

# International Survey of Audiologists during the COVID-19 pandemic: Use of and attitudes to telehealth

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31 **Abstract**

32 Objective: To determine the attitudes of audiologists towards telehealth and use of  
33 telehealth for the delivery of ear and hearing services pre-, during- and post- the COVID-19  
34 pandemic, and to identify the perceived effects of telehealth on services and barriers to  
35 telehealth.

36 Design: An online survey distributed through the International Society of Audiology and  
37 member societies.

38 Study sample: 337 audiologists completing the survey between 23 June and 13 August 2020.

39 Results: There was a significant increase in the perceived importance of telehealth from  
40 before (44.3%) to during COVID-19 (87.1%), and the use of telehealth previous (41.3%),  
41 current (61.9%) and expected use of telehealth (80.4%). Telehealth was considered  
42 adequate for many audiology services, although hearing assessment and device fitting by  
43 telehealth received least support. Matters related to timeliness of services and reduction of  
44 travel were reported as the main advantages, but relationships between practitioners and  
45 clients may suffer with telehealth. Important barriers were technologies related to the client  
46 or remote site; clinic-related items were moderate barriers, although more clinician training  
47 was a common theme provided through open-ended responses.

48 Conclusion: The COVID-19 pandemic has resulted in audiologists having a more positive  
49 attitude towards and greater use of telehealth, but with some reservations.

50

51 **Keywords:** telehealth, tele-audiology, audiology services, COVID-19

52 **Introduction**

53 Major events such as earthquakes, storms, fire, floods and outbreaks of disease usually  
54 result in short to medium term disruption to communities on a local or regional level. Yet a  
55 country level response is often required before life goes back to normal for the majority of  
56 the affected population. The COVID-19 pandemic is different in that it has affected almost  
57 everyone indiscriminately across the globe to different degrees with emerging evidence that  
58 there will be long-lasting shifts in behaviour and practices. Hygiene practices, travel, work  
59 practices, personal interactions and access to services have all changed for most of the  
60 global population.

61 Not least of these changes has been access to health services, including to audiological care  
62 (Blumenthal et al., 2020). As governments enforced lockdowns of varying degrees (Our  
63 World in Data, n.d.), audiologists were faced with dilemmas on how to continue to care for  
64 clients under the fluctuating restrictions on business practice (Saunders and Roughley, 2020,  
65 Swanepoel and Hall, 2020, Ballachanda et al., 2020). Professional associations have provided  
66 support and advice (British Academy of Audiology, 2020, British Society of Hearing Aid  
67 Audiologists, 2020) and have interacted with governments to make the case for hearing  
68 services to be considered an essential service. Some governments put in place temporary  
69 allowances for hearing services to be delivered remotely, when funding had previously only  
70 been provided for in-person services (Department of Health, 2020, U.S. Department of  
71 Health & Human Services, 2020, National Center for Immunization and Respiratory Diseases  
72 (NCIRD)-Division of Viral Diseases, 2020).

73 To date, the evidence of how and to what degree the COVID-19 pandemic has affected  
74 audiology services has only been documented by a few (Saunders and Roughley, 2020, Aazh  
75 et al., 2020, Zaitoun et al., 2021). A survey of 120 audiologists in the United Kingdom  
76 (Saunders and Roughley, 2020) reported an almost universal use of telehealth for audiology  
77 service delivery during restrictions, alongside a range of concerns (e.g. impact on personal  
78 interactions, capacity of technology for certain tasks) and benefits of telehealth (e.g.  
79 reduced travel, convenience). A study of people undergoing CBT for tinnitus, found that 80%  
80 accepted telehealth-delivered therapy during the COVID-19 lockdown in the UK, but those  
81 with poorer hearing and greater distress from their tinnitus were less likely to use this  
82 service (Aazh et al., 2020). As an alternative to in-person consultations, the use of telehealth

83 for delivering health services has been promoted across many sectors (Garcia-Huidobro et  
84 al., 2020, Lin et al., 2020).

85 Although telehealth delivery of audiology services has been the subject of much discussion  
86 in recent years, clinical uptake has been slow, despite a growing body of evidence  
87 supporting the use of telehealth for audiology services (Munoz et al., 2020). Although many  
88 aspects of audiology have been validated for use in telehealth (Swanepoel and Hall, 2010,  
89 Tao et al., 2018) reports of it being used in routine clinical practice are still limited (Ratanjee-  
90 Vanmali et al., 2020b). Others studies have shown mixed attitudes of audiologists towards  
91 telehealth (Singh et al., 2014, Eikelboom and Swanepoel, 2016). The COVID-19 pandemic  
92 has escalated telehealth in audiology from a matter of convenience and preference to a  
93 service-delivery option that puts safety as paramount (Swanepoel & Hall, 2020). This study  
94 aimed to capture a global perspective of telehealth use by audiologists before and during  
95 the COVID-19 pandemic, and what they anticipate its role to be after COVID-19. We report  
96 on the effect of the pandemic on the workforce (Manchaiah et al., Submitted), and on the  
97 mental wellbeing of audiologists (Bennett et al., Submitted) in separate reports.

98

## 99 **Methods**

### 100 **Study Design and Data Collection**

101 The study used a cross-sectional survey design. Ethics approval for the study was received  
102 (HUM023/0420) from the Faculty of Humanities, University of Pretoria, South Africa.

103 A survey was developed to capture the following information pertinent to this report:

- 104     ▪ Demographics: country of residence, sex, age (years), education level, scope of work,  
105       years of clinical experience.
- 106     ▪ Opinions on telehealth for audiology services: importance of telehealth (before and  
107       current), use of telehealth, effects of telehealth on quality of service, scope of  
108       practice for telehealth services, barriers, and priorities of patient needs.

109 The survey was administered online using Qualtrics (Provo, Utah and Seattle, Washington,  
110 USA), and distributed through the International Society of Audiology (ISA) to all affiliated  
111 regional societies with a request for them to distribute it to their members. The survey was  
112 available only in English. Invitations were also distributed through professional and personal  
113 networks, and via social media platforms.

114

115 **Data Analysis**

116 Quantitative data analysis: Data were analysed and plotted using summary or descriptive  
117 methods using Microsoft Excel and SPSS (v26, IBM Corporation). The reported importance  
118 of telehealth either before COVID-19 or during COVID-19 analysed for the relationships with  
119 gender and previous use of telehealth at the workplace (yes or no) by calculating the  
120 Fisher's Exact Test Chi-squared coefficient. The relationships between the importance of  
121 telehealth before and during COVID-10, and age and experience (as continuous variables)  
122 were examined using univariate ordinal regression. The responses to the questions on the  
123 importance of telehealth were summarised to Not Important (for Not important at all, and  
124 Not important), Neutral, or Important (for Important and Very Important) because of low  
125 expected cell counts in the cross-tabulation. A  $p < 0.01$  was used to determine statistical  
126 significance. Some of the questions in the survey were related to the use of telehealth in the  
127 clinic; as these would be relevant to practising clinicians only, respondents whose scope was  
128 only in research or industry were excluded for the analyses of these data viz. attitudes to  
129 telehealth, and the modes and utilisation of telehealth.

130 Qualitative data analysis: Free text provided by audiologists' in response to the question  
131 "What could be done to overcome these barriers?" were analysed using content analysis  
132 (Graneheim and Lundman, 2004). This qualitative analysis involved: (1) reading participants'  
133 answers to survey questions; (2) identifying meaning units within the data (identifying  
134 individual words/phrases within the data, yet still retaining their original meaning and  
135 context; (3) coding meaning units by grouping together those most closely related; and (4)  
136 grouping coded meaning units into categories. Peer debriefing was used to improve the  
137 rigour of the qualitative content analysis. One research assistant completed the initial  
138 content analysis and two members of the research team (RJB & RE) then crosschecked all of  
139 the analysed data to strengthen the accuracy of the coding, with discrepancies resolved  
140 through group discussion. Categories and meaning units were tabulated, with the number of  
141 participants contributing to each category provided.

142

143 **Results**

144 ***Demographics***

145 A total of 337 people from 44 countries responded to the survey between 23 June and 13  
146 August 2020. Of these, 298 people from 41 countries completed questions related to

147 telehealth. Approximately 60% of the responses came from three countries (Australia, South  
 148 Africa, and USA), and at least 10 responses were received from a further three countries  
 149 (Canada, India, Singapore) (Table 1, Supplementary material]. According to the World Bank  
 150 Atlas (The World Bank, n.d.) method of classifying the economy of countries 222 (66%)  
 151 responses were from High Income countries, 94 (28%) from Upper-Middle Income  
 152 countries, 21 (6%) from Lower-middle Income countries, and none from Low Income  
 153 countries.

154

155 **Table 1: Respondents per country; see supplementary information for full list of**  
 156 **respondents by country.**

Country	Number (%)
Australia	76 (25.5)
United States of America	53 (17.8)
South Africa	50 (16.8)
Canada	13 (4.4)
India	10 (3.4)
Others with less than 10 respondents	119 (39.9)
Total	298

157

158 The respondents consisted of 214 females (78%) and 61 males (22%), with a mean age of  
 159 44.7 years (SD 12.7; Range: 22 to 81) and mean years of clinical experience of 18.9 (SD 12.4;  
 160 Range 1 to 53). There was no significant difference in age and clinical experience between  
 161 males and females.

162

163 ***Scope of services offered***

164 Responses were received from audiologists working in a wide range of clinical fields, with at  
 165 least 20% involved in adult hearing aids, adult implants, other adult related work, paediatric  
 166 hearing aids, other paediatric work, aged-care residents, and research/academia. They were  
 167 also active in industry (18.7%) and paediatric implantation (14.5%).

168 The survey provided eight types of services that may be offered in their clinics: hearing  
 169 screening, hearing assessments, discussion on hearing loss interventions, device fitting,  
 170 device fitting follow-up/fine-tuning, review appointments, communication training, and  
 171 psychosocial support; all were offered by at least 30% of the respondents, with a range of  
 172 other services reported, including tinnitus, vestibular assessment. Some respondents were  
 173 also involved in non-clinical duties, e.g. training, reviewing policies, and so forth.

174 ***Use and perception of telehealth***

175 There was a significant increase in audiologists' perception of the importance of telehealth  
176 during the COVID pandemic, compared to their reflections of the importance of telehealth  
177 before the pandemic (Fisher's  $\chi^2=40.74$ ,  $p<0.001$ ; Figure 1). The reported importance of  
178 telehealth at both time points was not significantly related to gender, experience or age  
179 (Table 2).

180 **Table 2: The importance of telehealth before and during COVID-19, and associations with gender, age, experience and previous use of**  
 181 **telehealth in the workplace (n=275).**

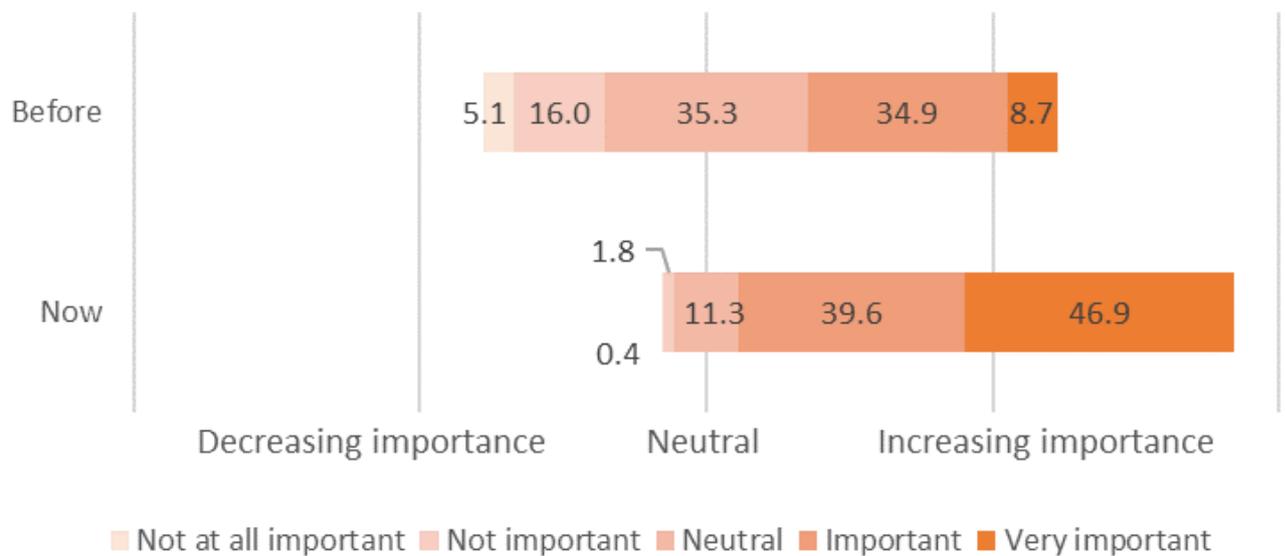
Importance of telehealth		Not important (%)	Neutral (%)	Important (%)	Fisher $\chi^2$	Wald $\chi^2$ (95%CI)	Significance (p)
<b>Before COVID-19</b>							
<b>Gender</b>	Females	19.2	37.4	43.5	2.93		0.232
	Males	27.9	27.9	44.3			
<b>Age (continuous)</b>						3.52 (-0.001 - 0.034)	0.610
<b>Experience (continuous)</b>						2.75 (-0.003 – 0.032)	0.097
<b>Previous use of telehealth</b>	Yes	6.00	35.0	59.0	35.78		<0.001
	No	32.3	35.4	32.3			
<b>After COVID-19</b>							
<b>Gender</b>	Females	0.9	11.3	87.8	5.92		0.048
	Males	6.6	11.5	82.0			
<b>Age (continuous)</b>						2.169 (-0.004 – 0.031)	0.141
<b>Experience (continuous)</b>						0.876 (-0.01 – 0.026)	0.372
<b>Previous use of telehealth</b>	Yes	1.7	12.1	86.2	0.34		0.909
	No	2.5	10.8	86.7			

182

183  
 184 There was a marked increase in the use of telehealth in the audiology workplace from  
 185 reflections before COVID-19 (n=117, 42.5%) to the use of telehealth at the time of the  
 186 survey (n=169, 61.5%), and again to the expectation of the use of telehealth after COVID-19  
 187 (n=205, 74.5%).

188 There was a significant positive association between use of telehealth in the workplace  
 189 before COVID-19 and the reported importance of telehealth before COVID-19 (Fisher's  
 190  $\chi^2=35.78, p<0.001$ ).

191  
 192 **Figure 1: The importance of telehealth before and during the COVID-19 pandemic. The**  
 193 **neutral responses are shown centred on the horizontal midline of the plot to demonstrate**  
 194 **the change in the distribution of the responses towards more importance being placed on**  
 195 **telehealth. The values represent the percentage of respondents (n=275).**



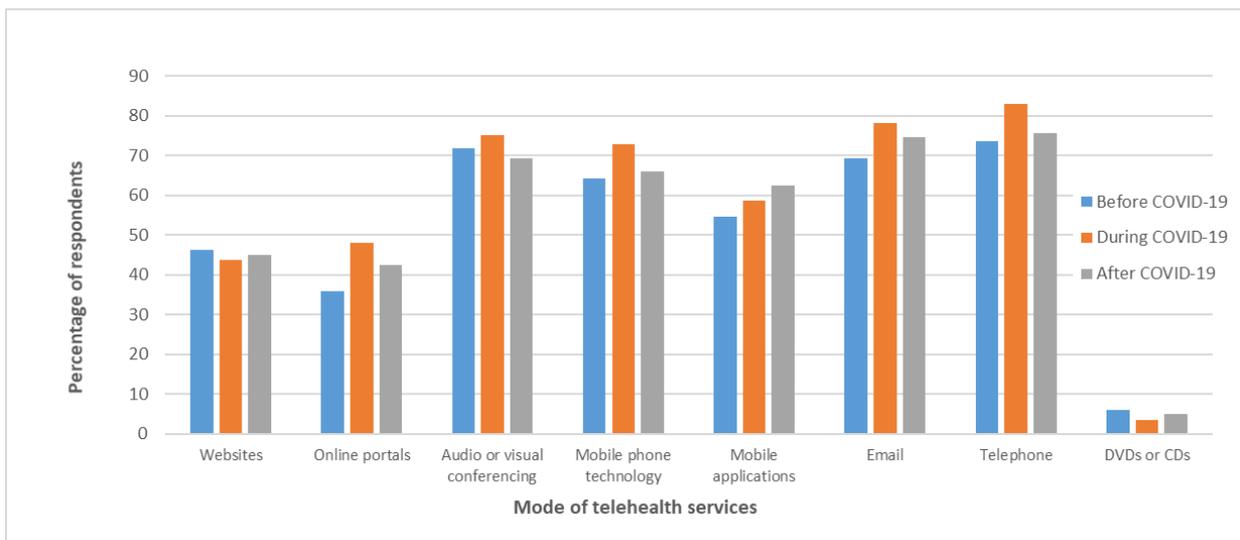
196

197 **Modes of telehealth and application to various consultations**

198 The use of various modes or tools for telehealth consultations used pre- and during-COVID-  
199 19, as well as expectation for their use after COVID-19 (Yes or No), did not vary much  
200 amongst those who reported using or expecting to use telehealth (Figure 2). Audio-video  
201 conferencing, mobile phone technology, email and the telephone are the most common  
202 modes of telehealth, all being used in over 60% of the workplaces that reported using  
203 telehealth before and during COVID-19, or expecting to use telehealth after COVID-19. In  
204 most instances, audiologists indicated that after COVID-19 they would likely reduce their  
205 use of the majority of modes of telehealth to some extent, with the exception of mobile  
206 phone technology, which participants indicated will increase beyond the pandemic.

207

208 **Figure 2: Modes of telehealth as a percentage of respondents who use telehealth in their**  
209 **workplaces before COVID-19 (n=117) and during COVID-19 (n=169), or expected to use**  
210 **after COVID-19 (n=205).**

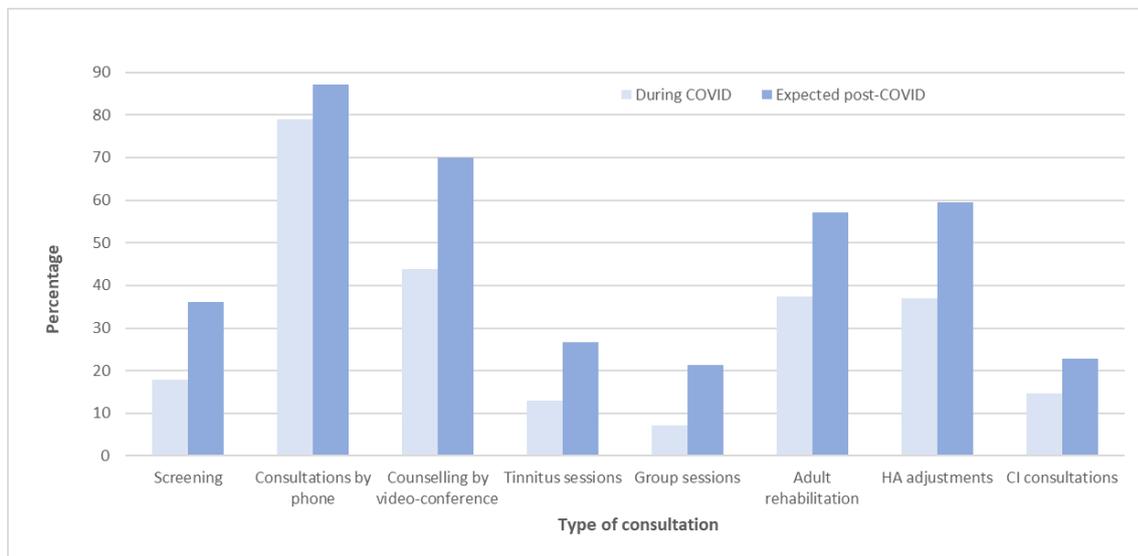


211

212 Survey participants were asked what types of audiology consultations they performed by  
 213 telehealth as a consequence of not being able to see patients in-person during COVID-19,  
 214 and which they expect to be doing after COVID-19. Telephone consultations was the most  
 215 commonly reported practice, conducted by 82% (177 of 224) of respondents (Figure 3),  
 216 which was expected to increase to 90% post-COVID-19 (195 of 224). All other types of  
 217 consultations are also expected to increase, and all from a lower baseline than telephone  
 218 consultations.

219

220 **Figure 3: Utilisation of telehealth for consultation types during COVID-19 and expected**  
 221 **use after COVID-19, by percentage of those who responded to both questions (Yes, No or**  
 222 **Not applicable; n=224).**



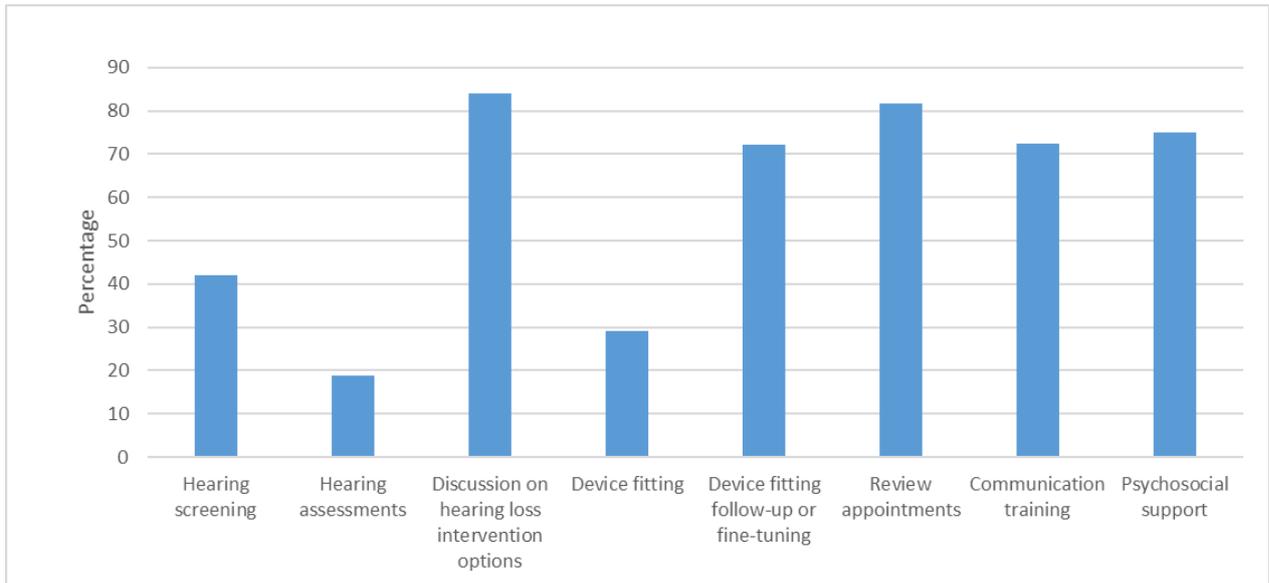
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224

225 ***Considerations of telehealth and barriers***

226 Participants were provided with a list of audiology-related services, and asked to indicate  
 227 those that could be adequately delivered by telehealth. A 70% to >80% positive response  
 228 was provided for five of the eight options (Figure 4). Telehealth was considered adequate  
 229 for hearing screening by 42% of respondents. Hearing assessment and device fitting were  
 230 the two services that respondents felt could least adequately be delivered via telehealth.

231 **Figure 4: Adequacy of telehealth for various audiology services; percentage of positive**  
232 **responses of the total of respondents who completed this question (n=240).**

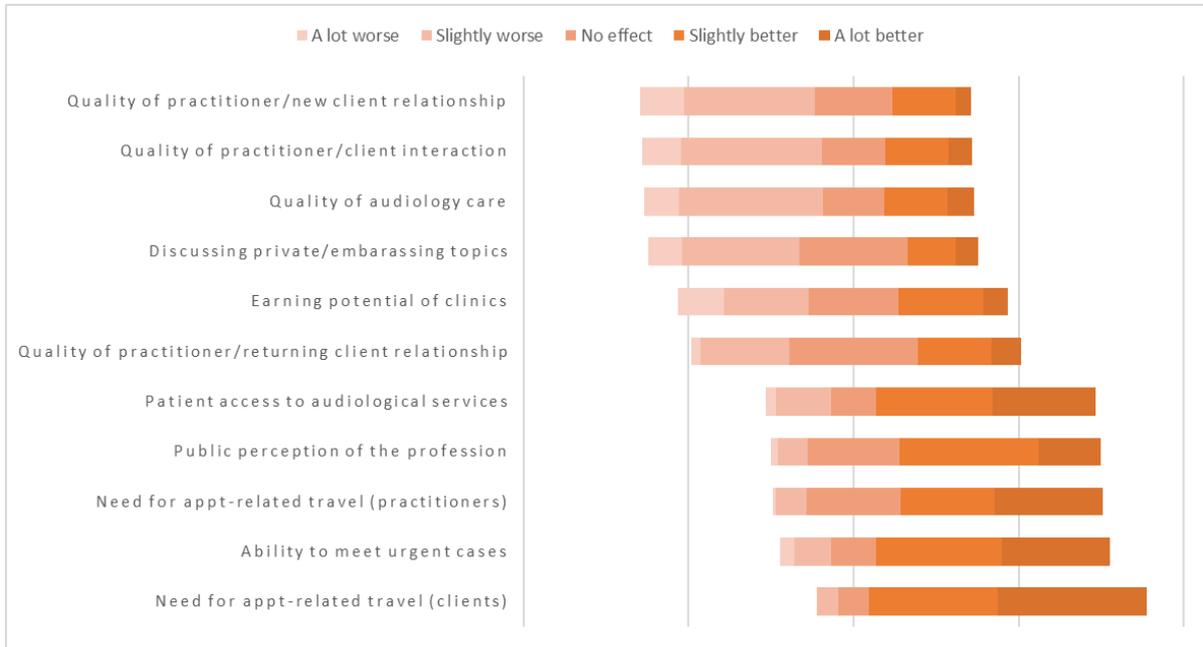


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234

235 Participants in the survey were asked how using telehealth as a mode of delivery of  
236 audiology services may affect a range of factors, providing their responses on a scale from  
237 “A lot worse” to “A lot better” (Figure 5). The expectation of more positive effects was  
238 related to practical aspects (e.g., allowing for urgent appointments, improved access, and  
239 demand on travel for both clinicians and patients) and also how the public perceives the  
240 profession. The tendency to expecting more negative effects was reported for personal  
241 factors (e.g., the quality of relationship between practitioners and *new* clients, the quality of  
242 the interaction between practitioners and clients, the quality of care in audiology, and  
243 discussing personal matters). There was a relatively even spread of negative and positive  
244 expectations for two other factors: the earning potential of clinics, and the quality of the  
245 relationship between practitioners and *returning* clients).

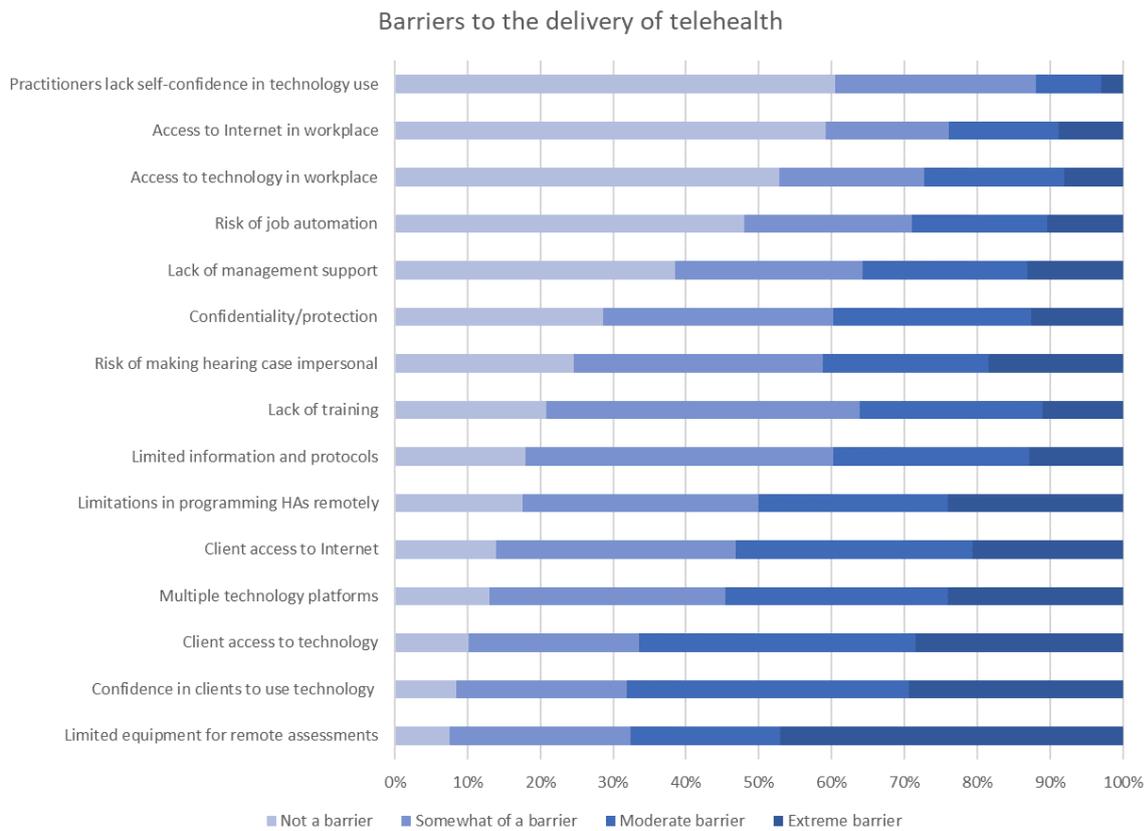
246 **Figure 5: Effect of telehealth on the delivery of audiological services. Percentage of**  
 247 **responds on the scale *A lot worse* to *A lot better*. Items shown are slightly abbreviated**  
 248 **from the phrases used in the survey; see supplementary information for full text of survey**  
 249 **questions and answers (n=240).**



250  
251

252 A list of potential barriers to telehealth for audiology services was presented to the  
 253 participants, asking them to respond with the degree to which they thought these were a  
 254 barrier. Those factors that were considered the greatest barriers were related to clinical  
 255 equipment (e.g., to conduct assessments remotely, multiple technologies across  
 256 manufacturers, inability to access hearing aids remotely) and patient related (e.g., lack of  
 257 confidence, access to the internet) (Figure 6). Factors considered to be the lowest barriers  
 258 were technology infrastructure related (e.g., internet access, communications technology in  
 259 the workplace), and personal factors (e.g., lack of confidence, risk of job redundancy, lack of  
 260 support).

261 **Figure 6. The degree to which potential barriers to the delivery telehealth are considered**  
 262 **a barrier. Items shown are slightly abbreviated from the phrases used in the survey; see**  
 263 **supplementary information for full text of survey questions and answers (n=240).**



264

265

266

267 ***Suggested tools and innovations***

268 An open field invited participants to answer “What could be done to overcome these  
 269 barriers?” A total of 131 participants provided 235 suggestions (Table 3). Qualitative analysis  
 270 showed that these suggestions were in four primary categories: Protocols & training, Access,  
 271 Support and Research.

272 A further open field invited participants to make suggestions for tools or innovations that  
 273 would be useful for delivering services during the COVID-19 pandemic; 108 participants  
 274 provided a response to this question (Table 4). Qualitative analysis revealed four major  
 275 Categories: Video-conferencing and sub-titling, Access to technology (for remote testing and  
 276 programming, and internet capacity), Training, and Governance (legislative and financial  
 277 support, security).

278

279 **Table 3: Qualitative themes and suggestions for overcoming barriers to telehealth for**  
 280 **audiology services.**  
 281

Categories	Sub-categories	Sub-category description	Number of meaning units
Protocols & training	Training and education	Clinician/student/admin staff training, as well as ongoing training to reinforce clinical behaviours. Practice and experience to build skills and confidence.	107
	Clinical practice guidelines and support	Development of standardised clinical protocols/ guidelines. Acknowledgment and funding for tele-audiology services in government hearing services program. Development of government legislations/ regulations/ guidelines.	32
	Time	With time, practice and perseverance	7
Access	Access to technology and internet	Improved access to stable, high-speed internet, technology, and equipment required for tele-audiology services. Development of reliable remote access technology/ devices that enable tele-audiology programs. Address issues concerning data privacy and security. Overcome limitations relating to client's abilities to use technology prior to using tele-audiology (such as through training sessions).	50
	Financial consideration	Access to funds/ affordable costs for setting up tele-audiology services (such as software and equipment costs). Reduce data/internet usage cost, possibly through government funding or partnerships with telecommunications companies. Availability of affordable (or government funded) hearing aids that enable remote programming.	18
	Access to space/ infrastructure	Access to improved infrastructure. Access to space to provide tele-services (hospital-based model). Establishment of community health centre for tele-audiology set up.	6
Support	Support from management and colleagues	Supportive management (organisational buy-in). Relax organisational permissions to enable use of digital technologies (such as permission to use video-conferencing software). Peer support (forums for clinicians to share experiences, hands on practice, success stories)	9

	Emotional connection	Develop a therapeutic/ client-clinician relationship that can be maintained when providing remote care.	<b>3</b>
Research	Research	Research to confirm validity of tele-health services.	<b>3</b>

282

283

284 **Table 4: Tabulation of themes and suggestions of tool or innovation to audiology service**  
 285 **delivery during COVID-19.**

286

<b>Categories</b>	<b>Sub-categories</b>	<b>Sub-category description</b>	<b>Number of meaning units</b>
Video-conferencing and sub-titling	Video-conferencing	Suggested improvements to current video-conferencing platforms included improved sound/video quality, live subtitling, live sign-language translation services, audiology-specific clinical platforms designed to facilitate audiological service delivery (such as embedding hearing assessment tools into video-conferencing platforms), and on the spot technological backup for troubleshooting video-conferencing issues as they arise.	32
	Subtitles	Improved accuracy of live subtitles in video-conferencing software, Subtitles in clients' languages with the possibility of automatic saving and sending of the final transcript of live subtitles to clients.	30
Access to technology	Remote testing	Remote otoscopy, screening, audiology tests by apps and software or by inexpensive equipment to be sent to clients' home.	29
	Remote programming and management programs	Remote fitting and programming hearing devices with a global integrated programming software. Tinnitus management programs as well as better compatibility of hearing devices with mobile phones with the possibility of self-made ear impressions.	24
	Access to technology and services	Access to stable internet and appropriate technology at low cost for all clients as well as access to open resources. Video-conferencing via TV.	23

Training	Information, education, and training for services during pandemic	Guidelines, simple instructions, videos, and written information (in clients' own language) as well as training on using technology for both clients and clinicians.	29
	Support	IT and financial support, legislative support, isolated clients' peer support, and alternative methods for supporting clients who cannot use technology for services.	8
Governance	Secure and confidential tools and apps	Information protection, security, and confidentiality of video-conferencing and apps.	5
	COVID-safe clinics	COVID regulated clinics with acoustic and visually transparent masks for in-person consultations.	2

287

288 **Discussion**

289 The purpose of this study was to gauge the response of the international audiology  
 290 community to the COVID-19 pandemic, particularly the perceived importance and role of  
 291 telehealth to deliver services including barriers to its use.

292 Responses came from audiologists across 44 countries (low, middle and high-income  
 293 countries) that have experienced severe 'lockdowns' at some stage throughout the  
 294 pandemic such that only key workers were able to carry out their normal activities. Updates  
 295 from the websites of professional organisations and governments (Audiology Australia,  
 296 2020, British Society of Hearing Aid Audiologists, 2020, American Academy of Audiology,  
 297 2020, Government of Ontario, 2020) suggest that audiologists have been considered as  
 298 essential health workers in many countries, but that there have been restrictions to the  
 299 services offered in-person with recommendations to offer remote services where possible.

300 This study has shown that audiologists recognise the potential for telehealth as a means to  
 301 improve the way they can deliver audiological services, both during this pandemic and  
 302 beyond it when not driven by the need for social/physical distancing. This is in line with the  
 303 previous findings of others (Singh et al., 2014, Eikelboom and Swanepoel, 2016). In this  
 304 study we have shown that previous exposure to telehealth has helped to shape audiologists'

305 attitude to telehealth, but that the current pandemic has resulted in a strong shift to a large  
306 majority perceiving telehealth to be of primary importance, even beyond the pandemic  
307 situation. The fact that the attitude to telehealth was significantly associated to previous use  
308 of telehealth prior to COVID-19, but not to the attitude during COVID-19 demonstrates that  
309 the pandemic has resulted in a change of attitude. The desire to continue to deliver  
310 audiology services, and the large amount of publicity that telehealth has received since the  
311 onset of the pandemic, not only in audiology but in health in general, is likely to have  
312 contributed to that change. The actual use of telehealth reported in this study was lower  
313 than that reported in the UK (Saunders and Roughley, 2020), probably reflecting the fact  
314 that this survey included respondents from low- and middle-income countries where  
315 facilities and infrastructure may not be in place, as indicated by participants in their free  
316 field responses.

317 The use of the different modes to deliver audiology services remotely appeared to increase  
318 slightly as a result of the pandemic. Of note, is that modes that promote self-management  
319 of the health condition (websites and online portals, and especially DVDs/CD) appear less  
320 utilised. Whilst the modes of delivery may not have changed much, participants expected a  
321 large increase in the number of services, especially for screening, tinnitus sessions and  
322 group sessions. The small amount of change is likely to have been because lockdowns during  
323 the COVID-19 pandemic have restricted accessibility to additional equipment, its purchase,  
324 installation and training. In addition, there have been considerable supply chain problems as  
325 the demand for video-conferencing equipment and home computers exceeded availability  
326 during the pandemic (Dave, 2020). There are a number of validated tools for remote  
327 hearing screening that includes an assessment of overall hearing sensitivity (Potgieter et al.,  
328 2016, Smits et al., 2016), conductive hearing loss (De Sousa et al., 2020) and speech  
329 recognition (Smits et al., 2013), as well as screening focused on hearing implants recipients  
330 (Kaandorp et al., 2015, Cullington and Aidi, 2017). Rehabilitation services for people with  
331 tinnitus can be delivered by telehealth and has been widely accepted (Aazh et al., 2020).  
332 While remote rehabilitation in audiology has been shown to be effective in one-on-one  
333 sessions with a clinician (Thoren et al., 2014, Malmberg et al., 2017, Meyer et al., 2019), the  
334 effective remote delivery of group audiological rehabilitation has yet to be demonstrated,  
335 even though it is technically feasible.

336

337 Respondents appeared to take a pragmatic approach, based on their available knowledge,  
338 technology and skills, to identifying those audiology services that could be adequately  
339 delivered remotely. Most of the services received an endorsement over 70%, which is quite  
340 high in light of the lack of strong evidence of the effectiveness of tele-audiology services  
341 (Tao et al., 2018), and therefore support implementation of tele-audiology services in a  
342 clinical setting. This endorsement is also similar to the percentage of audiologists who  
343 indicated that they would be using telehealth. This may reflect the pragmatic approach of  
344 audiologist to continue to provide services, despite the limitations that they may or may not  
345 recognise. Changing audiological practices to be more reliant on technologies, including  
346 remote care, has also raised fears that some services may become entirely automated  
347 leaving audiologists with a smaller scope of practice (Swanepoel et al., 2010). Few  
348 audiologists were in favour of providing hearing assessments and device fittings via tele-  
349 audiology. These aspects are essential elements of initial patient engagement, both of  
350 assessment and fitting of a hearing device, and also the most challenging to telehealth  
351 service delivery. This may be influenced by current limitations regarding access to  
352 equipment at remote sites. Hearing assessment usually includes obtaining air and bone  
353 conduction, and speech hearing thresholds which require specific equipment and a sound  
354 treated space (Swanepoel et al., 2010, Swanepoel and Hall, 2020, De Sousa et al., 2020).  
355 There may be some scope to utilise automated audiometers away from a clinic (e.g.  
356 (Brennan-Jones et al., 2018), but a facilitator is likely still required. Alternatively, mobile  
357 technologies may provide increasingly sophisticated self-test solutions as recently  
358 demonstrated using air conduction tests, including digits-in-noise and pure tone  
359 audiometry, to accurately differentiate conductive from sensorineural hearing loss  
360 (Swanepoel and Hall, 2020, De Sousa et al., 2020). This type of approach can enable hearing  
361 assessments in unconventional settings because cases of conductive hearing loss or ear  
362 disease can be escalated to clinics (Swanepoel and Hall 2020).

363 Device fitting is a task with many physical aspects that usually requires the audiologist to be  
364 with the client. Previous research in this area highlighted limitations in self-fitting of hearing  
365 aids (Convery et al., 2013) but have more recently supported the potential of self-fitting  
366 with advances in technology and patient-support (Keidser and Convery, 2018). Some  
367 elements of audiology practice (e.g., discussion of hearing loss intervention options,  
368 communication training, psychological support) have been demonstrated to be effective

369 (Beukes et al., 2018, Malmberg et al., 2017, Thoren et al., 2014). However, not all  
370 respondents appear to be aware of this, or remained unconvinced of the evidence. This  
371 highlights a need for training of audiologists on various telehealth models and technologies,  
372 and further validation studies.

373 Respondents to the survey indicated that audiology services by telehealth are most likely to  
374 affect the relationship between the clinician and the clients, and included aspects of  
375 confidentiality, discussing sensitive matters, and quality of care. However, it should be  
376 noted that this view was not universal, and over 50% in each case said that telehealth would  
377 have no effect, or potentially improve these aspects of the services. On the other hand,  
378 there appears to be a need for these aspects to receive attention when implementing  
379 services and educating audiologists. These findings are largely in line with those of recent  
380 studies during the COVID-19 pandemic (Saunders and Roughley, 2020, Zaitoun et al., 2021).  
381 It remains to be seen whether audiology patients in general have the same concerns. One  
382 fifth of patients in a tinnitus treatment programme declined it being delivered remotely for  
383 reasons that included lack of access to devices, and lack of confidence of usefulness (Aazh et  
384 al., 2020). Others report that patients are open to telehealth consultations, but retain a  
385 preference for face-to-face services (Eikelboom et al., 2014, Eikelboom and Atlas, 2005, Tao  
386 et al., 2020). There was a strong recognition amongst audiologists that telehealth services  
387 can lead to better efficiency: less travel for clients or clinicians, more timely attention, and  
388 better overall access, as evidenced in the audiology (Saunders and Roughley, 2020, Reginato  
389 and Ferrari, 2014) and broader literature (Caffery et al., 2016, Taylor et al., 2018, Kokesh et  
390 al., 2011).

391 Audiologists' perceived barriers to telehealth may partly explain their restricting attitude  
392 towards telehealth practices. The least prominent barriers were related to the audiologists  
393 themselves (confidence, support from management, and job security) and communications  
394 technology available to them. More moderate barriers were protocols, training, the risk of  
395 making hearing care impersonal, and confidentiality. The most prominent barriers were  
396 aspects external to the audiologists: unavailability of suitable equipment either in the clinic  
397 or at the client's site, and uncertainty whether their clients could cope with the technology.  
398 These barriers were also captured recently in a thematic report of non-use of telehealth and  
399 the effects of telehealth on personal interactions, quality of service and confidence in  
400 delivering services (Saunders and Roughley, 2020), and survey of audiologists in Jordan and

401 Arab countries (Zaitoun et al., 2021). This reflects a lack of confidence in their clients,  
402 something that may be misplaced. It has been shown that people utilising hearing health  
403 services are proficient in using devices like mobile phones or computers (Ratanjee-Vanmali  
404 et al., 2020a). What clinicians may be reporting are their own barriers to acquiring, installing  
405 and managing telehealth tools for their clients, reflective of the fact that there is no  
406 common platform for tele-audiology. It is also known that patient preference was typically  
407 for in-person service over telehealth services pre-COVID-19 (Donelan et al., 2019, Eikelboom  
408 and Atlas, 2005, Tao et al., 2020).

409 The findings from these questions were reinforced by responses to an open-ended question  
410 on what innovations and improvements audiologists would like to see, and confirm the  
411 findings of others (Saunders and Roughley, 2020). Responses covered ten major themes  
412 relating to digital resources for communicating and remote services, and increased support  
413 from managers or government facilitation of improved access to technology and services,  
414 training and education. In order to provide an effective telehealth service, it is important  
415 that the focus be on optimising the communication between the clinician and the client, not  
416 only through the use of technology e.g. live captioning, but also conscious of the limitations  
417 and the need to compensate for these.

418 Results suggest that whilst audiologists have responded to the COVID-19 pandemic with a  
419 greater appreciation of telehealth, they are mindful that they need to discriminate about  
420 the appropriate services it can be used for. In some cases, they require their managers and  
421 organisations to empower and better support them, and in other cases investment is  
422 needed by industry or government to develop new technologies and products. Unless these  
423 are in place, audiologists will continue to struggle to provide services to vulnerable people,  
424 especially in terms of future emergencies such as the COVID-19 pandemic.

425

#### 426 **Study Limitations**

427 This study has involved a sample of 337 audiologists from 44 countries which, while  
428 representing the views from a wide cross-section of ages, clinical experience and scope of  
429 practice, as well as industry, research and academia, is too small to represent the global  
430 population of audiologists. Responses were also representative of those working in high as  
431 well as upper- and lower-middle income countries; there were no responses from 29 (of  
432 218) countries classified by the World Bank as having Low Income economies, but where

433 there are very few audiologists (Goulios and Patuzzi, 2008, World Health Organization,  
434 2013, Mulwafu et al., 2017). It is possible that there was a sampling bias, with the high  
435 numbers from the countries of the authors already noted, and greater uptake from  
436 predominantly English-speaking countries. We were unable to estimate the response rate.  
437 Responses were also likely to be affected by the current lockdown situation faced by the  
438 respondent.

439

## 440 **Conclusions**

441 A wide cross-section of the international audiology community provide insights into how  
442 telehealth plays a role in delivering audiology services in response to the COVID-19  
443 pandemic. There is an overwhelming acceptance that telehealth is important and necessary  
444 in the COVID-19 situation and also in the future when lockdowns may still be a risk. Some  
445 barriers were identified, mostly relating to limitations in technology and a lack of confidence  
446 that clients are well-placed to receive telehealth services. More innovation and validation is  
447 needed in technology to enable safe and reliable methods of assessment and device fitting.

448

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454

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