directly predicts RGL (Kincaid et al., 1975). The F-K used a criterion score of 35% on the Cloze test, which correlates to 75% comprehension on the McCall-Crabbs (Kincaid et al., 1975). This means it estimates a lower RGL and may overestimate the readability of information (Wang et al., 2013). The F-K is calculated using the following formula (adapted from Kincaid et al., 1975):

$$Grade = .39\left(\frac{Total\ Words}{Total\ Sentences}\right) + 11.8\left(\frac{Total\ Syllables}{Total\ Words}\right) - 15.59$$

1.5.3 Readability of Health Information

1.5.3.1 Printed

Many studies have assessed the readability of written health information. High readability levels of written health information have been an ongoing problem (Pichert & Elam, 1985). High readability continues to be reported in the literature despite awareness of its consequences and the availability of best-practice formatting guidelines for developing health information (Gal & Prigat, 2004). This could be due to incorrect assumptions about the

literacy skills of readers and a lack of health information verification (Gal & Prigat, 2004). There are also discrepancies in readability when information that is intended for health care professionals is accessible to the public (Gal & Prigat, 2004).

It was established early on that the reading ability of the average individual was not high enough to match the reading levels needed to comprehend written health information (Davis et al., 1990). Davis et al. (1990) assessed the readability of written health information and clinical forms used in hospitals. The RGLs of written health information ranged from 11 to 14, while the consent form RGLs ranged from 13 to 31. This discrepancy highlighted the need for education materials that were designed for low-literacy levels.

Adkins, Singh, McKeegan, Lanier, and Oswald (2002) assessed the effects of improving the readability of written health information on treatment outcomes. They found that the mean RGL of behaviour treatments plans for mental illnesses was 13. This was higher than the average RGLs of the staff who were required to understand and implement treatment. The treatment plans were revised to improve readability and comprehension by removing jargon and using active voice. The revised information had an RGL of 4 and met the criteria of a comprehension tool. The revised treatment plans lead to improvements in treatment outcomes that were sustained long-term.

L. Pothier, Day, Harris, and Pothier (2008) revised health information commonly used in speech and language therapy departments. The mean FRE score for the original leaflets was 60 or ‘fairly difficult’ and was revised to 72 or ‘fairly easy’. The mean F-K RGL for the original leaflets was 7 and was revised to 5. These improvements were statistically significant. Only 25% of the original leaflets met the recommended sixth RGL, while 75% of the revised leaflets met the recommendation. This was achieved by applying best-practice formatting guidelines. This highlights the efficacy of best-practice formatting guidelines as

aiming to improve readability alone may not be sufficient to improve written health information.

Similar to other health disciplines, audiologic written information is often written above the recommended sixth RGL. Joubert and Githinji (2014) assessed the readability of written information for parents of children with HL. The RGL of this information ranged from 4 to 10. The quality of information was found to be poor due to inappropriate use of illustrations, poor flow of information, and lack of explanation of medical jargon. Donald and Kelly-Campbell (2016) assessed the readability of an existing and revised paediatric diagnostic audiology report. The RGL of the existing report was 15 using the F-K, 16 using the SMOG, and had a 'difficult' reading score of 35 using the FRE. The report was revised following best-practice formatting guidelines and feedback from parents who had received the report. The readability of the revised report was reduced by 7 to 8 RGLs. This shows that following best-practice formatting guidelines is a valid strategy for improving the readability of written health information. Audiologic written information can be successfully improved to meet the literacy levels of clients.

Nair and Cienkowski (2010) assessed the RGL of both verbal audiological counselling and written information. The language that audiologists used during counselling had a significantly lower RGL than the language used in the hearing aid user guides. However, their choice of language was not suitable for client understanding. There was a communication gap between audiologists and their clients. The written information that was provided to supplement audiologists' verbal counselling had an RGL of 8. Client understanding was impeded both by a lack of appropriate language used in verbal counselling and written information (Nair & Cienkowski, 2010). If the ability of audiologists to verbally explain complex information is limited, then audiologists cannot rely on written information

to supplement understanding. Until readable written information is made available, audiologists must be able to effectively educate clients verbally (Joubert & Githinji, 2014).

1.5.3.2 Online

More individuals with low health literacy are turning to the Internet for health information (McInnes & Haglund, 2011). Poor readability of online health information is significant and widespread, and not limited to a specific health condition (Eloy et al., 2012). The readability of online information about various health conditions have been assessed extensively (Berland et al., 2001; Friedman et al., 2006; McInnes & Haglund, 2011; Walsh & Volsko, 2008; F. L. Wilson et al., 2000). The majority of online health information was found to exceed the recommended sixth RGL.

The majority of online audiologic information was also found to exceed the sixth RGL. This included online information about otitis media (D. Pothier, 2005; Ritchie et al., 2016), grommets (McKearney & McKearney, 2013), and acoustic neuroma (Cherla et al., 2013). It also encompassed health information from various organisations including the American Speech and Hearing Association (Atcherson et al., 2014), web pages from academic otolaryngology departments (Svider et al., 2013), and various otolaryngology association web pages (Eloy et al., 2012; Greywoode, Bluman, Spiegel, & Boon, 2009; Kasabwala, Agarwal, Hansberry, Baredes, & Eloy, 2012). Finally, patient education information about HL (Laplante-Lévesque et al., 2012; Laplante-Lévesque & Thoren, 2015) and hearing aids (Joseph et al., 2016) also had high readability levels.

The readability of online health information tended to increase throughout the text, so that final paragraphs were harder to understand (McInnes & Haglund, 2011; F. L. Wilson et al., 2000). This can cause feelings of frustration and prevent individuals from reading information completely (Friedman et al., 2006). This creates a risk of missing or

misinterpreting important information (Friedman et al., 2006). Low readability needs to be maintained throughout online health information to avoid the risk of discouraging readers (McInnes & Haglund, 2011). Readability is an important component of health literacy, however, it only measures one aspect of comprehension (Moult, Franck, & Brady, 2004). It should be used to supplement assessments of the suitability of health information (Doak et al., 1996; Pichert & Elam, 1985).

1.6 Suitability

1.6.1 What is Suitability

The suitability of written information influences how much information an individual can access and understand (Shieh & Hosei, 2008). It is determined by content and design. The suitability of information should be assessed to account for the limitations of readability measures (Badarudeen & Sabharwal, 2010).

1.6.2 Suitability Assessment of Materials

The Suitability Assessment of Materials (SAM) was developed to assess the suitability of healthcare information (Doak et al., 1996). It is a systematic and efficient tool (Doak et al., 1996). It was validated using individuals from a variety of different cultural backgrounds (Doak et al., 1996). It identifies deficiencies in the suitability of information based on 22 factors. These factors assess suitability in six main areas: content, literacy demand, illustrations and graphics, layout and typography, learning stimulation and motivation, and cultural appropriateness (Doak et al., 1996).

Deficiencies suggest information needs to be corrected or supplementary information needs to be provided (Doak et al., 1996). Most deficiencies can easily be overcome. However, deficiencies in readability or cultural appropriateness are more significant than the overall score (Doak et al., 1996). This is because information with high RGL will not be

understood and inappropriate cultural representations are likely to be rejected by the target audience. Overall SAM scores are interpreted as: 70-100% ‘superior’ material, 40-69% ‘adequate’ material, and 0-39% ‘not suitable’ material (Doak et al., 1996).

1.6.3 Suitability of Health Information

The SAM tool has been widely used in research to evaluate the content and design of health information (Lampert, Wien, Haefeli, & Seidling, 2016). Shieh and Hosei (2008) assessed the readability and suitability of prenatal health information. The information had an average RGL of 10, which is ‘not suitable’ according to the SAM. It had an average SAM score of 66%, indicating ‘adequate’ materials. The authors found that while most information had ‘superior’ and ‘adequate’ suitability qualities, there were specific factors that required improvement. They reported that suitability could have been improved by adding a summary or review at the end, by enhancing reader interaction, and by modelling specific behaviours.

Caposecco, Hickson, and Meyer (2014) assessed the readability and suitability of hearing aid user guides. Most guides had a SAM rating of ‘not suitable’, with only one third rated as ‘adequate’. The factors that were identified as deficiencies were scope of information, vocabulary, layout and typography, and reading level. Scope of information consistently expanded beyond the purpose of the information. The majority of user guides included instructions for other hearing aids with different functions and controls. Vocabulary was inappropriate as there was frequent use of uncommon words, technical words, and jargon where common words could have been used. Layout and typography did not adhere to best-practise guidelines. Finally, the average RGL was 9 which was ‘not suitable’.

A. McMullan et al. (2018) assessed the readability and suitability of a revised hearing aid user guide. The original readability score was above the sixth RGL and the SAM score was ‘not suitable’. The authors reported improvements in both readability and suitability of

the revised user guide, but specific scores were not reported. Revisions included placing easier tasks earlier to build self-efficacy and including a video to model the desired behaviour. Individuals who used this revised user guide had improved self-efficacy. This study supports previous research that has reported the benefits of information revision (Adkins et al., 2002; Caposecco, Hickson, & Meyer, 2011; Convery et al., 2011; Donald & Kelly-Campbell, 2016; Ming & Kelly-Campbell, 2018; L. Pothier et al., 2008; Sakai, 2013).

Caposecco et al. (2011) developed a hearing aid user guide following best-practice formatting guidelines. They used simple line drawings with captions to model behaviours about hearing aid use. This user guide achieved an RGL of 3.5, an FRE score of 91 or 'very easy', and a SAM score of 'superior'. These authors considered all aspects of suitability, not just readability, including cohesion, organization, layout, graphics, writing style, cultural factors, and the amount of information presented. This shows the importance of suitability for comprehension. These same considerations need to be applied to online health information (Caposecco et al., 2011)

Convery et al. (2011) used a revised hearing aid guide to determine if individuals could assemble an over-the-counter hearing aid. The user instructions were written at an RGL of 3.5, with a large font, and were illustrated with black-and-white line drawings. They used the recommendations provided by Caposecco et al. (2011). Using the revised user guide, almost all participants were successfully able to assemble the hearing aids, insert the devices into the ear, and use the button functions, either on their own or with the assistance of a partner.

Sakai (2013) revised an online article about chronic otitis media adjusting different factors to determine the most effective revision. These revisions included: dividing long sentences into shorter sentences, replacing medical jargon with common words or providing an explanation in the following sentences, or presenting important information first. A further

two revisions included mixed methods to determine the interaction of factors. No revision showed a significant effect in the comprehension tests used. However, revising medical jargon and presenting important information first showed the most improvements. These results suggest that vocabulary may be a critical factor, that may be combined with better text structure, to improve comprehension of health information.

Ming and Kelly-Campbell (2018) assessed the readability and suitability of a revised tinnitus brochure. The mean RGL of the original brochure was 10 while the revised brochure had a RGL of 6. The mean SAM score for the original brochure was 'not suitable' while the mean SAM score for the revised brochure was 'superior'. Again, this shows that revision of health information following best-practice formatting guidelines can lead to improved readability and suitability.

These findings demonstrate that readable and suitable health information is important for self-efficacy (Ming & Kelly-Campbell, 2018). These findings also highlight the efficiency of assessing readability and suitability of written health information. Readability formulas can be used easily and quickly online, and suitability can be evaluated efficiently using the SAM tool.

1.7 Improving Health Information

Assessing the readability and suitability of health information determines where revision is needed or if new materials need to be developed (Shieh & Hosei, 2008). Best-practice formatting guidelines should be used to guide the development of effective health information (Hoffmann & Worrall, 2004). Best-practice formatting guidelines can help minimise disparities between individuals and health information (Doak et al., 1998). Most commonly, there are differences between the reading level of individuals and the high readability of health information (Doak et al., 1998). There are also differences in

assumptions of health care professionals and the skills of individuals (Doak et al., 1998). Health care professionals may incorrectly assume that individuals can make inferences about desired behaviours from health information and apply these changes (Doak et al., 1998). Using best-practice formatting guidelines ensures that health information facilitates comprehension and motivates desired changes in health behaviours (Caposecco et al., 2011).

Following best-practice formatting guidelines helps to minimise the cognitive demands of health information (E. Wilson & Wolf, 2009). It helps improve processing and retention of new information (E. Wilson & Wolf, 2009). This is especially important for individuals with HL (Rönnberg et al., 2011), and individuals with low health literacy and declining cognitive ability (E. Wilson & Wolf, 2009) who may have difficulty retaining new information. Working memory can only process a finite number of different ideas at any one time (G. A. Miller, 1994). This is reduced when individuals are stressed, which is common for individuals with health concerns (E. Wilson & Wolf, 2009). Using effective formatting shifts cognitive effort from processing design features to understanding health information (E. Wilson & Wolf, 2009). This helps improve retention of new information.

There are many best-practice formatting guidelines available for writing health information (Caposecco et al., 2011; Centers for Disease Control Prevention, 2009; Doak et al., 1996; Hoffmann & Worrall, 2004; Mayer & Villaire, 2007; Moult et al., 2004). The process of producing readable and suitable health information can be simplified into three key stages: planning, development, and verification. The development stage focuses on achieving appropriate readability and suitability of health information.

1.7.1 Planning

The first step in creating comprehensible health information is to determine the target audience. Planning should focus on understanding the needs and expectations of the target

audience (Doak et al., 1996). This ensures information is tailored to match their reading and health literacy levels and will be culturally appropriate (Badarudeen & Sabharwal, 2010). Health information that is tailored to the target audience will be suitable for readers (Lampert et al., 2016)

1.7.2 Readability

For individuals to benefit from health information, it needs to be readable (Boyd, 1987). Information should be written at the lowest reading level that does not distort meaning (Hoffmann & Worrall, 2004). The average readability that is recommended is the sixth RGL (Doak et al., 1996). If targeting individuals at risk of low health literacy, however, information should be written at the third to fifth RGL (Boyd, 1987). This is because information should be written two to four grade levels below the average RGL (Boyd, 1987). Appropriate readability can be achieved without compromising quality of information (Laplante-Lévesque et al., 2012). This can be done by limiting to one idea per sentence, avoiding complex grammatical structures, and using short words and sentences where possible (Boyd, 1987). Information written with low readability is accessible and preferred by individuals of all literacy levels (Doak et al., 1996; Hoffmann & Worrall, 2004).

1.7.3 Suitability

1.7.3.1 Content

Health information should focus on an individual's experience of their health condition and not the underlying pathophysiology (Safeer & Keenan, 2005). This includes questions they are likely to be asked, different treatment options, different health care professionals they may interact with, and nature of follow-up visits (Doak et al., 1996). Health information should incorporate information that patients need and will want to know (Boyd, 1987). This ensures that the focus of health information is limited to a few necessary key objectives about desired behaviours (Caposecco et al., 2011).

Health information should not begin with a review of anatomy and physiology (Weiss, 2003). This is known as the medical model of providing information, and is the most commonly used, but is the least suitable (Doak et al., 1996). Individuals do not need to learn underlying principles to understand and apply desired behaviour (Knowles, 1970). Giving priority to pathophysiology can make health information appear irrelevant to readers (Doak et al., 1998). Facts imply desired behaviour, but individuals with low health literacy may not be able to make these inferences and interpret information correctly (Doak et al., 1996). Both the content and sequence of this information does not match the needs and wants of readers (Doak et al., 1996).

Individuals with low health literacy skills can be apprehensive about learning new information due to past failures, so information should be designed to minimise failure (Doak et al., 1996). This can be achieved by organising information appropriately to increase motivation (Doak et al., 1996). The most important and useful information should be presented first (Boyd, 1987). Information should remain focussed on key objectives to avoid overloading readers with irrelevant information (Boyd, 1987). Information should be presented in the order that individuals are likely to use it (Caposecco et al., 2011). This ensures individuals, especially those with low literacy who are more likely to fatigue and lose interest, get the most benefit (Doak et al., 1996). The effectiveness of online health information is dependent on easy navigation (Kuk, 2002).

1.7.3.2 Literacy Demand

Information should be written using active voice (Boyd, 1987) and in a conversational style (Pichert & Elam, 1985). This is easier to read and understand and is preferred by individuals over information written in short, bullet point style (Michielutte, Bahnson, Dignan, & Schroeder, 1992). Information should also be written using positive and motivating writing (Caposecco et al., 2011). Self-efficacy can be improved when individuals

are told they have the capabilities to accomplish the desired behaviour (Bandura, 1977). Self-efficacy is lowered when anxiety is high (Bandura, 1977) so health information should avoid negative descriptors (Doak et al., 1996).

Context should be presented before new information is given (Doak et al., 1996). Relating new information to existing knowledge creates an association between new and familiar information that helps understanding and retention of information (Doak et al., 1996). It provides a context in which to store new information (Doak et al., 1998). Context also helps individuals find answers to specific questions efficiently (Boyd, 1987). When context is provided at the end, individuals must retain all the information in their short-term memory before they are able to process it (Doak et al., 1996). This is not effective, especially for individuals with low health literacy. Context can be provided by using introductory paragraphs (Pichert & Elam, 1985). Within paragraphs, use topic and concluding sentences (Pichert & Elam, 1985). Include summaries that review the most important information (Pichert & Elam, 1985). When editing, it is important to maintain conversational flow and cohesion as to not increase the amount of inferences readers need to make (Pichert & Elam, 1985). Cohesion can be maintained by using connections between sentences, paragraphs, and topics (Caposecco et al., 2011).

In some health information it may be necessary to keep jargon that individuals will be exposed to during their health care to reinforce their understanding (Doak et al., 1996). In this case, the context of the words needs to be provided and meaning needs to be clearly explained using simple words in the following sentences (Pichert & Elam, 1985). Jargon should be repeated throughout, in different contexts, to promote retention (Doak et al., 1996). New vocabulary should be limited to three or less words that individuals are likely to encounter in their health care (Doak et al., 1996)

1.7.3.3 Graphic Illustrations

Illustrations should be used to supplement the key objectives (Doak et al., 1996). In a systematic review by Houts, Doak, Doak, and Loscalzo (2006) it was found that illustrations linked to written information increased attention, comprehension, recall, and adherence to health information. This was especially true for individuals with low health literacy. Illustrations should present information in small steps within a familiar context to increase motivation and self-efficacy (Doak et al., 1996). Illustrations can make health information more accessible for individuals with low literacy while still being accepted by individuals with high literacy (Michielutte et al., 1992). These benefits are only achieved, however, if images are culturally appropriate (Houts et al., 2006). Also, illustrations should be simple line drawings (Caposecco et al., 2011) because child-like illustrations may be rejected as inappropriate by readers (Doak et al., 1996).

Graphics such as tables and graphs can be used to replace hard to read text or supplement understanding of information (Pichert & Elam, 1985). Graphics should have one main purpose and directions on how to read them (Doak et al., 1996). They help to shift cognitive effort from trying to read hard information to processing and retention of information (M. Wilson, 2009).

Illustrations and graphics need captions that explain meaning (Caposecco et al., 2011). This promotes understanding and retention of information (Weiss, 2003). Illustrations placed after information without captions cannot be related to a specific portion of text so are unhelpful (Doak et al., 1996). Visual cueing, such as arrows and colour, should be used within illustrations and graphics to direct individuals to the main point (Doak et al., 1998) and explain meaning (Caposecco et al., 2011).

1.7.3.4 Layout and Typography

How reader-friendly information is can be determined by layout and typography (Weiss, 2003). Legibility can be increased by balanced use of white and black space (Meade & Smith, 1991) and use of dark fonts on light backgrounds (Caposecco et al., 2011). Size 14-point serif fonts are more legible, faster to read, and significantly more preferred than smaller size fonts (Bernard, Liao, & Mills, 2001). They are recommended for body text (Caposecco et al., 2011). Sentence eye span should be no longer than 60 to 70 characters and all caps should be avoided (Boyd, 1987). To highlight and reinforce important information, larger fonts, bold, or italics can be used (Caposecco et al., 2011; Pichert & Elam, 1985). Most importantly, formatting should be kept consistent throughout information to reduce cognitive effort (Meade & Smith, 1991).

Similar information should be divided using headings and subheadings (Boyd, 1987). This is known as chunking (Doak et al., 1996). Headings attract the attention of readers (Doak et al., 1996) while chunking partitions information into manageable sections in a logical, cohesive order (Pichert & Elam, 1985). This promotes processing of information into short-term memory to improve retention (Doak et al., 1998). As more than seven independent items are unlikely to be remembered (G. A. Miller, 1994), information should be chunked into groups of three to five items per section (Doak et al., 1996). Chunking also promotes self-efficacy by presenting information in small practical steps that improve motivation (Caposecco et al., 2011). This ensures tasks feel achievable and allows individuals to feel success throughout (Doak et al., 1996).

1.7.3.5 Learning Stimulation and Motivation

Interaction increases motivation and retention of information (Doak et al., 1996). It causes a protein change in the brain that stimulates retention of information into long-term memory (Jonassen, 1982). Interaction can include question-answer format (Boyd, 1987) or

testimonials that reinforce and support health information (Doak et al., 1998). Individuals report more benefit from online health information when websites are interactive and allow for self-testing of knowledge (Pletneva et al., 2011).

1.7.3.6 Cultural Appropriateness

Health information needs to address the cultural factors of the target audience (Boyd, 1987; Meade & Smith, 1991; Pichert & Elam, 1985). Information that is not culturally tailored may be rejected by the individuals it is aiming to help (Doak et al., 1996). Using culturally appropriate language and illustrations when modelling desired behaviours and demonstrating success helps to improve self-efficacy (Bandura, 1977).

1.7.4 Verification

Written health information can be verified by using a sample group of the target audience and by using a validated tool such as the SAM (Caposecco et al., 2011). While it is recommended that both methods are used, the SAM tool can be used alone if there is insufficient time or resources for user tests (Doak et al., 1996). User tests can be completed efficiently (Lampert et al., 2016) and verification with only a few individuals is beneficial (Redish, 2000). It is recommended that ten individuals are used (Doak et al., 1996), but researchers found using fewer individuals effective as no new information was gained from further users (Lampert et al., 2016). Health care professionals cannot be a substitute for user tests because their knowledge makes them unable to view health information as members of the target audience (Doak et al., 1996).

User tests determine which features of health information are not understood or accepted by the target audience (Doak et al., 1996). This verifies whether information will positively influence the health behaviours of readers (Doak et al., 1996). Tests should include individuals from the target audience, particularly those with low literacy skills (Weiss, 2003).

Individuals should be asked closed and open-ended questions about the factors of suitability (Doak et al., 1996). Comprehension can be verified by asking knowledge questions about the key objectives of the health information (Lampert et al., 2016). From the user feedback provided, appropriate modifications can be made to improve the suitability of health information (Weiss, 2003).

1.8 Study Rationale

Many individuals are using the Internet to access health information to guide their health decisions. Individuals with HL are known to seek information online. As NIHL is preventable, access to educational information is a critical aspect of management. Efforts to educate individuals about NIHL about preventative measures online may be hindered due to low health literacy. It is known that occupational NIHL prevention is hindered due to poor compliance with HPDs and many young adults are unaware of the risk of recreational NIHL.

Previous literature has established that the readability of online health information exceeds the recommended sixth RGL. The quality of online health information is variable and lacks suitability. A previous study has found that the readability of online NIHL information is high (Johnson, 2017). To date, the suitability of online NIHL information has not been reported. Studies have demonstrated the positive effects of using best-practice formatting guidelines to develop readable and suitable health information. Identifying how the content and design of online NIHL information can be improved will guide the development of accessible educational information.

1.9 Research Aims and Hypotheses

The aim of this study was to report on the readability and suitability of online NIHL information available in English. The study aimed to investigate the following research questions:

1. Is there an even distribution of NIHL related online written material from different regions?
2. Is there an even distribution of NIHL related online written material from different types of organisations?
3. Is there an even distribution of NIHL related online written material from web pages with and without HON certification?
4. Are there significant differences in the readability of NIHL related online written material from different regions?
5. Are there significant differences in the readability of NIHL related online written material from different types of organisations?
6. Are there significant differences in the readability of NIHL related online written material from web pages with and without HON certification?
7. Are there significant differences in the suitability of NIHL related online written material from different regions?
8. Are there significant differences in the suitability of NIHL related online written material from different types of organisations?
9. Are there significant differences in the suitability of NIHL related online written material from web pages with and without HON certification?
10. Is there a significant correlation between readability and suitability of NIHL related online written material?

Based on these research questions ten null hypotheses exist:

1. There is an even distribution of web pages based on region.
2. There is an even distribution of web pages based on type of organisation.
3. There is an even distribution of web pages based on HON certification.
4. There is no significant difference in mean RGL of web pages based on region.

5. There is no significant difference in mean RGL of web pages based on type of organisation.
6. There is no significant difference in mean RGL of web pages based on HON certification.
7. There is no significant difference in SAM scores of web pages based on region.
8. There is no significant difference in SAM scores of web pages based on type of organisation.
9. There is no significant difference in SAM scores of web pages based on HON certification.
10. There is no significant correlation between mean RGL and SAM scores.

Chapter 2: Method

2.1 Overview

This study investigated the readability and suitability of online NIHL information available in English. First, readability was assessed using the FOG, SMOG, and F-K. Second, the suitability of web page content was assessed using the SAM tool. Quality was determined by HONcode certification. No ethical approval was required for this study.

2.2 Identification of Search Terms

The search terms for this study were determined by asking a group of 15 informants what search terms they would use to access online NIHL information. The question used was: "If you thought you had a hearing loss after being exposed to noise and you wanted to search the Internet for more information, what words would you search in Google? Feel free to mention as few or as many as you can think of". The informants were fluent speakers of English and prior knowledge of hearing and hearing healthcare was not required.

The most-mentioned search terms related to NIHL were selected for further analysis in Google trends (www.google.com/trends). Google trends is a free public website that analyses the popularity of search queries in Google Search across various regions and languages. It was used to determine which informant search terms were the most frequently used and to identify any popular related queries. This has been done in previous studies (Laplante-Lévesque et al., 2012; Manchaiah et al., 2017).

The search terms were entered into Google Trends to obtain their search frequency. The following settings were selected for the analysis: *worldwide* in the *past 12 months* within *all categories* using *web search*. The analysis was performed on the 23rd of August 2018. The search terms resulted in the same data regardless of whether the term "loud" was included or not. The term "hearing loss noise" was the most commonly searched. The related query

"noise induced hearing loss" was rising in search frequency. The terms "hearing loss sound", "hearing damage noise", and "hearing damage sound" were not frequently used search terms. They were excluded from the search terms. The terms "noise exposure" and "sound exposure" were trending down so were excluded from the search terms. The terms "sensitive ears" and "ringing ears" were excluded from the search terms as these would introduce unrelated web pages about hyperacusis and tinnitus respectively. Based on this, two search terms "hearing loss noise" and "noise induced hearing loss" were selected.

2.3 Search Locations

To determine the English-speaking countries for the search, all countries that had a Google domain were collected. This was a list of the country-coded Top-Level Domains (ccTLD). From this, countries where English is an official language and/or used for commerce were determined. This gave a total of 56 countries. To narrow the search, countries with fewer than 2 million Internet users were excluded. This gave a total of 19 countries and maintained the proportions in each region similar to overall proportions. The region, Internet penetration rate, and total number of Internet users for these countries were collected (see Table 1). These countries encompassed 94% of the total number of Internet users in English-speaking countries.

Table 1. *Countries Included in Internet Search with English as an Official Language and/or Used for Commerce and at least Two Million Internet Users.*

Country	**Region**	**Internet Penetration Rate**	**Population of Internet Users**
Kenya	Africa	26%	43,329,434
South Africa	Africa	21%	30,815,634
Tanzania	Africa	13%	23,000,000
Uganda	Africa	22%	19,000,000

Zimbabwe	Africa	23%	6,796,314
Cameroon	Africa	25%	6,128,422
United States	Americas	76%	320,059,368
Canada	Americas	90%	33,000,381
Puerto Rico	Americas	83%	3,047,311
United Kingdom	Europe	95%	63,061,419
Ireland	Europe	85%	4,453,436
India	South-East Asia	30%	462,124,989
Indonesia	South-East Asia	25%	143,260,000
Philippines	Western Pacific	41%	67,000,000
Malaysia	Western Pacific	71%	25,084,255
Australia	Western Pacific	88%	21,743,803
Hong Kong	Western Pacific	85%	6,461,894
Singapore	Western Pacific	82%	4,839,204
New Zealand	Western Pacific	88%	4,078,993
Total in study			**1,219,770,002**
Percentage in study			**94%**

Note. Adapted from CIA World Factbook (Central Intelligence Agency, 2007) to determine languages spoken, World Health Organization regional offices (World Health Organization, 2018) for region, World Bank and International Telecommunication Union (The World Bank, 2017) for Internet penetration rate, and Internet World Stats (Internet World Stats, 2018) for population of Internet users.

2.4 Inclusion and Exclusion Criteria

The inclusion criteria for the web pages were: (1) written in English, (2) provided relevant information about NIHL, and (3) available to the public. Web pages were excluded if

they: (1) contained paid advertisements or a paywall (were not open access), (2) were a video, (3) were a directory listing, and (4) were less than 100 words long. The exclusion criteria were set as these web pages could not be analysed using readability tools.

2.5 Search Procedure

To perform the Google search, the ccTLD of each country was selected through Google settings. The search was completed on the 23rd of August 2018 using a Google Chrome browser. The two search terms were entered into the 19 ccTLDs one at a time. The first ten search listings were accessed and measured against the inclusion and exclusion criteria. This is based on research that demonstrates that individuals only access the first page of Google results, that defaults to ten listings, when searching for information online (Eysenbach & Köhler, 2002). Only the web pages that met the criteria were selected for analysis. Once the search was completed, all duplicate web pages were removed. This gave a final list of 32 unique web pages.

The Uniform Resource Locator (URL), country of origin, website type of organisation, and HONcode certification of the web pages were recorded in a Microsoft Excel file. The country of origin was determined by the URL or by information provided in the *About Us* (or similar) section of each web page. If the country was not apparent, further information was gathered through an Internet search. Web pages that targeted a global audience and provided information in multiple languages were coded as World.

The website type of organisation referred to whether the organisation was non-profit, commercial, or government. This was determined by the URL and information provided in the *About Us* (or similar) section of each web page. The web page was coded as commercial if it was supported by advertisers. It was coded as government if it was produced by a

governmental agency. It was coded as non-profit if it was verified as being non-profit on the *About Us* (or similar) section of the web page or further search information on the Internet.

HONcode certification was used as a measure of quality of information. The presence or absence of HONcode certification was recorded, using *yes* or *no*. HONcode certification was determined using a plug-in that is available for download from the HON web page (https://www.hon.ch/en/tools.html). If HONcode certification is present, a HON icon appears next to the listing on the Google search results.

Only the relevant web pages of the websites were assessed for readability and suitability. Web pages that contained internal links to related web pages with relevant information were also accessed for analysis. Any external content or external links were not assessed.

2.6 Readability Analysis

For each web page, three measures of readability where used: FOG, SMOG, and F-K. An online English readability tool that is available for free was used to estimate readability (www.online-utility.org/english/readability_test_and_improve.jsp). This was done by copying the content of each web page into the readability tool. The calculated readability scores were entered into an excel spreadsheet and the mean RGL was calculated.

2.7 Suitability

The suitability of web pages was assessed using the SAM tool. The researcher and primary supervisor read the SAM tool and discussed it together. They performed SAM ratings on non-study material and discussed discrepancies between their ratings. This was to ensure agreement between subjective interpretations of scoring. Then, the researcher scored all 32 NIHL web pages using the SAM tool. To determine inter-rater agreement, 16 web pages were randomly selected and rated by the primary supervisor.

Each of the 22 SAM factors was scored as either ‘superior’ (2 points), ‘adequate’ (1 point), or ‘not suitable’ (0 points). Factors that did not apply for a specific web page were not scored. For example, a web page with no illustrations was not be scored for type of illustrations. All scores were added, for a possible total of 44, and a percentage was calculated. When one or more SAM factors did not apply two points were subtracted, for each non-applicable factor, from the 44 total. This accounts for the non-applicable factors in the calculated percentage.

The entire web page was assessed using the SAM unless it was a “long” web page. As the SAM tool does not provide specific criteria for what is considered a “long” web page, this was decided by the researcher and primary supervisor. There were six web pages in total that were deemed “long”. For these web pages, a section from beginning and a section from the end where chosen. Chapters and headings were used to determine these sections, for example the first and last chapter or the first and last headings. If these sections were short then a consecutive chapter was also included, for example if the first chapter was insufficient, the second chapter was also read.

2.8 Data Analysis

There were two dependent variables in this study. They were mean RGL and SAM score. The two independent variables were country of origin and type of organisation. To analyse the data, country of origin, which had eight levels, was revised to three regions. These were World, Americas, and Other. These groupings were established to ensure statistical analysis would be possible by achieving an even distribution of data.

Statistical analysis of data was performed using IBM SPSS Version 24 software (IBM Corp, 2016). The assumptions of normality were tested, and the data meet the assumptions of parametric testing. Several statistical analyses were performed to investigate the research

questions. The descriptive statistics included: intraclass correlation coefficient (ICC), Chi-square test, analysis of variance (ANOVA), and Pearson's correlation coefficient. An alpha level of 0.05 was used to determine significance for all statistical analyses.

Chapter 3: Results

3.1 Overview

The main purpose of this study was to assess the readability and suitability of online NIHL information available in English. In addition, this study aimed to compare the readability and suitability between web page region, type of organisation, and presence or absence of HONcode certification. In total, 32 web pages were analysed.

3.2 Descriptive Statistics

3.2.1 Region and Type of Organisation

The web page country of origin was recorded. Most were from the United States of America (*n* = 9, 29%), then the World and Australia (*n* = 6, 19% each), followed by New Zealand, Canada, and the United Kingdom (*n* = 3, 9% each), and then South Africa and Ireland (*n* = 1, 3% each).

Due to the variability of web page distribution between countries, location was grouped into regions. This resulted in three regions with an even distribution of web pages. Most web pages were from Other (*n* = 14, 44%), then Americas (*n* = 12, 37%), and then World (*n* = 6, 19%). Other consisted of Australia, Ireland, New Zealand, South Africa, and the United Kingdom. Americas consisted of Canada and the United States of America. World consisted of the web pages that were coded as World during the initial Internet search. These were web pages that targeted a global audience and provided information in multiple languages.

The type of organisation that published each web page was recorded. Most were non-profit and government (*n* = 13, 41% each). The fewest were commercial (*n* = 6, 18%). See Figure 1 for a breakdown of the types of organisations within each region.

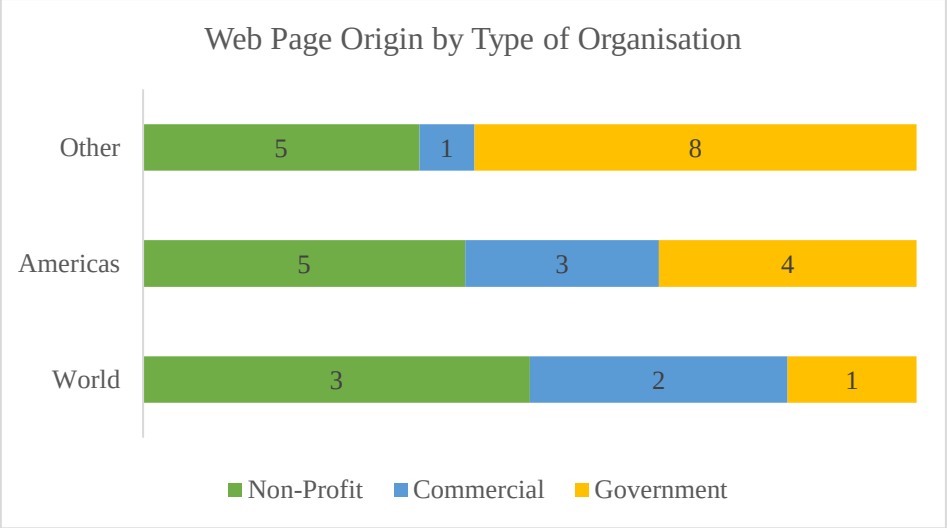

Figure 1. *Number of web pages from the three types of organisations in each region.*

3.2.2 HONcode Certification

Only one of the 32 web pages (3%) had HONcode certification. This web page was from Family Doctor, American Academy of Family Physicians. It is a commercial web page from the United States of America.

The null hypotheses related to HONcode certification were removed from the hypothesis testing because of this lack of variability. These were: (1) Is there an even distribution of NIHL related online written material from web pages with and without HONcode certification? (2) Are there significant differences in the readability of NIHL related online written material from web pages with and without HONcode certification? (3) Are there significant differences in the suitability of NIHL related online written material from web pages with and without HONcode certification?

3.2.3 Readability

Using the FOG, the RGL of the web pages ranged from 8.13 to 25.68 (M = 13.36, SD = 3.16). Using the SMOG, the RGL ranged from 10.30 to 21.02 (M = 13.23, SD = 2.11). Finally, using the F-K, the RGL ranged from 8.25 to 22.39 (M = 11.77, SD = 2.80). The mean RGL of all three readability measures ranged from 9.17 to 23.03 (M = 12.79, SD = 2.67).

3.2.4 Suitability

Suitability scores of the SAM tool ranged from 32% to 71% (*M* = 54%, *SD* = 10%). This ranged from 'not suitable' (0-39%) to 'superior' (70-100%). The mean SAM score met the criteria for 'adequate' material (40-69%). The inter-rater agreement for the total scores was high. The ICC single measure was .953, $p < .001$. This shows excellent agreement beyond chance (Fleiss, Levin, & Paik, 2013). The ICC is a widely used measure of inter-rater reliability for quantitative ratings. Table 2 provides a summary of the frequency of SAM scores for each factor for the materials assessed.

Table 2. *Frequency and Percentage of SAM Scores for each Factor (N = 32).*

SAM Factor	**Not suitable *n* (%)**	**Adequate *n* (%)**	**Superior *n* (%)**
Content			
Purpose	0 (0%)	17 (53%)	15 (47%)
Content topics	12 (38%)	16 (50%)	4 (13%)
Summary or review	30 (94%)	2 (6%)	0 (0%)
Literacy Demand			
RGL	30 (94%)	2 (6%)	0 (0%)
Writing style	3 (9%)	17 (53%)	12 (38%)
Sentence construction	0 (0%)	6 (19%)	26 (81%)
Vocabulary	9 (28%)	16 (50%)	7 (22%)
Advance organisers	2 (6%)	1 (3%)	29 (91%)
Graphic Illustrations			
Cover graphic	0 (0%)	25 (78%)	7 (22%)
Type of illustrations	1 (6%)	5 (28%)	12 (67%)
Relevance of illustrations	15 (47%)	16 (50%)	1 (3%)

Graphics	1 (10%)	6 (60%)	3 (30%)
Captions	8 (35%)	10 (43%)	14 (22%)
Layout and Typography			
Typography	0 (0%)	2 (6%)	30 (94%)
Layout	3 (9%)	21 (66%)	8 (25%)
Subheadings and chunking	8 (25%)	10 (31%)	14 (44%)
Learning Stimulation and Motivation			
Interaction	28 (88%)	2 (6%)	2 (6%)
Modelling of behaviours	4 (13%)	11 (34%)	17 (53%)
Motivation	3 (9%)	4 (13%)	25 (78%)
Cultural Appropriateness			
Cultural images and examples	13 (41%)	18 (56%)	1 (3%)

Note. 14 web pages did not include illustrations, 22 web pages did not include graphics, and 9 web pages did not require captions due to the absence of illustrations and/or graphics. Percentages were adjusted to account for non-applicable factors.

3.3 Hypothesis Testing

3.3.1 Normality

Given the sample size (N = 32) normal distribution was assumed. There were no significant outliers in the dataset. The data was determined to meet the assumptions of parametric testing.

3.3.2 Distribution based on Region and Type of Organisation

The study aimed to answer the following research questions:

1. Is there an even distribution of NIHL related online written material from different regions?
2. Is there an even distribution of NIHL related online written material from different types of organisations?

A chi-square test of independence was performed to examine the distribution of NIHL online information from different regions. There was an even distribution based on region χ^2 (2, N = 32) = 3.25, p = .20. A chi-square test of independence was performed to examine the distribution of NIHL online information from different types of organisations. There was an even distribution based on type of organisation χ^2 (2, N = 32) = 3.06, p = .25.

Based on these results, the null hypotheses that (1) there is an even distribution of web pages based on region, and (2) there is an even distribution of web pages based on type of organisation were supported. There was an even distribution of web pages based on region and type of organisation.

3.3.3 Readability based on Region and Type of Organisation

The study aimed to answer the following research questions:

1. Are there significant differences in the readability of NIHL related online written material from different regions?
2. Are there significant differences in the readability of NIHL related online written material from different types of organisations?

A two-way ANOVA was conducted on the influence of two independent variables (region, type of organisation) on the mean RGL. Region included three levels (World, Americas, Other) and type of organisation consisted of three levels (non-profit, commercial, government). There was no significant interaction F(4, 23) = 0.78, p = .55, and the main effects were examined. The main effect for region yielded an F ratio of F(2, 23) = 0.14, p =

.87, η_p^2 = .012, indicating there was not a significant difference in mean RGL between World (*M* = 12.89, *SD* = 2.54), Americas (*M* = 12.69, *SD* = 1.97), and Other (*M* = 12.83, *SD* = 3.35). The main effect for type of organisation yielded an F ratio of *F*(2, 23) = 0.49, *p* = .62, η_p^2 = .041, indicating there was not a significant difference in mean RGL between non-profit (*M* = 12.03, *SD* = 1.85), commercial (*M* = 12.89, *SD* = 2.30), and government (*M* = 13.50, *SD* = 3.42).

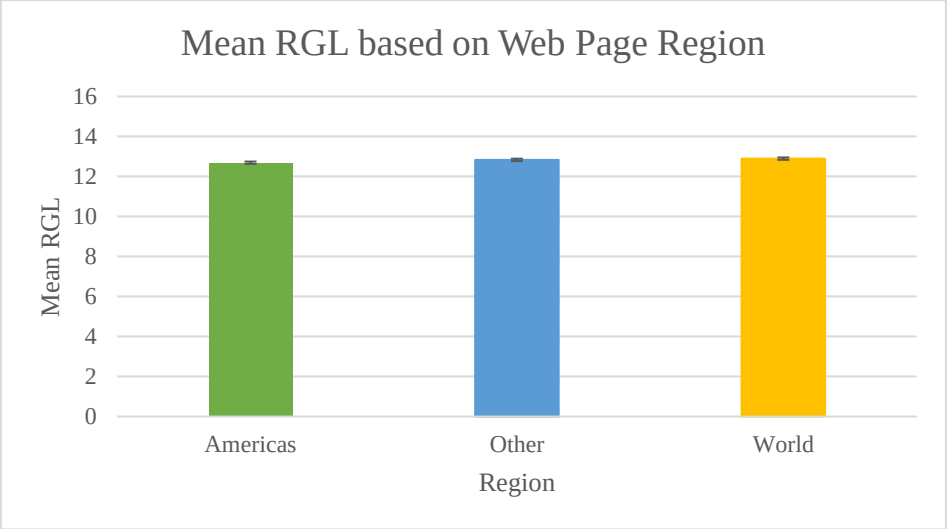

Figure 2. *Mean RGL of web pages from the three regions: Americas, Other, and World. Error bars represent one standard error.*

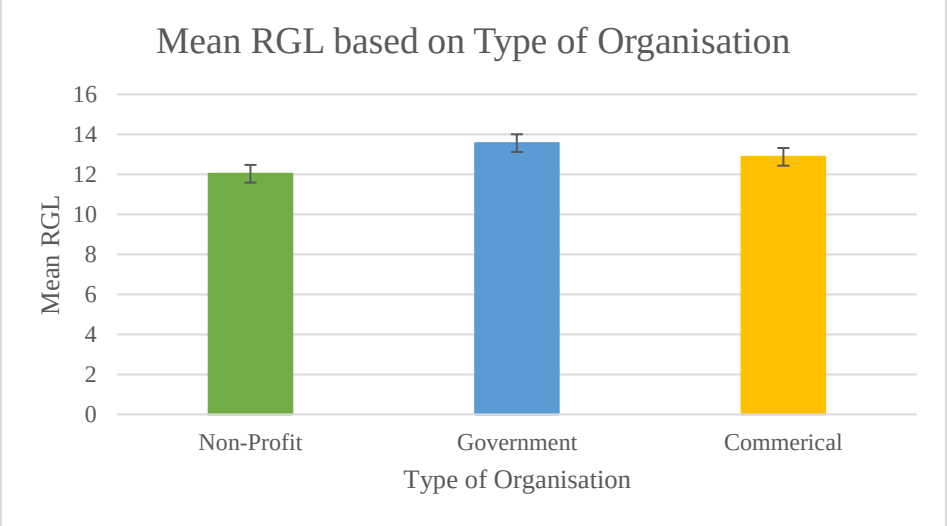

Figure 3. *Mean RGL of web pages from the three types of organisations: Non-profit, Government, and Commercial. Error bars represent one standard error.*

Based on these results, the null hypotheses (1) there is no significant difference in mean RGL of web pages based on region and (2) there is no significant difference in mean RGL of web pages based on type of organisation were supported. There were no significant differences in readability of web pages based on their region or type of organisation.

3.3.4 Suitability based on Region and Type of Organisation

The study aimed to answer the following research questions:

1. Are there significant differences in the suitability of NIHL related online written material from different regions?
2. Are there significant differences in the suitability of NIHL related online written material from different types of organisations?

A two-way ANOVA was conducted on the influence of two independent variables (region, type of organisation) on the SAM scores. Region included three levels (World, Americas, Other) and type of organisation consisted of three levels (non-profit, commercial, government). There was no significant interaction $F(4, 23) = 1.95$, $p = .14$, and the main effects were examined. The main effect for region yielded an F ratio of $F(2, 23) = 0.04$, $p = .96$, $\eta_p^2 = .003$, indicating there was not a significant difference in SAM scores between World ($M = 54.70$, $SD = 12.45$), Americas ($M = 54.77$, $SD = 10.53$), and Other ($M = 54.08$, $SD = 9.45$). The main effect for type of organisation yielded an F ratio of $F(2, 23) = 1.63$, $p = .22$, $\eta_p^2 = .124$, indicating there was not a significant difference in SAM scores between non-profit ($M = 54.36$, $SD = 9.30$), commercial ($M = 49.34$, $SD = 10.99$), and government ($M = 56.91$, $SD = 10.33$).

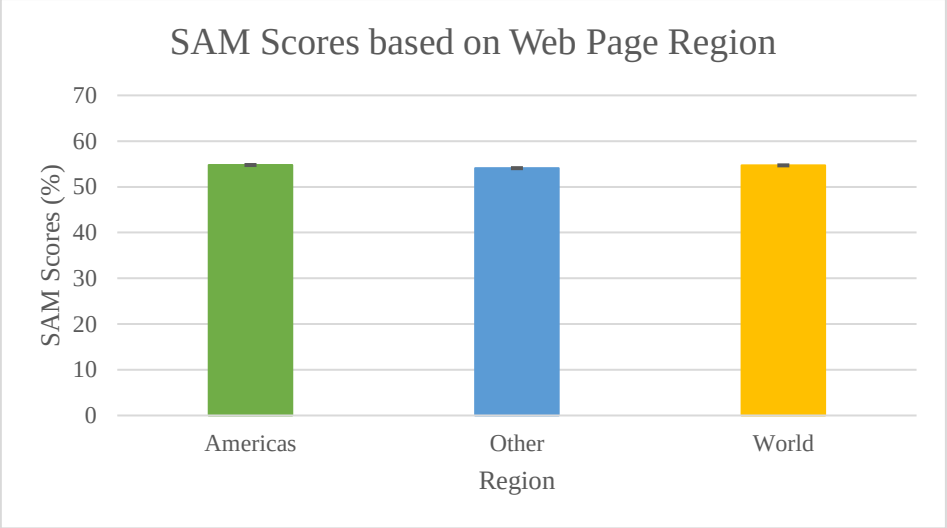

Figure 4. *Mean SAM scores of web pages from the three regions: Americas, Other, and World. Error bars represent one standard error.*

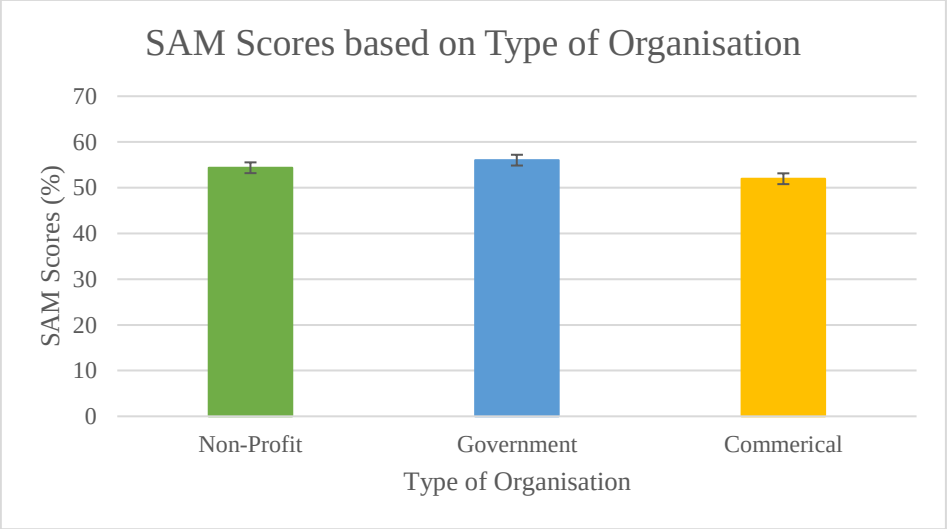

Figure 5. *Mean SAM scores of web pages from the three types of organisations: Non-profit, Government, and Commercial. Error bars represent one standard error.*

Based on these results, the null hypotheses (1) there is no significant difference in SAM scores of web pages based on region and (2) there is no significant difference in SAM scores of web pages based on type of organisation were supported. There were no significant differences in suitability of web pages based on their region or type of organisation.

3.3.5 Correlation between Readability and Suitability

The study aimed to answer the following research question:

1. Is there a significant correlation between readability and suitability of NIHL related online written material?

Mean RGL and SAM scores were significantly correlated, Pearson's $r(30) = .45$, $p = .01$. With the coefficient of determination, $r^2 = 0.20$. This means 20% of variance is shared between mean RGL and SAM scores.

3.4 Summary

Parametric statistical analysis was used as the data did not violate the assumptions of parametric testing. Hypotheses regarding HONcode certification were removed from the statistical analysis as there was not an even distribution of web pages with and without HONcode certification. Based on the statistical analysis, it was found that all the null hypotheses were supported except for one; there is no significant correlation between mean RGL and SAM scores.

Chapter 4: Discussion

4.1 Overview

The aim of this study was to investigate the readability and suitability of online information related to NIHL available in English. The results found that the mean readability of online NIHL information was high and the suitability of online NIHL information was 'adequate'. This chapter will discuss the readability and suitability levels in relation to previous studies and the strengths and weaknesses across the six main areas of suitability.

The study also assessed the relationships between readability and suitability and the two factors: web page region and type of organisation. There was an even distribution of web pages based on region and type of organisation. There were no significant differences in readability or suitability of web pages based on their region or type of organisation. These findings will be discussed alongside the clinical implications and limitations of this study and areas of future research.

4.2 Readability of Online NIHL Information

The results of this study found the readability of online NIHL information was high. All information was above the recommended sixth RGL. This supports the findings of Johnson (2017) who assessed the readability of 153 NIHL related web pages. The mean RGL was 15 using the SMOG, 14 using the F-K, and 40.9 using the FRE which corresponds to a college RGL and is considered 'difficult'. None of the assessed web pages assessed by Johnson (2017) met the recommended sixth RGL. The results of this study also reflect findings of previous studies that assessed the readability of online information including but not limited to HL (Laplante-Lévesque et al., 2012; Laplante-Lévesque & Thoren, 2015), hearing aids (Joseph et al., 2016), tinnitus (Manchaiah et al., 2017), and otitis media (D. Pothier, 2005; Ritchie et al., 2016).

Providing health information with low readability is important as it promotes understanding and retention of health information (Shieh & Hosei, 2008). Information that is hard to understand will not have the potential to positively affect health behaviours and health outcomes. Achieving low readability for NIHL information is especially important as prevention of NIHL relies on effective education about the risks of excessive noise and use of HPDs. Information needs to be readable if individuals are to understand and interpret information and apply desirable changes to their health behaviours. High readability of information also reduces the self-efficacy of individuals (A. McMullan et al., 2018). Individuals with low self-efficacy are less likely to translate health information into desirable health behaviours.

Readable NIHL information is especially important due to the high prevalence of low health literacy (Ministry of Health, 2010). Individuals with low health literacy are even less likely to understand, interpret, and apply health information, so require information that is readable (Nutbeam, 2006). Higher rates of low health literacy are observed in individuals with lower socioeconomic status and education levels lower than high school (Berkman et al., 2011). These individuals are also less likely to access the Internet for health information (Hesse et al., 2005). However, these individuals may be more likely to hold jobs that have greater noise exposure, such as labourers and production workers (Nelson et al., 2005). This means that individuals who would receive the most benefit from online NIHL information are less likely to access it and are more likely to have difficulty understanding it.

4.3 Suitability of Online NIHL Information

The suitability of online NIHL information, assessed by the SAM tool, was found to be ‘adequate’. This reflects the findings of studies assessing the suitability of hearing related information where most information was rated as ‘adequate’ or ‘not suitable’ (Caposecco et al., 2014; A. McMullan et al., 2018; Potter, 2015). Previous studies showed that the

suitability of hearing related information could be improved to ‘superior’ by following best-practice formatting guidelines (Caposecco et al., 2011; Ming & Kelly-Campbell, 2018). Other studies (Convery et al., 2011; Sakai, 2013) also demonstrated that revising hearing related information using suitability factors as a guide led to increased comprehension of information by participants. This shows that while online NIHL information is not currently suitable for readers, it likely can be improved to ‘superior’ suitability by following best-practice formatting guidelines.

SAM factors that were overall ‘adequate’ or ‘superior’ were: purpose, writing style, context, advance organisers, cover graphic, type of illustrations, graphics, typography, layout, modelling of behaviours, and motivation. SAM factors that were overall ‘adequate’ or ‘superior’ but also rated as ‘not suitable’ by 25% or more were: content topics, vocabulary, relevance of illustrations, captions, subheadings and chunking, and cultural images and examples. SAM factors that were overall ‘not suitable’ were: summary, RGL, and interaction. This is especially concerning as ‘not suitable’ ratings for RGL or cultural appropriateness suggest that information will be unsuitable, regardless of overall SAM score (Doak et al., 1996).

Suitability of online NIHL information is important as simply providing readable information does not guarantee that information will provide effective education about the prevention of NIHL. Information that is suitable promotes self-efficacy by motivating individuals and increasing their health knowledge and skills (Bandura, 1990). It models how health knowledge can be translated into desirable behaviours (Bandura, 1990). A. McMullan et al. (2018) demonstrated that self-efficacy was improved when hearing related information was improved in suitability. Self-efficacy is an essential component of NIHL prevention as individuals are required to make complex changes to their behaviours, such as the consistent use of HPDs.

4.3.1 Strengths and Weaknesses Identified by SAM

4.3.1.1 Content

The factors comprising content were: purpose, content topics, and summary or review. All information assessed stated the purpose of information in the title, cover illustration, or introduction either explicitly or implicitly. Stating the purpose guides readers through information to minimise the risk of missing key objectives.

Half (50%) of the information had content topics that were rated as ‘adequate’ as they focussed on desirable behaviours for at least 40% of the content. Only a small percentage (13%) of information had a strong focus on desirable behaviours throughout. A ‘not suitable’ rating was found in 38% of information due to a focus on non-behaviour facts. This means approximately half of online NIHL information could improve its focus on desirable behaviour topics. Individuals are less likely to make inferences about desirable behaviours when information focuses on facts, especially if they have low health literacy (Doak et al., 1996). The majority (94%) of information did not include a summary or review. This is an easy area for improvement to promote understanding and retention of information.

4.3.1.2 Literacy Demand

The factors comprising literacy demand were: RGL, writing style, sentence construction, vocabulary, and advance organisers. The majority (94%) of information had readability that exceeded the recommended sixth RGL and was above the eighth RGL.

The majority of information used sentence construction (81%) and advance organisers (91%) that were rated as ‘superior’. Sentence construction involves providing the context before presenting new information. This is an important part of teaching new information as individuals are more likely to learn when they can relate new facts to familiar knowledge (Doak et al., 1996). Advance organisers is the use of headings and captions. This helps guide

individuals through information and uses partitioning to promote interest and understanding. Writing style was rated as ‘superior’ for 38% of information and approximately half (53%) was ‘adequate’. This factor can be improved to promote motivation and understanding, especially for individuals with low health literacy.

Half (50%) of the information used vocabulary that was rated as ‘adequate’. Over one quarter (28%), however, was rated as ‘not suitable’. This means uncommon words and jargon were used extensively and technical, concept, category, and value judgement words were used without explanation or examples. These words are difficult and hinder understanding, especially for individuals with low health literacy.

4.3.1.3 Graphic Illustrations

The factors comprising graphic illustrations were: cover graphic, type of illustrations, relevance of illustrations, graphics, and captions. The majority (67%) of illustrations were rated as ‘superior’ for type. A large percentage of cover graphics (78%) and graphics (60%), however, were rated as ‘suitable’. Cover graphics need to be friendly, attract attention, and clearly portray the purpose of information to promote reader interest. Graphics were often presented with directions that were too brief. Clear explanatory directions are needed for graphics to have the best possibility of improving self-efficacy. They can be used to clearly model desirable health behaviours.

Half (50%) of the information was rated as ‘adequate’ for relevance of illustrations and just under half (47%) was rated as ‘not suitable’. The majority of information had either insufficient or no use of illustrations. Illustrations promote understanding of information, especially when used to replace hard to read text. Nearly half (43%) of information was rated as ‘adequate’ for use of captions. Over one third (35%), however, was rated as ‘not suitable’.

This means brief or no captions were used extensively. Explanatory captions are necessary to help individuals understand the purpose of graphic illustrations.

4.3.1.4 Layout and Typography

The factors comprising layout and typography were: typography, layout, and subheadings and chunking. The majority (94%) of information used typography that was rated as 'superior'. This involves the use of type size and fonts to promote legibility. One quarter (25%) of information was rated as 'superior' for layout, however, a large percentage (66%) was only rated as 'adequate'. Layout has a significant impact on the understandability and suitability of information. The majority of web pages rated poorly on layout because visual cueing was not used to direct attention to key content, pages appeared cluttered, line length was longer than 30 to 50 characters and spaces, illustrations were not adjacent to related text, and layout and sequence of information was inconsistent. These changes can be easily made to improve suitability. Over half of information was rated as 'adequate' (31%) or 'not suitable' (25%) for subheadings and chunking. This means that seven or more items were presented without a subheading. Chunking is important for retention of information as the average individual is unable to remember more than seven independent items (G. A. Miller, 1994).

4.3.1.5 Learning Stimulation and Motivation

The factors comprising learning stimulation and motivation were: interaction, modelling of behaviours, and motivation. Over half (53%) of information was rated as 'superior' for modelling of behaviours. Over one third (34%), however, was rated as 'adequate'. Explicitly modelling health behaviours using clear common language reduces the likelihood that individuals will make inferences from health information. This is especially true for individuals with low health literacy.

The majority (78%) of information was rated as ‘superior’ for motivation. Information was partitioned to promote motivation and understanding of complex information. The majority (88%) of information was rated as ‘not suitable’ for interaction. Neither active interaction, such as problems and questions for reader response, or passive interaction, such as question and answer format to discuss problems and solutions, were provided. Asking individuals to solve problems and make choices enhances retention of information in long-term memory (Jonassen, 1982).

4.3.1.6 Cultural Appropriateness

The factor comprising cultural appropriateness was: cultural images and examples. Over half (56%) of information was rated as ‘adequate’. However, just under half (41%) was rated as ‘not suitable’. Information that is not culturally appropriate is likely to be rejected by members of the target audience (Doak et al., 1996). Negative depictions of NIHL included the use of negative words such as “suffer” and referring to NIHL as a “devastating disability”, “disease”, or “disorder”. Information that increases anxiety of readers decreases self-efficacy (Bandura, 1977). Only one web page used positive language such as, “hearing loss is not something you should hide or be ashamed of”.

4.4 Region and Type of Organisation

This study found that there were no significant differences in readability of web pages based on their region or type of organisation. There are differences in the findings of previous research about readability of information from different types of organisations. Potter (2015) and Manchaiah et al. (2017) found no significant differences in readability of online hearing-related and tinnitus information and the type of organisation respectively. In contrast, Fitzsimmons, Michael, Hulley, and Scott (2010) analysed web pages about Parkinson’s disease and found that commercial websites had significantly lower readability than non-

profit websites. Johnson (2017) also found that web pages of a commercial origin had lower readability than web pages of a government origin.

The results of this study did not reflect the findings of previous studies assessing the suitability of information based on type of organisation. Cheng and Dunn (2015), Kieran, Skinner, Donnelly, and Smyth (2010), and Laplante-Lévesque et al. (2012) found online information developed by non-profit organisations had higher suitability than other origins. In contrast, Potter (2015) found that web pages from a commercial origin had significantly higher suitability than web pages from non-profit origins.

Information that is created by government agencies and medical organisations is perceived as more trustworthy by individuals seeking online health care (Pletneva et al., 2011). This information is perceived as more accurate. Accuracy of health information, however, was not assessed in these studies of readability and suitability. Information that has low readability or superior suitability can negatively impact health behaviours and outcomes if it is inaccurate. It is important to determine if information is accurate and unbiased (Manchaiah et al., 2017) and not make assumptions about information from certain types of organisation without this evidence.

4.5 Readability and Suitability

The results of this study found a significant correlation between mean RGL and SAM scores. The readability of online NIHL information required an average of 12 to 13 years of education and the suitability was ‘adequate’. This shows there is a need for separate analysis of readability and suitability.

The creators of the SAM, Doak et al. (1996) reported that if readability is high then suitability is usually low. It is known that appropriate readability of information can be achieved without compromising quality (Laplante-Lévesque et al., 2012). This suggests that

both readability and suitability of health information can be improved to facilitate comprehension. Both the readability and suitability of online NIHL information needs to be appropriate to promote understanding and desirable health behaviours.

4.6 Clinical Implications

It is known that NIHL is prevalent and many individuals may be unaware of the risks of noise on their hearing (Beach et al., 2013). Many individuals use the Internet to search for health-related information and perceive this information as influential in their decision-making (Couper et al., 2010). Individuals with HL are more likely to access online health information because of their chronic and stigmatising health condition (Wallhagen, 2009). This means it is likely that individuals who are at risk of or have NIHL will access the Internet for information about their condition. Education about the risks of excessive noise and consistent use of HPDs are important for hearing protection interventions. Online NIHL information has the potential to educate a diverse range of individuals. It will only be effective, however, if it is readable and suitable. The findings of this study suggest that online NIHL information has high readability and adequate suitability. This reflects general findings about the readability and suitability of online health related information. Online NIHL needs to be improved, and there is a role for both web developers and audiologists.

4.6.1 How to Improve Online NIHL Information

Table 3 provides recommendations about the how the suitability of online NIHL information can be improved to achieve a ‘superior’ rating.

Table 3. *Recommendations for Improving Suitability of Online NIHL Information.*

SAM Factor	**Recommendation**
Content	
Purpose	Explicitly state the purpose in the cover. Use headings and descriptive subheadings that indicate what topics will be discussed.
Content topics focus on behaviours	Focus information on desirable behaviours about prevention of NIHL, including minimising exposure to excessive noise and use of HPDs, rather than pathophysiology of NIHL.
Summary or review	Include a summary that reviews key objectives of information. Ideally in bullet-point format with no more than five items.
Literacy Demand	
RGL	Write information at least at the sixth RGL to promote understanding.
Writing style	Write information in conversational style using active voice to promote interest. Use simple sentences consistently while maintaining cohesion.
Sentence construction	Provide context before new information is taught. This is especially important when teaching desirable behaviours about NIHL prevention.
Vocabulary	Avoid the use of jargon and uncommon words. Jargon that is specific to NIHL and necessary for management should be defined using common words and repeated to promote understanding. For example, different styles and types of HPDs. Define and quantify technical and value judgement words. For example, quantify excessive noise levels in dB and provide examples of everyday activities that correspond.

Advance organisers	Precede information by descriptive headings or topic sentences to introduce new information.
Graphic Illustrations	
Cover graphic	Include a cover graphic that is friendly, attracts attention, and portrays the information's purpose. Avoid negative images of NIHL.
Type of illustrations	Use simple illustrations that are appropriate for adults. Prefer line drawings that are familiar to readers to photographs.
Relevance of illustrations	Use illustrations that promote understanding of key information and replace long or hard to read text. For example, images of different styles and types of HPDs.
Graphics	Promote self-efficacious behaviour with graphics. Graphics require directions on how to achieve desired behaviours. For example, a chart about how to match listening needs to the appropriate HPD.
Captions	Accompany illustrations and graphics with captions to explain content and purpose. They should direct readers' attention.
Layout and Typography	
Typography	Use sentence case and avoid all caps. Font should be at least 12-point, but 14-point is preferable. Typographic cues should be used to direct attention.
Layout	Promote understanding and motivation with layout. For example, use white space to reduce clutter, line lengths of 30 to 50 characters and spaces, illustrations adjacent to related text and not below, and visual cues to direct attention.
Subheadings and chunking	Chunk information with subheadings. No more than five items should be presented without a descriptive subheading.
Learning Stimulation and Motivation	

Interaction	Ask readers to interact with information to promote understanding. Present problems to solve and choices to make. For example, ask readers to choose appropriate HPDs based on their lifestyle and provide feedback about appropriateness.
Modelling of behaviours	Use familiar and specific language to model behaviours about how to prevent NIHL. Use the pronoun 'you' to make direct statements about desirable health behaviours.
Motivation	Subdivide information to promote self-efficacy. For example, split information about HPDs into categories so readers can experience small successes throughout their learning.
Cultural Appropriateness	
Cultural images and examples	Use positive images and words to portray NIHL. Avoid negative images and words. For example, avoid images of people wincing in pain from noise and avoid words such as "suffer" and "disorder".

4.6.2 Recommendations for Web Developers

Web developers should follow the three key stages outlined in best-practice formatting guidelines: planning, development, and verification. First, information should be planned by determining the intended target audience and the key objectives that are most important for these individuals to know. Planning should specifically consider the needs of individuals with low health literacy. Secondly, information should be developed with a focus on maximising suitability. This ensures information will have the highest level of suitability and the greatest chance of promoting self-efficacy. It avoids the risk of developing information that has unsuitable readability and/or cultural appropriateness that would not be understandable and may be rejected by individuals from the target audience. This involves using readability formulas to predict RGL. Finally, the suitability of information should be

verified by user testing and the SAM tool. Revisions should be made based on the feedback provided.

Web developers have a responsibility to design online health information that is accessible and comprehensible to a diverse range of individuals. Consumers value information that is trustworthy, accurate, accessible, and easy to navigate (Pletneva et al., 2011). According to Kreps and Neuhauser (2010), developing effective online health information can be achieved by utilising the following factors. Firstly, information should use interactive communication to promote understanding and retention of information. Information should also be accessible across different media platforms and be suitable for a diverse range of individuals. Finally, information should engage the interests and emotions of individuals to motivate them to take an active involvement in their health care. Web developers should also consider the order of information. Order should reflect the content topics for which individuals are searching the Internet. This is information about health conditions and management followed by information about symptoms (Shuyler & Knight, 2003). Presenting information that matches the needs of individuals will motivate individuals and maximise the effectiveness of health information.

4.6.3 Recommendations for Health Care Professionals

Health care professionals need to use clear communication to facilitate learning of health information (Kickbusch et al., 2006). Individuals forget 40 to 80% of healthcare information immediately after it is provided by health care professionals (Kessels, 2003). Retention of health information is often poor and inaccurate, especially when individuals have reduced memory function due to age, high anxiety and stress levels, or they do not perceive the information as important (Kessels, 2003). This is true for some individuals with HL, as they tend to have poorer episodic and semantic long-term memory (Rönnberg et al., 2011). Health care professionals often use jargon and communicate more information than

individuals can process (Houts et al., 2006). The language of audiologists was also found to be unsuitable (Nair & Cienkowski, 2010). Health care professionals should avoid jargon and talk at slower rate to promote comprehension (Safeer & Keenan, 2005). Verbal information should be supplemented with written health information (Safeer & Keenan, 2005).

Written health information promotes understanding as individuals are able to review information. However, this means health care professionals need to have the skills to assess the readability and suitability of online health information, so they can direct individuals to suitable information. It is known that individuals ask their health care professionals about health information they find online (Bylund et al., 2007). They feel validated and less anxious when their health care professionals acknowledge the information found and answer their questions (Bylund et al., 2007). Again, health care professionals need to be able to evaluate the readability and suitability of online health information, so they can evaluate the suitability of information found by clients (M. McMullan, 2006). Over time, this assessment process would give health care professionals a list of web pages they can confidently recommend to their clients. They can also make modifications to existing information they use clinically to ensure low readability and 'superior' suitability.

4.7 Limitations of Readability Formulas

It is important to note that readability only measures one aspect of comprehension (Moult et al., 2004). It cannot be assumed that information that matches the RGL of readers will be understandable (Pichert & Elam, 1985). Readability estimates need to be interpreted with an understanding of their intended purpose and their limitations (Bailin & Grafstein, 2001).

Readability formulas measure quantitative information about sentences and words, but not qualitative factors about the quality and suitability of content (Redish, 2000). They

are based on a set of linguistic assumptions (Bailin & Grafstein, 2001). They assume that short and common words are an adequate indicator of difficulty (Kandula & Zeng-Treitler, 2008). Long words do require more reading effort and long sentences can contain complex grammatical structures that need to be retained in short-term memory before meaning can be interpreted (McLaughlin, 1969). However, these factors alone do not predict comprehension (Pichert & Elam, 1985). For example, certain words are considered readable by formulas as they are short but are difficult to understand, such as 'cochlea' (Greywoode et al., 2009). Also, certain medical jargon cannot be substituted for shorter words as they are central to the healthcare process, especially for chronic conditions (Pichert & Elam, 1985). These jargon words will become familiar to individuals as they are exposed to the word during their healthcare (Pichert & Elam, 1985).

Formulas do not address the interactive nature of reading (Meade & Smith, 1991). There can be a lack cohesion between short sentences, which can be more difficult to understand (Bailin & Grafstein, 2001). Short sentences may also distort the intended meaning (Pichert & Elam, 1985). Longer sentences that show relationships between ideas and clearly sequence information are more cohesive and easier to understand (Bailin & Grafstein, 2001). Reducing long sentences into shorter sentences may require readers to make inferences about information which increases cognitive effort and can increase chance of misinterpretation (Pichert & Elam, 1985). Written information that has short sentences, but has low cohesion, will have an adequate RGL but will be less accessible than text that has longer sentences but higher cohesion (Kandula & Zeng-Treitler, 2008).

Readability formulas do not consider the personal factors of readers. Readability estimates can be misleading as they assume that all individuals are alike and do not account for individual characteristics (Redish, 2000). This includes their background knowledge, their

levels of interest and motivation, and their interpretation of information (Meade & Smith, 1991; Moult et al., 2004; Pichert & Elam, 1985).

Readability formulas were designed to estimate RGL and not as a criterion to make information more readable (Irwin & Davis, 1980). They should not be used as a writing guide as writing health information to fit the formulas focuses on the structure and not the content of information (Pichert & Elam, 1985). Revision should not be based on achieving low readability as comprehension is more complex than readability alone (Klare, 1976). A low RGL does not guarantee understandable and effective information (Redish, 2000). Readability formulas should be used to identify written information with high RGLs that require revision (Redish, 2000). They should be used to supplement assessments of the suitability of health information (Doak et al., 1996; Pichert & Elam, 1985).

4.8 Study Limitations and Future Research

The search strategy used in this study was carefully planned but it may be different to how consumers search for NIHL information online. Consumers spend, on average, only one minute on each web page (Eysenbach & Köhler, 2002). The researchers, however, systematically assessed each web page for a longer period. Also, consumers are unlikely to use search terms that consist of more than one word (Eysenbach & Köhler, 2002). The researchers used search terms that were three and four words. These search terms were identified by a sample group, but consumers may use different search terms. Finally, the researchers and sample group were not looking for health information that had a direct impact on their health, unlike consumers who search about health conditions they or a significant other have. Consumers for which the outcome of their search would have a greater impact on their health may change their search strategy or search terms (Eysenbach & Köhler, 2002). Future research could use consumers to perform the search and determine whether they are able to access helpful information. This would allow for interpretation about what consumers

encounter when they search for information and how well they interpret the information they find. This could include a comprehension test.

The search only used one common search engine (google.com). Also, only English information was assessed. These choices where necessary due to the scope of the study, but this does not represent all search methods or search engines. It may also have missed web pages in other languages. This means the sample size would not be a full representation of the range of NIHL information available online. It also means the findings are only specific to English speaking cultures. Future research could assess online NIHL using different search engines and information in other languages.

While the SAM tool is validated, scoring does have a subjective component for most criteria (Nasser, Mullan, & Bajorek, 2012). This may have introduced some variability in the scoring. However, the inter-rater agreement for suitability scores was found to be high. This study only used two measures of quality (SAM and HONcode). The HONcode was removed from hypothesis testing due to the lack of web pages that used this certification. Future research could use other quality measures, such as the DISCERN, that do not rely on web developers to apply for quality certification. Future research could also assess the accuracy of online NIHL information as this is an important component to determine the appropriateness of information.

The information available on the Internet changes regularly. The findings of this study were valid at the time of assessment but are subject to change as information is updated online. It is unlikely that the high readability and ‘adequate’ suitability found would change significantly in a short period of time. Also, as this study only assessed online NIHL information, the readability and suitability of printed information could also be assessed.

Studies could assess the readability and suitability of hearing protection programmes including both verbal counselling and written education.

Finally, the focus of future research could shift towards improving online NIHL information. This can be done by following best-practice formatting guidelines and user verification. The readability and suitability of revised information would be assessed. Revised information could then be made available for audiologists and the public.

4.9 Conclusions

The Internet is an important tool for accessing health information. The effectiveness of online health information, however, is determined by its readability and suitability. Accessible education is an important aspect of the prevention of NIHL. Online NIHL information was found to have high readability and ‘adequate’ suitability. There is a need for the development of readable and suitable online NIHL information to educate individuals about the risks of excessive noise and the importance of protecting hearing.

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