Readability and Suitability of Online Materials Related to the Vestibular System in English

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Abstract

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

Method: Four search terms ("vertigo" "dizziness" "dizzy" and "nausea") were entered into 19 country-specific Google domains. The first ten relevant web pages were included. After removing duplicates, a total of 92 webpages were assessed. Their region (Africa, Americas, Europe, Western Pacific, World), type of organisation (commercial and other), and HONcode certification were recorded. Readability was assessed using the FOG, SMOG, and F-K readability formulas. Suitability was assessed using the DISCERN, PEMAT and Plain Language tools.

Results: Online information on the vestibular system was found to have high readability and low to adequate suitability. None of the webpages met the recommended sixth RGL. There were no differences in readability or suitability of web pages based on their region or type of organisation. There was not an even distribution of web pages based on type of organisation, there was a significant difference between mean RGL in the study sample and the recommended sixth RGL, there were significant differences in DISCERN scores based on type of organisation, there were significant differences in PEMAT understandability scores based on region and type of organisation and there were significant differences in plain language scores based on region.

Conclusions: The current information available online on the vestibular system has less than ideal readability and suitability scores. To access information on treatment and management for the number of vestibular disorders that can occur, adequate online information needs to be available for internet users. Improvements in both online information and the methods of accessing this information needs to occur.

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List of Abbreviations

AMA	American Medical Association
AN	Acoustic Neuroma
ANOVA	Analysis of Variance
BPPV	Benign Paroxysmal Positional Vertigo
ccTLD	Country-coded Top-Level Domains
F-K	Flesch-Kincaid
FOG	Gunning Fog Index
FRE	Flesch Reading Ease
HIT	Head Impulse Test
HON	Health on the Net
ICC	Intra-class correlation coefficient
ICT	Information Communication Technology
NIH	National Institutes of Health
PEMAT	Patient Education Materials Assessment Tool
PCC	Patient-Centred Care
RGL	Reading Grade Level
SCC	Semicircular Canals
SDM	Shared Decision Making
SMOG	Simple Measure of Gobbledygook
URL	Uniform Resource Locator
VN	Vestibular Neuritis
VS	Vestibular Schwannoma

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Chapter 1: Introduction

1.1 The Vestibular System

1.1.1 Definition

The vestibular system, also called the balance system, is the oldest part of the inner ear. It detects the motion of our head in relation to space and integrates visual, proprioceptive and extra-vestibular information. The vestibular system plays a vital role in gaze stabilisation, balance and posture (Cullen, 2012). It is not until a deviation in the vestibular system occurs when the importance of this integration becomes apparent, leading to symptoms such as vertigo, dizziness, gaze instability and postural imbalance (Tian, Shubayev, Baloh & Demer, 2001).

1.1.2 Structure and Function

The vestibular system has three components: the peripheral apparatus, a central processor and a system responsible for motor output (Hain & Helminski, 2014). The peripheral system is comprised of two parts: the bony labyrinth and membranous labyrinth. The bony labyrinth is filled with perilymphatic fluid (Della Santina., Potyagaylo, Migliaccio, Minor & Carey, 2005) and contains the three semicircular canals (SCC), the cochlea (responsible for hearing) and a chamber called the vestibule. The membranous labyrinth is contained within the bony labyrinth and consists of the three SCC and the otolith organs; the utricle and saccule (Hain & Helminski, 2014). The membranous labyrinth, however, is filled with endolymphatic fluid (Della Santina et al., 2005). The endolymph and perilymph differ in their chemical composition, albeit equally as important for different functions within the vestibular and hearing system (Hain & Helminski, 2014).

Two types of sensors exist in the vestibular system: the three semicircular canals and two otolith organs (Pfeiffer, Serino & Blanke, 2014). All five organs are necessary for the

functioning of the vestibular system. The three SCC are the horizontal canal, superior canal and the posterior canal. All three lie within approximately 90 degrees to one another (Hamann, 2006) and are responsible for detecting rotational acceleration of the head (Cullen, 2012). The two otolith organs, the utricle and saccule, detect linear movement (Rutka, 2004). The utricle is positioned in a horizontal plane and tilted upward, detecting movement in the horizontal plane. The saccule is oriented in the vertical plane and detects movement in the vertical plane (Balaban, Black & Silberstein, 2019).

The SCC and otoliths both contain hair cells. Hair cells detect mechanical energy generated by head movement and convert this energy into neural signals. The neural signals are then sent to different locations in the brain (Hain & Helminski 2014). Specifically, the signals are sent up the vestibulocochlear nerve, also known as the eighth nerve, up to the central processor. The eighth nerve consists of three nerves; the auditory nerve, the facial nerve and the vestibular nerve. The central processor consists of the vestibular nuclear complex and the cerebellum. The cerebellum monitors and readjusts any vestibular processing, acting as an adaptive processor. The vestibular nuclear complex, however, functions as a link between the systems: it receives information from the inner ear and sends fast direct connections to the motor output system. The central processor, thus, integrates the vestibular, visual and somatosensory input (Cullen, 2012).

1.2 Disorders of the Vestibular System

1.2.1 Prevalence

Vestibular disorders are among the most frequent complaints in healthcare. After lower back pain and headaches, vertigo is the most common complaint presented to neurologists (Brandt, 1996). Using data from the 2001 to 2004 National Health and Nutrition Examination Survey (NHANES), Agrawal, Carey, Della Santina, Schubert and Minor (2009)

found that 35% of Americans aged 40 years and older (equating to approximately 69 million individuals) had some form of dysfunction of the vestibular system, alongside one third of the population experiencing some form vestibular disorder by age 60 (Luxon, 2004).

Although dizziness and vertigo are often used interchangeably, there is a notable difference. Vertigo is the illusionary sensation that the world around you is spinning when you are not moving. Dizziness, on the other hand, is the sensation of presyncope (feeling as though you are about to faint), unsteadiness, feeling lightheaded and is of a non-vestibular origin (Neuhauser et al., 2005).

Vertigo is classified into two categories: subjective and objective. Subjective vertigo is feeling like you are moving, whereas objective vertigo is the perception of objects around you moving (Rutka, 1998, as cited in Rutka, 2004). Vertigo can be further classified as rotational, the sensation of self-motion or object motion, and positional, instigated by movements and changes in position such as rolling over in bed, bending forward and extension of the neck to look upwards (Neuhauser, 2007). The affected ear can be identified depending on the side the movement occurs to stimulate these sensations. Vertigo is often associated with feelings of dizziness, loss of balance, nausea and oscillopsia (blurring of vision). Vertigo is slightly more prevalent in females and the likelihood of it occurring increases significantly with age (Neuhauser et al., 2005), being three times more common in the elderly population. Agrawal, Ward and Minor (2013) found 85% of individuals over the age of 80 years have evidence of a balance dysfunction, with the risk of falling for these individuals also being greater by 2.6-fold (Agrawal et al., 2009).

1.2.2 Psychological Impact

Not only is vertigo physically uncomfortable, it can also significantly impact the individual on a psychological and psychopathological level. Vertigo attacks are often

intermittent and random and the individual cannot predict when they will occur. This can result in a person experiencing anxiety for when the next episode will be, sometimes leading to a panic attack (Eagger, Luxon, Davies, Coelho & Ron, 1992). The findings by Monzani, Casolari, Guidetti and Rigatelli (2001) support previous research that psychological distress, such as anxiety and depression, is greater than expected for people with vestibular dysfunctions than the general population. The clinical implications of untreated vertigo and vestibular symptoms can therefore be severe, including decrease in quality of life, negative psychological impact and increased risks of falling, especially in older adults (Agrawal et al., 2009).

Many individuals with vestibular symptoms also develop secondary psychiatric disorders (Eckhardt-Henn et al., 2008). These individuals are also more likely to have lasting dizziness and/or vertigo symptoms even after the acute stage of the disease has passed, including decreased psychosocial functioning, dizziness and disease-specific handicap (Luxon, 2004). The somatopsychic theory suggests that the disorder or symptom has a pathological influence on the individual's mind, leading to a persistence of vertigo symptoms even after the underlying disorder has come to a resolution (Jacob & Furman, 2001). The connection between vestibular and psychiatric symptoms, however, is an ongoing debate (Best, Tschan, Eckhardt-Henn & Dieterich, 2009).

1.2.3 Causes

Vertigo and disorders of the vestibular system are mainly from damage to the peripheral or central vestibular system (Best et al., 2009). The main causes include displaced inner ear particles (BPPV), an infection in the vestibular labyrinth (vestibular neuritis), a tumour on the vestibular nerve (acoustic neuroma), and pressure build-up of endolymphatic fluid (Ménière's Disease).

1.2.3.1 Benign Paroxysmal Positional Vertigo

Benign paroxysmal positional vertigo (BPPV), is the most common cause of vertigo (Neuhauser et al., 2005). The semicircular canals are filled with endolymph; at the base of each semicircular canal there is a sensory region called the ampulla, and the top layer of the otolith organs contains calcium carbonate crystals known as otoconia (Balaban et al., 2019). Under normal conditions, head movement causes flow of the endolymph and likewise, movement of the crystals. BPPV is when the crystals are free-flowing within the canal or remain attached to the cupula without head movement, resulting in dizziness and sensation of movement when there is none (Hamann, 2006). BPPV is not life threatening (benign), occurs in sudden spells (paroxysmal), is triggered by certain head movements (positional) and results in a false sensation of movement (vertigo). BPPV can be unilateral (occurring in one ear) or bilateral (affecting both). Majority of BPPV cases occur in isolation, each episode usually lasting around 30 seconds (Neuhauser et al., 2005), and account for approximately 50%–70% of reported BPPV cases. BPPV is easily diagnosable and, likewise, easily treatable in majority of circumstances (Parnes, Agrawal & Atlas, 2003).

1.2.3.2 Vestibular Neuritis

Vestibular neuritis (VN) is the most common form of acute dizziness and is thought to arise from a viral infection of the vestibular ganglion (Schuknecht & Kitamura, 1981). Symptoms associated with vestibular neuritis include sudden spontaneous vertigo lasting 24 hours or more, normal hearing in both ears, peripheral nystagmus (rapid involuntary movement of the eyes), nausea and/or vomiting, postural imbalance and no other neurologic deficits which are non-vestibular in origin (Taylor, McGarvie, Reid, Young, Halmagyi & Welgampola, 2016). Certain methods are used to test for VN, such as the head-impulse test (HIT) where a ‘positive’ result for the horizontal and superior SCCs indicates presence of VN

(Kim & Kim, 2012). Another method is caloric testing, where hot and cold water is applied to each external ear canal. In the presence of VN, the nystagmus between the two eyes will be asymmetric (Schmid-Priscoveanu, Böhmer, Obzina & Straumann, 2001).

1.2.3.3 Ménière's Disease

Ménière's disease (MD) is a disorder named after Prosper Ménière. The characteristics of MD are intermittent episodic vertigo that can last from a few minutes to a several hours; tinnitus which is often reported as low frequency "roaring;" aural fullness/pressure, and fluctuating sensorineural hearing loss (Goebel, 2016). In many cases, aural fullness is a sign that a Ménière's attack is about to occur, often beginning approximately twenty minutes beforehand. In the early stages, hearing loss occurs in the low frequencies and can return to normal after an episode, but the loss can become progressive and stable over time (Vassiliou, Vlastarakos, Maragoudakis, Candiloros & Nikolopoulos, 2011). Although there is no definitive cause of MD, the most popular theory is endolymphatic hydrops (EH). EH is an increase in volume of endolymph within the total fluid space of the inner ear. Infection, allergies, autoimmune disorder, trauma or surgery can also trigger EH (Gürkov et al., 2015). MD is slightly more prevalent in females than males, occurring up to 1.3 times more often than in men, and commonly occurs in the fourth and fifth decade of life (Sajjadi & Paparella, 2008).

1.2.3.4 Acoustic neuroma

Acoustic neuromas (AN), also known as vestibular schwannomas (VS) are benign, often slow-growing tumours located on the eighth cranial nerve. The term acoustic neuromas are used interchangeably with vestibular schwannomas because they grow on the Schwann cells of the vestibular portion of the eighth nerve (Lee et al., 2015a). Majority of ANs are

unilateral and appear spontaneously. Symptoms characteristic to AN include progressive sensorineural hearing loss on one side, tinnitus, and speech discrimination scores that are worse than expected and inconsistent with the individual's hearing thresholds (Brahmabhatt & Moorhouse, 2016). Although AN are benign and can often be present for years without causing discomfort, it is essential to identify when they are present so that appropriate management can take place.

1.2.4 Treatment/Management

Because of the varying nature of the disorders of the vestibular system, and likewise the symptoms associated with each one, specific treatments are employed depending on the condition in question. For instance, BPPV has multiple repositioning manoeuvres in attempts to return the otoconia crystals back into place, one being the Epley manoeuvre (Luxon, 2004). In terms of MD multiple treatment options are available, the primary option consisting of diet modification such as salt reduction. Other alternatives to treat MD include medication such as diuretics which help change the electrolyte balance of the endolymph; intra-tympanic gentamicin injections and surgery (Patel & Isildak, 2016). VN requires anti-inflammatory medication and unless an acoustic neuroma is pressing on surrounding nerves and causing the patient problems in their daily life, it is often left alone and monitored yearly (Lee et al., 2015a).

Due to the nonspecific nature of the symptoms of vestibular disorders (Agrawal et al., 2009), diagnosis relies on looking at a person's condition as a whole and taking into account other factors to decipher what the disorder could be. The individual being able to identify what their specific symptoms mean and what treatment they need is, therefore, of utmost importance. For this reason, treatment information that is not only readily available, but presented at a readability level that a lay audience can understand and interpret is vital.

Patient autonomy and determining what steps to take regarding healthcare is an important step in the treatment process.

1.3 Patient-Centred Care

Patient-centred care (PCC) is one of the foundations of healthcare. It is defined as care that is "respectful of and responsive to individual patient preferences, needs, and values and ultimately, the clinical decisions are guided by the patient" (Wolfe, 2001; pp. 2). It is also widely advocated in the management of chronic health conditions due to its positive effect on health outcomes (Michie, Miles & Weinman, 2003). Historically, the classic mode of health care was practitioner-centred and characterised by a power imbalance between the patient and the healthcare professional. The focus of the healthcare professional was almost exclusively providing the information and the patient being at the receiving end of the decision-making process (Mead & Bower, 2000). PCC is a more holistic approach and is a system that promotes active patient engagement in healthcare through the creation of a power balance between the patient and the healthcare professional (Goodyear-Smith & Buetow, 2001). Mead and Bower (2000) came up with five dimensions of PCC: biopsychosocial, patient as person, sharing power and responsibility, therapeutic alliance and practitioner as person. The first two dimensions convey the individual's perspective of their health condition; the next two focus on the interaction between the patient and practitioner and the last one relays the influence of the health professional on patient centred care.

1.3.1 Shared Decision Making

Shared decision-making (SDM) is a subcomponent of PCC. It is a healthcare model where both the patient and the clinician are involved in making decisions around the patient's healthcare, with emphasis on active engagement of the patient when important healthcare

decisions must be made (Elwyn et al., 2012). Research shows that individuals who feel in control of their lives and who are actively involved in making judgements about their healthcare have significantly improved health outcomes (Anderson et al., 1995). Patients who understand their health condition also increases their capacity for involvement (Barry & Edgman-Levitan, 2012). This active engagement is a product of self-efficacy or having a sense of control in one's life, which ultimately allows the individual a greater sense of patient autonomy (Tesoriero, 2010, as cited in Pulvirenti, McMillan & Lawn, 2011).

Patient autonomy can be accomplished through means of SDM by breaking down the barrier between clinicians and patients. Exchange of information is an integral part of this. The healthcare professional offers the patient effective tools to help them understand their options and the consequences of their decisions, while the patient expresses his or her preferences and values. Both parties are provided with a better understanding of the situation and share mutual responsibility in what decision to proceed with (Charles, Gafni & Whelan, 1997). Patients should also receive the emotional support they need to express their values and preferences, and be able to ask questions without criticism from their clinicians (Barry & Edgman-Levitan, 2012). The positive outcome of the SDM process is supported by a Cochrane systematic review conducted in 2011. Across 86 studies, patients were given patient decision aids to assist them in their healthcare decision-making process. The provision of patient decision aids resulted in increased knowledge, more accurate risk perceptions, a greater number of decisions consistent with patient values, reduced internal conflict regarding decision-making, and fewer patients remaining passive or undecided (Stacey et al., 2011).

1.4 Health Information

1.4.1 Printed Health Information

Patient activation refers to having skills, beliefs and the confidence in making active decisions about health. The amount of knowledge a patient has is a predictor of their behaviour regarding their health, their use of health services as well as their own health outcomes and the cost of healthcare to the community (Li, Theng & Foo, 2016). As a result, enhancing both health information and the individuals' capacity to use the information effectively is becoming a public health goal (Sørensen et al., 2008).

Health information is available in written, print and web-based forms. Printed materials are the most common tool health professionals use to provide information and have been a primary method of reinforcing health-related information for a long time (Griffin, McKenna & Tooth, 2003). Printed health information includes booklets, leaflets, information handouts and pamphlets (Bernier, 1993). Print materials are advantageous as they can be distributed across many locations, including libraries, healthcare facilities, schools, mailboxes, grocery stores and pharmacies (Shieh & Hosei, 2008). They allow flexibility in the timing and delivery of information; patients can refer to them when required, read at their own pace and can make notes to look back on later for reference (Griffin et al., 2003).

Written materials also provide support for counselling and self-guidance for hospital patients. Studies have shown that having written information at the patients' disposal helps their physical and functional well-being, as well as shortened hospital stays (Gibson et al., 2002). Written materials also supplement oral information. Oral communication alongside provision of written information is the method preferred by most patients (Wilson et al., 1993) as people often struggle to retain crucial information from oral communication on its own. Ley (1982) found that patients recall less than 35% of information provided orally to

them by health professionals. Thus, combining the two methods will result in a greater likelihood of memory retention.

1.4.2 Online Health Information

Although written materials are still a common method of distributing information the growth in popularity of the internet, alongside the instantaneous access to online information, has increased the use of internet usage over the last few years; particularly for health-related information (Takahashi et al., 2011). The internet has the power to be an important platform for an individual's self-empowerment as it can lead to understanding a health problem or illness from their own means (Lemire, Sicotte & Paré, 2008). Advantages of seeking health information online includes providing consumers a quick, easy and anonymous method to accessing information (O'Keeffe & Clarke-Pearson, 2011). Another appeal of using the internet to search for health information is that users can access information without the fear of getting criticism from their healthcare professional, as one of the main reasons that individuals search the internet is to find information that they are uncomfortable discussing (Walsh & Vosko, 2008).

Research shows that people seek information online to both self-diagnose and increase their level of knowledge about their health condition to feel more at ease (Aydın, Kaya & Turan, 2015). Thus, the internet has been recognized as a primary source of health information. This is supported by statistical data. In Europe alone, the rate of internet usage is at 58% (Fox & Duggan, 2013) and in 2011 over half the adult population in the United States (57%) used the internet to seek health information (Park, Rodgers & Stemmle, 2011). In comparison, 2012 statistics showed that 88% of the New Zealand population were internet users (Internet World Statistics, 2012). The usage numbers will continue to rise, as Fox and Duggan found that 72% percent of US adults searched online for health-related information,

with these figures expected to increase even further with the proliferation of mobile devices over the last several years.

Due to its increasing popularity, the internet now serves as a challenge to be able to meet the needs of its users, especially for health-related material. Fox and Fallows (2003) identified three main groups of health information seekers; the majority being people seeking information on behalf of someone else; people living with a chronic illness or disability, and caregivers tending to someone in their home. On average, users seeking health-related information are older than other Web users (Fox and Fallows, 2003). In particular, a survey conducted between March and December 2000 established that 53% of older adults seek online information compared to 56% of the general population online (Fox, 2011). Individuals who seek information online are more likely to be involved in SDM and be more proactive in the clinical relationship between patient and clinician (Kaphingst et al., 2014).

1.4.3 Impact of Online Health Information

There are special implications for the distribution of health-related information. Health-related online information requires additional oversight to ensure the content meets the specific needs for each individual and that the information is understandable, appropriate and accurate. The growth of online health-related information and the number of people who use it daily to access important information has therefore risen concern about the quality of information available (Gagliardi & Jadad, 2002). Before health material was accessible online, information was mainly obtained through direct contact with reliable information sources such as printed material, medical professionals and teachers. Now, information can be accessed indirectly through multiple sources with low levels of reliability (Brossard, 2013). If the information is poorly moderated it can lead to the spread of potentially harmful information, endangering the reader (Arsenault, Blouin & Guitton, 2016).

Social media can positively impact the spread of online health-related information. Social media allows for direct instantaneous communications with people globally, can expand social ties and improve psychological well-being (Chen & Lee, 2014). Platforms such as Facebook and Twitter lets people build relationships and gain social support from others who may be in a similar situation (Mano, 2014). In 2012, Manhattan Research found that one in four users with a chronic health condition sought others online with a health condition comparable to their own. Sharing and exchanging information with peers can also lead to health empowerment (Dutta-Bergman, 2006), allowing users to become more confident in their abilities to search for information related to their healthcare situation and be more involved in their health. In turn, this can lead to adopting more positive health habits.

1.5 Health Literacy

1.5.1 Definition

Health literacy is defined as one's ability to use a set of knowledge, skills and experiences related to healthcare to make informed decisions for himself or herself (Navarro-Rubio, Rudd, Rosenfeld & Arrighi, 2016). The term was devised in the 1970s, yet has since deviated from its original definition. Whereas health literacy originally referred to the ability of managing words and numbers in a medical context, it has since become being able to read and act on health information, communicating the information to health professionals and understanding healthcare instructions (Peerson & Saunders, 2009). Nutbeam (2008) proposed three types of health literacy: basic/functional, communicative/interactive and critical health literacy (Fleary, Joseph & Pappagianopoulos, 2018).

Functional health literacy is the ability to apply basic reading, writing and numeracy skills to health-related information, such as prescriptions, medications and labels (Nutbeam, 2000). Functional health literacy can be further divided into scientific information literacy,

citizen literacy and cultural literacy. Scientific information literacy is being attentive of complicated scientific methods, understanding terminology and specific concepts. Citizen literacy is awareness of social issues and possessing critical thinking and decision-making processes. Finally, cultural literacy is interpreting and implementing health information based on worldview, social identity and collective societal beliefs (Aydın et al., 2015).

Communicative/interactive health literacy is applying social and cognitive skills when trying to understand forms of communication as well as applying new information in various and evolving settings. It is using cognition to develop positive health behaviour by implanting knowledge into ever-changing health conditions (Aydın et al., 2015). Lastly, critical health literacy is critical analysis of health information for personal and social benefit (Nutbeam, 2008) and is the least understood and developed aspect of health literacy (Sykes, Wills, Rowlands & Popple, 2013). It involves critical evaluation of health information and understanding all aspects of health, such as political, economic and social (Nutbeam 2001, as cited in Aydın et al., 2015).

Recently, media literacy has been included as a fourth level of health literacy (Manganello, 2008), with media health literacy a sub component incorporating all three types of health literacy. Media health literacy refers to identification of health-related media, recognition of its impact on health behaviour, critical analysis and action or intention to use the information, either for oneself or society (Levin-Zamir, Lemish & Gofin, 2011).

1.5.2 eHealth

The application of technology and computer communication to healthcare, or eHealth, is viewed as an essential means for the ageing population and treatment options (van Gemert-Pijnen, Wynchank, Covvey & Ossebaard, 2012). EHealth includes websites, web apps and mobile phones. EHealth literacy is having the skills to pursue, discover and assess electronic

health information and subsequently apply this information to a health situation (Quinn, Bond, & Nugent, 2017). While the internet is a prime location to acquire information on healthcare, symptoms and management options (Hodgetts, Bolam & Stephens, 2005), it cannot be of use if individuals cannot navigate their way around the internet, especially for older individuals (Lee, Hoti, Hughes, & Emmerton, 2015). If users do not possess the skillset to utilise eHealth tools then the effect of the tools will be limited (Norman & Skinner, 2006). A study on chronic health conditions found that older adults with lower levels of eHealth literacy struggled to both navigate their way around the internet and find health information (Lee et al., 2015b).

Norman and Skinner (2006) created what is called the model of eHealth literacy. The model comprises of six core literacies which are required for a reader to engage in eHealth and are subdivided into two main categories: analytic and context-specific. Analytic skills involve traditional methods of reading, writing and numeracy. It also includes information literacy; an individual's ability to comprehend how information is organised, and media literacy; the ability to understand how media-based information is composed and influenced. Context-specific skills include health literacy, computer literacy, which is the ability to use computers and adapt to new software and technologies and scientific literacy.

1.5.3 Low Health Literacy

A large proportion of people are not able to make decisions about their health as they are limited not only by the difficulty of the online material available, but also their own literacy levels. Although the access of health-related information online is increasing, it is not providing help to people of all literacy levels and educational backgrounds. Low literacy in adults is extremely common (Parker, 2000): approximately 80 million adults have substandard levels of health literacy (Svider et al., 2013); over 40 million adults are functionally illiterate and another 50 million have insufficient reading skills (Kirsch,

Jungeblut, Jenkins, & Kolstad, 2002). Low health literacy is linked to less frequent searches for health information and a poorer ability of understanding information (Schillinger et al., 2002), supported by the National Adult Literacy Survey which reported 48% of American were lacking in reading and numeracy skills to act on health information (Wolf, Gazmararian & Baker, 2005).

Low health literacy is especially prevalent in lower socioeconomic populations and the elderly. Other variables related to poor health literacy include education, income, country of birth, and ethnicity (Rudd, Kirsch & Yamamoto, 2004). People with inadequate health literacy are more likely to be older, male, part of minority groups and have lower income, education, and are generally sicker with poorer physical and mental health (Berkman, Sheridan, Donahue, Halpern & Crotty, 2011). Studies show that racial and ethnic minority groups are less likely to have access to healthcare and are more likely to be impacted and die from diseases such as cancer and diabetes (Feldman & Fulwood, 1999). This is a discouraging finding because many of these chronic diseases are preventable, and if access to the right information was possible, it may have been avoided.

1.5.4 Impact of Low Health Literacy

Low functional health literacy has been linked to delayed diagnoses, problems with use of preventative services, adherence to medical instructions, understanding one's medical condition and self-management skills (Wolf et al., 2005). Poorer understanding of health information has also been found to be directly correlated with increased mortality (Bostock & Steptoe, 2012). The Institute of Medicine released a report indicating that almost half of the American population may have difficulties relaying health information (Nielsen-Bohlman, Panzer, & Kindig, 2004), termed the "health literacy epidemic" (Davis & Wolf, 2004).

Low health literacy can also have an impact on mental health. Other factors commonly associated with low health literacy poor general literacy, inadequate decision-making ability, reduced cognitive functioning, and lack of social support (James, Boyle, Bennett & Bennett, 2012). Low health literacy is also detrimental to physical health and is concurrent with a decrease in health-promoting behaviour such as exercise, reduced physical functioning and poorer overall physical health (Baker, Wolf, Feinglass, Thompson, Gazmararian & Huang, 2007).

Good health literacy is not only important for the population, but for the general healthcare costs for the community, with the expenses of poor health and low functioning literacy on the health system estimated at 73 billion each year (National Academy on Aging Society, 1998, as cited in Birru et al., 2004). People with lower levels of functional literacy are also less likely to be employed full time or part time, are less likely to be involved in activities such as volunteering and voting and less likely to use email or internet. The children of low-literacy adults are also at risk of not having a good literacy development; both at home and in educational settings (Purcell-Gates, 1996). The importance of having health information that a lay person can read and interpret is therefore vital as it can allow access to preventative measures, treatment options and general information for their well-being.

1.5.5 Improving Low Health Literacy

Information and communication technologies (ICTs) are methods of providing healthcare information to the public, including computers, the internet, mobile phones and social media (Kim & Xie, 2017). Promoting the use of ICTs requires vulnerable groups to be educated in these areas, as purely focusing on improving individual health literacy is not enough. Interventions are therefore required to enhance e-health literacy. Educational

strategies to help individuals with limited health literacy to learn how to use ICTs and eHealth services are available (Xie, 2012). This includes skills like accessing online resources regarding health information, management and treatment options, how to search for information effectively, and how to evaluate the quality of online health information (Kim & Xie, 2017).

Unfortunately, teaching people how to use ICTs and attempting to improve low health literacy status is not the only way to solve the issue. Even if individuals become more health literate, it does not change the quality of online information. Thus, alongside interventions to help people become more health literate, improving the quality of online health information is the other goal. When engaging in information online, understanding the information at a linguistic level is important, but also all the other factors which influence the reader's understanding of the material.

1.6 Readability

1.6.1 Definition

Websites and health information sourced from the internet are widely used to supplement patient education because of the ease of access and low cost, but their usefulness may be limited if they cannot be read or understood (Tian, Champlin, Mackert, Lazard & Agrawal, 2014). The quality and reliability of material is also questionable. When evaluating textual information, a priority is assessing whether the material is understandable linguistically (Beaunoyer, Arsenault, Lomanowska & Guitton, 2017). This is also referred to as readability. Readability is how easily information can be understood based on sentence and word length (Tian et al., 2014) and predicts comprehension of the written material (Eloy et al., 2012). The readability of information is calculated using readability formulas to give an overall score called the reading grade level (RGL). RGL refers to the number of years of

education required to understand the information (Ley & Florio, 1996). The higher the score, the harder it is to comprehend the material (Eloy et al., 2012). Materials with a RGL of five or lower are marked as 'superior', 'adequate' if they fall between the sixth and eighth RGL, and 'not suitable' if at the ninth RGL and above (Ley & Florio, 1996).

The 2015 adult literacy evaluation revealed that approximately 27.6% of adults in America aged 25 and older are estimated to have a high school diploma or high school equivalency certificate, and 12.8% of adults have less than a high school education (U. S. Census Bureau, 2015, as cited in Ames, 2019). Among older adults aged 65 years and older, 27.2% have less than a high school education. Some research has shown that the differences in reading grade levels between a person's reported education level and their measured reading level can be four to five grade levels apart (Arnold et al., 2006), suggesting that many individuals who have completed high school may only be able to read at the seventh or eighth grade level.

In the United States, the average RGL for an adult is eight, whereas the National Institutes of Health (NIH) and American Medical Association (AMA) recommend any information to be between fourth and sixth RGL (American Medical Association, 1999). However, these suggestions are for the general population. For at-risk populations such as individuals from ethnic and racial minority groups, people whom English is not their primary tongue and adults over the age of 65 years, this number needs to be lower. The recommended RGL for these populations is three (Caposecco, Hickson & Meyer, 2014).

Most health-related material surpasses the recommended readability level and is outside the scope of many adults' reading capabilities; the average health-related patient educational material sitting at ninth reading grade level and higher (Shieh & Hosei, 2008). The 1992 National Adult Literacy Survery (NALS) categorized literacy skills into 5 levels. NALS Level I literacy indicates an adult is illiterate or is only able to understand a single

piece of information from short pieces of text and NALS Level II infers the individual can locate moderate amounts of information from a complicated text, but struggle when the material requires dissection from distracting information or a complex presentation (Comings & Kirsch, 2005, as cited in Shieh & Hosei, 2008). NALS suggested that to progress through 21st century life, an individual must have the abilities to the level of at least level III literacy.

1.6.2 Readability formulas

Readability formulas were used historically by schoolteachers, the US military and print media publishers (DuBay, 2004). Readability formulas are currently used to help the development of written health-information materials to meet the recommended RGLs (Wang, Miller, Schmitt & Wen, 2013). Over the last half a century, numerous tools have been developed to assess readability. Although a number of readability formulas exist, all formulas are based on the same theoretical framework of literacy (Wang et al., 2013). Most formulas are based on sentence length, words with three or more syllables and number of words in a sentence. When assessing text-based material, whether written or from an online source, multiple tools are often used simultaneously to gather broader range of results.

Readability formulas must be measured against some criteria to ensure their validity. A gold standard which many readability formulas are compared to is the McCall-Crabbs Standard Test Lessons in Reading (Gunning, 1968). The McCall-Crabbs Standard Test Lessons in Reading uses word passages which all vary in reading difficulty, followed by a set of multi-choice questions at the end of each passage. Test scores from students of various grades are used to determine cut-off scores. The cut-off scores are used to estimate RGL as they indicate an expected comprehension for readers of a specific RGL for a given material (Flesch, 1948). Some of the most common readability tools include the Flesch Kincaid Grade Level (F-K), the Simple Measure of Gobbledygook (SMOG) and the Gunning Fog Index (FOG) (Wang et al., 2013); the FOG and F-K serving as the most used tools since the 1940s.

1.6.2.1 Simple Measure of Gobbledygook

The Simple Measure of Gobbledygook (SMOG) is a readability formula that counts all words containing three or more syllables within three 10-sentence passages of a document. The assessor counts 10 sentences at the beginning of the material, 10 in the middle and then 10 at the end of the document. Each word that contains 3 or more syllables within the 30 sentences is counted. The total number of syllables is then converted into a corresponding reading grade level score (McLaughlin, 1969). SMOG has been shown to be very useful and research indicates it predicts 100% comprehension (Rudd & Anderson, 2006). The SMOG is believed to be the best suited readability tool in healthcare due to consistency in results, using the most up-to-date validation criteria to estimate RGL, and its ease of use (Wang et al., 2013).

The SMOG formula is as follows (adapted from McLaughlin, 1969):

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

1.6.2.2 Flesch-Kincaid

The Flesch-Kincaid (F-K) is a modified version of the original Flesch Reading Ease (FRE) tool created in 1943 (DuBay, 2004). It calculates readability by analysing sentence length and syllable count. The revised F-K tool was developed by Rudolph Flesch in 1948 to be more suitable for Navy personnel use as well as meeting the limitations posed by the original FRE tool (Kincaid, Fishburne, Rogers & Chissom, 1975). The limitations included an average completion time of six minutes for each 100-word passage (Fihe, Wallace & Schulz, 1946); over-emphasis of sentence length in readability calculation which often concealed other features, and affixes which users found too difficult to apply (Flesch, 1948).

The updated version cuts usage time in half and automatically calculates RGL, whereas the original equation calculated reading ease, but manual conversion then had to be performed to estimate RGL. A score 80 to 90 is 'easy' and corresponds to the suggested sixth RGL, 60 to 70 is 'plain English' and a score of 30 to 50 is considered 'difficult' (DuBay, 2004).

The F-K formula is as follows (adapted from Kincaid et al., 1975):

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

1.6.2.3 Gunning-Fog Index

The Gunning Fog Index was created by Robert Gunning as a readability formula for adults. It is based on two variables: average sentence length and the number of words containing more than 2 syllables per 100 words in a material (Gunning, 1952). The formula has a grade criterion of 90% correct-score and is higher than most other readability formulas apart from the SMOG, which is based on a 100% correct-answer criterion. As a result, the grade-level scores predicted by FOG tends to be higher than formulas (DuBay, 2004). The ideal score for readability using the FOG is 7 or 8 and anything over 12 is deemed too difficult for most people to read.

The FOG is calculated as follows (from Wang et al., 2013):

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

1.6.3 Readability of Information on the Vestibular System

The complexity of the vestibular system makes it a challenge for people to understand educational materials, even if the disorder is not complex in nature. Vestibular health material that is written at a high RGL can result in readers misunderstanding crucial aspects of information. In turn, this may hinder them seeking medical care and potentially worsening their condition (Svider et al., 2013). Low RGLs for online information on the vestibular

system has been seen in studies such as Spiers, Amin, Lakhani, Martin and Patel (2017). Spiers et al. used FOG and F-K to assess webpages on acoustic neuromas. Only 3 of the 58 websites were written at the appropriate level for an average adult in the UK. Cherla, Sanghvi, Choudhry, Jyung, Eloy and Liu (2013) also analysed patient materials on acoustic neuromas and found that none of the articles were below the recommended sixth RGL**.** These studies highlight the importance of improving patient materials on the vestibular system by simplifying the material available to readers.

1.7 Content Assessment

1.7.1 Definition of Suitability

Suitability is another measure used to assess health-related materials. Suitability refers to how well the individual can comprehend the information based on the design and layout of the material (Shieh & Hosei, 2008). Adding human elements to materials, such as visual attraction, interest, motivation and cultural factors influences the information a person absorbs (Meade & Smith, 1991). Suitability is advantageous as it can measure non-textual methods of information, such as graphs, tables, pictures, multimedia, alongside formatting and presentation. Individuals often understand information better when presented with these additional features than through text alone (Houts, Doak, Doak & Loscalzo, 2006).

1.7.2 Measurement Tools

Various suitability tools exist in the literature, but the ones used in the present study are the DISCERN, Patient Education Materials Assessment Tool (PEMAT) and the Plain Language checklist.

1.7.3 PEMAT

The Patient Education Material Assessment Tool is a relatively new suitability tool, created by Agency for Healthcare Research and Quality in 2014 (Shoemaker, Wolf & Brach, 2014). The PEMAT assesses the understandability and actionability of patient education materials. Understandability refers to the user being able to understand the information and actionability means the user can manipulate the information to make decisions about their healthcare. The PEMAT is useful as it does not only assess suitability of printed materials, but also audio-visual materials, including interactive webpages and websites such as YouTube.

Questions 1 to 19 of the PEMAT relate to the understandability of the material, and questions 20 to 26 relate to the actionability of the material. Some questions are only tailored for printable materials, others can only be answered for audio-visual materials, and the remainder can be used for both. The questions are answered either with "disagree" for 0 points, or "agree" for 1 point. Scores for understandability and actionability are calculated separately by dividing the number of points by total number of points possible, multiplied by 100. The higher the score, the more understandable or actionable the material is. A score greater than 70 is considered either 'understandable' or 'actionable' and a score below 70 of not understandable or actionable. The PEMAT was used in the present study as it has good reliability, strong internal consistency and construct validity (Shoemaker et al. 2014).

Little information is available on PEMAT in relation to the vestibular and hearing systems. To my knowledge, this is one of the first studies conducted using PEMAT as a suitability measure for material specifically on the vestibular system.

1.7.4 DISCERN

The DISCERN is a valid tool that uses a standardized set of criteria to evaluate educational materials regarding treatment options. The DISCERN focuses on content rather than presentation or delivery of the material (Demir, Ozsaker & Ilce, 2008). The DISCERN

focuses on aspects of the material such as source credibility, dates, biases and benefits of treatment. Although the assessment of treatment options is the main purpose of the DISCERN, it can be used to evaluate material that provides little or no treatment options at all (Charnock & Shepperd, 2004).

The DISCERN questionnaire is divided into 3 sections with a total of 16 questions. Each question is rated on a 5-point scale; 1 meaning the information has no relevance to treatment, 3 being partially relevant and 5 being extremely relevant. The DISCERN is useful as each question provides a description on how to interpret the material to answer each question, assisting in the user rating each question in a reliable and consistent manner. This is particularly helpful when comparing individual scores to assess inter-rater reliability (Charnock & Shepperd, 2004). The total score is then accumulated, being anywhere between 15 and 75; the lower the score, the lower the quality of the material (Demir et al., 2008). However, the overall rating of the material is decided by the final question, where the marker gives the entire piece of material a mark out of five based on how they answered the previous questions, and their impression of the material is a whole.

Like PEMAT, a limited number of studies on the vestibular and hearing systems have included DISCERN as an assessment measure, however one study using the DISCERN includes McKearney and McKearney (2013) who analysed webpages on ventilation tubes for otitis media using the DISCERN. The results indicated the webpages to be generally of a mixed quality, suggesting treatment options for middle ear infections where ventilation tubes are required to be of little help. Laplante-Lévesque, Brännström, Andersson and Lunner (2012) also assessed the suitability of information on adults with hearing impairment using the DISCERN. The average DISCERN score was 2.04, equating to a ‘low’ rating, suggesting online information on the hearing system does not provide suitable treatment options.

1.7.5 Plain Language

The Quick Checklist for Plain Language assesses the degree of plain English language terms used in the material. Employing plain language in patient educational materials is strongly associated with readers gaining knowledge in relation to understanding medical procedures (Sudore et al., 2007), administering medication (Yin, Mendelsohn, Fierman, van Schaick, Bazan & Dreyer, 2011) and prompting discussion of the medication during the clinical encounter (Kripalani et al., 2007). The simpler the terminology, the greater the likelihood of users understanding the information, especially in the health field. Smith and Wallace (2013) demonstrated this by comparing standard patient medical-related instructions to a simplified version with plain language. Participants given the "plain language" instructions had significantly better understanding of how to prepare and self-administer the medication alongside showing consistent accurate demonstration of self-injecting the medication.

The checklist used in the present study was created by merging questions from two previous plain language checklists: the 'National Adult Literacy Agency: Plain English Checklist for Documents Center for Health Literacy: Quick Checklist for Plain Language' and **'**Plain Language Action & Information Network: Checklist for Plain Language on the Web.' The plain language checklist contains 20 statements requiring a yes or no answer; the more items that are checked, the easier the material is to read and the greater the likelihood that the material can be understood by the reader.

1.7.6 HON Code

The Health on the Net Foundation Code of Conduct (HONcode) is a code of ethics that evaluates the credibility of the health-related material. The HONcode assesses whether the health material is of a quality standard and provides objective and accurate medical information for its intended audience (Boyer & Geissbuhler, 2005). A website will receive an

HONcode certificate if it meets the eight principles in the HONcode code of conduct. The eight principles are: authority, complementarity, privacy, attribution, justification, contact details, financial disclosure, and advertising policy (Health on the Net Foundation, 2014). The assessment is performed by an individual who uses a set of specific guidelines for each principle (Boyer & Dolamic, 2015).

The HONcode helps the reader decide whether the webpage material is of quality. Not all websites contain HONcodes, however, because to obtain one a manual request must be taken by the manager of each website.

1.8 Improving Health Information

1.8.1 Readability

One method of improving information is by following a set of procedures, or golden rules, of documentation writing which are applicable for any patient education material, whether it be online, printed or written form (Hackos & Stevens, 1997). Some of these rules include using short, simple and familiar words; simple sentences, active voice and present tense, avoiding jargon; correct grammar, spelling and punctuation and commencing instructions in an imperative manner, to name a few. More specific to the field of hearing, Caposecco, Hickson and Meyer in 2011 developed a set of best-practice guidelines when creating user manuals for hearing aids, including appropriate font size (ideally, size 12-14), writing the material in an active rather than passive voice, organizing the material in an appropriate manner and having text captions. An example of the impact of font size on legibility of material on older adults was examined by Bernard, Liao and Mills (2001). Older adults between the ages of 62 and 83 read two passages in size 12 and 14 fonts and reading time, legibility and preferred passage were then measured. Participants preferred the passage with the larger font and could understand it more clearly.

1.8.2 Suitability

Improving information is not just how the information is written, but incorporating elements which make a material visually appealing to the reader, such as bullet points, numbered steps, checklists and more (Hackos & Stevens, 1997). This also includes incorporating pictures and illustrations where necessary, as combining illustrations with difficult text improves patient recall and attitudes for people with low health literacy (Meppelink, Smit, Buurman & van Weert, 2015). Thus, making web-based material more accessible and user friendly by integrating pictures and multimedia strategies can be a method of improving online healthcare material.

1.9 Study Rationale

The growth of online health information has led to more people using the internet to access information on healthcare as well as seeking treatment information. Individuals with vestibular disorders seek information to learn more about their condition and to know the next steps in the decision-making process. Dizziness could be indicative of several diagnoses, thus access to information to differentiate between each condition is crucial for treatment and management. Attempts for individuals to educate themselves about their health condition may be difficult due to a mixture of low health literacy alongside high readability and low suitability of online health information. Many people are not aware that the vestibular system is linked to the hearing system and that dizziness could be indicative of more serious concerns, further highlighting the importance of readable online information.

Previous literature has verified that the readability of online health information exceeds the recommended sixth RGL. The suitability of online health information is also inconsistent, and the degree of plain English language to depict the information to a lay audience is less than desired. Being able to pinpoint specific attributes, such as design,

content and semantics of patient materials can be a start on the road to improving the material for future users.

1.9.1 Research Aims

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

1. Is there an even distribution of online information on the vestibular system from different regions?
2. Is there an even distribution of online information on the vestibular system from different types of organisations?
3. Is there a significant difference between the mean RGL in the study compared to the recommended sixth RGL?
4. Are there significant differences in the readability of online information on the vestibular system from different regions?
5. Are there significant differences in the readability of online information on the vestibular system from different types of organisations?
6. Are there significant differences in DISCERN scores of online information on the vestibular system from different regions?
7. Are there significant differences in DISCERN scores of online information on the vestibular system from different types of organisations?
8. Are there significant differences in PEMAT understandability scores of online information on the vestibular system from different regions?
9. Are there significant differences in PEMAT understandability scores of online information on the vestibular system from different types of organisations?

10. Are there significant differences in PEMAT actionability scores of online information on the vestibular system from different regions?
11. Are there significant differences in PEMAT actionability scores of online information on the vestibular system from different types of organisations?
12. Are there significant differences in plain language scores of online information on the vestibular system from different regions?
13. Are there significant differences in plain language scores of on online information on the vestibular system from different types of organisations?

1.9.2 Hypotheses

Based on these research questions, thirteen null hypotheses exist:

1. There is an even distribution of webpages based on region.
2. There is an even distribution of webpages based on type of organisation.
3. There is no significant difference between the mean RGL in the study compared to the recommended sixth RGL.
4. There is no significant difference in the mean RGL of webpages based on region.
5. There is no significant difference in the mean RGL of webpages based on type of organisation.
6. There is no significant difference in DISCERN scores of webpages based on region.
7. There is no significant difference in DISCERN scores of webpages based on type of organisation.
8. There is no significant difference in PEMAT understandability scores of webpages based on region.
9. There is no significant difference in PEMAT understandability scores of webpages based on type of organisation.

10. There is no significant difference in PEMAT actionability scores of webpages based on region.
11. There is no significant difference in PEMAT actionability scores of webpages based on type of organisation.
12. There is no significant difference in plain language scores of webpages based on region.
13. There is no significant difference in plain language scores of webpages based on type of organisation.

Chapter 2: Method

2.1 Overview

This study investigated the readability and suitability of online information available on the vestibular system in English. Readability was assessed using the FOG, SMOG, and F-K. The suitability of webpage content was assessed using the DISCERN. PEMAT and Plain Language tool. Quality was determined by HONcode certification and the level of plain English language was assessed using a revised checklist. Ethical approval was granted from the University of Canterbury Human Ethics Committee (see Appendix).

2.2 Participants

Informants were recruited through online social media platforms, such as Facebook, as well as through word of mouth and email. The inclusion criteria were that (1) informants must be over 18 years of age, and (2) were able to provide search terms in the English language. The minimal sample size required was 10 informants. Recruitment continued until saturation; search terms reached saturation when they were mentioned twice by different informants. The total number of informants recruited was 17. No form of inducement was offered.

The search terms for this study were determined by asking the group of 17 informants to generate a list of search terms they would use online when presenting with symptoms of dizziness, imbalance or any other balance dysfunction. The question used was: “If you, or someone you knew felt dizzy, what search terms would you put into Google? Please list as many as you can think of.” The informants were fluent speakers of English and prior knowledge of the vestibular system and vestibular healthcare was not required.

2.4 Google Trends

The most-mentioned search terms related to dizziness from the surveys were selected for further analysis in Google Trends (www.google.com/trends). Google Trends is a free public website that analyses the popularity of words and phrases searched in Google across various regions and languages. Google Trends was used to check the frequency of each search term as well as identify any popular related terms. This has been done in previous studies such as Laplante-Lévesque et al., (2012) and Manchaiah et al., (2017).

The settings selected for analysis was: *worldwide* in the *past 12 months* within *all categories* using *web search*. The analysis was performed on the 17th June 2019. Based on this, the four search terms selected were "vertigo" "dizziness" "dizzy" and "nausea."

2.3 Search and Selection Procedure

2.3.1 Inclusion and Exclusion Criteria

Webpages that were candidates for inclusion in the study were chosen first. This was done by including all the webpages from the first page of search results and if the first page contained less than 10 webpages, the second page was clicked so that a minimum of 10 webpages were collected.

The 10 webpages were then examined against the inclusion criteria. Inclusion criteria for examining the webpages were that they were (1) in English, (2) had information relevant to the vestibular system, (3) were available to the public, (4) at least 100 words in length (or if a video, the transcript was at least 100 words in length), (5) not a directory listing and (6) not a duplicate of a previously-included webpage (using a different search term or different ccTLD). The webpages that met the criteria were selected for analysis.

2.3.2 Identification of Search Domains

English-speaking countries for the search were gathered. Country coded top-level domains (ccTLDs) indicate the site's relation to a specific country or region (e.g., *co.nz* for New Zealand) (Zook, 2000). To determine the ccTLDs for this study, the Google sites specific to locations which had at least 2 million internet users and English as the official language were identified. Countries with Google domains were found from the list of regions in the Advanced Search section of Google Settings and then put into an excel spreadsheet. Countries with English as an official language were selected by using information from the CIA World Factbook (Central Intelligence Agency, 2007). The outcome of this was 66 countries, and the total number of internet users from these countries was 1,420,288,344.

Using information from the Internet World Stats (2019), the search was narrowed by removing countries with less than two million internet users, resulting in 21 countries and 1,377,149,400 internet users and encompassed 97% of English-speaking internet users. World Stats (2019) provided information on the internet penetration rates of these countries. Table 1 shows these data along with the World Health Organisation regional offices for each country (World Health Organisation, 2018).

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

Country	**Region**	**Internet Penetration Rate**	**Population of Internet Users**
Kenya	Africa	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%**

2.3.3 Search Procedure

The ccTLD of each country was selected through Google settings, and the search was completed using a Google Chrome browser on incognito mode. The type of computer was an Apple MacBook Pro. The system was macOS Catalina version 10.15.1. The search was completed on the 17th of June 2019. The search terms were entered into each ccTLD one at a time. The first ten search listings were gathered and measured against the inclusion and exclusion criteria. This was done because individuals often only access the first page of Google results when searching for information online (Eysenbach & Köhler, 2002). The webpages that met the criteria were selected for analysis and duplicate webpages were removed once the search was completed. This gave a final list of 92 unique webpages.

The country of origin, website type of organisation, the Uniform Resource Locator (URL) and HONcode certification of the webpages were recorded in a Microsoft Excel file. The country of origin was governed by the URL or by information provided in the *About Us* section of each webpage (or similar). If the country was not evident, additional information was found through an internet search. Webpages that were directed toward a worldwide audience and provided information in multiple languages were coded as World. The type of organisation for the website referred to whether the organisation was non-profit, commercial, or government and was determined by the URL and information provided in the *About Us* section of each webpage (or similar). The webpage was coded as 'commercial' if it was supported by advertisers, 'government' if it was produced by a governmental agency and 'non-profit' if it was verified as being non-profit on the *About Us* (or similar) section of the webpage, or from further information on the internet.

Only relevant webpages were assessed for readability and suitability. Webpages that also had relevant sources of information via internal links on the webpage were also accessed for analysis. External content or external links were not analysed.

2.4 Readability Assessment

Webpages were analysed using three readability measures: FOG, SMOG, and F-K. Readability was estimated using a free online English readability tool (www.online-utility.org/english/readability_test_and_improve.jsp). This was done by copying the content of each webpage into the readability tool. The mean RGL was calculated by entering the readability scores into an excel spreadsheet.

2.5 Suitability Assessment

2.5.1 PEMAT

One tool for measuring suitability was the PEMAT. PEMAT assesses the understandability and actionability of patient education materials and can evaluate the suitability of both printed and audio-visual materials. Understandability means the user can understand the information, and actionability suggests the user can use the information to actively make their own decisions about their healthcare. The first 17 questions are about understandability of content and the next 7 are about actionability. The questions are answered either with “disagree” for 0 points, or “agree” for 1 point. Separate scores for understandability and actionability were calculated by dividing the number of points by total number of points possible and multiplied by 100. The higher the score, the more understandable or actionable the material is (Shoemaker et al., 2014).

A revised version of the PEMAT was generated to increase inter-rater reliability. The revised PEMAT tool had the same questions from the original PEMAT tool, but with additional comments under most of the questions to make it easier for the research team to understand what the question was asking and how to answer the question accurately.

2.5.2 DISCERN

The DISCERN tool evaluates educational materials about treatment options. The DISCERN questionnaire is divided into three sections with a total of 16 questions. Each question is rated on a 5-point scale; 1 being the information has no relevance and 5 being extremely relevant. The total score will then be accumulated and will fall between 15 and 75; the lower the score, the lower the quality of the webpage (Demir et al., 2008). The DISCERN tool used in the present study was a modified version generated by a previous researcher (Strathdee-Goomes, 2019).

2.5.3 Plain Language Checklist

The plain language checklist assesses the degree of plain English language terms used and whether the material is formatted in a way that readers will understand. A modified version of the checklist was used, adapted from the 'National Adult Literacy Agency: Plain English Checklist for Documents Center for Health Literacy: Quick Checklist for Plain Language' and the **'**Plain Language Action & Information Network: Checklist for Plain Language on the Web.' The modified checklist contains 20 questions derived from both original checklists. The questions are answered with a yes or no; the more items checked off, the easier the level of English-language terminology used and the greater the likelihood the material can be understood by the reader.

2.5.4 Reliability

To assess the reliability of scoring using the suitability tools, inter-rater reliability checks were done. A sample of the webpages collected were selected for the reliability check; 20% of webpages from each region were selected and a random number generator was used to select the webpages. These were distributed amongst the research team as evenly as

possible. The content of the webpages were analysed by each researcher using the DISCERN, PEMAT and Plain Language Checklist. The main measure of inter-rater reliability is the Intraclass Correlation (ICC) and is a widely-used measure of inter-rater reliability for quantitative ratings. The kappa generated from the ICC is used to determine how reliable the ratings between researchers are for each measure. Values of kappa range from 0 (no agreement between raters) and 1.0 (perfect agreement). Kappa values greater than .75 indicate 'excellent agreement beyond chance.' Values between .60 and .75 indicate 'good agreement beyond chance.' Values between .40 and .59 indicate fair agreement beyond chance (Fleiss, Levin & Paik, 2013). Once each researcher rated their allocated webpages, the scores between each researcher were compared and a kappa score for each measure was generated for each researcher.

2.6 Quality Assessment

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

2.7 Data Analysis

The two independent variables in this study were the country of origin and type of organisation. The dependent variables were the RGL, DISCERN, PEMAT understandability, PEMAT actionability and the revised checklist for the assessment of plain language. To analyse the data, country of origin was revised to five regions: Africa, Americas, Europe, Western Pacific and World, and type of organisation was revised to Commercial and Other.

These groupings were established to ensure statistical analysis would be possible by achieving an even distribution of data.

IBM SPSS Version 24 was used to perform statistical analysis of the data (IBM Corp, 2016). The assumptions of normality were tested and the data met the assumptions of parametric testing. The descriptive statistics included: intra-class correlation coefficient (ICC), Chi-square test, analysis of variance (ANOVA) and Levene's test. The significance level for all statistical analyses was an alpha level of 0.05.

Chapter 3: Results

3.1 Overview

The main purpose of this study was to assess the readability and suitability of online information on the vestibular system available in English. In addition, this study aimed to compare the readability and suitability between webpage region, type of organisation, and presence or absence of HONcode certification. In total, 92 webpages were analysed.

3.2 Descriptive Statistics

3.2.1 Region and Type of Organisation

The webpage country of origin was recorded. Due to the variability of webpage distribution between countries, location was grouped into regions. This resulted in five regions with an even distribution of webpages. Most webpages were from World (n = 21, 22.8%), followed by Western Pacific, Africa and the Americas (n = 18, 19.6%) then Europe (n = 17, 18.5%). Americas consisted of Canada and the United States of America. World consisted of the webpages that were coded as World during the initial internet search. These were webpages that targeted a global audience and provided information in multiple languages. Five webpages were from the Southeast Asian region but these were added to the World category for statistical purposes.

The type of organisation that published each webpage was recorded. Most were commercial (n = 65, 70.7% each), followed by other (n = 27, 29.3%). Other consisted of non-profit (n = 19, 20.7%) and government (n = 8, 8.7%). See Figure 1 for a breakdown of the types of organisations within each region.

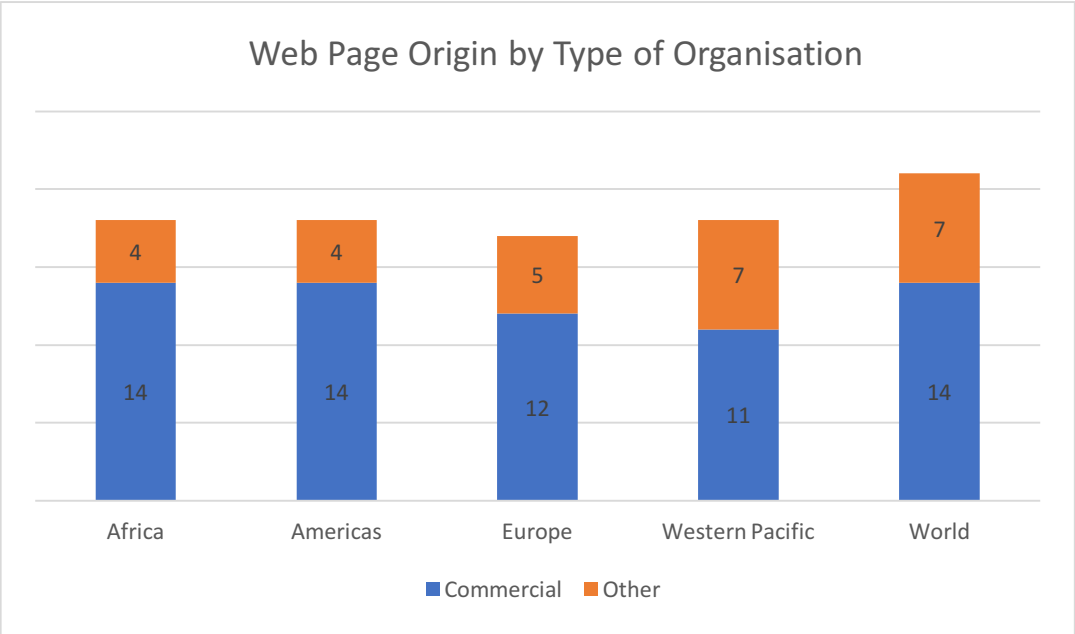

Figure 1. *Number of webpages from the two types of organisations in each region.*

3.2.2 Readability

Using the FOG, the RGL of the webpages ranged from 8.75 to 23.25 (M = 13.10, SD = 2.48). Using the SMOG, the RGL ranged from 8.77 to 19.49 (M = 12.30, SD = 1.77). Finally, using the F-K, the RGL ranged from 6.06 to 19.55 (M = 10.78, SD = 2.18). The mean RGL using all three readability measures ranged from 7.86 to 20.76 (M = 12.06, SD = 2.08).

3.2.3 Suitability

3.2.3.1 PEMAT

Suitability was measured using DISCERN, PEMAT Understandability, PEMAT Actionability and Plain Language. The PEMAT tool consists of two scores: understandability and actionability. Suitability scores of the understandability tool ranged from 43% to 100% (M = 70%, SD = 13.52%). The suitability scores of the actionability tool ranged from 0% to 80% (M = 36.30%, SD = 22.48%). The higher the score, the greater the understandability or actionability of content. The inter-rater agreement for the total scores was excellent quality.

The ICC understandability single measure was .945, $p < .001$ and the ICC actionability single measure was .903, $p < .001$. This shows excellent agreement beyond chance. Table 1 provides a summary of the PEMAT understandability and actionability scores for each factor for the materials assessed. Questions were categorized as NA if they were not applicable to the webpage being assessed, and therefore removed from the sample size and analysis.

Table 1. *Sample Size and Percentage of PEMAT Scores for Each Statement*.

Measure	**Factor**	**Statement**	**Sample size**	**Total % answering yes**
Understandability	**Content**	The material makes its purpose completely evident	92	47.8%
	Word choice and style	The material does not include information or content that distracts from its purpose (P)	92	95.7%
		The material uses common, everyday language (P, A/V)	92	57.6%
		Medical terms are used only to familiarize audience with the terms. When used, medical terms are defined (P, A/V)	92	52.2%
		The material uses the active voice (P, A/V)	92	94.6%
	Use of numbers	Numbers appearing in the material are clear and easy to understand (P)	84	85.7%
		The material does not expect the user to perform calculations (P)	92	100%
	Organisation	The material breaks or "chunks" information into short sections (P, A/V)	92	93.5%
		The material's sections have informative headers (P, A/V)	92	71.7%
		The material presents information in a logical sequence (P, A/V)	92	92.4%
		The material provides a summary (P, A/V)	92	42.4%
	Layout and Design	The material uses visual cues (e.g., arrows, boxes, bullets, bold, larger font, highlighting) to draw attention to key points (P, A/V)	92	52.5%

		Text on screen is easy to read (A/V)	4	100%
		The material allows the user to hear the words clearly (e.g., not too fast, not garbled) (A/V)	4	75%
	Use of visual aids	The material uses visual aids whenever they could make content more easily understood (e.g., illustration of healthy portion size) (P)	89	19.1%
		The material's visual aids reinforce rather than distract from the content (P)	16	100%
		The material's visual aids have clear titles or captions (P)	19	68.4%
		The material uses illustrations and photographs that are clear and uncluttered (P, A/V)	20	85%
		The material uses simple tables with short and clear row and column headings (P, A/V)	13	61.5%
Actionability		The material clearly identifies at least one action the user can take (P, A/V)	92	76.1%
		The material addresses the user directly when describing actions (P, A/V)	92	56.5%
		The material breaks down any action into manageable, explicit steps (P, A/V)	92	35.9%
		The material provides a tangible tool (e.g., menu planners, checklists) whenever it could help the user take action (P)	92	7.6%
		The material explains how to use the charts, graphs, tables, or diagrams to take actions (P, A/V)	18	5.6%
		The material uses visual aids whenever they could make it easier to act on the instructions (P)	92	7.6%

3.2.3.2 DISCERN

Suitability scores of the DISCERN tool ranged from 0 to 5 ($M = 2.55$, $SD = 0.97$).

The inter-rater agreement for the total scores was good quality. The ICC single measure was .678, $p < .001$. This shows good agreement beyond chance.

3.2.3.3 Plain Language

Suitability scores of the plain language tool ranged from 8 to 20 ($M = 14.51$, $SD = 2.34$). The inter-rater agreement for the total scores was excellent quality. The ICC single measure was .901, $p < .001$. This shows excellent agreement beyond chance. Table 2 provides a summary of the frequency of Plain Language scores for each factor for the materials assessed. Questions were categorized as NA if they were not applicable to the webpage being assessed, and therefore removed from the sample size and analysis.

Table 2. *Sample Size and Percentage of Plain Language Scores for each Factor*.

Factor	**Question**	**Sample size**	**Total % answering yes**
Reader focus	Does one or more of the headings contain the topic of interest?	92	94.6%
	Does the introduction (first paragraph) inform the reader what they are about to read?	92	37.0%
	Is the content relevant to the topic of interest?	92	96.7%
Organisation	Does the material begin with the most important message of that webpage/video?	92	33.7%
	Is the content arranged in a sensible order?	92	96.7%
	Are different topics grouped under separate headings or subheadings?	92	78.3%
Writing	Are personal pronouns such as "you" and "we" used throughout?	92	64.1%
	Is an active voice used throughout?	92	93.5%
	Are lay terms predominately used throughout?	92	68.5%
	If technical terms are used, are they explained?	91	64.8%
	Are simple sentences used throughout (i.e. no more than one new idea per sentence)?	92	67.4%
	Is correct grammar used throughout?	92	93.5%
	Is correct punctuation used throughout?	92	97.8%
	Are unnecessary words eliminated (e.g. technical jargon or adverbs)?	92	31.5%
Design and Formatting	Is the appearance of the material consistent throughout (i.e. consistent use of fonts, italics, bold print, colour, and bullet points)?	92	100%
	Does the material look easy to read, with an uncluttered layout, plenty of white space, and dark text on a light background or light text on a dark background?	92	59.8%
	Are the fonts clean in their design and easy to read (not fancy or unusual, e.g. Arial)?	92	100%
	Is the text size large enough for easy reading and does each line have about 10-15 words?	92	60.9%
	Are italics, underlining, capitalisation, and bold print used sparingly?	92	84.8%
	Are images clear and uncluttered and related to the content?	56	46.4%

3.2.4 HONcode Certification

Only 8 of the 92 webpages (8.7%) had HONcode certification. These webpages were from Merck Manual, Health Info Canterbury, Mayo Clinic, Web MD, Brain and Spine Foundation, Health Navigator NZ, NPS medicine and Health Direct. All websites were from a range of commercial, government and non-profit organisations.

The null hypotheses related to HONcode certification were:

1. There is an even distribution of webpages with and without HON certification
2. There are significant differences in the readability of webpages with and without HON certification.
3. There are significant differences in suitability using DISCERN from webpages with and without HON certification.
4. There are significant differences in suitability using PEMAT understandability from webpages with and without HON certification.
5. There are significant differences in suitability using PEMAT actionability from webpages with and without HON certification.
6. There are significant differences in suitability using plain language from webpages with and without HON certification.

The null hypotheses related to HONcode certification were removed from the hypothesis testing because of lack of variability.

3.3 Hypothesis Testing

3.3.1 Assumptions of Normality

Given the sample size ($N = 92$) normal distribution was assumed. There were no significant outliers in the dataset. The data were determined to meet the assumptions of parametric testing.

3.3.2 Distribution based on Region and Type of Organisation

The hypotheses were:

14. There is an even distribution of webpages based on region.
15. There is an even distribution of webpages based on type of organisation.

A chi-square test of independence was performed to examine the distribution of online information on the vestibular system from different regions. There was an even distribution based on region $\chi 2\ (4, N = 92) = 0.50, p = .97$. A chi-square test of independence was performed to examine the distribution of online information on the vestibular system from different types of organisations. There was not an even distribution based on type of organisation $\chi 2\ (1, N = 92) = 15.70, p < .001$.

Based on these results, the null hypotheses that (1) there is an even distribution of webpages based on region was supported and (2) there is an even distribution of webpages based on type of organisation was not supported.

3.3.3 Single Sample t-test

The hypothesis was:

1. There is no significant difference between the mean RGL in the study compared to the recommended sixth RGL.

A single sample t-test was conducted to determine if a statistically significant difference existed between the mean RGL from the sample in the study and the recommended 6th RGL. The mean RGL from the webpages collected in this study was significantly higher ($M = 12.06, SD = 2.08$) compared to the 6th RGL, $t(91) = 27.87, p < .001$.

Based on these results, the null hypothesis that there was no significant difference between the mean RGL in the study compared to the recommended sixth RGL was not supported.

3.3.4 Readability based on Region and Type of Organisation

The hypotheses were:

1. There is no significant difference in the mean RGL of webpages based on region.
2. There is no significant difference in the mean RGL of webpages based on type of organisation.

A Levene's test was done to assess whether there was equality in variance between the groups. The Levene's test was not significant, indicating the groups did not have significantly different variances in data. ANOVA testing was therefore conducted.

A two-way ANOVA was conducted on the influence of two independent variables (region, type of organisation) on the mean RGL. Region included five levels (Africa, Americas, Europe, Western Pacific, World) and type of organisation consisted of two levels (commercial, other). There was no significant interaction $F(4, 82) = .87, p = .49$, and the main effects were examined. There was no significant effect of region, $F(4, 82) = 0.64$ $p = 0.63, \eta_p^2 = .03$, or type of organisation, $F(1, 82) = .01, p = .94, \eta_p^2 = .00$. See Table 3 for mean and standard deviation for each location and region.

Based on these results, the null hypotheses (1) there is no significant difference in mean RGL of webpages based on region and (2) there is no significant difference in mean RGL of webpages based on type of organisation were supported.

Table 3. Mean and Standard Deviation (SD) values for location and organisation based on dependent variable.

	Mean RGL		**Understand**		**Action**		**Plain language**		**DISCERN**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Africa	11.78	2.09	65	16.59	33.33	22.49	13.61	2.33	2.47	1.01
Americas	12.16	1.84	72.67	12.16	44.26	22.51	15.11	2.27	2.72	0.89
Europe	11.86	1.70	76.53	11.84	38.06	24.83	15.65	2.45	2.41	1.06
Western Pacific	12.42	2.91	70.33	11.99	33.33	19.40	15.22	1.48	2.28	1.07
World	12.05	1.86	66.43	12.60	33.14	23.23	13.24	2.21	2.81	0.81
Commercial	12.03	1.95	67.97	12.51	35.23	22.10	14.25	2.35	2.38	0.95
Other	12.12	2.42	74.89	14.79	38.89	23.59	15.19	2.23	2.94	0.92

3.3.5 Suitability based on Region and Type of Organisation

3.3.5.1 DISCERN

The hypotheses were:

1. There is no significant difference in DISCERN scores of webpages based on region.
2. There is no significant difference in DISCERN scores of webpages based on type of organisation.

A Levene's test was done to assess whether there was equality in variance between the groups. The Levene's test was not significant, indicating the groups did not have significantly different variances in data. ANOVA testing was therefore conducted.

A two-way ANOVA was conducted on the influence of two independent variables (region, type of organisation) on DISCERN scores. Region included five levels (Africa,

Americas, Europe, Western Pacific and World) and type of organisation consisted of two levels (commercial, other). There was no significant interaction, $F(4, 82) = 1.09$, $p = .37$, and the main effects were examined. The main effect for region was not significant, $F(4, 82) = .69$, $p = .60$, $\eta_p^2 = .03$. However, there was a significant main effect for type of organisation, $F(1, 82) = 7.28$, $p = .01$, $\eta_p^2 = .08$. See Table 3 for mean and standard deviation for each location and organisation.

Based on these results, the null hypotheses (1) there is no significant difference in DISCERN scores of webpages based on region was supported and (2) there is no significant difference in DISCERN scores of webpages based on type of organisation was not supported.

3.3.5.2 PEMAT understandability

The hypotheses were:

1. There is no significant difference in PEMAT understandability scores of webpages based on region.
2. There is no significant difference in PEMAT understandability scores of webpages based on type of organisation.

A Levene's test was done to assess whether there was equality in variance between the groups. The Levene's test was not significant, indicating the groups did not have significantly different variances in data. ANOVA testing was therefore conducted.

A two-way ANOVA was conducted on the influence of two independent variables (region, type of organisation) on PEMAT understandability scores. Region included five levels (Africa, Americas, Europe, Western Pacific and World) and type of organisation consisted of two levels (commercial, other). There was no significant interaction $F(4, 82) = 1.10$, $p = .36$, and the main effects were examined. The main effect for region yielded an F ratio of $F(4, 82) = 2.53$, $p = .05$, $\eta_p^2 = .11$, indicating there was a significant difference in

PEMAT understandability scores between Africa, Americas, Europe, Western Pacific and World. Post hoc testing using LSD correction showed scores were significantly different between Europe and Africa ($p = .02$) and Europe and World ($p = .01$). The main effect for type of organisation yielded an F ratio of $F(1, 82) = 5.56$, $p = .02$, $\eta_p^2 = .06$, indicating there was a significant difference in PEMAT understandability scores between Commercial and Other. See Table 3 for mean and standard deviation for each location and organisation.

Based on these results, the null hypotheses (1) there is no significant difference in PEMAT understandability scores of webpages based on region and (2) there is no significant difference in PEMAT understandability scores of webpages based on type of organisation were not supported.

3.3.5.3 PEMAT actionability

The hypotheses were:

1. There is no significant difference in PEMAT actionability scores of webpages based on region.
2. There is no significant difference in PEMAT actionability scores of webpages based on type of organisation.

Levene's test was done to assess whether there was equality in variance between the groups. The Levene's test was not significant, indicating the groups did not have significantly different variances in data. ANOVA testing was therefore conducted.

A two-way ANOVA was conducted on the influence of two independent variables (region, type of organisation) on PEMAT actionability scores. There was no significant interaction, $F(4, 82) = .95$, $p = .44$, and the main effects were examined. The main effects for region, $F(4, 82) = 1.25$, $p = .30$, $\eta_p^2 = .06$, and type of organisation were not significant, $F(1, 82) = 1.29$, $p = .26$, $\eta_p^2 = .02$. See Table 3 for mean and standard deviation for each location and organisation.

Based on these results, the null hypotheses (1) there is no significant difference in PEMAT actionability scores of webpages based on region and (2) there is no significant difference in PEMAT actionability scores of webpages based on type of organisation were supported.

3.3.5.4 Plain language

The hypotheses were:

1. There is no significant difference in plain language scores of webpages based on region.
2. There is no significant difference in plain language scores of webpages based on type of organisation.

A Levene's test was done to assess whether there was equality in variance between the groups. The Levene's test was not significant, indicating the groups did not have significantly different variances in data. ANOVA testing was therefore conducted.

A two-way ANOVA was conducted on the influence of two independent variables (region, type of organisation) on plain language scores. There was no significant interaction $F(4, 82) = 1.18, p = .33$, and the main effects were examined. The main effect for region yielded an F ratio of $F(4, 82) = 4.58, p = .002, \eta_p^2 = .18$, indicating there was a significant difference in plain language scores between Africa, Americas, Europe, Western Pacific and World. Post hoc testing using LSD correction showed scores in World were significantly different to scores in Americas ($p = .01$), Europe ($p < .001$) and Western Pacific ($p < .001$) and scores in Europe were significantly different to scores in Africa ($p = .04$). The main effect for type of organisation was significant, $F(1, 82) = 4.25, p = .04, \eta_p^2 = .05$, indicating there was a difference in plain language scores between Commercial and Other, See Table 3 for mean and standard deviation of plain language score for each location and organisation.

Based on these results, the null hypotheses (1) there is no significant difference in

plain language scores of webpages based on region was not supported and (2) there is no significant difference in plain language scores of webpages based on type of organisation was supported.

3.4 Summary

Parametric statistical analysis was used as the data did not violate the assumptions of parametric testing. Hypotheses regarding HONcode certification were removed from the statistical analysis as there was not an even distribution of webpages with and without HONcode certification. Based on the statistical analysis, it was found that six of the null hypotheses were not supported; (1) there was not an even distribution of webpages based on type of organisation (2) there was a significant difference between mean RGL in the study sample and the recommended sixth RGL (3) there was a significant difference in DISCERN scores based on type of organisation (4) there was a significant difference in PEMAT understandability scores based on region (5) there was a significant difference in PEMAT understandability scores based on organisation and (6) there was a significant difference in plain language scores based on region. Post hoc testing using LSD correction revealed that there were significant differences in PEMAT understandability scores between Europe and Africa and Europe and World. Post hoc testing also revealed that there were significant differences in plain language scores between World and the Americas, World and Europe, World and Western Pacific and between Europe and Africa.

Chapter 4: Discussion

4.1 Overview

The aim of this study was to investigate the readability and suitability of online information on the vestibular system available in English. The mean readability of online information on the vestibular system was high and using the DISCERN tool the suitability of online information was considered 'moderate,' the PEMAT understandability score was 70% or "understandable," the actionability score was 36.3% or not very "actionable" and the mean plain language score was 14.5. This chapter will include discussion on previous readability and suitability scores relative to the results of the study, alongside analysis of the DISCERN, PEMAT and plain language tools.

Another focus of the study was the relationship between readability and suitability and the two factors: webpage region and type of organisation. There was an even distribution of webpages based on region but not on type of organisation; there were no significant differences in readability of webpages based on their region or type of organisation; there were significant differences in DISCERN scores based on type of organisation; there were significant differences in PEMAT understandability scores based on region and type of organisation and there were significant differences in plain language scores based on region. These findings will be discussed, alongside the clinical implications and limitations of this study and areas for future research.

4.2 Readability of Online Information on the Vestibular System

The mean RGL of webpage information on the vestibular system was 12.06; a significantly greater value then recommended sixth RGL. These results are consistent with previous studies on readability, including a systematic review in 2015 by Laplante-Lévesque and Thoren who found that, on average, individuals with a hearing loss and their significant

other needed 9 to 14 years of education to read and comprehend online information on the hearing system. Joseph et al. (2016) also reviewed both printed and online patient materials on behind-the-ear (BTE) hearing aids and found the six printed materials at a 10th RGL and websites on behalf of professional organisations, suppliers, and health information services written at 10th, 10th, and 11th grade reading levels, respectively.

More specific to the present study, Spiers et al., (2017) measured the RGL of 58 websites on acoustic neuromas using FOG and F-K. The average FOG score was 13.40; the equivalent reading capability of a first-year university student and using the F-K, only three of the 58 websites were written at the appropriate level for an average adult in the UK. Cherla et al., (2013) also analysed patient materials relating to acoustic neuromas and found the average RGL was also significantly higher than the sixth RGL, with none of the articles having a RGL of lower than six.

The number of people with low health literacy combined with the high RGL of online health material is less than ideal. Individuals who are educated in their health condition experience less anxiety, are better prepared for consultations with their healthcare professionals and are active in the decision-making process, leading to more positive patient outcomes (Hoffmann & Worrall 2004). Dysfunctions of the vestibular system are non-specific in nature; thus, accessing information about symptoms specific to certain conditions to make a diagnosis is crucial. For instance, although acoustic neuromas are mostly benign tumours, the word 'tumour' can alarm individuals who may already be going through high levels of stress. Having material that is easy to read and understand can inform people to go see a medical professional if they think they may have an acoustic neuroma, or to direct them on what to do next.

Kerber et al. (2014) conducted a study to find the most popular search terms regarding dizziness to get a better idea of consumer demand for dizziness-related articles on the

internet. By inserting BPPV-related search terms, they discovered a substantial amount of information, reflecting that there is a significant demand to know more about BPPV on the internet. As such, the appropriate information needs to be available to meet this demand. Finally, one-third of BPPV videos on YouTube present inaccuracies around BPPV (Kerber et al., 2012), further showing the level of information out there that is both inadequate as well difficult to read.

4.3 Suitability of Online Information on the Vestibular System

The suitability of the materials in the present study using the DISCERN tool had an average score of 2.5, equating to a 'low to moderate' rating. Similarly, Laplante-Lévesque et al. (2012) reported an average DISCERN score of 2.04 (a 'low' rating) for readability and suitability of information on adults with hearing impairment. McKearney and McKearney (2013) also analysed webpages on ventilation tubes for otitis media using the DISCERN and found the webpages to be generally of a mixed quality. The present findings suggest that overall, the online information available on the hearing and vestibular system does not provide useful information on treatment options.

The average PEMAT understandability score was 70% and the actionability tool was 36.3%. A score of 70 or greater indicates material being understandable or actionable and a score less than 70 is considered poorly understandable or poorly actionable (Shoemaker et al., 2014). Limited information is available on PEMAT in relation to studies on the hearing and vestibular system, but the outcomes of the present study are comparable to Kang and Lee (2018) who assessed audio-visual patient education materials on diabetes care and found understandability scores higher than actionability, with scores at 49.5% and 31.4% respectively. Fajardo, Balthazaar, Zalums, Trevena & Bonner (2019) also found the mean understandability score (79%) of type 2 online diabetes risk calculators to be higher than

mean actionability score (42%). This pattern of findings indicates that although webpages are presented at a quality that could be understood to a certain degree by the reader, the reader is not able to use the information to make decisions about what to do next. This is a concerning finding because many people search up their health condition because they wish to know what to do about their condition (Li et al. 2016).

A modified version of the Plain Language checklist was used to assess the level of plain language used in the webpages. The average score for the 92 webpages was 14.5 out of a possible 20; the greater the score, the greater the level of plain language was used. The checklist consisted of 20 questions with required either a yes or no answer. The questions which were answered yes most frequently across the sample size were: "is the appearance of the material consistent throughout (i.e. consistent use of fonts, italics, bold print, colour, and bullet points)?" which received a score of 100%, indicating all 92 webpages had met the criteria for having consistent appearance of material throughout. The second most answered question was "is correct punctuation used throughout?" with a score of 97.8%. Finally, the third most answered questions were "is the content relevant to the topic of interest?" and "is the content arranged in a sensible order?" receiving a score of 96.7%. The question that received the lowest score of 31.5% was "are unnecessary words eliminated (e.g. technical jargon or adverbs)?" followed by "does the material begin with the most important message of that webpage/video?" with 33.7% and "does the introduction (first paragraph) inform the reader what they are about to read?" with 37%.

The question receiving the lowest score "are unnecessary words eliminated (e.g. technical jargon or adverbs)?" is consistent with the rest of the findings in the study; allowing patient education materials to consist of medical jargon will not provide the simple yet effective information that is desired, but will rather lead to confusion, stress, misunderstanding and an overall undesirable experience (Deitel, Deitel & Nieto, 2001, as

cited in Boldyreff, Burd, Donkin & Marshall, 2001). When coming across difficult or complex diction on the internet, users do not take the time to read long or complex passages, therefore only having one idea per paragraph and simple sentence structures are crucial in achieving better material for readers (Nielsen, 1999). The other common questions which received low scores ("does the material begin with the most important message of that webpage/video?" and "does the introduction (first paragraph) inform the reader what they are about to read?") also relate to simplification of information. By having material which contains a summary paragraph or highlighting the most important messages at the start or end of the material, it allows the user to skim over unnecessary information and gather the most important facts quickly and efficiently. This was not observed in many of the webpages on the vestibular system.

4.4 Region and Type of Organisation

The present study found no significant differences in readability of webpages based on their region or type of organisation. This finding was similar to previous research by Manchaiah et al. (2017) where there were no significant differences in online information on tinnitus based on type of organisation, and Potter (2015) who found no significant differences in readability of online hearing-related information based on organisation.

There were significant differences in DISCERN scores based on type of organisation. Mean DISCERN scores were lower for commercial webpages (2.38) than for webpages classified as 'other' (2.94), which were government and non-profit institutions. This was also seen in Laplante-Lévesque et al. (2012), where DISCERN scores were lower for commercial webpages than for non-profit and government webpages. This differed to results by Potter (2015) who observed no difference in DISCERN scores between commercial, non-profit and government webpages for hearing-related information. There were also significant differences in PEMAT understandability scores based on region and type of organisation and

significant differences in plain language scores based on region. Thus, overall, commercial organisations had lower suitability scores for all three suitability measures compared to organisations classified as 'other'.

The greater suitability scores for webpages from non-profit and government organisations could be because, although commercial organisations may have information on vestibular symptoms, the treatment for conditions such as BPPV, acoustic neuromas, Meniere's disease and so forth are distinctive and knowledge for this type of treatment will be better when presented by government organisations such as hospitals, or non-profit organisations whose sole focus may be providing help and information for these conditions. Commercial websites can also be made by anyone, regardless of whether the information quality is accurate, reliable or legitimate. Information is perceived as more trustworthy by people seeking online healthcare if it is created by government agencies and medical organisations (Pletneva, Cruchet, Simonet, Kajiwara & Boyer, 2011).

4.5 Clinical Implications

The average RGL in the present study was 12.04, considerably higher than the recommended sixth RGL suggested by the AMA guidelines; a concerning finding. This indicates that millions of people who are functionally illiterate cannot read and comprehend essential healthcare information. This statistic is especially prevalent among the elderly population, who have the largest number of chronic disease and the greatest health-related reading demands (Kirsch et al., 2002). Ideally, the ease of the internet allows users to access information and get a brief overview of the topic they are investigating so they can decide what actions to take regarding their healthcare. The standard of the current webpages means this will make it harder for people, and especially harder for older individuals and people who have lower education levels, to gather appropriate information. People of lower educational levels are already less likely to be action-seekers (Murray et al., 2003, as cited in

Wald, Dube & Anthony, 2007), and by accessing the internet and not being able to comprehend the information, they may misinterpret the information leading to harm such as incorrect self-treatment which may worsen their health outcome (Svider et al., 2013), unnecessary anxiety and preventable mortality rates (Kiley, 2002). Although low health literacy is more prevalent for certain groups such as minorities and underprivileged populations, low health literacy is seen in people of all ages, races, incomes, and education levels (Walsh & Vosko, 2008).

The internet is intended to serve as a middle ground to enable people and communities to come together to celebrate economic, professional and social successes (Bodie & Dutta, 2008). However, the internet is not accessible to everyone and patterns of use differ between ethnic, socioeconomic and racial groups (Kim & Xie, 2017). The gap between people who do and do not have access to the internet, specifically online healthcare information, is referred as the digital divide (Campbell & Nolfi, 2005). The digital divide is a concern for older adults as medical information and other healthcare regimes are making information more accessible via the internet rather than coming in to physically see a healthcare professional. Thus, older people who lack access to the internet as well as eHealth skills necessary to find, retrieve, and evaluate information are at a distinct disadvantage in managing their health care (Campbell & Nolfi, 2005). The digital disparities that exist for accessing the internet can lead to unequal opportunities which can hinder benefit from available health resources (Kim & Xie, 2017).

Many people are unaware of the link between hearing and the vestibular system, and by prolonging seeking treatment for what is more than just a headache or a dizzy spell, it could worsen the condition. Online information on the vestibular system has the ability to help many people, but only if the information is both readable and suitable. The materials used in this study have high readability and low suitability, thus, both clinicians, web

developers and creators of patient education materials have a role to play in improving the current materials.

4.6 Improving Online Information on the Vestibular System

When designing online health information, the key things to bear in mind are stimulation and motivation (Doak et al., 1996, as cited in Ryan et al., 2014). Summarizing information allows for only the most critical information being presented, and repeated information reinforces learning. Graphics should be used only when wanting to enhance information provided in the text without making it more complicated to the reader. This is particularly for people with low health literacy or limited education who may find the diagrams more confusing rather than helpful. When done well, adding pictures to written and spoken language can increase patient attention, comprehension, recall and adherence, especially for people with low health literacy (Houts et al., 2006). As a rule: use plain language and simple graphics, as even people with higher levels of education and reading abilities prefer materials that are written with simple language (Ryan et al., 2014). The aim, therefore, is to improve both access to good healthcare information, as well as ways of presenting the information that can be used in patient decision making and to motivate individuals to search for this information.

4.6.1 Recommendations for Web Developers

Ninety-two webpages were analysed in the present study. Most webpages were not at an adequate level of suitability; poor webpage design played a role. Factors which contributed to the low suitability scores included the layout. Many webpages had long complex passages compressed to one area of the webpage making it difficult for the reader to extract the most important messages quickly and efficiently. Other elements were lack of

visual and interactive elements. As mentioned earlier, users absorb information more efficiently with visual and audio elements rather than through text alone. The Checklist of Checkpoints for Web Content Accessibility Guidelines (WCAG) version 1.0 state that a website should use "the clearest and simplest language appropriate for a site's content." The WCAG 2.0, an updated version, stated that a website should be perceivable, operable, understandable and robust. A website is considered perceivable if it contains elements such as media, audio and visual components that complement the important textual information, including elements for special populations which require additional assistance. Operable means the user can manipulate and navigate through the webpage; understandable that the reader can understand the content, and robust meaning it can be compatible with other information and technological sources.

Although users of any age and background struggle to deduce information from a website with poor design, older adults especially struggle. According to Lustbader (1997), many older adults feel they cannot keep up with technological advancements, resulting in reduced self-esteem with internet use. The National Institute on Aging and the National Library of Medicine developed a set of guidelines to aid Web designers in generating "senior friendly" websites tailored specifically to older adult users (Echt, 2002, as cited in Hardt & Hollis-Sawyer, 2007). Three areas of interest to improve on were: readable text, comprehension of website content and enhancing memory, and improving the ease of navigation. The developers believe that improving these areas would increase older adults accessing online information and their willingness to explore the internet.

4.6.2 Recommendations for Healthcare Professionals

Audiologists and healthcare professionals have an important role to play in the future of readability for patient education materials. Audiologists have limited knowledge of the

literacy levels of their clients as well as limited knowledge of what the average literacy levels are, the consequences of low literacy and of the readability levels of their clinic forms (Atcherson, Zraick & Hadden, 2013). Health professionals also often overestimate the health literacy levels of their patients (Walsh & Vosko, 2008). This overestimation may influence a physician's choice of words or medical terms and cause him or her to exceed the patient's ability to comprehend the advice or instructions. Audiologists becoming more educated in these areas could have large implications and be advantageous for clients. This can result in greater knowledge and understanding of the vestibular system, hearing information and hearing impairments for clients and their significant others (Laplante-Lévesque & Thoren, 2015).

Using written materials as an educational tool for patients has several advantages. This includes a general decrease in postoperative complications, use of medications, length of hospital stay, degree of nausea and vomiting and general anxiety of the patient (Gokdogan et al. 2003a, as cited in Demir et al., 2008). Written materials also help the patient to cope with their situation (Hoffmann & Worrall 2004). People often forget information after being communicated to verbally, thus it is considered better to give the written educational materials to the patients so that the information can be retained in their memory and recalled later (Hoffmann & Worrall 2004).

Another concern is that a lot of online information focuses solely on diagnosis but not enough on treatment. An option could be for healthcare professionals to explain to patients what they should do and point them in the right direction. This could include giving patients websites they consider reliable and of good quality and websites that the audiologist has gone and investigated themselves and performed readability analyses on. Another option could be for healthcare professionals to write their own material to disperse to their patients.

In some instances, no treatment is still a treatment option, which can be the case for problems with the vestibular system. On the other hand, there may be more than one available option, but only one medical option. Thus, it is important to speak to a medical professional about what option is best for the individual, as online information is often generalised to the general population but a treatment option for one person might not be the optimal choice for another.

4.7 Limitations of the Assessment Tools

4.7.1 Limitations of Readability Tools

The FOG, SMOG and FK, are the most common readability analysis tools used for hearing and hearing-related online information as they have both high reliability and validity. Albeit useful, readability formulas have a few significant limitations. Early readability research focused on linguistic elements of a text and defined readability as comprehensibility (Dreyer, 1984). However, readability formulas do not define readability. Although they measure factors which reflect readability and can correlate with difficulty, they do not call attention to other features of a text that impacts comprehension (Davison et al., 1980). For instance, many of the readability formulas take sentence length and word length into calculation, assuming the longer a word or sentence is, the more difficult it is. However, words can be longer yet familiar to the reader, whereas shorter words can be more complex. Words which are gibberish or made up, but short and only have one or two syllables will also be scored highly unless the readability formula specifically uses a vocabulary list, such as the Dale-Chall (Redish, 1981). Finally, readability formulas also do not consider factors such as the readers' background knowledge on a topic, familiarity of words, their interest in the text and context.

4.7.2 Limitations of Suitability Tools

The DISCERN has a few major weaknesses, the first is concerning reliability. The DISCERN has a low inter-rater agreement (Duenas-Garcia, Kandadai, Flynn, Patterson, Saini & O'Dell, 2015). The DISCERN contains 16 questions all which are rated subjectively by the reader, with the final overall rating of the material based on the last question and not all the questions collectively. The rating process and the general interpretation of the material, therefore, are based on the reader's opinion. The DISCERN, therefore, does not generate interpretable scores regarding educational health material (Clayton, 2009).

Although the DISCERN was designed to evaluate treatment options, it assesses whether the information is presented in a way that aids in the decision-making process rather than assessing the information on the actual treatment. For instance, a material may be scored highly for treatment options that may be incorrect or contain errors (Pusz & Brietzke, 2012). Thus, the DISCERN cannot discuss the evidence-base for those treatment options.

Discrepancies in scoring is often seen between trained medical specialists and lay users, resulting in the DISCERN having low reliability. Ratings are also impacted by the degree of general knowledge about web design (Cerminara, Santarone, Casarelli, Curatolo & Malhany, 2014). Finally, the creators of the DISCERN outline what a value of 1, 3 and 5 is when scoring a piece of material, but do not specify 2 or 4. In this instance, the numbers are behaving more like are ordinal level variable as opposed to interval level. Many times the researchers had to guess what a 2 or 4 was with no clarification. In this instance, a 2 is treated as a lower score than a 3, thus being treated as an ordinal variable. However, when scoring the researchers treated both the scores and the numbers as integers. The nature of scoring raises the question of whether the DISCERN is scored at the interval level. If it is not, a further question arises of whether it is suited for parametric testing.

One limitation of the PEMAT is an absence of a grading system. A separate score is generated for the understandability and actionability of the material, but both scores are simply scored out of 100. Although the creators label a score of 70 and greater as understandable or actionable, and less than 70 as not, it is still very generalised and does not give detail to the specific factors which make the materials more understandable or actionable. Another limitation of the PEMAT is that some questions are ambiguous and a rater's response could differ from another rater's. An example is question two "the material does not include information or content that distracts from its purpose." One individual may think some aspects of information are important to the overall understanding of a topic, whereas another individual may disagree.

The plain language checklist used was a modified version created by the researchers. The plain language checklist was created solely for the purpose of this study, and is therefore not a validated tool. There is also limited information on the original two tools from which the checklist was created from. Thus, conclusions regarding the plain language checklist should be taken with caution.

4.8 Study Limitations and Future Research

The current study was limited to English language websites and a single search engine – Google; neither options being a full representation of available information. Other search engines and languages may have revealed additional valuable information. Therefore, the 92 webpages found on the vestibular system in the study is not a complete representation of the information available online. Future research could assess online vestibular information using different search engines and information in other languages.

Apart from the RGL, which was calculated using an online automated formula, the suitability of each webpage was assessed by the researcher and not an objective automated

formula. Although the ICC between the researchers was completed and were all excellent quality, ICC is a measure of reliability and not validity. In the future, an established validity tool would be convenient to ensure that what is being done is validated. The researchers were also all naïve and was their first time assessing webpages using the three suitability tools. If more experienced individuals used the tools it may have generated different results.

The target population for the study are help seekers and individuals who have vestibular issues. A crucial predictor of online health seeking behaviour is the seriousness of the patient's health condition (Wald et al., 2007) and may act as a motivating factor for the individual searching the internet for information (Li et al., 2016). If the people recruited were presenting with these issues during the time of data collection the key words may have differed or the participant may have used different strategies to access the information. Future research could focus on allocating participants who either have chronic or acute vestibular problems for more accurate findings.

Future research could focus on improving online information on the vestibular system. Using websites with high RGLs and basic yet effective design and content as well as following best-practice formatting guidelines can all help with production of future patient materials.

4.9 Conclusions

The internet has become one of the most important tools of the 21st century, especially in the realm of healthcare. Although harbouring a wealth of information, the world-wide web is not useful if the material cannot be read or understood by majority of its users. The present study analysed the readability and suitability of 92 webpages on the vestibular system, revealing low levels of both readability and suitability. This implies the information currently available is sub-optimal. The importance of being able to access information on elements such as symptoms and red flags is crucial to know what actions to take, whether it be treatment or

preventative measures to stop the condition it from recurring in the future. A re-development of online material on the vestibular system is therefore required if a change is to occur.

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Appendix

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Rebecca Robinson
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Ref: HEC 2019/07/LR

1 April 2019

Ana Blagojevic, Aynsley Hickson, Carol Hewitt, Katie Murphy, and Sarah Folkerts
Psychology, Speech and Hearing
UNIVERSITY OF CANTERBURY

Dear Ana, Aynsley, Carol, Katie, and Sarah

Thank you for submitting your low risk application to the Human Ethics Committee for the research proposal titled "Quality of Hearing-Related Internet Information".

I am pleased to advise that this application has been reviewed and approved.

With best wishes for your project.

Yours sincerely

Dr Dean Sutherland
Chair, Human Ethics Committee