Evaluation of a Revised Webpage on Otitis Media

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Abstract

***Purpose*:** The current study sought to assess a poorly rated webpage on Otitis Media (OM), revise it using best-practice guidelines, and, using a randomised experimental design, evaluate the effect of these revisions on reader comprehension, self-efficacy, and opinion.

Method: The original webpage material was identified from a precedent study where it generated the lowest readability, quality, and content scores of all the assessed webpages. Multiple readability formulas, the DISCERN tool, the adapted Plain Language Checklist, and the SAM were used for readability, quality, content and suitability analysis. To revise the webpage, best-practice guidelines and the aforementioned standardised tools were used. Once modified, 52 participants were randomly allocated to read either the (1) unrevised, or the (2) revised material before completing an anonymous online questionnaire.

***Results*:** Poor readability, quality, content, and suitability ratings indicated that the unrevised webpage on OM was inaccessible to readers. Participants who read the revised webpage were found to exhibit significantly higher comprehension and opinion scores than those in the unrevised group. Self-efficacy scores were similar across two groups.

Conclusion: Post-revision analysis of the OM webpage demonstrated that best practice guidelines can be used to revise existing health materials to improve their readability, suitability, quality, and content. Owing to its significant implications on reader comprehension and self-perceived opinion these findings have critical consequences on patients and caregivers of children who seek online information on OM. High quality health information on OM can aid in understanding, managing, and treating the health condition, reducing its progression, complications, and improving health outcomes. Thus, initiatives

that necessitate the improvement of existing materials or the development of easy to read, suitable and high-quality online health information on OM are vital.

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List of Abbreviations

ANOVA	Analysis of Variance
ET	Eustachian Tube
F-K	Flesch-Kincaid Readability Formula
FRE	Flesch Reading Ease Formula
FOG	Gunning FOG Index
HCP	Health Care Professional
HL	Hearing Loss
ICC	Intraclass Correlation Coefficient
MANOVA	Multivariate Analysis of Variance
NZ	New Zealand
OM	Otitis Media
PCC	Patient Centred Care
PLC	Plain Language Checklist
RGL	Reading Grade Level
SAM	Suitability Assessment of Materials
SDM	Shared Decision Making
SES	Socioeconomic Status
SMOG	Simple Measure of Gobbledygook
TM	Tympanic Membrane

Chapter 1: Introduction

1.1 Overview

Otitis Media (OM) is a widespread condition with information frequently sought after. Its complications are a severe cause of child morbidity, health care visits, and preventable hearing loss (HL) globally (Monasta et al., 2012; Qureishi et al., 2014). While most cases spontaneously resolve, in others, the condition manifests, with symptoms challenging to identify and treatment unclear (Qureishi et al., 2014). The provision of accessible and appropriate written health material can help mitigate these implications by enabling patients or caregivers to better understand and recognise symptoms; vital in making informed management decisions.

Due to the significant proliferation of internet users worldwide, the landscape of information exchange has changed (Fox, 2014; Jacobs et al., 2017). Owing to its ubiquity, the internet is a more practical, accessible, and cost-effective source of health information (Bert et al., 2013; Cline & Haynes, 2001; Morahan-Martin, 2004). Instigated by arising symptoms, patients or caregivers of children with OM may turn to the internet to access relevant health information. However, such information is only beneficial if it is accessible, comprehensible, and remembered by its audience (Hoffmann & Worrall, 2004). Copious studies have determined that health education materials within the scope of audiology are challenging to read and understand (Joury et al., 2018; Laplante-Lévesque, 2015; Laplante-Lévesque et al., 2012; Laplante-Lévesque & Thorén, 2015; Lee, 2020; Manchaiah et al., 2019; McKearney & McKearney, 2013; Potter, 2015); yet developers continue to produce

such materials (Freda, 2005). In her study, Lee (2020) concluded that all the assessed OM-related online health materials had poor readability, quality, and content. Thus, it is necessary to question whether OM-related online health information is reducing or creating disparities in people's knowledge, health-related decision-making, and subsequently, health outcomes (Jacobs et al., 2017).

Defined as limited health literacy, if patients or caregivers are unable to access, read or understand health information, then they cannot engage in informed decision making (Freda, 2005; Nutbeam, 1998). Given its invisibility, these issues may be exacerbated by feelings of embarrassment and shame (Parikh et al., 1996). While increasing the health literacy skills of the audience would be an appropriate long-term goal for the health care system, prompt action would be to focus on redesigning online health information materials to better match the skills of the general audience (Caposecco et al., 2014). Material can be written in a way that enhances comprehension and self-efficacy (Donald & Kelly-Campbell, 2016). What is not known is whether the same outcomes exist for online informational material on OM. Due to its high prevalence in children, and risk of complications, improving one's understanding of health information could serve to enhance patient self-efficacy, and simultaneously, better manage a condition such as OM. This thesis aims to evaluate whether readable and comprehendible web-based information on OM, could serve to enhance reader comprehension, self-efficacy and opinion.

Chapter one begins by describing OM, including its aetiology, implications, diagnosis, management, and treatment options. It will then go onto reviewing the importance of health education, health literacy, self-efficacy, and health information. Next, the concepts of readability, comprehension, suitability, and content are described, before

analysing the literature on best-practice guidelines for improving patient materials. Lastly, the aim and hypothesis of this thesis are defined to provide the rationale for this study.

1.2 Otitis Media

The term OM encapsulates a spectrum of complex diseases that affect the middle ear cavity and mucosa, tympanic membrane (TM), and/or eustachian tube (ET) (Plack, 2018). Its aetiology is complex and multifaceted; with inflammation primarily preceded by dysfunction or anatomical variations of the ET (Musiek et al., 2019; Qureishi et al., 2014). Viral upper respiratory tract infections, bacterial pathogens, irritants, allergies, weak palatal muscle, or the geometry of the tube are responsible for the functional blockage of the ET or inflammation of its mucosa (Musiek et al., 2019; Plack, 2018; Qureishi et al., 2014; Roland et al., 2019; Schilder et al., 2016). If this persists, then a transudate from the middle ear mucosa may form, or pathogenic bacteria that colonize the nasopharynx may migrate or reflux into the middle ear and reside; resulting in infection (Madell & Flexer, 2014).

Although ubiquitous across the life span, globally, OM is the most common paediatric diagnosis; its prevalence peaks at aged two years then begins to decline over the age of six years (Madell & Flexer, 2014; Roland et al., 2019). By the age of three approximately 50%-85% of children are expected to have had at least one episode of OM, (Klein, 1994; Qureishi et al., 2014), and 76%-95% by six years (Madell & Flexer, 2014). It is the leading cause of recurrent health care visits, antibiotic prescription, and HL in children due to their immature immune systems and the anatomical differences of their ETs (Bluestone, 2004; Qureishi et al., 2014). With age, the ET matures and the relative prevalence of OM declines (Qureishi et al., 2014). Adult-onset OM is associated with

underlying illnesses, such as sinusitis, smoking-induced nasopharyngeal lymphoid hyperplasia, adult-onset adenoidal hypertrophy, and nasopharyngeal carcinomas (Finkelstein et al., 1994; Qureishi et al., 2014). Due to the seriousness of these conditions, particularly if unilateral, management is focused on assessing and treating the underlying conditions first (Harmes et al., 2013; Qureishi et al., 2014). These complications are significant causes of preventable HL and morbidity, particularly within economically developed nations (Qureishi et al., 2014).

1.2.1 Implications

In prolonged and untreated cases of OM, serious complications and sequela may develop. The fluid within the middle ear may impair auditory reception, by impeding the conduction of sound to the inner ear (Musiek et al., 2019). The fluctuating and inconsistent acoustic stimulation inhibits the maturation of the auditory pathway as it filters sounds from reaching the auditory centres of the brain (Madell & Flexer, 2014). For children who are in the critical stage of development, early or persistent OM has been associated with long-term speech, language, learning, and behavioural problems (Bennett et al., 2001; Nittrouer & Burton, 2005; Qureishi et al., 2014; Teele et al., 1990; Walker & Wigglesworth, 2001). Other complications include TM perforations, tympanosclerosis, cholesteatoma, or secondary infection of the outer ear (Madell & Flexer, 2014). In rare, yet severe cases, due to their confluent relationship, the infection may also spread into surrounding structures including the mastoid air cells, brain, meninges, and sigmoid sinus; ensuing in intra- and extra-cranial complications including mastoiditis, labyrinthitis, brain abscess, meningitis,

and sigmoid sinus thrombosis (Bluestone et al., 2002; Klein, 1994; Qureishi et al., 2014). Seldom, OM may result in death (Madell & Flexer, 2014).

1.2.2 Management and Treatment

Numerous recommendations exist for the management and treatment of OM (Qureishi et al., 2014). Commonly, a period of observation is recommended (Klein, 1994; Qureishi et al., 2014), as a spontaneous resolution is seen within two weeks in 80% of acute episodes in children (Qureishi et al., 2014), and 90% of OM with effusion cases (Roland et al., 2019). Analgesics are often suggested to relieve symptoms of pain, fever, and irritability (Harmes et al., 2013; Qureishi et al., 2014; Schilder et al., 2016). While decongestants and antihistamines provide symptomatic relief for congestion, their efficacy is minimal in resolving acute symptoms or effusion (Harmes et al., 2013; Klein, 1994; Roland et al., 2019; Schilder et al., 2016). For cases where OM is bilateral and persistent, or severe and accompanied by otalgia and fever antibiotics are recommended (Klein, 1994; Qureishi et al., 2014). Antibiotic use is however disputed due to concerns around adverse side effects and bacterial resistance (Harmes et al., 2013; Musiek et al., 2019; Schilder et al., 2016). In cases where structural anomalies are suspected, a HL is diagnosed or spontaneous resolution does not occur, surgically placed ventilation tubes are considered (Klein, 1994; Qureishi et al., 2014). By draining the effusion and aerating the middle ear, this procedure is shown to improve hearing and reduce the duration of OM (Roland et al., 2019). Due to its high prevalence in children, it is not surprising that it is currently the most common paediatric surgical procedure (Klein, 1994). Enlarged adenoids are a likely source of chronic inflammation (Roland et al., 2019); treatment via an adenoidectomy has also

been shown to reduce acute episodes and recurrent effusion (Klein, 1994; Schilder et al., 2016). In cases where a HL is present and where traditional medical management is contraindicated, hearing aids are a useful alternative (Musiek et al., 2019; Roland et al., 2019). Because numerous management and treatment options exist for OM, the course of treatment is not always clear. Instead, emphasis must be placed on the importance of patient knowledge and health education which may be valuable in avoiding risk factors and/or preventing the progression of the condition.

1.3 PCC and SDM

It is evident that patients desire and value knowledge regarding their diagnosis, treatment, and management, and that it is ethically and legally imperative to involve them in decision-making (Charles et al., 1997; Elwyn et al., 2010; Hoffmann et al., 2014; Légaré et al., 2008). Patient-centred care (PCC) embodies the provision of care, and formulation of clinical decisions that encompass, and are responsive to the needs, values, and preferences of the patient (Institute of Medicine (US) Committee on Quality of Health Care in America, 2001). This is integral to a health care system that intends on providing safe, reliable, integrated, and accessible care. Intertwined within PCC is shared decision making (SDM), defined as the use of best available evidence to guide and support decision-making; made collectively by the patient and their health-care professional (HCP) (Elwyn et al., 2010; Hoffmann et al., 2014). This concept extends beyond patient involvement, enhancing autonomy and control by encouraging patients to reflect on health-care options and select their preference(s) (Charles et al., 1997; Elwyn et al., 2010). Shifting from a traditional

paternalistic ideology where patients adopt a passive role, SDM encourages control over their health, and health-decisions (Brabers et al., 2017).

Implementation has been challenging and slow due to misconceptions such as time constraints, limited HCP training, and patient reluctance (Elwyn et al., 2010; Hoffmann et al., 2014; Légaré et al., 2008). Further, a mismatch exists between available health information and patients' backgrounds and literacy levels (Elwyn et al., 2010). 'Informational asymmetry' described by Charles et al., (1997) as the belief that HCPs occupy superior knowledge regarding health care, can only be addressed by providing patients with material that complements their literacy skills. Comparably, Elwyn and colleagues (2010) reveal three elements necessary for successful and sustainable SDM including 1) the provision of readily available evidence-based information, 2) assistance with clinical equipoise and 3) a clinical ethos that enables patient participation.

Randomised trials of 'decision aids', defined as consultation tools that provide evidence-based information to guide decision-making, were used to examine the benefits of SDM (Elwyn et al., 2010). Comparable to other studies, Elwyn et al. (2010) found that increased patient participation improved patient knowledge, particularly risk-perception understanding, increased satisfaction with treatment decisions, improved confidence, active involvement, and greater adherence to treatment (Brabers et al., 2017; Hoffmann et al., 2014). A reduction in inappropriate utilisation of examinations and treatments and increased elective involvement in conservative treatment options was also acknowledged; a positive correlation with reduced healthcare costs (Elwyn et al., 2012**).** Furthermore, empowering patients and reducing the power-divide between them and HCPs undoubtedly

reduces clinician burden by allowing them to focus on management (Charles et al., 1997; Kelly-Campbell & Manchaiah, 2020).

Former studies that examined PCC consultation styles revealed a positive association between 'patient activation' and patient satisfaction (Kuipers et al., 2019; Michie et al., 2003). This consultation style was defined as the patient's active involvement and control over the discussion and management of their condition; essentially an amalgamation of PCC and SDM. Increased patient management was found to positively influenced their satisfaction with care, and their health outcomes; beyond that to which patients are solely provided with advice from their HCP (Michie et al., 2003). This is likely because patients are more aware of their lifestyles and needs, compared to their HCP (Michie et al., 2003). As these studies are primarily cross-sectional or prospectively designed, with only two randomised controlled trials, their internal validity may be questionable. Although this prevents the determination of causality of a relationship and a conclusive effect, the findings remain tentative that PCC and SDM are essential to good quality care. A substantial impediment to facilitating PCC, and involvement in SDM, is the patient's understanding of health information and treatment outcomes. Commonly expressed through written materials, health information is only effective if it is accessible, comprehensible, and remembered by its audience (Hoffmann & Worrall, 2004). Thus, the concept of health literacy is an important determinant of this.

1.3.1 Health Literacy

The definition of health literacy has evolved beyond a person's educational level, or their ability to read health information (Miller et al., 2009). Functional health literacy is

described as the degree to which persons have the appropriate cognitive and social skills to access, understand, and utilise basic health information and services; important for engaging in informed decision-making, and successfully interacting with systems in ways that promote good wellbeing (Nutbeam, 1998).

Those with limited health literacy skills often face difficulty with analysing information and deciphering important points. This impedes their capacity to ask questions to help them understand, cope with, and manage their diagnosis. An adequate level of health literacy is a necessary in enabling individuals to access health information; essential for patient self-management, successful participation in PCC and SDM, and function in health care settings (Elwyn et al., 2010; Kelly-Campbell & Manchaiah, 2020). Such tasks involve reading and comprehending appointment forms, medication or prescription labels, and understanding health-related materials (Andrus & Roth, 2002).

Unlike other studies, Kutner et al. (2006) conducted a cross-sectional demographic assessment of American adults (aged 16 years and older), where they measured health literacy levels through literacy-relevant tasks. Published as the renowned National Assessment of Adult Literacy, statistical and significant findings from this report revealed that 36% of adults had basic, or below basic reading and numeracy skills. Limited health literacy was disproportionately greater in adults aged 65 years and older, ethnic minority populations, non-native English speakers, those with limited English proficiency, those with limited educational attainment (did not attend or complete high school), and those with lower socioeconomic status (SES). It is not surprising that it is these population groups that also suffer from disparities in health status.

Several studies have reported of a correlation between low health literacy and its detrimental implications on health behaviours, health outcomes, health care costs and quality of care (Andrus & Roth, 2002; Baker et al., 1998; Berkman et al., 2011; Lindau et al., 2002; Rudd et al., 1999; Weiss et al., 1992). Health literacy seems to be a stronger predictor of health status, beyond the determinants of health; broadly defined as one's biological and genetic endowment, SES, behaviours, psychosocial influences and access to health services (Weiss et al., 1992). Outcomes are somewhat explained by low health literacy manifesting into challenges with navigating literature, such as understanding health-related information, completing consent forms and misinterpreting advice due to limited health-related knowledge (Andrus & Roth, 2002; Rudd et al., 1999).

Berkman et al. (2011) conducted a systematic review of the relationship between health literacy and outcomes. A strong correlation was evident between those with low levels of functional health literacy and diminished health-related knowledge, inappropriate use of, and lower satisfaction with health care services (Berkman et al., 2011). Moderately-rated evidence revealed higher rates of improper use and interpretation of medication, poorer health status and higher mortality among those with low health literacy (Berkman et al., 2011). Using multivariable analysis in a sample population of 74 Medicaid patients, Weiss and Palmer (2004) revealed an independent association between limited literacy skills and higher health care costs. It is important to note that although these findings are yielded from secondary analysis of data from a previous study that found no association, they are well-supported and validated by results of other studies (Weiss et al., 1992).

In their study, Parikh et al. (1996) assert that low health literacy was also associated with feelings of embarrassment or shame. Within a highly literate healthcare environment

this stigma poses as a challenge for those with limited health literacy, as it may diminish their ability to express concern; affecting their relationships with HCPs, causing them to withdraw from society and lack control over everyday events (Parikh et al., 1996).

For parents and caregivers, low health literacy levels may exacerbate difficulties in comprehending and managing their children's care. This is important for conditions such as OM in infancy and childhood as caregivers are the primary managers of their child's health condition. To provide care, caregivers must understand HCPs recommendations, medication labels and education materials. In a study which assessed parental health literacy and numeracy skills, Kumar et al. (2010) found that of the 182 parents, 25% were unable to prepare appropriate medication doses, 50% did not understand a growth chart, and over 75% could not comprehend a popular breastfeeding brochure. This highlights the importance of enhancing parental comprehension, as low health literacy among caregivers is related to poorer child behaviours and outcomes (Kumar et al., 2010). In countries where the prevalence of disabling HL in children is higher, the average parents' literacy rate is lower (World Health Organisation, 2012). Such findings are concerning as it is these children that require prompt treatment and intervention(s).

1.3.2 Self-efficacy

Access to information that complements one's health literacy could enhance self-efficacy, as better comprehension of vital health information would subsequently result in greater knowledge about their health (Donald & Kelly-Campbell, 2016; Reisi et al., 2016) Self-efficacy is a pervasive concept in understanding individual behaviour and/or motivation (C. C. Doak et al., 1996). It refers to one's belief in his or her ability to organise

and perform necessary courses of action; whereby neither skills nor personality are influential, but rather their sense of confidence manifests into taking control over their motivation, behaviour, and environment (Bandura, 1977, 1986, 1989).

Due to its influential nature, self-efficacy is an important determinant of health behaviours and health outcomes (Hevey et al., 1998; Reisi et al., 2016). Bandura (1989) elucidates that this construct affects cognition in self-aiding or self-hindering ways. Individuals with higher self-efficacy persist when faced with challenging situations as they tend to envisage positive scenarios that provide encouraging guides for performance (Bandura, 1989). Contrarily, those with low self-efficacy, judge themselves as incapable and visualise failure scenarios. In a review by Hevey et al. (1998), enhanced self-efficacy was found to be a predictor of exercise uptake and maintenance, success in obesity treatment programmes, and long-term smoking cessation. Due to its self-limiting nature, low self-efficacy was associated with increased relapse to alcohol abuse, and greater intentions to use illicit drugs (Hevey et al., 1998). This is because individuals with low self-efficacy are unlikely to carry out new or change an ingrained behaviour (C. C. Doak et al., 1996).

Reisi et al. (2016) found that patients who received greater diabetes education had better diabetes self-care behaviours. This is likely because those with higher levels of learning reported feeling more confident about their ability to execute such behaviours. Unique to their study, Donald and Kelly-Campbell (2016) compared reader self-efficacy between two groups of parents. Their findings revealed that when compared to parents who were given a standard paediatric diagnostic audiology report, those assigned the revised version, which was written according to best practice guidelines, had significantly greater

comprehension and sense of self-efficacy. These findings emphasise that greater patient involvement ensues better decision-making outcomes. This is especially important for those with OM due to the uncertainty around treatment choices. Established by the aforementioned literature, it is assumed that access to high quality health information on OM may promote self-efficacy, which may increase patient confidence, motivation, and capacity in making efficacious health management decisions. Such behaviours may also increase participation in SDM, which is a fundamental part of PCC, and a key element in promoting positive health outcomes.

1.4 Health Information

1.4.1 Accessibility of Online Information

Historically, propagation of and access to health information was dependent on traditional sources, such as newspapers, radio, television, HCPs, and family members or friends (Couper et al., 2010). Due to the significant proliferation of internet use worldwide, the landscape of health information exchange is changing (Chen et al., 2018). Information is now accessible through online search engines and social networks; with ubiquitous access using devices such as smartphones, laptops, or computers (Tonsaker et al., 2014). Despite its rapid dissemination, HCPs continually remain the most trusted informational source among patients' health decision-making (Couper et al., 2010; Hesse et al., 2005; Tonsaker et al., 2014). The internet is used as a supplementary, rather than a substitute source of health information (Sillence et al., 2006). This reiterates the HCP's responsibility

to recommend or provide patients with legitimate, valid, and credible online healthcare resources to utilise (McMullan, 2006).

As of 2019, 90% of surveyed American adults were internet users (Pew Research Center, 2019); leaving 10% of the American population reportedly offline, a substantial decline from 48% in 2000 (Anderson et al., 2019). Health information was recognised as the third most popular search, behind email and search engines (Fox & Duggan, 2013). Specific diseases and treatment were the most frequent topics explored by users; closely followed by searches for medical treatments or procedures (Fox, 2014; Fox & Duggan, 2013). Approximately 72% of internet users in the US, and 75% in the UK reportedly use the internet to access health information; of this figure, the majority sought to diagnose or understand a personal medical condition, or one that someone else has (Bussey & Sillence, 2019; Fox & Duggan, 2013).

The wide-spread availability of online information poses the idea of whether it could help reduce social inequalities in health (Jacobs et al., 2017). A demographic breakdown reveals that younger persons, have at least a high school education, higher SES, and live in urban settings were more likely to be online (Anderson et al., 2019; Pew Research Center, 2019). This questions whether online information perpetuates the disparities in health information availability. Correspondingly, findings from Jacobs et al. (2017) reveal that among their population of surveyed American adults, older adults, those with lower SES, lower educational level, and lower internet self-efficacy were less likely to access online health information. The effects of education and income, in particular, parallels the literature (Couper et al., 2010). This gap is labelled as the ‘digital divide’, as findings suggest that despite the growth of health information online, some individuals remain at a

disadvantage as accessibility to this information is imbalanced (Couper et al., 2010; Jacobs et al., 2017). This is concerning as it is usually these individuals that tend to have limited health literacy, more health issues, and require more health information (Cline & Haynes, 2001; Couper et al., 2010; Jacobs et al., 2017).

One barrier to the accessibility of health information is deficient navigational, or limited internet-literacy skills (Cline & Haynes, 2001). For this reason, individuals tend to seek information from HCPs, family, and friends, or more traditional sources such as books (Jacobs et al., 2017). Other barriers include geographic location, literacy skills, accessibility (including languages, costs associated with computer or internet service providers, and computer literacy skills), and institutional policies (Cline & Haynes, 2001).

1.4.2 Benefits of Online Information

Providing one has access to the internet, anyone is able to search for, and locate an extensive database of health information suitable to their needs (Morahan-Martin, 2004). Information that may have otherwise been difficult to access beforehand, is available with little to no cost, at any location, is convenient and rapid (Bert et al., 2013; Cline & Haynes, 2001; Morahan-Martin, 2004). Accessibility to such information is shown to expedite health-related decision making and increase communication with HCPs (Kim, 2016). By guaranteeing anonymity and confidentiality, the internet enables users to explore information on sensitive or stigmatised health topics (Morahan-Martin, 2004; Sillence et al., 2006). Also, unlike any other informational source, the internet offers interactivity by enabling exchange of personal health experiences, reflections and insights (Cline & Haynes, 2001; Tonsaker et al., 2014).

Patients reportedly used online health information as a supplementary tool, to initiate decision-making, validate existing knowledge, clarify misunderstandings, complement health information provided by their HCPs, and/or validate medical decisions (Bert et al., 2013; Bussey & Sillence, 2019; Chen et al., 2018; Lagan et al., 2010). The accessible nature of the internet supports its potential as a resource for distributing information, and thus, suggests its likelihood of influencing engagement in PCC and SDM (Bussey & Sillence, 2019; Charles et al., 1997; Hoffmann et al., 2014). The informational source has been acclaimed as a catalyst for patient power; with the central motivation being a desire to obtain more information, or gain control over one's wellbeing (Sillence et al., 2006). Findings by Bert et al. (2013) revealed that patients who utilised online health information to support their medical issues were reported to have higher confidence in the information, and greater self-efficacy. Considering the negative implications of OM, access to high quality online information on OM will allow individuals to enhance their health knowledge and identify appropriate management options; encouraging them to participate in decision-making regarding their health, promoting PCC and efficacious behaviours.

1.4.3 Risks of Online Information

While internet-based health information may positively influence decision making and subsequent health-seeking behaviours, it may also have the opposite effect. Although the health literacy levels of patients seeking care for hearing-related conditions are unknown, it can be inferred from the literature on other health conditions. Seeing as online information is used as a supplementary tool, the information obtained is influential.

The volume of health-related websites available approximates around 70,000 (Sillence et al., 2006). Coupled with the number of people utilising the internet for health advice, this is concerning as the abundant amount of available online information is not only overwhelming and challenging to sort through, but is also uncontrolled, and unregulated (Cline & Haynes, 2001; Eysenbach et al., 2002; Morahan-Martin, 2004). Literature is immersed with studies showing that online health education materials are difficult to read, and of highly variable quality, with concerns raised around its accuracy, bias, currency, credibility, and reliability (Chen et al., 2018; Cline & Haynes, 2001; Eysenbach et al., 2002; Lagan et al., 2010; Morahan-Martin, 2004). Attributed to factors such as poor readability and quality of the material, former studies have found that online health information is not fit for purpose. Relevant to this study, OM-related webpages were reported to have poor layout and design, overuse of jargon/medical terminology, and have insufficient information on the risks of treatment (Lee, 2020). This cautions access to information that may be erroneous as it may be difficult to extricate, particularly for vulnerable populations, such as those with limited health literacy (Cline & Haynes, 2001; Tonsaker et al., 2014).

Inaccurate and unreliable health information may influence online users to make incorrect decisions regarding their care, leading to detrimental implications for their health (Kim, 2016; Lagan et al., 2010). Such concerns have prompted the American Medical Association to reprimand against substituting online health information for information from a HCP (Morahan-Martin, 2004). In their systematic review, Eysenbach et al. (2002) revealed that 70% of the studies found that health websites were of poor quality. Such

regulation complications mitigate the benefits of online information while stressing the importance of providing good quality information (Kim, 2016).

While online information seekers can obtain health information from credible scientific and institutional sources (Cline & Haynes, 2001); an inability to judge the quality of available information poses as another barrier to accessibility, even if accurate, those with limited health literacy may not have the appropriate literacy skills necessary to obtain and act on the information (Atcherson et al., 2014).

1.4.4 Audiology-Related Online Health Information

Audiology-related health information is commonly searched for online. In a survey by Pehora et al. (2015), 98% of the surveyed population of parents used the internet to access health-related information regarding their child's health. The relevance of these findings to this study lies in the frequently searched conditions of colds/flu or fevers which are commonly associated with OM. A qualitative, descriptive study conducted by Meherali et al. (2019) revealed mothers' informational needs when caring for a child with acute OM; being the cause and treatment. These findings necessitated the need for the provision of accessible, appropriate, and evidence-based information on the condition. Such information is deemed necessary in enhancing their ability to communicate with health providers, participate in SDM and consequently better manage their child's condition (Meherali et al., 2019).

1.5 Readability

1.5.1 Definition

Almost all studies which explore health literacy reference the readability of the written material. Readability is defined as how easily an individual can read and understand written text (Freda, 2005). If patient education materials are to be easily read, understood, and efficacious it is imperative that the reading level of the material complements the literacy abilities of its audience (Dowe et al., 1997; Meade & Smith, 1991). Unfortunately, numerous studies have shown otherwise; the readability levels of patient health education material(s) exceed the education level of the target audience (D'Alessandro et al., 2001; Donald & Kelly-Campbell, 2016; Freda, 2005; Meade & Byrd, 1989).

The reading complexity of a written text can be measured using a mathematical formula; generated by an amalgamation of measures, including vocabulary difficulty, syllable count, length of words and sentences (Freda, 2005; Ley & Florio, 1996). This combination of syntactic and semantic measures yields a score of reading difficulty; represented as a specific reading grade level (RGL). This score is interpreted as the number of years of American schooling education required to understand a piece of text (either a 75% or 100% comprehension criterion) (Freda, 2005; Ley & Florio, 1996; Meade & Smith, 1991). Once generated, the RGL is often compared with the reading skills of the population to determine suitability. Although RGL does not ascertain comprehension, it serves as a quantitative, rapid, simple, and cost-effective evaluation of how much education a person requires to understand written health materials (Ley & Florio, 1996).

US national surveys reveal that although the average RGL is between 7th and 9th grade, approximately 20% of the adult population have significant literacy limitations (at or below 5th RGL) (Atcherson et al., 2014; C. C. Doak et al., 1996). One's reading skills are estimated to be at least three grades lower than their highest educational level (D'Alessandro et al., 2001; Dowe et al., 1997; Meade & Byrd, 1989). This is because years of education cannot be directly translated to expected reading skills, as it does not necessarily measure what a person achieves with that education, or their ability to apply it to everyday life (Andrus & Roth, 2002). Globally, to facilitate health literacy, it is mutually agreed upon that patient health-related materials should be written at the 6th RGL or lower (Atcherson et al., 2014; L. G. Doak et al., 1996; Weiss, 2003). Additionally, for at-risk populations, RGL recommendations are further reduced to the 3rd RGL (Weiss, 2003).

Considering that the mean RGL of most patient health materials is between 9th and 11th, an apparent disparity exists when compared with the average readers RGL (D'Alessandro et al., 2001; Meade & Byrd, 1989). This insinuates that a large population of individuals with marginal literacy skills are unable to use current health-education materials.

Compared to those with higher literacy skills, when reading written material, persons with limited literacy skills are reported to read at a slower pace, skip unfamiliar words, have difficulties with interpreting key ideas, pay more attention to insignificant details, and struggle to make inferences from factual data (C. C. Doak et al., 1996; Friedman & Hoffman-Goetz, 2006). It is known that individuals are likely to stop reading material if it is beyond their reading ability (Atcherson et al., 2014). Therefore, information that is written above a reader's RGL can interfere with comprehension, prevent them from

actively participating and being informed decision-makers in their health care (Meade & Smith, 1991).

1.5.2 Readability Formulas: F-K, FOG, SMOG, and Mean RGL

Numerous algorithms are readily available to objectively analyse and predict the readability of written health materials (Gemoets et al., 2004; Ley & Florio, 1996). Commonly used formulas within the health literacy domain and those used within this study include the Flesch-Kincaid Readability Formula (F-K), the Gunning FOG Index (FOG), and the Simple Measure of Gobbledygook (SMOG) (Kelly-Campbell & Manchaiah, 2020; Ley & Florio, 1996). The aforementioned formulas all have high reliability, validity and are strongly correlated with each other; the FOG scores positively correlate with SMOG (r = .97 to .99), and the SMOG highly correlates with F-K (r = .93) (Friedman & Hoffman-Goetz, 2006; Meade & Smith, 1991).

1.5.2.1 The Flesch-Kincaid (F-K) Grade level formula.

The F-K formula is based on a revised version of the Flesch Reading Ease (FRE) formula, which generates an RGL for written materials that correspond to an academic grade. This measure is primary based on word length and sentence length, per three 100 word passages (Friedman & Hoffman-Goetz, 2006). Manually this formula requires more time to calculate compared to the others; however, using computer software, calculation of the RGLs is undoubtedly quicker, automated, and easily accessible (Friedman & Hoffman-Goetz, 2006). F-K is readily and conveniently accessible within the widely used Microsoft Word software. The controversy surrounding this tool is centred on its tendency to provide

artificially low scores due to having a lower comprehension criterion. RGL using the F-K is calculated using the following formula (Kincaid et al., 1975):

$$\text{Grade level} = \left(0.39 \text{ x } \frac{Total\ words}{Number\ of\ sentences}\right) + \left(11.8 \text{ x } \frac{Total\ syllables}{Total\ words}\right) - 15.59$$

1.5.2.2 The Gunning Fog Index (FOG).

This formula was developed by Gunning in 1952 to address the "fog" or redundant complexity of written material (Dubay, 2004). Similar to the F-K formula, it uses the average number of words per sentence as one variable. Stringently, the FOG also analyses syllables for polysyllabic words, per 100 consecutive words (Dubay, 2004). This may pose a limitation as not all multisyllabic or 'complex' words are difficult. Moreover, while infrequent, monosyllabic words may too be challenging if unfamiliar. By analysing the percentage of words with only two or more syllables, this formula takes less time to administer. Comparably, results are interpreted as a score that estimates the number of formal years of education needed to read the text (Friedman & Hoffman-Goetz, 2006). To calculate RGL using the FOG, the following formula is used (Dubay, 2004):

$$\text{Grade level} = 0.4 \text{ x } \left(\left(\frac{Total\ words}{Number\ of\ sentences}\right) + \left(\frac{Polysyllabic\ words}{Total\ words}\right)\right)$$

1.5.2.3 The SMOG Grade Level Formula.

Developed by McLaughlin in 1969, the SMOG analyses readability based on polysyllabic word count across 30 sentences (Friedman & Hoffman-Goetz, 2006). Unlike the FOG and F-K, analysis approximates to 600 words, which provides a robust and greater sample. While the F-K and FOG estimate 75% and 90% comprehension respectively, the

SMOG generates RGLs based on a strict criterion of 100% comprehension of the passage (Friedman & Hoffman-Goetz, 2006; Ley & Florio, 1996). Owing to its quick calculation time, stringent comprehension criteria, as well as its robust measurement, the SMOG is the most frequently used readability test across health education literature (Meade & Smith, 1991; Wang et al., 2013). Compared to the other formulas, the SMOG is not considered accurate for assessing materials written at lower RGL (Mayer & Villaire, 2007). To calculate RGL using the SMOG, the following formula is used (Mc Laughlin, 1969):

$$\text{Grade level} = 3 + \sqrt{(number\ of\ polysyllabic\ words)} \text{ x } \left(\frac{30}{number\ of\ sentences}\right)$$

1.5.3 Readability of Online Health Information

Several studies have consistently and contemptuously reported that the readability of online audiology-related materials is written at levels beyond that of the recommended sixth RGL (Joury et al., 2018; Laplante-Lévesque, 2015; Laplante-Lévesque et al., 2012; Laplante-Lévesque & Thorén, 2015; Lee, 2020; Manchaiah et al., 2019; McKearney & McKearney, 2013; Potter, 2015). Further, the highly variable quality across websites raises additional concerns of potential misinformation and confusion (Atcherson et al., 2014).

Atcherson et al. (2014) evaluated the readability of 225 audiology- and speech-language pathology consumer materials, located on the American-Speech-Language-Hearing Association website. Irrespective of the readability formula used, findings revealed that 85% of the materials exceeded the recommended level; indicating that at least half of the consumers would struggle to read the material (Atcherson et al., 2014). This is an issue as the possibility of misinterpretation or misapplication of online information by

consumers, particularly those with limited health literacy, may cause potential health risks for themselves or others.

In their studies, Joury et al. (2018) and McKearney and McKearney (2013) analysed webpages on ‘otitis media’, ‘middle ear infections’, and ‘ear tubes’. Both studies revealed a mean RGL score between ninth and 10th level, using the F-K formula. Comparatively, yet more recently, and fittingly to this study, Lee (2020) conducted a study that analysed the readability of 18 webpages related to OM in English. Findings revealed that the mean RGL for all webpages (9.44, 11.68, and 11.55 using the F-K, FOG, and SMOG respectively) was greater than the recommended sixth RGL. An average of 9 to 12 years of education were required to be able to read and comprehend the online information relevant to OM.

1.5.4 Limitations of Readability Formulas

It is imperative to understand that readability formulas encompass an atheoretical stance, as they assess readability based on text properties (Meade & Smith, 1991). Central interactive factors such as reader motivation, knowledge, and conceptual background, and the design of written material which are highly influential in attributing meaning to information are disregarded (Meade & Smith, 1991). Reading is a complex and interactive process. To avoid misjudgement or a false sense of the validity of the reading difficulty, it is important to recognise that these formulas should be combined with the aforementioned attributes and not used as a panacea for comprehension (Friedman & Hoffman-Goetz, 2006; Meade & Smith, 1991; Wang et al., 2013). Accuracy is also questioned due to discrepancies in the RGL scores of written texts (Friedman & Hoffman-Goetz, 2006; Meade & Smith, 1991). To increase reliability and avoid underestimating difficulty,

researchers encourage the use of multiple readability formulas; with an increase in reliability from 0.74 to 0.97 with a single formula, to 0.89 to 0.99 with a combination of formulas (Friedman & Hoffman-Goetz, 2006; Ley & Florio, 1996; Meade & Smith, 1991). This may be achieved by taking the highest estimated RGL score, or using an average score or mean RGL generated using multiple formulas on a single text (Friedman & Hoffman-Goetz, 2006).

1.6 Comprehension

Comprehension, defined as the ability to understand, remember, and learn the material, is another concept within the realm of health literacy (C. C. Doak et al., 1996; Friedman & Hoffman-Goetz, 2006). It is important to recognise that one's ability to read or decode material does not necessitate comprehension (C. C. Doak et al., 1996). Rather, active reading comprehension involves encoding the information that is read into the working memory, and then processing it into useful meaning. This complex and multifaceted process depends on the interaction of several factors including logic, language, and experience; revealing why it is challenging to evaluate (C. C. Doak et al., 1996). A comprehension assessment may be used to evaluate whether or not those with limited health literacy understand available online health information; and if not, utilising it to revise the material (Gemoets et al., 2004).

Several instruments can be used to approximate reader comprehension, with the cloze procedure test being among the most widely used in literature and healthcare settings (Friedman & Hoffman-Goetz, 2006; Taylor, 1953). The purpose of this psychological tool is defined in its name, which derives from the word "closure" (Taylor, 1953).

Comprehension is evaluated from a person's ability to mentally complete a sentence by closing up the gap(s) in a language pattern (Taylor, 1953). Persons with appropriate reading skills are expected to comprehend the context of the information and provide closure to the passage using various syntactic, semantic, and pragmatic cues, together with information redundancy (Friedman & Hoffman-Goetz, 2006; Gemoets et al., 2004; Miller et al., 2009). Attaining this is presumed to be a valid indicator of reader comprehension of that specific passage or material (C. C. Doak et al., 1996). Its administration involves the deletion of every *n*th word from a written passage, and replacing it with a standardised blank(s) (C. C. Doak et al., 1996). The randomly set omission interval is intended to avoid selection bias of words. Although the scores highly correlate with the results of the readability formula's (Gemoets et al., 2004), the significance of this procedure lies in its ability to account for an aggregate of factors that readability formulas may ignore; for example, readers previous knowledge regarding a topic (Taylor, 1953).

Literal comprehension necessitates understanding what is read. Though the cloze procedure test is a valuable, reliable, administratively straight-forward, and easily quantifiable measure of reader comprehension, it is unable to inform researchers of the precise concepts that readers have difficulty understanding (Friedman & Hoffman-Goetz, 2006; Rankin & Culhane, 1969). Alternatively, reader comprehension may be more closely approximated using multiple-choice comprehension questions (Bormuth, 1967). This involves a person reading a passage, and then answering a few detailed comprehension questions regarding the content of the passage. If the reader can respond correctly to the questions then comprehension is assumed (C. C. Doak et al., 1996). This is presumed to be a closer approximation to reader comprehension as the questions directly test

understanding. However, caution must be taken as this measure is not mechanically, or objectively performed. Therefore reading difficulties of the same passage may systematically vary from one text writer to another (Bormuth, 1967).

1.7 Suitability

1.7.1 Definition

Another important concept in evaluating the appropriateness of written health material is suitability; loosely defined as the readability, content, design (organisation, layout, and/or graphics), and cultural elements of the material (L. G. Doak et al., 1996). To be deemed suitable, the aforementioned elements must complement the literacy and cognitive requirements of the target audience, particularly those with limited literacy skills (L. G. Doak et al., 1996). Although insufficient attention is paid to this concept, appropriately designed health care materials are shown to enhance readability and self-efficacy (Nasser et al., 2012). For example, font sizes of at least 12 point, and high contrast designs are shown to improve readability (L. G. Doak et al., 1996).

The Suitability Assessment of Materials (SAM) is a standardised instrument used to objectively, rigorously, and quantifiably evaluate the suitability of written health material; within a short period (L. G. Doak et al., 1996). Patient health-educational materials are rated on 22 factors, grouped into six categories that affect the readability and comprehension of the material; these factors include content, literacy demand, graphics, layout and type, learning stimulation and motivation, and cultural appropriateness. According to the objective criteria outlined by C. C. Doak et al. (2016), each factor is rated

as either being superior (2 points), adequate (1 point), or not suitable (0 points). The sum of all the ratings, divided by the total possible SAM score, indicates the overall suitability of the health-education material as a given percentage. A score of less than 39% is considered inadequate, 40%-69% is adequate, and 70%-100% is considered superior.

One limitation of the SAM is its subjective nature, where there is latitude in the interpretation of criteria. For this reason, peer-reviewing is encouraged, whereby other researchers also evaluate the material; any discrepancies are then discussed until a mutual agreement is made. Additionally, the total SAM score may vary among materials as some factors are inapplicable. Therefore, it is necessary to remove the 'not suitable' factors from the total SAM score.

1.7.2 Suitability of Health-Education Materials

The literature reveals that current health-education materials are primarily produced at an inadequate suitability level for its audience. As part of their analysis, Nasser et al. (2012) evaluated the quality of online patient information regarding the use of Warfarin, a high-risk medication. The overall SAM scores revealed that none of the webpages achieved a superior rating, and only 54% yielded an adequate score (Nasser et al., 2012). Concerns were related to insufficient or inappropriate use of layout and graphics and learning motivation (Nasser et al., 2012). Relevant to audiology, Caposecco et al. (2014) evaluated the content, design, and readability of printed hearing aid user guides to establish their suitability for older adults. Using the SAM, 69% of the user guides were unsuitable, and 31% were deemed adequate; none of the brochures received a 'superior' suitability score. If adhering to the guidelines by Doak et al. (1996) if the readability level of the material is

inadequate (M = 9.6), then the health care materials must be deemed not suitable. Caposecco et al. (2014) revealed that mutually the poorly scored brochures had scopes that extended beyond their intended purpose, had recurrent and excessive use of uncommon and jargon terms in lieu of common words, an excessive amount of technical jargon, long sentences, and inappropriate formatting (Caposecco et al., 2014).

Aptly and unique to his study, Potter (2015) used the SAM to assess the suitability of online audiological health information concerning HI. All the webpages were found to be not suitable due to poor RGLs, lack of interaction and motivation, and inappropriate use of cultural images. The researcher noted that these issues were likely to confuse the reader. These findings are especially relevant and noteworthy as they provide insight into how suitable audiology-related online materials are for target populations; highlighting the importance of ensuring materials attain satisfactory suitability scores (Potter, 2015).

1.8 Quality

1.8.1 Definition

Quality, defined as the degree to which materials are relevant and reliable, is another key component in the production and evaluation of written health materials. This concept focuses on the accuracy of the information, and whether the sources used are current, scientific, and evidence-based (Charnock et al., 1999; Manchaiah et al., 2020). Low quality information may be misleading or inaccurate (Charnock et al., 1999).

The majority of health information sources continue to focus on the disease process; despite an understanding that treatment choices are shown to primarily and positively affect

psychological status and treatment outcomes (Charnock et al., 1999). Currently, no universalised standard has been established for evaluating the quality of online health information (Robillard et al., 2018). However, instruments such as the DISCERN are readily available to quantitively assess the quality, and facilitate the production of online health materials (Manchaiah et al., 2020). This standardised tool consists of 16 questions aimed to judge the quality of written information relating to treatment choices; concerning its readability and credibility, whether the information is clear and unbiased, and an overall quality rating of the material (Charnock et al., 1999). A scale of one to five which numerically pertains to whether the material has extensive shortcomings, or minimal shortcomings respectively is used. The overall scores can range from 16 to 80, with higher scores indicating better quality of information.

Charnock et al. (1999) recruited an expert panel of information providers and group members from self-help organisations who testified the tool to have face and content validity, and inter-rater reliability. These findings have been validated by recent reviews where the DISCERN was disclosed to have substantively good validity and reliability as a quality assessment tool (Ademiluyi et al., 2003; Breckons et al., 2008). However, its focus on treatment choices is restrictive as it is not appropriate for evaluating online information pertaining to other areas of health such as diagnosis or prevention (Robillard et al., 2018).

1.8.2 Quality of Audiology-Related Health Education Materials

Manchaiah et al. (2020) conducted a descriptive review of 34 studies to examine the quality, readability, and suitability of hearing health information; ranging from diagnostic reports, patient education materials to audiology-related webpages. Using the DISCERN

instrument, of the eight webpages that were examined most were deemed to be low quality (Manchaiah et al., 2020). The webpages score ranged from 35 to 57, with the mean scores ranging from 2.05 to 2.39 out of five; demonstrating low or moderate quality (Manchaiah et al., 2020). Comparably, Laplante-Lévesque et al. (2012) assessed the quality and readability of 23 websites on hearing loss and hearing aids and found that they had a mean DISCERN score of 2.04, indicating moderate quality. These findings emphasise the need for evaluating the quality of audiology-related health information before propagation.

1.9 Principle of Plain Language

Lastly, plain language is another strategy designed to enable those with limited reading skills to better understand written health information (Friedman & Hoffman-Goetz, 2006; Kelly-Campbell & Manchaiah, 2020). Health-related webpages are often difficult to read due to their lengthy text material and technical language. Plain language strategies may be implemented to aid in creating more accessible information. Stemming beyond just that of using simple vocabulary, the term ‘plain language’ embodies the use of strategies that seek to transform the text into clear, engaging, and accessible material, creating reading ease (Stableford & Mettger, 2007). These evidence-based strategies stem from an abundance of research that has assessed how individuals obtain, remember and act on information (Stableford & Mettger, 2007). Key elements of this writing style include defining technical terms, using an active voice, organising information to prioritise important points first, and decomposing complex information into comprehendible fragments (Stableford & Mettger, 2007).

Writing to accessible RGLs is only one component of the plain language process, as readability formulas alone do not consider the reader's attention or background knowledge, nor the clarity of writing (Stableford & Mettger, 2007). Plain language surpasses this by focusing on the interaction of multiple elements, including text, graphics, layout, and reader response. Writing in plain language does not necessarily improve the RGL of the material; rather both readability and plain language are required in writing patient material that intends to improve health literacy and promote SDM (Kelly-Campbell & Manchaiah, 2020).

Critics of this strategy propose that this writing style is oversimplified and dull, resulting in the neglect of important technical information (C. C. Doak et al., 1996; Stableford & Mettger, 2007). Furthermore, they believe that it is written in a condescending tone where highly skilled readers are insulted. Yet, experienced plain language writers challenge this notion by stating that the writing style does not avoid all detail, but instead focuses on brevity (C. C. Doak et al., 1996; Stableford & Mettger, 2007). By focusing on key messages, retaining necessary technical language, and removing unnecessary abstract concepts or jargon-filled terminology, this writing style captures the balance between scientific information and the reader's needs and interests (L. G. Doak et al., 1996). The evidence-base is mixed regarding changes in reader comprehension between standard materials and plain language materials; this may be due to the varying comprehension measures used throughout the literature (Stableford & Mettger, 2007). Despite the variability in the literature, there is evidence to show that simply written materials are preferred by readers of all literacy levels, with benefits including increased comprehension

and reduced reading time (Davis et al., 1996; C. C. Doak et al., 1996; Kelly-Campbell & Manchaiah, 2020; Mindlin, 2005).

1.10 Best practice guidelines

1.10.1 Guidance to Revising Online-Educational Material

An extensive amount of literature provides evidence-based, best practice methodology related to improving accessibility and clarity of health-care materials, particularly for those with limited health literacy (Caposecco et al., 2011; Doak et al., 1998; L. G. Doak et al., 1996; Mayer & Villaire, 2007). These processes apply to written information disseminated through all sources – including the internet.

In their analyses of the mismatch between readability, suitability, and content of audiology-related hearing materials for their target populations, Caposecco et al. (2014) and Potter (2015) provided suggestions for improving written materials. Despite the inadequate suitability of their materials, both authors contended that, if revised according to best practice guidelines, there was strong potential for increasing reader comprehension, self-efficacy, and motivation. Both authors suggested including clear aims and/or a summary section, limiting the scope of the material, ensuring the material is tailored to the intended audience, that readability is below sixth RGL, and only including essential technical information (Caposecco et al., 2014; Potter, 2015).

C. C. Doak and colleagues (1996) provide a comprehensive book entitled “Teaching Patients with Low Literacy Skills”, with guidelines for designing, simplifying, and presenting patient education material that is suitable for all population groups, specifically

those with limited health literacy skills. In chapter six, entitled “writing the message”, the authors provide a three-part framework on producing simplified and suitable material, comprising of 1) planning, 2) writing and producing, and 3) testing of health education materials (C. C. Doak et al., 1996). Overlapping with this framework, the National Institute of Health (2018) has a guideline entitled “Clear & Simple: Developing Effective Print Materials for Low-Literacy Audiences”, that provides strategies for developing educational materials for people with limited literacy. More recently, these ideas are supported by Mayer and Villaire (2007) in chapters seven and eight of their publication entitled “Health Literacy in Primary Care: A clinician’s Guide”.

The first step, termed the ‘Planning Phase’ focuses on identifying and ascertaining the makeup of the target audience, such as their demographic background, motivations, health literacy levels, topic knowledge, and learning and behaviour (Caposecco et al., 2011; C. C. Doak et al., 1996; National Institutes of Health, 2018). Doak et al. (1998) state that lowering the readability of a text does not necessitate comprehension, especially if the information is irrelevant or incoherent to the reader. Hence, this is an imperative step in ensuring the material communicates successfully with the intended audience, as the material is tailored to their unique constellation of needs, and meets their expectations (Mayer & Villaire, 2007). Conducting this needs assessment before beginning the design and development process, will help ascertain the core purpose of the material, and in doing so limit, minimise and define the learning objective and message of the material. To avoid confusion, increase information recall and patient compliance, Mayer and Villaire (2007) recommend limiting the concepts included in the written education material to those that

are necessary. For complicated topics that require more discussion, dividing the information into smaller written pieces and using headings is recommended.

Phase two guides the writing and production of readable material. Techniques for producing clear and simple writing (Caposecco et al., 2011; D'Alessandro et al., 2001; Doak et al., 1998; C. C. Doak et al., 1996; Mayer & Villaire, 2007; National Institutes of Health, 2018) broadly focus on the following variables: content, language, writing style, layout and typography, graphics, organisation and cultural factors (Caposecco et al., 2011; Mayer & Villaire, 2007; National Institutes of Health, 2018). Most researchers mutually recommend using writing styles such as an active voice, familiar words, and short sentences, providing examples when explaining challenging concepts or jargon terms, and including interaction (C. C. Doak et al., 1996; Mayer & Villaire, 2007).

It is recommended that patient education materials should focus on providing practical information to guide desired actions, rather than being purely informational (Caposecco et al., 2011). This is because those with limited health literacy tend to lack problem-solving skills, and are therefore unlikely to comprehend information by drawing inferences from facts (Doak et al., 1998). This may result in reduced empowerment and self-efficacy, which subsequently reduces motivation. Writers can use an active voice, pronouns, or provide small pieces of information as it makes materials more inviting and exciting; this is likely to encourage the reader to take action (Mayer & Villaire, 2007). Writing in an active voice is also shown to dramatically decrease the RGL of text by a maximum of six grade levels (Mayer & Villaire, 2007)**.** While the use of common words and shorter sentences are encouraged, avoiding negatively worded statements, concept, category, and value judgment words is also recommended to increase patient

comprehension (Caposecco et al., 2011). In their study, Donald and Kelly-Campbell (2016) revealed that excessive use of audiology-specific terminology and numbers contributed to difficulties in readers comprehending their materials. If necessary, providing examples to explain difficult words is encouraged, as it not only affects comprehension but enhances interest in reading the text (C. C. Doak et al., 1996).

When focusing on the design of written material, Wolf et al. (2009) stress the importance of considering the demand that overall appearance places on the working memory. Well-designed material is expected to reduce cognitive strain and minimise the amount of working memory that is used when reading educational material (Wolf et al., 2009). They assert that design elements such as reducing visual clutter and distraction, using organisational elements (simple lists or instructions), and appropriate sequencing of the information, all help lessen the mental resources necessary for processing new information. In doing so, this subsequently promotes increased participation and allows for an understanding of the intended health information (Wolf et al., 2009). Other elements to consider include text, white space, paper, and graphics (National Institutes of Health, 2018). A comprehensive literature review by Houts et al. (2006) revealed that the use of graphics in written health-care materials can substantially increase patient attention, comprehension, recall, and adherence, particularly for those with limited health literacy.

Lastly, phase three focuses on testing and revising the health education material for quality assurance. All researchers mutually commend the use of readability formulas, plain language tools, and suitability measures to guide analysis and revision of written materials (Caposecco et al., 2011; Doak et al., 1998; L. G. Doak et al., 1996; Lee, 2020; Mayer & Villaire, 2007).

Authors recommend the use of readability formulas to ensure the readability of the material matches the readability levels of the intended audience; writing to a sixth RGL or lower is strongly recommended (Mayer & Villaire, 2007). However, merely rewriting health material to a simpler level is not enough. As stated in section 1.5.5 RGLs do not account for other factors that influence comprehension including reader motivation, cognition, and layout of the material. Therefore, the SAM is recommended to assess the readability, usability, and suitability of the material. As explained in section 1.7, the tool helps identify detailed improvements due to its scoring of 22 factors. More recently, following rigorous assessment, Lee (2020) provided recommendations on how to improve the quality and readability of OM-related online information. Correspondingly, she also encouraged the use of overtly stated aims, use of active voice, defining medical jargon, organising information using relevant headings, and visual aids to supplement information.

If possible, researchers encourage collaboration with the target audience in designing, testing, and revising material; for example, ad hoc focus groups can be used to gain insight into the attributes of the population, as well as provide invaluable feedback on the effectiveness of the material (Ming & Kelly-Campbell, 2018). In addition to the repertoire of testing methods that are strongly recommended, the use of professional peer validity checks is strongly encouraged.

1.10.2 Outcomes of Document Revision

Previous studies that have used the aforementioned three phases to produce or revise health education materials to match the literacy demands of their intended audience

have shown positive outcomes (Davis et al., 1996; Donald & Kelly-Campbell, 2016; Pothier et al., 2009).

Davis and colleagues (1996) conducted a randomised trial exploring whether a simply written polio vaccination pamphlet was preferable to an equivalent and commonly available one by the Centres for Disease Control and Prevention. Patient reading time, comprehension, and attitudes were used as measures. The simplified pamphlet was written according to best practice guidelines; containing condensed information, visual graphics, and was written at an appropriate sixth RGL. The findings demonstrated that those who read the simplified version had greater mean comprehension and three times lower reading time; this version was unanimously preferred by all participants regardless of their literacy levels.

Mindlin (2005) compared reader comprehension of a traditional judiciary form, to a simply written revised version. The revised form contained an appropriate RGL, familiar reader language, explanations of complex concepts, the use of an active voice, and graphics that aided in understanding. Similarly, the author revealed statistically significant improvements in reader comprehension with the revised version. Although this study lies outside the realm of health education, the findings that comprehension improves when education material is written according to best-practice guidelines are relevant and consistent with other studies. More recently, Donald and Kelly-Campbell (2016) assessed the comprehension, self-efficacy, and opinion of parents who received a current and unrevised paediatric diagnostic report. Adhering to best-practice guidelines, the revised report contained reduced sentenced length and passive sentences which contributed to improved readability. It also included appropriate graphics, better organisation, and

typography, necessary to develop parental understanding. Compared to parents who read the unrevised report, parents who read the well-designed revised report showed significantly greater comprehension, enhanced self-efficacy, and better opinion ratings. The aforementioned studies demonstrate the efficacy of modifying health education materials using best practice guidelines, to better match the health literacy levels of a population. This thesis aims to investigate whether revising online information on OM according to best practice guidelines will result in comparable findings of improved reader comprehension, enhanced self-efficacy, and positive opinion.

1.11 Study Rationale

This study sought to provide necessary information about the accessibility of online information on OM, by revising a webpage on OM in English, and evaluating whether it improves readability, reader comprehension, self-efficacy, and opinion. Such research is necessary to fill in the knowledge gap in this area for several reasons.

Firstly, it is evident that the readability, quality, and content of online information related to OM is inadequate. Education on this condition is vital in seeking appropriate advice, making suitable treatment choices, and adhering to management. In her analysis, Lee (2020) revealed that the overall readability of online information on OM was high and quality was below moderate. Although such patterns are evident across other health domains, no other study has sought to revise OM-related online material, to see if improvements and benefits can be observed.

Secondly, this study also sought to contribute to the literature on the accessibility of online information on OM. Although there is abundant literature on the unsuitability of

available online information, and limited information on audiology-related health conditions, what remains unknown is whether the same problem exists for online informational material on OM. This study aimed to address that gap in the literature.

Lastly, while increasing the health literacy skills of the audience would be an appropriate long-term goal for the health care system, prompt action would be to focus on improving online information materials to make them more comprehensible and valuable to the general audience. The literature is rich with information on the production of material that is readable, comprehensible, and suitable, particularly for those with limited health literacy skills. This thesis aimed to identify whether using best practice guidelines to produce accessible online-based health information on OM could serve to enhance the comprehension, self-efficacy, and positive perception of readers; and in doing so, complement their literacy skills. Improving people's understanding of health information would be vital in managing a condition such as OM, while also, enhancing patient empowerment, SDM, and fostering PCC. Ultimately, this study intended to address this need for interventions and efforts that focus on reducing this digital disparity by providing online health information that is appropriate for all persons.

1.12 Aim and Hypotheses

1.12.1 Aim

The overarching aim of this study was to evaluate a revised webpage on OM in English, with the goal being that it showed improvement in readability, reader comprehension, self-efficacy and opinions. This was achieved by randomly assigning

participants to read either the revised or unrevised webpage material. In doing so, the study sought to demonstrate that the provision of accessible health information on OM could improve people's comprehension, self-efficacy and opinion, which could in turn could promote PCC and SDM.

1.12.2 Hypotheses

Ultimately, this study sought to answer the following three hypotheses:

1. The mean comprehension score of adults who read the revised webpage is expected to be significantly higher than those who read the unrevised webpage.
2. The mean self-efficacy score of adults who read the revised webpage is expected to be significantly higher than those who read the unrevised webpage.
3. The mean opinion score of adults who read the revised webpage is expected to be significantly higher than those who read the unrevised webpage.

Chapter 2: Method

2.1 Overview

This study sought to evaluate and revise a webpage on OM in English rated to have poor readability, plain language, and suitability. The objective being the revised webpage material showed improvement in readability, reader comprehension, self-efficacy, and self-perceived opinion. Multiple readability formulas, the Plain Language Checklist (PLC), the DISCERN and the SAM, were used to analyse and revise the readability, content, quality and suitability, respectively, of the material. Additionally, best practice methodologies were drawn from literature and used to amend the unrevised webpage. Finally, the revised

webpage was evaluated and compared to the unrevised webpage using outcome measures of readability, comprehension, self-efficacy, and opinion. Comparison of the latter three measures involved a randomized experimental design via an anonymous online survey. Participants were allocated randomly to read either the (1) unrevised, or the (2) revised webpage, before completing the questionnaires. The outcomes of the two webpages were compared using a Multivariate Analysis of Variance (MANOVA), followed by a series of Univariate Analysis of Variance (ANOVA). This chapter discusses the methodology of this study, including the construction of the revised material, participant recruitment, procedures, measures, and the statistical analyses exercised.

2.1.1 Ethical Considerations

Before commencing this study, ethical approval was sought from the University of Canterbury Human Ethics Committee, New Zealand (NZ). Approval was granted on the 14th of February 2020 (Ref: HEC 2019/07/LR Amendment 2). See Appendix A. All procedures were conducted in this study per the approval, and all participants signed online consent forms before commencing the study.

2.2 Unrevised OM-webpage material

2.2.1 Selection of the Unrevised Material

In selecting the original webpage material, the precedent study by Lee (2020) was used. Of the 441 OM-related webpages that Lee (2020) analysed along measures of readability, quality, and content, the lowest scoring webpage was selected for revision in this study. This webpage was chosen as it remains actively used by the public, despite its

established inappropriateness for its audience. Furthermore, this webpage was likely to show a significant improvement following revision.

The unrevised material was selected using the procedure below:

1. A short-list was generated by removing webpages that scored well on one or more of the assessment tools. This was done to focus on those webpages that overall were found to be least suitable. Webpages were removed from consideration if they:
    1) Had a mean RGL below 9.0.
    2) Had a Plain Language score of 19 or 20.
    3) Had an Understandability score of 80 or greater.
    4) Had an Action score of 80 or greater.
    5) Had a DISCERN score of 4 or 5.
    6) Contained less than 500 words.
    7) Had hyperlinks that were no longer active.
2. This resulted in a short-list of 8 webpages. To select the webpage for revision from this list, the following steps were taken.
    1) The inverse of the mean RGL was calculated so that lower scores equated to poorer readability.
    2) An arithmetic mean of the scores of each assessment tool was generated for each short-listed webpage.
    3) The short-listed webpages were ranked, and the webpage with the poorest overall combined score was selected for assessment.

2.2.2 Analysis of the Unrevised Material

The unrevised webpage material was analysed using multiple tools, including three readability formulas (FOG, SMOG, and F-K), the adapted PLC, the DISCERN tool, and the SAM.

2.2.2.1 Readability Analysis.

Both webpages' readability was examined using the following readability formulas: FOG, SMOG, and F-K, and results were compared to the internationally acknowledged recommendation of a below sixth RGL. These three formulas were selected based on their popularity within the healthcare literature, high correlation with each other, and independent validity. All three readability formulas defined readability as an approximate RGL necessary to understand the webpages. Readability analysis was conducted using a free online English readability test tool (https://www.webfx.com/tools/read-able/). The material's entire text was copied and pasted directly into the readability tool to ensure accurate readability analysis.

As discussed in *Section 1.5.5*, the use of a combination of readability formulas is recommended to prevent underestimating reading difficulty, avoid a false sense of validity and increase the accuracy of results. Consequently, the mean RGL using multiple formulas was calculated. This was manually achieved by adding the generated FOG, SMOG, and F-K scores for the single text and then dividing this score by the total number of readability formulas (i.e., three). The obtained scores were then recorded onto a separate Microsoft Word document sheet.

2.2.2.2 Quality and Content Analysis.

The quality of the material was analysed using the DISCERN tool and the Adapted PLC. The DISCERN is a standardised instrument consisting of 16 items, divided into three sections to assess the overall quality of the material. These items pertain to how readable the material is (i.e., the aim(s) of the material and the inclusion of publication dates), the quality of the information (i.e., provision of clear and unbiased information), and finally, an overall quality rating of the material. Items are rated from 1 to 5, which numerically pertain to whether the material has extensive shortcomings or minimal shortcomings, respectively.

To assess the content of the material, the Adapted PLC was used. This checklist is an amalgamation of the Quick Checklist for Plain Language (Center for Health Literacy MAXIMUS & McGee & Evers Consulting Inc, 2012), the Plain English Checklist for Documents (National Adult Literacy Agency, 2008), and the Checklist for Plain Language on the Web (Plain Language Action and Information Network, n.d.). The tool consists of 20 *yes* or *no* responses, concerning the organisation, writing, design, and format of the material. For example, the arrangement of content, use of lay terms, and appropriate font use. A higher score is indicative of good quality material. All obtained scores were then recorded onto a Microsoft Word document sheet.

2.2.2.3 Suitability Analysis.

The SAM tool was used to evaluate the suitability of the material. Described in *Section 1.7,* this instrument scores material across 22 factors, on the material's readability and comprehension. Each factor was rated as either being superior (2 points), adequate (1 point), or not suitable (0 points). The ratings were then totalled and divided by the possible

SAM score. The score was then interpreted as a percentage and recorded on the Microsoft Word document. All items were rated for both webpages, except for those that could not be applied; this included a summary or review, list, tables, and items concerning cultural appropriateness.

2.3 Revised Webpage Material

2.3.1 Overview

The principles of readability, plain language, and suitability were then used to modify the original OM webpage material to produce a more comprehensible webpage. In assessing the revision, the researcher used the aforementioned standardized assessment tools to ensure the revised webpage adhered to best practices for promoting health literacy, PCC, and informed decision making. Appendix B illustrates the original webpage with annotations used to highlight suggested changes.

2.3.2 Use of Best Practice Guidelines

Throughout the revision, the author adhered to the best practice guidelines outlined in *section 1.10,* and the recommendations provided by Lee (2020). The author endeavoured to include as many of these suggestions as possible. Ultimately, the author sought to ensure the revised material would help the audience better read, understand and act on the webpage's information, particularly for those with limited health literacy.

When revising material most researchers recommend using techniques and design elements that focus on content, language, writing style, layout and typography, graphics,

and organisation. Subsequently, the revised webpage on OM employed several changes on the variables mentioned (see Appendix C).

Firstly, several amendments were made to achieve adequate readability and reduce the material to a sixth or lower RGL. Word and sentence length were reduced (to a maximum of 15 words per sentence), unnecessary and complex words were removed, grammatical and spelling errors were corrected, and the use of passive sentences was diminished. Complex polysyllabic words found in the unrevised material, such as 'occurrence', 'malady', 'causative', and 'propagate', were either eliminated or replaced with mono- or bi- syllabic words. For example, the four-syllable term 'implication' was substituted with a monosyllabic and commonly understood term 'cause'. Additionally, where an audiology-related specific terminology or a jargon term had to be used, examples were provided to explain them. For example, the term 'grommets' was defined, and an image of a grommet was provided to supplement the definition.

In adherence to the principles of plain language, further changes were made. Unnecessary complex words were removed. Value judgement words, such as 'relatively', 'regular' and 'eventually' were either removed or replaced with statistics. For example, the sentence "children are far more prone to be affected by the condition known as Otitis Media" was replaced with "up to 85% of children have at least one ear infection before they turn 3 years old", in the revised material.

To improve the suitability of the material, the purpose was explicitly stated in the title and introduction, and it was achieved throughout. With the thrust of the original material being purely informational with non-behaviour facts, the material was open to interpretation with no specific action(s) to follow. Using an interactive and conversational

writing style, the information was revised to include more applicable knowledge to engage the reader, and encourage desirable behaviour; an active voice, personal pronouns, present tense, and small chunks of information were implemented throughout.

On the content, the revised material only included relevant and necessary information on OM, focusing on causes, symptoms, management/treatment, and prevention. Extraneous and irrelevant information on Otitis Externa found in the original was eliminated as it was beyond the scope of the topic. The information presented was balanced and unbiased, for example, by providing information on the benefits and risks of treatment. The original misleading title explicitly referred to adults and used the broad misinterpreted term 'ear infections' was amended to focus on 'OM' specifically. In the revised material, additional sources of support and information were included. This was necessary to ensure that the audience was able to obtain more information if required. Finally, three graphics (i.e., a diagram of the ear, the eustachian tubes of a child and an adult, and a picture of a grommet) were added to the revised material to supplement the understanding of the written information.

The layout and typography were modified by making several changes to the organisation and presentation of the material. The text's font was changed from 'Roboto', a neo-grotesque sans serif type font, to Calibri. The original font features a 'folded-up' and curve design, which may make it more difficult to read. Although part of the same family, Calibri is a text-font with good legibility and familiarity, increasing readability. Text size was also increased to size 12-point for body text and size 21 for the title. To allow for adequate spacing of text, 1.15 line spacing was set. Additionally, to organize the information, the revised material used appropriate headings that were bolded, in colour, and

presented in question form (for example, ‘how do we hear?’). These headings were also listed in the beginning paragraph to outline what the material will include. The sequence of information was modified sensibly to ensure that the order did not confuse the reader and to enhance memory. The order was amended to include the definition, causes, symptoms, treatment, and prevention. Where appropriate information was presented in bullet points to reduce visual clutter. In contrast to the original, the revised webpage included a date of publication and a bibliography.

2.3.3 Evaluation of Revised Material

Similarly, the revised webpage was also analysed using multiple readability formulas (FOG, SMOG, and F-K) and then compared to international readability recommendations. The Adapted PLC, the DISCERN, and the SAM were also used.

2.3.3.1 Veracity and Inter-rater Reliability Check.

In addition to these instruments, it was necessary to assess the veracity of the revised material further. To do this, an academic professor with extensive audiological expertise aided in modifying and evaluating the webpage; this was to safeguard the accuracy of the information on the webpage. The professor provided several recommendations on how to improve the content, including writing in the third person, avoiding the use of long sentences, jargon, and value judgement terms, as well as switching between terms (i.e., “middle ear”, “middle part” or “middle part of the ear”) as it would confuse the audience. Valuably, the professor, suggested not completely colouring the diagrams as that would make it difficult for those with impaired vision and recommended

adding labels. Lastly, the professional helped clarify the content of the webpage by explaining concepts; for example, that the term OM meant that “the middle ear is inflamed”, and “that it may or may not be infected”. The characteristics of other terms such as the three types of OM were also clarified.

To ascertain inter-rater reliability, two Master students at the University of Canterbury conducted an independent evaluation of the revised webpage. Such professional peer validity checks are important as it helps establish that there is no bias in the subjective interpretation of scoring; and provides an opportunity for improvement. All researchers agreed that the material was accurate and appropriate for the target population.

The final version of the revised webpage consists of an amalgamation of the best practice guidelines, a professional veracity check, and an inter-rater reliability check. A copy of the revised webpage is available at the following URL https://saraibrahim65.wixsite.com/otitismedia2.

2.4 Participants

2.4.1 Recruitment

Participants were recruited from the general population using advertisements on social media (Facebook and Instagram). The advertisement briefly details the study’s aim, eligibility requirements, inducement offer and included a link to the anonymous online survey. A copy of the advertisement is attached in Appendix D. A closing date was featured in the advertisement to promptly encourage potential participants to express interest.

Participants were offered incentives to enter a draw to win one of two $50 USD Amazon gift cards; from the international store Amazon.

Recruitment began via the researcher's networks (i.e., through family and friends) and continued over four weeks using a snowball sampling technique. Sample size analysis, using G*Power software, indicated that a minimum sample size of 24 participants was required in each group to detect a partial eta squared of 0.5 (using a power level of 0.8 and an alpha level of 0.05). Consequently, recruitment continued until the 24 participant requirement was achieved at a minimum. A total of 52 participants (26 in each group) fully completed the online survey via the Qualtrics website and were included. Results from partially completed responses were excluded from the data analysis.

2.4.2 Inclusion Criteria

All participants were screened to ensure their suitability to participate in the study. Participant inclusion criteria were:

1) Adults at and over the age of 18 years old
2) Able to read in the English language
3) Willing to read the informational material and participate in a questionnaire
4) Have access to the internet for the online questionnaire

The study focused on recruiting these participants as the unrevised and revised materials were aimed at adults. This is important as it allows results to be more generalisable when recruiting from the general population of adults for the survey. Regarding the first inclusion criteria, the definition of 'adults' as being over 18 years was

adopted from The Care of Children Act 2004, which defines an adult as a person at, or over the age of 18; as they are legally independent of their parent or legal guardian (New Zealand Legislation, 2019). The second and third inclusion criteria were necessary to ensure that participants could complete all tasks required of them, including reading the webpage and answering the questionnaire. Lastly, the fourth inclusion criteria attempted to ensure that all participants could access the online material.

2.5 Procedures

A randomised experimental design was used to compare the three measures of comprehension, self-efficacy, and opinions between the two materials. Qualtrics Core^{XM} survey software (2020) was used to develop a 30-minute online survey. If interested, participants asked to access a link to this anonymous online survey. Participants were instructed to read the information sheet, read, and sign the consent form by clicking "I consent" indicating that they agree to participate in the survey. Next, the consenting participants were instructed to complete the demographic questionnaire, read the webpage material by accessing the hyperlink, and complete the questionnaires. The survey questions were developed based on a questionnaire created by Donald and Kelly-Campbell (2016).

The recruited 52 participants were randomly assigned one of two groups - to read either (1) the unrevised material or (2) the revised material before completing the comprehension questions and the subjective questionnaires. The method was based on a short-term subscription basis where the participants were given the correct hyperlink for the version of the webpage they were randomly assigned to visit and the online questionnaire. A free online website builder tool (https://www.wix.com/) was used to access the revised

and unrevised webpages on OM. Each of the two materials was uploaded onto a different site to ensure independent webpage URLs. If interested in entering the draw to win one of two $50 USD Amazon gift vouchers at the end of the survey, participants were redirected to a separate survey that collected identifying information, including their name, email, and contact number.

2.6 Measures

2.6.1 Demographic Questionnaire

A demographic questionnaire consisting of seven questions was created to provide basic information about the participants in the study. Shown in Appendix E, the assessed variables included: (1) gender, (2) age, (3) marital status, (4) ethnicity, (5) years of education, (6) highest qualification, and (7) occupation. Such responses were documented to identify whether any significant differences in results pertained to such variables.

2.6.2 Verification Questionnaire

The three primary measures in this study of comprehension, self-efficacy, and overall opinion were evaluated through an online questionnaire adapted from Donald and Kelly-Campbell (2016). A copy of the questionnaire is shown in Appendix E. The questionnaires were piloted on a group of adults from the general public to gauge their understandability and perceptions (i.e., difficulty) of the questions. The adults mutually agreed that the questions were indeed appropriate.

Participants were assessed on their comprehension of the randomly assigned webpage using ten multiple-choice questions. See Appendix E. These questions were

carefully constructed to ensure appropriate difficulty and relevancy to both webpages. For example, to ensure unbiased reader responses, questions on the different types of OM were precluded as the unrevised webpage did not provide this information. Consequently, it would be inappropriate to assess the comprehension of those who read the unrevised material based on this question. These also questions underwent veracity and inter-rater reliability checks. To score the comprehension questions, all answers were transformed into dichotomous variables, where each correct answer was labelled '1', and incorrect answers a value of '0'. All correct answers were summed up and given a score out of 10 to generate a sum comprehension score for each participant. Because each question had only one right answer, scores ranged from 0 (minimum) to 10 (maximum); a higher score indicated greater comprehension.

Provided in Appendix E, self-efficacy, synonymous with 'confidence' in the questionnaire, was evaluated using three questions that were graded along a fixed ten-point slider scale. Participants were asked to indicate their confidence level along the scale, where 0 indicated '*not confident at all*', 5 '*moderately confident*', and 10 '*very confident*'; a higher score signified greater self-efficacy. A sum self-efficacy score was generated per participant by averaging the scores from all three questions. A slider scale was used in adherence to how traditional self-efficacy questionnaires were presented in the literature. These questions focused on participants' self-perceived confidence in how well they understood the material.

To evaluate reader opinion, participants were given eight statements and asked to answer along a fixed 5-point slider scale; 0 indicated '*not at all*', 2-3 indicated '*moderately*', and 5 indicated '*very much*'. See Appendix E. An equal ratio of positively

and negatively constructed statements was included to minimise agreement bias; defined as a respondent's tendency to agree with items of a questionnaire regardless of its content or their 'true' personal preference (Baron-Epel et al., 2010). To score this, the positively worded statements were added, while the negatively worded items (statements 2, 4, 7, and 8) were reverse scored. A sum opinion score was then generated by averaging the scores per participant; a higher score indicating a more positive perception of the material. These questions sought to gather information on how the reader perceived the material to be. For example, whether it met their expectations, whether it was confusing or beneficial, of good length, difficult to read, or used too much jargon. Finally, the reader was given an optional short answer question that allowed them to provide any comments about the material.

2.6.2.1 Scoring.

A Microsoft Office Excel spreadsheet was used to score and store all responses to the questionnaire. The scores from each sub-section of the questionnaire were tallied separately to provide a sum comprehension score, sum self-efficacy score, and sum opinion rating of the material.

2.6.3 Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 26 was used to perform the statistical analysis for this study. The statistical tests were selected based on the characteristics of the data. To assess the demographic variables, a combination of chi-square test and one-way ANOVA was employed. To compare the two webpage materials along the three outcome measures, a MANOVA was used. This was followed up with a

series of Univariate ANOVAs, with each construct (comprehension, self-efficacy, and opinion) as the dependent variables in the ANOVAs.

Chapter 3: Results

3.1 Overview

This chapter recounts the results of the data collected. Firstly, the unrevised and revised webpages were compared using readability, suitability, and quality assessments. These evaluations were used as a metric that the revised material needed to meet before launching the survey. Next, concerning the three outcome variables, the statistical analysis results from the MANOVA and univariate ANOVAs were described. A total of 48 participants were included in the analyses, with 25 adults randomly assigned to read the unrevised webpage and 23 adults assigned to read the revised webpage. Statistical analyses demonstrated no statistical differences in demographic variables and self-efficacy scores between the two groups. Compared to those in the unrevised webpage group, adults who read the revised webpage demonstrated statistically and significantly higher comprehension and opinion scores, with large observed effect sizes.

3.2 Readability Results

3.2.1 Comparing the Unrevised and Revised Webpages

With an average RGL of 17.22 (calculated by averaging the FOG, SMOG, and F-K scores), the findings from the readability assessment revealed that the unrevised webpage was written at a level that substantially exceeded the internationally endorsed sixth RGL

(see Table 1). Across all three readability formulas, the unrevised webpage generated an RGL of above 16 years, indicating that readers would require at least graduate-level literacy skills to read the text with ease. Following the revision, the readability of the webpage markedly improved across all three readability estimates (shown in Table 1). The revision reduced the RGL required to read the webpage by approximately 11.79, 10.45, and 11.52 years, using the FOG, SMOG, and F-K formulas. With an average improvement of 11.26 RGLs, the mean RGL of the revised webpage approximated the internationally recommended sixth RGL or lower for patient health-related materials.

Table 1

Readability Scores of the Unrevised and Revised Webpages using Readability Formulas

Readability test	Unrevised webpage	Revised webpage
FOG	18.99	7.2
SMOG	16.35	5.9
F-K	16.32	4.8
Mean RGL	17.22	5.96

Note. FOG = Gunning FOG Index, SMOG = Simple Measure of Gobbledygook, F-K = Flesch-Kincaid. Estimates are presented as reading grade level or number of years of education required to be able to read a text.

3.2.2 Suitability and Quality Analyses

To evaluate the SAM and DISCERN's inter-rater reliability, the Jamovi Version 1.2.27 software was used to complete an intraclass correlation coefficient (ICC); to calculate a kappa. This measure is used to determine the degree of agreement between 2 or

more raters after correcting for chance (Fleiss & Cohen, 1973). Kappa measures range from -1 (poor agreement) to +1 (excellent agreement) (Fleiss & Cohen, 1973). For the revised webpage, the kappa value was .76 for SAM and .88 for the DISCERN. These values both indicate "good reliability beyond chance".

As shown in Table 2, the unrevised webpage's suitability score was noticeably lower than the revised webpage. Regarding the SAM criteria, with a score of less than 39%, the unrevised webpage is considered unsuitable. Following the revision, the webpage generated an average percentage score of 95% (calculated by averaging the scores of all three researchers). With a score of above 70%, the SAM deems the webpage to be of superior quality and appropriate for its audience.

Table 2

SAM Scores of the Unrevised and Revised Webpages

SAM factor	Webpage	
	Unrevised	Revised
Purpose is evident	1	2
Content is about behaviours	0	2
Scope is limited	0	2
Summary or review included	N/A	N/A
Reading grade level	0	2
Writing style, active voice	0	2
Vocabulary uses common words	1	2
Context is given first	0	2
Learning aids via "road signs"	0	2

Cover graphic shows purpose	N/A	2
Type of graphics	N/A	2
Relevance of illustrations	N/A	2
List, tables, etc. explained	N/A	N/A
Captions used for graphics	N/A	2
Layout factors	0	2
Typography	0	2
Subheads (“chunking”) used	N/A	2
Interaction used	0	1
Behaviours are modelled and specific	0	2
Motivation – self-efficacy	0	2
Match in logic, language, experience	N/A	N/A
Cultural image and examples	N/A	N/A
Total SAM score	2	35
Total possible score	26	36
Percentage score	8%	97%

Note. SAM factors are reprinted from chapter four of C. C. Doak et al. (1996).

Table 3 presents the plain language scores of the unrevised webpage. By attaining only 4 of the 19 requirements, the unrevised webpage did not conform to plain language recommendations. Following the revision, the webpage achieved all 19 of the plain language requirements, indicating a substantial improvement in its content. With only one item, the ICC for the adapted PLC could not be calculated; however, all reviewers rated the webpage a score of 19.

Table 3

Adapted PLC Score of the Unrevised Webpage

Plain language factor	Unrevised webpage
Does one or more of the headings contain the web search term?	Y
Does the introduction (first paragraph) inform the reader what they are about to read?	N
Is the content relevant to the search terms used?	N
Does the material begin with the most important message?	N
Is the content arranged in an order that makes sense?	N
Are different topics grouped under separate headings or subheadings?	N
Are personal pronouns such as “you” and “we” used throughout?	N
Is an active voice used throughout?	N
Are lay terms predominantly used throughout?	N
If technical terms are used, are they explained?	N
Are simple sentences used throughout (i.e. no more than one new idea per sentence)?	N
Is correct grammar and punctuation used throughout?	N
Are unnecessary words eliminated (e.g. technical jargon or adverbs)?	N
Is the appearance of the material consistent throughout (i.e. consistent use of fonts, italics, bold print, colour, and bullet points)?	Y

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?	N
Are the fonts clean in their design and easy to read (not fancy or unusual e.g. Arial)?	Y
Is the text size large enough for easy reading and does each line have about 10-15 words?	N
Are italics, underlining, capitalisation, and bold print used sparingly?	Y
Are images clear and uncluttered and related to the content?	N/A
Total	4

Note. Checklist is reprinted from the Adapted PLC (Center for Health Literacy MAXIMUS & McGee & Evers Consulting Inc, 2012; National Adult Literacy Agency, 2008; Plain Language Action and Information Network, n.d.). Y = Yes, meets criteria; N = No, does not meet criteria; N/A = Not Applicable.

Lastly, Table 4 compares the quality scores of both webpages using the DISCERN instrument. With a total score of 20 out of 80, the unrevised webpage material is consistent with having potentially serious or extensive shortcomings (Charnock et al., 1999). Once revised, the webpage earned an average quality rating of 77 out of 80 (calculated by averaging the ratings generated by the researcher and two independent evaluators). The greater quality score indicates that the material was of good quality, with potential minimal shortcomings (Charnock et al., 1999).

Table 4

DISCERN Scores of the Unrevised and Revised Webpages

Criterion	Webpage	
	Unrevised	Revised
1. Are the aims clear?	1	5
2. Does it achieve its aims?	N/A	5
3. Is it relevant?	2	5
4. Is it clear what sources of information were used to compile the publication?	1	5
5. Is it clear when the information used or reported in the publication was produced?	1	5
6. Is it balanced and unbiased?	1	5
7. Does it provide details of additional sources of support and information?	1	5
8. Does it refer to areas of uncertainty?	1	5
9. Does it describe how each treatment works?	2	5
10. Does it describe the benefits of each treatment?	1	5
11. Does it describe the risks of each treatment?	1	4
12. Does it describe what would happen if no treatment is used?	1	5
13. Does it describe how the treatment choices affect overall quality of life?	1	5
14. Is it clear that there may be more than one possible treatment choice?	3	4
15. Does it provide support for shared decision-making?	1	5

16. Overall quality of the publication as a source of information about treatment choices	2	5
Total	20	78

Note. Each criterion is scored out of 5. N/A = Not applicable.

3.3 Sample Characteristics: Descriptive and Frequency Statistics

Although 52 participants met the eligibility criteria and completed the online survey, only 48 participants were included in the analysis. Before commencing the online survey, the potential bias of including audiologists on the results was not considered. Following extensive deliberation, the four participants were deemed as experts in the field and were removed. This resulted in a total of 48 participants who completed the survey.

Ethnicity was categorised into four profiles of European, Asian, Middle Eastern, and Māori; based on those created by StatsNZ (2013). Concerning education, the outcome variables were condensed into three groups on the highest qualification held. The High School (HS) variable consisted of respondents who had either completed Year 12 or finished high school. Respondents who had completed at least one year of university or attained a bachelor's degree were categorised into the Undergraduate degree (UG) category. Those in the Postgraduate (PG) category consisted of respondents who held a Master's or Doctoral degree. The occupation variable was categorised into job profiles set by the Careers NZ webpage (careers.govt.nz, 2020).

As the webpages were randomly assigned, it was assumed that there would be no significant differences between the two groups along the measured demographic variables. To evaluate this assumption, a chi-square test was conducted for the following variables:

gender, ethnicity, highest qualification, and occupation. Additionally, to assess age, a one-way ANOVA was conducted as it was a continuous measurement. Table 5 presents the analyses' results indicating no significant differences between the two groups along the demographic variables.

Table 5

Sociodemographic Characteristics of Participants and Statistical Analyses of the Webpages

Variable	Webpage group (*n*)		X^2 or *F*	*df*	*p* (2-tailed)
	Unrevised	Revised			
Gender			.27	1	.764
Male	8	9			
Female	17	14			
Ethnicity			6.50	3	.076
European	13	12			
Asian	5	0			
Middle Eastern	7	10			
Māori	0	1			
Highest Qualification			1.36	2	.571
HS	4	2			
UG	17	19			
PG	4	2			
Occupation			5.80	10	.951
Student	11	8			
Retail	3	2			
Apprentice	1	0			
Engineer	0	1			

Transport/ Logistics	1	1			
Healthcare	2	3			
Media	2	2			
Business	4	2			
Hospitality/ Tourism	0	1			
Education	0	1			
Unemployed	1	2			
Age			0.024	1	0.877
M	27.92	27.48			
SD	9.67	9.977			

Note. HS = High School; UG = Undergraduate degree; PG = Postgraduate degree

3.4 Hypothesis Testing using MANOVA

3.4.1 Normality Testing

Given the small sample size (n = 48), testing for normality was imperative. The data were examined for skewness, kurtosis, and significant outliers. The value of 1.96 was used to determine the significance level. Only the comprehension scores of the revised webpage group had both skewness and kurtosis. Furthermore, after data box plot inspection, no significant outliers were identified for the unrevised and revised webpage groups. The data was determined to meet the assumptions of normality (i.e., parametric testing) as no significant skewness or kurtosis was detected within the rest of the dataset.

3.4.2 Examining MANOVA Assumptions

A significant MANOVA was conducted to determine whether a linear combination of the comprehension sum score, the average self-efficacy score, and average opinion score (dependent variables) was significantly affected by the version of the webpage that each adult was assigned to.

Before analysis, the assumptions of MANOVA were met; data was randomly sampled from the population of interest, residuals were assumed to have multivariate normality, and independence of observation, normality, and homogeneity of variance was met. Following the exclusion of four participants, the sample sizes between the unrevised and revised group varied; to address this, the Box's M test was also conducted. The assumption of homogeneity of covariance was met (Box's M = 10.66, $p = .129$), indicating that the results of the analyses can be trusted.

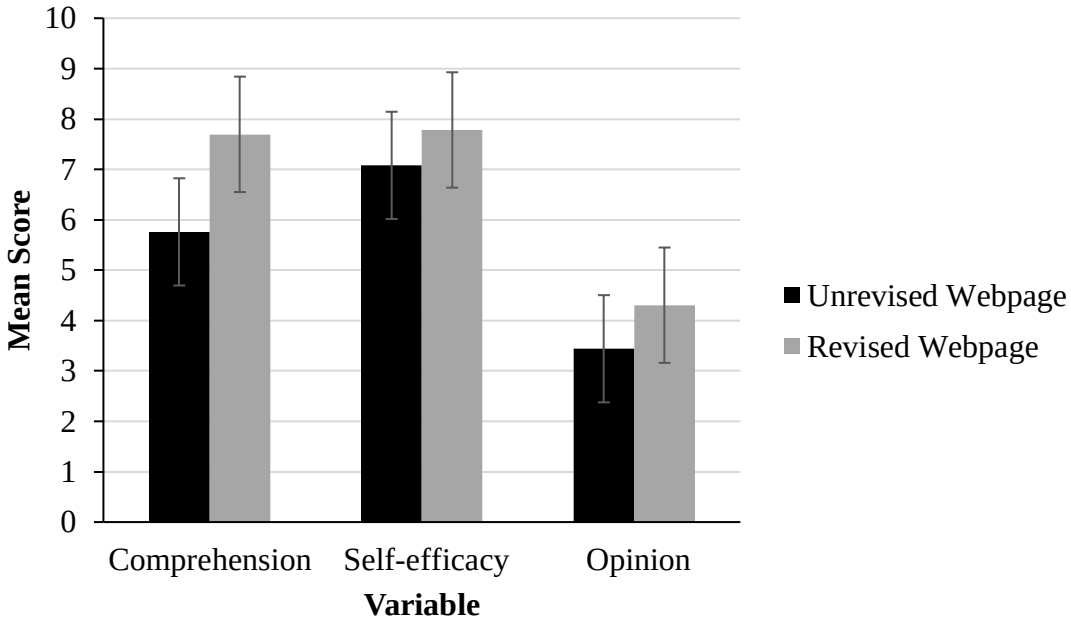
Levene's test of equality of error variances revealed the data to meet this assumption for all dependent variables ($p > .05$). When analysing the data box plots for the unrevised and revised groups, no significant outliers were identified. These findings determined that the data did not contain bias, allowing parametric testing to occur.

3.4.3 MANOVA Results

Displayed in Figure 1, the MANOVA analysis, ($F(3, 44) = 12.62$, $p < .05$; Wilks' L = .538, $\eta_p^2 = .462$), revealed a statistically significant difference in the assessed outcome variables based on webpage allocation The effect size of $\eta_p^2 = .462$ indicates that 46.2% of the variance in scores is accounted for by webpage allocation.

Figure 1

Mean Comprehension, Self-efficacy, and Opinion Scores for Unrevised and Revised Webpage Groups



Note. Error bars represent 1 standard error.

3.4.4 Univariate ANOVA

To investigate the effect of webpage allocation on each dependent variable, the statistically significant MANOVA results were then followed up with separate univariate ANOVAs. These results are summarised in Table 6.

The following hypotheses were examined:

1. The mean comprehension score of adults who read the revised webpage is expected to be significantly higher than those who read the unrevised webpage
2. The mean self-efficacy score of adults who read the revised webpage is expected to be significantly higher than those who read the unrevised webpage

3. The mean opinion score of adults who read the revised webpage is expected to be significantly higher than those who read the unrevised webpage

Table 6

Summary of Results for each Univariate ANOVA

Variable	*F* ratio	*df*	Error df	*p*	η_p^2
Comprehension	14.81	1	46	< .001	.244
Self-efficacy	3.38	1	46	.072	.068
Opinion	16.36	1	46	< .001	.262

These results support hypotheses 1 and 3. The adults assigned to read the revised webpage had significantly higher sum comprehension and opinion scores than those who read the unrevised webpage. The effect size indicates that 24.4% and 26.2% of the variance in comprehension and opinion scores, respectively, are accounted for by webpage allocation. For self-efficacy, only 6.8% of the variance is accounted for by webpage allocation. Additional analyses of participant responses are included in Appendix F.

3.5 Participants Opinion Comments

Table 7 presents the comments collected from participants who read the unrevised webpage and those who read the revised webpage using the voluntary open-ended question. This question briefly asked the participants if they had any comments regarding how easy or hard they found the material(s).

Table 7

Participant Opinion Comments

Webpage	
Unrevised	Revised
• I kept losing track of where I was because the writing was small and all in one colour! • The material was bit confusing for first time materials for myself. I understood a bit of it. • I think if this were to be printed as patient material, simpler language would need to be used. Those with poorer health literacy would find it difficult to read and you need to concentrate to understand what is being said – although this is the case with many things when they are new to you. Other than that, it was informative and fairly straightforward to read (although I am aware some questions answered in the previous sections were answered incorrectly due to misinterpretations!). • I found the material confusing to read as it dove into what OE following from the introduction (which highlighted what OME was). There was a lot of jargon and the diction utilised was unnecessarily complex. The material failed to explain what the ET does succinctly and easily.	• Everything was well articulated. • It is always helpful to have a video or an audio either to watch or hear the proper pronunciation of a given term. I had to check the pronunciation of some words to memorise them in the long term memory. Normal people often would not bother doing this. • The material was very clear. The diagrams incredibly helpful. • Very good, background information supports full understanding. • The article was very clear and well written. • It was easy to understand. • It was easy partly because I was familiar with the topic. • It reads very well. • I found it fairly simple due to the use of subtitles for each section of material and the diagrams.

- It was a little confusing when describing the middle and outer ear, but not bad at all.
- The material gave direct information about otitis externa, and when finally referring to otitis media, made it a comparison to otitis externa. This rather meant that if your understanding of OE was sketchy (having skimmed through since the topic of the study is on OM…), one had to go back and re-read how OM was different from OE.
- I wish I had a labelled diagram. Me not do so good at visualising internal ear layout.
- For someone without a level of higher education I think this would be hard to read and follow, there was a lot of complicated words and ideas and I think that if someone was reading this trying to learn about it quickly it was too complicated to understand. However, if this was a more medical or advanced explanation of it, it was good as I (with no knowledge of inner ears) could follow along if I focused about what I was reading. More of an academic explanation rather than a general public informative explanation.
- Lots of complex language made it difficult to find the key information. Overly wordy.
- Nice and easy to read, simple and valid explanations that allowed me to understand some new information I never thought to read about, will be aware the next time I'm swimming!
- The material was easy to understand and had great diagrams.
- Coming from a background with no medical or health knowledge, I found the written material provided very informative and clear to understand. The structure was great and logical, and the tone used was explanatory without being overbearing. A great read and I learned a lot about otitis media (middle ear infections).
- The material was easy to read with nice, short and jargon free sentences. The paragraphs were nice and short also. I found the included images to be beneficial in the understanding of the written material.
- Very informative no problems.
- Very good use of colour and words. Was easy to read and did not take long.
- I feel like the information may be a little too scientific and lengthy, I personally didn't mind it because I have a science background! However, it was structured well to help me understand this condition.
- I found the tone of the material very patronising.
- I think the material was very useful and clear to understand. Very good info.

Chapter 4: Discussion

4.1 Introduction

The overarching aim of this thesis was to evaluate a revised webpage on OM, in an attempt to provide necessary information on its accessibility. In doing so, the study sought to demonstrate that the provision of accessible information on OM that complements patient health literacy, may in turn, promote PCC and SDM. Using best practice processes and without tarnishing the veracity of the material, the poorly-rated webpage on OM was revised. The goal being that it demonstrated improvements in reader comprehension, self-efficacy, and opinion. The readability analysis corroborated that the unrevised webpage material on OM was challenging to read and comprehend. The results from the randomised experiment demonstrated how improvements offered by the revised webpage, significantly implicated reader comprehension and opinion scores. This chapter reviews the hypotheses with relevance to the literature, discusses their implications, outlines the study's limitations, and provides suggestions for future research.

4.2 Readability, Suitability and Quality Analysis of the Webpages

Both materials were evaluated using standardized readability, suitability, and quality tools. To warrant use, the three aforementioned tools were used as a metric that the revised material needed to meet before launching the survey.

4.2.1 Readability

Based on previous studies on online audiology-related health materials (Atcherson et al., 2014; Joury et al., 2018; Laplante-Lévesque, 2015; Laplante-Lévesque et al., 2012; Lee, 2020;

Manchaiah et al., 2019; McKearney & McKearney, 2013; Potter, 2015), it was anticipated that the readability of the unrevised webpage would exceed the internationally endorsed recommendation of writing materials at a sixth or lower RGL. With a mean reading complexity between 9th and 11th RGL, these studies consistently disclosed that patient health education materials were difficult to read and inappropriate for their audience. Comparably, and expectedly, the unrevised webpage greatly exceeded the recommended RGL. Germane to OM-related online information, the findings from Lee (2020), who analysed the readability of 18 webpages related to OM in English, revealed that the mean RGL for all webpages was 9.44, 11.68, and 11.55 using the F-K, FOG, and SMOG, respectively. The mean RGL of the unrevised webpage used in this study (M = 17.22) is considerably greater than the RGLs of previous audiology- and OM-specific webpages. This may be attributable to the fact that the poorest rated webpage on OM was purposefully selected for revision.

Former findings have shown that one's reading skills are estimated to be at least three to five grades lower than their highest educational level (D'Alessandro et al., 2001; C. C. Doak et al., 1996; Dowe et al., 1997; Meade & Byrd, 1989). This indicates that readers would require at least a graduate-level education to effectively understand the unrevised OM webpage's content. Among those who read the unrevised webpage, only 16% held a master's or doctorate. Of the remaining respondents, 16% had either completed Year 12 (11th Grade) or finished high school, and 68% had completed at least one year of university or attained a bachelor's degree (14th to 16th grade). This indicates that even with an equivalent grade level of 11th to 16th, these respondents may likely have a readability level as low as 6th to 8th grade level. Therefore, with a mean RGL of 17.22, 84% of the adults assigned to read the unrevised webpage material would have likely struggled with using the health-education resource.

When compared to the findings from the 2018 census, 44% of the surveyed NZ population (aged 15 years and over) held between a Level 1 to Level 3 certificate, equivalent to completing some or finishing high school (StatsNZ, 2018a). This was followed by 24%, which had completed a bachelor's degree, 10% which had completed a postgraduate diploma or honours, and a minute 7% which held a Masters or Doctorate. It is interesting to see that the participants' demographic background is somewhat reflective of the population, as they demonstrate that most adults hold a bachelor's degree and below; and are therefore likely to struggle with such health-education material. OM symptoms may motivate parents and patients to seek health information to guide decision-making regarding medical intervention (Joury et al., 2018; Meherali et al., 2019). This is concerning as the material on OM does not support the readers' health literacy (Lee, 2020). Given the presence of low health literacy levels, a difficult to read webpage on OM may result in readers overlooking their diagnosis, misidentifying symptoms, seeking ineffective or inappropriate medical management and treatment, and undertaking harmful health behaviours (Berkman et al., 2011; Joury et al., 2018; Lee, 2020). Therefore ensuring low readability of OM-related material will warrant that readers, regardless of their health literacy level, have access to appropriate knowledge on their health condition (Kutner et al., 2006).

Within their comprehensive book, C. C. Doak and colleagues (1996) endorsed that all materials with an RGL at or above 9th grade level must be revised to make them comprehensible by readers. The authors stated that using these best practice guidelines to revise material would offer significant improvements in readability. Previous studies by Donald and Kelly-Campbell (2016), Ming and Kelly-Campbell (2018), and Potheir et al. (2009) found the RGL of materials dramatically reduces when written according to these best-practice guidelines. Comparably, in

this study, the use of best practice strategies in amending the webpage significantly reduced the readability of the webpage by an average of 11.26 RGL. With a mean RGL of 5.96, and RGL of 7.2, 5.9, and 4.8, using the FOG, SMOG, and F-K, respectively, the revised webpage material approximated the international recommendation.

As explained in section 1.5, writing to a sixth RGL or lower does not necessitate reader comprehension as influential variables such as reader motivation, knowledge, and characteristics of the material are unaccounted for by these formulas (Friedman & Hoffman-Goetz, 2006). Nevertheless, readability remains a crucial variable in the writing and production of effective, clear, and simple materials, appropriate for those with limited health literacy (Caposecco et al., 2011; D'Alessandro et al., 2001; Doak et al., 1998; C. C. Doak et al., 1996; Mayer & Villaire, 2007; National Institutes of Health, 2018).

4.2.2 Suitability and Quality

The SAM, DISCERN, and adapted PLC tools were used to evaluate both webpages' suitability and usability. C. C. Doak et al. (1996) reported a strong correlation between the readability and SAM scores. Suppose the readability score is high, then the SAM score is generally low and vice versa. Furthermore, if the readability level of a material is considered unsuitable, then the health care material must be regarded as inappropriate for its audience irrespective of its overall rating (C. C. Doak et al., 1996). Unsurprisingly, the unrevised material webpage used generated a high RGL and a low SAM score of 2 out of 26 or 8%, indicating unsuitability for patient education. These findings are consistent with those reported in the literature, where health-education materials with greater RGLs were also deemed unsuitable for its audience (Nasser et al., 2012). Caposecco et al. (2014) rated 25 out of the 36 (or 69%) of the hearing aid user guides as 'not suitable' due to inappropriate readability, a scope that stemmed

beyond the purpose of the material, a complex layout and typography, which decreased reading ease. Readability factors, including the use of jargon and uncommon concept words in place of common words, generated a mean RGL of 9.7 among the user guides. Donald and Kelly-Campbell (2016), Ming and Kelly-Campbell (2018), and Potter (2015) show similar findings; where an original paediatric diagnostic report, an unrevised tinnitus brochure, and online webpages on hearing-impaired adults, respectively, were rated as unsuitable.

The unrevised webpage generated an overall DISCERN rating of 2 out of 5 and a plain language score of 5 out of 19. Such low quality and content findings were comparable with other audiology-related education material (Laplante-Lévesque et al., 2012; Manchaiah et al., 2020). Together these results signified the need for revising the online webpage material on OM. Following the revision, the webpage received a low average RGL score of 5.96; and a high SAM score of 95%, indicating the material was of superior quality.

The results from this study validate the amassing body of literature that reveals that revising materials according to best practice methodology improves their readability, suitability, and overall quality, irrespective of its initial complexity. As most individuals use the internet to obtain health information and advice, it is more effective to ensure that all online written health materials are written in a way that is easily accessible. Along with previous studies, these findings should inspire revision of any existing inaccessible health material.

4.3 Study Hypotheses in Relation to the Literature

Although the health literacy realm is inundated with information on the poor readability, suitability, and quality of patient health materials and guidelines to revise them, scarce studies exist on their application and subsequent assessment. This study necessitated evaluating the

comprehension, self-efficacy, and opinion scores between adults who read the unrevised webpage compared to those who read the revised.

4.3.1 Comprehension

Reader comprehension encompasses the RGL of a material in conjunction with an amalgamation of skills, including reader motivation, knowledge, and conceptual backgrounds involved in comprehension (C. C. Doak et al., 1996; Ley & Florio, 1996; Meade & Smith, 1991). For this reason, this study used ten multiple-choice questions to ascertain reader comprehension estimates, where correct reader responses entailed comprehension of the material (C. C. Doak et al., 1996).

The first hypothesis stated that the adults who read the revised webpage would have a higher comprehension sum score than the adults who read the unrevised webpage. The findings from this study support this hypothesis by revealing that adults who read the revised webpage had a significantly and statistically greater sum comprehension score, with a large clinically meaningful effect size ($\eta_p^2 = .244$). This demonstrates that revising the original webpage using best practice strategies significantly improved reader comprehension. These findings are comparable to the study by Donald and Kelly-Campbell (2016), where an improvement in reader comprehension was found following the revision of a mock audiology report. This demonstrates that writing or revising audiology-related online patient education materials using best practice guidelines can significantly improve reader comprehension. This is important in an OM context as poor comprehension of material could have serious implications on health outcomes and healthcare costs (Joury et al., 2018).

Additionally, there is evidence to show that simply written materials are preferred by readers of all literacy levels, with benefits including increased comprehension and reduced

reading time (Davis et al., 1996; C. C. Doak et al., 1996; Kelly-Campbell & Manchaiah, 2020; Mindlin, 2005). This is evident in this study as the revised group consisted of a mixture of respondents who had completed high school, held an undergraduate degree or a postgraduate degree. Given the complex and multifaceted causes of OM, the triage of symptoms, and ambiguous management/treatment plans, understanding patient materials is vital to identifying the condition, and making informed treatment choices to avoid progression and complications.

4.3.2 Self-efficacy

The second hypothesis stated that the sum self-efficacy scores of adults who read the revised webpage would be significantly higher than the adults who read the unrevised webpage. This was anticipated as former studies found that access to information that complements reader health literacy increases self-efficacy due to better comprehension of information (Donald & Kelly-Campbell, 2016; Reisi et al., 2016). However, this study did not find a significant effect of webpage allocation on participant self-efficacy scores, irrespective of the statistically significant improvements in comprehension scores. Although adults in the revised webpage group had a greater sum self-efficacy score than those who read the unrevised webpage, the effect size was small. Hence, the second hypothesis was not supported because the revision did not improve reader self-efficacy. These findings were in contrast to what is reported in the literature. One possible explanation may be the ceiling effect, as the participants' self-efficacy scores in the unrevised group were already high, sitting at a 7 out of 10.

4.3.3 Opinion

The third hypothesis stated that the sum self-perceived opinion score of the adults who read the revised webpage would be significantly higher than those who read the unrevised

webpage. This study supports this hypothesis by demonstrating that those who read the revised webpage had a statistically and significantly greater sum opinion score, with a large effect size measured. These findings are comparable and consistent with those by Donald and Kelly-Campbell (2016), where their sample of parents who read the revised report showed significantly better opinion ratings than those who read the unrevised report. Research has shown that a positive perception of material will mean that readers are more likely to read, comprehend and follow material's recommendations. In the context of OM, this signifies that patients or caregivers of children with OM are more likely to follow the recommendations of the material, whether it may be to monitor the progression of the condition or seek medical intervention. This may reduce unnecessary healthcare costs, health complications, and potentially enhance self-efficacy.

4.3.4 Opinion Comments

The author added an opinion section at the end of the survey to further gauge participant perception of the webpages. Interestingly, analogous comments were observed among participants within each webpage group. The unrevised report's responses were primarily negative, compared with the revised report, which generated considerable positive feedback. Adults who were assigned to read the unrevised webpage testified that the material was confusing and difficult to understand. The information stemmed beyond the scope of the material, contained challenging terminology and language, had a complex layout, and lacked images. Participants suggested the use of diagrams and a more familiar language.

Conversely, adults who read the revised webpage stated that the material was clear, simple, and easy to understand, contained good content and structure, and employed diagrams that complemented understanding. Readers suggested improvements included using audio or

video to support the pronunciation of terms and facilitate better comprehension. Although voluntary, these reader comments are invaluable to the study as they more closely approximate the thoughts that the readers held about the material. The comments are also useful in cross-checking with the objective scores obtained from the comprehension, self-efficacy, and opinion responses.

4.4 Clinical Implications

This study has demonstrated that revising online health education material using best practice guidelines results in statistical and significant improvements in reader comprehension and self-perceived opinion. An overwhelming number of people have limited health literacy skills. They struggle to understand health information and access services vital for making informed health decisions, undertake self-management, and function in health care settings (Kelly-Campbell & Manchaiah, 2020). The impact of limited health literacy on health behaviours, health care costs, quality of care, and health outcomes are detrimental and concerning (Andrus & Roth, 2002; Baker et al., 1998; Berkman et al., 2011; Elwyn et al., 2010; Lindau et al., 2002; Rudd et al., 1999; Weiss et al., 1992). Former studies have shown that caregivers routinely search for audiology-related health information online relating to their child's health (Meherali et al., 2019; Pehora et al., 2015). Relevant to the topic of this thesis, symptoms of colds/flu or fevers are frequently searched by parents. The content and quality of online health information have influential outcomes on the individuals' knowledge and behaviours, mainly due to its ubiquitous accessibility. This suggests the importance of taking proactive measures to provide accessible, appropriate, and evidence-based information on OM to enable these individuals to better manage their child's health better, and improve communication with their HCP. Furthermore, Doak et al. (1996) eliminate the widely held misconception that

those with limited health literacy skills are deficient in intelligence. Instead, they can comprehend any health education material as long as it is designed in a readable and suitable manner. This pushes the need for a fundamental movement towards improving the quality of online health information in an attempt to improve health literacy, and ultimately population health.

4.5 Limitations

Although the researcher attempted to make the sample results generalisable, the sample population consisted of 52.1% European, 35.4% Middle Eastern, 10.4% Asian ethnicity, and 2.1% Māori. When compared to data from the most recent NZ census, statistics reveal that 70.2% of the population are European, followed by Māori (16.5%), Asian (15.1%), Pacific peoples (8.1%), and a lesser 1.5% identifying as Middle Eastern, Latin American and/or African (StatsNZ, 2018b). Thus, the study sample contained an atypical overrepresentation of those identifying as Middle Eastern and an underrepresentation of Māori and Pacific peoples. This may have been because the researcher recruited active participants via her social network, which is likely to reflect her personal characteristics. In contrast to the census data, where the median age in NZ was 37.4 years (StatsNZ, 2018b), the study sample population was younger (*Mdn* = 23.50). An overrepresentation of those aged 20-25 years was expected as the researcher was within this age bracket. Additionally, the study participants tended to be highly educated, with 75% of the respondents holding a bachelor's degree, 12.5% certified with a master's or doctorate, and 12.5% having a high school qualification. These findings are noticeably different from those by StatsNZ (2018b), where most of the population (18.2%) had no qualification, and 14.6% had a bachelor's degree or level 7 equivalent. Furthermore, only 21.3% and 3.2% of the NZ population were enrolled in full-time and part-time study, respectively, with 75.5% of people

not studying (StatsNZ, 2018b). The differences in demographic characteristics between the study population and the NZ census indicate that the study sample is not representative of the population, limiting the generalizability of the results. With a small sample set, combined with the challenges inherent in an online survey, the limitation of selection bias was anticipated. This threat to generalizability suggests that the hypothesized relation may not hold for the NZ population. It is also assumed that the study volunteers may have been more proactive about solving the issue than the average person is. This threat may be addressed by replicating the study with a different randomized research sample and assessing whether the same conclusions hold.

Additionally, the researcher attempted to avoid the effect of the 'difficulty of question' between the two materials. For instance, the participants' answers to the comprehension questions may have been affected by the webpage material they were randomly assigned. Those assigned to read the revised material may have found it easier to uncover the answers to the questions than those who read the unrevised material as the information had to be disentangled. Unfortunately, the construct of 'question equivalency' stemmed beyond the scope of this master's thesis as it was not practically feasible. It is encouraged that future studies attempt to achieve this.

Another serious threat to the validity of the research findings results from the participation of nonserious respondents known as participant bias. While the internet provides a platform for an easily accessible and cost-effective method for data collection, it too provides exposure to potential limitations. In this study, participants completed the survey from their own homes without any supervision; therefore, the honesty of participants may have threatened the validity of the results. The study may have recruited participants who completed the survey out

of curiosity rather than in an attempt to provide genuine valid answers. This is a critique of online data collection, as such behaviour is suspected to increase noise and reduce experimental power (Aust et al., 2013).

Finally, the dilemma of employing an open versus closed survey method may have influenced the results. The line between using an open versus closed method to conduct the survey was 'blurry'. The survey was limited by the Qualtrics software as the platform only provided two options to display the webpage material; specifically, via a new tab (open method) or pasted within the survey (closed method). Such a dilemma may have limited the study's generalizability or external validity as it is unknown how people behave online. The researcher made the arbitrary decision to employ an open method survey as she felt that it genuinely mimicked reality. An open method suggests that an individual can easily refer to the information whenever required, compared to the closed method; where it is assumed that the reader would view the information once and retain it, relying more on memory and cognition. To address this dilemma, future studies are encouraged to investigate how people examine information online as there is currently a gap in this research area.

4.6 Future Directions

Numerous studies have found that current online health information is difficult to read and of lower quality and suitability for its readers (Laplante-Lévesque et al., 2012; Laplante-Lévesque & Thorén, 2015; Manchaiah et al., 2020; McKearney & McKearney, 2013). The findings from this study add to this amassing pool of research, revealing that the online health-education material on OM is complex, unsuitable for its audience, and written at a level that does not meet international readability standards. Owing to its implications on reader comprehension and self-perceived opinion, this study provides a call to action to improve the quality of existing

material or develop appropriate new material by providing initiatives that implement such changes.

To facilitate patient self-management, HCPs are encouraged to provide clients with access to health materials, whether written or online. Current literature examining audiological clinical protocols demonstrates that audiologists are selecting materials for clients. However, there is limited knowledge of whether these professionals are considering the readability of the material. Given the variability of health-care materials, clinicians must examine the complexity of online education material before recommending them to patients. If this notion is disregarded, then the provision of inappropriate materials may implicate a client's trust in their clinician, impairing their relationship and ultimately influencing patient health outcomes (Preminger et al., 2015).

Unlike former studies, this study stemmed beyond readability and suitability assessments. By employing an experimental design, the findings have demonstrated that reader comprehension and self-perceived opinion can be improved by revising health material in accordance with best-practice guidelines. These results are valuable as improving reader comprehension is linked with several benefits, including enhancing PCC and SDM, improving health outcomes, and reducing health care costs.

4.7 Conclusion

While HCPs remain the primary source of health information, the internet has quickly gained recognition. Owing to the increasing number of users, the internet can be a valuable and influential health information resource. However, to ensure informed decision-making, online health information must be readable, suitable, and of high quality for readers, particularly those with limited literacy skills. This study's results validate those of other researchers as the

unrevised webpage material was found to be inaccessible to readers due to its poor readability, quality, and suitability ratings. Consequently, adults who read this webpage had lower reader comprehension and opinion scores. Encouragingly, this study also revealed that a poorly rated webpage on OM could be revised and made accessible using standardised tools and best practice methodology. By achieving this, the readability, quality, and suitability of the material were improved; and resultantly, significant improvements in reader comprehension and opinion scores were evident. These findings highlight that providing readers with accessible and appropriate online OM-information can help them better understand and manage their health condition, which may, reduce its progression, complications and improve health outcomes.

The subject of readability has been extensively researched, and it is time to action by implementing such changes. It is anticipated that this study's findings, in conjunction with those by the abovementioned researchers, will be recognised and implemented. The outset of achieving this may be difficult as current online health materials will require revision. However, the potential benefits of improving reader comprehension and opinion should counterbalance these challenges.

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Appendix A: Letter Of Approval From Human Ethics Committee

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Rebecca Robinson
Telephone: +64 03 369 4588, Extn 94588
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2019/07/LR Amendment 2

14 February 2020

Rebecca Kelly
Psychology, Speech and Hearing
UNIVERSITY OF CANTERBURY

Dear Rebecca

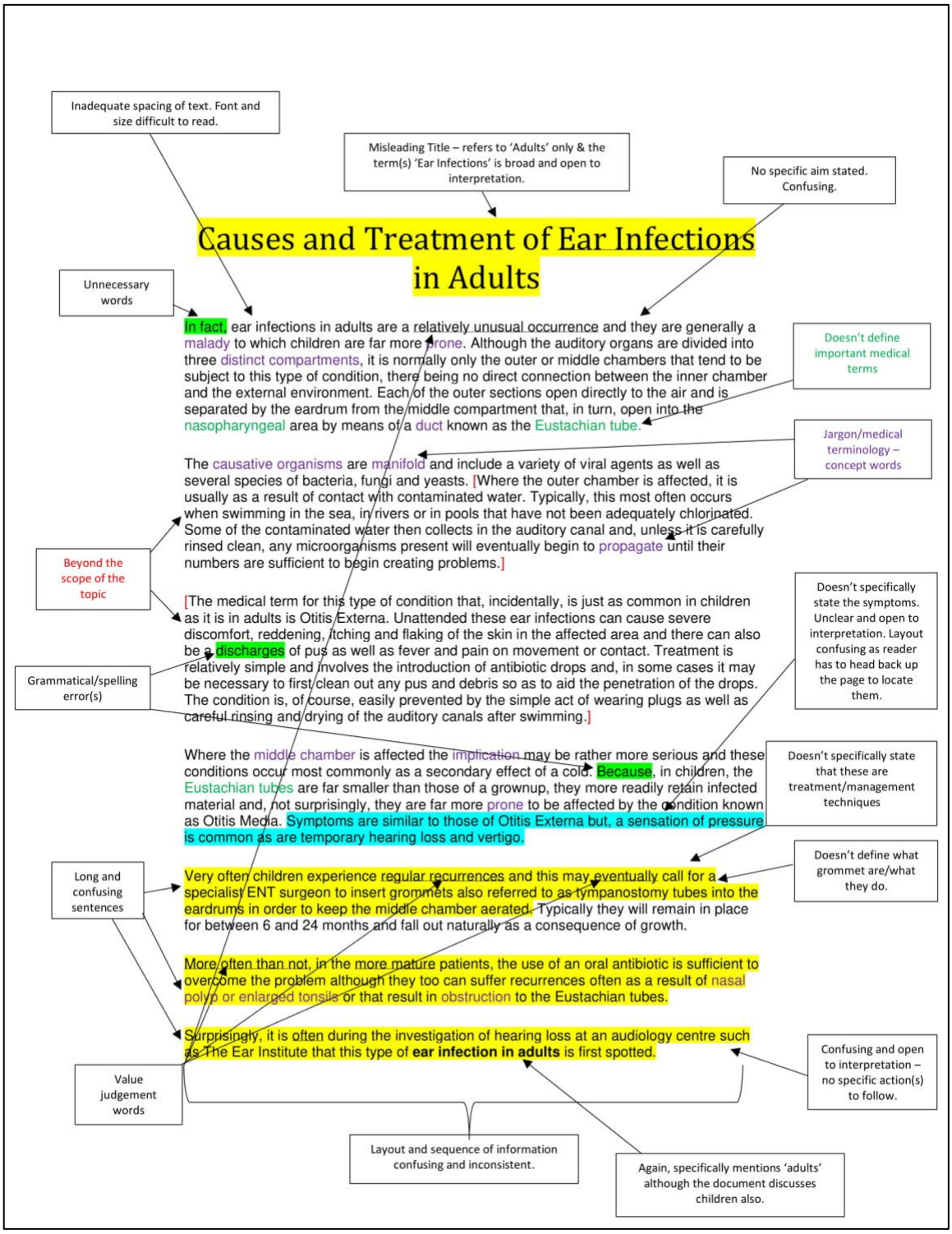
Thank you for your request for an amendment to your research proposal "Quality of Hearing-Related Internet Information" as outlined in your email dated 10th February 2020.

I am pleased to advise that this request has been considered and approved by the Human Ethics Committee.

Yours sincerely

Dr Dean Sutherland
Chair, Human Ethics Committee

Appendix B: Copy Of Unrevised Material Annotated To Highlight Modifications



Appendix C: Modifications Made to the Revised Material and Comparison Between the Two Webpages

Element	Suggestions	Comparison of unrevised and revised webpage material
Content	• Purpose overtly stated in the title, cover illustration or introductory paragraph.	• Title of material modified from 'Causes and Treatment of Ear Infections in Adults', which is broad, misleading and open to interpretation, to a more specific title 'Causes, Signs, and Treatment of Middle Ear Infections (otitis media)' in the revised version. • Cover illustration of a child's 'pinna' added to assist in clarifying that the material is focused on ears, and to gauge reader attention. • A contents-like section added to the introductory paragraph that stated all the headings, to inform the reader of what is included in the material.
	• Unnecessary information is avoided.	• Information on otitis externa was removed as it stemmed beyond the scope of the topic.
	• Thrust of material focuses on application of knowledge and desirable behaviour.	• Unlike the original material, which was written in an informative and factual manner, the revised version focused on behavioural information (i.e., what can be done to manage and prevent the condition).
	• Additional sources of information are included.	• While the unrevised material did not include additional sources of information, the revised webpage material included hyperlinks to eight different explanatory websites.
Language	• Technical or jargon terms are eliminated. • If necessary, appropriately described and explained.	• Jargon/medical terminology, difficult concept terms, and unnecessary words were eliminated in the revised material and replaced with common lay terms. For example, the terms 'malady', 'manifold', 'propagate', 'obstruction' and 'implication' were all removed.

	• Readability of the material is at or below 6th RGL.	• Unrevised material included an abundant number of complex, poly-syllabic terms. Where possible, these terms, such as 'occurrence', 'malady', and 'causative', were replaced with familiar mono- or bi-syllabic words. For example, the four-syllable term 'implication' was substituted with the term 'cause'. • Where used unfamiliar audiology-related concept terms, such as 'grommets' were defined, explained, and an image was also used to support understanding.
Writing style	• Conversational and active voice used throughout.	• Material modified from being purely descriptive and passive, to conversational by using personal pronouns such as "you" and "your" throughout.
	• Simple sentences used extensively (less than 15-20 words)	• The original material included long and confusing sentences (i.e., approximately 46 words). This was modified by shortening the sentences to a maximum of 20 words per sentence.
	• Correct grammar and punctuation used.	• Errors were found throughout the unrevised material. For example, the sentence "there can also be a discharges of pus" is grammatically incorrect. This was corrected in the revision.
Layout / organisation	• All topics preceded by an advance organiser.	• Nine question-headings were added to the revised material. • Most of the headings included 'OM' to foster detection of the web search term.
	• Paragraphs limited to less than 5 lines, and one idea.	• Paragraph length was as excessively long in the unrevised material (i.e., 9 lines per paragraph), with the majority of paragraphs covering numerous ideas. Significantly reduced in the revised material with a maximum of 5 lines, and one idea per paragraph.

	• Sensible layout and sequence of information.	• In the unrevised material when describing the symptoms of otitis media in the middle section of the material, the reader is told that they are similar to those of otitis externa, which are located at the beginning of the material. The revised material includes a contents section to outline separate ideas and organised the flow of information according to these headers (i.e., logically from the definition, causes, symptoms, management/treatment to prevention).
	• Pages do not appear cluttered.	• Unrevised material included minimal spacing, small font style, size and long paragraphs. When modified, the font was changed, and the size was increased. • 1.15 spacing, headers and bullet points added.
	• Use of colour supports and is not distracting to the message.	• Only the title in the unrevised webpage was in colour. • Revised material used colour for the headings and images. For example, the three parts of the ear were labelled in three distinctive colours to help the reader efficiently distinguish the three different parts.
Typography	• Font clean in its design and easy to read. • Italics, underlining, capitalization and bold print used sparingly.	• The unrevised webpage material used a Roboto type font, with a small size (approximately size 10 to 11). In the revised material, the type size is at least 12-point, Arial font, in upper/lower case when necessary. Typographic cues used where appropriate (i.e., headings are bolded and in red).
Graphics	• Images included are 1) friendly, 2) attracts attention, and 3) clearly portray the purpose of the material.	• The revised webpage included three graphics, supported by explanatory/descriptive captions to announce the images.

Appendix D: Advertisement Shared on Facebook

Hi everyone! 👋🏼

As part of my Master's research, I am looking for people (18 years old and older) who are willing and able to participate in a 30-minute online survey that looks at the accessibility of online information on otitis media in English.

For your participation, you will go into the draw to win one of two $50 USD Amazon gift vouchers. 💰💰

If interested please contact me, Sara Ibrahim: sara.ibrahim@pg.canterbury.ac.nz, flick me a message on Facebook, or directly use the link below
http://canterbury.qualtrics.com/jfe/form/SV_7P2lOrr6rf1ZB5j

Thanks heaps in advance!!! 🥰

The closing date is the 29th of June 2020! so get in quick 🙂

Appendix E: Questionnaire

Part 1. In this section, you will be asked questions about how well you **understood** what was in the online material. Please read each question and choose the answer you think is correct.

1. What does the term otitis media mean?
    - Infection of the middle ear.
    - Inflammation of the middle ear.
    - None of the above.
2. What is the main cause of otitis media?
    - Contact with contaminated water.
    - The eustachian tube being blocked.
    - Several species of bacteria, fungi or yeast.
3. What does the Eustachian tube do?
    - Drains fluid out of your middle ear.
    - Provides air to your middle ear.
    - All of the above.
4. Why are children more likely to get otitis media?
    - They have far smaller Eustachian tubes.
    - They have enlarged tonsils.
    - They have smaller ears.
5. Which of the following is a sign or symptom of otitis media?
    - Earache and/or feeling of fullness or blockage.
    - Redding, itching and flaking of the skin.
    - All of the above.
6. What is recommended for children with otitis media with severe symptoms?
    - Watchful waiting.
    - Antibiotic treatment.
    - Surgical treatment.
7. What does a grommet help with?
    - Helps to drain out any fluid and keep the middle ear space open so that air can get in.
    - Helps to heal enlarged adenoids or nasal polyps.
    - Helps to block any bacteria from entering your middle ear.
8. What can you do to reduce your risk of getting otitis media?
    a. Wear earplugs.
    b. Carefully rinse and dry out your ear canals after swimming.
    c. Things to reduce your risk of catching a cold, like washing your hands.
9. When is surgical management recommended?
    a. If you have fluid that stays in your middle ear for longer than 3 months.
    b. If your ear is always getting infected even with the use of antibiotics.
    c. If you have trouble with your adenoids.
    d. All of the above.
10. Who is best to seek for help with otitis media?
    a. A hearing health profession at a hearing clinic.
    b. Your local doctor or GP.
    c. All of the above.

Part 2. In this section, you will be asked questions about how **confident** you feel about your understanding of the material. Please read each question and **move the slider** to where you think best describes your level of confidence.

Not Confident at all. Moderately Confident. Very Confident.

0 1 2 3 4 5 6 7 8 9 10

1. After reading the material, how confident are you that you understand the terms in the material?
2. After reading the material, how confident are you that you understood the causes of otitis media?
3. After reading the material, how confident are you that you understood how to manage otitis media?

Part 3. In this section, you will be asked questions about your **opinion** of the material. Please read each question and **move the slider** to where you think best describes your opinion.

Not at all. Moderately. Very much.

0 1 2 3 4 5

1. The material was what I expected it to be.
2. I found the material confusing.
3. The material was beneficial to me.
4. I felt frustrated reading the material.
5. The order of the information in the material was helpful.
6. I thought the material was of good length.
7. I thought the material was hard to read without some help.
8. I thought the material used too much "jargon".

Please give any comments you have about how easy or hard you found this material.

_____

_____

Appendix F: Comparison of the Unrevised and Revised Webpage Groups along the Three Variables

Figure F1

Performance of the Unrevised and Revised Webpage Groups on the Comprehension Questions

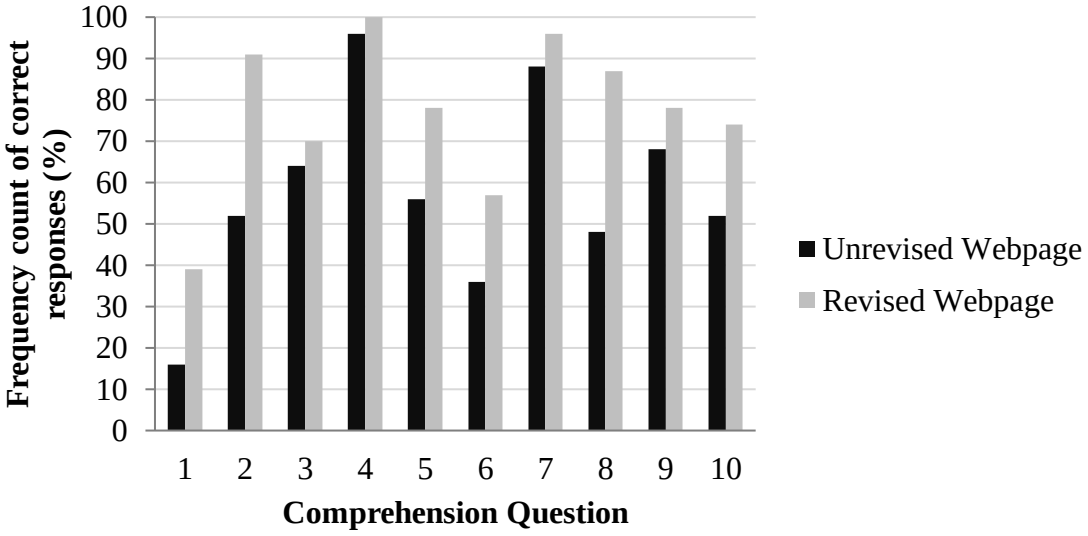
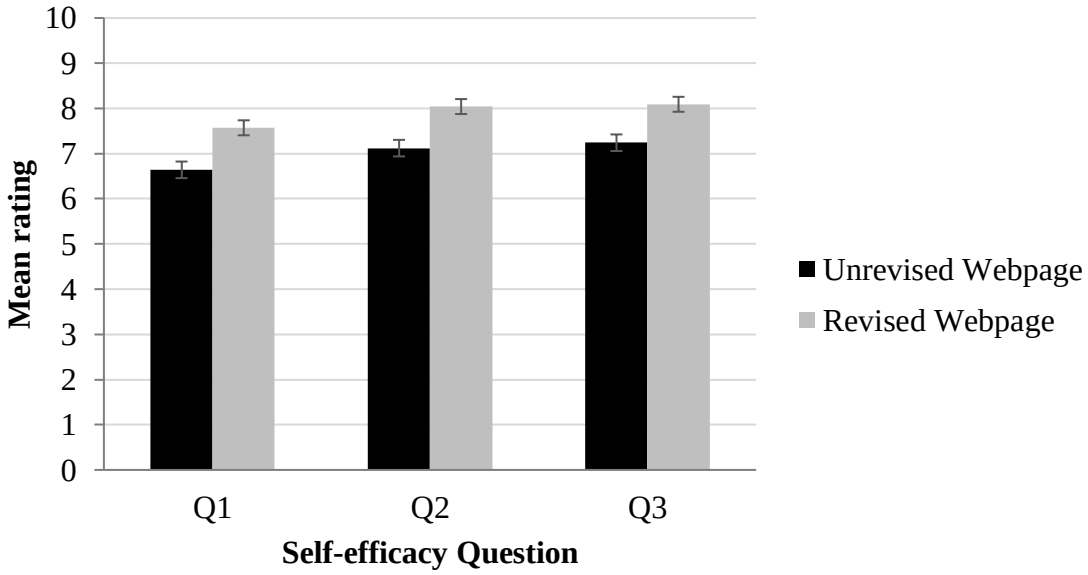


Figure F2

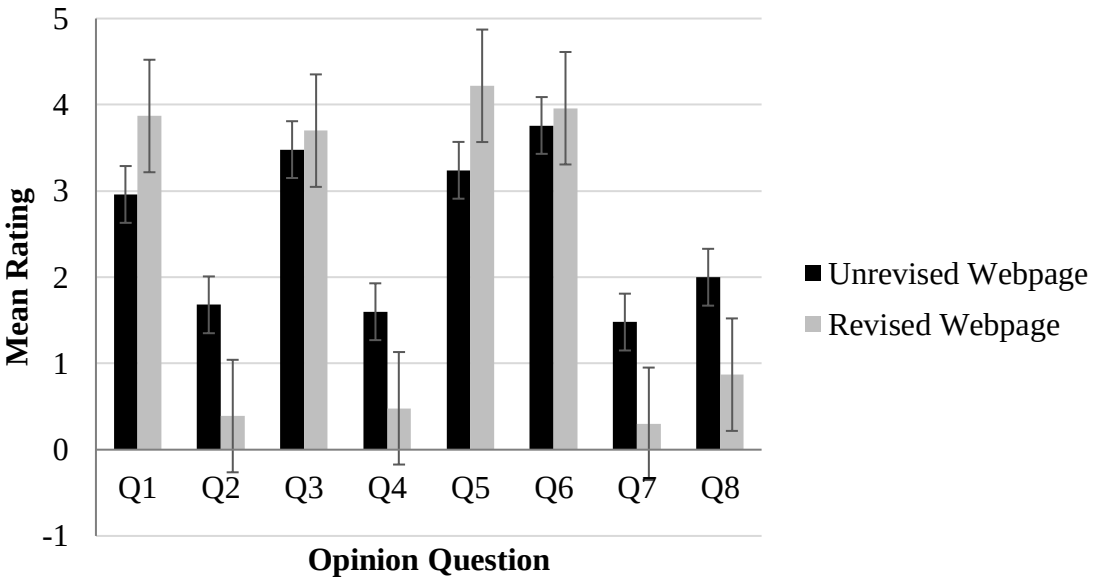
Comparison of the Unrevised and Revised Webpage Groups on the Self-efficacy Questions



Note. Higher rating indicates greater self-efficacy. Error bars represent 1 standard error.

Figure F3

Comparison of the Unrevised and Revised Webpage Groups on the Opinion Questions



Note. Error Bars Represent 1 Standard Error.