EVALUATING THE ACCEPTANCE OF TELEAUDIOLOGY FOR TINNITUS MANAGEMENT AMONG AUDIOLOGISTS AND PATIENTS WITH TINNITUS IN MALAYSIA

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LIST OF SYMBOLS

r	Correlation coefficient
β	Unstandardized coefficient
α	Cronbach alpha
p	Significance value

LIST OF ABBREVIATIONS

ACT	Acceptance and Commitment Therapy
BM	Bahasa Melayu
CBT	Cognitive Behavioral Therapy
COVID	Coronavirus Disease
CSQ	Client Satisfaction Questionnaire
CVI	Content Validity Index
CVR	Content Validity Ratio
DCN	Dorsal Cochlear Nucleus
HA	Hearing Aid
HIPAA	Health Insurance Portability and Accountability Act
HL	Hearing Loss
HPj	Hospital Putrajaya
HRC	Hospital Rehabilitasi Cheras
HSNZ	Hospital Sultanah Nur Zahirah
HUKM	Hospital Universiti Kebangsaan Malaysia
HUSM	Hospital Universiti Sains Malaysia
I-CVI	Item-level Content Validity Index
IBM	International Bussiness Machines Corporation
iCBT	Internet-Based Cognitive Behavioral Therapy
ICT	Information and Communication Technology
IIUM	International Islamic University Malaysia
IS	Information System
IT	Information Technology
JEPeM	Jawatankuasa Etika Penyelidikan Manusia
MCMC	Malaysian Communication and Multimedia Commission
MOH	Ministry of Health
MREC	Medical Research and Ethics Committee
MyTUQ-T	Malay Teleaudiology Usability Questionnaire for Tinnitus
ORL	Otorhinolaryngology
PEOU	Perceived Ease of Use
PPSK	Pusat Pengajian Sains Kesihatan
PSQ	Patient Satisfaction Questionnaire

PTA	Pure Tone Audiometry
PTM	Progressive Tinnitus Management
PU	Perceived Usefulness
QoL	Quality of Life
QR	Quick Response
QUIS	Questionnaire for User Interaction Satisfaction
RCT	Randomized Clinical Trial
S-CVI	Content Validity Index for Scale
SOP	Standard Operating Procedure
SPSS	Statistical Package for the Social Sciences
SUS	System Usability Scale
SUTAQ	Service User Technology Acceptability Questionnaire
TAM	Technology Acceptance Model
TBI	Traumatic Brain Injury
TFI	Tinnitus Functional Index
THI	Tinnitus Handicap Inventory
TPB	Theory of Planned Behavior
TRA	Theory Reasoned Action
TRT	Tinnitus Retraining Therapy
TSQ	Telemedicine Satisfaction Questionnaire
TUQ	Telehealth Usability Questionnaire
UK	United Kingdom
UKM	Universiti Kebangsaan Malaysia
US	United States
USM	Universiti Sains Malaysia
VAS-A	Visual Analogue Scale for Annoyance
VAS-L	Visual Analogue Scale for Loudness
WHD	World Hearing Day

LIST OF APPENDICES

MENILAI PENERIMAAN TELEAUDIOLOGI BAGI PENGURUSAN TINITUS DI KALANGAN AUDIOLOGIS DAN PESAKIT TINNITUS DI MALAYSIA.

ABSTRAK

Teleaudiologi untuk pengurusan tinitus belum dikaji di Malaysia yang menekankan keperluan untuk mendapatkan pandangan awal daripada pengguna, khususnya audiologis dan pesakit yang mengalami tinitus. Kajian ini bertujuan untuk menilai penerimaan teleaudiologi untuk pengurusan tinitus dalam kalangan audiologis dan pesakit yang mengalami tinitus di Malaysia. Kajian dijalankan dalam dua fasa. Dalam fasa I, empat panel pakar menterjemah dan menyesuaikan *Telehealth Usability Questionnaire (TUQ)* ke dalam versi Bahasa Melayu untuk pengurusan tinitus. Taklimat kognitif melibatkan sekumpulan kecil audiologis dan pesakit yang mengalami tinitus telah dijalankan untuk memastikan kebolehfahaman versi Bahasa Melayu. Kesahan kandungan dinilai menggunakan indeks kesahan kandungan (Item-CVI dan Skala-CVI) dan nilai kappa oleh sembilan pakar. Semua item adalah memuaskan (I-CVI ≥ 0.78, S-CVI ≥ 0.96 dan analisis kappa ≥ 0.78). Konsistensi dalaman dinilai menggunakan alpha Cronbach (α) dan korelasi item-to-total pada 10 audiologis dan 10 pesakit yang mengalami tinitus. initialMyTUQ-T menunjukkan alpha Cronbach yang baik iaitu .758 hingga .893 untuk audiologis dan .740 hingga .850 untuk pesakit yang mengalami tinitus. Korelasi item-to-total adalah sangat baik antara .550 hingga .945 untuk audiologis dan .578 hingga .948 untuk pesakit yang mengalami tinitus. Dalam fasa II, kajian keratan rentas menggunakan MyTUQ-T yang disahkan dan boleh dipercayai untuk menilai penerimaan teleaudiologi untuk pengurusan tinnitus di kalangan 42 audiologis, umur purata 36.71 (± 4.74), dan 84 pesakit yang mengalami tinnitus, umur min 46.04 (± 14.52) di seluruh Malaysia.

Audiologis dan pesakit yang mengalami tinitus agak bersetuju menerima penggunaan teleaudiologi untuk pengurusan tinnitus di Malaysia. Subskala kebolehgunaan menerima skor purata tertinggi, manakala subskala kebolehpercayaan memperoleh purata skor terendah dalam kedua-dua kategori responden. Analisis korelasi Spearman digunakan untuk mengkaji korelasi antara lima faktor kebolehgunaan dalam MyTUQ-T. Korelasi positif yang kuat telah dikenal pasti antara semua faktor kebolehgunaan untuk kedua-dua audiologis dan pesakit yang mengalami tinnitus. Kolerasi tertinggi didapati antara faktor kebolehpercayaan dan faktor keberkesanan dalam kedua-dua kumpulan responden, dengan pekali korelasi (r) sebanyak .888 untuk audiologis (p = .000, r = .888) dan .923 untuk pesakit yang mengalami tinitus (p = .000, r = .923). Regresi linear berbilang (MLR) digunakan untuk meneroka perkaitan antara ciri sosiodemografi, sisian kehilangan pendengaran, keterukan tinnitus dan penerimaan teleaudiologi untuk pengurusan tinitus. Jantina mempengaruhi penerimaan audiologis dengan ketara (β = 0.800; 95% CI 0.06, 1.54; p = .035) dan umur mempengaruhi penerimaan pesakit dengan ketara (β = - 0.019; 95% CI - 0.04, 0.00; p = .027). Walau bagaimanapun, tiada hubungan yang signifikan ditemui antara penerimaan dan faktor lain ($p \geq .05$). Kesimpulannya, audiologis dan pesakit yang mengalami tinitus di Malaysia semakin menghampiri tahap menerima penggunaan teleaudiologi bagi pengurusan tinnitus. Kajian lanjut diperlukan untuk memahami bagaimana jantina di kalangan audiologis dan umur di kalangan pesakit yang mengalami tinitus mempengaruhi penerimaan mereka terhadap teleaudiologi untuk pengurusan tinitus. Pemahaman ini akan membantu dalam membangunkan pelan pengurusan yang berkesan untuk penjagaan tinitus pada masa hadapan.

EVALUATING THE ACCEPTANCE OF TELEAUDIOLOGY FOR TINNITUS MANAGEMENT AMONG AUDIOLOGISTS AND PATIENTS WITH TINNITUS IN MALAYSIA

ABSTRACT

Teleaudiology for tinnitus management has not been studied in Malaysia emphasizing the need for preliminary insights from users, particularly audiologists and patients with tinnitus. This study aimed to assess the acceptance of teleaudiology for tinnitus management among audiologists and patients with tinnitus in Malaysia. The study was conducted in two phases. In phase I, four expert panels translated and adapted the Telehealth Usability Questionnaire (TUQ) into the Bahasa Melayu version for tinnitus management. A cognitive debriefing involving a small group of audiologists and patients with tinnitus was conducted to ensure the comprehensibility of the Bahasa Melayu version. Content validity was evaluated using content validity indexes (Item-CVI and Scale-CVI) and kappa values by nine experts. All items were satisfactory (I-CVI ≥ .78, S-CVI ≥ .96 and kappa analysis ≥ .78). Internal consistency was assessed using Cronbach's alpha (α) and item-to-total correlation on 10 audiologists and 10 patients with tinnitus. The initialMyTUQ-T demonstrated good Cronbach's alphas of .758 to .893 for audiologists and .740 to .850 for patients with tinnitus. The item-to-total correlation was very good ranging from .550 to .945 for audiologists and .578 to .948 for patients with tinnitus. In phase II, a cross-sectional study utilized the validated and reliable MyTUQ-T to assess the acceptance of teleaudiology for tinnitus management among 42 audiologists, mean age 36.71 (± 4.74), and 84 patients with tinnitus, mean age 46.04 (± 14.52) across Malaysia. Audiologists and patients with tinnitus are somewhat agree to accept the use of teleaudiology for tinnitus management in Malaysia. Usefulness subscale received the

highest average score, while the reliability subscale obtained the lowest average score in both categories of respondents. Spearman's correlation analysis was used to examine the correlation between the five usability factors in the MyTUQ-T. A strong positive correlation was identified between all usability factors for both audiologists and patients with tinnitus. The highest correlation is between the reliability factor and the effectiveness factor in both groups of respondents, with a correlation coefficient (r) .888 for audiologists (p = .000, r = .888) and .923 for patients with tinnitus (p =. 000, r = .923). Multiple linear regressions (MLR) were applied to explore the associations between sociodemographic characteristics, hearing loss laterality, tinnitus severity and acceptance of teleaudiology for tinnitus management. Gender significantly influenced audiologists' acceptance (β = 0.800; 95% CI 0.06, 1.54; p = .035) and age significantly influenced patients' acceptance (β = - 0.019; 95% CI - 0.04, 0.00; p = .027). However, no significant relationships were found between acceptance and other factors ($p \geq .05$). In conclusion, both audiologists and patients with tinnitus in Malaysia are approaching the level of acceptance to accept the use of teleaudiology for tinnitus management. Further research is needed to understand how gender among audiologists and age among patients with tinnitus influence their acceptance of teleaudiology for tinnitus management. This understanding will aid in developing effective management plans for tinnitus care in the future

CHAPTER 1

INTRODUCTION AND RESEARCH OVERVIEW

This chapter presents an overview of the structure of this thesis. Also, it presents all the background information, critical concepts, and terms that define the problem this thesis will address, the importance of this problem, and how it applies to the larger field of research. In this chapter, the researcher also outlines the structure of this thesis.

1.1 Introduction

Chapter 1 introduces the research focus and highlights important points that have received attention in the field of tinnitus management. It provides a brief overview of current tinnitus management in Malaysia, explains the challenges in the delivery of tinnitus management in Malaysia, identifies the main research questions, and defines the objectives that the research aims to achieve. In addition, this chapter outlines the thesis structure and concludes with a comprehensive summary of the entire research effort.

1.2 Background of the Study

1.2.1 Tinnitus

Tinnitus, which is the sensation of hearing sound when there is no external sound present, typically arises from either a problem with the auditory system (peripheral/central), the somatosensory system (head and neck), or a combination of both (Levine & Oron, 2015). The term tinnitus originates from the Latin word "tinnire" which means "to ring" (Baguley et al., 2013), but the sounds heard can also be described as clicking, buzzing, hissing, or roaring (Han et al., 2009) and can vary in loudness, pitch, and location (Baguley et al., 2013).

Tinnitus is not a disease but a symptom that can arise from various underlying causes, occurring at different levels of the auditory system or even outside of it (Han et al., 2009). The most prevalent factors contributing to tinnitus are hearing damage, noise-induced hearing loss, and age-related hearing loss, also known as presbycusis (Crummer & Hassan, 2004).

Tinnitus usually leads to challenges such as trouble concentrating, sleep disturbances, and a reduced ability to hear and understand speech. There is evidence suggesting that tinnitus may be associated with anxiety and depression (Bhatt et al., 2017; Salazar et al., 2019). Early psychological perspectives on tinnitus distress, noted that many individuals naturally habituate to tinnitus over time, perceiving it as unremarkable, much like the sound of distant traffic (Rachman, 2013). However, some individuals fail to habituate to the tinnitus sound. Negative thoughts on tinnitus or one's ability to cope with it may be a contributing factor that hinders habituation (Rachman, 2013).

Effective tinnitus management are crucial for individuals with tinnitus to avoid negative thoughts and foster acceptance of tinnitus. Without proper management, tinnitus can significantly impact a patient's quality of life.

Patients with tinnitus are commonly managed by ENT specialists/doctors and audiologists. Audiologists perform a complete audiological evaluation. Based on the findings, they may refer the patient to an ENT specialist for further medical evaluation and treatment to determine the underlying cause of the tinnitus. ENTs diagnose, evaluate, and address any underlying medical factors contributing to the condition. Once medical clearance is obtained and if tinnitus persists, management strategies may involve the use of hearing aids and tinnitus masking devices to help patients adapt and manage their tinnitus.

It is particularly important to address psychological distress in patients who are experiencing depression or other psychological issues, as appropriate therapy can help prevent the worsening of their condition, including the risk of suicide (Han et al., 2018; Seo et al., 2016).

1.3 Problem Statement

In Malaysia, patients with tinnitus are typically directed to hospitals offering specialized services for tinnitus management. Audiologists, professionals in diagnosing and addressing hearing disorders, play a crucial role in delivering tinnitus management services. It's important to note that not all hospitals in Malaysia can provide this specific service, especially hospitals in rural areas.

A cross-sectional survey study of subjective tinnitus management by clinical professionals in Malaysia provides valuable insight into the current challenges faced in managing tinnitus in Malaysia. One of the challenges found in tinnitus management in Malaysia is limited access to specialized tinnitus management services (Husain et al., 2020).

Teleaudiology holds the promise of improving tinnitus management by increasing accessibility, convenience, and cost-effectiveness, while improving patient outcomes and ensuring consistent care (Andersson & Kaldo, 2004; Kaldo et al., 2004; Kaldo et al., 2008; Beukes et al., 2018b). This approach can extend tinnitus management services to individuals in remote locations, reduce travel costs, and enable healthcare providers to seamlessly monitor and exchange patient data across multiple care settings (Swanepoel & Hall, 2010).

Teleaudiology is a branch of telehealth, which uses technology to provide audiology services remotely. Although it is relatively new in Malaysia, interest in

teleaudiology is growing. The Malaysian Audiology Technical Committee 2020/2021 has established teleaudiology service guidelines for the Ministry of Health (MOH), demonstrating a proactive approach.

Despite its introduction, the use of teleaudiology in Malaysia remains limited, with a lack of studies on its implementation. To date, only one study has explored teleaudiology in Malaysia, revealing that audiologists' willingness to adopt it varies based on clinical tasks and client groups. Further research is essential, especially focusing on the acceptance of teleaudiology users for each audiology clinical task, to ensure the continued use of teleaudiology in the future.

Existing studies mostly focus on effectiveness rather than user reactions. To develop effective implementation methods, it's vital to grasp users' attitudes toward Information Systems/Information Technology (IS/IT). Recognizing user perceptions helps developers improve the system and boost user acceptance (Aggelidis & Chatzoglou, 2009).

Building on previous research on teleaudiology in Malaysia by Rashid et al. (2020), a study was conducted to evaluate the acceptance of teleaudiology for tinnitus management in Malaysia. This study assessed acceptance not only among audiologists but also among patients with tinnitus in Malaysia. As teleaudiology users include both audiologists and patients, this study serves as a preliminary study to evaluate acceptance in both groups of users.

To assess the acceptance of teleaudiology for tinnitus management among both audiologists and patients with tinnitus in Malaysia, this study used the Telehealth Usability Questionnaire (TUQ) developed by Parmanto et al. (2016). However, there is currently no Bahasa Melayu version of the TUQ. Therefore, the original TUQ will

undergo translation and cross-cultural adaptation process to produce a Bahasa Melayu version of the TUQ to be used in this study.

Research also has shown that sociodemographic factors can influence the acceptance and adoption of teleaudiology. Although research on sociodemographic influences among audiologists is still lacking, a study conducted by Lee et al. (2020) revealed that individuals who expressed willingness to engage in teleaudiology services tended to be younger, have a higher level of education, and reported more frequent use of computers or smart devices.

A study by Eikelboom et al. (2005) showed no relationship between willingness and age or gender. However, the results of the study also show that women aged 55 and over were less willing to use teleaudiology.

It is important to consider sociodemographic factors when implementing and promoting teleaudiology services to ensure equitable access and utilization of these services across different populations.

In this study, the relationship of sociodemographic factors with acceptance were tested among audiologists including age, gender, and years of working experience. For tinnitus patients, sociodemographic factors examined include age, gender, and education level.

In studies involving patients with tinnitus, the effect of both hearing loss severity and tinnitus severity on teleaudiology acceptance were also examined. This is because a study conducted during the Covid-19 outbreak in the United Kingdom (UK) revealed that the main reason patients refused telehealth appointments for tinnitus therapy was the severity of hearing loss and tinnitus (Aazh et al., 2021). The reluctance to use teleaudiology among these patients is likely due to the significant challenges in

understanding speech over the internet. Poor hearing and severe tinnitus lead to difficult to understand the meaning in conversation and perceive speech clearly.

The Technology Acceptance Model (TAM), introduced by Davis (1989), is commonly used to understand how users adopt and embrace technology in telemedicine research (Harst et al., 2019). While TAM is widely employed to assess user acceptance in various technological contexts, including telehealth, it wasn't initially designed specifically for healthcare. This gap may limit its ability to fully grasp the distinctive features of telehealth.

By incorporating the usability factors of the TUQ into the TAM, a conceptual framework was constructed for this study. This allows the researcher to show relationships and provide explanations in this teleaudiology study for tinnitus management. Sociodemographic factors of audiologists and patients with tinnitus were added and examined as potential factors influencing the acceptance of teleaudiology for tinnitus management. This study also combined the factors of laterality of hearing loss (HL) and severity of tinnitus to examine how it affects the acceptance of teleaudiology for tinnitus management among patients with tinnitus in Malaysia.

1.4 Research Objectives

The main objective of this research is to evaluate the acceptance of teleaudiology for tinnitus management among audiologists and adult patients with tinnitus in Malaysia. The specific research objectives are listed as follow:

1.4.1 Specific Objectives

1.4.1(a) Phase I

i) To translate and adapt the Telehealth Usability Questionnaire (TUQ) into the Bahasa Melayu version of TUQ with a specific focus on its applicability for tinnitus management in Malaysia.

ii) To determine the reliability and validity of the Bahasa Melayu version of TUQ for tinnitus management.

1.4.1(b) Phase II

i) To determine the total score and subscales score of MyTUQ-T for audiologists and adult patients with tinnitus.

ii) To determine the correlation between MyTUQ-T usability factors (i.e., usefulness, ease of use, effectiveness, reliability, and satisfaction) related to the total score of MyTUQ-T.

iii) To assess the association between audiologists' sociodemographic factors (age, gender, and years of working experience) with their acceptance of teleaudiology for tinnitus management.

iv) To assess the association between patients with tinnitus' sociodemographic factors (age, gender, and education level), laterality of HL, Visual Analogue Scale of Loudness (VAS-L) score, and Visual Analogue Scale of Annoyance (VAS-A) score with their acceptance of teleaudiology for tinnitus management.

1.5 Research Question

This research aims to answer four research questions that guide and motivate the research, which are as follows:

i) How is the reliability and validity of the Bahasa Melayu version of TUQ for audiologists and adult patients with tinnitus in Malaysia?

ii) How is the total score and subscales score of MyTUQ-T for audiologists and adult patients with tinnitus in Malaysia?

iii) How is the correlation between the usability factors (i.e., usability, ease of use, effectiveness, reliability, and satisfaction) related to the total score of MyTUQ-T?

iv) Is there any association between audiologists' sociodemographic factors (age, gender, and years of working experience) with their acceptance of teleaudiology for tinnitus management?

v) Is there any association between patients with tinnitus' sociodemographic factors (age, gender, and years of working experience), laterality of HL, VAS-L score, and VAS-A score with their acceptance of teleaudiology for tinnitus management?

1.6 Thesis Overview

As described in section 1.4, this study was conducted in two consecutive phases. In Phase I, the process of translation and cross-cultural adaptation of the TUQ was carried out to produce the Bahasa Melayu version of the TUQ specifically for tinnitus management in Malaysia. It will be followed by a psychometric evaluation to ensure that the Bahasa Melayu version of the TUQ is valid and reliable for use in Phase II. Phase II is a cross-sectional study utilizing the Bahasa Melayu version of the TUQ

to assess the acceptance of teleaudiology for tinnitus management among audiologists and patients with tinnitus in Malaysia. The detailed methodology for every phase of the study is described in Chapter 3. Chapter 4 presents the results of each research objective, while a detailed discussion and conclussion is provided in Chapter 5.

1.7 Summary

In this chapter, an overview of the study is provided including the background of the study, research problem, research objectives, and research questions. The next chapter will present a broad review of tinnitus and its management, literature on theories/models of technology acceptance, teleaudiology for tinnitus management, TUQ as the main research instrument, as well as the process of translation and cross-cultural adaptation of questionnaires. In addition, Chapter 2 will explain the conceptual framework used in this study

CHAPTER 2

LITERATURE REVIEW

The previous chapter introduced general thoughts regarding the research as a whole. This chapter has been assembled to give information on literature reviews on a theoretical basis, research background, and critical literature on teleaudiology. This chapter also includes the conceptual framework for this study.

2.1 Introduction

This chapter presents the literature search for this study. At the beginning, important literature is offered to learn about the introduction to the tinnitus and the management involved, as well as the challenges of tinnitus services in Malaysia.

Then, the discussion continues with a literature search about teleaudiology for tinnitus management which serves as the basic structure of the study. This section investigates teleaudiology research for tinnitus management that have been initiated by previous researchers. From this literature review, research gaps were identified to complete what is lacking in previous studies.

Next, a literature review on theories model and the most suitable research tools used in this study is described to provide a valuable conceptual framework for this study. It will explain and review the basic concepts of how the framework is built.

2.2 Tinnitus

2.2.1 Definition and Terminology

Tinnitus is described as having a perception of sound without any outside stimuli. Tinnire, which means "to ring" in Latin, is where the word tinnitus originates. As a result, the phrase "ringing in the ears" has been employed to characterize the conscious sensation. However, the sounds heard varied greatly in nature, pitch, and location and were not just described as ringing. People describe their experiences of noise in a variety of ways, but typically they characterize it as a buzzing, hissing, whistling, or cricket-like sound (Stouffer & Tyler, 1990). Depending on the individual, the sound may be heard in one or both ears, elsewhere in the head, or occasionally outside of the head.

Tinnitus is categorized as subjective and objective tinnitus. Subjective tinnitus refers to the perception of internal sounds that can only be felt by the person experiencing the symptoms, whereas objective tinnitus is the perception of sounds that can be heard by both the individual and others (Dobie, 2004). The cause of objective tinnitus has been proposed as a physiological activation of the cochlea by increased blood flow, muscle contraction, or otoacoustic emissions, which produces a sound that is frequently detected by an outside observer (Dobie, 2004). Some disagree, saying that tinnitus by its definition is a subjective experience (Henry et al., 2005).

Some researchers suggest making a differentiation between neurophysiological and somatic tinnitus based on the etiology of tinnitus (Heller, 2003). Somatic tinnitus may suggest an underlying medical condition, such as a vascular lesion, middle ear disease, or hypertension, and should be evaluated and treated further. Therefore, earlier

distinctions based on etiology may be more effective since they offer a classification that may help with treatment decisions.

Some researchers have proposed that tinnitus usually last longer than five minutes (Coles, 1983), or it must occur for more than five minutes on several occasions a week (Dauman & Tyler, 1992). However, most people in many cases tend to agree that tinnitus is often experienced for longer periods of time and is present most of the time or constantly (Henry et al., 2005). Davis & El Refaie (2000) stated that tinnitus can be referred to as chronic if it persists for more than six months, although there is no consensus on what defines long-term or chronic tinnitus.

The degree to which tinnitus affects a person's daily function and overall quality of life is one factor in determining how severe it is. Other factors include how loud the sound is and how easily it may be covered up by background noise. It essentially reflects the type and extent of issues that the person has because of having tinnitus (Meikle, 2003, p. 59). This description allows for the inclusion of various effects of tinnitus, including psychoacoustic elements, emotional disturbances, concentration issues, and more.

The COVID-19 pandemic has exacerbated stress and anxiety (Mazurek et al., 2019). Since stress can increase tinnitus intensity, ensuring continued access to tinnitus care and education for patients during this period is important (Beukes et al., 2020).

Telehealth has emerged as an effective delivery model for providing tinnitus management services (Henry et al., 2020; Coco & Marrone, 2020; Saunders & Roughley, 2021). Teleaudiology can be utilized to reduce exposure for both patients and audiologists, facilitating social distancing by conducting essential tasks in person while reserving extensive counseling for virtual visits.

2.2.2 Prevalence

2.2.2(a) Prevalence of Tinnitus Among Adults and Children

Global prevalence and incidence of tinnitus revealed over 740 million adults worldwide are affected by tinnitus, and tinnitus is considered a significant issue for more than 120 million people (Jarach et al., 2022).

A comprehensive systematic review of the prevalence and incidence of tinnitus found that the average prevalence of any tinnitus among adults was 14.4% and ranged from 4.1% to 37.2% with more than 2% have severe tinnitus (Jarach et al., 2022). The average annual incidence rate approaches 1%. These data shows that tinnitus is very common among adult populations. Health policy makers must consider the worldwide impact of tinnitus, and greater efforts should be made to increase research efforts focused on tinnitus.

Data on tinnitus in children or adolescents show that tinnitus is often overlooked as an under-recognized or under-appreciated problem in this population (Savastano et al., 2009). One possible reason is that children are often asked about the presence of noise without specifically mentioning the name of the symptom "tinnitus". Other researchers have proposed that children may report the presence of noise to please the examiner (Baguley and McFerran, 1999). Therefore, obtaining reliable data on tinnitus in the paediatric population is quite difficult.

2.2.2(b) Prevalence of Tinnitus According to Age

There is an increase in the prevalence of tinnitus symptoms with increasing age (Gallus et al., 2015; Jalessi et al., 2013; Park et al., 2014). The prevalence of tinnitus in older adults (aged 45–64 years) was almost 2.5 times higher than in younger adults

(aged 18–44 years), and the prevalence of tinnitus was highest in older adults (≥ 65 years) which about 20 times higher than in young adults (Jalessi et al., 2013). These findings suggest that tinnitus is a more common in the older population. However, it should be noted that some of the studies reporting the highest prevalence of tinnitus only examined populations of adults aged 55 years and older (Sindhusake, 2003). This may lead to higher prevalence rates in older adult age groups.

2.2.2(c) Prevalence of Tinnitus Among Men and Women

There is no universal agreement among studies in the literature regarding the relationship between gender and tinnitus. In general, McCormack et al. (2016) revealed that men were more likely than women to experience tinnitus, but Biswas et al. (2021) discovered that women were more likely than men to experience bothersome tinnitus. This most recent discovery is in line with other research showing an association between severe tinnitus and suicide attempts among women but not men (Lugo et al., 2019). A thorough analysis of the literature revealed no gender-specific differences in the frequency or severity of tinnitus (Jarach et al., 2022). Therefore, it cannot be concluded from the available data that men and women experience tinnitus at different rates.

In 2004, Hospital Universiti Kebangsaan Malaysia (HUKM) conducted a study on the prevalence of tinnitus among patients aged 3 months to 101 years with otological problems. The study revealed that tinnitus was more common among unemployed women in middle-aged group (40-49 years old) (Cheu Lih, 2004). Contrastingly, a study focusing on the clinical characteristics of Malaysian patients with tinnitus was conducted at Hospital Universiti Sains Malaysia (HUSM) in 2016, yielding different results. In this study, tinnitus was more frequently observed among

retired elderly Malay men (Mohamad et al., 2021). However, it is important to highlight that the sample size in this study is limited, underscoring the need for a large-scale survey in the future to validate these findings. Furthermore, these two studies did not involve samples taken throughout Malaysia. The study sample was taken from tinnitus patients attending the Tinnitus Clinic at the Hospital Universiti Sains Malaysia (HUSM) and otology patients with tinnitus from the ENT clinic, Hospital Universiti Kebangsaan Malaysia (HUKM).

While a comprehensive study on the prevalence of tinnitus in Malaysia is yet to be conducted, the Laporan Tahunan Perkhidmatan Pemulihan Perubatan Audiologi 2021 does provide valuable insights. According to the report, there were 278 new tinnitus patient registrations in a year. Although this number may not fully reflect the actual count of patients with tinnitus in Malaysia, it serves as an evidence that tinnitus is a prevalent issue among Malaysians.

2.2.3 Mechanism of Tinnitus

Multiple theories have been developed to explain the ambiguous pathophysiology of tinnitus, with considerable attention initially focused on cochlear mechanisms. According to the Jastreboff neurophysiological model, cochlear involvement in tinnitus generation was suggested (i.e. cochlear loss) (Jastreboff, 1990; Jastreboff, 2004). However, recent human neuroimaging methods and animal models emphasize the central auditory system as the main site of the tinnitus generation.

Studies suggest that increased neural activity levels above the cochlear nerve may be implicated in tinnitus generation. For instance, elevated spontaneous activity in the dorsal cochlear nucleus (DCN) (Brozoski et al., 2002; Dehmel et al., 2012; Kaltenbach & Afman, 2000; Kaltenbach et al., 2000; Kaltenbach et al., 2002; Kraus et

al., 2009; Middleton et al., 2011; Rachel et al., 2002; Wang et al., 2009; Wei et al., 2010; Zacharek et al., 2002) and the inferior colliculus (Abbott et al., 1999; Bancroft et al., 1991; Basta & Ernest, 2004; Bauer et al., 2008; Burkard et al., 1997; Chen and Jastreboff, 1995; Dong et al., 2010; Jastreboff & Sasaki, 1986; Kazee et al., 1995; McFadden et al., 1998; Milbrandt et al., 2000; Salvi et al., 1990; Wang et al., 2008; Wang et al., 1996; Wang et al., 2002) has been reported. Certain studies have also highlighted tonotopic reorganization in these structures, signifying alterations in the representation of sound frequencies (Mühlnickel et al., 1998). Additionally, the synchronization of spontaneous neural activity has been proposed as a potential factor contributing to tinnitus generation (Eggermont, 1984; Moeller, 1984).

2.2.4 Effects of Tinnitus

Tinnitus can become bothersome and can effect four essential functions: (1) thought and emotion, (2) hearing, (3) sleep, and (4) concentration (Tyler et al., 2014; McCormack et al., 2016). When essential functions are affected by tinnitus, it can interfere with many daily activities and affect the overall quality of life (QOL).

Watts et al. (2018) conducted a study to investigate why tinnitus is considered problematic in a clinical setting. They retrospectively analysed data from 678 patients who had sought treatment at a tinnitus and hyperacusis clinic and provided an explanation for why they found tinnitus bothersome. This analysis resulted in the identification of 18 different problem domains related to tinnitus. Among the 18 problem domains identified, the most frequently reported effects included reduced QOL, anxiety, persistent awareness, irritability, and difficulty maintaining focus or concentration (Watts et al., 2018).

Individuals with tinnitus may react differently to their tinnitus, depending on their psychological state and the hearing level (Andersson, 2003; Hiller & Goebel, 2006; Wallhäusser-Franke et al., 2012). In extreme cases, some people with tinnitus have suicidal thoughts or actions (Han et al., 2018; Seo et al., 2016).

Persistent tinnitus with hard-to-identify cause of primary tinnitus contribute more to poor QOL (Negrila-Mezei et al., 2011; Cima et al., 2011). Disturbed sleep problems that are very common reported by individuals with tinnitus also affect the ability to concentrate and make them angry, frustrated, and experience other emotional disturbances (Henry et al., 2005; Lasisi and Gureje, 2011). Patients with tinnitus with comorbid conditions such as hypertension, diabetes mellitus, and arteriosclerosis show an increased negative impact on QOL (Negrila-Mezei et al., 2011).

Psychological problems are very common in patients with tinnitus. The relationship between depression and tinnitus has been studied and the results found that depression occurs in 48% to 60% of tinnitus patients (Harrop-Griffiths et al., 1987); Sullivan et al., 1988). Severity of depression and anxiety correlates with tinnitus severity. Depression makes tinnitus worse, and tinnitus also results in stress and depression (Geocze et al., 2013).

Patients who are depressed with tinnitus problems or have psychological problems should get treatment to prevent worse conditions from occurring. The increased risk of committing suicide is largely attributable to the severity of the tinnitus problem that causes depression and stress (Han et al., 2018; Seo et al., 2016).

A person suffering from tinnitus usually needs an explanation and guidance to prevent all the negative thoughts. Patients with tinnitus who have a clear explanation will be more positive and tend to be more accepting (Handscomb et al., 2017).

2.2.5 Management and Treatments

Tinnitus is a heterogenous condition with many possible aetiologies and is often associated with significant negative psychological states. Even though there are numerous therapies and technologies which are used to alleviate tinnitus, to date no tinnitus treatment is singularly effective. A range of tinnitus management options are currently offered. These will be discussed in the following sections.

2.2.5(a) Psychoeducation

Psychoeducation is an important component of all treatment options for patients with tinnitus who are disturbed by their tinnitus to the extent that it affects their QOL, which is often referred to as counseling. It may be enough in many situations to help them overcome their tinnitus.

In order to help patients with tinnitus to get used to the tinnitus sound and to better manage any potential adverse effects (i.e., emotional distress, sleep problems, loss of concentration, attention issues, and disruption to their personal, professional, and social lives), counseling is about offering them with information, advice, and empowerment (Bentler & Tyler, 1987; Sheldrake et al., 1985; Tyler & Baker, 1983; Hallam, 1989). Counseling intends to educate patients on their tinnitus, eliminate misconceptions about the condition, and help them comprehend their symptoms. It is critical to promote compliance with treatment plans by providing the necessary information about achievable outcomes of the various methods of therapy.

2.2.5(b) Hearing Aids (HAs)

The use of HAs has been long recognized especially for those who complain of tinnitus with a significant hearing loss (HL) (Hoare 2012; Sereda 2015). HAs are designed to amplify external sounds and improve speech perception in order to compensate HL. For tinnitus, amplification of external sounds by hearing aids may divert attention away from tinnitus and potentially mask the tinnitus.

2.2.5(c) Sound Therapy

Sound therapy or tinnitus masker are designed on the principle to cover up the tinnitus sound (Hoare et al., 2014). Sound therapy devices are commonly prescribed for those who do not have a significant hearing loss (Sereda et al., 2018).

2.2.5(d) Tinnitus Retraining Therapy (TRT)

Tinnitus retraining therapy (TRT) is a branch of psychoeducation that is a unique combination of counseling and sound therapy based on the hypothesis that the neurophysiological correlates of tinnitus are aberrant activity and connectivity of auditory and non-auditory central neural circuits (Jastreboff, 2007)·

Sound therapy can help the brain ignore certain tinnitus frequencies. Regardless of the lack of data, this procedure has no harmful effects (Baguley et al., 2013; Hoare et al., 2014; Sereda et al., 2018). Tinnitus sound therapy can be done in several techniques. The first is a fine adjustment to compensate for individual hearing loss. A second approach is to trim the spectral decay of the signal to eliminate energy near the tinnitus frequency (Shore et al., 2016; Hesse, 2016).

TRT aims to create habituation through education or counseling to reclassify the tinnitus signal to a neutral stimulus category, as well as sound therapy to reduce the strength of the tinnitus signal. Although several studies suggest a beneficial effect (Bauer and Brozoski, 2011; Henry et al., 2006), a Cochrane meta-analysis (Phillips & McFerran, 2010) states that no final conclusions about the effectiveness of TRT can be made due to the lack of high-quality randomised clinical trials.

2.2.5(e) Cognitive Behavioral Therapy (CBT)

Cognitive behavioral therapy (CBT) is the most supported treatment for tinnitus (Langguth et al., 2013; Martinez-Devesa et al., 2010; Hoare et al., 2011). Patients with tinnitus experience less stress as a result (Hesser et al., 2011). However, CBT, is a psychological intervention provided specifically by psychologists that helps patients reduce the impact of tinnitus on their lives (Martinez-Devesa et al., 2010; Hesser et al., 2011).

In recent years, audiologists specializing in tinnitus and hyperacusis rehabilitation in the UK and many other countries have increasingly conducted tinnitus and/or hyperacusis-specific CBT. Aside from a lack of expertise in tinnitus and/or hyperacusis rehabilitation among psychologists, another issue in referring all patients with tinnitus and/or hyperacusis to mental health services is long waiting times due to inadequate resources and high demand (Iacobucci, 2014). Early intervention for tinnitus and/or hyperacusis treatment is required because 12.7% of patients seeking care for tinnitus and/or hyperacusis had suicide and self-harm thoughts, and the frequency of these related to their tinnitus and hyperacusis handicap (Aazh & Moore 2018).

One way to address these issues is to have audiologists, as an alternative to mental health professionals, provide psychological therapy. Patients with symptoms of co-morbid psychological illnesses should be referred to mental health specialists for assessment and proper care of their psychological symptoms. Audiologist-delivered CBT is focused on addressing hyperacusis/tinnitus-related problems. These should be recognized at the assessment step before beginning treatment. When necessary, patients should receive psychiatric/psychological assessment/treatment concurrently with or before to tinnitus and hyperacusis rehabilitation.

Several studies have found that audiologist-delivered CBT for tinnitus and hyperacusis produces promising outcomes (Beukes et al. 2017; Aazh & Moore 2018). Although most audiology programs do not include training in providing psychological interventions, many authors have recommended using psychological interventions in the process of audiological rehabilitation (English et al. 2000; Brooks & Johnson 1981; Aazh 2016; Aazh & Moore 2017a). There is evidence that non-psychologist healthcare workers can benefit from adding psychological interventions to their training programs (Kosowicz et al. 2007).

2.2.6 Tinnitus Management in Malaysia

Tinnitus management in Malaysia is handled by ENT specialists/doctors and audiologists who have received specialized training in the field of tinnitus and/or hyperacusis. This audiologist must have a bachelor's degree in Audiology or an equivalent qualification. Furthermore, they must be officially registered as an audiologist in compliance with the Allied Health Professions Act 2016 (Act 774).

Figure 2.1 is a flow chart of the tinnitus management process in Malaysia. The flow chart is adapted from the Standard Operating Procedure (SOP) for Tinnitus, MOH Malaysia 2023.

The process begins with a detailed assessment of the patient's with tinnitus history including the characteristics of tinnitus. This comprehensive history is obtained before proceeding with any audiological examination.

Routine audiological examinations such as otoscopy, pure tone audiometry (PTA), and acoustic impedance tests are performed. Beyond these examinations, the severity of tinnitus is assessed through the administration of questionnaires such as the Tinnitus Handicap Inventory (THI) before moving on to the next step of tinnitus management such as counseling.

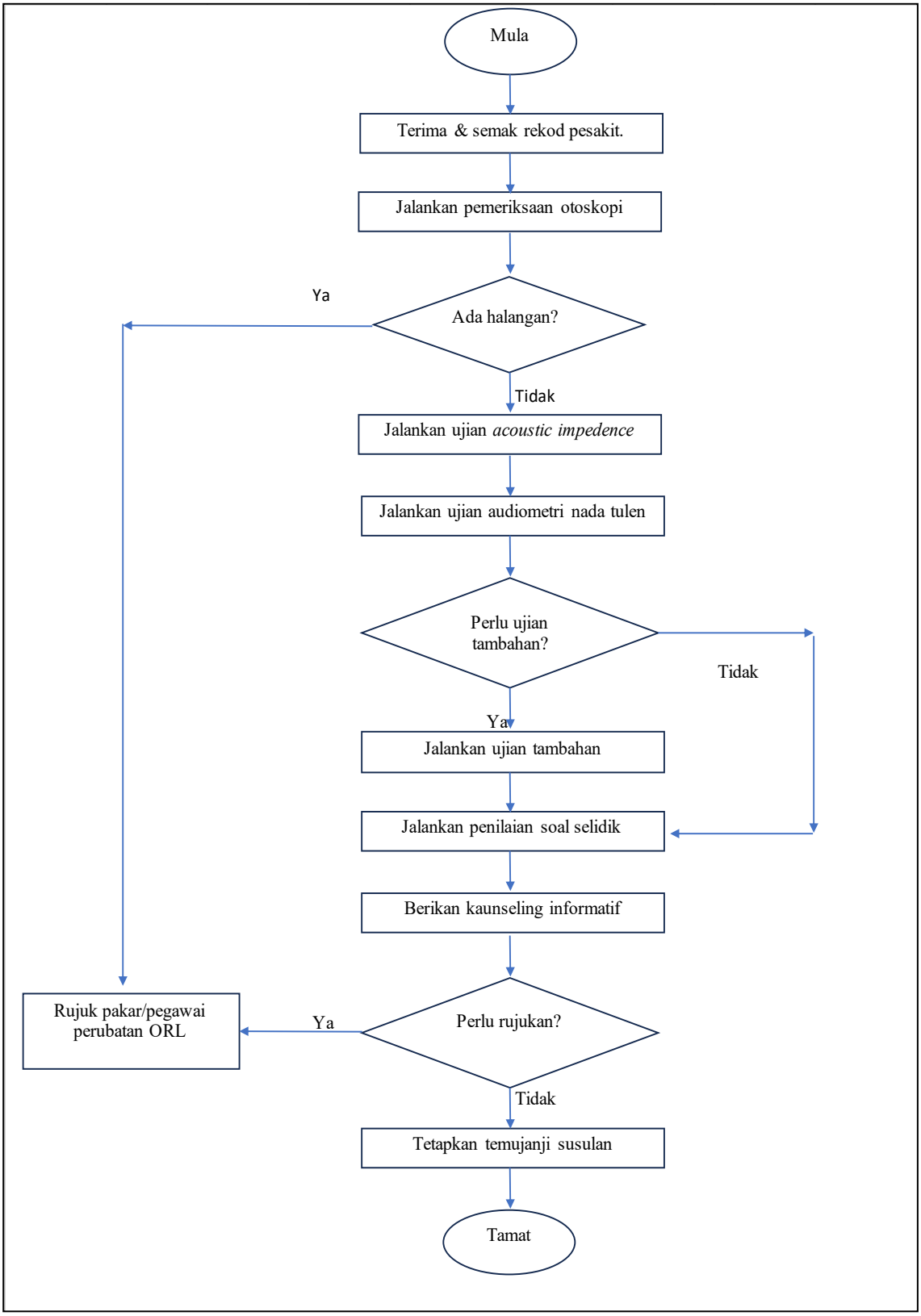

Figure 2.1 Flow Chart of The Tinnitus Management Process in Malaysia (Standard Operating Procedure (SOP) for Tinnitus, 2023).

Not all hospitals or private clinics in Malaysia provide tinnitus management services. Patients with tinnitus who require specialized tinnitus therapy will be referred to hospitals with tinnitus specialists, which are usually located in urban areas. This allows patients with tinnitus, particularly those living in rural areas reluctant to seek treatment since the referral hospital is too far away from their house. As a result, they choose to hide their problem, which allows the impacts of bigger problems to arise.

Recently, the COVID-19 pandemic has created widespread disruption in healthcare service throughout the world, accelerating the demand of using teleaudiology for delivering hearing care services (Mao et al., 2021; Muñoz et al., 2020). The increased use of teleaudiology all over the globe for example in the delivery of tinnitus management service seems allowing patients with tinnitus to obtain treatment without having to visit a hospital or leave their home. This appears to be assisting audiologists in giving access to those who are unable to obtain tinnitus treatment, hence bridging the gap between patients who find it difficult to get tinnitus services.

Nonetheless, teleaudiology for tinnitus management is still not widely used in Malaysia until now. This motivates researcher to conduct a preliminary study to explore the acceptance of teleaudiology for tinnitus management in Malaysia among primary users, specifically audiologists and patients with tinnitus.

2.3 Teleaudiology

Telemedicine has been adapted to the field of audiology, known as *tele-audiology*, to provide remote hearing screenings, diagnostic testing, intervention, and/or rehabilitation services (e.g., hearing aid adjustment, cochlear implant programming) (ASHA, 2021).