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Association of Intrinsic and Extrinsic Factors on Hearing Aid Servicing, Repair and Users' Satisfaction During COVID-19 Pandemic

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Purpose: Hearing aids (HAs) are electronic devices that provide amplification for individuals with hearing impairment. It requires good maintenance for its trouble-free function, but when HAs are not repaired or serviced on time, it affects communication. In the lockdown period during COVID-19 pandemic, many services were put on hold, including the HA service leading to poor user satisfaction. The study aimed to survey the HA user's perspectives on its repair, servicing, and satisfaction during COVID-19 using a questionnaire.

Methods: Sixty-seven participants reported to the organization during the COVID-19 pandemic for service and repair of HAs participated in the study. All the participants answered a questionnaire which consisted of different variables (extrinsic and intrinsic) affecting HA service, repair and satisfaction.

Results: The chi-square test showed that extrinsic factors enjoyed relatively more (14) significant associations than intrinsic ones (8 associations). The lack of transport and non-availability of the HA centres were associated with the significant reason for the delay in the HA being brought for repair.

Conclusions: The lockdown due to the COVID-19 pandemic had affected the service, repair and satisfaction of the HA users. The associations among the variables would make the service delivery better during any such pandemics.

Keywords: Hearing aid repair, Hearing aid service, Survey, Lockdown, COVID-19

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INTRODUCTION

Hearing aid (HA) amplification is a crucial rehabilitation technique when hearing loss cannot be treated medically or surgically. The HA's function is to amplify sounds and maximize their audibility for the hearing impaired (HI) user [1]. Owing to the inherent nature of electronic circuits used in HA, these devices generally require good maintenance and care for their smooth and trouble-free functioning [2]. The output from the HA gets adversely affected if due care and maintenance are not provided.

HAs are prone to physical and electroacoustic breakdown. Variations of the HA electroacoustic characteristics can be seen with the use of HA over some time. The other environmental causes, such as humidity and temperature, also affect the proper functioning of HAs [3]. Debris found naturally within the ear, such as cerumen, may block earmolds or In-the-ear/In-the-canal (ITE/ITC) HAs [4]. Sweat, certain sprays, and gels used outside the ear canal may also unintentionally contact the HA [5]. The effect of

relative humidity (RH) on the proper functioning of receivers or ITC HAs has also been reported [6]. The temperature between 80°F (26.67°C) and 99°F (37.22°C) in 77% of the shells of ITC and ITE HAs is reported [7]. All these conditions affect the functioning of the, leading to repair and affecting listening.

Whenever HAs become defective, they have significant negative effects on communication. Greater the defect, higher is the reported hearing handicap and communication difficulties [8]. Communication breakdowns impact cognitive, speech, language, emotional, academic, and psychosocial development and functioning [9]. One important reason for the repeated high incidence of communication breakdown is the generalized lack of knowledge and HA troubleshooting. Whether the reported problem is minor or significant, the consumer would render HA 'useless' or 'unsatisfactory' until it is repaired. Satisfaction with the HA depends on many factors like cost, appearance, acoustic benefit, comfort, and service. Satisfaction with the HA is the measurement of the auditory rehabilitation effect that represents a combination of factors which are not only related to the performance of HA [10], but also on the perceptions and attitudes of the customers [11].

Depending upon the consumer's complaint, type of HA, and problem, the repair duration will vary from weeks to months. Most of the HA dispensers send their products to authorized dealers/manufacturers for repair and services. Reviewing the repair of HA, Gupta [12] found that 50% of the problems were minor/peripheral and did not require the opening of the HA, 30% mechanical, 10% required replacement of defective parts, 5-8% electronic (mostly dry soldering, loose contact, or shorting) and 2% needed advice by experts. Many HA had more than one defect, with 60% of the defective HAs being of a specific model having defective switches [13]. Despite its crucial role in preventing averting communication breakdowns and enhancing customer satisfaction, there is scanty literature on the factors affecting HA repair and servicing.

Impact of COVID 19 on audiological services

The novel coronavirus (SARS-CoV-2) leading to COVID-19 has affected over 0.5 million people and has caused a plethora of documented symptoms. This new disease is highly contagious and quickly became a global pandemic [14]. The governmental constraints aiming to slow down the stretch of epidemic and pandemic eruptions lead to impairments for financial operations, impacting transportation of road, rail, air, and trucking industries, leading to a lockdown across the countries world-wide.

During the pandemic, audiologists continued to provide rehabilitation services to those with HAs. In light of the COVID-19 pandemic, Audiology professionals have adapted by providing tele-assessment, tele-guidance, HA fitting and programming (including Bluetooth devices), and tele-therapy (including listening, speech, and language therapy) to meet the needs of their clients. Due to COVID-19 constraints, Audiologists were unable to perform extensive audiological evaluations, cochlear implantations, HA troubleshooting and repairs, accessory provision, ear mold fitting, and ear mold troubleshooting. During counseling, patients will need direct contact for instructions and testing involving equipment like headphones, probe tips, otoscopes, electrodes, microphones, impression syringes, earmolds, and HAs.

Although partial or total lockdowns were enforced, patient care and rehabilitation professionals persisted in delivering their services. During the pandemic, audiologists continued to provide services to those with hearing loss, including fitting of HAs. The effect of COVID-19 is an interesting issue in audiology. Audiologists have adapted by providing tele-assessment, tele-guidance on hearing-related aspects, fitting and programming of HAs (including bluetooth devices), and teletherapy (including listening, speech, and language therapy) to meet the needs of their clients. However, the confounds of COVID-19 placed Audiologists at a disadvantage to deliver many conventional services such as in-depth/detailed audiological evaluation, cochlear implantation, troubleshooting or repair of HAs, providing accessories to HAs, and fitting ear molds. During counseling, and while performing these services, audiologists will require direct patient contact. Direct physical contact is required while giving instructions and testing involving equipments such as placing headphones, probe tips, otoscopes, electrodes, microphones, impression syringes, earmolds, and HAs. During the COVID-19 pandemic, HA users have encountered challenges. Obtaining batteries, repairing HAs, replacing ear moulds or tubing, and programming them are some of the hurdles faced [15]. There could also be other factors that can be challenging including the type of HA used, duration of the hearing problem, age of the HA user which could have an association with that of service, repair, and satisfaction during the COVID-19 pandemic. This study surveyed HA users perspectives regarding repair, servicing issues, and satisfaction during COVID-19, and investigated factors (intrinsic and extrinsic) influencing these experiences.

METHODS

A total of sixty-seven participants aged 0-87 years (49 males, 18 females) participated in the present study. These participants were HA users who reported to the organization during the lockdown due to the COVID-19 pandemic. The survey questions include the demographic data and the complaints from the HAs provided through the Assistance to Disabled Persons for Purchase/Fitting of Aids and Appliances (ADIP) scheme and Hearing aid dispensing (HAD) scheme. The developed questionnaire had 44 questions, and 10 audiologists rated the questionnaire for content validation. The experts were asked to check if the questionnaire's sentences met the criteria regarding familiarity, and absence of emotional, cultural, and religious overlay. They were asked to mark it as highly relevant or not relevant. The items were revised based on the suggestion and comments provided by the expert for rephrasing and relevancy. The content validity index (CVI) value of 0.8 was obtained [16]. Written consent was taken for their willingness to participate in the study.

The developed questionnaire has 38 questions divided into four subsections (Appendix-I). Section I (9), questions 1-4: patient's demographic details, questions 5-9: onset of hearing loss, duration of HA use, and style of HA (intrinsic factors of the study). Section II (18) questions were related to the complaints, questions 1-3 of section II are multiple-choice, and the remaining 15 questions have 'yes,' 'no' as choices for responses. Section III (4) questions were related to the patient's problems with HA servicing during the pandemic with the multiple-choice answer. Section IV (7) questions were about the repair section regarding components repaired/replaced, cost, duration of the repair, the reason for the delay in repair, and their remarks/satisfaction of repair (extrinsic factors) under the subheadings of general problems with the HA, physical issues related to HAs, sound quality/output related issues of HAs during analysis. The participants filled the developed questionnaire, and in the case of children, the responses were obtained from the parents or the caregivers, and the data was documented. However, for further analysis of the data, these questions were categorized into six intrinsic (age, gender, duration of the hearing problem, ear in which HA was used, HA experience, and hearing instrument) and three groups of extrinsic factors (general problems, physical issues, and sound quality/output related issues to HAs) according to Wong et al. [2] as in Table 1. The influence of these factors on HA service, repair, and satisfaction was analyzed in Table 2.

Ethical issues

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional guidelines on human experimentation. These guidelines adhered to the standards of the Helsinki declaration [17]. Ethical approval for this study was obtained from the ethics review committee before recruitment (CRN/AUD-04/2021-22). Information related to the participants was kept confidential to protect their privacy.

Data analyses

The collected data's raw scores were subjected to statistical analysis using IBM Statistical Package Social Sciences, version 25.0 (SPSS Inc., Chicago). Descriptive statistics (count, percentage) were detailed for all questions related to service, repair, and customer satisfaction issues separately for the intrinsic and extrinsic factors considered in the study. The significant associations and correlations (if any) for intrinsic and extrinsic factors with questions related to the service, repair, and customer satisfaction issues were then explored statistically using the chi-square (χ^2).

RESULTS

The demographic data (count and number of participants) for intrinsic factors (age, gender, duration of hearing problem, ear in which HA is used, HA experience, and HA) and extrinsic factors (general features, physical issues of the HAs, the sound quality/output of the HAs) of the cohort considered in the study are detailed in Table 1.

The distribution of the number of participants for each question under the categories of service, repair, and satisfaction issues is given in Table 2.

The association (if any) between the intrinsic and HA service, repair, and satisfaction examined using the chi-square test are shown in Tables 3 and 4 respectively.

Chi-square analyses showed eight significant associations of intrinsic factors with the repair and satisfaction-related domains enlisted in the study. On the observed eight significant associations, four questions were service-related, while the two questions in the repair and satisfaction-related domains constituted the other significant associations. The association related to service of the HAs was reported for the duration of the hearing loss and the number of years of HA experience with that of the number of times the HA was serviced. The longer the years of experience with the HA, the number of

Table 1. Descriptive statistics for intrinsic and extrinsic factors considered in the study

	Participants count (n)	Percentage (%)
Intrinsic factors		
Age (yr)		
0-12	10	14.93
12-40	16	23.88
40-87	41	61.19
Gender		
Male	48	71.64
Female	19	28.35
Duration of hearing problem		
0-6 months	0	0
6 months-1 year	5	7.46
1-3 years	19	28.34
Greater than 3 years	43	64.18
Ear using the hearing aid		
Right	25	37.31
Left	8	11.94
Both	34	50.75
Hearing aid experience		
0-6 months	2	2.99
6 month-1 year	7	10.44
1-3 years	23	34.33
Greater than 3 years	35	52.24
Type of hearing instrument		
BTE	45	67.16
RIC	22	32.84
Extrinsic factors		
General problems with the hearing aid		
Since when is the hearing aid not working?	<3 months: 28	<3 months: 41.88
	3-6 months: 30	3-6 months: 44.88
	>6 months: 9	>6 months: 13.44
Which hearing aid has the problem?	Right: 38	Right: 56.77
	Left: 27	Left: 40.33
	Both: 2	Both: 3
Physical issues related to hearing aids		
Is there any physical damage to the hearing aid?	Yes: 8	Yes: 11.99
	No: 59	No: 88.11
Is the problem with the switches of the hearing aid?	Yes: 10	Yes: 14.99
	No: 57	No: 85.11
Is there any accumulation of wax in the hearing aid?	Yes: 4	Yes: 6
	No: 16	No: 70.11
	Not sure: 47	Not sure: 23.99
Is the tubing of the earmold broken?	Yes: 4	Yes: 6
	No: 63	No: 94
Is the tubing of the earmold hardened?	Yes: 6	Yes: 9
	No: 61	No: 97

(Continued to the next page)

Table 1. Continued

	Participants count (n)	Percentage (%)
Is the ear mold broken?	Yes: 3	Yes: 4.5
	No: 64	No: 95.5
Is the tubing of the earmold loss fitted?	Yes: 6	Yes: 9
	No: 50	No: 74.6
	Not sure: 11	Not sure: 16.4
At any time did the hearing aid fell in the water?	Yes: 0	Yes: 0
	No: 11	No: 83.6
	Not sure: 56	Not sure: 16.4
Was there any accumulation of sweat in the hearing aid?	Yes: 0	Yes: 0
	No: 46	No: 68.77
	Not sure: 21	Not sure: 31.33
Was there any accumulation of moisture in the hearing aid?	Yes: 0	Yes: 0
	No: 44	No: 65.77
	Not sure: 23	Not sure: 34.33
Sound quality/output related issues of hearing aids		
Is the sound from the hearing aid distorted?	Yes: 57	Yes: 85.11
	No: 10	No: 14.99
Is there any intermittent output from the hearing aid?	Yes: 27	Yes: 57.77
	No: 40	No: 40.33
Is there low output in the hearing aid?	Yes: 17	Yes: 25.44
	No: 50	No: 74.66
Are you not able to hear through the hearing aid?	Yes: 18	Yes: 26.99
	No: 49	No: 73.11

Table 2. Descriptive statistics for hearing aid service, repair, and satisfaction-related questions

Hearing aid issues	Participants count (n)	Percentage (%)
Service-related issues		
How many times have you come to service your hearing aid?	One time: 27	One time: 40.33
	Two times: 35	Two times: 52.22
	Three times: 3	Three times: 4.5
	>3 times: 2	>3 times: 3
During this COVID pandemic, was there any problem with servicing the hearing aid?	Yes: 60	Yes: 89.66
	No: 7	No: 10.44
Were you able to get the batteries for the hearing aid during COVID-19?	Yes: 19	Yes: 28.44
	No: 48	No: 71.66
Is the hearing aid within the warranty period?	Yes: 35	Yes: 52.22
	No: 32	No: 47.88
Repair related issues		
Was the hearing aid sent to the company for repair	Yes: 67	Yes: 100
	No: 0	No: 0

(Continued to the next page)

Table 2. Continued

Hearing aid issues	Participants count (n)	Percentage (%)
How long did it take for the repair of the hearing aid?	<Week: 8	<Week: 11.9
	1 week to 3 weeks: 17	1 week to 3 weeks: 25.4
	3 weeks to 2 months: 19	3 weeks to 2 months: 28.4
	2 months to 4 months: 3	2 months to 4 months: 4.5
	>4 months: 0	>4 months: 0
	Not applicable: 20	Not applicable: 29.9
Reason for delay in repair	Company delay due to non-availability of technician: 0	Company delay due to non-availability of technician: 0
	Spare parts not available: 7	Spare parts not available: 10.4
	Delay in payment of repair amount: 7	Delay in payment of repair amount: 10.4
	Delay in transport: 2	Delay in transport: 3
	Not applicable: 21	Not applicable: 71.6
What was the cost involved in repair? ($)	0-1.2: 1	0-1.2: 1.5
	1.30-6.5: 8	1.3-6.5: 11.99
	6.6-13.00: 3	6.6-13.0: 4.5
	14-39.00: 5	14-39.00: 7.5
	40.00-65.00: 7	40.00-65.00: 10.4
	65.00-90.00: 8	65.00-90.00: 11.9
	>90.00: 9	>90.00: 13.4
	Free of cost: 26	No cost involved: 38.88
Why were you not able to get your hearing aid for repair?	No transport: 30	No transport: 44.88
	Non-availability of the center for servicing: 26	Non-availability of the center for servicing: 38.88
	No person to accompany to the servicing: 4	No person to accompany to the servicing: 6
	No financial support: 0	No financial Support: 0
	Health issues: 6	Health issues: 9
	Doesn't want to reveal: 20	Doesn't want to reveal: 29.9
Satisfaction related issues		
Are you not satisfied with your hearing with a hearing aid?	Yes: 24	Yes: 35.88
	No: 43	No: 64.22
Was the hearing aid repair satisfactorily?	Excellent: 0	Excellent: 0
	Very good: 0	Very good: 0
	Good: 67	Good: 100
	Poor: 0	Poor: 0
	Very poor: 0	Very poor: 0
Other relevant information	No output from HA: 2	No output from HA: 2
	Replaced spares with pricing: 25	Replaced spares with pricing: 25
	Company service cost: 3	Company service cost: 3
	Repaired without cost, due to warranty: 18	Repaired without cost, due to warranty: 18
	Not applicable: 19	Not applicable: 19

times the servicing required for the HA was also more. There was a significant association of warranty period with the duration of hearing problems and HA experience. The difficulty getting the HA serviced was more during the pandemic, though the HAs were within warranty period. Also, the more the years the HA was used by the participant, the time taken to repair the HA was also longer by 3 weeks to 2 months as in Figure 1.

As in Figure 2 the duration of the hearing loss had significant associations with the problems with the servicing of the

Table 3. The chi-square test of association for intrinsic factors with service, repair, and consumer satisfaction issues. The stars (*) represents different significance levels

	Intrinsic factors						
	Age	Gender χ^2 (2)	Duration of hearing problem	Ear in which hearing aid is used	Hearing aid experience	Type of hearing aid	Company
Service-related issues							
How many times have you come to service your hearing aid?	χ^2 (6)=6.93	χ^2 (3)=2.51	χ^2 (6)=11.43	χ^2 (6)=12.55	χ^2 (9)=17.99*, p=0.04	χ^2 (3)=1.77	χ^2 (39)=48.42
During this COVID pandemic was there any problem with servicing the hearing aid?	χ^2 (2)=2.58	χ^2 (1)=0.14	χ^2 (2)=6.95*, p=0.04	χ^2 (2)=3.96	χ^2 (3)=3.43	χ^2 (1)=0.001	χ^2 (13)=10.61
Were you able to get the batteries forthe hearing aid during COVID-19?	χ^2 (2)=2.42	χ^2 (1)=0.30	χ^2 (2)=3.40	χ^2 (2)=5.01	χ^2 (3)=4.95	χ^2 (1)=0.02	χ^2 (13)=11.49
Is the hearing aid with in the warranty period?	χ^2 (2)=1.5	χ^2 (1)=3.53	χ^2 (2)=7.34*, p=0.03	χ^2 (2)=0.85	χ^2 (3)=3.82, p=0.31	χ^2 (1)=0.07	χ^2 (13)=18.91
Repair related issues							
Was the hearing aid sent to the company for repair	Not applicable, all hearing aids sent for the company to repair						
How long did it take for the repair of the hearing aid?	χ^2 (8)=6.43	χ^2 (4)=3.82	χ^2 (8)=7.87	χ^2 (8)=3.56	χ^2 (12)=24.67*, p=0.02	χ^2 (4)=1.93	
Reason for delay in repair	χ^2 (6)=5.78	χ^2 (3)=0.69	χ^2 (6)=8.07	χ^2 (6)=2.95	χ^2 (9)=11.93	χ^2 (3)=1.11	
What was the cost involved for repair? (in rupees)	χ^2 (14)=5.19	χ^2 (7)=8.24	χ^2 (14)=10.84	χ^2 (14)=10.78	χ^2 (21)=15.16	χ^2 (7)=15.86*, p=0.03	χ^2 (52)=63.06
Why were you not able to get your hearing aid for repair?	χ^2 (8)=8.83	χ^2 (4)=1.63	χ^2 (8)=7.13	χ^2 (8)=15.18	χ^2 (12)=19.67	χ^2 (4)=1.96	
Satisfaction related issues							
Are you satisfied listening with your hearing aid?	χ^2 (2)=6.11*, p=0.07	χ^2 (1)=0.07	χ^2 (2)=2.05	χ^2 (2)=3.80	χ^2 (3)=5.95	χ^2 (1)=10.18***, p=0.001	χ^2 (13)=9.89
Was the hearing aid repair satisfactorily?	Not applicable, all participants reported HA repair as satisfactory (good category)						

*p<0.05, **p<0.01, ***p<0.001.

Table 4. The chi-square test of association for extrinsic factors with service, repair, and consumer satisfaction issues. The stars (*) represents different significance levels

	Extrinsic factors	
	General Problems with the hearing aid	
	Since when is the hearing aid not working?	Which Hearing aid has the problem?
Service-related issues		
How many times have you come to service your hearing aid?	χ^2 (2)=21.16**, p=0.002	χ^2 (6)=11.38
During this COVID pandemic, was there any problem with servicing the hearing aid?	χ^2 (2)=1.18	χ^2 (2)=1.97
Were you able to get the batteries for the hearing aid during COVID 19?	χ^2 (2)=4.12	χ^2 (2)=1.93
Is the hearing aid within the warranty period?	χ^2 (2)=2.53	χ^2 (2)=2.80
Repair related issues		
Was the hearing aid sent to the company for repair	Not applicable, all HA were sent for the company for repair	
How long did it take for the repair of the hearing aid?	χ^2 (8)=9.70	χ^2 (2)=6.69
Reason for delay in repair	χ^2 (6)=15.91**, p=0.014	χ^2 (6)=4.31
What was the cost involved for repair? (in rupees)	χ^2 (14)=18.99	χ^2 (14)=11.76
Why were you not able to get your hearing aid for repair?	χ^2 (8)=8.29	χ^2 (8)=5.24
Satisfaction related issues		
Are you not satisfied with your hearing with a hearing aid?	χ^2 (2)=2.25	χ^2 (2)=0.85
Was the hearing aid repair satisfactorily?	Not applicable, all participants reported HA repair as satisfactory (good category)	

	Physical issues related to hearing aids									
	Is there any ---------- (or) is the ---------- (or) did the ----------									
	Physical damage to the hearing aid?	Problem with switches of the hearing aid?	Accumulation of wax in the hearing aid?	The tubing of the earmold broken?	The tubing of the earmold hardened?	Was ear the mold broken?	The tubing of the earmold loss fitted?	Hearing aid fell in the water?	Accumulation of sweat in the hearing aid?	Accumulation of moisture in the hearing aid?
Service-related issues										
How many times have you come to service your hearing aid?	χ^2 (3)=13.05**, p=0.005	χ^2 (3)=2.48	χ^2 (6)=6.61	χ^2 (3)=2.19	χ^2 (3)=3.56	χ^2 (3)=2.87	χ^2 (6)=5.09	χ^2 (3)=1.76	χ^2 (6)=2.57	χ^2 (3)=3.11
During this COVID pandemic was there any problem with servicing the hearing aid?	χ^2 (1)=0.89	χ^2 (1)=1.76	χ^2 (2)=0.65	χ^2 (1)=22.76***, p<0.001	χ^2 (1)=0.65	χ^2 (1)=0.31	χ^2 (2)=5.61	χ^2 (1)=1.38	χ^2 (2)=10.46**, p=0.005	χ^2 (1)=3.06
Were you able to get the batteries for the hearing aid during COVID-19?	χ^2 (1)=2.09	χ^2 (1)=0.40	χ^2 (2)=3.06	χ^2 (1)=1.68	χ^2 (1)=4.76*, p=0.03	χ^2 (1)=2.67	χ^2 (2)=0.21	χ^2 (1)=0.41	χ^2 (2)=0.72	χ^2 (1)=0.09
Is the hearing aid within the warranty period?	χ^2 (1)=0.79	χ^2 (1)=1.49	χ^2 (2)=1.30	χ^2 (1)=3.89	χ^2 (1)=0.013	χ^2 (1)=0.26	χ^2 (2)=0.33	χ^2 (2)=0.69	χ^2 (2)=1.85	χ^2 (1)=0.27

(Continued to the next page)

Table 4. Continued

	Physical issues related to hearing aids										
	Is there any ---------- (or) is the ---------- (or) did the ----------										
	Physical damage to the hearing aid?	Problem with switches of the hearing aid?	Accumulation of wax in the hearing aid?	The tubing of the earmold broken?	The tubing of the earmold hardened?	Was ear the mold broken?	The tubing of the earmold loss fitted?	Hearing aid fell in the water?	Accumulation of sweat in the hearing aid?	Accumulation of moisture in the hearing aid?
Repair related issues										
Was the hearing aid sent to the company for repair	Not applicable, all HA were sent for the company for repair									
How long did it take for the repair of the hearing aid?	χ^2 (4)= 17.29**, p=0.002	χ^2 (4)=2.35	χ^2 (8)= 7.96	χ^2 (4)=2.47	χ^2 (4)=2.85	χ^2 (4)=2.91	χ^2 (8)=4.97	χ^2 (4)=8.43	χ^2 (8)=7.49	χ^2 (4)=4.86
Reason for delay in repair	χ^2 (3)=9.27*, p=0.03	χ^2 (3)=6.41	χ^2 (6)=3.81	χ^2 (3)=0.87	χ2 (3)=4.86	χ^2 (3)=1.15	χ^2 (6)=8.02	χ2 (3)=3.03	χ^2 (6)=1.06	χ^2 (3)=0.55
What was the cost involved for repair? (in rupees)	χ^2 (7)= 20.79**, p=0.004	χ^2 (7)=8.11	χ^2 (14)= 15.71	χ^2 (7)=4.14	χ^2 (7)= 7.39	χ^2 (7)=3.20	χ^2 (14)= 13.73	χ^2 (7)=7.84	χ^2 (14)=8.29	χ^2 (7)=8.34
Why were you not able to get your hearing aid for repair?	χ^2 (4)= 1.99	χ^2 (4)=6.45	χ^2 (8)=0.96	χ^2 (4)= 9.99*, p=0.04	χ^2 (4)=0.90	χ^2 (4)=2.34	χ^2 (8)=5.12	χ^2 (4)=2.69	χ^2 (8)=4.03	χ^2 (4)=0.02
Satisfaction related issues										
Are you not satisfied with your hearing, with hearing aid?	χ^2 (1)=0.01	χ^2 (1)=0.17	χ^2 (2)=0.71	χ^2 (1)=2.84	χ^2 (1)=2.73	χ^2 (1)=1.3	χ^2 (2)=3.86	χ^2 (1)=2.00	χ^2 (2)=2.68	χ^2 (1)=2.20
Was the hearing aid repair satisfactorily?	Not applicable, all participants reported HA repair as satisfactory (good category)									

*p<0.05, **p<0.01, ***p<0.001.

HA during the pandemic, with more the years of use with the HA reporting better listening satisfaction with HA.

Among the satisfactory measures depicted in Figure 3, the type of HA use had a significant association with the cost involved for the repair of the HA. The behind-the-ear (BTE) HA involved more cost for repair; however it was dependent on the problem with the HA.

As shown in Figure 4, the general extrinsic factors which had a significant association with the duration from when the HA was not working are the number of times for services of HA (service related factor) and reason for the delay in repair (repair related factor). Significantly higher number of participants who had their HA not working for 3-6 months reported that they had given their HA for repair for atleast 2 times. While the same group reported the reason for the delay of their HA repair was the unavailability of the spare parts for repair of the HA during the pandemic situation. From Table 2, it is evident that there were sigfnificant associations of physical extrinsic factors with service-related issues, were physical damage to the HA, hardening and breaking of the tube of the ear mould, and accumulation of the sweat in the HA.

From Figure 5, significant association of the sound quality-related extrinsic factors with repair related issues were delay in transport, duration of HA repair, and not availing the HA for repair to the service centers. The above factors significantly had associations with sound clarity. Those participants who complained of poor sound clarity from HA for 3 weeks to 2 months had the major reason of non-availability of the service center and lack of transport during pandemic to avail the service facility for their HAs. Out of those who availed facility for complaint of sound clarity had non-availability as spare parts as the major reason for the delay in HA repair. Similarly, when the complaint was distorted sounds from their HA, unavailability of spare parts and delay in payment of the amount for repair were the major reasons for service delay of the HAs.

The question evaluating the problems related to servicing HA in COVID-19 lockdown encountered larger and more significant associations (p<0.05 and p<0.001) with physical issues in the service-related category. Among the general problems with the HA, the number of times the HA user had visited the institute had an association with the duration of the HA repair also there was significant association between the duration of the HA repair and the various reasons for the delay in repairing back the HA to provide it to the users. The reasons majorly include the delay in transport, the delay in payment for the repair, and the unavailability of the spares for re-

pairing the HA. However, no significant associations were seen in the consumer satisfaction-related category.

The significant associations of service-related (continuous black lined frames), repair-related (black dotted frames), and satisfaction related (grey dotted frames) issues considered in the study with intrinsic factors in descending order are HA experience (3 associations, Figure 1), duration of hearing loss (1 association, Figure 2), and HA (1 associations, Figure 3).

The significant associations of service-related (continuous black lined frames), repair-related (black dotted frames), and satisfaction related (grey dotted frames) issues were considered in the study with questions corresponding to extrinsic

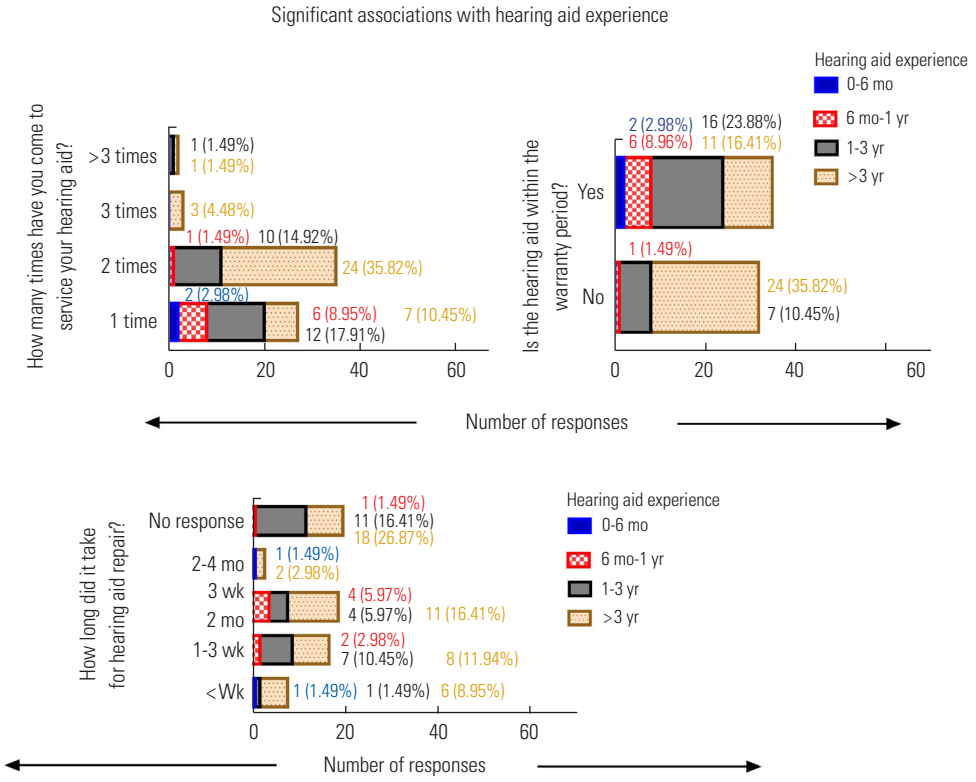

Figure 1. Demographics (count and percentage) for hearing aid experience (intrinsic factor) questions with significant associations with service-related (continuous black lined frames) and repair-related (black dotted frames) issues considered in the study. The association of hearing aid experience (intrinsic factor) questions with satisfaction issues was not significant, hence not represented. The numerals represent total count of participants for each sub-category of the questions with significant associations, with the corresponding percentage in the brackets.

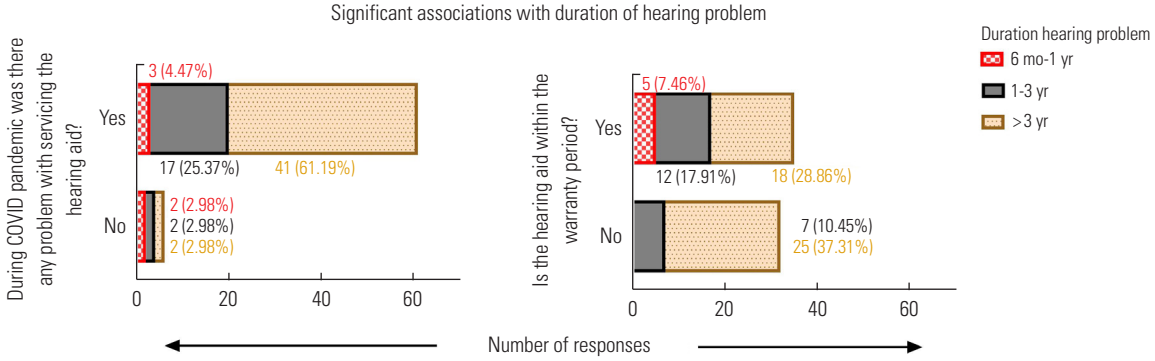

Figure 2. Demographics (count and percentage) for duration of hearing loss (intrinsic factor) question with significant associations with service-related (Continuous black lined frames) issues considered in the study. The association of duration of hearing loss (intrinsic factor) question with repair-related and satisfaction-related issues were not significant, hence not represented. The numerals represent total count of participants for each sub-category of the questions with significant associations, with the corresponding percentage in the brackets.

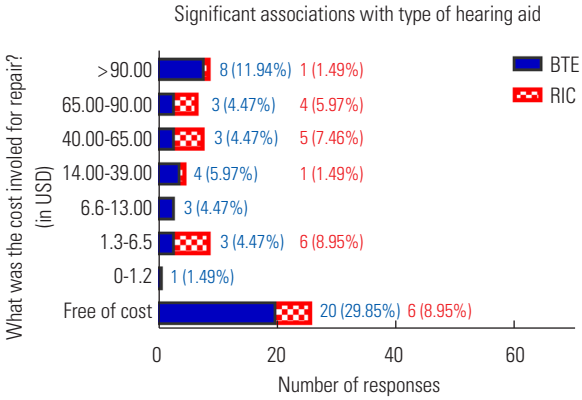

Figure 3. Demographics (count and percentage) for type of hearing aid (intrinsic factor) question with significant associations with repair-related (black dotted frames) issues considered in the study. The association of type of hearing aid (intrinsic factor) questions with service-related and satisfaction-related issues was not significant, hence not represented. The numerals represent total count of participants for each sub-category of the questions with significant associations, with the corresponding percentage in the brackets.

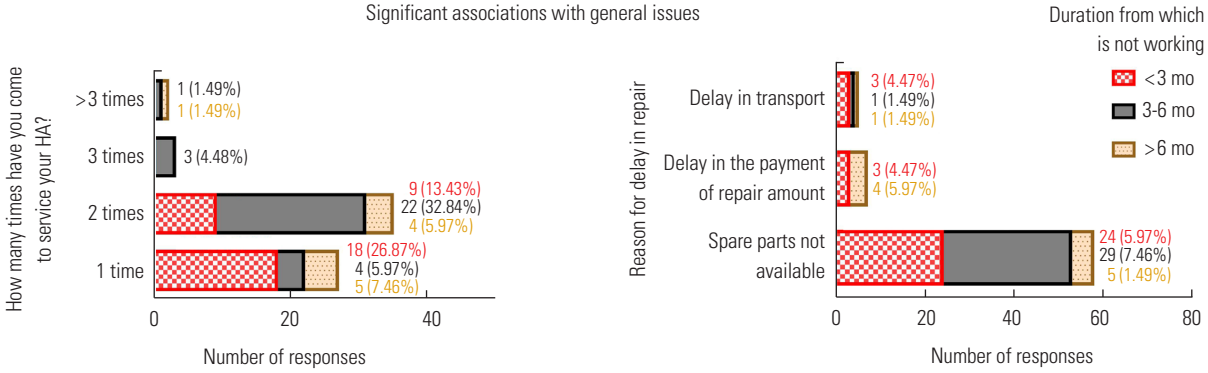

Figure 4. Demographics (count and percentage) for questions with significant associations of general factors with service-related (continuous black frames) and repair-related (dotted black frames) issues considered in the study. The numerals represent the total count of participants for each sub-category of the questions with significant associations, with the brackets' corresponding percentage. The association of general factors with satisfaction-related question was not significant, hence not represented.

factors categorized under general issues, HA's physical issues, and sound quality-related issues are shown in Figures 4 and 5 respectively. The three most extrinsic factors which showed significant associations with measures used in the study were sound quality (4 associations, Figure 5), broken tube (2 associations, Figure 5), and duration from which HA is not working (2 associations, Figure 4).

DISCUSSION

The COVID-19 pandemic is an prodigious, fortuitous situation which made the worldwide changes. The challenges posed by COVID-19 on healthcare sector was huge and first of its magnitude. Audiologists and speech-language pathologists, as healthcare professionals, directly interact with patients during service delivery. Due to safety and precautionary measures during COVID, only limited services were provided. One such service which was limited during the pandemic was the servicing of the HA after being subjected to physical or programming realated damages. During pandemic, HA users encountered challenges in obtaining new ear molds, replacing earmold tubing, purchasing new batteries, and repairing their HAs. The reasons for these challenges included lack of transport facility, closure of the HA servicing and repair center, self-illness, and limited availability of professionals. Hence the HAs remained unrepaired, affecting optimal listening and communication. So, HI users faced many difficulties due to the suboptimal performance of HAs and ill-fitting ear molds. The present study aimed to survey the HA-related repairs and the servicing issues during the COVID 19 pandemic. The data collected through the questionnaire were divided into intrinsic factors and extrinsic factors and were associated

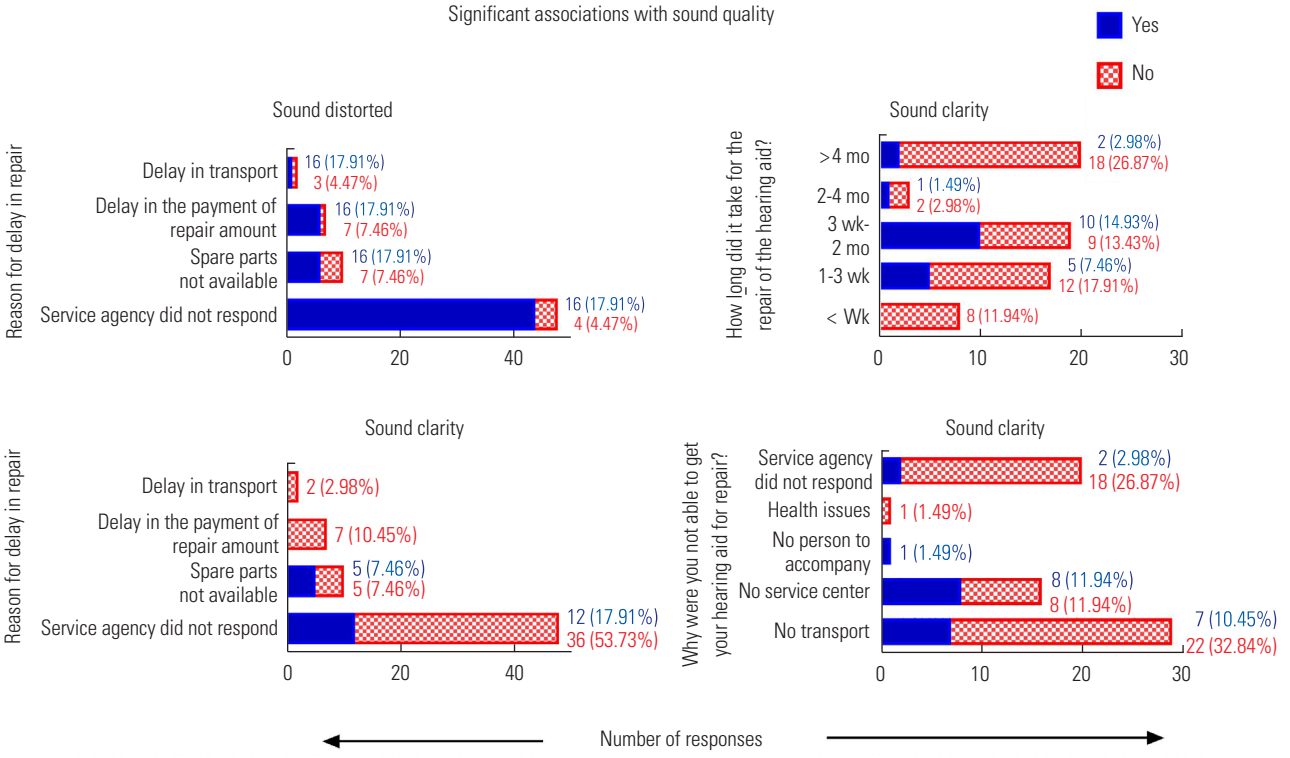

Figure 5. Demographics (count and percentage) for questions with significant associations of sound quality related factors (extrinsic) with repair-related (dotted black frames) issues considered in the study. The numerals represent the total count of participants for each sub-category of the questions with significant associations, with the brackets' corresponding percentage. The association of sound quality related factors with service-related and satisfaction-related question was not significant, hence not represented.

with HA servicing, repair, and satisfaction-related corners. The results of the analysis are also discussed accordingly. The service-related domain analysis with intrinsic variables revealed that the number of services sort for HA complaints increased with the HA user's experience and duration of the hearing loss. Jones [18] reported that despite HAs design and durability materials used in its construction, some structural degradation occured over time, leading to internal distortion and non-functionality. This explanation is also supported by the study's findings, where 85.1% of the HA users reported distortion, and 59.7% reported intermittent sound output. The general issues of HA output stemming from wear and tear are usually sorted out by servicing, especially when in warranty period. Despite being under warranty, HA users encountered significant challenges getting their devices repaired during the pandemic.

Related to the HA repair aspects, there was significant association between the HA experience and the HA repair duration. It suggests that more problems are reported with various HA components with he time of usage and hence takes a longer duration to replace and repair the components. Also, the unavailability of the spares parts was due to obsolete status. However, this increase in the waiting period for the repair of the HA was more notable due to the lockdown in pandemic.

The HA type and usage duration also had a significantly strong association with repair cost. The repair for the digital BTE HAs was expensive compared to the digital receiver-in-the-canal (RIC) HAs. However, in the present study, the number of users of RIC HAs were lesser compared to the BTE HAs. The increase in cost for repair could be dependent on the cause for the damage of the HA. The HAs are liable to get damaged due to damp environments. Though the HAs are nano-coated, the moisture, dust, ear wax, sweat, and extreme temperatures add to HA's working life span [18] leading to increase in cost of repair. According to Kochkin at al. [19], around 10.3% of the individuals reported dissatisfaction with their HAs due to the repair cost. The number of HA repairs negatively influences satisfaction and the use of the individual's HA [20].

Under satisfaction measure, the type of HA had a more significant association with satisfaction measures. Since the HAs provided are digital, the noise reduction would be more with

better speech clarity. Hence the satisfaction with these HA after the repair is also higher. The longer the hearing loss, the more frequent the HA repair issues reported by the user. However, the more the duration of the hearing loss, the use of their HA will also be for longer duration, hence the repair issues were reported more. Still, there was a good association with their satisfactory measure, which means that the experienced users had a higher acceptance of the HA and were satisfied. Greater satistsfaction rates in experience users is in contrast to Kochkin et al. [21] who reported that the new HA users had less satisfaction with the HA.

On analyzing the association of other variables, it was found that physical damage has a significant association with the frequency of the HA servicing. 11.9% reported physical damage to the HA. 6% reported problems due to wax accumulation 6% to earmold tubing breakage, and 9% to tubing hardening. During the COVID pandemic lockdown, the HA services were suspended, preventing individuals from utilizing them. The issues causing the most trouble were a faulty receiver (29.9%) and a malfunctioning internal board (22.4%). The other problems were the microphone (11.9%) and switches (11.9%). The repair durationfor the HA depends on the HA company and the parts that require the replacement. During the lockdown, the HA technician's absence prevented the availability of spare parts at several company service centers. Without transport services, acquiring spares and accessories on time proved challenging. 28.4% of HAs took between 3 weeks and 2 months for repair. However, 100% satisfied post-repair with their HA. The other HA factors that had a good correlation include loose-fitted tubing of the earmold, tubing becoming harder, broken tubing, and non-availability of the batteries with the time required to get the batteries HA serviced. The inadequate HA repair and services during lockdown disrupted individuals' communication requirements. The interlinking of intrinsic and extrinsic factors demands users to exercise caution concerning HA satisfaction in general, and during pandemic situation in particular.

CONCLUSIONS

The lockdown during the COVID-19 pandemic has an adverse effect on the services provided for the repair of the HA users. The unavailability of spares for repair, and the lack of transport facility had an adverse effect. There was overlap of intrinsic variables and extrinsic variables considered in the study that affected the overall servicing and repair of the HA users during the pandemic. Being informed of the relationships among HA repair, service, and satisfaction is essential. This would enhance a professional's ability to deliver effective HA repair services, especially during pandemics.

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APPENDIX - I

Section I: Demographic data and general information about hearing aid

1. Name
2. Age
3. Sex
4. Phone number
5. Since when are you having a hearing problem?
6. How long are you using a hearing aid?
7. Which ear are you using the hearing aid?
8. What is the type of hearing aid that you use?
9. What is the company of the hearing aid?

Section II: Hearing aid related complaints

1. How many times have you come to service your hearing aid?
2. Which ear's hearing aid has a problem?
3. Since when is your hearing aid not working?
4. Is the sound from the hearing aid distorted?
5. Is there a problem with switches of the hearing aid?
6. Is there any intermittent output from the hearing aid?
7. Is there any physical damage to the hearing aid?
8. Is there low output in the hearing aid?
9. Are you not able to clearly hear through the hearing aid?
10. Are you not satisfied with your hearing, with hearing aid?
11. Is there any accumulation of wax in the hearing aid?
12. Is the tubing of the ear mould broken?
13. Is the tubing of the ear mould hardened?
14. Is the ear mould loss fitted?
15. Is the ear mould broken?
16. At any time did the hearing aid fell in the water?
17. Was there any accumulation of sweat in the hearing aid?
18. Was there any accumulation of moisture in the hearing aid?

Section III: Problems of hearing aid servicing during the pandemic

1. During this COVID pandemic was there any problem with servicing the hearing aid?
2. Why were you not able to get your hearing aid for repair?
3. Were you able to get the batteries for the hearing aid during COVID-19?
4. Is the hearing aid within the warranty period?

Section IV: Hearing aid repair section

1. The hearing aid was sent to the company for repair
2. The following were the problem in the hearing aid
3. What was the cost involved for repair? (Rupees)
4. How long did it take for the repair of the hearing aid
5. Reason for delay in repair
6. Was the hearing aid repair satisfactorily?
7. Any other relevant information