READABILTY AND SUITABILITY ASSESSMENT OF ONLINE HEARING-RELATED INFORMATION IN TRADITIONAL CHINESE IN TAIWAN

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ABSTRACT

Purpose: The purpose of this study is to assess readability and suitability of online hearing-related web pages written in traditional Chinese (TC) in Taiwan.

Methods: Five keywords identified by a previous researcher (Hsu & Kelly-Campbell, 2020) were keyed into the Google Taiwan search engine one by one. The first ten uniform resource locators (URLs) obtained from the search were recorded, and webpages meeting exclusion criteria were excluded. After applying the exclusion criteria, 37 webpages were analysed by using Chinese Readability Index Explorer 3.0 (CRIE 3.0) to assess readability grade level (RGL), and by Suitability Assessment of Materials (SAM)-TC to assess suitability.

Results: The mean RGL calculated by using CRIE 3.0 was 5.3, which is not significantly different from the recommended RGL level 6. No significant difference was found between the calculated RGLs of webpages from different origins. The SAM of 37 pages showed that four webpages were unsuitable, with scores of 23.81%, 33.33%, 37.50% and 35.29%. The rest 33 of the webpages included 19 adequate and 14 superior webpages. No significant correlation was found between RGL and SAM scores. In addition, there was no significant difference in SAM rating between webpages of different origins.

Conclusion: The mean RGL calculated by CRIE 3.0 was within the recommended value (6) which means that online hearing health-related information available in TC is easy to read. Also, no correlation was found between RGL and SAM, which indicates that if a webpage has a low RGL, it does not mean that it will be suitable to assess the online information. Origins of websites did not impact the readability and suitability of the online information available in TC.

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LIST OF ABBREVIATIONS

TC	Traditional Chinese
URL	Uniform Resource Locators
RGL	Readability Grade Level
SAM	Suitability Assessment of Materials
CRIE 3.0	Chinese Readability Index Explorer 3.0
HON	Health On the Net
WHO	World Health Organisation
SDM	Shared Decision Making
RAS	Readability Analyser System
POS	Part of Speech
WECAn	Word Extractor for Chinese Analysis
CKIP	Chinese Knowledge and Information Processing
SVM	Support Vector Machine
NGO	Non-Government Organisation

1. CHAPTER ONE: INTRODUCTION

1.1. Study overview

The population in Taiwan is aging rapidly and the incidence of hearing loss increases with age (Lam Yinwei et al., 2016). People with hearing loss require aural rehabilitation to help them manage the extensive impact of hearing loss in daily life. If patients participate with their audiologist in their journey of rehabilitation, better outcomes can be obtained (Pryce & Hall, 2014; Sweetow & Henderson Sabes, 2010). This further improves the relationship between patients and audiologists and is called shared decision making (Barry & Edgman-Levitan, 2012; Mahmoudi et al., 2019). Clinicians collaborate with patients and empower them to be responsible for their own health. It is undoubtedly a challenge for patients with low health literacy when they are expected to understand health-related information that is not easy to read and is unsuitable for their literacy level.

Health literacy is "the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health" (Nutbeam D,2000, p.259). Patients are often challenged with a lot of complicated information while making health decisions. It requires high health literacy skills, including the ability to search for relevant information, assess the credibility and quality of health information, analyse relative risks and benefits, comply with health instructions, interpret test results, read charts, and so on (Ratzan & Parker, 2006).

In the internet era, a large amount of health information can be obtained online, and its impact on individuals cannot be ignored. However, the credibility and accuracy of online health information is variable (Kwon et al., 2015). People may lack background knowledge to interpret online health information correctly, thus harming their health because of poor self-diagnosis and self-treatment (White & Horvitz, 2009). In addition, online health information should provide good readability and suitability, so that individuals can analyse and use

information in critical situations to gain control of their health (Nutbeam, 1999). There is insufficient literature about the readability and suitability of online hearing-related information in traditional Chinese (TC). Therefore, the aim of this study is to investigate the readability and suitability of online hearing-related material available in TC in Taiwan.

1.2. Hearing loss

1.2.1. Prevalence of hearing loss globally and in Taiwan

According to the latest update by World Health Organization (WHO), approximately 6.1% of the world's population were living with disabling hearing loss in 2018 (Organization, 2019). Disabling hearing loss defined by WHO is a hearing loss with more than 40 dB pure tone threshold average through 500, 1000, 2000 and 4000 Hz in the better ear (Olusanya et al., 2014). In Taiwan, hearing impairment accounted for the second leading cause of physical and mental disabilities in Taiwan according to statistics from the Ministry of Health and Welfare (Lan Yinwei et al., 2016). From 2000 to 2014, the prevalence of hearing impairment among men increased from 2.13‰ to 3.03‰, and the prevalence of hearing impairment among women increased from 1.31‰ to 2.22‰. Overall, the prevalence of hearing impairment in Taiwan increased significantly from 2000 to 2014. By age group, the largest increase was for those over 65. The number of people over 65 years old with hearing impairment increased from 208.52 to 345.8 per 100,000 of the population in 15 years, an increase of about 1.37‰. The age group of those over 65 was also the largest age group throughout the study period (Lan Yinwei et al.,2016).

Ageing (presbycusis) is one of the main causes of hearing impairment. A study found that every 10 years' increase in age doubled the prevalence of hearing loss (Bainbridge & Wallhagen, 2014). In 2018, 14% of Taiwan's population was over 65. It is estimated to exceed 20% by 2026 and exceed 40% by 2065 (Lu Lili, 2018). As the population of older people

increases, so does the population with hearing loss. The PSA Charitable Foundation released the latest hearing screening report for senior citizens in Taiwan and found that 40% of people over 65 years of age and nearly one in two people over the age of 75 had hearing loss (Huang Yongyao, 2018).

1.2.2. Impact of hearing loss

Hearing loss can affect different aspects of our life (Ciorba et al., 2012; Dalton et al., 2003). It can aggravate anxiety, which can develop further into sleep deprivation (Clarke et al., 2019). Hearing loss does not only affect the lives of hearing-impaired individuals but also their family members, because they are not able to communicate effectively (Wallhagen et al., 2004). A similar study conducted in Taiwan showed similar results (Hsu et al., 2016). Researchers found that patients with hearing loss have a higher risk of depression, regardless of sex, age, and comorbidities, with a risk ratio of 1.73 (Hsu et al., 2016).

The connection between hearing loss and dementia has also attracted the attention of many professionals and the public. In a survey conducted by Deal et al. (2016), 639 dementia-free adults were recruited at the beginning of the study and followed up for nearly 12 years. During this time, a total of 58 cases of dementia were found. Results showed that hearing loss is independently associated with the incidence of dementia, and the risk of developing dementia increases with the deterioration of hearing loss (Deal et al., 2017). Similar results can be found in other studies (Gurgel et al., 2014; Martini et al., 2014); however, the causality between hearing loss and dementia has not yet been confirmed (Lin et al., 2011).

Prompted by the adverse impact of hearing loss described above, Carlsson et al. (2011) conducted a study which demonstrated that aural rehabilitation can help individuals with permanent irreversible hearing loss to improve their quality of life.

1.2.3. Rehabilitation of hearing loss

A multidisciplinary approach including mental, psychological and social elements have been proven by researchers to help individuals managing the impact of hearing loss (Bishop & Eby, 2010; Carlsson et al., 2011). A hearing aid fitted appropriately can make hearing-impaired individuals hear better by amplifying sounds; however, wearing hearing aids is not the same as aural rehabilitation (Ross, 1997). Hearing aid performance can be affected by several factors such as environmental noise, and distance and direction of the sound source (Ricketts, 2000), and therefore hearing aid wearers can still struggle to hear in complex hearing situations. In addition, due to stigma, cost and management issues, not everyone with hearing impairment can use hearing aids (Erber et al., 1996). As a result, other rehabilitation tools should be added to improve the effectiveness of hearing aids (Kiessling et al., 2003; Tye-Murray et al., 2009; Liu Junrong, 2005).

Kiessling et al. (2003) classified all aural rehabilitation tools into three categories: (1) instrumentation with instruction, training and verification; (2) non-instrumentation, such as counselling, communication training, and involvement of others (significant others, self-help groups, and voluntary groups), changes in the acoustic, electromagnetic and visual environment, and changes in the social environment; (3) ancillary help, such as environmental changes to living arrangements, social and other health services. Tye-Murray et al. (2009) proposed that the aural rehabilitation for hearing-impaired adults should include provision of hearing devices, a communication strategy, informative consultation, psychosocial therapy, assertiveness training, speech perception training, and other methods.

In Taiwan, Liu Junrong (2005) also found that aural rehabilitation for older people should include provision of hearing knowledge, hearing aids, social resources, hearing care, communication and psychological adjustment strategies. In an interesting study conducted by

Habanec and Kelly-Campbell (2015), rehabilitation programmes provided a significant benefit to hearing-impaired individuals who did not even wear hearing aids. Therefore, it is important for a hearing-impaired individual to make an informed decision with the help of an audiologist about what type of intervention will be appropriate for them; this is called shared decision making (Laplante-Lévesque et al., 2010).

1.2.4. Shared decision making in aural rehabilitation

Shared decision making (Grad et al., 2017) has been shown to be effective in the health industry (Joosten et al., 2008). Pryce and Hall (2014) published a study demonstrating the advantages of shared decision making in aural rehabilitation. The researchers found that shared decision making increases a patient's awareness, decreases pressure on audiologists, and reduces chances of misdiagnosis. If a patient needs to be involved in decision making, the audiologist needs to provide access to appropriate audiological information and material for the client (Kelly-Campbell & Manchaiah, 2020).

1.3. Consumer health information

It is important for a clinician to provide sufficient information related to health for the consumer, and a clinician should be aware of the definition, scope and function of the health information.

1.3.1. Definition, scope and function of consumer health information

Consumer health information is defined as "any information that enables individuals to understand their health and make health-related decisions for themselves and their families" (Patrick and Koss,1995, p.262). Consumer health information is not just medical care information, but a wide range of information related to health and medical topics that meets the needs of the people (including patients and their families) and supports individuals in

making health decisions (Cline & Haynes, 2001). In other words, consumer health information is centred on the needs of consumers and can enhance their active participation in the medical care system (Sangl & Wolf, 1996).

The scope of consumer health information is defined differently according to the opinions of different scholars. In general, it includes all information about personal health, such as health promotion, preventive health behaviours, health hazards, diseases, medical facilities and services (Lambert & Loiselle, 2007).

Consumer health information has a multifaceted function in health promotion. At the psychological level, acquisition of consumer health information can increase the sense of control, hope, and energy, and help reduce anxiety and medical uncertainty in the patient (Brashers, 2002). At the behavioural level, it can enhance knowledge, promote attitude changes, induce incentives, provide the resources needed to change behaviours, help individuals make informed decisions, and promote healthy behaviours (Lambert & Loiselle, 2007). At the social level, it can increase awareness of health and create the social atmosphere that encourages healthy behaviours (Epp, 1986).

1.3.2. Sources of consumer health information

The sources of consumer health information can be divided into active consumption channels (i.e., interpersonal communication, printed materials, the internet) and passive consumption channels (i.e., television and radio) according to the users (Dutta-Bergman, 2004). They can also be divided into formal channels (e.g., doctors, hospitals, Ministry of Health), informal channels (e.g., families and friends) and hybrid channels (e.g., the internet) (Warner & Procaccino, 2004). Based on the method of transmission, they are categorised into interpersonal communication (transmission via people) and mediated sources (transmission via the media) (Brashers, 2002).

1.3.3. Consumer health information-seeking behaviour

Health information-seeking behaviour can be divided into two phases: the active seeking phase and passive receipt phase (Longo, 2005; Wilson, 1999). The process of actively seeking is to be aware of available information, attempt to access it, and be able to use it to make personal healthcare decisions. The process of passive reception is to receive information as a by-product of daily activities such as reading a newspaper or watching television (Longo, 2005). Social networks can affect the dissemination of information, so it may either be a contributing factor or a barrier for an individual's access to health information (Wathen & Harris, 2007). Geographical accessibility to information (Maibach et al., 2006) and personal information-seeking skills (Borgers et al., 1993) both affect health information-seeking behaviour. In other words, the individual's information-seeking behaviour is influenced by individual, interpersonal and environmental factors.

1.3.4. Accessibility of online health information globally and in Taiwan

In the past, health and medical information was in the hands of a small number of professionals. Alongside the development of information technology, the internet has become the most accessible source of information in modern life (Appleby, 1999). Because the internet is not limited by time and space, it can provide easy-to-access health information to many remote areas (Edejer, 2000). There are many ways to obtain health information on the internet, such as searching using search engines, and participating in online community discussions. Researchers reported that 77% of US online consumer health information users first searched from an online search engine (such as Google), and only 13% chose to seek health information from professional websites first (Fox & Duggan, 2013).

Pew Internet and American Life Project in their research report "Health Online 2013" pointed out that in the previous year, about 81% of the population in the United States had

access to the internet, of which 59% of the people used the internet to search for health information. In the study, 35% of adults said that they had specifically searched the internet for relevant information to determine their own or other's health status or symptoms (Fox & Duggan, 2013). The increased accessibility and availability of the internet is closely related to the wide spread of consumer health information. In Taiwan, the internet penetration rate (DiMaggio & Hargittai, 2001) of people aged 12 and over increased from 72% in 2011 and 79.7% in 2016 to 86.2% of the total population in 2019. About 18.27 million people had accessed the internet during 2019 (National Development Council, 2019). Health information was ranked fourth among the most commonly searched data types for users aged 65 and above on the internet (National Development Council, 2011). It was found that 67% of internet users had searched for health-related information, 38% had booked medical appointments online, 28% had searched for comments on doctors via the internet, and 16% had asked a doctor online for a health consultation (National Development Council, 2016). The internet has become one of the important ways for people to obtain health information in Taiwan.

1.3.5. Credibility of online health information

Because of the openness of the internet, users can freely and conveniently find, browse, and download the information they need on the internet without exposing their identities, to achieve a one-to-many or many-to-many information exchange. The internet allows anyone to set up websites and post information, but the quality of that information may vary (Boyer & Patterson, 2010).

Health On the Net (HON) is a non-profit organisation whose main mission is to improve the quality of online health information. The HON score evaluates six features of the websites: "transparency and honesty, authority, privacy and data protection, updating of information, accountability, and accessibility" (Smith et al., 2012, p. 1806). The results of the study showed

that online health information had doubtful reliability. The study further noted that the credibility provided by non-profit and academic websites is generally better, and that internet users should maintain a cautious and conservative attitude about health information on websites set up by private businesses or individuals. Similar results were found in other studies on various diseases (Jo et al., 2018; Park et al., 2012; Winship et al., 2014) both globally and in Taiwan (Yang Yijng, 2013; Pan Jiaxin et al., 2009).

1.4. Health literacy

The Ottawa Charter for The World Health Organization (1998) defines health literacy as "the cognitive and social skills which determine the motivation and ability of individuals to gain access to understand and use information in ways which promote and maintain good health" (Nutbeam, 2000, p. 259). Nutbeam (2000) further elaborated health literacy into three levels: functional health literacy, interactive health literacy, and critical health literacy. Functional health literacy refers to the basic reading and writing skills that a person can effectively use in daily life. Interactive health literacy refers to the more advanced abilities a person possesses to actively capture useful health-related information from daily life, get inspiration in interactive communication with others, and apply new information to a changing environment. Critical health literacy is the highest level ability to analyse information critically and apply the result of the analysis properly to gain greater control over life events and situations (Nutbeam, 2000). Health promotion can effectively enhance these three levels of health literacy, and the enhancement of health literacy can have a further positive impact on the health of individuals, communities and society. Health literacy can also affect health information-seeking behaviour, determine health behaviours and ultimately affect health outcomes (Longo, 2005). Health literacy is not only a personal responsibility, but also requires cooperation between the government and the health system to ensure that health-related information is clear, correct, appropriate and accessible to healthcare users (Organization, 2017).

1.4.1. Prevalence of health literacy globally and in Taiwan

The determinants of health literacy include personal, social and environmental factors. Some groups of people tend to have lower health literacy, such as older people, people with low educational level, people with low social and economic status, ethnic minorities and immigrants (Nielsen-Bohlman et al., 2004; Paasche-Orlow et al., 2005). However, young people and highly educated people could find themselves with insufficient health literacy to deal with the problems in complicated health situations (Cha et al., 2014; Ickes & Cottrell, 2010).

According to the results of the European Health Literacy Survey (HLS-EU), 47% of the total respondents had insufficient and problematic health literacy (Sørensen et al., 2015). In Taiwan, a national survey was conducted in 2008. The results showed that 30% of the respondents had low health literacy (Lee et al., 2010). This figure rose to 50% in a recent study in Taiwan (Wei Mixiu et al., 2017). Healthcare providers should be more aware of the high prevalence of low health literacy while making and using health information materials.

1.4.2. Impact of low health literacy

Low health literacy can hinder communication, understanding, interaction and trust between the public and medical staff. People with low health literacy have difficulty obtaining correct health-related information. They are less able to understand a medical diagnosis and recommendations, prone to have repeated medical treatments and hospital admissions, prone to misunderstand prescriptions and misuse medication, and susceptible to more emergency medical treatments (Sørensen et al., 2012). Studies found that people with low health literacy had insufficient health-related knowledge. Instead of positive health behaviours (e.g., regular exercise), they may have more adverse health behaviours (e.g., smoking and drinking) and poor disease management (Berkman et al., 2011; Osborn et al., 2011). Adverse health behaviours

lead to poor health status, poor treatment outcomes, and higher morbidity rate. (Berkman et al., 2011; DeWalt et al., 2004). People with low health literacy are less able to understand drug labels and take medicine correctly. They also have lower influenza vaccination coverage, lower cancer screening rate, and higher probability of hospitalisation and emergency department use, which, unsurprisingly result in increased medical costs (Berkman et al., 2011).

People with low health literacy are more passive in seeking health information (Ledford et al., 2015), and less able to express their ideas and collaborate with their doctors in the shared decision-making (SDM) process. They show less interest in participation and prefer to let the doctor make decisions (Smith et al., 2009). They also have poorer self-care skills (Berkman et al., 2011). The effect of low health literacy will further widen health inequality due to poorer health outcomes, less use of preventive health services and poorer doctor–patient communication (Berkman et al., 2011).

1.5. Readability

Studies have shown that medical information materials are often not fully understood by readers, especially those with low health literacy. Possible reasons include the content of the materials being too profound, with many technical terms not being explained; too much information covered by the content; and not being designed for the reader's health literacy level. These obstacles will affect the patient's degree of understanding and cooperation (Kerka, 2000). Therefore, it is important to evaluate and improve the readability of health information materials.

1.5.1. Definition

Successful reading comprehension is the result of a good interaction between readers and their reading materials. Readability refers to the degree to which reading materials can be understood by readers (Ley & Florio, 1996). If the reading materials have high readability, the

readers will have a better understanding, as well as better learning and better learning retention (Klare, 2000). Reading comprehension can be affected by factors relating to both the text and the reader. When it comes to the enhancement of reading comprehension, it is easier achieve this by working on text factors rather than reader factors.

1.5.2. Readability formula for English language

Reading materials with good readability were found to have certain text features in common. They are mostly written with common words that have clear meanings instead of technical terminologies. The sentence structure is simple, containing fewer pronouns and compound words. For example, the content conforms to readers' prior knowledge, appropriately restates the previous paragraphs, provides relevant information and reduces irrelevant, interferential content (Klare, 2000). Based on these findings, researchers attempted to evaluate text difficulty in a scientific way, and so they developed readability formulas. A readability formula is a mathematical formula to predict the reading difficulty of a piece of text by analysing text-related variables. Most readability formulas generate numbers called readability grade levels (RGLs).

Since the 1920s and until now, there have been more than 200 readability formulas created for evaluating text readability in English (Gunning, 2003), and its research and research methods are constantly being developed and improved. Most readability formulas for English texts consist of textual variables such as sentence length (i.e., the average number of words in a sentence), the number of words, sentences and syllables, and the proportion of difficult words (Hiebert, 2002).

Readability formulas have been applied in many fields. The United States started using readability formulas to evaluate and grade textbooks in the 1970s. Today, textbooks in all fields are required to match the semantic and syntactic parameters of certain readability formulas

(Hiebert, 2002). Some readability formulas were specially created for specific domains, such as insurance regulations and contract texts (Pearson et al., 2016).

The readability formulas that are often used in healthcare include Gunning Frequency of Gobbledygook (FOG), Flesch Reading Ease Score (FRES), Simple Measure of Gobbledygook (SMOG), and Flesch–Kincaid Grade Level (FKGL) (Boztas et al., 2017). The US Department of Health and Human Services (USDHHS) recommends that the readability level for consumer health-related materials should not be over 6 (Dobbs et al., 2017). However, much online health information was reported with RGLs exceeding the recommended grade level (Dobbs et al., 2017; Patel et al., 2013; Patel et al., 2015; Svider et al., 2013).

1.5.3. Readability formula for TC language

Compared with the vigorous development of English readability research, TC readability research is relatively rare. Due to the fundamental difference in language characteristics between TC and English, the findings of the previous research for readability formulas for the English language are not necessarily suitable for TC. Finding the textual features that can affect the readability of TC texts is the key to developing readability formulas for TC. This section will discuss the language characteristics of TC that might affect readability, and the development of readability formulas for the TC language to date.

Chinese characters are logographs used to record spoken Chinese, (Sampson, 1994). Chinese characters can be broken down into strokes, radicals and parts and can be used alone or/and combined with one another to form words. Words are strung together to construct sentences. There are no inter-word spaces in sentences.

a. Stroke

The simple strokes of Chinese characters can be divided into six types: horizontal (一), vertical (丨), dot (丶), upward horizontal (𠂉), throw (丿), and press (乀). The number of strokes refers to the total number of strokes that make up a character. The smallest number of strokes of a Chinese character is one, and the largest is fifty-two. The average number of strokes of the most commonly used characters is eleven to twelve (Jin et al., 2011). The number of strokes is related to recognition of Chinese characters, especially when the reading time is limited. The smaller number of strokes, the better the recognition (Ogawa & Taniguchi, 1979).

b. Radicals and Parts

Radicals and parts are the fundamental writing components of Chinese characters. Radicals are used to categorise characters in the dictionary. For example, “口” (mouth) is a radical. Characters like “吃” (eat)、” 唱” (sing)、” 吹” (blow) share the same radical of” 口”, so they belong to the same category. Understanding the radicals not only helps look up the Chinese dictionary, but also enhances the understanding of the meaning of characters (Li & Zhou, 2007; Taft & Chung, 1999). As the example mentioned above has shown, characters which have the radical of “口” (mouth) mostly means actions related to mouth. There are 214 radicals in TC dictionaries published in Taiwan (Cheng & Hsu, 1991).

A Part is composed of strokes and several parts are combined to form a Chinese character. For example, the character "碧" is composed of three parts"王", "白" and "石". Some parts are radicals, and some are not. While radicals can provide semantic cues, parts can often provide clues to the pronunciation of characters (Taft & Chung, 1999). For example, “請”

(please; pronounced /qǐng/) and “情” (emotion; pronounced /qíng/) share the same part of “青” (green; pronounced /qing/) and are pronounced similarly.

c. Structure

Structure refers to the relative spatial position of parts in a Chinese character (Dai et al., 2007). For example, some characters are composed of upper and lower parts, such as "字" and "思”, while some characters are composed of left and right parts, such as “江” and “信”. Yu et al. (1990) studied recognition of TC character and found that the reaction time of the subjects in recognising the structure was shorter than the reaction time of recognising parts. This is to say, readers might recognise characters by their structure rather than their parts while reading (Yu et al., 1990).

d. Word

A word is the smallest meaningful unit that can be used independently when making a sentence. Most Chinese characters have a meaning in themselves but only some of them can be used alone, such as "天" (sky) and "地" (land). These characters are equivalent to words (Fang, 1997). On the other hand, some other characters have their own relatively ambiguous meanings, and they often combine with other characters to express a more specific meaning. Therefore, they are not words but morphemes (Fang, 1997). For example, "危險” (danger) is a word, and "危" (uncertain, danger, close, etc.) and "險" (risk, danger, sharp, etc.) are morphemes. On the other hand, there are a few Chinese characters that have no meaning in themselves, and only make words when they appear in a set, such as “葡萄” (grapes) and “蜻蜓” (dragonfly). The characters “葡”, “萄”, “蜻”, “蜓” are phonemes to provide sounds to

words. In addition, there are no morphological changes in Chinese words. For example, the verb does not change its form due to the change of the gender of subject. For example, “去” (go) in “我去” (I go) and “他去” (he goes) is the same.

The total number of Chinese characters is at least 100,000, but the frequently used ones are less than 5% of these. According to the report published in 2000, there are 5,021 Chinese characters and 46,666 words frequently used by primary school students in Taiwan (Ministry of Education, 2000). While reading a Chinese text containing words that are used more frequently, a reader will take less time than if the text contained words that are used less frequently. Some words are frequently used on their own so are fast to read and understand, but might appear less frequently when used in combinations of multiple characters. This difference in frequency of use can make it difficult to read Chinese text. It can be possibly due to assessment of most frequently used word as a single entity and least frequently used as a composition of multiple characters which can make it more difficult to read. It further means that the frequency can change the ease of reading of a word in a Chinese text.

e. Sentence

Blank spaces are used to mark the boundaries of words in English sentences, so that each word can be quickly identified. However, that is not the case in Chinese sentences. Because of the lack of inter-word spaces, readers must perform word segmentation when reading Chinese texts (Foo & Li, 2004). Researchers found that the readers’ word segmentation processing for the same sentence were flexible (Liu et al., 2013). For example, there are two ways to do word segmentation in the sentence "花生長得很快". One is "花 生長 得 很 快" (Flowers grow fast) and the other is "花生 長 得 很 快" (Peanuts grow fast). Word segmentation error results in completely incorrect comprehension of sentences. Even though the complex structure of

characters was believed to be the main obstacles to learning TC, Hong Lan et al. (1993) suggested that word segmentation was the main problem for Taiwanese school children in reading and understanding TC texts (Hong et al., 1993).

1.5.4. Traditional versus Simplified Chinese

TC is currently used only in Taiwan and Hong Kong, while simplified Chinese is used in other Chinese-speaking regions. The difference between these two written systems is mainly at the character level. The purpose of Chinese character simplification is to achieve the goal of easy learning and writing by reducing the strokes and the number of Chinese characters. Simplification brings up mainly two issues in reading for TC users.

Firstly, although many simplified Chinese characters are similar in shape to TC characters, the parts or radicals are changed; for example, "**獎**"(award) is simplified to "**奖**". Radicals and parts often carry semantic and phonetic cues and once they are changed, the difficulty in understanding increases (Fu Wei, 2007). Some simplified characters have few similarities to their traditional counterparts. For example, "**蘿蔔**" (radish) is simplified to "**萝卜**", and "**樹叢**" (bush) to "**树丛**". It is difficult for TC readers to recognise those simplified characters especially when they come without a clear context.

Secondly, one simplified character often corresponds to multiple traditional characters. For example, the traditional characters of "**臺**", "**台**", "**檯**", "**枱**", "**颱**" are all replaced by "**台**" in the simplified Chinese system. Because the correspondence is not on a one-to-one basis, it is hard for any computer program to transform words from simplified Chinese to TC without manual correction. Considering the readability formulas for the Chinese language often consider the character-level features such as the number of strokes, the reliability of the results

might be compromised if a TC-specified readability formula is used to analyse simplified Chinese texts and therefore this study excludes webpages written in simplified Chinese.

1.5.5. Differences between TC in Taiwan and in Hong Kong

TC in Hong Kong takes the written form of TC characters, and the basic words and sentence structure is consistent with the TC used in Taiwan. Although there is a similarity of more than 50%, the main difference between TC in Taiwan and in Hong Kong is that the latter is deeply influenced by Cantonese and English (Shao & Shi, 2006). The influence of the local spoken dialect and English from the colonisation is systemically imposed on every aspect of TC in Hong Kong including vocabulary, grammar, pragmatics, and so on. As a result, it is not appropriate to use the readability formula based on the model trained by the TC textbooks published in Taiwan to analyse the TC texts published in Hong Kong.

1.5.6. Development of TC readability formula

In 1971, Yang developed the first TC readability formula using regression analysis (Yang, 1971). Regression analysis was used to determine the influence of the variables. As a result, the Yang formula includes variables such as the percentage of the characters having more than ten strokes, the average sentence length and the percentage of difficult words. According to this formula, the more common the words and the shorter the sentences are, the easier it is to read, and the higher the average number of strokes, the harder it is to read (Yang, 1971). In 1995, Jing used sentence length, text length, and common word ratios as predictive variables and developed readability formulas in TC based on the grade levels of textbooks edited by the National Institute for Compilation and Translation in Taiwan (Jing, 1995). Recently, Sung et al. (2016) published a Chinese text analysis tool, CRIE (the Chinese Readability Index Explorer). CRIE focuses on the cohesion and coherence of TC texts, and the

text variables that can be analysed include part-of-speech, word frequency, cohesion, word information, conjunctions, sentence structure, and so on. In addition, CRIE uses a model built by support vector machines (SVM) to estimate the appropriate grade levels of texts (Sung et al., 2016). The details of the CRIE formula are further explained in Chapter 2.

1.5.7. Research on readability for online hearing health information in TC

Only one study has assessed the readability for online hearing health information in TC by using the formulae of Jing (Jing.,1995) and CRIE 1.0 (Sung et al., 2016) (Hsu & Kelly-Campbell, 2020). In this study, the five most commonly used keywords to search online hearing-related information were identified by recruiting 39 participants who did not have any hearing background. The information obtained by using these keywords on the Google Taiwan and Hong Kong sites was assessed to calculate the readability. The results showed that CRIE 1.0 gave lower readability scores than the Jing formula on the same website, and therefore it is difficult to comment on the readability levels of the information available on the internet in TC. In addition, no significant difference in the readability level was found in the websites of different types of organisations.

1.6. Suitability

Initial research aimed to improve the readability of health information materials to strengthen the general public's health knowledge and promote healthy behaviours (Jacobson et al., 1999). However, studies have shown that the improvement of readability alone did not improve the health outcomes of patients with low health literacy (Isaacman et al., 1992). Therefore, C Doak et al (1996) suggested that health information materials should take into account other factors besides readability, such as layout, text design, and content (Doak et al., 1996). A standardised tool is required for evaluating the suitability of existing health

information materials and for those in the process of developing health care materials for readers with low health literacy (Doak et al., 1996; Weintraub et al., 2004).

1.6.1. Suitability assessment tool

In addition to readability analysis, the Suitability Assessment of Materials (SAM) was developed and widely used in research on the development of health education tools for patients with low health literacy (Doak et al., 1996).

The evaluation of suitability is not only required for readability. SAM includes a total of six topics: content, literacy demand, graphics, layout, learning stimulation and motivation, and cultural relevance. A total of 22 items are scored. Each item is scored according to the instructions, with a score of 2 for “superior”, a score of 1 for "adequate" and a score of 0 for "not suitable". If the item is not suitable for evaluation, it will be marked as "non-applicable". The degree of suitability is determined by a percentage of the scores. The highest possible score of the total applicable items is used as the denominator (X), and the total score obtained is the numerator (Y). The higher the percentage, the more the suitability. Superior material is 70–100%, adequate material is 40–69%, and unsuitable material is 0–39% (Doak et al., 1996).

The online health-related information that has been analysed by SAM includes that for cancer screening, cancer care, chronic diseases, and so on. Results showed that much health information material was not suitable for readers with low health literacy (Rhee et al., 2013; Sadeghi et al., 2019; Tian et al., 2014). One study analysed the readability and suitability of 12 web pages regarding colorectal cancer screening. The results showed that 10 web pages had RGLs higher than sixth grade. Only one had superior suitability, and three were not suitable (Tian et al., 2014). Another study evaluated the readability and suitability of printed and web-based materials about rheumatic diseases and found that only five out of 23 study materials were of superior suitability, with an average readability above 6th RGL (Rhee et al., 2013).

From past studies, it has been shown that healthcare materials are still generally unsuitable. Low health literacy may become an obstacle to the acquisition of information and thus affect health outcomes.

1.6.2. SAM in TC

The TC version of SAM has been translated and validated by Taiwanese researchers (Chang et al., 2014). The details of this tool are elaborated in Chapter 2. However, there is limited research on the suitability of health information materials using the TC version of SAM. One study assessed the suitability of written paediatric healthcare educational materials using the TC version of SAM in Taiwan. The results showed that one third of the study materials were not suitable. It was also found that existing health-related materials did not provide a review of the content, and they lacked appropriate layout and learning stimulation. Terminologies and jargon were used frequently (Zhang et al., 2015). The study suggested that it is necessary to strengthen the ability of healthcare providers to design health information materials that are easy to read and understand.

1.7. Study rationale

Due to availability of limited research available on the readability and suitability of online hearing health information in TC and considering the increased burden of hearing loss and the high prevalence of low health literacy in Taiwan, this issue should be addressed immediately. The rationale for this study is to address this issue and try to fill in the gaps in the literature.

1.8. Aims and hypothesis

The aim of this study is to answer the research questions listed below.

1. What is the readability of online hearing-related web pages written in TC in Taiwan?

2. What is the suitability of online hearing-related web pages written in TC in Taiwan?

The planned alternative (research) hypotheses are:

***Hypothesis 1*:** The mean RGL of selected web pages calculated by the CRIE formula is not significantly different from 6.

***Hypothesis 2*:** The mean RGLs of selected web pages on profit and non-profit websites are not significantly different from each other.

***Hypothesis 3*:** The SAM rating has no significant relationship with the mean RGL for the selected web pages.

***Hypothesis 4*:** The SAM ratings of the selected web pages on profit and non-profit websites are not significantly different from each other.

2. CHAPTER TWO: MATERIALS AND METHODS

2.1. Identification of keywords

This study continued Hsu & Kelly-Campbell's study (2020) in which he enrolled 39 participants to identify keywords that are most commonly used to search for hearing health information via the internet. These participants did not have a hearing background and were native Mandarin Chinese speakers. In this study, I used five keywords identified in Hsu & Kelly-Campbell's study (2020): 耳朵 (ear), 聽力(hearing), 助聽器 (hearing aids), 重聽 (hard of hearing), and 聽不清楚 (can't hear properly) (Hsu & Kelly-Campbell, 2020).

2.2. Hardware and software setup

The study was carried out on a 13-inch Windows laptop with Windows 10 operation system. Goole Chrome (version 84.0.4147.89) was the web browser used in this study. An extension application of Google Chrome named Fonts Ninja was installed to collect the information of font styles and sizes on websites.

2.3. Population and sample

The research materials for this study were derived from the internet, and the search for hearing-related online information was conducted in a way that simulated how people use the internet to search for health information.

Search engines are the simplest and most popular tools used by the public to navigate the internet compared to others. According to the data retrieved from Stat Counter Global Stats, Google was the main search engines used by most internet users in Taiwan, accounting for 92.84% of total usage between June 2019 and June 2020. Therefore, this study used Google TW (google.com.tw) to search for the relevant webpages.

Search keywords identified in Hsu & Kelly-Campbell's study (2020) were again adopted, which were: 耳朵 (ear), 聽力(hearing), 助聽器 (hearing aids), 重聽 (hard of hearing), and 聽不清楚 (can't hear properly) (Hsu & Kelly-Campbell, 2020). These five keywords were entered the Google TW search engine to find webpages of interest on 12 June 2020.

It has been shown that the first nine search engine results draw most attention from internet users (Eysenbach & Köhler, 2002) and this study therefore only included the top 10 results returned from each keyword search. A total of 50 webpages were assessed and then screened out against the following exclusion criteria: if (1) they were videos only, (2) they were photos only, (3) they were directory lists, (4) the content had less than 100 words, (5) the content was irrelevant to hearing or hearing impairment or the relevant content was too small (less than 100 words), (6) the target audience was not the general public in Taiwan, (7) they were not written in TC, and (8) the content was identical to another.

This study analysed the whole content under the main topic of each webpage, including those under the links. However, if the link led to a different URL, its content was not included in the analysis.

2.4. Assessment tools

CRIE (Chinese Readability Index Explorer) 3.0 was used to do computational analysis and calculation of RGLs, and the SAM-TC version was used for assessing suitability in this study.

2.4.1. CRIE 3.0

In Hsu & Kelly-Campbell's study (2020), two readability formulas, Jing and CRIE, were used to assess the readability of online hearing-related health information in TC. In this study, only one readability formula was required to conduct both readability and suitability

assessment. Ideally, the Jing formula should have been chosen because it was used to calculate RGLs in the previous study which translated and validated the SAM-Chinese version (Chang et al., 2014). However, the Readability Analyzer System (RAS), which is the online readability software based on the Jing formula, was broken during the study period and CRIE was therefore substituted.

CRIE is a computational text analysis system that can automatically analyse multiple textual features. CRIE's model includes three parts: text pre-processing, SVM model training, and readability formula (Sung et al., 2016). In the stage of pre-processing, a text is broken down into words and each word's part-of-speech (POS) is recognised and labelled by the Word Extractor for Chinese Analysis (WECAn) program. WECAn identifies words in a string of characters by matching them with 11.68 million TC words derived from four corpora: Sinica Balanced Corpus 4.0, Sinica Treebank 3.1, Chinese Knowledge and Information Processing (CKIP) group's Chinese Electronic Dictionary and Gigaword (Chang et al., 2012; Sung et al., 2016). POS tagging can be done and further optimised by WECAn when a word is labelled with more than one POS by analysing its association with adjacent words. POS-tagged words thereafter undergo sentence parsing using HanParser program. HanParser can analyse the grammatical relationship between words to evaluate syntactic complexity (Chang & Sung, 2019; Sung et al., 2016).

As for readability prediction, CRIE uses support vector machine (SVM) to build models to estimate RGLs (Sung et al., 2016; Sung, Chen, et al., 2015). SVM is an artificial intelligence learner that can memorise the relationship between textual features and the grade level of text. Texts derived from the textbooks of Grades 1 to 9 in Taiwan were segmented and parsed and their identified textual features were entered into SVM for model training (Sung et al., 2016). After the model training was completed, the SVM can predict the grade level of any text based on the trained model. Because the SVM model can map linear inseparable data to multi-

dimensional space, it has better accuracy in data classification (Sung et al., 2016). The SMV model of CRIE has been updated to the third version (CRIE 3.0) in 2019. The link to access CRIE 3.0 is http://www.chinesereadability.net/CRIE/index.aspx?LANG=CHT.

The readability formula proposed by CRIE is:

The RGL of the text = 4.53 + 0.01 × [difficult words] − 0.86 × [simple sentence ratio] − 1.45 × [content word frequency in logarithmic] + 0.02 × [personal pronouns]

CRIE could not generate RGLs directly but yielded the score of each textual feature. Four essential textual features in the CRIE formula are described in detail below:

(a) Difficult Words: The number of words that are not in the commonly used word list. A word frequency list was developed for CKIP corpora and the top 3,000 words on it were used to create a commonly used word list. Words that do not exist in the commonly used word list are regarded as the difficult words. It is usually difficult for readers to read articles with more difficult words.

(b) Simple Sentence Ratio: Calculates the proportion of simple sentences in the article. Sentences can be divided into simple and complex sentences in structure. A simple sentence is an independent unit of expression composed of a subject and a predicate. A complex sentence is composed of two or more single sentences. The higher the simple sentence ratio in the text, the simpler the structure.

(c) Logarithm of Content Word frequency: Calculates the frequency of the content words of the text in the entire data set, take the logarithm and then average it.

Content words include nouns, verbs, adjectives, adverbs, quantifiers, pronouns, and so on. The greater the number of content words in a text, the higher the amount of information it

contains. A high logarithmic average of the content word frequency usually indicates a higher difficulty of reading.

(d) Personal Pronouns: The number of personal pronouns in a text.

The Grammatical Categories of Chinese (CKIP, 1993) was used to designate personal pronouns such as *he, she, it, we, they, me, him, her, us* and *them*.

2.4.2. The Suitability Assessment of Materials –TC

The evaluation of the suitability of hearing-related TC online information was conducted using SAM-TC. SAM-TC was a translated TC version of SAM and verified by Chang et al. (2014). The aim of using SAM-TC is to systematically assess in a short period of time the suitability of TC health information materials designed specifically for the targeted audience (Chang et al., 2014; Doak et al., 1996). SAM-TC takes account of 22 factors addressing six key elements of information materials in terms of suitability: (1) content, (2) literacy demand, (3) graphics, (4) layout and type, (5) learning stimulation and motivation, and (6) cultural appropriateness. The factors of each element are listed and explained below (Doak et al., 1996):

(1) **Content** (Doak et al.,1996)

(a) Purpose: The title, cover photo or introduction should directly point out the purpose of the material so that it can immediately attract the reader's attention.

(b) Content topics: The content should focus on readers' behaviours to solve their immediate health problems rather than just provide medical facts.

(c) Scope: The content should be able to be read within the time allowed, and the scope of the content should be closely related to the goal of the material.

(d) Summary and review: There should be a review and a summary using different words or examples to emphasise the key points at the end.

(2) **Literacy demand** (Doak et al.,1996)

(a) Reading grade level: Material with an RGL of Grade 5 or below is superior, Grades 6 to 8 are average, Grade 9 or above is unsuitable.

(b) Writing style: Materials should be written in an active voice instead of passive voice. Sentences should not be too long and too esoteric.

(c) Vocabulary: The more common words are used, the better the readability.

(d) In sentence construction, the context is given before new information: The context needs to be provided first followed by new facts/information to make it easy to learn and remember.

(e) Learning enhancement by advance organisers (road signs): There should be an advance organiser like a header between the paragraphs to connect the preceding and the following paragraphs to enhance the reader's learning.

(3) **Graphics** (Doak et al., 1996)

(a) Cover graphic: The cover graphic provides the first impression for readers to judge whether to read the content. The cover graphic should clearly state the purpose of the material.

(b) Type of illustrations: Sketches of simple lines are better than photos. Illustrations should be familiar to targeted readers.

(c) Relevance of illustrations: Irrelevant patterns or colours in the background will distract the reader's attention. Illustrations should emphasise only key points.

(d) Graphics includes lists, tables, graphs, charts and geometric forms: A thorough explanation should be given to each graphic presented on the material.

(e) Captions are used to explain graphics: Each graphic must have a caption.

(4) **Layout and Type** (Doak et al., 1996)

(a) Layout: The illustration and the content should be on the same page. The sequence of information should be consistent and predictable to make the reading easier. Visual cues such as arrows, shadows, frames, and so on, can be applied to facilitate reading. Appropriate blank spaces prevent the content from being too cluttered. The use of colour should not be distracting and should be understood without extra explanation. Black text on white matt or low-gloss paper is the most comfortable combination for reading (Doak et al., 1996). A value of 15–30 characters per line is recommended for information materials written in TC (Chang et al., 2014).

(b) Typography: There should not be more than 6 different types and sizes of fonts on one page. The font size should be at least 12 pt. It is easy to identify characters, numbers or other symbols using a serif font. Ming style is the most commonly used serif font in TC. A sans-serif font is more attractive but less readable than a serif font and is often used for titles or headings (Chang et al., 2014). Round black font is the most commonly used sans-serif font in TC (Chang et al., 2014).

(c) Subheadings or "chunking": Most people cannot usually remember more than five items under a heading. Subheadings should be used to partition a long list of items (Doak et al., 1996).

(5) **Learning stimulation and motivation** (Doak et al., 1996)

(a) Interaction included in text and/or graphic: When thinking about questions, it will help strengthen long-term memory retention. The material should therefore include some questions to prompt readers to solve problems and make choices in a timely manner. Interaction with readers can stimulate the reader's motivation to learn new information (Doak et al., 1996).

(b) Desired behaviour patterns are modelled and shown in specific terms: It is easier for readers to learn through real-life examples than via reading or being informed of medical factors (Doak et al., 1996). For example, giving cooking recipes with weight control instructions is better than listing the nutritional components of food.

(c) Motivation: When the information given is perceived as doable, readers are motivated to learn. The content of care guidance should therefore be divided into several small sections to give readers a sense of accomplishment (Doak et al., 1996).

(6) **Cultural appropriateness** (Doak et al., 1996)

(a) Cultural match: Logic, language, experience (LLE): Logical thinking, reader's language and experience should be considered (Doak et al., 1996). For example, the food suggested in the nutrition care guidance should be consistent with the food the readers often eat in their daily lives.

(b) Cultural image and examples: The content presents a positive cultural impression and must not discriminate against any culture. The cultural appropriateness can be judged from the illustrations, photos, examples, and titles used in the material (Doak et al., 1996; Weintraub et al., 2004).

2.5. Procedure

After selection of samples and assessment tools, the study proceeded following the steps below.

2.5.1. Website classification

Website classification was done to compare the readability and suitability of the webpages from different organisations. According to Hsu & Kelly-Campbell (2020), the classification of websites was based on the identity of the website owner provided by the

contact information on the webpage. This study adopted the same method for website classification and divided websites into two categories: non-profit websites (e.g., government organisations, academic and educational organisations, hospitals, NGOs, Wikipedia, charity foundations) (Rush & Tracy, 2010; Wu&Lu, 2002; Chen et al., 2014) and profit websites (e.g., private companies, private clinics, and others not in the previous category). Apart from judging by the identity of the website owner, the last part of domain names such as .gov, .org,.edu, blog, and so on can also assist in website classification.

2.5.2. Inter-rater reliability test

Before the suitability analysis of the study webpages, an inter-rater reliability test was carried out using random webpages related to hearing and hearing impairment in TC to confirm that there was a mutual agreement in scoring between the author and the other researcher. The author and the fellow researcher were both master's students in audiology to whom TC is the native language.

2.5.3. Calculation of RGLs

An Excel spreadsheet was set up to calculate RGLs using the CRIE readability formula. The text content of the webpage was copied and pasted into Microsoft Word first for archiving and all archived documents were being compressed into a zip file to be further processed by CRIE 3.0. CRIE 3.0 was accessed at https://tinyurl.com/y2ut3cyn. User registration is needed before going on text analysis. CRIE 3.0 is composed of three parts, CRIE, CRIE-CFL, and CRIE-DK and each of them is designed for different types of text. Because this study analysed texts written for native TC readers, CRIE was chosen after logging in. In the next step, four essential textual features were ticked out of a total of 30 features that CRIE can analyse. After

uploading the zip file, CRIE yielded the result of the text analysis based on the features previously selected. Finally, the result was entered into the Excel sheet to generate the RGLs.

2.5.4. Calculation of SAM-TC percentage score (SAM-TC %)

The author first read through the whole webpage, including the graphics and captions and scored the webpage against 22 factors in SAM-TC based on the evaluation criteria. A score of 2 = superior, 1 = adequate, and 0 = unsuitable was given. If a factor does not exist for evaluation, it is marked as non-applicable (N/A). A total SAM-TC score is obtained by adding up the scores of each factor. A total possible score is 44 deducting the number of non-applicable factors multiplied by 2. The SAM-TC percentage score (SAM-TC %) is the result of a total SAM-TC score divided by a total possible score. The rating of suitability is defined by SAM-TC %: 70–100% is superior, 40–69% is adequate, and 0–39% is unsuitable. The calculation of total SAM-TC score was done by EXCEL, while total possible score and SAM-TC % was done manually by the author.

2.5.5. Planned statistical analysis

The data achieved by the process described was used to run planned statistical tests using IBM SPSS 22 statistics software. Two scale variables (RGL, SAM %) and one nominal variable (Type of organisation) were entered in the data file. Descriptive analysis was run first to check the distribution of data. The planned statistical analysis is shown in Table 2-1.

Table 2-1 Planned statistical analysis

ID	Hypothesis	Statistics
1	The mean RGL of selected web pages calculated by the CRIE formula is not significantly different from 6	Descriptive analysis, One - sample *t* test/One -sample Wilcoxon Signed Rank test
2	The mean RGLs of selected web pages on profit and non-profit websites are not significantly different from each other	Descriptive analysis, Independent sample *t* test/ Mann- Whitney U test
3	The SAM rating has no significant relationship with the mean RGL for the selected web pages	Descriptive analysis, correlations test/Spearman's rho
4	The SAM ratings of the selected web pages on profit and non-profit websites are not significantly different from each other	Descriptive analysis, Independent sample *t* test/ Mann- Whitney U test

3. CHAPTER THREE: RESULTS

3.1. Overview

This chapter describes (1) the sample characteristics, (2) the RGLs of the research webpages and the distribution of the scores of four readability evaluation factors, and (3) the suitability rating of the research webpages and the distribution of the score of 22 SAM evaluation factors.

3.2. Basic attributes of the research webpages

A total of 37 webpages of hearing-related online information written in TC were collected via Google TW search engine. The URLs and their website classifications are shown in Table 3-1. Among the 37 webpages, 10 webpages come from non-profit organizations, and all others are provided by private companies or businesses.

Table 3-1 Basic attributes of webpages

ID	URL	Type of organisation
1	https://zh.wikipedia.org/wiki/%E8%80%B3	Non-profit
2	http://web2.ctsh.hcc.edu.tw/stu98/s9811330/public_html/w4.html	Non-profit
3	http://web2.ctsh.hcc.edu.tw/stu98/s9810836/public_html/w06.html	Non-profit
4	https://heho.com.tw/archives/44013	Profit
5	https://www.hearingsolutions.philips.com/zh-tw/hearing-loss/hearing-test	Profit
6	https://www.chfn.org.tw/publication/webpage/2/audiology_hidden	Non-profit
7	https://www.beltone.com/zh-tw/hearing-loss/types-and-causes-of-hearing-loss	Profit
8	https://www.signia.tw/hearing-and-hearing-loss/	Profit
9	https://www.signia.tw/blog/protect-your-hearing-be-aware-of-noise/	Profit
10	http://www.kmuh.org.tw/www/kmcj/data/9003/4670.htm	Non-profit
11	https://epaper.ntuh.gov.tw/health/201903/project_2.html	Non-profit
12	https://www.signia.tw/blog/guide-to-choosing-hearing-aids/	Profit
13	http://www.drhearing.com.tw/content/product/index	Profit
14	https://www.ilong-termcare.com/Webpage/Detail/1032	Profit

15	http://www.vapor.com.tw/%E8%AA%8D%E8%AD%98%E5%8A%A9%E8%81%BD%E5%99%A8/	Profit
16	https://www.best-sound.net/introduce	Profit
17	https://www.goldenday.com.tw/learn.php	Profit
18	https://www.chfn.org.tw/publication/webpage/2/hearingaids	Non-profit
19	https://www.drskyclinic.com/service-detail.php?Mid=16&cid=54&id=118	Profit
20	https://epaper.ntuh.gov.tw/health/201503/project_1.html	Non-profit
21	https://kb.commonhealth.com.tw/library/196.html	Profit
22	https://www.ilong-termcare.com/Webpage/Detail/3035	Profit
23	https://app.tzuchi.com.tw/tzuchi/Health_ContentHealth/Default.aspx?Action=ViewDetail&ContentType=2&ContentModule=16&IdentityID=120	Non-profit
24	https://health.tvbs.com.tw/medical/312754	Profit
25	https://heho.com.tw/archives/23157	Profit
26	https://www.edh.tw/object/19861	Profit
27	https://www.goldenday.com.tw/hearing_info.php?sn=124&link_class=5	Profit
28	https://www.top1health.com/Webpage/56154	Profit
29	https://heho.com.tw/archives/41397	Profit

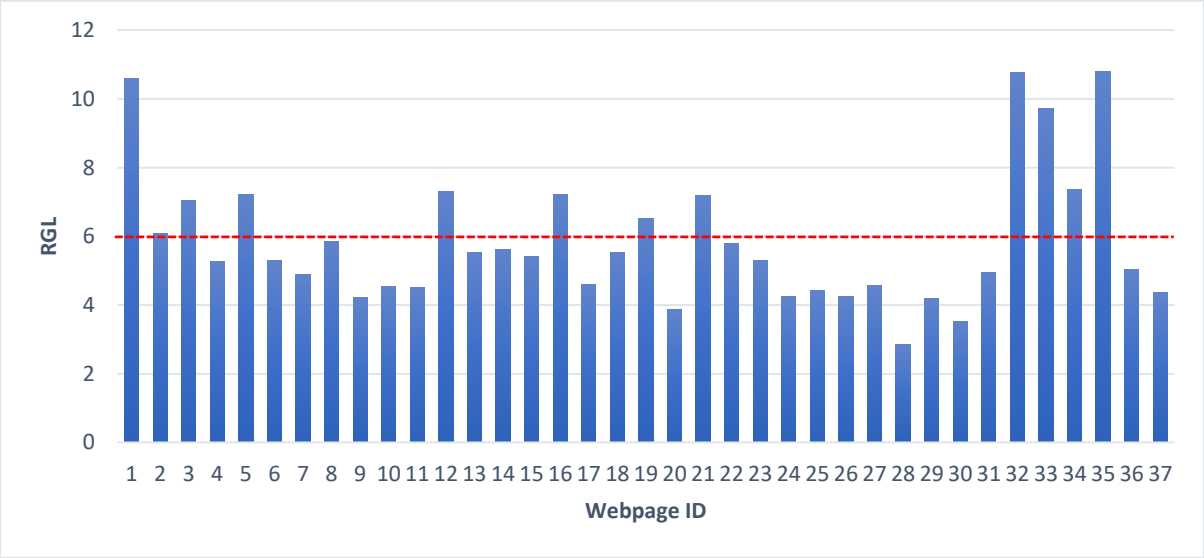
30	https://health.tvbs.com.tw/regimen/308199	Profit
31	https://ankemedia.com/2019/15244	Profit
32	https://www.thenewslens.com/webpage/93102	Profit
33	https://www.careonline.com.tw/2018/06/hearing-loss.html	Profit
34	https://gooddoctor321.com/2018/07/10/news-health-hearing-loss-test/	Profit
35	https://loveearshome.pixnet.net/blog/post/304644608	Profit
36	https://www.commonhealth.com.tw/webpage/webpage.action?nid=70762	Profit
37	http://www.youth.com.tw/db/epaper/es002001/eb2335.htm	Non-profit

3.3. The RGLs of webpages

The RGL calculated by using CRIE formula of the research webpages is shown in Figure 3-1. The minimum RGL is 2.85 and the maximum RGL is10.80.

Figure 3-1 RGL scores for 37 webpages

RGL scores for 37 webpages with webpage ID (Red line represents the recommended RGL)



There are four webpages with readability over Grade 9, three of them are from profit websites and one was from a non-profit. Descriptive analysis of the data was conducted by using SPSS software, which did not show any significant outlier and kurtosis but there was significant skewness, and therefore non- parametric analysis of data was performed.

3.3.1. Hypothesis 1

According to Hypothesis 1, the mean RGL of the selected webpages calculated by the CRIE formula is not significantly different from 6. Due to presence of significant skewness in the data, One-sample Wilcoxon Signed Rank test with normal distribution was used to analyse the data. The median RGL of the webpages was 5.3 and the test showed that the median value of RGL is not significantly different from 6: Z (37) = 253.00, p = *.137*. This means that Hypothesis 1 is retained.

3.3.2. Hypothesis 2

Due to the absence of normal distribution of data, a Mann-Whitney U test was performed to find if the mean RGL of selected webpages from profit and non-profit organisations is not significantly different from each other. The results showed that there is no significant difference between the median RGL of profit and non-profit organisations' webpages: [U = 146, Z = 146, p = .724] and Hypothesis 2 is accepted.

3.4. The suitability rating and the distribution of the scores

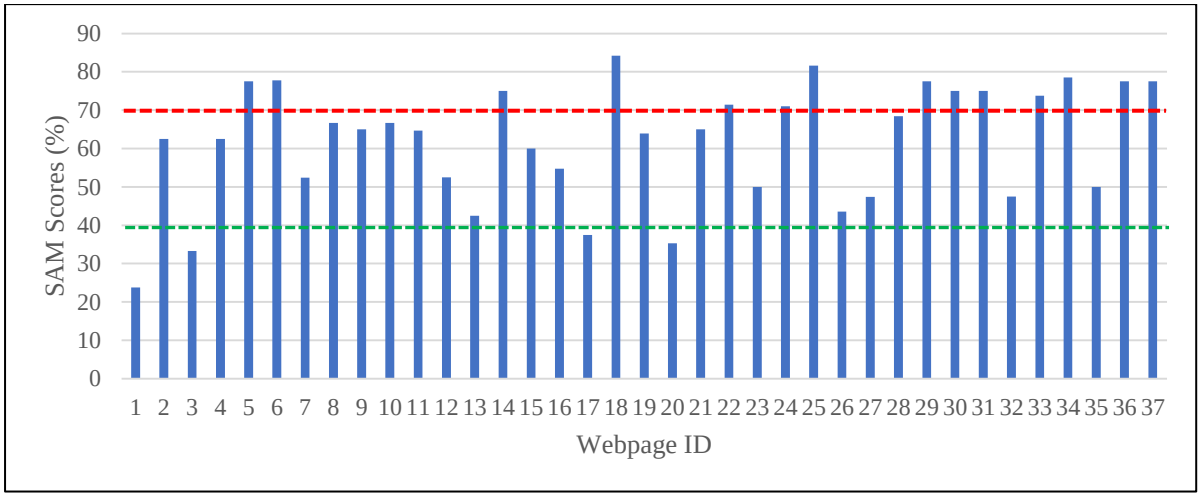
The suitability of 37 hearing-related webpages in this study was evaluated by the SAM-TC, which contains 22 evaluation factors in six categories.

3.4.1. The suitability rating of the webpages

According to the evaluation criteria of SAM-TC, those with an overall score of more than 70% are considered superior suitability; those with 40% to 69% are adequate suitability; those with less than 40% are unsuitable. The results of the SAM ratings for each research webpage are shown in Figure 3-2.

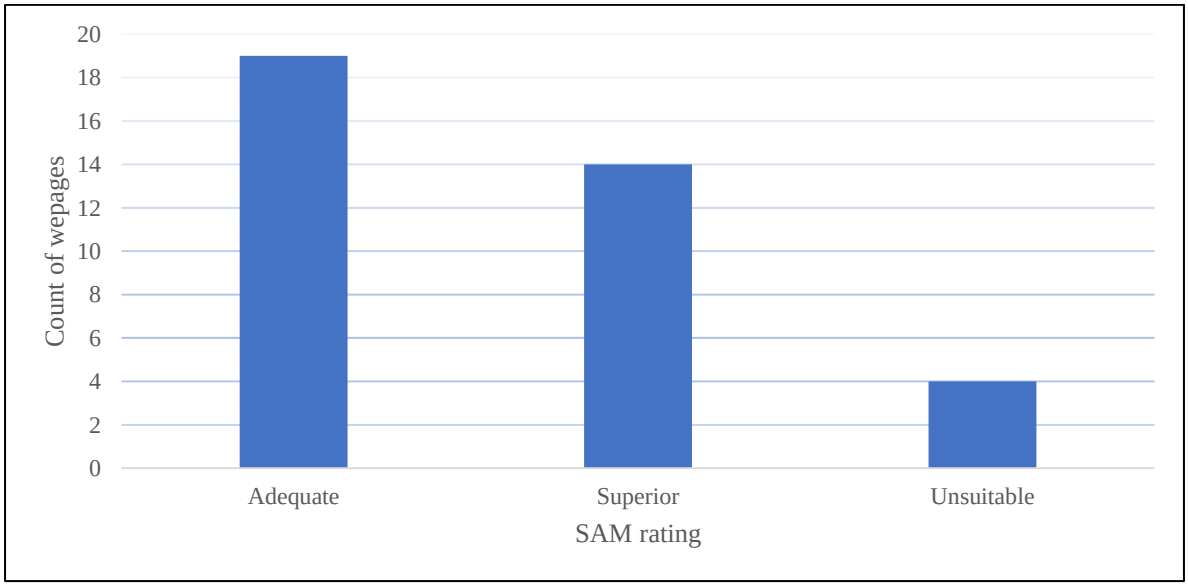
Figure 3-2 SAM scores percentages of webpages with their ID

Note. Above red line – superior, between red and green line – adequate, below green line – unsuitable)



Only 4 out of the 37 hearing-related webpages in this study were unsuitable, with scores of 23.81%, 33.33%, 37.50% and 35.29% respectively. The rest 33 of the webpages included 19 adequate and 14 superior webpages as presented in Figure 3-3.

Figure 3-3 Number of webpages by SAM rating



The frequency and percentage of SAM scores for each SAM factor is illustrated in Table 3-4. If webpages did not contain the information according to the SAM factor, then

those webpages were rated as non-applicable (N/A). Percentages were adjusted to account for non-applicable factors.

Table 3-2 Frequency and adjusted percentage of SAM scores

SAM factor	N/A	Superior		Adequate		Unsuitable	
(1) Content							
(a) Purpose	0	31	(84%)	5	(14%)	1	(3%)
(b) Content topics	0	10	(27%)	17	(46%)	10	(27%)
(c) Scope	0	33	(89%)	3	(8%)	1	(3%)
(d) Summary and review	0	8	(22%)	10	(27%)	19	(51%)
(2) Literacy Demand							
(a) Reading grade level	0	25	(68%)	8	(22%)	4	(11%)
(b) Writing style	0	11	(30%)	15	(41%)	11	(30%)
(c) Vocabulary	0	12	(32%)	21	(57%)	4	(11%)
(d) In sentence construction, the context is given before new information	0	15	(41%)	13	(35%)	9	(24%)
(e) Learning enhancement by advance organizers	0	28	(76%)	6	(16%)	3	(8%)
(3) Graphics							

(a) Cover graphic	37	N/A		N/A		N/A	
(b) Type of illustrations	7	4	(13%)	19	(63%)	7	(23%)
(c) Relevance of illustrations	0	2	(5%)	20	(54%)	15	(41%)
(d) Graphics: lists, tables, graphs, charts. Geometric forms	25	9	(75%)	2	(17%)	1	(8%)
(e) Captions are used to explain graphics	6	4	(13%)	10	(32%)	17	(55%)
(4) Layout and Typography							
(a) Layout	0	21	(57%)	15	(41%)	1	(3%)
(b) Typography	0	23	(62%)	12	(32%)	2	(5%)
(c) Subheadings or chunking	11	12	(46%)	6	(23%)	8	(31%)
(5) Learning Stimulation and Motivation							
(a) Interaction included in text and/or graphic	0	6	(16%)	15	(41%)	16	(43%)
(b) Desired behaviour patterns are modelled, shown in specific terms	0	15	(41%)	15	(41%)	7	(19%)
(c) Motivation	0	22	(59%)	10	(27%)	5	(14%)

(6) Cultural Appropriateness							
(a) Cultural match: logic, language, experience	0	22	(59%)	14	(38%)	1	(3%)
(b) Cultural image and examples	0	1	(3%)	36	(97%)	0	(0%)

3.4.2. Hypothesis 3

The correlation of readability and suitability of study samples were tested with Spearman's correlation coefficient (r_s). The results did not show a significant correlation between RGLs and SAM scores: $r_s = .190$, $p = .259$ and Hypothesis 3 is also retained.

3.4.3. Hypothesis 4

To test Hypothesis 4, a Mann-Whitney U test was performed, and the results showed that there is no significant difference in SAM rating between selected webpages of profit and non-profit organisations: [U = 156, Z = 156, $p = .489$]. Hence, data supports Hypothesis 4.

4. CHAPTER FOUR: DISCUSSION

In this study, 37 webpages of hearing-related online information were assessed for their readability and suitability. Readability is one of the 22 SAM factors, and the relationship between readability and suitability will be explored in this chapter later.

4.1. Readability of online hearing health information in TC in Taiwan

The results of this study showed that the mean RGL of online TC hearing-related health information in Taiwan measured by the CRIE formula was low. The mean RGL was below the suggested level of 6. This result was consistent with the result found in Hsu & Kelly-Campbell's pilot study published in 2020 in which CRIE was one of the readability formulas used to assess 32 hearing-related web pages written in TC (Hsu & Kelly-Campbell, 2020). However, the results of this study did not agree with the findings of previous studies that assessed the readability of online hearing-related information written in English where the mean RGLs were higher than 6 (Laplante-Lévesque et al., 2012; Laplante-Levesque & Thoren, 2015). It is risky to conclude that the hearing-related online health information written in TC is more readable than in English, considering that the validity of the CRIE formula used for assessing online health information is still in doubt. The pilot study (Hsu & Kelly-Campbell, 2020) showed that the CRIE formula generally generated lower RGLs than the other readability formula for TC language. A possible reason for the low RGLs generated by the CRIE formula was the computational errors accumulated during the word segmentation and parsing (Hsu & Kelly-Campbell, 2020).

Good readability can facilitate readers' understanding and retention of health information (Shieh & Hosei, 2008) and potentially further affect health behaviours and health outcomes in a positive way. If health information is not easily readable, readers are less likely

to understand and apply information to positively change their health behaviours. Moreover, low readability of health information can reduce self-efficacy (McMullan et al., 2018).

High prevalence of low health literacy rate in Taiwan (Lee et al., 2010) makes the results of the study more relevant. Low health literacy is observed in people with low socio-economic background or lower education levels (Hesse et al., 2005). The results of this study demonstrate that the mean RGL of online hearing health-related information is within recommended levels, which can provide benefit to individuals with low literacy.

4.2. Suitability of online hearing health information in TC in Taiwan

An overall adequate suitability was found in this study by assessing online hearing-related health information written in TC in Taiwan with the SAM tool. This finding is consistent with previous studies' results where most hearing-related webpages were rated as adequate suitability (Elmadani, 2019). Among 22 SAM factors, purpose, scope, reading grade level, learning enhancement by advance organisers, graphics, layout, typography, motivation, cultural match were overall rated as "superior". Content topics, writing style, vocabulary, sentence construction, type of illustrations, subheadings or chunking, desired behaviour patterns, and cultural image and examples were overall rated as "adequate". Summary and review, relevance of illustrations, captions used to explain graphics, and interaction included in text and/or graphic were overall rated as "unsuitable".

The suitability of research webpages assessed against six SAM elements is discussed below:

(1) Content

This study shows current hearing-related webpage content often lacks review and summary and it is important to address this problem to improve readers' understanding. The finding of this study is consistent with a previous study (Elmadani, 2019). Doak et al. (1996)

pointed out that readers often miss some key points when they are exposed to new information for the first time (Doak et al., 1996). The summary and review at the end of the content can emphasise the important information in a different way, allowing readers to review and strengthen memory and understanding.

(2) Literacy demand

RGLs generated by a readability formula can be used to predict the level of reading comprehension and play an important part in measuring suitability. There were 25 webpages (67%) in this study rated superior suitability, while only 4 webpages showed unsuitability in terms of RGL. Previous study suggests that the readability of written health information materials should be Grade 5–6 or lower (Weiss & Coyne, 1997). Although most webpages met the recommended RGL, this study found that the use of jargon in TC hearing-related webpages was still frequent, which may increase the difficulty of reading. To address this issue, Sand-Jecklin (2007) suggested that jargon and technical terms should be replaced with simple words as much as possible or explained clearly (Sand-Jecklin, 2007). Doak et al. (1996) also mentioned that using examples to explain uncommon words can help readers understand more.

As for writing style, 11 (30%) webpages used passive voice throughout the content and had more than half of the sentences composed of multiple phrases; 28 webpages (76%) were able to provide the context before new information; 34 webpages (92%) in this study used advance organisers (road signs) to strengthen readers' focus, enabling readers to know in advance what content will come next (Sand-Jecklin, 2007)

(3) Graphics

Illustrations, lists, tables or statistical graphs can simplify complex messages and make them easy to understand (Mayer & Michael Villaire, 2007). The addition of illustrations can facilitate readers' attention, memory and comprehension, especially for those with low literacy (Houts et al., 2006). However, not every webpage needs graphics. Graphics are needed only

when they can enhance readers' understanding of important information. Inappropriate use of graphics can easily distract readers (Rohret & Ferguson, 1990).

In this study, each webpage generated by a specific URL was regarded as a single sheet so that there was no cover page and cover graphic to be rated. Among the 37 webpages, only 12 webpages contain lists and tables of which the purpose was not explained, while illustrations and graphics in 17 webpages (55%) lacked captions. Only four (13%) out of 30 webpages reached superior suitability in terms of graphics, because most webpages used photos instead of line drawings or sketches. As for the relevance of illustrations, 15 (40%) webpages had confusing or technical illustrations that were not behavior related and therefore rated as unsuitable.

Inappropriate use of illustrations and graphics are often identified in many studies about the suitability of health information materials (Demir et al., 2008; Weintraub et al., 2004). Simple line drawing is a better form of illustration than photos. Photos are likely to contain unnecessary background details, which can cause confusion while reading. In addition, the use of familiar and easily recognisable images is more acceptable to readers (Doak et al., 1996; Hoffmann & Worrall, 2004; Mayer & Michael Villaire, 2007).

(4) Layout and typography

In addition to the RGL, a good design of layout and typography will make written information easier to read. Many elements are related to layout and typography including the font size and type, the blank space, the choice of colour, the use of icons, and so on. (Mayer & Michael Villaire, 2007). Among the 37 webpages in this study, 32 webpages had font sizes bigger than 12 points, and 33 webpages had more than 30 TC characters per line. The font size affects the degree of recognition of characters, and the length of a line affects the comfort and speed of reading (Hoffmann & Worrall, 2004; Mayer & Michael Villaire, 2007). It is

recommended that the Chinese characters should be at least 12 pt for adults, and 12–18 pt for elderly and child readers (Yeh Guodong, 2006). Generally, 15–30 or 20–30 TC characters in a line are recommended (Yeh Guodong, 2006).

There are eight factors to evaluate a superior layout in SAM-TC assessment. In this study, 15 webpages (40.5%) demonstrated at least three factors rated adequate, and 21 webpages demonstrated more than five factors that were rated superior. The colour of content text was mainly black except in two webpages where it was blue and gray. All webpages had white backgrounds, resulting in a good contrast between type and paper.

On the other hand, there are three factors of superior typography in the SAM-TC assessment, including font, text size, and typographic cues. The fonts of the 37 hearing-related webpages in this study are all in serif or sans-serif fonts. The fonts of the title and the content are mostly the same, but the text size and colour were often changed to distinguish them. The content text usually had a smaller type size and was in black. In total, 35 (95%) webpages obtained two or more superior factors of typography.

In the evaluation of chunking, eight out of 26 webpages had more than seven items listed without a subheading, which could be too many for readers to remember.

(5) Learning stimulation and motivation

Learning stimulus and motivation is another important evaluation factor for the suitability of health information materials. A total of 16 (43%) webpages in this study did not provide any kind of interaction with the readers, but most of the webpages (81%) were able to give learning stimulation using common words and familiar examples. Five webpages (13.5%) failed to divide the content into small units, which might cause difficulties for readers to experience small successes and be motivated to learn more (Doak et al., 1996).

(6) Cultural appropriateness

The evaluation of the cultural appropriateness is based on the use of illustrations, examples, and the narration style presented on the webpages. None of the webpages showed discrimination against certain ethnic groups, nor negative descriptions of them. The information was mostly described in a neutral way. A few illustrations showed western culture but had little effect on the understanding of the content.

Overall, this study used SAM-TC to analyse the suitability of 37 hearing-related webpages written in TC targeting Taiwanese audience, and the results showed that most of them had adequate suitability. However, the content of the webpages generally lacked a summary to lead readers to review the key points. Although the mean RGL was rated as superior, the use of jargon without explanation still occurred. Photos were commonly used on the webpages, which might not provide useful information but cause distraction. The sentences tended to be too long. The active interaction with readers that can arouse learning motivation was not often adopted on the research webpages.

4.2.1. Recommendations for improving suitability

The suitability of online hearing-related health information can be improved by fulfilling the superior suitability criteria established in the SAM tool (Caposecco et al., 2011; Ming & Kelly-Campbell, 2018). Revision of health information following best practice formatting guidelines can effectively improve readers' comprehension of information (Sakai, 2013). In order to improve the suitability of online hearing-related health information written in TC in Taiwan, some recommendations were proposed to address the SAM factors that were rated below 50 % in this study and are shown in Table 4-1.

Table 4-1 Recommendations for improving suitability of online health information

SAM factor	**Recommendations**
1. The main message is clearly displayed	The main message must be fully visible upon entering the page, without requiring the user to scroll down.
2. Interaction	It is recommended that when designing health information materials, you can ask questions and provide blank spaces for patients to fill in the correct answers, or they can circle the correct images to strengthen learning motivation and stimulation (Doak et al., 1996).
2. Modelling of behaviours	1. The content should focus on telling the target audience what they can do to protect and promote health. Readers should get at least one or more behavioural suggestions after reading the health information. 2. Health information should explain why health behaviours are needed and the results of doing and not doing them and provide enough information to assist in decision making. 3. Behavioural recommendations should include step-by-step instructions. The time, length, frequency, and so on of execution should be specified for certain practices.
3. Summary and review	The review of the key information can be a brief text description in a bulleted list or a chart, which can be emphasised by a framed text box.
4. Plain language and writing style	Health information should be presented in everyday language. Use common words instead of jargon. When there are irreplaceable

	technical terms, explain them with easy-to-understand descriptions or examples.
5. Relevance of illustrations and diagrams	1. Use images that are familiar to readers and clearly present the information related to the subject without unnecessary background details to distract attention. 2. Use simple sketches rather than photos. 3. Tables and charts should have explanatory titles, and when it is necessary, examples should be provided to make it easy for readers to understand.
6. Cultural image and examples	The content of health information should be adjusted to the region and cultural characteristics of the target audience. Use the language that the target audience is accustomed to. Avoid words, images or examples that negatively suggest specific ethnic groups.

4.3. Readability and suitability by type of organisation

No significant differences were found in the readability and suitability by type of organisation. The results do not support the results of Hsu & Kelly-Campbell's previous study (2020) where a high RGL was observed in the online hearing health-related information published by government organisations and a low RGL was observed in the online hearing health-related information published by commercial organisations. It is important to consider the small sample size of government webpages before applying the results clinically. Although there was no significant difference between the readability by type of organisation, the mean RGL for commercial webpages was higher than for government webpages, which can be explained by the requirement to make profit for commercial webpages. The webpages designed by commercial organisations mostly focus on the sale of hearing aids and discounts while the government webpages focus on the funding criteria available for hearing disabilities and cochlear implants. This study was the first study conducted to assess the suitability of online hearing health-related information in TC, and therefore the results could not be compared with other studies.

4.4. The relationship between readability and suitability

Although it was observed that as RGLs increased the SAM scores decreased in this study, the relationship between RGL and SAM score was not statistically significant. It means that health information that has good readability is not necessarily suitable for readers with low health literacy. The readability and suitability of online hearing-related health information written in TC in Taiwan should be assessed and interpreted separately.

4.5. Clinical implications

Hearing loss has been one of the most common aging-related impairments in Taiwan. Hearing rehabilitation requires clients' input of their hearing difficulties and hearing needs, and

a shared treatment decision should be made to ensure the best rehabilitative outcome. It is a difficult task for individuals with low health literacy if they are not provided with readable, suitable and understandable information. Therefore, there is an urgent need to review and reform hearing-related health information written in TC and transmitted via accessible channels to ensure the greatest benefits for people with low health literacy. The internet has become one of the main sources from which Taiwanese people can obtain health information. This study suggests online hearing-related information written in TC has good readability and adequate suitability. There is still room to improve the reading experience and outcome, however, which requires effort from both website developers and audiologists.

4.5.1. Recommendation for website developers

Website developers should confirm that the content of the webpages is clear and simple, so that users can easily understand it. It can be difficult for people with cognitive or learning disabilities to read or understand written information full of formal or technical terms. Using clear and simple language can not only promote effective communication but benefit those people whose native language is different, including those who communicate primarily with sign language. In addition, web developers should adopt a clear webpage layout, recognisable graphics, and cultural appropriateness. This will benefit all users, especially those with cognitive disabilities and reading difficulties.

To achieve suitability, website developers must take the initiative to consider every detail in the web page design and the problems that users may have in use at the beginning of building the website. When designing web pages, web developers tend to use new technologies to enhance their webpage operations, thus ignoring the problems that may occur to those who use old browsers to process information. Therefore, web developers should make sure that even

when newer technologies are not in place or turned off for the user, the web page is still accessible and allows users to process the information on the web page.

4.5.2. Recommendations for audiologists

Audiologists should be aware that individuals with hearing loss have a higher potential to develop memory and cognitive problems, leading them to have poor health literacy. In order to enhance the comprehension of health information for patients with low health literacy, the Agency for Healthcare Research and Quality (AHRQ) in the USA developed the concept of "universal precautions" (Brown et al., 2004), encouraging healthcare providers to provide information and services that are applicable to all health literacy levels. A six-step approach was proposed:

(1) Spend more time in evaluating the patient's health literacy skills e.g. collect information about the level of education and occupational background.

(2) Use plain language instead of medical terms.

(3) Use pictures to enhance understanding and review the key points.

(4) Don't give too much information in one visit and repeat the instructions.

(5) Ask the patient to "teach back" and confirm their understanding.

(6) Be respectful, considerate and sensitive so that patients are empowered to take part in their own healthcare (DeWalt et al., 2010).

Audiologists also need to be aware that although the online hearing-related information might be easy to read and suitable for clients' health literacy level, the accuracy of that information is still in doubt. Incorrect information can negatively affect clients' health beliefs and behaviour even though the information may be readable and suitable. This study did not

explore the accuracy of the content of webpages. It is recommended that further studies in this field could explore the accuracy of online hearing-related information written in TC.

4.6. Limitations

4.6.1. Validity of using the CRIE formula

One of the limitations of using the CRIE formula in this study is the validity and applicability for health information written in TC. The CRIE system can analyse multilevel features such as vocabulary, semantics, grammar, and text cohesion. The CRIE model uses the support vector machine (SVM) machine learning method to predict the readability of TC texts (Sung et al., 2016). Because the readability of texts is determined by a wide variety of factors, using the SVM model to establish readability calculations can obtain a better readability prediction, compared with regression analysis that often includes only two or three features. The correction rate of CRIE's prediction of the readability of TC as a foreign language textbook was 89.86% (Sung, Dyson, et al., 2015).

Past studies have found that both stepwise regression and SMV models have poorer predictions of readability while assessing textbooks of Grades 5 to 6 and above (Sung et al., 2013). This may be because the high-grade texts are mostly expository with more multi-sense words, and the sentence structure is more complicated. A readability formula composed of simple textual features cannot accurately predict the readability of this kind of article. In addition, the CRIE SMV model training and verification was based on elementary school textbooks published in Taiwan (Sung et al., 2016). Its grading may not be applicable to online health information texts. Medical terms are often used in health information materials and they are often easily misunderstood. A study by Sand-Jeckin (2007) found that the use of medical terminology increased the readability grade and increased the difficulty of reading. After removing medical terms, the RGL decreased by about three grades (Sand-Jecklin, 2007). The

current readability formula for the TC language including CRIE does not take into account the impact of technical terms on readability. According to Sand-Jeckin's research results, the use of general readability formulas may underestimate the RGL of health information materials (Sand-Jecklin, 2007). More research is needed in the future to explore if the RGLs of webpages in this study were also underestimated. It is recommended that the results obtained by the CRIE in this study be verified by subjective tests like a cloze test, which uses readers' comprehension of the text or information.

4.6.2. The reliability of using SAM criteria

Because the SAM's scoring criteria can be interpreted with a certain level of subjectivity, the results of the SAM scoring may differ depending on the raters. The possible reasons for the inconsistency of SAM scores between raters include the raters' familiarity with either the content of health information materials or the SAM tool. Some studies had only one rater to score health information materials against SAM criteria, or had two or more raters but did not explain the inter-rater reliability (Demir et al., 2008; Eames et al., 2003; Murphy et al., 2001). Other studies carried out by two or more raters usually calculate the Cohen's kappa coefficient to show agreement of scores between raters (Vallance et al., 2008; Wallace et al., 2008). A value for Cohen's Kappa coefficient <0.20 indicates poor agreement, 0.21–0.40 average, 0.41–0.60 moderate, 0.61–0.80 strong, and more than 0.80 indicates excellent agreement (Fleiss et al., 1981). The possible reasons for this achievement may be that both raters were audiology students in the same university and used TC as the first language. The higher degree of agreement between raters, the more reliable the SAM scores are.

4.7. Future research

The readability assessment tool used in this study, the CRIE system, was developed to evaluate the readability of TC textbooks from elementary schools to high schools, using general

language features. Past studies have found that general language features cannot accurately reflect the readability of texts in specific domains (Yan et al., 2006). For example, this study used the CRIE formula to analyse the readability of online hearing-related information that contains hearing-related technical terms. Although many technical terms used simple or common TC characters, their meanings were abstruse, resulting in underestimated readability levels given by the CRIE formula. In a future study, it will be necessary to address the issue by inviting the participants to carry out a subjective readability assessment and comparing the results with the predicting RGLs provided by CRIE. The cloze test is one of the popular subjective readability tests that could be used in such future studies.

This study used suitability assessment tools to evaluate the suitability of online hearing-related information written in TC. The quantitative data could describe the general strengths and weaknesses of online hearing-related information and infers the suitability of the information accordingly. However, because the rater was not a real information user, this kind of objective quantitative research may lack validation. Therefore, future research should explore the suitability of hearing-related online information based on users' perspectives. Using qualitative data provided by the users can illustrate the personal subjective experience of the suitability of online hearing-related information. The combined results of the quantitative and qualitative analysis can comprehensively explain the suitability of the existing online hearing-related information in TC and increase the validity of the research results.

4.8. Conclusions

The mean RGL calculated by CRIE 3.0 was within the recommended value (6) which means that online hearing health-related information available in TC is easy to read. Also, no correlation was found between RGL and SAM which indicates that if a webpage has low RGL, it does not mean that it will be suitable to assess the online information. Origins of websites did not impact the readability and suitability of the online information available in TC.

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