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Exploring teleaudiology adoption, perceptions and challenges among audiologists before and during the COVID-19 pandemic

Nicky Chong-White^{1,2*}, Paola Incerti^{1,2}, Marisa Poulos¹ and Joseph Tagudin¹

Abstract

Background The COVID-19 pandemic and its associated lockdowns accelerated the uptake of remote services, however, the integration of teleaudiology into regular clinical practice has been slow, with audiologists reporting several barriers and mixed attitudes. To develop effective strategies and solutions to enhance teleaudiology services and facilitate their acceptance beyond the pandemic, a better understanding of the factors influencing audiologist's attitudes and usage is needed.

The purpose of this study was to explore the attitudes towards and usage of teleaudiology by audiologists prior to and during the COVID-19 pandemic.

We aimed to uncover underlying factors influencing teleaudiology adoption to identify potential barriers and opportunities that could inform interventions and future developments.

Method and results Two cross-sectional surveys were administered to audiologists between September and October in 2018 and 2021. Questions addressed issues regarding quality of care, satisfaction, and perceived benefits of teleaudiology. Survey items based on the COM-B behaviour model were also included in the 2021 survey. Data were analysed using descriptive and non-parametric statistics.

Eighty audiologists completed the 2018 survey and 105 audiologists completed the 2021 survey. In 2021, teleaudiology users reported increased quality of care, quality of relationships with clients and client satisfaction compared to non-users. However, among teleaudiology users, there was a decrease in quality of care, relationships with new clients and job satisfaction in 2021 compared to 2018. The COM-B framework helped identify the major barriers for non-users of teleaudiology such as lack of training, unclear guidelines, and concerns about service quality.

Conclusion The attitudes towards teleaudiology for clinicians before and during the COVID-19 pandemic were investigated, revealing a substantial increase in usage and varying effects on client satisfaction, clinician job satisfaction and service quality. Key potential barriers and factors influencing usage were identified. Targeted solutions may include providing training, scheduling regular teleaudiology appointments to build confidence, and developing reliable tools and technologies to improve remote hearing care.

Keywords Teleaudiology, Telehealth adoption, COVID-19 pandemic, Remote hearing care

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Introduction

Although telehealth technologies and capabilities have grown rapidly over the past decade, the integration of teleaudiology, the provision of hearing health services from a distance, into regular clinical practice has been slower than expected. Even in the context of the COVID-19 pandemic, which led to a significant reduction in face-to-face consultations and necessitated the swift uptake of teleaudiology all around the world, remote services are not ubiquitous, widely vary in usage between practices, and garner mixed attitudes from both clients and clinicians [1–8]. Despite a growing body of evidence supporting the benefits of teleaudiology, numerous reported barriers prevent its blending into routine clinical practice and thus optimal use.

Teleaudiology offers a range of benefits for both clients and clinicians. In a survey of 120 practising audiologists in the UK, over 80% believed teleaudiology improves service provision and convenience; it increases scheduling flexibility and has the potential to overcome factors such as distance, mobility, family or work commitments, and pandemic restrictions [2]. In a systematic literature review of teleaudiology services and technology, the fundamental benefits identified were improved access, improved quality, cost-effectiveness and patient demand [9].

Teleaudiology has a wide range of applications; hearing screening, diagnostic testing, intervention and rehabilitation have all been validated for use with both children and adults [10]. While clinicians historically limited teleaudiology to only counselling and education, systematic reviews have found otoscopy, pure-tone and immittance audiometry, and objective assessments such as otoacoustic emissions (OAE) and auditory brainstem response (ABR) conducted through teleaudiology give no clinically significant differences in results compared to in-person administration [6, 11, 12]. Teleaudiology is also feasible for the fitting, verification and maintenance hearing aids and cochlear implants. Comparisons of in-person and remote hearing aid fitting and follow-up consultations have revealed no differences in appointment duration, self-reported hearing benefits and quality-of-life, or communication outcomes (speech perception in quiet and noise) [13, 14].

Teleaudiology usage has increased significantly since before the COVID-19 pandemic. In a 2016 survey of 102 Australian hearing care professionals, telephone was used most often for exchanging information and follow-ups (67%), whereas very few used videoconferencing (6%) or used teleaudiology to conduct more complex tasks such as assessment or monitoring [15]. In a mid-2020 international survey ($n=337$), 62% of respondents reported they used telehealth at the time of the survey, compared

to 41% when reflecting on usage before COVID-19 [1]. In a UK survey of audiologists also conducted mid-2020 ($n=140$), the increase was even greater with 32% reporting they used teleaudiology prior to COVID-19, and 98% had done so at the time of the survey [2]. The study also reported that the majority of the teleaudiology consultations were limited to follow-up services to review client satisfaction with hearing aid fittings and to provide device management tips through the use of phone calls (82% respondents), followed by videoconferencing (75% respondents). In a late-2020 survey of 249 Australian hearing healthcare clinicians, key drivers for clinicians to provide teleaudiology services were the desire to keep patients and themselves safe, adherence to social distancing practices, as well as amended government funding for teleaudiology services in response to the pandemic [3].

There have been significant advancements in the availability and accessibility of remote hearing technology. Self-directed air conduction pure tone audiometry and digits-in-noise tests can be performed on smartphones or tablets, and self-test kits complete with digital otoscope are available to be sent to people's homes, enabling remote hearing assessment [16–18]. These mobile, digital tests have been validated against conventional audiometry and demonstrate good reliability [19, 20]. Additionally, there has been a growing number of hearing aids that support remote adjustments by an audiologist or can be self-adjustment using a smartphone app. This has enabled greater customisation of hearing aid settings for clients without the need for in-person visits. Another notable technology advancement is the availability of closed captions on many videoconferencing platforms. Automatic speech recognition technology now has very good accuracy in quiet conditions and can help ease communication for people with hearing difficulties.

However, despite a large consensus of evidence supporting teleaudiology, a number of barriers and variation in attitudes persist. Some of the most prominent identified barriers include limitations in procedures that can be performed remotely, lack of policy and procedures in relation to use of telehealth, and overall client and clinician preference for in-person appointments [2]. Aspects external to audiologists themselves, such as the unavailability of equipment at clinics or client sites, clients' ability to access and cope with technology [1], concerns about the reliability of remote assessments and information security [3] have been reported. Furthermore, inadequate clinic management support or infrastructure, time constraints, billing and remuneration concerns, deviation from the status quo, and the cost of equipment and software have also been reported by clinicians as logistical barriers to teleaudiology adoption [21]. In a survey of 323 healthcare professionals, over 50% also rate client factors

such as digital literacy, access to suitable technology and reliable internet, and their lack of confidence in clients to use technology as a moderate or extreme barrier [7].

One final barrier is the perceived impact of teleaudiology on the quality of hearing care and the client/clinician relationship. Many clinicians are also not willing to use teleaudiology for new clients, or those aged less than 12 years or over 80 years [22, 23]. In a UK survey of clinicians ($n=120$) almost 57% believe teleaudiology would be detrimental to the quality of their interpersonal interactions [2].

The COVID-19 pandemic has meant that there has been a greater shift towards using teleaudiology services. For some clinicians this transition has been easy and for others it has been challenging. Understanding the rationale for the variation in teleaudiology usage amongst audiologists and identifying appropriate components to be addressed to bring about targeted behaviour change to improve uptake and usage of this practice is of value. In this study, we aim to compare how usage of and attitudes towards teleaudiology of audiologists have changed since before the COVID-19 pandemic. Moreover, we aim to gain further insight into the responses by analysing how perceptions differ between audiologists who use teleaudiology and those who do not, as well analyse the capabilities, opportunities, and motivations of audiologists with varying levels of telehealth experience to identify specific potential barriers that may be addressed to increase acceptance and usage.

Methods

Study design and data collection

Attitudes towards and usage of teleaudiology were gathered as part of a design thinking study to identify the unmet needs of teleaudiology users [24]. The study, conducted prior to the COVID-19 pandemic in 2018, aimed to identify user unmet needs and determine critical factors for teleaudiology success. It included four online surveys targeted to audiologists, adults with hearing loss, parents of children with hearing loss, and audiology clinic managers. Additionally, the study employed ethnographic observation, semi-structured interviews, and an analysis of existing teleaudiology tools and methods. In this article, we focus on the survey for audiologists (Survey A1: Sept – Oct 2018). A second survey was conducted three years later, approximately 18 months after COVID-19 restrictions were introduced (Survey A2: Sept – Oct 2021). The surveys A1 and A2 captured the following information:

- Demographics: country of residence, years of clinical experience, location (metro/regional/rural), type of audiology practice (private/government (public))
- Use of teleaudiology: frequency of teleaudiology use, types of hearing tasks provided using teleaudiology, communications technologies used for teleaudiology
- Opinions on teleaudiology: willingness to use teleaudiology to perform certain services, effect of delivering services by teleaudiology on quality, job satisfaction and other criteria, benefit of teleaudiology for different tasks, factors indicating client suitability for teleaudiology
- Audiologists' perspectives on their capabilities, opportunities, and motivations towards teleaudiology (Survey A2 only)

Due to the anonymity of the survey respondents, it was not possible to follow-up with the same group again. Many questions from Survey A1 were repeated in Survey A2 allowing responses to be compared. The purpose was to investigate general shifts in attitudes and usage before, and a considerable amount of time into, the pandemic and explore underlying factors. While many teleaudiology studies conducted during COVID-19 have relied on retrospective comparisons, this study's use of two snapshot views may help to mitigate factors that might influence the accuracy of self-reported responses, such as recall bias. Ethics approval for both studies was received from the Hearing Australia Human Ethics Committee, approvals AHHREC 2018–22 and HAHREC 2021–13. Both surveys were administered online with Survey A1 conducted using SurveyMonkey (Momentive Inc, San Mateo, California, USA), and Survey A2 using REDcap (Provo, Utah and Seattle, Washington, USA). The surveys were promoted through National Acoustic Laboratories (NAL) social media channels (LinkedIn, Facebook, Twitter) as well as within online communities of audiologists, such as Facebook groups or LinkedIn groups dedicated to audiologists. Informed consent was provided by participants at the beginning of the survey. The surveys were available only in English.

Use of a theoretical model of human behaviour

Theoretical models of behaviour are increasingly used in health psychology to explain individual behaviours and design interventions that support the uptake and use of effective clinical practices. The application of a theoretical model from health psychology to a hearing research context can provide a useful and systematic way to assess and conceptualise behaviour in clinicians with varying levels of teleaudiology experience.

One such model, the COM-B, proposes that capability (C), opportunity (O) and motivation (M) are three components required for any behaviour to occur, as shown in Fig. 1 [25]. To engage in a particular behaviour, a person needs to have the required physical and psychological

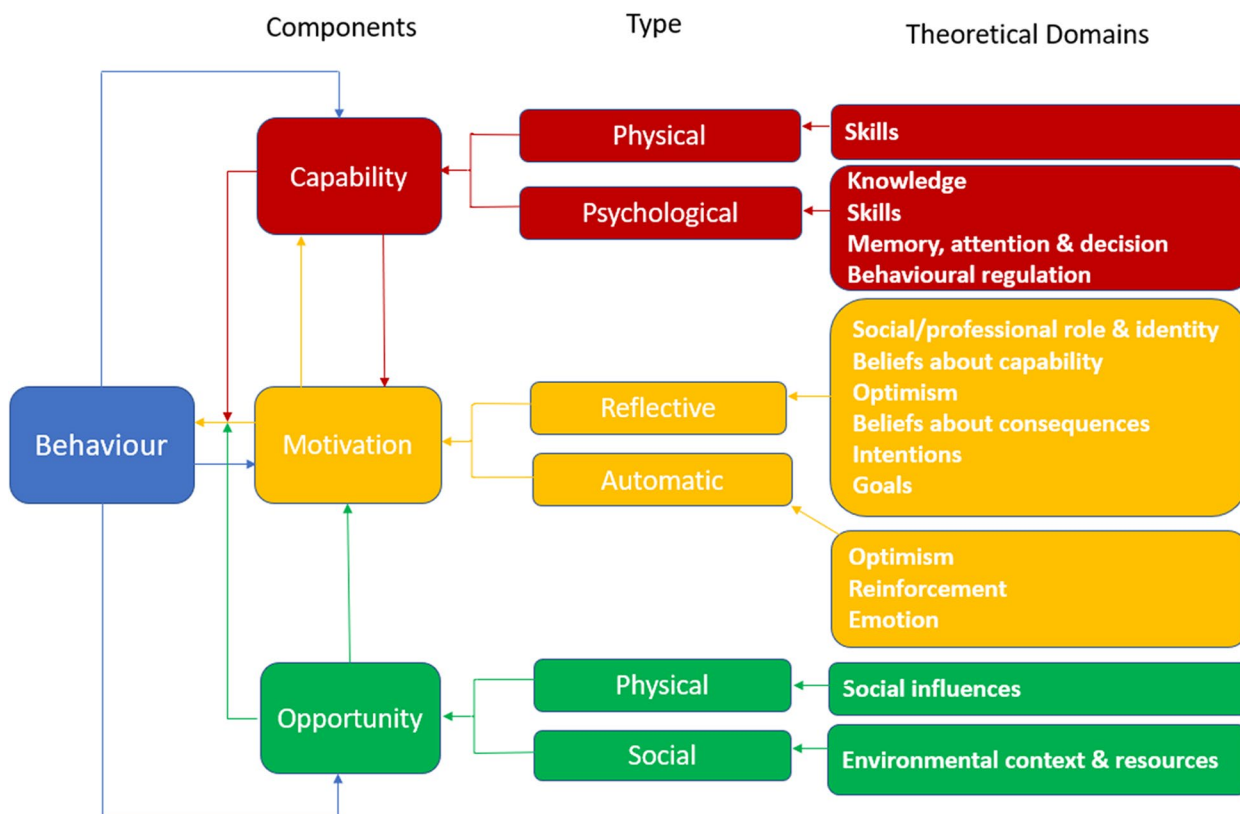


Fig. 1 The COM-B model of behaviour, theoretical domains framework and constructs. ((adapted from Cane et al., 2012, p.15 [26])

skills, social and physical environment, and underlying beliefs and intentions. The three factors interact with each other. They can provide rationale for specific behaviour patterns and identify individual areas to address to modify that behaviour. To design effective interventions that address the identified potential barriers and facilitators, researchers can utilise the full behaviour change wheel (BCW) framework.

In previous studies, the COM-B model has been applied to assess hearing aid use and guide interventions to increase usage [27, 28], increase use of family-centred care in audiology appointments [29], inform teleaudiology survey development [30] and guide data analysis and reporting [3].

We chose to incorporate the COM-B model in Survey A2 (2021) to gain a deeper understanding of the rationale behind survey responses and to facilitate structured consideration of potential influencing factors. This approach was particularly useful as unlike Survey A1 (2018), we did not conduct any clarifying, post-survey interviews in 2021. Ten statements were added specifically focusing on audiologists’ skills, knowledge, beliefs, and environmental and social influences. Clinicians were asked to rate how much they agreed or disagreed with these

statements on a 5-point scale from Strongly Disagree to Strongly Agree to help us further understand the potential barriers and facilitators to teleaudiology usage.

Data analysis

Due to the different samples of audiologists in each survey, some t-test assumptions were not met. Therefore, the data analysis primarily employs descriptive statistics and non-parametric tests, such as the Mann–Whitney U test and Chi-square test. The analysis explores differences among responses between the 2018 and 2021 surveys, differences between various subsets of respondents within each survey year, and associations of years of experience and country with use of teleaudiology.

Results

Demographics

Eighty audiologists completed Survey A1 and 105 audiologists completed Survey A2. Participant demographics for each of the survey samples are reported in Table 1. Years of experience as an audiologist and workplace location were similar between the two survey years, with the majority of respondents having more than 3 years of experience. In both surveys, most participants were

Table 1 Participant demographics

Sample characteristics	Survey A1, 2018 (N=80)	Survey A2, 2021 (N=105)
Years' experience (n, %)		
0–2 years	13 (16)	8 (8)
3–5 years	18 (23)	22 (21)
6–10 years	11 (14)	22 (21)
11–20 years	17 (21)	27 (26)
20+ years	21 (26)	26 (25)
Country of practice (n, %)		
Australia	39 (49)	77 (73)
United States	9 (11)	8 (8)
United Kingdom	7 (9)	2 (2)
Other	26 (33)	17 (15)
Workplace location (n, %)		
Metro	58 (73)	72 (69)
Regional	14 (18)	29 (28)
Rural/remote	8 (10)	4 (4)
Clinical practice setting (n, %)		
Public/government	31 (40)	57 (54)
Private	47 (60)	48 (46)

practicing in Australia, and the majority worked in metropolitan areas.

Use of teleaudiology

The following definition of teleaudiology was provided in the survey to ensure consistent understanding: Teleaudiology refers to the use of communication technologies such as telephones, smartphone applications, web chat, email, and video conferencing to assist with the provision of hearing healthcare services at a distance. There was a large increase in the proportion of audiologists who have provided hearing services using telehealth from 43% in 2018 to 86% in 2021. (*Question: Have you provided services to a client using teleaudiology (excluding scheduling appointments)? Yes/No*). The frequency of teleaudiology usage also increased, with 62% of audiologists who used teleaudiology responding that they used it at least a few times per week, compared to 26% in 2018. Phone calls remained the most common telecommunication mode, used by 90% of teleaudiology users in 2021. Use of smartphone apps to remotely adjust hearing aids was more prevalent in 2021, with 58% of teleaudiology users utilising them, as opposed to 29% in 2018. A chi-square test of independence was performed to examine the relation between teleaudiology use (have/have not used) and years of experience. In both 2018 and 2021, there was no significant association found (2018: $\chi^2(4)=4.604$, $p=0.330$; 2021: $\chi^2(4)=6.896$, $p=0.141$). No statistically significant association between teleaudiology

Table 2 Comparison of perceptions regarding aspects of teleaudiology among teleaudiology users in 2018 and 2021

Aspect of teleaudiology	Mann–Whitney U-test			Mean rank	
	U	z	p	2018	2021
Quality of care	915.0	-2.956	.003*	76.48	55.67
Quality of relationship between audiologists and new clients	1030.5	-2.241	.025*	72.76	56.92
Quality of the relationship between audiologists and returning clients	1347.0	-.301	.763	62.55	60.47
Client satisfaction	1077.0	-1.755	.079	69.60	57.47
Clinician job satisfaction	963.0	-2.646	.008*	74.94	56.20

* denotes a statistically significant difference, $p < .05$

use and country (Australia/non-Australia) was observed in 2018 ($\chi^2(1)=1.778$, $p=0.182$), but there was a statistically significant association in 2021 ($\chi^2(1)=9.943$, $p=0.002$) that was moderate ($\phi=0.302$).

Perceptions of the effect of teleaudiology

The perceptions of teleaudiology users and non-users regarding the impact of teleaudiology services on various aspects of clinical practice were compared using the non-parametric Mann–Whitney U-test between teleaudiology users and non-users within each year (Table S1 provided in [Supplementary Information](#)) and between teleaudiology users in 2018 and 2021 (Table 2).

Effect of teleaudiology on quality of care

The ability to provide high quality care and establish rapport with clients without a face-to-face appointment is often viewed as a barrier for teleaudiology uptake. When comparing the perceptions of teleaudiology between different subsets of respondents and survey years, several key findings emerged. In 2018, no significant difference in the perceived quality of care was observed between teleaudiology users and non-users ($U=358.5$, $z=-1.806$, $p=0.071$) (Fig. 2a). However, in 2021, teleaudiology users reported a statistically significant increased quality of care (mean rank=56.47) than non-users (mean rank=32.17) ($U=362.5$, $z=-2.988$, $p=0.003$) (Fig. 2b). Furthermore, among teleaudiology users, the quality of care statistically significantly decreased in 2021 (mean rank=55.67) compared to 2018 (mean rank=76.48) ($U=915.0$, $z=-2.956$, $p=0.003$).

Effect of teleaudiology on quality of relationships with new and returning clients

Teleaudiology users reported statistically significant higher quality of relationships with both new

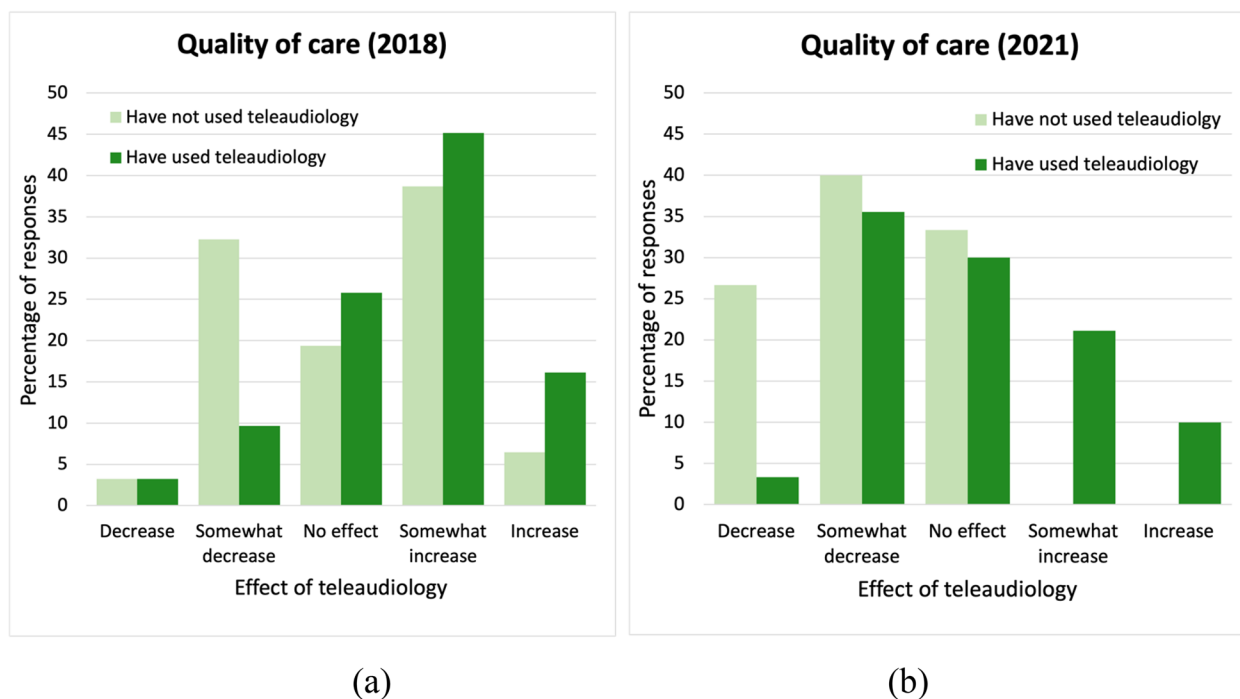


Fig. 2 Perceived effect of teleaudiology on quality of care by audiologists who have or have not used teleaudiology based on survey in (a) 2018 and (b) 2021

and returning clients than non-users in 2018 and 2021 (Table S1 in [Supplementary Information](#)). However, as depicted in Fig. 3, among teleaudiology users, while there was no significant difference in quality of relationship with returning clients between 2018 (mean rank=62.55) and 2021 (mean rank=60.47) ($U=1347.0$, $z=-0.301$, $p=0.763$), there was a statistically significant decrease in quality of relationships with new clients between 2018 (mean rank=72.76) and 2021 (mean rank=56.92) ($U=1030.5$, $z=-2.241$, $p=0.025$).

Effect of teleaudiology on client and clinician satisfaction

In 2021, audiologists who used teleaudiology reported that the provision of teleaudiology services resulted in a statistically significant higher client satisfaction compared to audiologists who hadn't used teleaudiology ($U=397.0$, $z=-2.700$, $p=0.007$). There was no significant difference in client satisfaction reported by audiologists who have used teleaudiology in 2018 and in 2021 ($U=1077.0$, $z=-1.755$, $p=0.079$) (Fig. 4a).

However, among teleaudiology users, there was a statistically significant decrease in job satisfaction from 2018 (mean rank=74.94) to 2021 (mean rank=56.20) ($U=963.0$, $z=-2.646$, $p=0.008$) (Fig. 4b).

Benefits of teleaudiology

Audiologists who used teleaudiology had a more positive perception of its benefits compared to those who did not use it. In both 2018 and 2021, the difference in benefit for troubleshooting with clients between teleaudiology users and non-users was statistically significant. In 2021, teleaudiology users (mean rank 55.42) reported a statistically significant higher benefit in monitoring client satisfaction with devices compared to non-users (mean rank 38.50) ($U=457.5$, $z=-2.117$, $p=0.034$). However, this difference was not statistically significantly in 2018 ($U=323.0$, $z=-1.208$, $p=0.227$).

Effect of COVID-19 on teleaudiology usage

Survey A2 respondents were asked to reflect on their clinical behaviours before the COVID-19 pandemic. Of the 83% of audiologists who indicated a change in their teleaudiology usage at the time of the survey, compared to their recollection of the period prior to the pandemic, the main differences included an increase in the amount of phone calls (88% used more often) and video calls (71% used more often) to deliver hearing services. Remote device fittings and adjustments were used more by 63% of audiologists. Remote diagnostics were performed more by 28% of audiologists, however, 47% did not perform remote diagnostic testing at all.

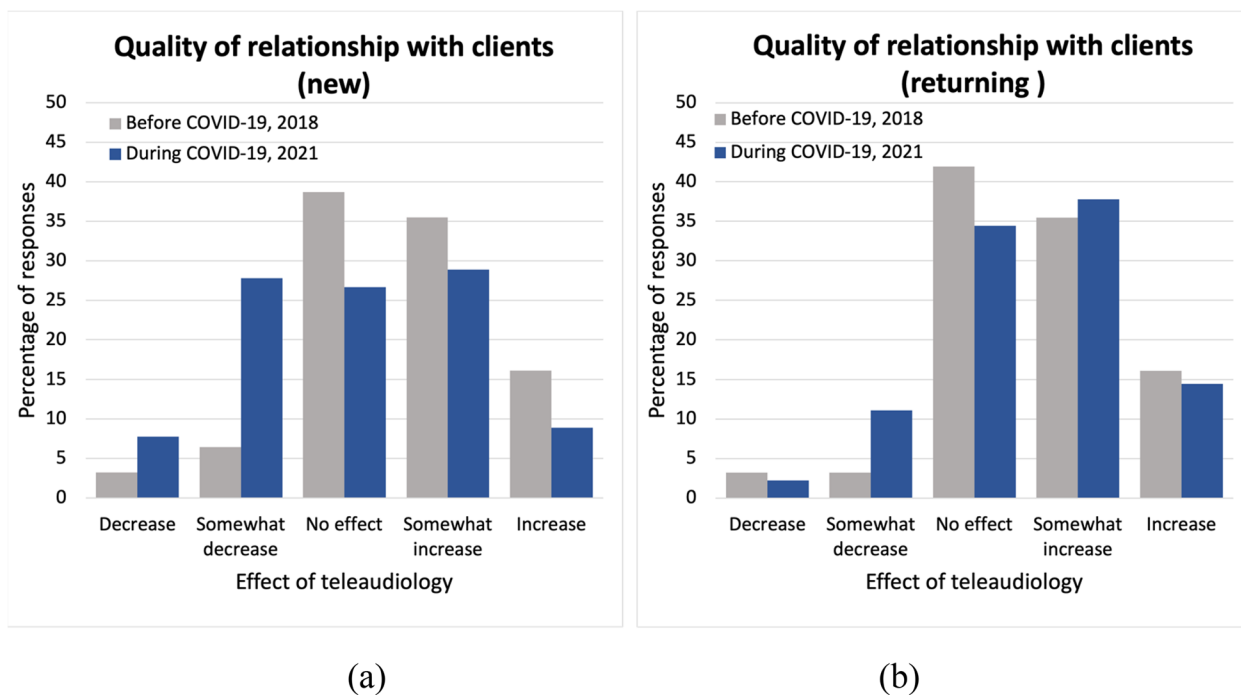


Fig. 3 Effect of teleaudiology on quality of relationships with a) new clients and b) returning clients reported in 2018 and 2021 by audiologists who have used teleaudiology

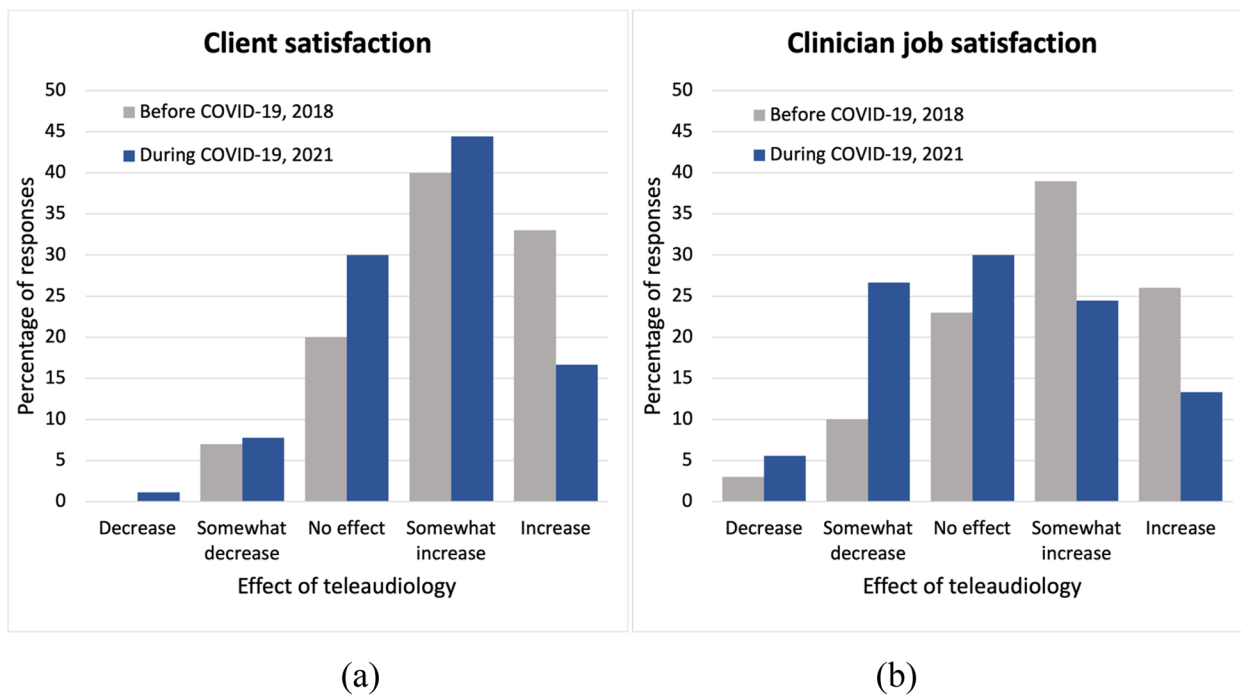


Fig. 4 Effect of teleaudiology on a) client satisfaction and b) clinician job satisfaction reported in 2018 and 2021 by audiologists who have used teleaudiology

Capabilities, opportunities and motivations

In the 2021 survey, to gain further understanding of audiologists’ capabilities, opportunities and motivations to use teleaudiology or not, they were asked to respond to ten statements on a 5-point scale: Strongly disagree, Disagree, Neutral, Agree or Strongly agree.

The responses from audiologists who have used teleaudiology (N=80) are shown in Fig. 5. The majority of audiologists agree (Agree or Strongly agree) that teleaudiology compliments in-person services (Motivation, 84%), agree they are competent using videoconferencing and apps (Capability, 82%), and agree they have support from their managers to conduct teleaudiology (Opportunity, 68%). Conversely, the top three potential barriers for audiologists who have used teleaudiology, as indicated by their disagreement (Disagree or Strongly disagree), are a lack of clear framework for billing and remuneration (Motivation, 53%), inability to provide a similar quality of service as in-person appointments (Motivation, 46%), and limited confidence in the clients’ ability to access and use communications technologies (Motivation, 40%).

For teleaudiology non-users, the top facilitators are that 42% agree teleaudiology compliments in person services, and 50% are competent using videoconferencing and smartphone applications. The most prominent potential barriers are disagreement that they can provide a similar quality of service as in-person appointments (Motivation,

83% disagree), and that there are clear guidelines to deliver telehealth (Opportunity, 75% disagree).

A striking difference between those who have and haven’t used teleaudiology was related to training. 42% of audiologists who have not used teleaudiology “Strongly disagree” that they had received appropriate teleaudiology training, compared to 0% for audiologists who had used teleaudiology.

Discussion

This study aimed to explore the attitudes towards and usage of teleaudiology by audiologists prior to and during the COVID-19 pandemic, and analyse the capabilities, opportunities, and motivations to identify potential barriers that may be addressed to increase acceptance and usage.

The current study findings illustrate a strong increase in teleaudiology usage during the pandemic. The 2021 survey findings that phone calls remained the most common telecommunication mode (90% of users) for service provision during COVID-19, followed by video conferencing (65% of users), as well as reported increase of smartphone apps usage to remotely adjust hearing devices, are consistent with and expanded on previous literature [1–3, 7, 31].

Research focussed across many domains suggests that people are more accepting of technological

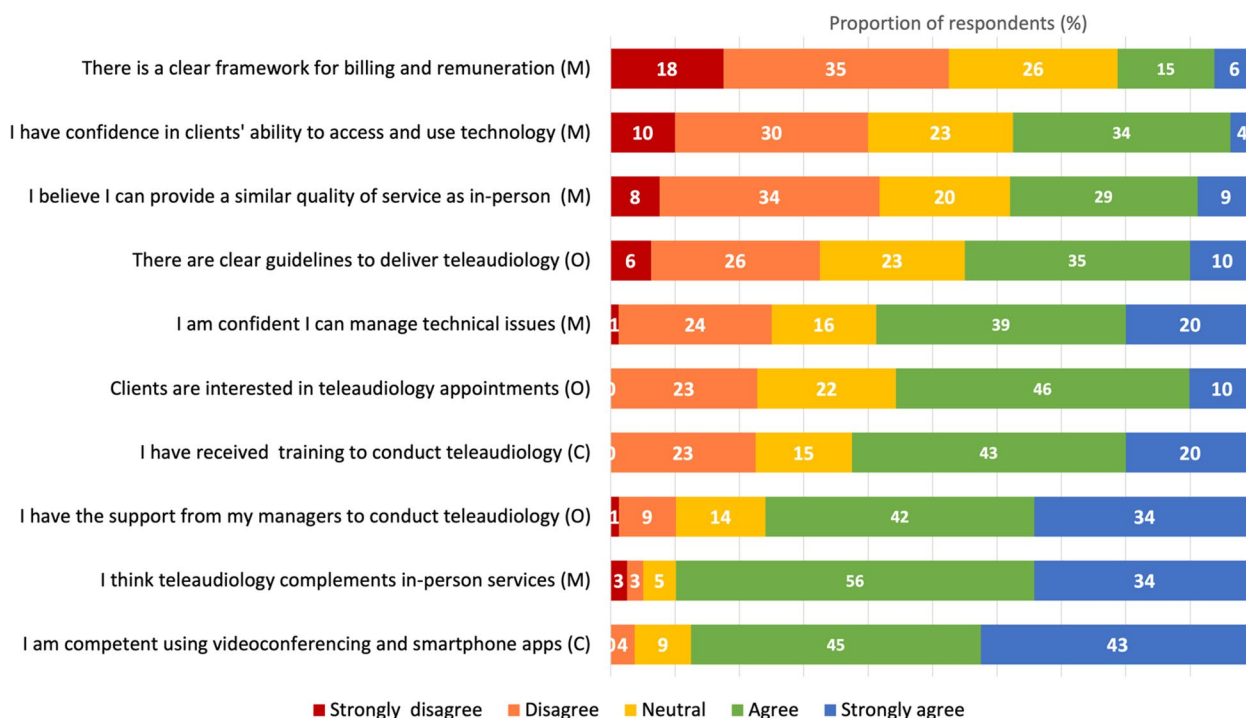


Fig. 5 Opinions of audiologists who have used teleaudiology on factors relating to their capabilities (C), opportunities (O) and motivations (M) towards teleaudiology, 2021 survey (n=90)

advancements once they have trialled them and teleaudiology is no exception [32]. Previous findings in both audiology and other health fields indicate exposure to telehealth helps shape a more positive attitude in clinicians and patients [1, 33]. In the present study, audiologists who have used teleaudiology perceived greater benefits in certain aspects of service delivery than non-users. Specifically, in 2021, teleaudiology users found more value in troubleshooting with clients and monitoring satisfaction with devices. These findings suggest that audiologists who have adopted teleaudiology are experiencing advantages that non-users may not yet realise. The significant higher perceived benefit of monitoring devices, which was not present in 2018, could indicate an evolving appreciation for teleaudiology as it continues to improve and audiologists and clients become more familiar with it. Current teleaudiology features implemented in hearing aids that are connected to smartphone apps have allowed clinical monitoring and fine-tuning to be more efficient, with automatic prompts delivered to users for feedback a few days after any device adjustments.

Teleaudiology users consistently reported a higher perceived quality of relationships with clients than non-users. However, there was a decrease in perceived quality of care among teleaudiology users between 2018 and 2021, and a decrease in the perceived quality of relationships with new clients. These findings highlight the need to explore strategies to improve the initial client-audiologist relationship in teleaudiology, to maintain high care quality.

The results also reveal an interesting contrast between client satisfaction and clinician job satisfaction. In 2021, teleaudiology users reported a significant increase in client satisfaction compared to non-users, but they experienced a decrease in job satisfaction compared to teleaudiology users in 2018. These findings suggest that while teleaudiology has been successful in meeting clients' needs during the COVID-19 pandemic, the decrease in job satisfaction among teleaudiology users may indicate challenges or increased stressors. A hypothesis is that in 2021, there was an urgent need imposed by the COVID-19 restrictions to provide remote services and many audiologists may have done so without adequate training, planning or intrinsic motivation. This is reinforced by the responses where audiologists indicated there was not enough time to consider such a large change in care provision [2], they would likely reduce the majority of modes of telehealth beyond the pandemic [1, 3], and a subsequent analysis of telehealth usage in a large hearing service provider in Australia which showed a drop in telehealth follow-up appointments when pandemic restrictions were relaxed [34].

The shift towards increased phone and videoconferencing calls for delivering hearing services, and the growing use of remote device fittings and adjustments during the COVID-19 pandemic demonstrates the willingness of audiologists to embrace alternative methods to continue providing essential care to clients. However, the reluctance of some audiologists to engage in remote diagnostic testing suggests that there may still be concerns about the accuracy and reliability of telehealth methods, or a lack of familiarity with available technologies.

Application of the COM-B theoretical framework in the 2021 survey uncovered specific behaviour patterns and highlighted individual areas to address to modify behaviour. A large majority of teleaudiology users agreed that it complements in-person services. Factors such as high competence with videoconferencing and apps, as well as managerial support, contribute to the adoption of teleaudiology. However, key potential barriers for teleaudiology users are related to motivation, including lack of a clear billing framework (a strong demotivating factor highlighted in our 2018 interviews), concerns about providing similar service quality as in-person appointments, and limited confidence in clients' ability to access and use communication technologies. These factors highlight areas that warrant further attention, and addressing them may improve the infrequent teleaudiology usage reported by some audiologists. As technology advances, reliable teleaudiology tools become accessible, and clients' technical competence grows, the motivation of audiologists to use teleaudiology may be positively influenced.

Key potential barriers to beginning to use teleaudiology include a lack of training (Capability), lack of clear billing frameworks (Motivation), and unclear guidelines for delivery (Opportunity). To bridge this gap around need for training and clearer guidelines, allied health professional organisations, such as Audiology Australia, have released teleaudiology guidelines to help healthcare providers set up teleaudiology services and enable clinicians to develop necessary skills to safely and effectively deliver teleaudiology services [35]. The disparity in training between users and non-users highlights the critical role of training and support in facilitating teleaudiology adoption. An additional key potential barrier was the lack of belief that the quality of teleaudiology services is comparable to in-person appointments (Motivation). Continued research into the effectiveness of teleaudiology, the development of validated tools, and greater evidence to support remote testing reliability, may help increase the confidence of audiologists and service providers towards teleaudiology. Strong buy-in from managers and organisations to deliver audiological services remotely, and hence, dedication of time towards appropriate training and higher investment in telehealth software and

equipment, may increase usage. While previous studies have identified similar barriers and numerous others [1, 21, 22] these results emphasise the essential aspects to focus on to facilitate audiologists' adoption of teleaudiology, particularly in the context of the COVID-19 pandemic.

The current findings support the use of health behaviour models, such as the COM-B framework, in audiological research to evaluate clinicians' attitudes towards telehealth and identify context-specific processes that can be utilised for appropriate and targeted interventions to change digital health-related behaviours and increase acceptance and adoption of teleaudiology.

Limitations of the study

The study aimed to survey a broad representative group of audiologists from multiple countries who conduct routine audiological rehabilitation and seek their opinions regarding the delivery of hearing healthcare teleaudiology services. To reach a wider audience, the two cross-sectional surveys for audiologists were administered online. This online survey format is likely to draw responses from clinicians who are technologically competent and have ready access to internet services, thus may be more inclined to use teleaudiology. The survey was in English only, and there was a larger representation of respondents from Australia, which may limit generalisability to other countries, regions, cultural backgrounds. Furthermore, Australia's government-funded hearing services program for eligible pensioners could also constrain the generalisability. Our primary goal was to uncover challenges that would inform technology development to suit the majority of audiologists, and hence we chose not ask a comprehensive set of demographic questions to shorten the survey and encourage participation. We acknowledge that more detailed demographic information could have provided a richer context for the findings. The anonymous nature of the surveys aimed to elicit honest opinions from respondents, and thus, it was not possible to ensure the same respondents participated in both surveys. Thus, the analysis primarily focuses on describing the findings, and non-parametric tests were used for comparisons.

Conclusion

This study highlights the attitudes and perceptions of audiologists towards teleaudiology before and after the COVID-19 pandemic. There has been a significant increase in teleaudiology usage between 2018 and 2021, with audiologists who used teleaudiology reporting higher perceived benefits and improvements in certain aspects of care. However, the results also revealed a decrease in job satisfaction among teleaudiology users

and challenges in establishing rapport with new clients. Applying the COM-B framework allowed for a better understanding of the factors influencing teleaudiology adoption, including the importance of appropriate training and support from managers, and encouraging clinicians to experience teleaudiology in order to improve their perception of the quality of services they can deliver without in-person consultations. Overall, the findings contribute valuable insights to the ongoing development and refinement of teleaudiology services, paving the way for more effective and accessible hearing care.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s44247-023-00024-1>.

Additional file 1: Table S1. Comparison of perceptions regarding aspects of teleaudiology between audiologists who have used teleaudiology (Yes) and audiologists who have not used teleaudiology (No). Data is analysed separately for each survey year. 2018 and 2021.

Additional file 2. 2021 Teleaudiology Survey for Audiologists

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Authors' contributions

NC designed the surveys for both the 2018 and 2021 studies, analysed and interpreted the data for both surveys, and was a major contributor to writing the manuscript. PI provided input to survey questions relating to the COM-B behaviour model in the 2021 survey, analysed and interpreted the COM-B data and was a major contributor to writing the manuscript. MP helped design survey questions for the 2021 survey and was a major contributor to writing the literature review. All authors read and approved the final manuscript. JT performed the statistical analysis for both the 2018 and 2021 surveys and contributed to the interpretation of the results.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All methods were performed in accordance with relevant guidelines and regulations governing our organisation (Hearing Australia Human Ethics Committee). Ethics approval for both studies was received from the Hearing Australia Human Ethics Committee, approval numbers AHHREC 2018–22 and HAHREC 2021–13, and all survey respondents gave their informed consent to participate.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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