Readability, Suitability, and Quality of Online Information in English on Single-Sided Deafness

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Abstract

Purpose: This study investigated the readability, suitability, and quality of online Single-Sided Deafness (SSD) information available in English.

Method: Four search terms ("Deaf in one ear", "Can't hear in one ear", "One sided hearing", and "Loss of hearing in one ear" were searched for using 21 country specific Google domains. Of each domain, the first ten relevant webpages were selected. Their country of origin, type of organisation that published them and whether HONcode certification was present or not was recorded. In total, 63 webpages were assessed after duplicates and irrelevant webpages were removed. Readability was measured with the SMOG, FOG and F-K formulas, suitability was measured with the SAM+CAM, and quality was measured with the PEMAT, DISCERN, and a plain language checklist.

Results: Online information on SSD was found to have high readability levels, and adequate suitability levels. Levels of content quality were shown to be moderate by DISCERN, with moderate to superior levels for understandability and poor to moderate actionability as shown by PEMAT. Content had good plain language use as shown by the plain language checklist. Neither country of origin nor organisation type had a significant effect on readability, suitability, or quality.

Conclusions: Access to quality information on SSD can have an effect on patient understanding and health outcomes, therefore this information must be useful and cater to a broad audience. The usefulness of online information on SSD can be indicated by readability, suitability, and assessment of the quality of its content. There is a need for revision of existing online information on SSD and/or development of new material that is readable, suitable, and of good quality. This is necessary to facilitate education on causes, symptoms, and appropriate treatment options for SSD and to encourage taking action towards good health outcomes.

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Introduction

1.1 Hearing Loss

In normal hearing, sound vibrations travel from the outer ear, through the middle ear, to the inner ear and activate auditory nerve fibres (Alshuaib, Al-Kandari, & Hasan, 2015). These fibres transmit neural signals to the brain which processes these as sound (Alshuaib et al., 2015). There are two main types of hearing loss: Conductive hearing loss (CHL) and sensorineural hearing loss (SNHL) (Alshuaib et al., 2015). Conductive hearing loss impedes sound from passing to the inner ear from the outer ear due to a problem anywhere between the external ear canal to the footplate of the stapes (Alshuaib et al., 2015; Fook & Morgan, 2000). Examples of conductive hearing losses are ossicular chain fixation and perforation of the eardrum (Fook & Morgan, 2000). Sensorineural hearing loss originates from the inner ear (cochlear), the auditory nerve, or more rarely the central neural pathways (Alshuaib et al., 2015; Fook & Morgan, 2000). Hearing loss can also present as a mixed hearing loss which is a combination of both CHL and SNHL (Alshuaib et al., 2015; Fook & Morgan, 2000). Hearing loss is present when an individual has hearing thresholds worse than 25 dB HL and therefore has a partial ranging to total inability to hear sound in one or both ears (Alshuaib et al., 2015; World Health Organisation, 2019).

Hearing loss itself is not a visually obvious disorder, however its impacts affect over 5% of the world's population (World Health Organisation, 2019). While the majority of individuals who have a disabling hearing loss are adults, where one third of which are over 65 years of age, people of all ages can be affected (Alshuaib et al., 2015; World Health Organisation, 2019).

Hearing loss results from congenital or acquired causes. These include aging, noise exposure, exposure to ototoxic drugs, genetic inheritance, birth complications, physical trauma, and certain infectious diseases (Alshuaib et al., 2015; World Health Organisation,

2019). It can present in a number of different ways and varies from person to person. For example, there are variations in whether one or both ears are affected, the severity of the loss, the frequencies that are affected, and the stability of the loss (Alshuaib et al., 2015).

There are various debilitating impacts that hearing loss can have on quality of life. Hearing losses can cause significant social, emotional, and communicative handicaps, even if they are only at a mild level of severity (Mulrow et al., 1990). Not only can individuals with hearing loss be negatively affected, communication partners can experience negative impacts also (Kamil & Lin, 2015). Spouses can experience communicative difficulties, emotional consequences, negative impacts on social lives, and needing to adapt to their partners hearing impairment (Scarinci, Worrall, & Hickson, 2008) Interestingly, two individuals with the same degrees of hearing loss will often have very different impacts on their lives as individuals experience hearing loss differently (Demorest & Erdman, 1998).

1.2 Single Sided Deafness

Single sided deafness (SSD) is the presence of normal hearing in one ear and no functional hearing in the other (Weaver, 2015). Unlike unilateral hearing loss, where residual hearing is still present in the affected ear, SSD thresholds are greater than 90 dB HL in the affected ear (Cire, 2012). There is no clear statistic on prevalence of this disorder, as the literature often does not differentiate between SSD and unilateral hearing loss. SSD may arise from genetic inheritance, structural abnormalities, syndromes, head injuries, illnesses, infections, and more (Weaver, 2015).

For individuals with normal hearing, the timing and intensity of sounds reaching each ear gives information about the position of the source of sound (Middlebrooks & Green, 1991). For example, a source of sound to the left of a listener will result in the sound waves reaching the left ear before the right ear. The sound will also be at a higher intensity in the

left ear than the right as there is more distance between the right ear and the sound source and the head acts as a barrier to the sound to reaching the right ear. These time and volume differences provide information for the brain to localise a sound source (Middlebrooks & Green, 1991).

There are other specific advantages to having two functional ears which are absent in individuals with SSD such as binaural squelch, binaural loudness summation, and binaural redundancy. Binaural squelch is a central auditory process where the listener can use the timing and intensity differences between ears to better understand speech in noise (Balkany & Zeitler, 2013). Signal to noise ratio is the comparison of the level of a desired signal to the level of background noise (Welvaert & Rosseel, 2013). When spatial separation of a target signal and noise is present, the use of two ears allows the listener to shift their attention to the ear with the better signal to noise ratio (Balkany & Zeitler, 2013; Zurek, 1993). For individuals with SSD, the lack of hearing in one ear results in binaural cues from time and intensity differences of sound between ears to be absent, as comparisons between ears cannot be made (Lucas, Katiri, & Kitterick, 2018). Sounds reaching the impaired ear first results in the sound being partially absorbed and diffracted before it reaches the normal hearing ear (Lieu, 2013; Lucas et al., 2018).

Binaural loudness summation is the increased perception of loudness that occurs with two functional ears as opposed to hearing with only one ear (Reynolds & Stevens, 1960). If monaural thresholds of each ear are equal in terms of sensation level, the binaural threshold will be approximately 3 dB better than the monaural thresholds on their own (Keys, 1947; Shaw, Newman, & Hirsh, 1947). Perception of loudness of sounds above detection thresholds are 6-10 dB higher with two ears compared to one (Haggard & Hall, 1982).

Having two functioning ears also facilitates binaural redundancy. This means that information from sound is received twice, once by each ear, meaning the auditory system has

two opportunities to obtain and process information (Ching, van Wanrooy, Hill, & Dillon, 2005). Hearing with only one ear results in a lack of redundancy and therefore poorer speech perception (Ching et al., 2005).

1.3 Impacts of Single-Sided Deafness

From the physiological differences and difficulties caused by SSD arise a range of psychological and psychosocial problems (Lucas et al., 2018). The lack of binaural hearing and the diffraction of sound waves around the head prior to reaching the hearing ear caused by SSD can negatively affect auditory processing and speech understanding in noisy environments (Lieu, 2013; van Wieringen, De Voecht, Bosman, & Wouters, 2011). It also negatively affects sound localisation abilities as the listener cannot compare sound characteristics between ears (Humes, Allen, & Bess, 1980). Reportedly, these impacts can in turn lead to withdrawal from social situations, embarrassment, and feeling like one is unable to participate socially (Douglas, Yeung, Daudia, Gatehouse, & O'Donoghue, 2007; Lucas et al., 2018). Some individuals also experience anxiety about losing hearing in their functional ear (Lucas et al., 2018). In children, such difficulties can result in delayed oral language acquisition, decreased academic performance, delayed verbal intelligence skills, and lack of control in challenging listening environments with irrelevant verbal information (Borg et al., 2002).

1.4 Treatment of Single-Sided Deafness

There are a number of ways to manage the impacts of SSD, one of which is using contralateral routing of signals through air or bone conduction (CROS) (Peters, Smit, Stegeman, & Grolman, 2015). This technology utilises a device that reroutes sound from the impaired ear to the non-impaired ear through a receiver transmitting to an earphone or

hearing aid presenting the sound to the hearing ear (Peters et al., 2015). This can be done through air conduction or through a bone-anchored hearing aid, through which the sound is vibrated through the skull to the functioning cochlea (Peters et al., 2015). When the signal to noise ratio is better (signal is louder) at the impaired ear, speech perception in noise can be improved using a CROS as the user is given access to those sounds (Lucas et al., 2018). In a study by Christensen, Richter, and Dornhoffer (2010) paediatric participants with SSD could only score 42% on the Hearing in Noise Test (HINT) when the signal to noise ratio was zero. After they were implanted with bone-anchored hearing aids, the HINT scores improved to 82% for the same signal to noise ratio (Christensen et al., 2010).

Another method of managing SSD is through the use of cochlear implants as they can provide interaural cues (Lucas et al., 2018). The user can transition from unilateral to bilateral hearing and therefore have some restoration of the benefits of binaural hearing as well as possible suppression of tinnitus (Arndt et al., 2011). The user must integrate acoustic and electric information to improve localisation and speech understanding in noise (Lucas et al., 2018). In order for this to be a viable option, the user must have functioning cochlear nerves. With cochlear implantation, there is an element of time sensitivity to increase chances of benefit. In SNHL, the lack of hair cell stimulation results in sensory deprivation of the auditory nerve, resulting in its degeneration (Burdo, Razza, Di Berardino, & Tognola, 2006; Shepherd & Hardie, 2001). The longer SSD or other hearing losses are left untreated, the more likely there is to be degeneration in the auditory neural pathways for spatial sensitivity (Gordon, Henkin, & Kral, 2015) and temporal processing (Fallon et al., 2014) also. This means there is great variability of listening abilities between patients after cochlear implantation in part depending on the length of sensory deprivation (Blamey et al., 2012). Another important factor is early implantation to facilitate language acquisition. Paediatric

patients do significantly better at growing expressive language skills when implanted earlier, as shown by the comparison study by Tomblin, Barker, Spencer, Zhang, and Gantz (2005).

These treatment options have a significant level of complexity when it comes to learning how they work, the benefit they may provide, and risks associated with them. As knowledge of these are likely have great effects on one's quality of life, decision making on treatment options for SSD requires sufficient understanding of each option. This education is likely to be done in part through searching of online information.

1.5 Health Literacy

There are various barriers to accessing and retaining information in the health setting such as age-related memory ability, anxiety, perceived importance of information, and mode of information delivery (Kessels, 2003). It is estimated that only one quarter (Protheroe & Rowlands, 2013) to one half (Kessels, 2003) of information given to a patient during a consultation is remembered correctly. This therefore enables poorer health outcomes (Kessels, 2003). One way to combat this is through the use of supplementary written information (Kessels, 2003). However, the communicative ability of written information is burdened with another barrier of its own: Low health literacy.

Literacy refers to a person's ability to read, write, speak, and solve problems ("Public Law 102-73," 1991). Health literacy is the level at which individuals are able to access, process, and comprehend health information in order to make good health decisions (Beauchamp et al., 2015; Nutbeam, 2000; Services, 2000).

Health literacy has also been divided into three classifications of functional health literacy, interactive health literacy, and critical health literacy by Nutbeam (2000). Functional

health literacy refers to the basic skills needed for reading and writing to function in day to day situations (Nutbeam, 2000). Interactive health literacy includes functional health literacy with the addition of more advanced cognitive and literacy skills for gaining information and meaning from different mediums of communication and the application of this to different circumstances (Nutbeam, 2000). Finally, critical health literacy involves advanced cognitive skills that are used for critical analysis of information and using it to manage situations and life events (Nutbeam, 2000).

Not only are health literacy levels associated with literacy ability itself, but also by social and economic circumstances (Nutbeam, 2000) as well as education level, age, and ethnicity (Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, & Rudd, 2005). Protheroe and Rowlands (2013) found that approximately 43% of adults in the United Kingdom are unable to use and understand health information. In the United States, over 30% of people would have difficulty with completing common health tasks, such as following directions on a medication label (U.S. Department of Health & Human Services, 2008). A survey by the Ministry of Health/Manatū Hauora (2010) showed that the majority of New Zealanders had low literacy, especially individuals between the ages of 16 to 18 and above the age of 65. Low literacy was more typical among males, the unemployed, those with low socioeconomic status, and a high school education or less. It was also significantly higher among Māori than non-Māori (Ministry of Health/Manatū Hauora, 2010).

Individuals with low health literacy tend to have less knowledge about their illness, have more emergency care visits, and have poorer health outcomes in general (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011). Preventative healthcare measures such as vaccinations and screening tests are pursued less in individuals with low health literacy also (Berkman et al., 2011). This is because these individuals lack the skills needed to adequately

pursue their health needs (Nutbeam, 2006). Lower health literacy results in less confidence (Bodie & Dutta, 2008) and reduced ability (Berkman et al., 2011) for accessing online health information. These consequences require the need for accessible and understandable health information (U.S. Department of Health & Human Services, 2008).

1.6 Sources of Health-Related Information for Consumers

Traditionally, alongside healthcare providers, mass media such as television and print media have been main sources of health information (Flay, DiTecco, & Schlegel, 1980). Healthcare providers, print media, and community organisations as health information sources are associated with increased likelihood of following recommended preventative health behaviours such as non-smoking, exercise, and fruit and vegetable intake (Redmond, Baer, Clark, Lipsitz, & Hicks, 2010). Increasingly, people are using the internet to gather health related information.

In a study by Hesse et al. (2005) it was shown that 63.7% of the online American population had looked at health information online in the past 12 months. To patients, physicians are reported to be the most highly trusted source of health information. Despite this 48.6% of people reportedly went online first, while 10.9% went to their physician first (Hesse et al., 2005). The practicality, cost effectiveness, ease of access and facilitation of anonymity of the internet incentivises the public to access health information online (Cline & Haynes, 2001). This information can be used to provide answers on health concerns, whether there is a need to seek medical attention based on these concerns, and treatment options. One in three adults use the internet to diagnose or learn about a health concern in the US (Fox & Duggan, 2013). However, it has not replaced information from healthcare professionals, rather, it is used to gain supplementary information to that from healthcare professionals

instead (Couper et al., 2010). Many people turn to the internet for health information in order to gain different perspectives from traditional sources such as healthcare practitioners, books, brochures, and more to supplement this information or find alternatives due to unsatisfactory doctor-patient interactions (Rains, 2007). Online health information also aids individuals to ask questions and make informed decisions with their health care practitioners (Baker, Wagner, Singer, & Bundorf, 2003). It is also useful in helping individuals take an active rather than passive role in their healthcare (McMullan, 2006). Not only is online health information sought out by patients, but healthcare professionals can guide their clients to relevant online information also to supplement their verbal information (Wilson, Baker, Brown-Syed, & Gollop, 2000).

If the internet is an individual's first exposure to information on a health condition, the accessibility, suitability, quality, and readability of the information will influence that individual's next actions. If they are overwhelmed, misled, or unable to understand the information, this could have negative effects on their health outcomes. As it is a type of hearing loss, individuals with SSD have a stigmatising condition (Wallhagen, 2009). Therefore, they may be more likely to seek online health information as online information seeking is less intimidating than seeing health care professionals (Berger, Wagner, & Baker, 2005).

1.7 Readability of Online Health-Related Information

In order to have beneficial health information, it must have good readability (Bundorf, Wagner, Singer, & Baker, 2006; Shieh & Hosei, 2008). Readability is described as how easy written information is to read and be understood (Ley & Florio, 1996). When a piece of writing is at or below the reading level of the reader, readability improves (Dubay, 2004).

There are a number of ways to quantify readability. These are estimates that can be reported as reading grade levels (i.e., the number of years of education needed for a reader to understand the information) (Ley & Florio, 1996). They can also be reported as levels of difficulty based on a scale that can be compared to a reading grade level (Flesch, 1948). According to a number of studies, health materials should be at the sixth reading grade level or lower in order to be readable to most of the population (Doak, Doak, & Root, 1996a; Friedman, Hoffman-Goetz, & Arocha, 2006; Safeer & Keenan, 2005; Walsh & Volsko, 2008). It has been shown that more individuals with low health literacy are getting health information online but the majority of health information exceeds the sixth RGL (McInnes & Haglund, 2011; Walsh & Volsko, 2008). Therefore, it is possible that this is a trend for information on SSD also.

A variety of formulas exist which are used to calculate the readability of documents and are used frequently in healthcare (Ley & Florio, 1996). The Dale-Chall Formula, Simple Measure of Gobbledygook (SMOG), Flesch-Kincaid Grade Level (F-K), and the Flesch Reading Ease (FRE) are among those commonly used (Ley & Florio, 1996). As there are many different formulas, using more than one to calculate an average RGL increases the reliability of the score (Ley & Florio, 1996).

The FOG which was developed by Gunning (1952) calculates the average sentence length and the percentage of hard words (words of three or more syllables that are not proper nouns, combinations of easy or hyphenated words, or two-syllable verbs made into three with -es and -ed endings). These are added together and multiplied by 0.4. A score of seven or eight corresponds to an ideal score on the scale. The threshold for comprehension for the FOG was 90% for an average person at a given grade level (Gunning, 1952).

The SMOG, developed by McLaughlin (1969), takes ten sentences near the beginning

of a text, ten in the middle, and ten and the end. All words with three or more syllables within these 30 sentences are summed and the square root of the sum is calculated. The result is rounded to the nearest ten and three is added to give a polysyllabic word count. This result is compared to approximate grade levels. For example, a total polysyllabic word count of 1-6 corresponds to readability at the 5th grade level. The criteria for comprehension was 100% for an average individual at a given grade level for the SMOG (McLaughlin, 1969).

The F-K was modified from the Flesch Reading Ease formula (Flesch, 1948) by Kincaid, Fishburne, Rogers, and Chissom (1975). It is used to calculate the average number of words per sentence and the average number of syllables per word. The average number of words is multiplied by 0.39 and the average number of syllables is multiplied by 11.8. These are then added together and 15.59 is subtracted from the result. The resulting score corresponds to a grade school level. For example, a score of 5.0 indicates that a fifth grader would be able to read the material. The criteria for comprehension was 75% for an average individual at a given grade level (Kincaid et al., 1975).

The SMOG, FOG, and F-K have been validated using the McCall-Crabbs Standard Test Lessons in Reading (McCall, Crabbs Schroeder, & Starr, 1979). Students from different grade levels were tested by reading passages from this text and completing a set of multiple-choice questions. These test scores were used to determine estimates of RGL.

It has been found that for a variety of printed health materials, the reading grade levels have exceeded that which is suitable for the public despite the availability of guidelines for creating health information (Gal & Prigat, 2004). Davis, Crouch, Wills, Miller, and Abdehou (1990) evaluated the reading comprehension of patients in ambulatory care settings as well as readability of patient education materials found in each setting. These results were compared, and the researchers found a large discrepancy between the average levels of reading

comprehension and the reading grade levels needed for the materials. While reading comprehension levels averaged at the 6th grade, the patient education materials were mostly at the 11th to 14th grade with consent forms reaching college levels of comprehension ability (Davis et al., 1990).

Pothier, Day, Harris, and Pothier (2008) found that leaflets used in speech and language therapy departments tend to be too hard to read. They revised the material and evaluated the effect these revisions had on the readability of these materials. The mean FRE score was 59.5 for the unrevised material (fairly difficult) and 72.3 for the revised material (fairly easy). The mean F-K RGL for the unrevised material was 7.7 while the revised material was 5.5.

Douglas and Kelly-Campbell (2018) investigated the readability of patient-reported outcome measures used for audiologic rehabilitation for adults. They found that most of the sections within these outcome measures were above the 6th grade level. This has implications for the validity of the data collected using these materials (Douglas & Kelly-Campbell, 2018).

Nair and Cienkowski (2010) investigated the grade level of verbal and written language in hearing aid orientation appointments. They found that the language used in both counselling and written information was not suitable for the clients. This was because the RGL of the written material was 8 and the RGL of verbal information was higher than the predicted patient health literacy levels. This indicates a communicative disconnect between patients and clinicians where health literacy affects the benefit from counselling and instruction guides (Nair & Cienkowski, 2010).

Similar to printed health materials, online health information can be difficult to read also. Which is likely exacerbated by the public accessibility of information intended for

healthcare professionals (Gal & Prigat, 2004). Studies from various health-related fields have shown online health materials to be of poor readability. Information on cancer (Walsh & Volsko, 2008; Wilson et al., 2000) and more specifically breast cancer (Berland et al., 2001; Friedman et al., 2006), and prostate and colorectal cancer (Friedman et al., 2006) demonstrated RGLs ranging from 9.8 to 13.7. Similarly, information on otolaryngology related information (Eloy et al., 2012; Greywoode, Bluman, Spiegel, & Boon, 2009; Svider et al., 2013) endoscopic sinus surgery (Cherla et al., 2013) and facial reconstructive surgery (Misra et al., 2013) showed RGLs ranging from 6.6 to 18.2. Other health topics such as depression, obesity, and childhood asthma (Berland et al., 2001), and heart disease, stroke, chronic obstructive pulmonary disease, and diabetes (Walsh & Volsko, 2008) also show high readability levels. RGLs ranged from 9.85 to 13.2.

Hearing related health information online has also been shown to exceed the recommended reading grade levels. For example, information on hearing (Laplante-Lévesque & Thorén, 2015), audiology and speech language pathology (Atcherson et al., 2014), adults with hearing impairment and their significant others (Laplante-Levesque, Brännström, Andersson, & Lunner, 2012), otitis media (Pothier, 2005), ear tubes (McKearney & McKearney, 2013) and hearing aids (Joseph et al., 2016) had RGLs ranging from 2.6 to 18.8, the majority of which was over the 6th reading grade level.

The findings of these studies highlight the poor readability of online health information. This may cause frustration in individuals and result in incomplete reading of materials and therefore risk of misinterpreting or missing important information (Friedman et al., 2006). Readability is important for individuals to successfully obtain the information they need, however, readability of online SSD information has not been investigated.

1.8 Suitability of Online Health Related Information

The suitability of written material, determined by content and design, affects the amount of information the reader can access and understand (Shieh & Hosei, 2008). To write suitable material, authors need to consider a clear vision of the focus of the information and the intended audience (Shieh & Hosei, 2008).

Suitability can be assessed in a number of ways. One test, the Suitability Assessment of Materials (SAM), is a 22-item validated tool that examines content, literacy demand, illustrations and graphics, layout and typography, learning stimulation and motivation, and cultural appropriateness to identify limitations of the suitability of materials (Doak et al., 1996). This is done through rating each area as either superior (two points), adequate (one point), or not suitable (zero points). Using this tool, an overall rating for suitability for the target population is chosen where 0 = "NO. Definitely not recommended" and 10 = "YES.

An amended version of this tool called the Suitability Assessment of Materials + Comprehensibility Assessment of Materials (SAM + CAM) was created to include ease of use, inclusivity, and objectivity, and comprehensibility (Helitzer, Hollis, Cotner, & Oestreicher, 2009). With this version, a percentage score is derived from the sum of the item scores. Information achieving greater than or equal to 70% is classed as superior, equal to 40-69% as adequate, and equal to 0-39% as not suitable (Helitzer et al., 2009). If deficiencies are found, it suggests that changes need to be made in the form of correcting or supplementing information or changing the design (Doak et al., 1996a).

Various studies have assessed material using SAM. And shown health material to be 'adequate'. Resources for cancer caregivers (Monton, Lambert, Belzile, & Mohr-Elzeki, 2019), mastectomy and lumpectomy (Tran, Singh, Singhal, Rudd, & Lee, 2017), breast reconstruction (Vargas, Kantak, Chuang, Koolen, & Lee, 2015) and lymphedema (Tran,

Singh, Lee, Rudd, & Singhal, 2017) all demonstrated average mean suitability and had scores ranging from ‘not suitable’ (0%-39%) to adequate (40% - 69%).

Few studies found materials that reached ‘superior’ ratings on SAM. Patient education materials on chronic kidney disease (Morony, McCaffery, Kirkendall, Jansen, & Webster, 2017) demonstrated 42% of materials to be ‘superior’, however, 19% were ‘not suitable’. Information on colon cancer screening (Tian, Champlin, Mackert, Lazard, & Agrawal, 2014) only had one material show ‘superior’ suitability while the remaining 11 ranged from ‘not suitable’ to ‘adequate’.

SAM has been used on audiological material also. Suitability of hearing aid user guides was assessed using SAM In a study by Caposecco, Hickson, and Meyer (2014) which found 69% of brochures evaluated to be inadequate. A similar finding was reported by McMullan, Kelly-Campbell, and Wise (2018) who assessed a hearing aid user guide using SAM which indicated the guide to be ‘not suitable’.

Suitability of online health information enables access to information, however further measures are required to assess the messages within. These studies show that the majority of health information is around an adequate level of suitability. There is, however, the presence of unsuitable health material also. This indicates that while most health information is relatively accessible, some individuals may have their access hindered by non-suitable aspects of the website content. Suitability of online SSD information has not yet been assessed. If suitability of information related to SSD is deficient, consumers would be faced with inadequate access to information that may be important to their health outcomes when attempting to learn about the disorder and treatment options.

1.9 Quality of Online Health Related Information

Another key characteristic of beneficial online health information is its quality. Indications of good quality online health information can be achieved through assessing the credibility of the publisher and comparing the presentation of the information to ethical standards (Health on the Net Foundation). One way of evaluating online health information is to investigate the presence of HONcode Certification (Health on the Net Foundation). The Health on the Net (HON) foundation created this code of conduct to standardise the validity and quality of health information online, as there are many biased and non-validated sources online, however only a small percentage of health related web-pages have this certification (Boyer et al., 1998).

The HONcode is made up of eight standards as follows: 1. Authoritative, 2. Complementary, 3. Privacy policy, 4. Attribution and date, 5. Justifiability, 6. Transparency, 7. Financial disclosure, and 8. Advertising policy (Health on the Net Foundation). The Authoritative principle pertains to the notion that medical or health advice is only given by medically trained and qualified professionals unless a statement is made. Complementarity means the information should support and not replace the doctor-patient relationship. Privacy is to do with respect of the confidentiality of personal data submitted to the site by the user. Attribution pertains to the website containing clear references to source data along with HTML links if possible and the date when the page was last modified. Justifiability refers to the sites responsibility to justify claims on benefits of a treatment, product, or service with appropriate evidence. Transparency refers to the clearness of the website presentation as well as accurate E-mail contact details. Financial disclosure calls on the need for organisations contributing funding, services, or material to the site to be identified. Finally, Advertising policy pertains to advertising and editorial content being clearly distinguishable. Presence of this certification indicates the website meets these standards.

Studies have investigated the prevalence of HONcode certification among various health websites. Nghiem, Mahmoud, and Som (2016) assessed websites related to breast-cancer. The study found that nine out of 26 websites had HONcode certification. Of these 26 websites, 46% were classed as 'excellent' using the DISCERN. Charity websites had the highest average scores, followed by non-profit organisations, healthcare providers, government websites, and finally commercial health information websites. Commercial health information websites had the highest number of HONcode certified websites, however, while charities and government websites had none (Nghiem et al., 2016).

Sullivan, Anderson, Ahn, and Ahn (2014) analysed online information on vertebroplasty. Of the websites evaluated, 16% were sponsored by academic institutions, 62% by private groups, 8% by biomedical device companies, and 14% were sponsored otherwise. Of these sites, only 9% had HONcode certification and no association with increased quality of information was found for these sites compared to non-certified sites. This suggests that HONCode certification may not indicate higher quality of website information (Sullivan et al., 2014).

Davis, McCormick, and Jabbour (2017) evaluated websites with information relating to vascular malformations. They found that 63% of the websites were owned by academic institutions and two websites had HONcode accreditation.

Manchaiah et al. (2019) evaluated information online for tinnitus. Most websites were of commercial or non-profit organisation origin and only 13.5% of the websites assessed had HONcode certification. In Laplante-Levesque et al. (2012) 14% of 66 hearing-related websites had HONcode certification. More than half of the websites with government origin had the certification. For non-profit organisation and commercial origin websites, only 14% and 2% of them had HONcode certification respectively.

These studies show that very few websites have HONcode certification, and those that do may not be of superior quality as shown by other content measures. To date, the prevalence of HONcode certifications among webpages on information relating to SSD has not been investigated.

1.10 Quality Analysis

1.10.1 DISCERN

DISCERN is a tool developed to enable patients and information providers to assess the quality of written information about treatment choices and serves as a guide to producing high quality consumer health information (Charnock, Shepperd, Needham, & Gann, 1999). It consists of a 16 item list each with scale ratings ranging from 1-5, where 1 = No, 3 = Partially, and 5 = Yes (Charnock et al., 1999). The items are categorised into three sections that contain questions assessing important aspects of good website content. The first section is for finding the levels of fulfilment of reliability, achieving aims, relevancy, acknowledgement of sources, date of production, evidence of information balance and non-bias, additional sources of information and support, and referral to areas of uncertainty. The second section is to investigate the quality of information on treatment choices, whether it describes benefits of each treatment, describes risks, describes what would happen if no treatment were used, describes how treatment choices affect overall quality of life, if it is clear that there may be more than one possible treatment choice, and the provision of support for shared decision making. The final section is for giving an overall rating of the publication. Possible ratings range from 1-5, where 1 = Serious or extensive shortcomings, 3 = Potentially important but not serious shortcomings, and 5 = Minimal shortcomings.

Some studies score materials by summing the ratings for each question and deriving an overall rating from that, where 80 is the highest possible score. Others sum the ratings up

to question 15, giving a possible total score of 75. Some studies also derive percentage scores from these sums. There does not appear to be guidelines providing information on these methods of scoring, therefore it is unclear the how scores relate to levels of quality.

The tool was developed using a panel of experts to test the instruments and a sample of health information providers and self-help group members testing the tool on consumer health information (Charnock et al., 1999).

Various health websites have been assessed using DISCERN and revealed moderate levels of quality. For example, information on vascular malformations (Davis et al., 2017), tinnitus (Manchaiah et al., 2019), and adults with hearing loss and their significant others (Laplante-Levesque et al., 2012) demonstrated mean scores ranging from 2.04 to 2.97. Laplante-Levesque et al. (2012) found differences in origin as non-profit websites had higher quality scores on the DISCERN questionnaire than websites with a commercial or government origin.

Other studies that derived scores from an overall sum of the rated items instead of selecting a rating from 1-5 found similar results. For example, information on metal-on-metal total hip arthroplasty (Crozier-Shaw, Queally, & Quinlan, 2017), vocal fold nodules (Doruk, Enver, Çaytemel, Azezli, & Başaran, 2018), bariatric surgery (Akbari & Som, 2014), breast cancer (Nghiem et al., 2016), cancer (Monton et al., 2019), and diverticulitis (Connelly, Khan, Victory, Mehmood, & Cooke, 2018) obtained mean scores ranging from 34.96 to 57.0.

The literature shows that the content of most health websites evaluated fulfil the variables that DISCERN evaluates to a moderate level on average. This does not exclude the presence of low scoring or high scoring websites, however. This does therefore highlight room for improvement of online health information. Good quality content is necessary for individuals searching for SSD information to obtain sufficient knowledge and develop health

strategies to benefit them. Despite this, the DISCERN has not yet been used to investigate quality of online SSD information.

1.10.2 PEMAT

For health information to be useful, individuals need to be able to understand information and take appropriate action following its consumption (Shoemaker, Wolf, & Brach, 2014). Understandability of material allows consumers with varying health literacy levels and of diverse backgrounds to process and explain key information (Shoemaker et al., 2014). Actionability of material allows consumers of varying health literacy levels and of diverse backgrounds to be able to identify what they can do based on the information (Shoemaker et al., 2014)

The Patient Education Materials Assessment Tool (PEMAT) (Shoemaker, Wolf, & Brach, 2013) is a validated tool used to evaluate understandability and actionability of written and audio-visual material. It is made up of 26 items which were rated as either 'Disagree' (0), 'Agree' (1), or 'Not Applicable' (N/A). The tool provides two scores for the material – one for actionability and one for understandability. To derive a score for the material, the total points for the understandability and actionability are summed separately. These are each divided by the total possible points excluding the items which were not applicable. These results are then multiplied by 100 to derive a percentage of understandability and a percentage of actionability for the material. Ratings are to be subjectively interpreted based on comparisons to scores of other materials. The higher the score, the more understandable or actionable the material (Shoemaker et al., 2013).

A number of studies have used the PEMAT to assess online information. Davis et al. (2017) evaluated websites related to vascular malformations. They used the PEMAT to assess understandability, of which an overall score of 59% was obtained.

McClure, Ng, Vitzthum, and Rudd (2016) examined patient education materials for people with sickle cell anaemia. They obtained a mean understandability score of 71.1% and a much lower mean actionability mean of 36.3%.

Balakrishnan, Chandy, Hseih, Bui, and Verma (2016) assessed online resources for patients to learn about vocal cord paralysis. They found that understandability ranged from 29% to 82% with a mean of 53%. Only 40% of articles defined medical terms used and only 54% had informative titles for each section. No articles had a summary at the end of the text.

Morony et al. (2017) examined printed patient education materials on chronic kidney disease. The materials scored 57 for understandability, 52 for actionability, and 37 for visuals. Over half of the graphics contributed no meaning to the text.

Wong, Gilad, B. Cohen, Kirke, and M. Jalisi (2017) investigated online education materials for laryngectomy. The mean understandability was 68.3% and the actionability was 66.3%.

Bonner, Fajardo, Hui, Stubbs, and Trevena (2018) assessed online risk calculators for cardiovascular disease. The calculators scored moderately on understandability with a mean score of 64% and poorly on actionability with a mean score of 19%.

These findings show that there is a large variability in the understandability and actionability of patient education materials online. Many disorders investigated appear to have low mean percentage scores also, indicating poor content of the material. While understandability and actionability are important in facilitating learning and appropriate decision making involving SSD, the PEMAT has not been used to investigate the levels of these in online SSD information.

1.10.3 Plain Language Checklist

Plain language is communication that can be understood the first time an audience sees or hears it (Wicklund & Ramos, 2009). It is a valuable tool in the health care setting as it benefits individuals by supporting health literacy, treatment adherence, informed consent, and shared decision-making (Wicklund & Ramos, 2009). Common factors used in plain language material involve logical organisation of the content, the use of pronouns, the use of active voice, common words, short sentences, and design features that aid reading (Plain Language Action and Information Network, 2017b). Plain language is useful in providing access to online health information and plain language checklists can be used to investigate whether readers can find and understand key messages (Mcgee, 2012).

The Quick Checklist for Plain Language (Mcgee, 2012) consists of five sections titled: Investigating reader focus, Organisation, Writing, Design and Formatting, and Tips for Checking the Language (Mcgee, 2012). The Checklist for Plain Language on the Web (Plain Language Action and Information Network, 2017a) contains 14 guidelines that can be used to write new material or analyse existing material. It contains items such as be concise, separate topics, shorten information, use lists, use questions as headings, and more (Plain Language Action and Information Network, 2017a).

Various studies have demonstrated the importance of using plain language in patient education materials and informational resources.

Otal et al. (2012) investigated parent satisfaction with plain language materials in relation to their levels of health literacy. The material was written at the 6th grade level and met the recommendations of the Canadian Public Health Association for communicating health information (Canadian Public Health Association, 2008). The participants reported satisfaction with the material regardless of their level of health literacy.

Holmes-Rovner et al. (2005) designed a decision aid for treatment decisions for localised prostate cancer. This was done with the use of plain language as the main focus. Newly diagnosed patients showed increased knowledge of radiation therapy side-effects and had more discussions with doctors about treatment options.

Smith and Wallace (2013) compared the effectiveness of a 'standard' Patient Instructions for Use document with one that was written using plain language. This was done through assessing user comprehension and the ability of a user to administer a substance with an auto-injector. Participants who were given the plain language material were more likely to correctly describe preparation and pre-injection steps. They also showed more correct self-injection steps compared to those who were given the 'standard' material.

Ancker, Send, Hafeez, Osorio, and Abramson (2017) selected dosing instructions that were within summaries for after-visit resources and recruited participants to rate them on comprehension. Participants either rated the original material or rated revised versions for enhancing plain language use. The researchers found a significant increase in comprehension with the revised material.

These studies show that writing or re-writing health material with the use of plain language can significantly improve comprehension, retention, and desired actions. Plain language is therefore an effective tool in conveying information and its presence should be investigated when evaluating material. Despite its importance in health information, levels of plain language use have not been investigated for online SSD information.

1.11 Study Rationale

Readability, suitability, and content of hearing related information has mostly been found to be inadequate to moderately adequate in various studies. To date, readability, suitability, and content of online information related to SSD has not been evaluated.

Therefore, it is not established whether the information that English-speaking consumers of online SSD related information are accessing is adequate for learning and decision-making about the disorder. If online information on SSD is of good quality, its consumers are more likely to have better understanding of the mechanisms of SSD and its treatment methods. Therefore, they would also be more likely to have better health outcomes. As it has been shown that audiological healthcare information tends to lack readability, suitability, and good content, it is possible that this is the case for SSD related information also.

1.12 Aims and Hypotheses

Therefore, the aim of the current study is to investigate the readability, suitability and quality of information on SSD available online and in English. It has four specific research questions:

1. Are there significant differences in the distribution of webpages on SSD based on: (a) locality of hosting organisation, (b) type of hosting organisation, (c) HONCode certification?

2. Are there significant differences in the readability of webpages on SSD based on: (a) locality of hosting organisation, (b) type of hosting organisation, (c) HONCode certification?

3. Are there significant differences in the suitability of webpages on SSD based on (a) locality of hosting organisation, (b) type of hosting organisation, (c) HONCode certification?

4. Are there significant differences in the quality of webpages on SSD based on (a) locality of hosting organisation, (b) type of hosting organisation, (c) HONCode certification?

From these research questions, there are four null hypotheses:

1. There are no significant differences in the distribution of webpages on SSD based on: (a) locality of hosting organisation, (b) type of hosting organisation, (c) HONCode certification.

2. There are no significant differences in the readability of webpages on SSD based on: (a) locality of hosting organisation, (b) type of hosting organisation, (c) HONCode certification.

3. There are no significant differences in the suitability of webpages on SSD based on (a) locality of hosting organisation, (b) type of hosting organisation, (c) HONCode certification.

4. There are no significant differences in the quality of webpages on SSD based on (a) locality of hosting organisation, (b) type of hosting organisation, (c) HONCode certification.

Methods

2.1 Overview

This study assessed the readability, suitability, and quality of online information on SSD in English related to the region and type of organisation it originates from. It was conducted in three stages. (1) generation of web search terms, (2) identification of websites for analysis, and (3) evaluation of materials on identified websites.

First, readability was measured with the SMOG, FOG, and F-K. Second, the suitability was measured with the SAM + CAM tool. Quality was assessed using the DISCERN tool, PEMAT tool, and the Plain Language Checklist. Quality was also investigated by presence of HONcode certification. Ethical approval for this study was given by the Human Ethics Committee.

2.2 Participants

The participants of this study were acquaintances of the author who were recruited through snowball and convenience sampling. This was done through the use of the author's social media (e.g. Facebook) and word of mouth. The participants were aged 18 years and older, and were able to provide search terms in the English language. Recruitment continued until the search terms supplied reached saturation (i.e. multiple repetitions of the same search terms were collected). They were given a link to an anonymous survey hosted by Qualtrics to provide demographic details and search terms. The demographic details were gender, age, English language fluency, highest level of education, and ethnicity.

2.3 Generation of Search Terms

The search terms for this study were generated by asking the participants through the survey what terms they would use to search for online SSD information. The question used was: “If you or someone you know had **NO** hearing in one ear, what search terms would you put into Google?”. Pre-existing knowledge of hearing healthcare was not a requirement. Questionnaires were distributed and collected via on anonymous online survey (Qualtrics). The most-mentioned search terms were entered into Google trends, a free public website that evaluates the popularity of search terms in Google Search across both regions and languages (www.google.com/trends). This was to establish the search frequency of the selected search terms. The settings selected for the analysis were: worldwide in the past 12 months within all categories using web search.

2.4 Internet Search

2.4.1 Inclusion and Exclusion Criteria

The inclusion criteria for the webpages were: (1) written in English, (2) involved material related to SSD, and (3) available to the public. The exclusion criteria were (1) not open access or contained paid advertisements, (2) were a directory listing, and (3) were no longer than 100 words long. External links or content were not included.

2.4.2 Identification of Search Domains

Search locations were based on countries with Google domains, English as an official language, and more than 2 million internet users. First, countries with Google domains were retrieved from the list of regions selectable in the Advanced Search section of Google

Settings. These were put into an excel spreadsheet. Second, countries with English as an official language were selected using information from the CIA World Factbook (Central Intelligence Agency, 2007). This resulted in 66 countries. The total internet users from these countries was 1,420,288,344. Finally, to narrow the search, countries with less than two million internet users were eliminated using information from Internet World Stats (2019). This resulted in 21 countries and 1,377,149,400 internet users and encompassed 97% of English-speaking internet users. The internet penetrance rates of these countries were retrieved from World Stats (2019) (See table 1). The regions that each country belonged to was derived using World Health Organisation regional offices (World Health Organisation, 2018).

Table 1. *Countries with English as an Official Language and at least Two Million Internet Users Included in the Internet Search*

Country	**Region**	**Internet Penetration Rate**	**Population of Internet Users**
Kenya	Africa	83.0%	43,329,434
South Africa	Africa	53.7%	31,185,634
Tanzania	Africa	37.8%	23,000,000
Uganda	Africa	41.6%	19,000,000
Zimbabwe	Africa	39.3%	6,796,314
Cameroon	Africa	24.2%	6,128,422
United States	Americas	89.2%	292,892,868
Canada	Americas	92.7%	34,558,385
Puerto Rico	Americas	83.3%	3,047,311
United Kingdom	Europe	94.2%	63,061,419
Ireland	Europe	91.9%	4,453,436
India	South-East Asia	40.9%	560,000,000
Indonesia	South-East Asia	53.2%	143,260,000
Philippines	South-East Asia	62.0%	67,000,000
Malaysia	South-East Asia	80.1%	26,009,000
Australia	Western Pacific	87.8%	21,743,803
Hong Kong	Western Pacific	89.4%	6,698,252
Singapore	Western Pacific	84.5%	4,955,614
New Zealand	Western Pacific	88.1%	4,184,520
Total in study			**1,361,304,412**
Percentage in study			**97%**

2.4.3 Search Procedure

The search was conducted in two stages. First, the webpages were collected through an advanced Google search. Using Google settings, The ccTLD of each country was chosen and the search terms were entered into the ccTLDs separately. The first ten search results were accessed and examined against the inclusion and exclusion criteria (see section 2.41). This is because individuals tend to access only the first page of Google results (Eysenbach & Kohler, 2002). After completion of the search, webpages that did not meet the criteria or were duplicates were removed.

Second, the country of origin, organisation type and presence or absence of HONcode certification was established for each webpage. The country of origin was established using the URL, information included on the website, or through an internet search. The type of organisation that published each webpage was determined using information from the webpage itself, for example, in an "About Us" section, or from the URL of the webpage. Webpages were coded as either "Non-profit", "Commercial", or "Government". The Uniform Resource Locator (URL), type of organisation, country of origin, and HONcode certification of the webpages were recorded in Microsoft Excel.

2.5 Readability Analysis

To assess the readability of each webpage, three measures were used. These were the Gunning Fog Index (Gunning, 1952) (FOG), Simple Measure of Gobbledygook (McLaughlin, 1969) (SMOG), and Flesch-Kincaid Grade Level formula (Kincaid et al., 1975) (F-K). Assessment was completed by using Test Document Readability (Online-Utility.org) a free online English Readability tool. The content of each webpage was copied

and pasted into the tool which calculated readability scores. These scores were then entered into an excel spreadsheet from which the mean RGL was calculated.

2.6 Suitability Analysis

The suitability of webpages was assessed using the SAM+CAM tool. This is done through rating each area as either superior (two points), adequate (one point), or not suitable (zero points). Using this tool, an overall rating for suitability for the target population was chosen where 0 = "NO. Definitely not recommended" and 10 = "YES. Recommended without reservation". If a webpage did not have content that applied to specific factors of the SAM+CAM, illustrations for example, these factors were not scored. To determine the results, the scores were summed and a percentage was calculated. If one or more of the SAM+CAM factors did not apply to a webpage, two points were subtracted from the total for each non-applicable factor. Results were entered into the excel spreadsheet.

2.7 Quality Analysis

2.7.1 DISCERN

Content was in part assessed using the DISCERN tool to investigate reliability, quality of information on treatment choices, and give an overall rating of each publication. Each item was scored a number from 1-5, where 1 = No, 3 = Partially, and 5 = Yes. Items could also obtain scores between these, such as 2.5. The overall rating was based on the ratings of the previous 15 items and ranged from 1 – 5 where 1 = "Serious or extensive shortcomings", 3 = "Potentially important but not serious shortcomings", and 5 = "Minimal shortcomings". The results were entered into the excel spreadsheet.

2.7.2 PEMAT

The PEMAT tool was used to assess content also. It was used to evaluate understandability and actionability of written and audio-visual material. It is made up of 26 items which were rated as either 'Disagree' (0), 'Agree' (1), or 'Not Applicable' (N/A). The tool provides two scores for the material – one for actionability and one for understandability. To derive a score for the material, the total points for the understandability and actionability were summed separately. These are divided by the total possible points excluding the items which were not applicable. These results were then multiplied by 100 to derive a percentage of understandability and a percentage of actionability for the material. The higher the score, the more understandable or actionable the material. To evaluate audio-visual material on webpages, videos were transcribed prior to scoring. The results were entered into the excel spreadsheet

2.7.3 Plain Language Checklist

A combined and adapted version of The Quick Checklist for Plain Language (Mcgee, 2012) and the Checklist for Plain Language on the Web (Plain Language Action and Information Network, 2017a) was also used to assess webpage content. The revision of the checklist was done by other researchers within the thesis group the author was a part of. The checklist was be used to assess whether the information is written plainly and formatted in ways that helps consumers find and understand key messages. This was done through investigating reader focus, organisation, writing, and design and formatting. The result was entered into the excel spreadsheet.

2.7.4 HONcode Certification

Quality was evaluated using HONcode certification. The Health on the Net (HON) foundation created the HON code of conduct to standardise the validity and quality of health information online. It is made up of eight standards as follows: 1. Authoritative, 2. Complementary, 3. Privacy policy, 4. Attribution and date,5. Justifiability, 6. Transparency, 7. Financial disclosure, and 8. Advertising policy (Health on the Net Foundation). Presence of this certification indicates the website meets these standards. The URL of each webpage was entered into the Health on the Net search bar to reveal the presence or absence of HONcode certification. Results were entered into the excel spreadsheet.

2.8 Reliability

Inter-rater reliability was established in two ways – Revising tools to enhance clarity on the scoring criteria and how to apply it to the material, and establishing agreement between raters. The PEMAT was revised by adding further clarification to each item in order to reduce ambiguity in how to score material. For example, the first item of the checklist was "The material makes its purpose completely evident (P and A/V)". To enhance clarity, the following sub question was added: "Is there a clear indication of what the material is going to be about? OR what it is meant to cover i.e. topics which will be covered within the material at the start OR throughout (as an example, headings)". The second way that inter-rater reliability was established was through the primary researcher and another researcher using DISCERN, PEMAT, SAM + CAM and the Plain Language Checklist on material not related to the study. This was to reveal and discuss differences in the subjective interpretations of scoring. Once agreement between interpretations was established, 20% of webpages from

each region were randomly selected and distributed throughout the research group to rate using the content assessment measures.

2.9 Statistical Analyses

The three dependent variables in this study were readability, suitability, and quality. The independent variables were region and type of organisation. The data was analysed using the IBM SPSS Version 24 software (IBM Corp, 2016). Assumptions of normality were tested to investigate whether data could undergo parametric testing. Descriptive statistics including frequency counts, chi-square tests, and analysis of variance (ANOVA) were conducted. A one sample t-test was conducted to evaluate the mean RGL.

Descriptive statistics such as frequency counts, a chi-square test for independence, and a chi square test for goodness of fit were used to assess the differences in distribution of webpages based on: (a) locality of hosting organisation (Americas, Europe, Western Pacific, Rest of World), and (b) type of hosting organisation (Commercial, Rest of World).

Descriptive statistics and two-way ANOVAs were used to assess differences in the readability, suitability, and quality of webpages on SSD based on: (a) locality of hosting organisation (Americas, Europe, Western Pacific, Rest of World), and (b) type of hosting organisation (Commercial, Rest of World). To determine significance for these analyses, an alpha level of 0.05 was used.

Results

3.1 Overview

The main purpose of this study was to evaluate the readability, suitability, and quality of information online related to SSD in English. It also aimed to compare these factors between webpage location, organisation type, and whether HONcode certification was present or not. Following the attrition of three webpages, as two duplicates were overlooked in the process and one website was later found to be irrelevant, 63 webpages were analysed in total.

3.2 Reliability

To measure inter-rater reliability, Intraclass Correlation (ICC) was used. The ICC values obtained were Plain Language: ICC = .934, PEMAT understandability: ICC = .887, PEMAT actionability: ICC = .891, DISCERN: ICC = .871, SAM + CAM: ICC = .855. These Kappa values are all greater than .75 which indicate 'excellent agreement beyond chance' (Fleiss, 1973).

3.3 Descriptive Statistics

3.3.1 Location

Each webpage country of origin was recorded to establish the distribution of online information related to SSD across localities. Most webpages came from the Americas (n = 17, 27.0%) and Western Pacific (n =17, 27.0%), followed by Europe (*n* = 16, 25.4%), then Africa (*n* = 7, 11.2%), Southeast Asia (n = 3, 4.8%), and World (n = 3, 4.8%). No webpages came from the Eastern Mediterranean (n = 0, 0%). Due to the large variability of web page distributions between these locations, the webpage regions were recoded to include four levels. This resulted in the following distribution: Americas (n = 17, 27.0%), Western Pacific

(n = 17, 27.0%), Europe (n = 16, 25.4%), Rest of World (n = 13, 20.6%). This is illustrated in Figure 1.

3.3.2 Type of Organisation

The publishers of each webpage were coded into types of organisations. Most were commercial (n = 45, 71.4%), followed by non-profit (n = 15, 23.8%), and the least were government (n = 3, 4.8%). Due to the lack of variability in distribution of organisation type, the webpages were recoded to include two levels (Commercial and Other). This resulted in the following distribution as shown in Figure 1: Commercial (n = 45, 71.4%), and Other (n = 18, 28.6%).

3.3.3 HONcode

Out of the 63 webpages assessed, only two had HON code certification (3.2%). These websites were from Merck Manual (non-profit, Europe) and Better Health Channel (government, Western Pacific). Due to this lack of variability, the null hypotheses involving HONcode certification were excluded from hypothesis testing.

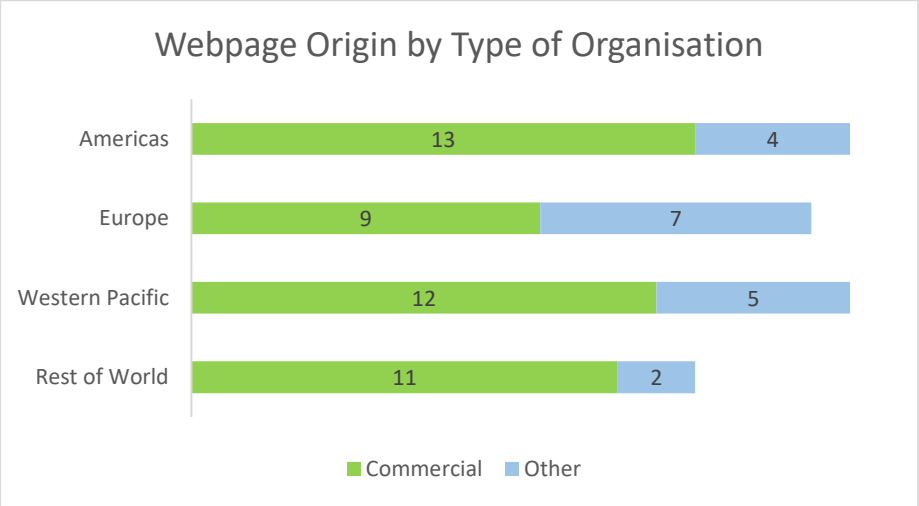

Figure 1. *Frequency distribution of webpages from commercial or other organisations in each location.*

3.3.4 Readability

Readability was measured using the SMOG, FOG, and F-K. The RGL of the webpages using the FOG ranged from 8.31 to 16.46 (*M* = 11.9, *SD* = 2.0). Using the SMOG, the RGL ranged from 8.77 to 20.39 (*M* = 11.9, *SD* = 1.9). Using the F-K, the RGL ranged from 6.65 to 15.22 (*M* = 11.4, *SD* = 1.8). The mean RGL of the webpages (SMOG, FOG, and F-K combined) ranged from 7.92 to 15.43 (*M* =11.4, *SD* =1.8). Please see Figure 2 for an illustration of RGL based on location, and Figure 3 for RGL based on organisation type.

3.3.5 SAM+CAM

Scores of the SAM+CAM tool ranged from 26.3 (“not suitable”, 0-39%) to 83.4 (“superior”, 70-100%). The mean SAM+CAM score (*M* = 56.1, *SD* = 12.0) met the criteria for “adequate” material (40-69%). Please see Figures 4 and 5 for the distribution of mean suitability scores based on location and organisation type respectively.

Most webpages did not have a suitable summary or review section (*n* = 54, 85.7%), motivators to attend to the text (*n* = 43, 68.3%), reader interactions (*n* = 54, 85.7%), or use of theories in text (*n* = 63, 100%). However, the majority of webpages did exhibit confusion reducers (*n* = 54, 85.7%), context (*n* = 40, 63.5%), good scope and length (*n* = 55, 87.3%), good layout and organisation (*n* = 55, 87.3%), and good typography (*n* = 62, 98.4%).

3.3.6 PEMAT

PEMAT scores ranged from 29.4% to 90.0% (*M* = 61.57%, *SD* = 14.06%). Actionability ranged from 0% to 100% (*M* = 37.54%, *SD* = 39.22), and understandability ranged from 38.50% to 93.40% (*M* = 69.34, *SD* = 13.08). Please see Figures 6 and 7 for the distribution of mean PEMAT scores based on location and organisation type respectively.

Most webpages did not use common, everyday language (*n* = 56, 87.5%), provide a suitable summary (*n* = 58, 92.1%), or use visual aids whenever they could make content more easily understood (*n* = 46, 73.0%). Most webpages had a clearly evident purpose (*n* = 57, 89.1%), exclusion of information that distracts from its purpose (*n* = 60, 93.8%), did not expect the user to perform calculations (*n* = 62, 98.4%), chunked information (*n* = 61, 96.8%), used informative headers (*n* = 54, 85.7%), presented information in a logical sequence (*n* = 62, 98.4%), and used visual cues (*n* = 53, 84.1%).

3.3.7 DISCERN

DISCERN scores ranged from 1 (Low: Serious or extensive shortcomings) to 4.5 (High: Minimal shortcomings). The mean DISCERN score corresponded to just over a low

quality rating (*M* = 2.27, *SD* = 0.83). Please see Figures 8 and 9 for the distribution of mean DISCERN scores based on location and organisation type respectively.

Most webpages did not clearly show what sources of information were used to create the publication (*n* = 45, 71.4%), describe the risks of each treatment (*n* = 57, 90.5%), describe what would happen if no treatment were used (*n* = 44, 69.8%), describe how treatments affect quality of life (*n* = 45, 71.4%), refer to areas of uncertainty (*n* = 39, 61.9%), or provide support for shared decision making (*n* = 45, 71.4%).

3.3.8 Plain Language Checklist

Plain Language scores ranged from 11 to 20 (*M* = 15.59, *SD* = 2.10). Most webpages did not explain technical terms used (*n* = 56, 88.9%), use simple sentences (*n* = 48, 76.2%), or eliminate unnecessary words (*n* = 50, 79.4%). Please see Figures 10 and 11 for the distribution of mean plain language scores based on location and organisation type respectively.

Under Reader Focus, most webpages had headings that contained the topic of interest (*n* = 60, 95.2%). Under Organisation, most webpages arranged content in a sensible order (*n* = 52, 82.5%), and grouped topics under separate headings (*n* = 61, 96.8%). Under Writing, most webpages used personal pronouns throughout (*n* = 52, 82.5%), used lay terms predominantly (*n* = 58, 92.1%), and used correct punctuation (*n* = 61, 96.8%). Under Design and Formatting, most webpages had a consistent appearance (*n* = 61, 96.8%), looked easy to read (*n* = 55, 87.3%), good text size and line length (*n* = 60, 95.2%), and had clear and uncluttered images that were related to the content (*n* = 59, 93.7%). All webpages had clean fonts and used italics, underlining, capitalisation and bold print sparingly (*n* = 63, 100%).

3.4 Hypothesis Testing

3.4.1 Normality

Due to the sample size (N = 63), a normal distribution was assumed. There were also no significant outliers, therefore the dataset was considered to meet the assumptions of parametric testing.

3.4.2 Distribution based on Location and Organisation Type

The study aimed to answer the following research question:

Are there significant differences in the distribution of webpages on SSD based on: (a) locality of hosting organisation, and (b) type of hosting organisation?

A chi-square test of independence was conducted, however the statistical assumptions of this test were not met, and therefore was excluded from the analysis. A chi-square goodness of fit test was calculated comparing the occurrence of webpages from Americas, Europe, Western Pacific, and Rest of World with the hypothesised occurrence of 15.8 per group. No significant deviation was observed $\chi2(3) = .683$, $p = .887$. A chi-square goodness of fit test was calculated to compare the occurrence of webpages from commercial and other types of organisations with the hypothesised occurrence of 31.5 per group. A significant deviation was observed: $\chi2(1) = 11.57$, $p = .001$.

Based on these results, the null hypothesis there are no significant differences in the distribution of webpages on SSD based on (a) locality of hosting organisation, and (b) type of hosting organisation was partially supported. There was no significant difference in distribution of webpages based on locality, however, there was a significant difference based on type of organisation.

3.4.3 Readability based on Location and Organisation Type

The study aimed to answer the following research question: Are there significant differences in the readability of webpages on SSD based on: (a) locality of hosting organisation, and (b) type of hosting organisation?

Levene's test showed that the null hypothesis that the variances for location and type of organisation are equal was supported $F(7,55) = 1.050$, $p = .408$. The variances were not significantly different, therefore the statistical assumption of equal variances for ANOVA were met.

A two-way ANOVA was performed to test for the main effects of location and organisation type. The results showed no significant interaction between type of organisation and location on mean RGL: $F(3,55) = .751$, $p = .526$, $\eta^2 = .039$. The main effects were examined.

a. There was no significant difference in mean RGL between locations, $F(3,55) = 1.535$, $p = .216$, $\eta^2 = .077$
b. There was no significant difference in mean RGL between types of organisation, $F(1,55) = 3.306$, $p = .074$, $\eta^2 = .057$.

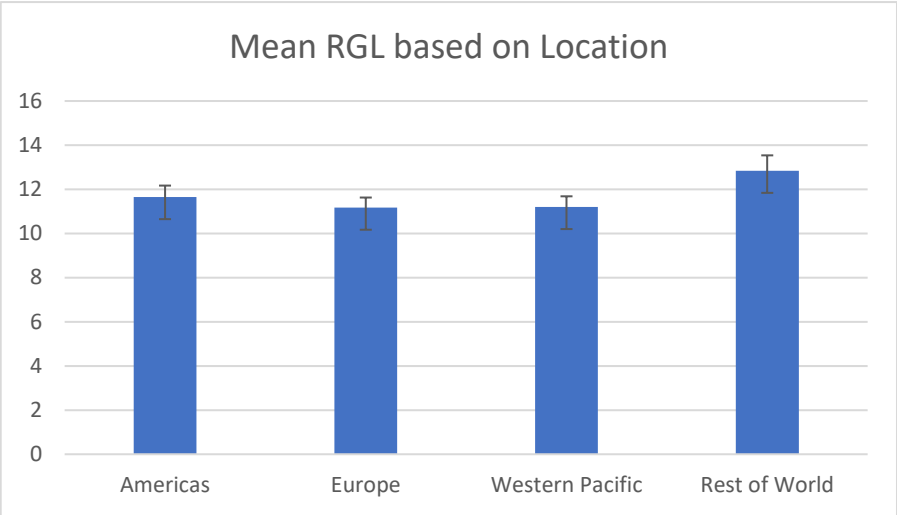

Figure 2. *Mean RGL of webpages from Americas, Europe, Western Pacific, and Rest of World. Error bars represent one standard error.*

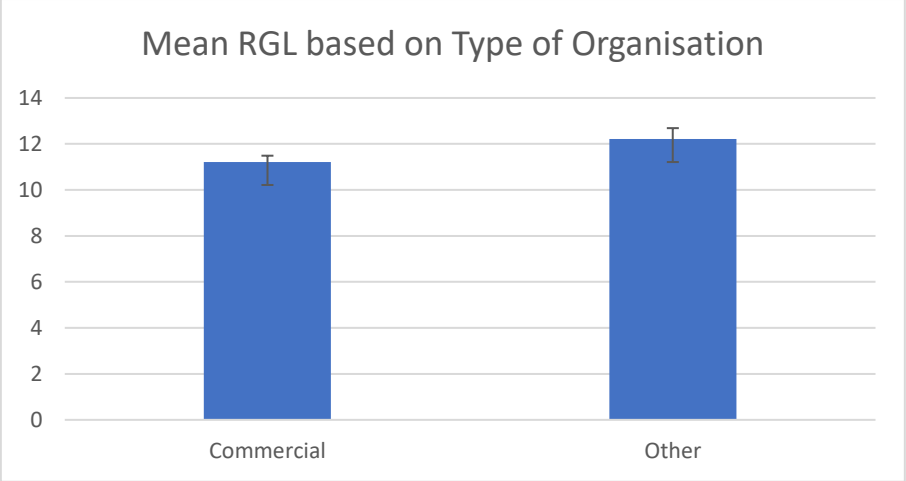

Figure 3. *Mean RGL of web pages from commercial and other types of organisations. Error bars represent one standard error.*

Based on these results, the null hypothesis there is no significant difference in mean RGL of webpages based on (a) location and (b) organisation type was supported. There were no significant differences in readability based on location and type of organisation.

A one sample t-test was conducted to evaluate the mean RGL. The webpages scored higher on the FOG (M =11.92, SD = 2.04) than the recommended RGL of 6: $t(62) = 23.01$, $p < .001$. The webpages scored higher on the SMOG (M =11.92, SD =1.91) than the recommended RGL: $t(62) = 24.65$, $p < .001$. The webpages scored higher on the FK (M =10.28, SD =1.94) than the recommended RGL: $t(62) = 10.28$, $p < .001$. Based on these results, web pages containing information related to SSD score higher than a RGL of 6 and therefore do not meet the recommended guidelines for suitable readability.

3.4.4 Suitability based on Location and Organisation Type

The study aimed to answer the following research question: Are there significant differences in the suitability of webpages on SSD based on (a) locality of hosting organisation, and (b) type of hosting organisation?

Levene's test showed that the null hypothesis that the variances for location and type of organisation are equal was supported $F(7,55) = 1.702$, $p = .128$. The variances were not significantly different, therefore the statistical assumption of equal variances for ANOVA were met.

A two-way ANOVA was conducted to investigate the relationship between location and type of organisation on SAM+CAM scores. The results show no significant interaction between location and type of organisation on SAM+CAM scores: $F(3,55) = .571$, $p = .637$, η^2 .030. The main effects were examined and revealed:

a. No significant difference in SAM+CAM scores between locations: $F(3,55) = 1.101$, $p = .357$, $\eta^2 = .057$.
b. No significant difference in SAM+CAM scores between types of organisation: $F(1,55)= .515$, $p =.476$, $\eta^2 = .009$.

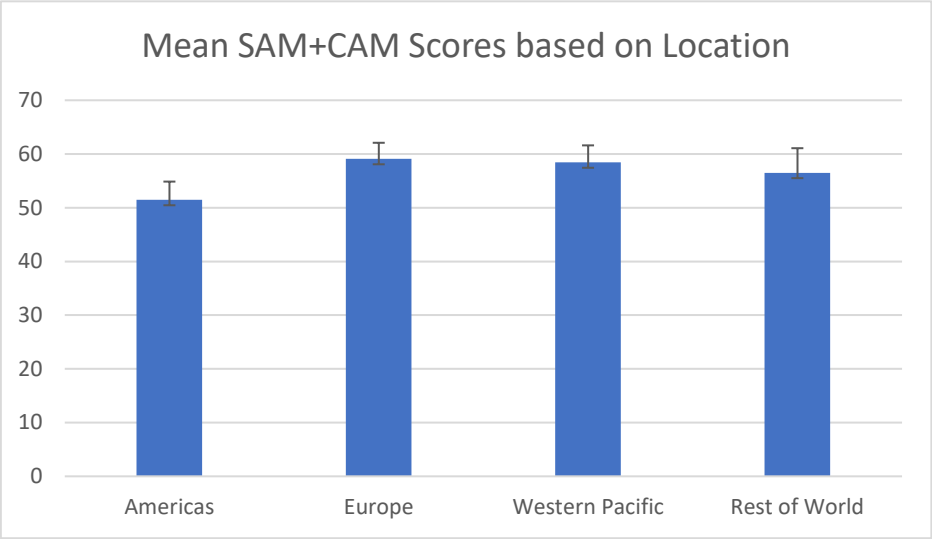

Figure 4. *Mean SAM+CAM scores of web pages originating from the Americas, Europe, Western Pacific, and Rest of World. Error bars represent one standard error.*

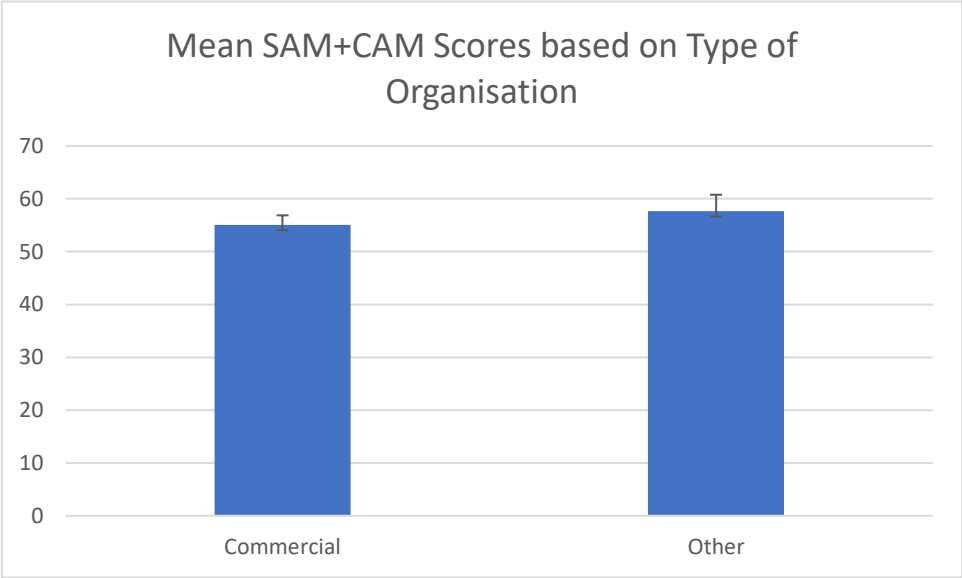

Figure 5. *Mean SAM+CAM scores of web pages from commercial and other types of organisations. Error bars represent one standard error.*

Based on these results, the null hypothesis there is no significant difference in the suitability of web pages based on (a) location, and (b) organisation type was supported. There

were no significant differences in suitability of web pages based on their location or organisation type.

3.4.5 Quality based on Location and Organisation Type

The study aimed to answer the following research question:

Are there significant differences in the quality of webpages on SSD based on (a) locality of hosting organisation, and (b) type of hosting organisation?

3.4.5.1 PEMAT

Levene's test showed that the null hypothesis that the variances for location and type of organisation are equal was supported $F(7,55) = 1.399$, $p = .225$. The variances were not significantly different, therefore the statistical assumption of equal variances for ANOVA were met.

A two-way ANOVA was performed to test for the main effects of location and organisation type. The results showed no significant interaction between location and type of organisation on PEMAT scores $F(3,55) = .916$, $p = .439$, $\eta^2 = .048$. The main effects showed:

a. No significant difference in PEMAT scores between locations $F(3,55) = .589$, $p = .625$, $\eta^2 = .031$.
b. No significant difference in PEMAT scores between types of organisation $F(1,55) = .195$, $p = .661$, $\eta^2 = .004$.

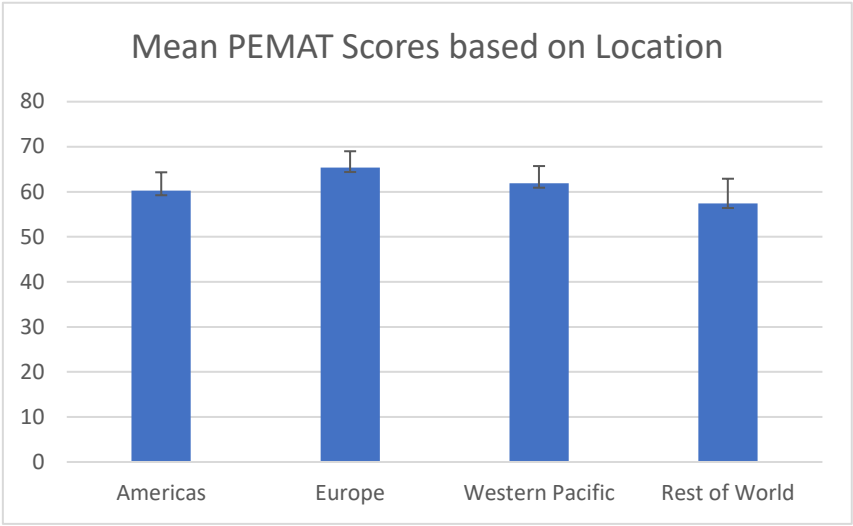

Figure 6. *Mean PEMAT scores of web pages originating from Americas, Europe, Western Pacific, and Rest of World. Error bars represent one standard error.*

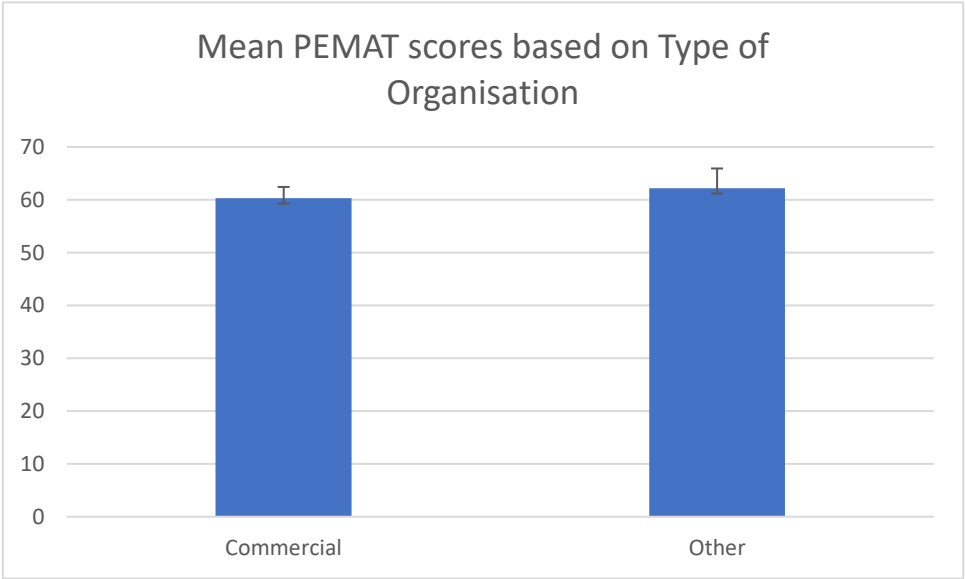

Figure 7. *Mean PEMAT scores from web pages commercial or other types of organisation. Error bars represent one standard error.*

3.4.5.2 DISCERN

Levene's test showed that the null hypothesis that the variances for location and type of organisation are equal was supported $F(7,55) = 1.743$, $p = .118$. The variances were not significantly different, therefore the statistical assumption of equal variances for ANOVA were met.

A two-way ANOVA was performed to test for the main effects of location and organisation type. The results showed no significant interaction between location and type of organisation on DISCERN scores: $F(3,55) = .877$, $p = .459$, $\eta^2 = .046$. The main effects revealed:

a. No significant difference in DISCERN scores between locations: $F(3,55) = .190$, $p = .902$, $\eta^2 = .010$.
b. No significant difference in DISCERN scores between type of organisation: $F(1,55) = 2.377$, $p = .129$, $\eta^2 = .041$.

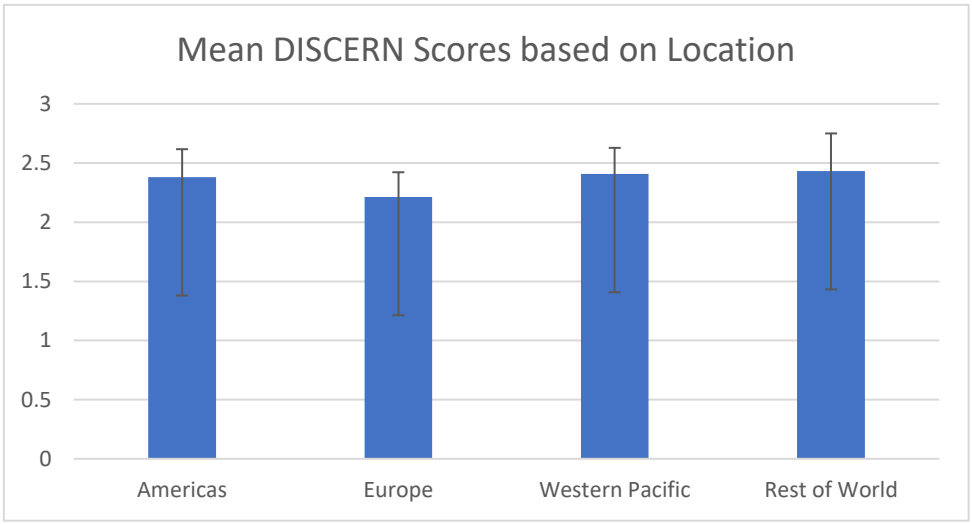

Figure 8. *Mean DISCERN scores of web pages originating from the Americas, Europe, Western Pacific, and Rest of World. Error bars represent one standard error.*

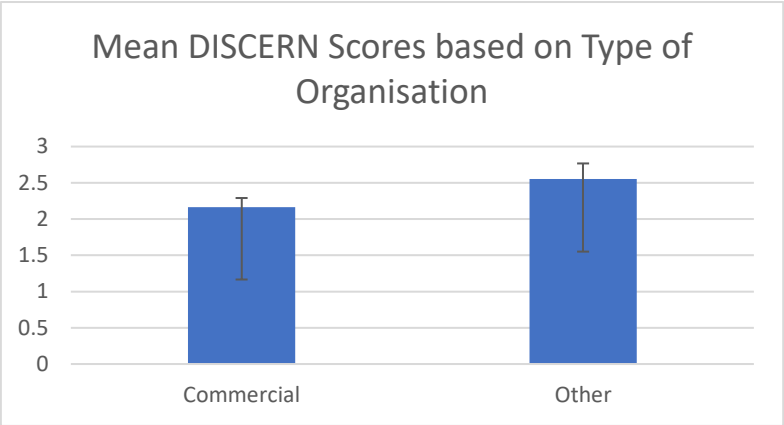

Figure 9. *Mean DISCERN scores of commercial and other types of organisation. Error bars represent one standard error.*

3.4.5.3 Plain Language Checklist

Levene's test showed that the null hypothesis that the variances for location and type of organisation are equal was supported $F(7,55) = 1.402$, $p = .223$. The variances were not significantly different, therefore the statistical assumption of equal variances for ANOVA were met.

A two-way ANOVA was performed to test for the main effects of location and organisation type. The results showed no significant interaction between location and type of organisation on plain language scores: $F(3,55)=1.177$, $p =.327$, $\eta^2 = .060$. The main effects revealed:

a. No significant difference in plain language scores between locations: $F(3,55) = .862$, $p = .466$, $\eta^2 = .045$.
b. No significant difference in plain language scores between types of organisation: $F(1,55) = .402$, $p = .529$, $\eta^2 = .007$.

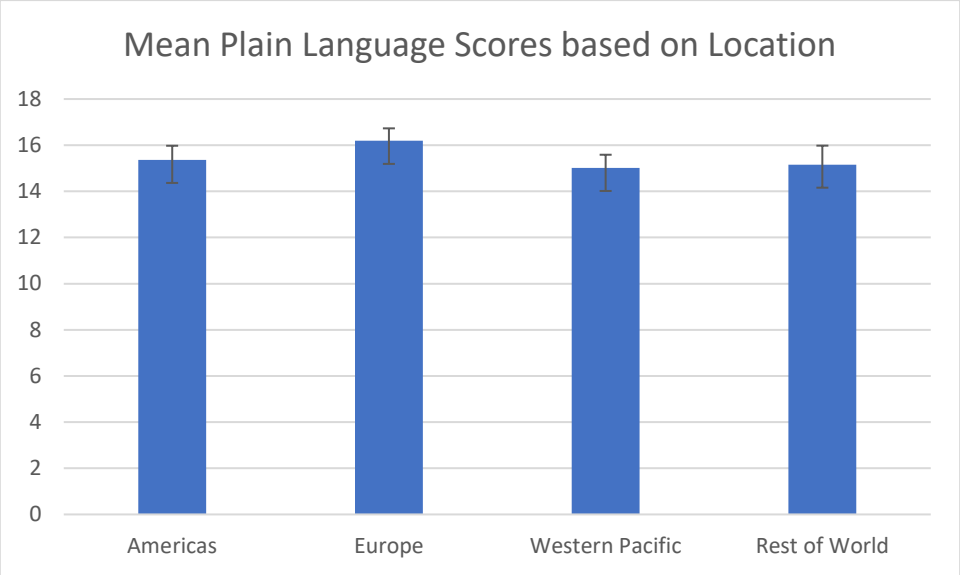

Figure 10. *Mean Plain Language scores of web pages originating from the Americas, Europe, Western Pacific, and Rest of World. Error bars represent one standard error.*

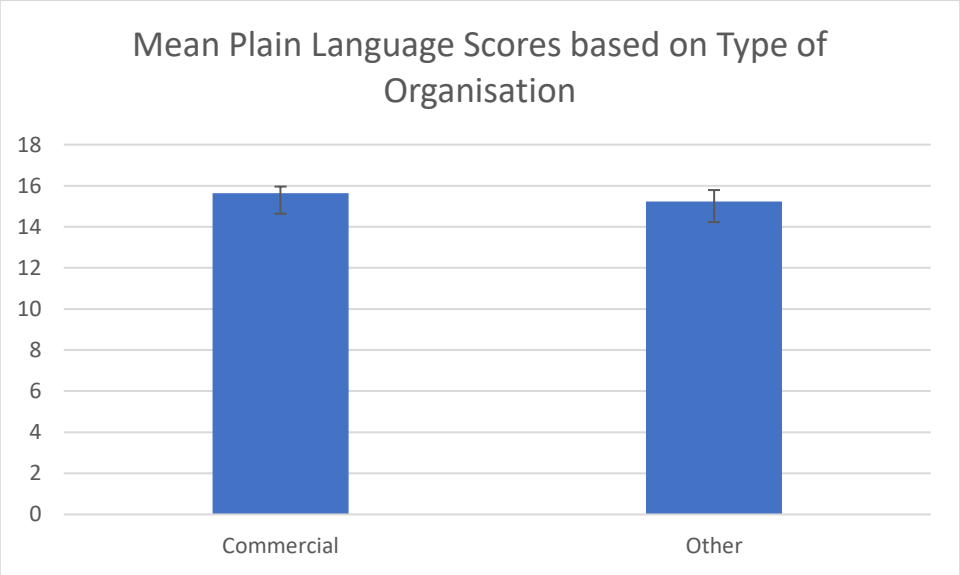

Figure 11. *Mean Plain Language scores of web pages from commercial and other types of organisation. Error bars represent one standard error.*

Based on these results, the null hypothesis there is no significant difference in quality of web pages based on (a) location, and (b) organisation type was supported. There were no significant differences in quality of webpages based on their location or organisation type.

3.5 Summary

The statistical analyses show that all null hypotheses were supported except for one. This was there are no significant differences in distribution of webpages based on (b) type of organisation. Because the data did not violate the assumptions of parametric testing, parametric statistical analyses were used. However, hypothesis testing for HONcode certification were removed due to the lack of an even distribution of webpages.

Discussion

4.1 Overview

The main purpose of this study was to assess the readability, suitability, and quality of online information on SSD available in English. It also aimed to compare these factors between webpage location, organisation type, and whether HONcode certification was present. Following the attrition of three websites, as two duplicates were overlooked in the process and one website was later found to be irrelevant, 63 webpages were analysed in total. Results found that online SSD information is above the 6th grade level and has an adequate mean suitability. It also has moderate levels of quality in reference to understandability, low levels of quality in reference to actionability, reliability and treatment options, and good quality in terms of plain language use. No differences in content assessment based on website location or organisation type was found. In this chapter the strengths and weaknesses revealed by this study will be discussed. Recommendations on improving these weaknesses will also be provided for web developers and clinicians to be mindful of.

4.2 Region and Type of Organisation

There was no significant difference in distribution of webpages based on locality, however, there was a significant difference based on type of organisation. Similar results have been found in previous research. For example, Nghiem et al. (2016) and Laplante-Levesque et al. (2012) had uneven distributions of websites based on organisation type, where the largest organisation category was commercial in both studies. In the current study, there were significantly more commercial websites than any other type also. This indicates that online information on SSD is primarily produced with involvement in advertising a business or treatment options. Commercial websites may be less likely to discuss options for

patients that do not align with the company's business model. Therefore, a reader may be less likely to come across important information or gain a full picture of the possible options. This may result in the reader opting for a treatment choice that might not be the best option available for them.

However, the study also found no differences in readability, suitability, or quality based on locality or type of organisation. Therefore, commercial websites were not found to be better or worse than other organisations. Users may have biases towards certain organisation types. Government websites for example are seen as more trustworthy by readers (Goldsmith, Lafferty, & Newell, 2000) and may be a preferred source of health information (Pletneva, Cruchet, Simonet, Kajiwara, & Boyer, 2011). This view may be inaccurate for webpages on SSD as indicated by the lack of significant difference in content assessment depending on organisation type in the current study.

In previous research Nghiem et al. (2016) found differences in DISCERN scores depending on organisation types which is unlike the current study. Charity websites had the highest average scores, followed by non-profit organisations, healthcare providers, government websites, and finally commercial health information websites (Nghiem et al., 2016). Laplante-Levesque et al. (2012) also found similar differences in DISCERN scoring depending on organisation type. Non-profit websites had higher quality scores on the DISCERN questionnaire than websites with a commercial or government origin (Laplante-Levesque et al., 2012; Laplante-Lévesque, Brannstrom, Andersson, & Lunner, 2012). The results of the current study not following this trend may be due to the limited and unequal distribution of organisation types.

The lack of significant difference in readability, suitability, and quality based on location of website origin indicates a homogeneity of content across regions. The internet is a

platform which provides links to other nations and which holds information that is accessible from virtually anywhere in the world. Perhaps this provides an environment where online information drifts towards having more similarities than differences due to the opportunity to compare and contrast information. However, this finding may be due to only English websites being evaluated, therefore the information may be skewed towards western ideals. No previous research evaluating the effect of webpage location on readability, suitability, or quality were found by the author. Therefore, this finding cannot be currently compared to other existing research.

4.3 Readability of Online Information on Single-Sided Deafness

The results of this study show that there were no significant differences in readability of webpages based on location of webpage origin and the type of organisation that published them. The results also show that webpages containing information related to SSD score significantly higher than a RGL of 6 on average and therefore do not meet the recommended guidelines for suitable readability.

Similar findings are reported in previous research on online hearing health information. Readability of information about hearing (Laplante-Lévesque & Thorén, 2015), audiology and speech language pathology (Atcherson et al., 2014), adults with hearing impairment and their significant others (Laplante-Levesque et al., 2012; Laplante-Lévesque et al., 2012), otitis media (Pothier, 2005; Ritchie, Tornari, Patel, & Lakhani, 2016) ear tubes (McKearney & McKearney, 2013), and hearing aids (Joseph et al., 2016) have been shown to be written above a RGL of 6. Joseph et al. (2016) also found that the overall average reading grade levels for the websites were at the 10^{th} grade for professional organisations, 10^{th} grade

for suppliers, and the 11th grade for health information services. This supports the finding that RGLs of websites are high regardless of the type of organisation that created them.

These findings are not limited to online or audiological information. Offline information such as leaflets used in speech and language therapy departments (Pothier et al., 2008), patient-reported outcome measures used for audiologic rehabilitation for adults (Douglas & Kelly-Campbell, 2018), verbal and written language in hearing aid orientation appointments (Nair & Cienkowski, 2010), and patient education materials in ambulatory care settings (Davis et al., 1990), are above the 6th RGL.

Online health information related to other health subjects have been shown to be difficult to read also. Online education materials related to breast cancer, depression, obesity, and childhood asthma (Berland et al., 2001), breast, prostate, and colorectal cancers (Friedman et al., 2006), heart disease, cancer, stroke, chronic obstructive pulmonary disease, and diabetes (Walsh & Volsko, 2008), cancer (Wilson et al., 2000), otolaryngology (Eloy et al., 2012; Greywoode et al., 2009; Svider et al., 2013), facial plastic and reconstructive surgery (Misra et al., 2013), and endoscopic sinus surgery (Cherla et al., 2013), was found to be significantly above the 6th RGL. Cherla et al. (2013) found that hospital and university sources had lower (better) readability scores. However, the materials evaluated were above the 6th grade level regardless of source type.

4.4 Suitability of Online Information on Single-Sided Deafness

The current study found no significant differences in suitability of webpages based on their location or type of organisation. It also found that webpages related to information on SSD were at an adequate level of suitability on average. These findings are supported by similar findings in previous research. Using SAM, online websites have been rated as adequate for cancer patient caregivers (Monton et al., 2019), mastectomy and lumpectomy,

(Tran, Singh, Singhal, et al., 2017), breast reconstruction (Vargas et al., 2015), colon cancer screening (Tian et al., 2014), depression self-management resources (Rathod, Ould Brahim, Belzile, & Lambert, 2019), and lymphedema (Tran, Singh, Lee, et al., 2017).

Two studies that assessed audiological materials using SAM revealed worse suitability scores than the current study. In assessing hearing aid user guides, Caposecco et al. (2014) found 69% of brochures evaluated to be inadequate. McMullan et al. (2018) assessed a hearing aid user guide using SAM which indicated the guide to be not suitable.

4.5 Weaknesses Identified by SAM+CAM

This study found that 85.7% of the websites did not have a suitable review and only 9.5% were adequate. The remaining 4.8% of websites were short materials and therefore did not need a summary. Inclusion of a summary provides a higher chance of the reader to pick up key messages they may have missed (Doak, Doak, & Root, 1996b). A summary also facilitates reinforcement of learning and therefore development of skills followed by enhanced self-efficacy (Doak et al., 1996b).

Online information on SSD had some shortcomings with the Learning Stimulation and Motivation section. Of the websites analysed, 68.3% did not have suitable motivators to attend to the text. It was also found that 85.7% of the websites did not have suitable reader interactions. None of the websites had suitable theoretical applications. This is supported by Monton et al. (2019) as the material for cancer caregivers they analysed also scored poorly on learning stimulation and motivation. Motivation is a significant factor in the consumption and comprehension of written material. Methods such as presenting content in unusual ways, addressing cultural beliefs, and posing questions the reader might ask and answering them are some forms motivators to attend can take (Helitzer et al., 2009). Focus on enhancing

attention, interest, and active engagement of the reader can prompt desired reader behaviours and allow for easier learning and understanding (Helitzer et al., 2009).

4.6 Strengths Identified by SAM+CAM

The materials assessed tended to score well with certain items related to Literacy Demand. It was found that 85.7% of the websites had superior use of confusion reducers and that 63.5% of the websites made superior use of context. The study found that 87.3% of the websites had superior scope and length. This is supported by Monton et al. (2019) as the material for cancer caregivers they analysed also scored highly on information scope. Most material used explicit, non-technical terms either instead of or in explanation of technical terms. There was also frequent use of new information presented within the context of established information. Along with low readability, confusion reducers such as active voice with personal and easy to understand language alleviate challenges to reader comprehension (Helitzer et al., 2009).

The information assessed scored well in some aspects of Layout and Typography. It was found that 87.3% of websites had superior layout and organisation and 98.4% of the websites had superior typography. This would have positive effects on reader comprehension as good layout and typography reduces confusion, makes things easier to read, and helps guide the readers from beginning to end (Helitzer et al., 2009).

4.7 Quality of Online Information on Single-Sided Deafness

4.7.1 DISCERN

The current study found no significant differences in quality, as measured by DISCERN, of webpages based on their location or type of organisation. The study also found that online material related to SSD scored on average 2.27, which is between the scores of 1: having serious or extensive shortcomings, and 3: potentially important but not serious shortcomings.

Similar findings have been reported in previous literature. Online information on vascular malformations (Davis et al., 2017), bariatric surgery (Akbari & Som, 2014), diverticulitis (Connelly et al., 2018) have been found to have potentially important but not serious shortcomings. Audiological material on tinnitus (Manchaiah et al., 2019), and information on hearing loss for adults and their significant others (Laplante-Levesque et al., 2012) has also been shown to have potentially important but not serious shortcomings. In contrast Nghiem et al. (2016) found that on the whole, online information related to breast cancer was of good quality.

Other previous studies did not use the same overall rating method for DISCERN. Instead, they derived a score out of a total of 75 to 80 points. Material on tinnitus (McKearney, MacKinnon, Smith, & Baker, 2018), and metal-on-metal total hip arthroplasty obtained ‘moderate’ levels of quality which may be similar to the findings of this study. Interestingly, this other method of scoring seems to introduce more subjectivity into the overall rating. This can be seen with differences in reports of quality with virtually the same score, i.e. McKearney et al. (2018) report 34.5 as ‘fair’ while Doruk et al. (2018), who investigated materials on vocal fold nodules report 34.96 as ‘very low’.

4.7.2 Weaknesses Identified by DISCERN

Some particular items were scored poorly for most of the websites. The study found that 71.4% of the websites did not make it clear what sources of information were used to compile the publication (other than the author or producer). It was also found that 54.0% of the websites did not make it clear when the information used in the publication was produced. While this was not directly investigated in this study, there are implications for the veracity of the information assessed. Science backed information as opposed to anecdotal, or pseudoscientific information that is not verified may be of better quality. Therefore, if one cannot discern where online information lacking in sources is originating from, there is a higher chance of less accurate information being presented. A lack of dates for sources also hinders investigating whether information presented in the material is outdated and/or has since been disproven (Charnock, 1998).

It was found in the study that 61.9% of the websites did not refer to areas of uncertainty. Due to the large number of commercial websites present online, all treatment options for SSD were usually not discussed within one webpage. The webpages were often promoting a particular device or brand. Therefore, the notion that this treatment may not work for everyone was not often explored. A lack of this notion may misguide patients to thinking that the choice for the most suitable treatment is more straightforward than it really is (Charnock, 1998).

The material scored worse on treatment choices as shown by the following specific items. It was found that 90.5% of websites did not describe the risks of each treatment. This means that readers do not get the full picture of what sort of outcomes can be expected following treatment. For example, if cochlear implantation were portrayed as a treatment choice for SSD, risks such as nerve damage, dizziness and balance problems, loss of residual

hearing, tinnitus, and infection, and more are all possible (Halawani, Aldhafeeri, Alajlan, & Alzhrani, 2019). Awareness of these risks may be a deciding factor in whether a client pursues a treatment option or not (Charnock, 1998). Unawareness of risks is a threat to informed choice and therefore desired patient outcomes.

It was shown that 69.8% of websites did not describe what would happen if no treatment was used. Much like treatment risks, knowing what would happen if no treatment was used is also part of providing the full picture of what can be expected. A client may opt for taking no action if all other treatment options do not suit their desired outcome (Charnock, 1998). Therefore, having the knowledge of what would happen is important to portray in online material.

The study found that 71.4% of the websites did not describe how the treatment choices affect overall quality of life. Treatment choices may require major lifestyle changes or impacts on family members that must be considered when deciding on treatments (Charnock, 1998).

The study also found that 71.4% of the websites did not provide support for shared decision making. Shared decision making involves clinician and patients working together to guide the patient to an informed decision where multiple options and evidence has been explored (Elwyn et al., 2012). Support for this involves suggestions of topics involving treatment choices to discuss with family, friends, and health professionals (Charnock et al., 1999). Failure to support shared decision making could mean a patient does not use the opportunity to take an active role during their next healthcare appointment. Therefore, their lack of activation may mean they miss out on better health outcomes (Carman et al., 2013).

4.7.3 PEMAT

The current study found no significant differences in quality, as measured by PEMAT, of webpages based on their location or type of organisation. The study also obtained variable levels of quality between websites. The combined PEMAT results had a minimum of 29.4% and a maximum of 90% (*M* = 61.57%, *SD* = 14.06%), understandability had a minimum of 38.5% and a maximum of 93.4% (*M* = 69.34%, *SD* = 13.08%) and actionability had a minimum of 0% and a maximum of 100% (*M* = 37.54%, *SD* = 39.22%).

This is similar to findings of previous studies. Online information on vascular malformations (Davis et al., 2017) scored 59% for understandability. Patient education materials for sickle cell anaemia (McClure et al., 2016) obtained a mean understandability score of 71.1% and a much lower mean actionability mean of 36.3%. Information on vocal chord paralysis (Balakrishnan et al., 2016), obtained a mean score of 53% for understandability. Online risk calculators for cardiovascular disease (Bonner et al., 2018) scored a mean of 64% on understandability and a mean score of 19% on actionability. These studies show that understandability tends to score better than actionability which is apparent in the current study also.

In contrast, Wong et al. (2017) investigated online education materials for laryngectomy and obtained similar mean scores for understandability (68.3%) and actionability (66.3%). The same was found in Morony et al. (2017) where patient education materials on chronic kidney disease scored 57% for understandability and 52% for actionability.

4.7.4 Weaknesses Identified by PEMAT

Some items relating to understandability scored poorly. It was found that 87.5% of the websites did not use common, everyday language. This is problematic because uncommon and non-conversational language, such as passive voice, long phrases, and embedded information hinder comprehension of the material and cause the reader to get through the material much slower (Doak et al., 1996b). Using common everyday language in a conversational style and with use of an active voice makes information easier to understand (Doak et al., 1996b)

It was found that 92.1% of websites did not provide a suitable summary. Inclusion of a summary provides a higher chance of the reader to pick up key messages they may have missed (Doak et al., 1996b). A summary also facilitates reinforcement of learning and therefore development of skill followed by enhanced self-efficacy (Doak et al., 1996b). The study also found that 73.0% of the websites did not use visual aids whenever they could make the content more easily understood. This shows that there were many lost opportunities to further comprehension and encoding of information for most websites. Not only does illustrating a concept beyond using just text increase understanding, it also provides repetition of the concept (Shoemaker et al., 2013).

It was found that 95.2% of the websites had no audio-visual material. This might be a lost opportunity to increase the likelihood of the user understanding key information by reiterating written information in a different format. Videos and slideshows can be affective in increasing health knowledge (Berkhout et al., 2018). Audio-visual material can be effective as a supplement or alternative to written material as patients with low literacy skills achieve similar levels of comprehension for written material and a video version with the same content (Meade, McKinney, & Barnas, 1994).

Some items relating to actionability also scored poorly. It was found that 63.5% of the websites did not address the user directly when describing actions. Addressing the reader can help in engaging them and to gain the attention necessary for them to learn and understand the content more easily (Helitzer et al., 2009). It was found that 54.0% of the websites did not provide a tangible tool whenever it could help the user take action and 55.6% of the websites did not break down actions into manageable, explicit steps. None of the websites used visual aids whenever they could make it easier to act on the instructions. This is detrimental to reader stimulation and learning. Material with good actionability should tell the reader how to take action and provide tools to aid this when possible rather than using ambiguous terms or health goals without advice on how to achieve them (Shoemaker et al., 2013).

4.7.5 Strengths Identified by PEMAT

Some items of the PEMAT scored well for understandability. Most websites had a clear purpose (89.1%), no information that distracted from its purpose (93.8%), did not require the reader to perform calculations (98.4%), chunked information (96.8%), used informative headers (85.7%) had a logical order (98.4%), and used visual cues to draw attention to key points (84.1%). The prolific presence of these aspects means that consumers of varying levels of health literacy are more likely to be able to process key messages of the material (Shoemaker et al., 2014).

It was found that 66.7% of websites did not use numbers. This may be because SSD has less involvement with numeric information as opposed to other health topics. It can be argued that this may be beneficial to understanding of the material as further opportunities for confusion due to limited health numeracy may be avoided. Limited numeracy is tied to

difficulty in understanding risks, treatment options, and adherence to desired patient management strategies (Golbeck, Ahlers-Schmidt, Paschal, & Dismuke, 2005).

4.7.6 Plain Language

The current study found no significant difference in quality, as measured by plain language, based on location and type of organisation. It also found that online information related to SSD has good levels of plain language use (M = 15.59, SD = 2.10). While the plain language checklist used in this study has not had test retest reliability or validity established, previous literature indicates that a stronger focus on plain language use promotes comprehension of the material. Decision aids for prostate cancer (Holmes-Rovner et al., 2005), patient instructions for use of an auto-injector (Smith & Wallace, 2013), and dosing instructions within after-visit resources (Ancker et al., 2017) showed positive effects on comprehension when plain language was used.

4.7.7 Weaknesses Identified by the Plain Language Checklist

Most items on this checklist were scored as present for most of the evaluated material, therefore showing many strengths involving plain language for online SSD information. However, some items tended to be absent from the content. It was found that 88.9% of the websites did not explain technical terms used, 76.2% of the websites did not use simple sentences throughout the text, and 79.4% of the websites did not eliminate unnecessary words or jargon. This indicates that most websites used complicated words related to SSD that should have been either explained or eliminated. The presence of these would likely decrease readability and therefore hinder understanding.

4.8 Clinical implications

The current study reported no significant differences between content assessments of webpages depending on webpage location and organisation type. Online information related to SSD is above the recommended 6th grade level, has moderate levels of quality in reference to understandability, good quality in terms of plain language use, and low levels of quality in reference to actionability, reliability, and treatment options. This is important because the internet is a medium that many can use to access information on the cause, symptoms, diagnosis, and treatment options of SSD. One can argue that there is likely a disparity between the number of individuals needing information on SSD and the number of individuals who successfully extract it that is in part due to the current online content. The difficulty in accessing, understanding, and acting on information needed arising from this has the potential to negatively affect health outcomes. Therefore, clinicians need to be careful in directing patients towards online information and there is rationale for developers revising information online related to SSD.

4.9 Recommendations for Web Developers

In the ideal future, developers of websites should take steps to improve their current materials or create new materials that optimise readability, suitability, and quality. From this, a higher occurrence of information uptake, patient understanding, and desired user behaviour is expected, resulting in improved health outcomes for people with SSD.

Primarily, material should be written to cater towards individuals with low health literacy. This would be achieved through focussing on the use of readability formulas and plain language checklists to bring the RGLs at or below 6 and provide content that facilitates reading ease and comprehensibility.

Higher levels of suitability can be achieved through utilising a measure to identify weaknesses in the material and adjusting the piece accordingly. As discussed earlier, online information on SSD has specific areas requiring improvement as shown by SAM+CAM. The material can be improved by altering the material to include the criteria laid out in the SAM tool by Doak et al. (1996a) and its revision by Helitzer et al. (2009). Due to the lack of summaries provided, it is recommended that developers bullet-point key information at the beginning or end of text with no more than five items. To improve motivators to attend to the text, developers should present information in unusual ways, use questions directed to the reader, and use verbal immediacy such as present tense. To improve reader interactions, developers could include questions that the reader responds to, provide visuals the reader is to compare and contrast, give examples of or encourage questions to ask health professionals, and use stories to convey messages or that the reader should complete. To alleviate lack of theoretical application, developers could use theoretical constructs to act as a science-backed framework to structure material that is aimed strongly towards improved health outcomes. An example is the Health Belief Model which was developed by Rosenstock, Hochbaum, Kegeles, and Leventhal (Rosenstock, 1974). It involves theoretical items that explain engagement or lack thereof in desired health behaviour with focus on patient belief about health problems, perceived benefit to action, barriers to action, and self-efficacy (Rosenstock, 1974).

Higher levels of quality can be achieved through using evaluative tools such as the DISCERN, PEMAT, and a plain language checklist. As previously identified, there are weaknesses in online SSD information identified by DISCERN that could be amended through following recommendations outlined by Charnock et al. (1999). To combat a lack of sources and the dates of their production in publications, developers should place higher

priority on including up to date referenced information. Arguably, developers may therefore be driven towards current and peer-reviewed information more often. Developers should also aim to refer to areas of uncertainty. To do this, they must explore all known available options and discuss their merits and inferiorities to provide context and opportunity for a reader to find the best option for them. Risks for treatment choices should always be included when describing treatment options and treatment options should also include taking no action. Developers should also include suggestions of topics involving treatment options or questions to discuss with healthcare professionals to enhance support for shared decision making.

Further weaknesses were revealed by PEMAT. To improve these, developers should follow the criteria described by Shoemaker et al. (2013). Emphasis on common, everyday language should be given by developers. To aid in this process, readability measures and plain language checklists can be used. The lack of summaries in the material, as also shown by the SAM+CAM, must be amended by including short reiterations of key information. Material must be constructed to often address the user directly when describing actions. For example, phrases such as ‘A healthcare professional should be contacted immediately’ should be replaced with ‘Contact a healthcare professional immediately’. Websites should include tools that help users take action and break actions into manageable steps. Examples of tools could involve symptom checklists to indicate whether readers should visit a healthcare professional or quizzes to guide readers to the most appropriate treatment choice. Steps to take action should be brief, unambiguous, and directly tell the reader how to take the action. Visual aids should be included that clearly support instructions to make them easier to understand.

Finally, weaknesses revealed by the Plain Language Checklist should also be eliminated. Technical terms should either be removed or be accompanied by explanations.

Complicated sentences should be simplified to remove embedded information. Unnecessary words or jargon should be replaced by more common terms to cater to a broad audience.

When creating new material, developers should also pilot the material to a sample of the public for user testing (Vallance, Taylor, & Lavallee, 2008). Doing so can indicate the effectiveness of the information and reveal further areas for improvement. Therefore, the result of a readable, suitable, and good quality publication may be more likely.

4.10 Recommendations for Clinicians

As mentioned earlier, only one quarter (Protheroe & Rowlands, 2013) to one half (Kessels, 2003) of information given to a patient during a consultation is remembered correctly. Elevated anxiety and stress, as well as age induced memory decline, all elements often present in the audiological setting, exacerbate this. One way to combat this is through the use of supplementary written information (Kessels, 2003). At this time, clinicians wanting to provide effective supplementary information to clients would need to direct them to specific sites that they know are suitable or write their own material. Therefore, they will need to have knowledge of what superior material constitutes of and what sort of weaknesses to be aware of. The best way this could be done is through evaluating material they wish to provide to clients using the measures used in this study, or other validated tools measuring the same or similar items, and collecting the best scoring webpages. For an example, see Table 2 for a list of the webpages that obtained the highest scores for each assessment tool. More simply, they could also assess the RGLs of material. Clinicians would need to overcome possible barriers of lack of willingness or time constraints to evaluate material. However, doing so would allow them to build up a list of curated sites that the clinician knows are readable, suitable, and of good quality that they can quickly access. The effects of biases that clinicians may hold towards government and non-profit organisations, as

discussed by Goldsmith et al. (2000) and (Pletneva et al., 2011), may be alleviated through using validated measures to evaluate material also.

Table 2. *Highest Scoring Webpages for each Assessment Tool*

Assessment Tool	Website	Score	Country of Origin	Type of Organisation	HONcode Certification
RGL	Cochlear: Signs of Hearing Loss in Adults https://www.cochlear.com/in/home/understand/hearing-and-hl/medical-conditions/medical-conditions-in-adults	7.92	Europe	Commercial	No
SAM+CAM	Cochlear: When to Consider Implants for Adults https://www.cochlear.com/au/home/understand/i-have-hl	83.4	Western Pacific	Commercial	No
PEMAT	NHS: Your Baby Has a Hearing Loss in One Ear https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/402695/Your_Baby_has_a_HL_unilateral.pdf	90	Europe	Other (Government)	No
DISCERN	Seminars in Hearing: Audiological Management of Children with	4.5	Rest of World	Commercial	No

	Single-Sided Deafness https://www.mm3admin.co.za/cms/cpd/articles/AudiologicalManagementofChildrenwithSingleSidedDeafness.pdf				
Plain Language Checklist	Canadian Hearing Society: Help for Single-Sided Deafness https://www.chs.ca/help-single-sided-deafness	20	Americas	Other (Non-profit)	No
	Cochlear: Signs of Hearing Loss in Adults https://www.cochlear.com/in/home/understand/hearing-and-hl/medical-conditions/medical-conditions-in-adults	20	Europe	Commercial	No
	Cochlear: When to Consider Implants for Adults https://www.cochlear.com/au/home/understand/i-have-hl	20	Western Pacific	Commercial	No

4.11 Limitations and Future Research

The study includes limitations involving the measures used, flaws in analysis, and human error. These have implications for the results and also provide cues for future research.

Only one search engine (www.google.com) was used to collect the webpages. This was done because it is the most commonly used engine (Fox & Duggan, 2013). However, this does therefore exclude all potential methods of searching for SSD information. Future research could include other popular search engines to improve the representation of online material.

Only four search terms were used in the internet search. More terms were obtained and evaluated using Google trends and were found to be relatively uncommon. However, there may be other common search terms used by the public to search for information on SSD that were not used in this study. This means that there is a possibility of viable SSD web results and articles that have not been accessed in this study.

Veracity of information was not investigated in this study, however it is an incredibly important component to the quality of online information. Therefore, misleading or incorrect information may have been able to receive good ratings with the measures used, simply because the measures are assessing the type of content and not necessarily the content itself. Future research could be conducted to investigate the accuracy of online SSD information.

Readability formulas have limitations because they do not consider the type of audience the material is aimed at. Material such as journal articles are aimed at an educated population and are required to be written in a formal manner. This however decreases the readability. Readability also does not consider reader characteristics, reader experience, the topic of the material, or what the reader is looking for.

The sample sizes for organisation types and locations were not evenly distributed. Therefore, these had to be collapsed into different groupings. This reduced the detail of the information obtained from the study as the specificity of website origins was removed.

The suitability measure used in this study (SAM+CAM) is a revision the SAM, which is what the previous research discussed has used. Therefore, direct comparison to past research is not as feasible.

The rater's criteria by which they select certain items appears to have varied across webpages and measures used. For example, using the SAM+CAM, 54 webpages were rated to have an unsuitable summary, six were adequate, and three were non applicable. Using the PEMAT, 58 were rated to not have a summary, one had a summary, and four were non applicable. There is also a discrepancy between similar items in the PEMAT and the plain language checklist. Using the PEMAT, 62 websites were rated to have a logical sequence while using the plain language checklist, only 52 websites were rated to be arranged in a sensible order. As these items are assessing the same aspect of webpages, these discrepancies indicate variances in interpretation of the content of webpages by the rater and therefore a flaw in the reliability of ratings that may be present for other items also. This may be due to the specific wording of the items or subjective views of how to rate the websites differing over time. This is despite the establishment of inter-rater reliability using ICC showing 'excellent agreement beyond chance'.

Of the initial 68 websites selected to be analysed, 3 were lost to attrition. This was due to 2 duplicates being overlooked in the selection process and one website was later found to be irrelevant. This rendered the study to produce less information to test the hypotheses and may have reduced the study power.

Chi-square test for independence could not be reported as the assumptions of the test were violated. Some variables also violated assumptions of parametric testing as the distributions had skewness and/or kurtosis. The PEMAT subcategories of understandability and actionability were combined to mitigate this, however, this reduced comparability to previous research as most report understandability and actionability separately.

The PEMAT does not have an established metric for what sort of percentage constitutes a poor, moderate, or good quality publication. This introduced further subjectivity into deciding the quality of the material as well as comparisons to previous research.

There is limited research on the effect of organisation type and location on webpage ratings. Future research could be conducted to fill this gap and provide information that may support or contradict the findings of this study.

There were not enough websites to include HONcode analysis into the hypothesis testing, therefore this hypothesis was excluded from the analysis. This does however show the lack of webpages aiming to follow a standard level of quality via the assessment and accreditation of an established code. Therefore, it is implied that improvements can be made by publishers through improving their webpages using the HONcode and striving to gain its accreditation.

The plain language checklist used is not a validated tool as test-retest reliability and validity have not been established. This means there be may flaws in the items that cause the tool to not be as effective as assumed. Perhaps the overall high plain language levels of the material in contrast to the poor to adequate levels of the remaining measures is an indication of this. Future research could use a validated checklist or aim to validate the checklist used in the current study.

The DISCERN tool did not define what a rating of 2 or 4 is. Therefore, there is an added level of subjectivity in the overall rating of each publication. The data may have been treated more as an ordinal scale of measurement where data is ranked instead of an interval scale.

Future research could also be directed to include material in languages other than English. This would provide comparability across languages and an indication of where English information stands in the context of the world. Online information on SSD will need

to be assessed again in the future due to the transient nature of information on the internet. It should also be reassessed due to information on SSD not having been assessed to date, meaning consistency of results has not been established.

4.12 Conclusions

The internet contains a vast deposit of health information and is commonly accessed to gain important information. The content of this information can directly affect an individual's health outcomes in a positive or negative way, depending on its readability, suitability, and quality. Online information related to SSD is too difficult to read for the public, has moderate levels of quality in reference to understandability, low levels of quality in reference to actionability, reliability and treatment options, and good quality in terms of plain language use. This indicates that the public may have difficulty in accessing, understanding, and acting on information they need. Subsequently, there may be negative effects on their health outcomes. There is rationale for revising and developing superior information online related to SSD to educate the public on the disorder and what treatment options are available to them.

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