

## SMARTPHONE BASED ASSESSMENT OF HEARING LOSS IN FISHERMEN COMMUNITY- A FIELD BASED CROSS SECTIONAL STUDY

Rajarajeswari N<sup>1</sup>, Kavya P<sup>2</sup>, Ramasamy Raja K<sup>3</sup>, Rehana S<sup>4</sup>, Manjula D<sup>5</sup>

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Corresponding Author:

**Dr. Rajarajeswari N**

Email: 1987manjula@gmail.com

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<sup>1,3,5</sup>Assistant Professor, Department of Community Medicine, Karpagam Faculty of Medical Sciences and Research, Tamil Nadu, India

<sup>2</sup>Senior Resident, Department of Community Medicine, Karpagam Faculty of Medical Sciences and Research, Tamil Nadu, India

<sup>3</sup>Senior Resident, Department of Community Medicine, Indira Medical College & Hospital, Tamil Nadu, India

### ABSTRACT

**Background:** Hearing loss is an under-recognized occupational health problem among fishermen, primarily due to prolonged exposure to high levels of noise from boat engines and the marine environment. Early detection is often limited by poor access to conventional audiometric facilities. Smartphone-based hearing assessment tools offer a low-cost and feasible alternative for community-level screening. This study aimed to determine the prevalence of hearing loss and its associated factors among active fishermen in Puducherry using a smartphone-based hearing test application.

**Materials and Methods:** A community-based cross-sectional study was conducted among 165 active fishermen from selected coastal villages of Puducherry between March and May 2021. Data were collected using a semi-structured questionnaire capturing sociodemographic details, occupational history, and hearing-related factors. Hearing assessment was performed using the Hearing Test™ smartphone application. Hearing loss was categorized based on standard audiometric thresholds. Data were analyzed using appropriate descriptive statistics and Chi-square/Fisher's exact tests, with a p-value <0.05 considered statistically significant. **Results:** The mean age of participants was 42.5 ± 12.9 years, and all were male. The overall prevalence of hearing loss was 79%. Minimal hearing loss was the most common finding in both ears. Significant associations were observed between hearing loss and duration of fishing (>12 hours/day), type of boat used (piper boats), past history of hearing problems, recent nasal congestion, and chronic ear discharge. No significant association was found with most sociodemographic variables. **Conclusion:** A high prevalence of hearing loss was observed among fishermen in Puducherry, highlighting a substantial occupational health burden. Smartphone-based hearing screening proved to be a practical and cost-effective tool for early detection at the community level. Regular screening, increased awareness, and use of hearing-protective measures are recommended to prevent progression of hearing impairment among fishermen.

## INTRODUCTION

Fishing is one of the world's oldest occupations and has more health hazards than other occupational categories in the world.<sup>[1]</sup> Fishermen community possesses unique characteristics of a folk society, since major portion of the life of fishermen is spent at sea with bizarre sleep and eating pattern, their risk profile for health illness are different from general population.<sup>[2]</sup> They also experience a range of environmental changes, economic fluctuations, and changes to policy and regulations that can have implications for their health and other aspects of

wellbeing.<sup>[3]</sup> Behavioral responses to the above changes can endanger both short term and long-term health outcomes.<sup>[4]</sup> Hearing loss is a highly prevalent problem in the world. As studies have shown that almost 50% of fishermen population is suffering from hearing loss.<sup>[5]</sup> Hearing impairment can affect safety and work performance and can reduce the quality of life for affected individuals.<sup>[6]</sup> Hearing problems among fishermen were commonly due to prolonged noise exposure in the engine room.<sup>[7]</sup> If hearing impairment is detected at the earliest serious health problems can be reduced. The gold standard method for screening of hearing impairment is pure tone

audiometer. However, the equipment is costly; moreover, it requires trained manpower and expensive and soundproof infrastructure to conduct the test and in addition to it majority of the population will not be aware of the hearing problem and will not seek any medical service.<sup>[8]</sup>

With the global rise in Smartphone penetration, apps offer a promising avenue to screen for hearing impairment and assess the causes in a low cost manner. A large number of apps for measuring hearing function is thought to exist that can potentially be utilized. Hence the present study has been planned, to determine the prevalence of hearing loss and the factors influencing them among the active fisherman in Puducherry.

### Review of Literature

Physically demanding occupations such as fisheries, health is a key asset underpinning productivity. Health issues related to fishing also extend beyond individual fishers to the wider fishing industry, fishing families, and fishing communities.<sup>[9]</sup> Hearing loss can cause sufficient mortality but early initiation of treatment increases the chance to regain hearing. Standard audiogram may not be available at the time and place of patient presentation. A Smartphone based hearing application can be useful in the initial evaluation of patients with hearing loss.<sup>[10]</sup>

According to this study, “Initial assessment of hearing loss using a mobile application for audiological evaluation” There was a statistically significant concordant relationship between Apple iOS mobile operating system application and conventional audiometry results ( $p < 0.05$ ).<sup>[11]</sup>

“Smartphone based hearing screening in primary health care clinics” done by Louw C, Swanepoel DW, Eikelboom RH, Myburgh HC. It reveals that the Smartphone application provides time-efficient identification of hearing loss with adequate sensitivity (81.7%) and specificity (83.1%) for accurate testing at primary health care settings.<sup>[12]</sup>

Based on the study “A Mobile Phone-Based Approach for Hearing Screening of School-Age Children” done in Taiwan by a group of doctors, the result of the proposed Smartphone-based self-hearing test demonstrated high concordance with conventional PTS in a sound-treated booth. The test was done in 170 ears (85 subjects) both screening methods produced comparable pass and fail results (pass in 168 ears and fail in 2 ears). Both the sensitivity and specificity of the Smartphone-based screening method were calculated at 100%.<sup>[8]</sup>

### Objectives

- To determine the prevalence of hearing loss among active fishermen in Puducherry using smart phone-based hearing test application.
- To assess the factors influencing the hearing loss among active fishermen in Puducherry.

## MATERIALS AND METHODS

**Study Design:** This study employed a community-based cross-sectional design with a quantitative approach. The design was chosen to estimate the prevalence of hearing loss and assess associated factors among active fishermen in Puducherry.

**Study Setting:** The study was conducted in selected coastal fisherman settlements of Puducherry, India. These communities primarily comprise active fishermen involved in sea-based fishing activities.

**Study Period:** Data collection was carried out over a two-month period, from March 2021 to May 2021.

**Study Population:** The study population consisted of active fishermen permanently residing in the coastal areas of Puducherry. Active fishermen were defined as individuals whose primary occupation is sea fishing and who regularly engage in fishing activities.

**Study Subjects:** All eligible and willing active fishermen residing in the selected coastal villages were included as study participants.

**Study Tools:** A semi-structured questionnaire and a smartphone-based hearing assessment application were used for data collection.

**Semi-structured Questionnaire:** Information on sociodemographic characteristics was obtained from each participant, including name, age, gender, education, religion, place of residence, monthly family income, type of family, number of family members, years of fishing experience, daily working hours, and habits such as alcohol and tobacco use. In addition, details on the relevant medical history were collected. Participants were asked about their use of hearing aids, any history of hearing difficulties, and whether they had previously consulted a doctor for hearing-related problems. Information was also gathered on past head injuries, episodes of vertigo or dizziness, family history of deafness, tinnitus or ringing in the ears, recent cold or nasal congestion, chronic ear discharge, and long-term medication use. Further questions included exposure to loud noise during non-occupational activities, the use of hearing-protective devices, and any previous hearing tests along with abnormalities identified in such assessments.

### Smartphone-Based Hearing Test™

Hearing assessment was conducted using the Hearing Test™ (e-audiologia.pl) mobile application installed on a Moto G5 Plus smartphone (Android version 8.1.0) with bundled earphones. The app was downloaded from the Google Play Store.

### Features of the Hearing Test™ Application

Pure-tone audiometry using bundled headphones with predefined calibration coefficients

Digits-in-noise test for assessing speech intelligibility

Noise meter to monitor background noise during testing

Capability for device calibration when using unsupported headphones

Previous validation studies have reported a mean absolute difference of <8.8 dB between conventional Pure Tone Audiometry (PTA) and the Hearing Test™ results, supporting its use as a field-level screening tool.

### Hearing Test and Severity Classification

Hearing threshold levels obtained from the application were classified based on standard audiometric ranges to determine the severity of hearing loss.

### Eligibility Criteria

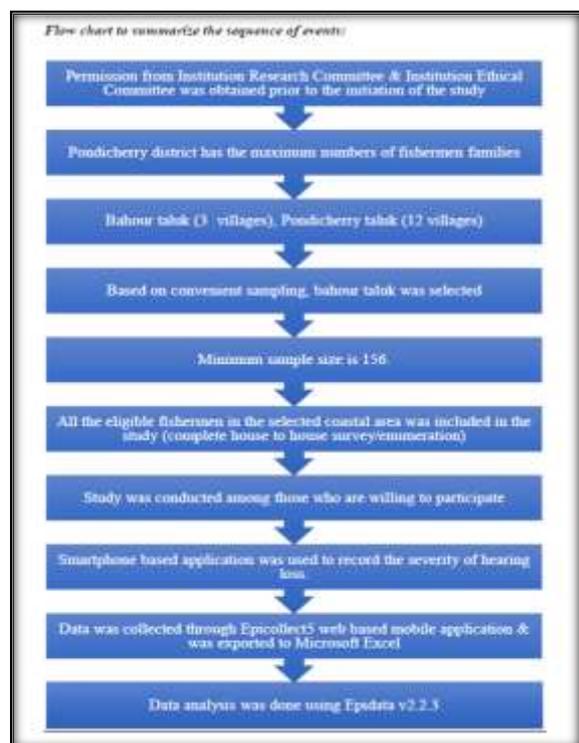
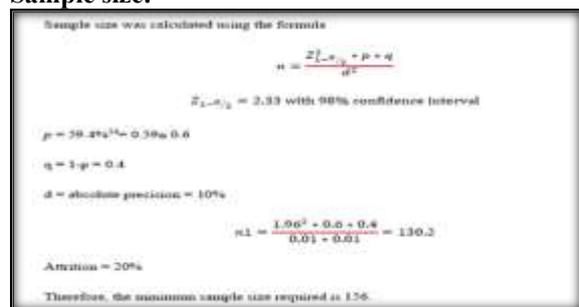
#### Inclusion Criteria

- Individuals aged above 18 years
- Active fishermen whose sole occupation is sea fishing
- Permanent residents of the selected coastal areas of Puducherry
- Willing to participate and provide consent

#### Exclusion Criteria

- Individuals with cognitive impairment or mental illness preventing informed participation
- Persons unwilling to take part in the study

### Sample size:



**Data Collection Procedure:** Institute Human Research Committee and Institute Human Ethical Committee clearance was obtained prior to initiation of the study. The study was done for a period of two months (March 2021- May 2021). In this time period participants who are meeting the inclusion criteria was invited to participate in the study and the questionnaire was administered to them. Estimated time schedule for this was 30 minutes approximately.

## RESULTS

A total of 165 fisherman's was interviewed for the study purpose. All of the participants were male and the Mean age of the study participants were  $42.5 \pm 12.92$ . Majority of them belonged to Hindu Religion (94.5%). More than one-fourth of the participants had education up to Middle school (37.6%), followed by illiterate (19.4%), Higher secondary school education (18.8%) and primary school education (17.6%). More than three-fourth of the participants were married (74.5%) and live in a nuclear family (70.9%). Majority of them belonged to Lower Middle class as per Modified BG Prasad Classification 2021(44.8%) followed by middle class (28.5%) and lower class (17.6%). [Table 1]

More than half of them uses a Piper boat (52.1%) followed by motor boat (35.2%) and Rowboat (12.7%). Majority of them were in fishing for less than 10 years (28.5%), 11yrs-20yrs (27.9%) and 21-30yrs (23%). More than half of them spend at least 8 hrs in the sea (58.2%) followed by 8-12hrs (18.8%) and 12-24hrs (14.5%). [Table 2]

Majority of them do not consume alcohol (63%) and tobacco (71.5%). [Table 3] More than half of them do not have any hearing trouble (78.2%) and majority of them haven't attended an ENT specialist in the past (88.5%). A few of them have suffered from head injury in the past (17.6%) and had a family history of deafness (20%). Less than one-third had vertigo (13.3%), ringing noise (7.3%) and chronic ear discharge (9.1%). [Table 4]

**Table 1: Distribution of Socio-Demographic Details (n = 165)**

Variable	Category	Frequency (%)
Marital Status	Single	25 (15.2)
	Married	123 (74.5)
	Widower	16 (9.7)
	Divorced	1 (0.6)
Religion	Hindu	156 (94.5)
	Christian	6 (3.6)
Education	Muslim	3 (1.8)
	Illiterate	32 (19.4)
	Primary School	29 (17.6)
	Middle School	62 (37.6)
	Higher Secondary	31 (18.8)
Type of Family	College	11 (6.7)
	Joint Family	36 (21.8)
	Nuclear Family	117 (70.9)
Socio-Economic Status	Three Generation Family	12 (7.3)
	Upper Class	3 (1.8)
	Upper Middle Class	12 (7.3)
	Middle Class	47 (28.5)
	Lower Middle Class	74 (44.8)
	Lower Class	29 (17.6)

**Table 2: Distribution of Details Related to Fishing (n = 165)**

Variable	Category	Frequency (%)
Type of Boat	Motor Boat	58 (35.2)
	Piper Boat	86 (52.1)
	Row Boat	21 (12.7)
No. of Years Involved in Fishing	≤10 years	47 (28.5)
	11–20 years	46 (27.9)
	21–30 years	38 (23.0)
	>30 years	34 (20.6)
No. of Working Hours	<8 hrs	96 (58.2)
	8–12 hrs	31 (18.8)
	12–24 hrs	24 (14.5)
	>24 hrs	14 (8.5)

**Table 3: Distribution of Alcohol and Tobacco consumption (n=165)**

Variable	Category	Frequency (%)
Alcohol Consumption	Yes	61(37)
	No	104 (63)
Tobacco Consumption	Yes	47 (28.5)
	No	118 (71.5)

**Table:4 Distribution of Hearing-Related Details (n = 165)**

Variable	Category	Frequency (%)
Do you wear a hearing aid?	Yes	0
	No	165 (100)
Had any hearing trouble	Yes	36 (21.8)
	No	129 (78.2)
Ever attended doctor with ear problems or hearing difficulties?	Yes	19 (11.5)
	No	146 (88.5)
Ever had a serious head injury	Yes	29 (17.6)
	No	136 (82.4)
Ever suffered vertigo or dizziness	Yes	22 (13.3)
	No	143 (86.7)
History of deafness in family	Present	33 (20.0)
	Absent	132 (80.0)
History of ringing in ears	Present	12 (7.3)
	Absent	153 (92.7)
History of recent cold or nasal congestion	Present	75 (45.5)
	Absent	90 (54.5)
History of chronic ear discharge	Present	15 (9.1)
	Absent	150 (90.9)
History of chronic medication	Present	52 (31.5)
	Absent	113 (68.5)
History of exposure to activities/hobbies involving loud noise	Present	60 (36.4)
	Absent	105 (63.6)
Usage of hearing protective aid	Yes	0 (0)
	No	165 (100)
	Yes	22 (13.3)

Had a previous hearing test?	No	143 (86.7)
Issues identified in previous hearing test (n = 22)	Present	7 (13.8)
	Absent	15 (68.2)

**Table 5: Distribution of Grading of hearing loss based on Smart phone-based Hearing TestTM (n=165)**

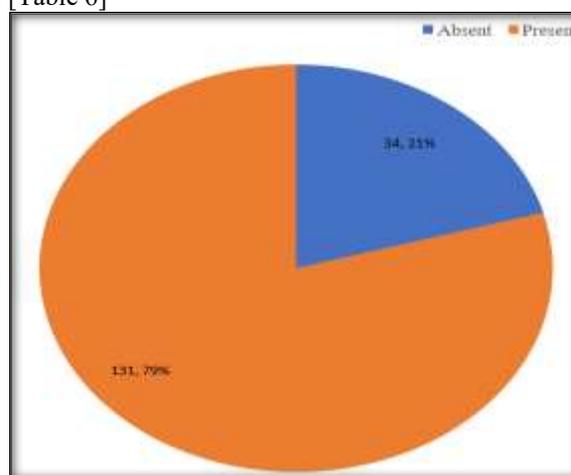
Grade	Audiometric Value (dB)	Right Ear n(%)	Left Ear n(%)
Normal	0-15	56 (33.9)	43 (26.1)
Minimal	15-25	74 (44.8)	98 (59.4)
Mild	26-40	22 (13.3)	11 (6.7)
Moderate	41-55	6 (3.6)	8 (4.8)
Moderately Severe	56-70	3 (1.8)	1 (0.6)
Severe	71-90	4 (2.4)	4 (2.4)

More than two-third of the fisherman suffered from hearing loss (79%). According to the analyses out of 165 fishermen almost half of the fisherman had minimal hearing loss in Right ear (44.8%) and Left ear (59.4%). Few fishermen had moderate (3.6%) and severe hearing loss (2.4%) and no one was found to have profound hearing loss. [Table 5]

#### Factors Influencing the hearing loss

Total 165 fisherman were grouped in terms of socio-demographic variables (age, gender, religion, education, marital status, socio-economic status, type of family, Tobacco use and alcohol) Fishing related variables (Number of years in fishing, Number of hours of fish, Type of boat) and Hearing related variables (History of hearing trouble, history of vertigo, family history of deafness, history of tinnitus, history of chronic ear discharge) These variables were considered as categorical variables and their association with the Hearing loss (Nominal variable) were done using Chi- square and fisher exact test. p value of <0.002 was considered as significant.

The age group of 18-30 years showed average values 18.07 and 18.09 decibels of hearing loss in the right and left ear respectively. There average values of hearing loss for the age group of 31-40 and 41-50 years were 23.42 and 20.96 decibels on the right side, 24.27 and 22.91 decibels on the left side respectively [Table 6]



**Table 6: Analysis of Results of Smart phone-based Hearing TestTM in Decibels and Age distribution of hearing loss (Mean values of right and left ear) (n=165)**

Age	Right Ear (dB) (Avg)	Left Ear (dB) (Avg)
18-30	18.07	18.09
31-40	23.42	24.27
41-50	20.96	22.91
>50	25.17	22.14

Among the Socio demographic variables, Majority of the literates had hearing loss (82%) followed by Illiterates (68.8%). More than three fourth of the fisherman belonging to Lower Middle class and Lower class had hearing loss (83.5%) followed by

Middle class (80.9%) and Upper class and Upper Middle class (46.7%). None of the socio demographic variables were found to have significant association.

**Table 7: Association Between Socio-Demographic Variables and Hearing Status**

Variable	Category	Normal Hearing n (%)	Hearing Loss n (%)	p-Value
Religion	Hindu	31 (19.9)	125 (80.1)	0.393
	Others	3 (33.3)	6 (66.7)	
Education	Illiterate	10 (31.2)	22 (68.8)	0.142
	Literate	24 (18)	109 (82)	
Marital Status	Married	30 (24.4)	93 (75.6)	0.047*
	Others	4 (9.5)	38 (90.5)	
Type of Family	Nuclear family	29 (24.8)	88 (75.2)	0.038*
	Others	5 (10.4)	43 (89.6)	
SES	Upper class and Upper Middle class	8 (53.3)	7 (46.7)	0.004*
	Middle class	9 (19.1)	38 (80.9)	
	Lower Middle class and Lower class	17 (16.5)	86 (83.5)	

Among the fishing related variables, the number of hours of fishing per day and type of boat used were significantly associated with hearing loss. Fisherman who underwent fishing for more than 12 hours had

higher rate of hearing loss (91.3%) followed by less than 12 hours (74.8%). Similarly, fisherman using Piper boats had higher rates of hearing loss (88.8%) than fisherman using motor boats (62.1%). [Table 8]

**Table 8: Association Between Fishing-Related Variables and Hearing Loss (n = 165)**

Variable	Category	Normal Hearing n (%)	Hearing Loss n (%)	p-Value
Number of Years of Fishing	≤10 years	6 (12.8)	41 (87.2)	0.162#
	11–20 years	8 (17.4)	38 (82.6)	
	21–30 years	9 (23.7)	29 (76.3)	
	>30 years	11 (32.4)	23 (67.6)	
Number of Hours of Fishing	<12 hrs	30 (25.2)	89 (74.8)	0.018
	>12 hrs	4 (8.7)	42 (91.3)	
Type of Boat Used	Motor Boat	22 (37.9)	36 (62.1)	<0.001
	Others	12 (11.2)	95 (88.8)	

Among the variables related to hearing problems and past history of the participants, Past history of hearing trouble, history of recent nasal congestion and history of chronic hearing discharge were found to be significant. The Hearing loss rate were higher in people with known history of hearing trouble

(94.4%) than people without any history of hearing trouble (75.2%). Similarly fisherman with recent history of nasal congestion had higher rate of hearing loss (88%) than fisherman without history of nasal congestion (72.2%). Almost all the fisherman with chronic ear discharge had hearing loss. [Table 9]

**Table 9: Association Between Hearing-Related Variables and Hearing Loss (n = 165)**

Variable	Category	Normal Hearing n (%)	Hearing Loss n (%)	p-Value
Had any hearing trouble	Yes	2 (5.6)	34 (94.4)	0.012#
	No	32 (24.8)	97 (75.2)	
Ever attended doctor with ear problems or hearing difficulties?	Yes	1 (5.3)	18 (94.7)	0.079
	No	34 (20.6)	131 (79.4)	
Ever had a serious head injury	Yes	7 (24.1)	22 (75.9)	0.604#
	No	27 (19.9)	109 (80.1)	
Ever suffered vertigo or dizziness	Yes	5 (22.7)	17 (77.3)	0.792
	No	29 (20.3)	114 (79.7)	
History of deafness in family	Present	4 (12.1)	29 (87.9)	0.178#
	Absent	30 (22.7)	102 (77.3)	
History of ringing in ears	Present	1 (8.3)	11 (91.7)	0.275
	Absent	33 (21.6)	120 (78.4)	
History of recent cold or nasal congestion	Present	9 (12)	66 (88)	0.013#
	Absent	25 (27.8)	65 (72.2)	
History of chronic ear discharge	Present	0	15 (100)	0.016
	Absent	34 (22.7)	116 (77.3)	
History of chronic medication	Present	6 (11.5)	46 (88.5)	0.051#
	Absent	28 (24.8)	85 (75.2)	
History of exposure to activities/hobbies involving loud noise	Present	11 (18.3)	49 (81.7)	0.585#
	Absent	23 (21.9)	82 (78.1)	
Had a previous hearing test?	Yes	2 (9.1)	20 (90.9)	0.255
	No	32 (22.4)	111 (77.6)	

## DISCUSSION

The mean age of the study participants was 42.5, this is similar to the other studies conducted among the other fisherman community. The prevalence of hearing loss among the fisherman in the present study was found to be 79%. This is similar to the study carried out by Arumugam et al. in Karaikal, where the prevalence of hearing loss among the fisherman was 71.43%.<sup>[15]</sup> Similarly the prevalence of hearing loss among the fisherman in an Indonesian study was 60.2%.<sup>[16]</sup>

The Age related distribution of hearing loss in decibels was lower in younger age group of 18- 30 years. Similar observations were also made in the karaikal study in which younger age group of 20-30 years had minimal hearing loss.<sup>[15]</sup> Similarly an

Indonesian study by Anwar et al also observed similar findings of positive relationship between the age of the participants and the degree of hearing loss.<sup>[17]</sup>

Anwar et al also observed that degree of hearing loss was significantly associated with the working period, these observations are similar to the present study that fisherman who work in the sea for more than 12hours have higher hearing loss rate of 91.3%.<sup>[17]</sup> Svendsen et al showed high noise levels in engine rooms (range 96–108 dBA) and lower values in the control cabins (range 70–90 dBA) on board Norwegian ships. In Italy, Rapisarda et al conducted a phonometric study on six fishing vessels and they also found that the equivalent sound pressure level in the engine rooms consistently exceeded 90 dBA on all vessels.<sup>[7,18]</sup> This explains the present study result

of fisherman's using Piper boat and motor boat having higher rate of hearing loss which can be attributed to the noisy engines.

The observation from Karaikal study depicts tinnitus as the forewarning of exposure to unrestricted sound stimuli and an important symptom in preventing Noise Induced Hearing Loss (NIHL). Noise induced hearing loss is preventable and can have negative consequences of different natures, leading to hearing impairment, auditory dysfunctions such as tinnitus. In the present study similar observations can be made that fishermen with existing hearing problems, tinnitus and chronic discharge were with higher rate of hearing loss.<sup>[15]</sup>

The present study had a major limitation of not using the Pure tone Audiometry for assessing the hearing loss due to limited resources and logistics. Hence the assessment through smart phone based hearing test TM can be considered as a screening method and further diagnosis has to be correlated with Pure Tone Audiometry.

## CONCLUSION

This study contributes to understand the hidden burden of hearing loss among the fisherman community. Early hearing loss can be detected through simple smart phone-based hearing test TM at the community level and preventive measures can be initiated to prevent further progression of hearing loss. It should be recognized that factors such as duration of working in sea, type of boat and past history of hearing problems influence the extent of hearing loss. It is also important to create the awareness and the need of using noise reducing ear plugs for the prevention of hearing loss among the fisherman.

### Summary

Fishermen community possesses unique characteristics of a folk society, since major portion of the life of fishermen is spent at sea with bizarre sleep and eating pattern, their risk profile for health illness are different from general population. Hearing problems among fishermen were commonly due to prolonged noise exposure in the engine room. If hearing impairment is detected at the earliest serious health problems can be reduced. Thus the present study the present study was planned, to determine the prevalence of hearing loss and the factors influencing them among the active fisherman in Puducherry. The present study was community based cross-sectional study among active fisherman from three coastal villages of Puducherry. Smart Phone Based Hearing Test TM (e-audiologia) was used to assess the hearing loss among the fishermen. Totally 165 fisherman participated in the study, it was observed the prevalence of hearing loss was 79% and factors such as duration of working in sea, type of boat used, previous history of hearing problem, nasal congestion and chronic ear discharge had significant association with hearing loss among fisherman.

Hence Early hearing loss can be detected through simple smart phone based hearing test TM at the community level and preventive measures can be initiated to prevent further progression of hearing loss.

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