ORIGINAL ARTICLES
PHILIPPINE JOURNAL OF OTOLARYNGOLOGY-HEAD AND NECK SURGERY VOL. 37 NO. 2 JULY – DECEMBER 2022

Hearing and Clinical Otologic Profile of Filipinos Living in Southern Tagalog Region IV-A (CALABARZON), Philippines: The Southern Tagalog ENT Hearing Specialists (STENTS) Survey 2012-2017

Patrick Joseph M. Pardo, MD[1]
Angeline Niñal-Vilog, MD[1]
Jose M. Acuin, MD, MSc[1,2]
Christopher Malorre E. Calaquian, MD[2,3]
Rubiliza DC. Onofre-Telan, MD[4]

[1]*Department of Otorhinolaryngology Head and Neck Surgery De La Salle University Medical Center*

[2]*Department of Otorhinolaryngology Head and Neck Surgery Asian Hospital and Medical Center*

[3]*Department of Otolaryngology - Head and Neck Surgery Philippine General Hospital - University of the Philippines Manila*

[4]*Qualimed Hospital-Santa Rosa*

ABSTRACT

Objective: To determine the prevalence of hearing loss and otologic diseases among Filipinos living in the Southern Tagalog Region IV-A: CALABARZON (Cavite, Laguna, Batangas, Rizal and Quezon), Philippines.

Methods:

Design:	Retrospective Review of Community Survey Data
Setting:	Communities in Region IV-A provinces, Philippines
Participants:	3267 residents of the five provinces aged 0 months and above

Results: About 71.29% and 74.60% had at least mild hearing loss, in right and left ears, respectively. For disabling hearing impairment, overall prevalence was 26.33%, distributed into 11.87% among 4 to 18-year-olds; 8.97% for 19 to 64-year-olds; and 3.17% for 65-year-olds and above. Absence of prevalent and hearing loss-associated diseases: serous otitis media [OR 0.362, 95% CI 0.167 to 0.782, p = .010], CSOM [OR 0.407, 95% CI 0.236 to 0.703, p = .001] COM [OR 0.229, 95% CI 0.106 to 0.494, p < .001] can decrease the risk for hearing loss development in the region. Prevention of noise-induced hearing loss or delay in the manifestation of presbycusis can reduce the risk of having hearing loss by as much as 75% [OR 0.253, 95% CI (0.180 to 0.355), p < .001]. All pure tone audiometry measurements were obtained with surrounding median ambient noise of 55dB (IQR 46 to 60dB).

Conclusion: The prevalence of hearing loss among surveyed residents of the Southern Tagalog Region IV-A provinces was high compared to the previous nationwide study but low compared to other low- and middle-income countries. The top otologic conditions of this population (ear occlusion with ear wax, chronic suppurative otitis media, chronic otitis media, presbycusis, noise-induced hearing loss) were associated with hearing loss and their absence decreased the risks for hearing impairment.

Correspondence: Dr. Patrick Joseph M. Pardo
Department of Otorhinolaryngology
Head and Neck Surgery
De La Salle University Medical Center
Gov. D. Mangubat Ave., Dasmariñas, Cavite 4114
Philippines
Phone: +63 46 481 8000
Email: orl-hns@dlshsi.edu.ph

The authors declared that this represents original material, that the manuscript has been read and approved by the authors, that the requirements for authorship have been met by each author, and that the authors believe that the manuscript represents honest work.

Disclosure: The authors signed disclosures that there are no financial or other (including personal) relationships, intellectual passion, political or religious beliefs, and institutional affiliations that might lead to a conflict of interest.

Philipp J Otolaryngol Head Neck Surg 2022; 37 (2): 8-15

Keywords: *prevalence; hearing loss; CSOM, pediatrics; adults; presbycusis; survey; otoscopy; otology*

The World Health Organization has estimated about 466 million people worldwide have moderate or greater hearing loss[1,2] with 80% residing in low- and middle-income countries (LMICs)[2] like the Philippines. However, less programs are devoted to hearing loss detection, prevention, and remediation programs among these countries.[1,3]

According to Newall *et al.* in 2020,[1] the Philippines has a prevalence of moderate or worse hearing loss (4 frequency average ≥ 41dBHL was 7.5% in children, 14.7% in adults 18-65 years old, and 49.1% among adults >65 years old) nationwide. To the best of our knowledge, there is no published data on the prevalence of hearing loss and otologic diseases in the Southern Tagalog Region IV-A or CALABARZON, composed of the five provinces of Cavite, Laguna, Batangas, Rizal and Quezon. Identifying the hearing profiles of constituents of municipalities and provinces in this region can help local health providers, health care workers and health policy makers design ear and hearing care programs that will fit their community's needs.

Our study aimed to determine the prevalence of hearing loss and otologic diseases among Filipinos living in the Southern Tagalog Region IV-A: CALABARZON (Cavite, Laguna, Batangas, Rizal, Quezon), Philippines based on data from the survey conducted by otolaryngologists who were practicing in this region from 2012 to 2017.

METHODS

Our study began after the approval of its research protocol submitted to the Independent Ethics Committee of the De La Salle Health Sciences Institute, IEC Protocol Code: 2021-54-01-A. We performed the procedural steps and conduct of this study following the Declaration of Helsinki of 1975, the 2017 National Ethical Guidelines for Health and Health-Related Research and the implementing rules and regulations of the Data Privacy Act of 2012.

Study design and setting

We conducted a retrospective review of charts and records based on the data gathered from a community survey by collaborating otolaryngologists practicing in the Southern Tagalog Region IV-A comprising the provinces of Cavite, Laguna, Batangas, Rizal, and Quezon, Philippines from 2012-2017.

Population and sample size

Our study reviewed and analyzed all 3452 charts and medical information obtained by the Southern Tagalog ENT Specialists (STENTS) 2012-2017 hearing survey collaborators from residents of the region aged 0 months and above, who consented to participate (or whose parents or guardians gave consent). All charts with incomplete, missing or erroneously encoded data were excluded. Proxy consents were obtained from the current president of the STENTS chapter of the Philippine Society of Otolaryngology – Head and Neck Surgery (PSO-HNS) and from the lead collaborator (RVCJ) who conducted the survey in 2012-2017 to use the database for the analysis of this study.

Data collection and analysis

We analyzed the demographic data (age and sex) and clinical data (ear symptoms, duration of hearing disability if present, family history of hearing loss, otoscopy findings, pure tone audiometry for participants 4 years old and above, behavioral hearing responses for children below 4 years old, and the need for ear and hearing condition management) collected from the survey, performed by otorhinolaryngologists, following the procedures recommended when utilizing the WHO/PEB ear and hearing disorders examination form version 7.1A.[4]

We categorized pure tone hearing levels based on the WHO 2008 recommendation: pure tone averages (PTAs) of ≤ 25 dBHL for normal hearing or no impairment, 26 to 40 dBHL for mild impairment, 41 to 60 dBHL for moderate impairment, 61 to 80 dBHL for severe impairment, and > 80 dBHL for profound impairment.[5] We also classified their hearing acuity based on the WHO definition of disabling hearing impairment as PTA thresholds at 500, 1000, 2000 and 4000Hz in the better ear ≥ 41 dB HL among adults[5] and ≥ 31dBHL for the pediatric age group.[6] These pure tone audiometry measurements were conducted in a single quiet room available in the health centers and primary hospitals located in each identified site. All ambient sound levels recorded in these sites obtained from the survey were also analyzed.

Statistical analysis

We used descriptive statistics (mean and SD, percentage, median and range) to describe demographic and clinical data. We illustrated the hearing status and otologic profile distribution based on sex and age using frequency distributions and computed the prevalence of hearing loss and common otologic diseases and conditions. The Chi-Square test was used to determine associations between, sex, presence of specific otologic conditions and presence of hearing loss- for both groups who underwent the pure tone audiometry and behavior hearing screening test; the Kruskal-Wallis test was used to determine presence of differences between hearing levels among those who underwent pure tone audiometry; and regression analysis was used to identify the relationship or correlation between factors associated with hearing loss odds ratio (OR) for data of subjects who underwent pure tone

audiometry screening. All p-values < .05 were considered significant. All data were encoded using MS Excel version 2112 (Microsoft 365®, Microsoft Corp., Redmond WA, USA), and analyzed using STATA 15.0 (Stata Corp LLC, College Station, TX, USA).

RESULTS

Only 3258 out of 3452 datasets were analyzed in this study, with 194 records excluded due to missing, incomplete, erroneous encoding and/or repeated entries during screening. All pure tone audiometry measurements were obtained with surrounding median ambient noise of 55 dB (IOR: 14, [46 - 60 dB]).

Our included population had a median age of 30 (IQR: 54 [12 to 64]) years old, composed of 42.20% children and 57.8% adults and dominated by females (62%). Adults were further classified into adults aged 19 to 64 years old (51.84%) and elderly aged 65 years old above (5.95%).

Based on age, their PTAs revealed that of the surveyed children > 4 years old to 18 years old, 24.30% had at least mild hearing impairment in their right ear and 23.21% in the left ear. For the adults, 46.99% had hearing loss in their right ear and 50.85% in their left ear. For sex, hearing loss of at least mild was higher in females in both ears (62.78% right ear, 63.24% left ear). The overall age prevalence of disabling hearing impairment was at 26.33%. In between age groups, the prevalence was identified as follows: 11.87% for ages 4 to 18 years old; 8.97% for those 19 to 64 years old; and 3.17% for ages 65 years old and above.

Representative graphs of each age group show that most hearing loss levels in all age groups were recorded as mild hearing loss. *(Figures 1 to 3)* However, among the three groups, hearing loss levels were significantly associated with age among the elderly, 65 years old and above (H statistic = 41.840; df = 26; p = .02). *(Figure 3) Figure 4* shows evaluations per province, with Quezon ranked first as having the highest overall prevalence of disabling hearing loss (34.15%) among the five provinces, followed by Rizal (23.24%) and Laguna (21.92%). For pediatric residents, the disabling hearing impairment percentages were high in Quezon (20.06%), Cavite (12.32%) and Rizal (12.16%). Smaller percentages of the study population aged 65 years old and above were noted to have disabling hearing loss: Quezon (3.83%), Rizal (3.24%), and Laguna (1.97%).

As for ear symptoms and ear examination findings, 50 of the participants complained of ear pain. On otoscopy, the top three ear findings were: presence of ear wax (18.17%), tympanic membrane perforation (3.96%) and otorrhea (3.60%). These three findings, together with hyperemic tympanic membrane (df = 1, p = .008), were found to have significant association with presence of hearing loss in our study population (df = 1, p < .05). *(Table 1)*

As for pertinent history, any identified length of time that these participants suffered difficulty of hearing was associated with the presence of hearing loss regardless of duration: 0-4 years, 1.26% (Chi-square test: observed value = 38.523, df = 1; p < .001), 5-59 years, 2.27% (Chi-square test: observed value = 14.997; df = 1; p < .001) and 60 years and above, 1.14% (Chi-square test: observed value = 34.160; df = 1; p < .001). In addition, information regarding recall of previous ear consultations or report of existing ear diagnoses revealed that ear occlusion with wax, 14.06% (Chi-square: observed value = 37.786, df = 1, p < .001) , non-infectious causes - presbycusis and noise-induced hearing loss (NIHL), 4.51% (Chi-square: observed value = 46.316; df = 1, p < .001), chronic suppurative otitis media (CSOM), 2.05% (Chi-square: observed value = 12.247, df = 1, p < .001), and chronic otitis media (COM), 0.86% (Chi-square: observed value = 11.227, df = 1, p = .001), were also found to be significantly associated with decline in hearing in this population. *(Table 1)*

Assessment and management data also revealed that 32.55% needed aural toilette, 30.61% needed medications, and 11.17% required hearing aid fitting. About 11% would be needing further diagnostic tests for hearing and 6% would require further investigation for hearing loss causes.

Among all the otologic and clinical characteristics analyzed in this population *(Table 2),* we found that as they reached adulthood, they were more likely to start experiencing decline in hearing [OR 1.010, 95% CI 1.005-1.014, p < .001]. On the contrary, male sex [OR 0.539; 95% CI 0.393 - 0.738; p < .001]; absence of otologic findings such as inflamed ear canal [OR 0.365, 95% CI 0.191 to 0.698, p < .002), earwax [OR 0.619, 95% CI 0.504 to 0.759; p < .001], dry perforated ear drums [OR 0.326, 95% CI 0.218 to 0.487, p < .001] and otorrhea in the middle ear [OR 0.452, 95% CI 0.308 to 0.665, p < .001] of both ears during examinations decreased the risk of developing hearing loss by 39 to 68% compared to the normal hearing individuals in our study population. Those who were not previously or currently diagnosed with serous otitis media [OR 0.362, 95% CI 0.167 to 0.782, p = .010], CSOM [OR 0.407, 95% CI 0.236 to 0.703, p = .001] COM [OR 0.229, 95% CI 0.106 to 0.494, p < .001] could lessen the chances of hearing impairment by 50% to 77%. Prevention of noise-induced hearing loss or delay in the manifestation of presbycusis could reduce the risk of having hearing loss by as much as 75% [OR 0.253, 95% CI (0.180 to 0.355), p < .001].

Sub-analysis of records of the 260 pediatric participants subjected to behavioral tests revealed an almost equal distribution of males and females suspected to suffer from hearing loss (36.03% versus 35.48%), with no significant difference noted (Kruskal-Wallis test: H statistic: 3.429, df = 2, p = .180).

Table 1. Clinical profile of subjects* (n=3258)

Clinical Characteristics	Frequency (%)	
	Without hearing loss	With hearing loss†
Symptom		
- *Ear pain*	*32 (0.98)*	*18 (0.55)*
Ear findings		
- *Inflamed Ear Canal*	*21 (0.65)*	*28 (0.86)*
- *Presence of ear wax*	*362 (11.11)*	*230 (7.06)*
- *Presence of otorrhea*	*65 (2.00)*	*51 (1.60)*
- *Presence of tympanic membrane perforation*	*62 (1.90)*	*67 (2.06)*
- *Presence of dull tympanic membrane*	*40 (1.23)*	*21 (0.65)*
- *Presence of hyperemic tympanic membrane*	*21 (0.65)*	*19 (0.58)*
Diagnoses		
- *Ear canal occlusion- ear wax*	*272 (8.35)*	*186 (5.71)*
- *Chronic Suppurative Otitis Media*	*35 (1.07)*	*32 (0.98)*
- *Serous Otitis Media*	*15 (0.46)*	*13 (0.39)*
- *Chronic Otitis Media*	*12 (0.37)*	*16 (0.49)*
- *Non-infectious causes*	*68 (2.09)*	*79 (2.42)*
a. Presbycusis		
b. Noise-induced hearing loss		

* Subjects whose hearing status were measured using behavioral tests were also included in this analysis.
† All clinical characteristics in bold letters were found to have significant association with presence or absence of hearing loss (Chi-square test: df=1, p-value <.05). Hearing loss defined as having disabling hearing loss as determined by pure tone audiometry, and hearing loss as detected by the behavioral screening test recommended by WHO/PEB ear and hearing disorders examination form version 7.1A

Table 2. Factors associated with disabling hearing loss* in this study population (n=2998)

Identified factors	Odds Ratio (95% CI)	P-value§
Demographics		
Age	1.010 (1.005 to 1.014)	**<.001**
Male Sex	0.539 (0.393 to 0.738)	**<.001**
Clinical Characteristics †		
Symptom, Ear Pain	0.816 (0.433 to 1.535)	.528
Absence of the following otologic examination findings -Inflamed ear canal	0.365 (0.191 to 0.698)	**.002**
-Ear wax in the canal	0.619 (0.504 to 0.759)	**<.001**
-Otorrhea (ear canal)	0.940 (0.510 to 1.733)	.844
-Tympanic membrane findings:		
A. Perforation	0.326 (0.218 to 0.487)	**<.001**
B. Dullness	0.713 (0.412 to 1.234)	.227
C. Hyperemia	0.541 (0.265 to 1.105)	.09
-Otorrhea in the middle ear	0.452 (0.308 to 0.665)	**<.001**
Absence of the following Otologic Diagnoses		
A. Otitis Externa	0.619 (0.243 to 1.576)	.314
B. Otitis Media	0.551 (0.237 to 1.282)	.167
C. Serous Otitis Media	0.362 (0.167 to 0.782)	**.010**
D. Chronic Suppurative Otitis Media	0.407 (0.236 to 0.703)	**.001**
E. Chronic Otitis Media	0.229 (0.106 to 0.494)	**<.001**
F. Non -infectious ‡	0.253 (0.180 to 0.355)	**<.001**
G. Genetic causes	0.328 (0.063 to 1.704)	.185

* Disabling hearing loss: >31dB for children5 and >41dB for adults6 on the better ear
† The clinical characteristic is present in at least one ear
‡ Non-infectious causes include presbycusis and noise-induced hearing loss
§ Subjects analyzed here were those who underwent pure tone audiometry. Logistic regression, df=1, p-values are significant if <.05

DISCUSSION

Our study population, composed of mostly female adults aged 19 to 64 years old, had an overall prevalence of hearing loss of 71.29% for the right ear and 74.06% for the left ear, with the majority having at least mild hearing loss in either or both ears. The disabling hearing loss was recorded at 26.33% with the province of Quezon having the highest percentage. They had common otologic symptoms of ear pain, and findings of earwax, perforated tympanic membrane and otorrhea. Their most frequently diagnosed otologic diseases were ear occlusion due to ear wax, CSOM, COM and non-infectious diseases namely, presbycusis and NIHL. Duration of their complaint of hearing loss was highly associated with presence of hearing loss. Among those with identified hearing difficulties and otologic problems, most were advised to have ear cleaning, medical treatment, hearing aid fitting and to undergo further testing to identify the etiology of their conditions.

As we compare our findings with local studies and with those among other LMICs, our pediatric hearing disabling impairment prevalence was higher compared to the national prevalence obtained by Newall *et al.* in 2020 of 7.5%[1] and the prevalence recorded in India in 2018 of 4.5%.[7] However, it was low compared to the Ghana reported rate of 12.5%.[8] We did not come across any recent studies where behavioral tests were utilized to compare with our subset of the pediatric population screened using alternative behavioral tests.

The 2018 study in India by Bright *et al.* screened the age group lower than 4 years old using otoacoustic emission testing and had a failure rate of 1.8% for both ears.[7] Although a comparison cannot be made due to differences in screening methods used, we can only approximate that the 5.69% prevalence of hearing loss in our pediatric subset population was higher compared to that reported from India.

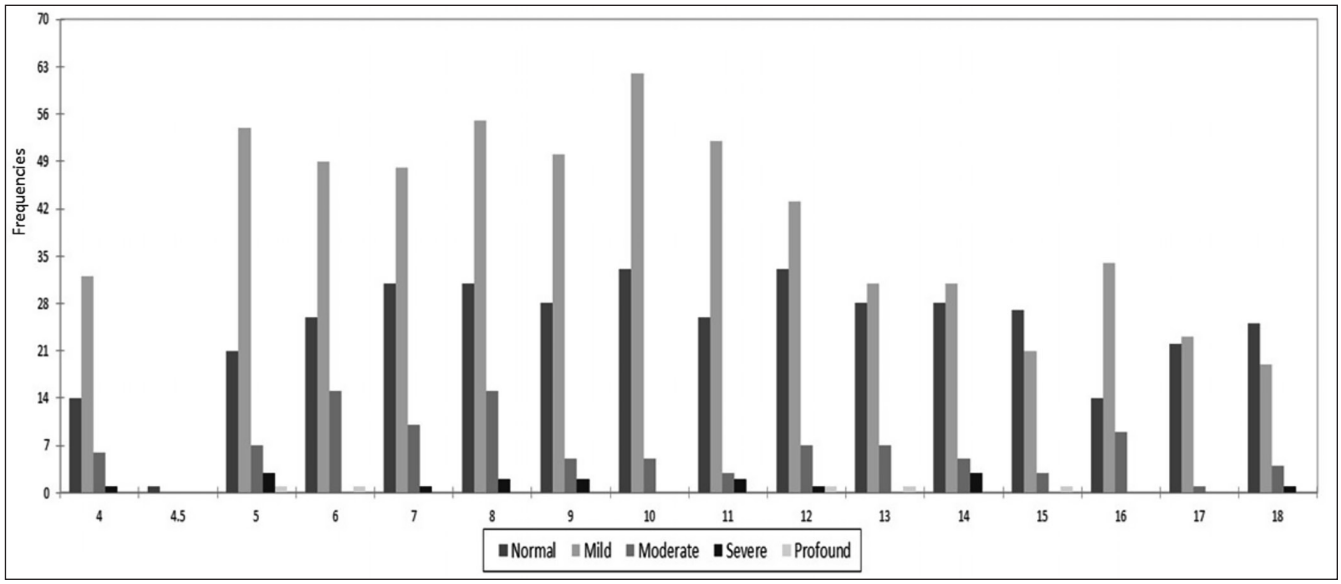

Figure 1. Frequency distribution of hearing loss in the right ear among pediatric age group (>4 to 18 years old), n=1115 (Kruskal-Wallis test; H statistic= 10.104; df = 15; p = .813).

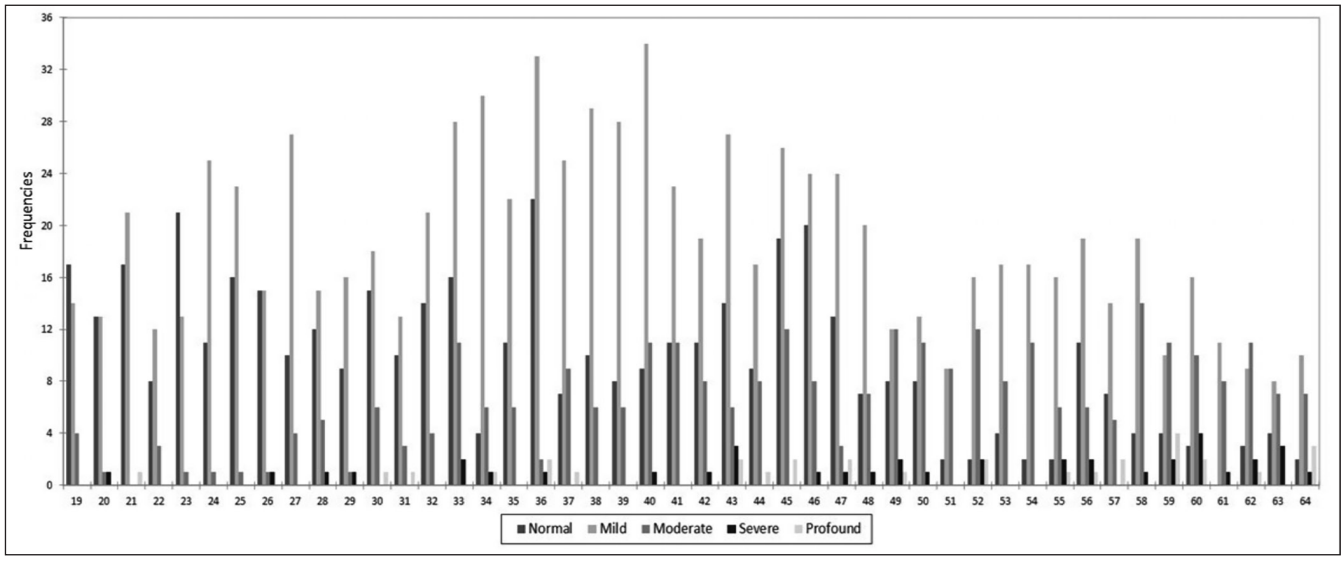

Figure 2. Frequency distribution of hearing loss in the right ear, among adults aged 19 to 64 years old, n=1689 (Kruskal-Wallis test; H statistic: 10.101; df: 45; p = 1.00).

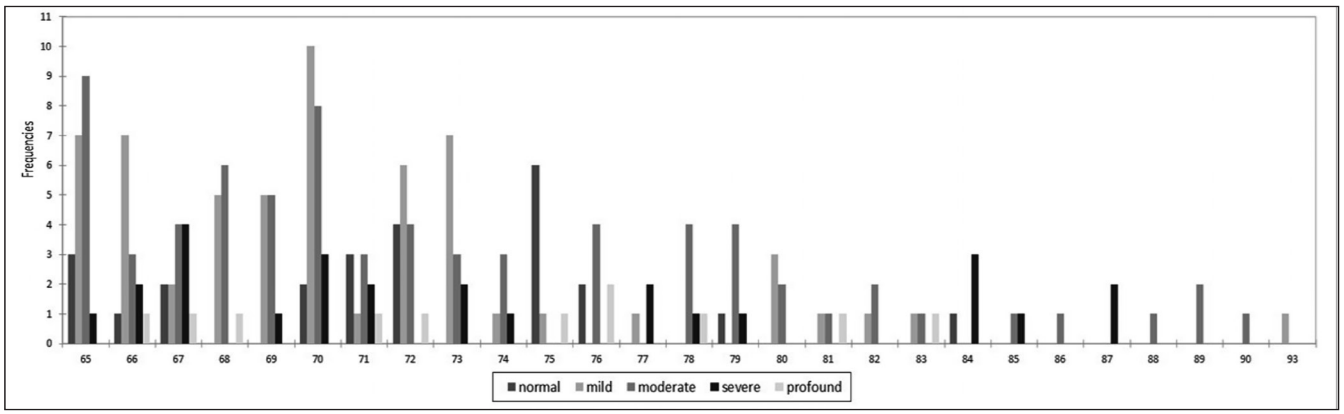

Figure 3. Frequency distribution of hearing loss in the right ear among adults aged 65 years old and above, n=194 (Kruskal-Wallis test; H statistic= 41.840; df = 26; p = .02).

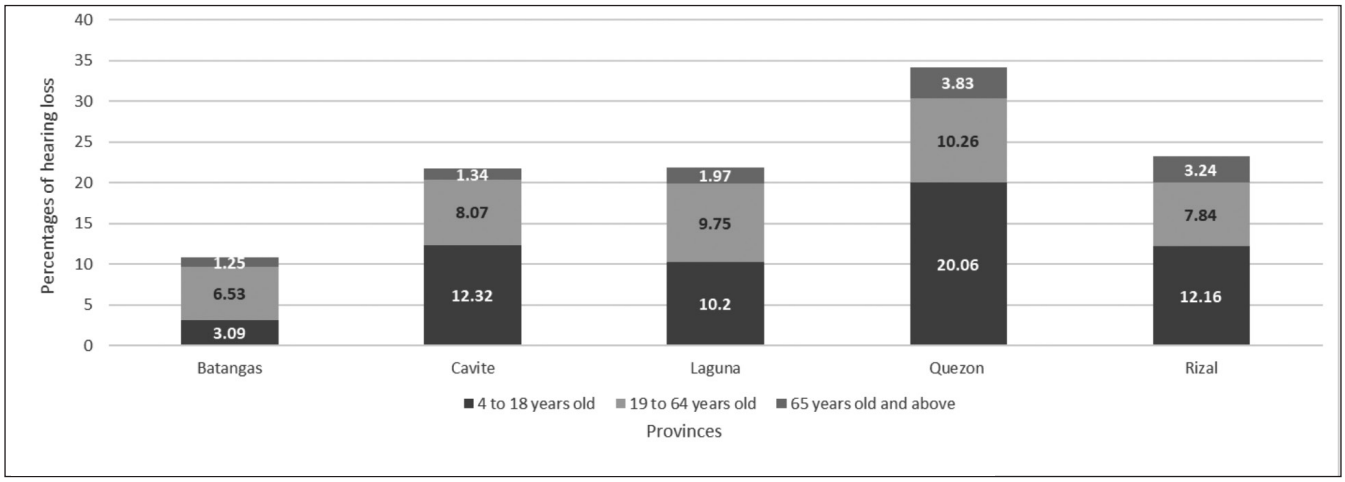

Figure 4. Distribution of disabling hearing impairment by percentage among provinces in Region IVA (n=2998).

Our adult population, on the other hand, had a lower prevalence of hearing loss compared to the 63.8% prevalence reported in the previous 2020 nationwide study.[1] It was higher than the prevalence of 8.5% reported for Thailand,[7] but lower than the 48.8% prevalence in India[7] or 26% prevalence in Malawi.[10]

Comparing our findings with upper middle to high income countries, our 26.33% overall prevalence for disabling hearing impairment was higher than the 14.3% estimated bilateral hearing loss in the United States of America by Goman *et al.* in 2016,[11] and the 22.73% overall prevalence reported for South Korea in 2015.[12]

Our mentioned otologic findings and having been previously or currently diagnosed with diseases affecting the ear canal and the middle ear were also strongly associated with possibly developing poor hearing levels. These findings and diseases cause faulty function of the diseased middle ear that affect the conduction of sound waves and its translation.[13] Any conditions that hamper sound wave travel and its conversion to electrical stimulus modify the quality of sound for interpretation, causing variation or deviation of hearing acuity from normal.[14] These findings were similar to the review of evidence by Leach *et al.* in 2020 that these diseases were very much related to hearing loss in LMICs especially among disadvantaged populations.[15] Similarly, otologic examination findings in our study (otorrhea in the middle ear and presence or absence of defects in the tympanic membrane) are significantly associated and evidently strengthen our earlier claim on their association with hearing difficulty. Our study also showed that non- infectious causes such as noise-induced hearing loss significantly linked to poor effects on the cochlear function of the ear.[16]

Among the items under pertinent medical history, we found an association between disabling hearing impairment and the duration of hearing loss regardless of the number of years affected. Prolonged untreated and/or unaided hearing problems can cause an increased risk in disability.[17] Furthermore, it aggravates the hearing acuity of the stricken individual and affects language development[17] if it involves children (11.87% of our study population) and doubles the risk for dementia and cognitive decline[18] among adults (8.97% as mentioned earlier), especially the elderly. Although the association between family members who are also hearing impaired and the development of hearing loss in an individual was not significant in our study, familial hearing status or having family members with hearing loss, regardless of the level of impairment was a high-risk indicator for developing unilateral, asymmetrical, or bilateral hearing loss.[19] In addition, the advent of genetic studies has exploded into various investigations and produced evidence about possible genetic reasons for hearing loss that run through a family or community. Approximately 50 to 60% of hearing loss in developed countries is rooted in genetic errors,[20] and some genetic coding has been detected among Filipinos that may explain possible causes of hearing loss, particularly the SCL26A4 c.706C>G (p.Leu236Val) found among hearing impaired Filipinos with cochlear implants[21] and the A2ML1 genotype making the indigenous Filipinos of Central Luzon at risk for developing otitis media.[22]

Since wax occlusion and middle ear disease remained to be the most associated causes of hearing loss in our study population, it was not surprising that removal of ear wax and medications for middle ear infections were the management most recommended by physicians who conducted this survey. These findings were similar to those of studies in India,[7] Ghana[8] and Malawi.[10]

Our study identified increasing age as detrimental to the development of hearing loss. On the other hand, the absence of earwax in the ear canal and otorrhea, having an intact tympanic membrane, being cleared from CSOM, COM, serous otitis media, and non-exposure

to noise, and delay in presbycusis factors lessen the risk for having hearing loss of at least mild severity. These findings were also reported in the previous nationwide study wherein age is a significant factor and having ear conditions of the outer or middle ear can aggravate hearing loss.[1] In fact, that same study stated that the Philippines had the highest number of hearing loss cases associated with wax occlusion and middle ear disease in the South East Asia region.[1] Furthermore, studies in the LMICs revealed same risk factors.[1,7-10] However, unlike the Newall *et al.* study,[1] CSOM was a common finding in our study population, similar to the results of Bright *et al*.[5] where the disease ranked as the top otologic diagnosis among their Indian study population subset with hearing loss. In studies across the globe, noise-induced hearing loss was also identified to be the one of the most common culprits[11] which was also found to be significantly associated and a risk for developing hearing loss in our study population. However, compared to studies in LMICs that usually identify infectious causes in the middle and outer ears as contributory factors for developing hearing loss, studies in high-income countries mostly associate hearing loss with factors such as age and noise exposure.[11,12] On the other hand, some European studies still consider the status of middle ear function among the key factors in developing hearing problems[23,24] and the 2017 cohort study by le Clercq *et al.* in the Netherlands still identified exposure to recurrent otitis media during childhood as a huge influence on hearing acuity[25] making hearing care and ear health an utmost priority.

The World Health Organization has always stressed the need for community-based screening for hearing loss to address its rising burden. However, similar to the experience in other LMICs, the STENTS collaborators survey teams that collected these data encountered difficulties that can be attributed to infrequent data gathering process evaluation, logistical problems, and poor regional representation.[15] Thus, there are several limitations to our study. Although the survey group uniformly followed the WHO/PBD ear and hearing disorders examination form and methods in conducting community-based hearing screening, the infrequent data gathering process evaluation and on-site data validation may have caused errors and missing data leading to exclusion of the other charts and records. This was the first time for the team to conduct a community-based hearing survey in a relatively large setting. To further improve the process of data quality checking, we recommend assignment of trained personnel per set of data collectors, adept with the WHO/PBD ear and hearing disorders examination form and methods, who can handle routine periodic data validation and checking to decrease missing data and errors of data encoding. A second limitation is the conduction of audiometric hearing screening in areas with a median ambient noise of 55dB (IQR 46 to 60dB) and the absence of a validated correction factor for ambient noise that may have caused an over- or under-estimation of hearing loss levels. The WHO has recommended that the ambient noise be at a maximum of 40dB. However, we failed to maintain or even attain this requirement for precise and accurate recording of the hearing acuity of our subjects. Our recorded ambient noise value was similar to recorded values among the other community-based studies[7-10] conducted in LMICs. However, to improve the results of future community-based hearing acuity studies, we recommend studies determining validated correction factors for hearing screening procedures be conducted in communities where it is impossible to control ambient noise to less than 30dB. A third major limitation is poor regional representation of the subjects included in our study. We had a relatively low yield of subjects to represent the actual number of residents in each area for us to determine the real hearing status of the communities. We attributed this to the few members of the survey team and limits in logistics and financial capacity. We failed to reach other areas of these regions. Region IV-A has at least 14.4M residents based on the 2015 Philippine Statistics Authority survey. To give a clear generalizable hearing and otologic condition or status of its constituents, the sample size must be increased, as well as the number of research team members. Fourth, the hearing level classification and cutoff values for disabling hearing impairment used during data gathering were based on the 2008 and 2016 guidelines of the WHO. For future studies, we recommend that the recently released 2021 WHO guidelines be used.

In conclusion, the prevalence of hearing loss among surveyed residents of the Region IV-A: CALABARZON provinces in Southern Tagalog, Philippines was high compared to the previous nationwide study but low compared to other low- and middle-income countries. The top otologic conditions of this population (ear occlusion with ear wax, chronic suppurative otitis media, chronic otitis media, presbycusis, noise-induced hearing loss) were associated with hearing loss and their absence decreased the risks for hearing impairment.

ACKNOWLEDGEMENTS

The authors would like to thank the STENTS 2012-2017 Hearing Survey Collaborators* for allowing us to analyze their survey results. Ms Whyla Amon Aquino for her help with data screening and evaluation and Mr Rhalp Jaylord Valenzuela for performing the statistical analysis.

STENTS 2012-2107 Hearing Survey Collaborators*

Acosta, Emilio Romel G.
Alcira, Ramon Carmelo V
Alcira, Winma Athena L.
Alonzo, Eugenio Tomas A.
Aragon, Rodney Oliver J.
Arceo, Roy O.
Azurin, Eunice A.
Billones, William U.
Burgos, Fidel P. (+)
Cabungcal, Alexander C.
Canlas, Rowena A.
Carmona, Ramon Jr V.
Carpiso, Olma C.
Cayetano. Leonides P.
Cordova, Ma.Ignatius E.
Cornista, Josefa Andrea G.
Cruz-Durian, Rosario M.
De Jesus, Arvin L.
Destriza, Waynn Nielsen C.
Diaz, Kathrina A.
Dimayuga, Maria Elaine M.
Duran, Cecile Trisha B.
Eslava, Erwin M.
Ferrolino, Brendan R.
Galicia, Michael Jr F.
Garing, Athony Vincent V.
Gasacao, Ryan A.
Go-Gasacao, Rosemarie C.
Gutierrez, Herbert Q.
Holgado, Jan Warren A.
Imperial, Mark Ray T.
Lagrosa-Saguiguit, Pamela A.
Laki-Pillas, Maria Rosario Constancia R.
Nofuente, Carlo A.
Olveda, Mildred B.
Pajarillo, Pio R.
Papa, Enrique II C.
Pascual, Theresa Paz G.
Perez, Medwin D.
Perez-Chua, Abegayle Machelle M.
Peteza, Martin D.
Ramos, Ramon III P.
Remulla, Felicidad M.
Rosanes, Michael M.
Reyes, Ana Maria M.
Rosanes, Michael M.
Rosas, Juan Lucas L.
Sampelo, Angelo Ian A.
Samson, Aurelio C.
Sebastian, Omar Carlo T.
Siasoco, Ramon Gerardo Albino E.
Talanay, Deo H.
Victoria, Roderic P.
Villanueva, Maria Elaine D.
Villaroman, Felipe A.
Zavalla, Mario Angelo S.

REFERENCES

1. Newall JP, Martinez N, Swanepoel DW, McMahon CM. A national survey of hearing loss in the Philippines. *Asia Pac J Public Health*. 2020 Jul;32(5):235-241. DOI: 10.1177/1010539520937078; PubMed PMID: 32608243.
2. Suen JJ, Bhatnagar K, Emmett SD, Marrone N, Robler SK, Swanepoel DW, et al. Hearing care across the life course provided in the community. *Bull World Health Organ*. 2019 Oct 1; 97(10):681-690. DOI: 10.2471/BLT.18.227371; PubMed PMID: 31656333; PubMed Central PMCID: PMC6796676.
3. Ekmann B, Borg J. Provision of hearing aids to children in Bangladesh: costs and cost -effectiveness of a community-based and centre-based approach. *Dis Rehab Assist Technol*. 2017 Aug;12(6):625-630. DOI: 10.1080/1743107.2016.1204631.
4. Smith AW, Mackenzie IJ. WHO ear and hearing disorders survey protocol. For a population-based survey of prevalence and causes of deafness and hearing impairment and other ear diseases. World Health Organization- Prevention of Blindness and Deafness (PBD). Geneva, Switzerland: WHO; 1999.
5. Olunsaya BO, Davis AC, Hoffman HJ. Hearing loss grades and the international classification of functioning, disability and health. *Bull World Health Organ*. 2019 Oct 1;97 (10):725-728. DOI: 10.2471/BLT.19.230367; PubMed PMID: 31656340; PubMed Central PMCID: PMC6796665.
6. World Health Organization. Childhood hearing loss. Strategies for prevention and care. World Health Organization; 2016. [cited 2022 September 17]. Available from: https://apps.who.int/iris/handle/10665/204632.
7. Bright T, Mactaggart I, Kuper H, Murthy GV, Polack S. Prevalence of hearing impairment in Mahabubnagar District, Telangana State, India. *Ear Hear*. 2019 Jan-Feb;40(1):204-212. DOI: 10.1097/AUD.0000000000000599; PubMed PMID: 29782444.
8. Larsen-Reindorf R, Otupiri E, Anomah JE, Edwards BM, Frimpong B, Waller B. et al. Pediatric hearing loss: a community-based survey in peri-urban Kumasi, Ghana. *J Laryngol Otol*. 2019 Aug:10-9. DOI: 10.1017/50022215119001658.
9. Yiengprugsawan V, Hogan A, Harley D, Seubsaman S, Sleigh AC, Thai Cohort Study Team. Epidemiological associations of hearing impairment and health among a national cohort of 87, 134 adults in Thailand. *Asia Pac J Public Health*. 2012 Nov; 24(6): 1013–1022. DOI: https://doi.org/10.1177/1010539511408712.
10. Bright T, Mulwafu W, Phiri M, Ensink RJH, Smith A, Yip J, *et al.* Diagnostic accuracy of non-specialist versus specialist workers in diagnosing hearing loss and ear disease in Malawi. *Trop Med Int Health*. 2019 Jul;24(7):817-828. DOI: 10.1111/tmi.13238; PubMed PMID: 31001894.
11. Goman AM, Lin FR. Prevalence of hearing loss by severity in the United States. *Am J Public Health*. 2016 Oct;106(10):1820-1822. DOI: 10.2105/AJPH.2016.303299; PubMed PMID: 27552261; PubMed Central PMCID: PMC5024365.
12. Jin HJ, Hwang SY, Lee SH, Lee JE, Song JJ, Chae S. The prevalence of hearing loss in South Korea: Data from a population-based study. *Laryngoscope*. 2015 Mar; 125(3):690-694. DOI: 10.1002/lary.24913; PubMed PMID: 25216153.
13. de Zinnis LOR, Campovecchi C, Parrinello G, Antonelli AR. Predisposing factors for inner ear hearing loss association with chronic otitis media. *Int J Audiol*. 2005 Oct; 44(10):593-8. DOI: 10.1080/14992020500243737; PubMed PMID: 16315450.
14. Cai T, McPherson B. hearing loss in children with otitis media with effusion: a systematic review. *Int J Audiol*. 2017 Feb; 56(2):65-76. DOI: 10.1080/14992027.2016.1250960; PubMed PMID: 27841699.
15. Leach AJ, Homee P, Chidzvia C, Gunasekera H, Kong K, Bhutta MF, et al. Panel 6: Otitis media and associated hearing loss among disadvantaged populations and low to middle income countries. *Int J Pediatr Otorhinolaryngol*. 2020 Mar; 130(Suppl 1): 109857. DOI: 10.1016/j.ijporl.2019.109857; PubMed PMID: 32057518; PubMed Central PMCID: PMC7259423.
16. Le TN, Straatman LV, Lea J, Westerberg B. Current insights in noise-induced hearing loss: a literature review of the underlying mechanism, pathophysiology, asymmetry, and management options. *J Otolaryngol Head Neck Surg*. 2017 May 23;46(1):41. DOI: 10.1186/s40463-017-0219-x; PubMed PMID: 28535812; PubMed Central PMCID: PMC5442866.
17. GBD 2019 Hearing Loss Collaborators. Hearing loss prevalence and years lived with disability, 1990-2019: findings from the Global Burden of Disease Study 2019. *Lancet*. 2021 Mar 13; 397(10278):996-1009. DOI: 10.1016/S0140-6736(21)00516-X; PubMed PMID: 33714390; PubMed Central PMCID: PMC7960691.
18. Lin FR, Albert M. Hearing loss and dementia-Who's listening? *Aging Ment Health*. 2014Aug; 18(6): 671-673. DOI: 10.1080/13607863.2014.915924; PubMed PMCID: OMC 4075051; PubMed Central PMID: 24875093.
19. Gouveia FN, Jacob-Corteletti LCB, Silva BCS, Araujo ES, Amantini RCB, Oliveira EB, et al. Unilateral and asymmetric hearing loss in childhood. *Codas*. 2020 Jan 27;32(1): e20180280. DOI: 10.1590/2317-1782/20192018280; PubMed PMID: 31994593.
20. Omichi R, Shibata SB, Morton CC, Smith RJH. Gene therapy for hearing loss. *Hum Mol Genet*. 2019 Oct 1;28(R1): R65-R79. DOI: 10.1093/hmg/ddz129; PubMed PMID: 31227837; PubMed Central PMCID: PMC6796998.
21. Chiong CM, Reyes-Quintos MRT, Yarza TKL, Tobias-Grasso CAM, Acharya A, Leal SM et al. The SLC26A4. c.706C>G (p.Leu236Val) variant is a frequent cause of hearing impairment in Filipino cochlear implantees. *Otol Neurotol*. 2018 Sept;39(8): e726-e730. DOI: 10.1097/MAO.0000000000001893; PubMed PMID: 30113565; PubMed Central PMCID: PMC6097524.
22. Santos-Cortez RLP, Reyes-Quintos MRT, Tantoco MLC, Abbe I, Llanes EGDV, Ajami NJ, et al. Genetic and environmental determinants of otitis media in an indigenous Filipino population. *Otolaryngol Head Neck Surg*. 2016 Nov; 155(5):856-862. DOI: 10.1177/0194599816661703; PubMed PMID: 27484237; PubMed Central PMCID: PMC5093071.
23. Pilka E, Jedrzejczqak WW, Kochanek K, Pastucha M, Skarzynski H. Assessment of the hearing status of school-age children from rural and urban areas of mid-eastern Poland. *Int J Environ Res Public Health*. 2021 Apr 18;18(8):4299. DOI: 10.3390/ijerph18084299; PubMed PMID: 33919574; PubMed Central PMCID: PMC8073182.
24. Paping DE, Vroegop JL, le Clercq CPM, Baatenburg de Jong RJ, van der Schroeff MP. A 4 year follow -up study of hearing acuity in a large population-based cohort of children and adolescent. *Laryngoscope Investig Otolaryngol*. 2021 Feb 9;6(2):302-309. DOI: 10.1002/LIO2.529; PubMed PMID: 33869762; PubMed Central PMCID: PMC8035936.
25. le Clercq CMP, van Ingen G, Ruytjens L, Goedegebure A, Moli HA, Raat H, et al. Prevalence of hearing loss among children 9 to 11 years old. The Generation R study. *JAMA Otolaryngol Head Neck Surg*. 2017 Sep 1;143(9):928-934. DOI: 10.1001/jamaoto.2017.1068; PubMed PMID: 28750130; PubMed Central PMCID: PMC5710286.