A National Survey of Hearing Loss in the Philippines

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Abbreviations: Four Frequency Average (4FA), Frequency (Freq.), Gross national income (GNI), Hearing Threshold Level (HTL), Hertz (Hz), Low or Middle Income Countries (LMICs), Pure-tone audiometry (PTA), Socioeconomic status (SES), South-East Asia Region (SEAR), University of Santo Tomas (UST), World Health Organization (WHO).

Ethical approval for the project was obtained from both Macquarie University Human Research ethics committee (reference: 5201100475) and the University of Santo Tomas Faculty of Medicine and Surgery ethics committee.

Abstract

This study aimed to estimate the prevalence of hearing loss in the Philippines using a nationally representative sample. A cross-sectional national survey was undertaken utilising a three-stage stratified cluster design. Participants in the present study comprised 2275 adults and children with pure tone hearing assessment results. Prevalence of moderate or worse hearing loss, defined as 4FA ≥41dBHL, was 7.5% in children <18 years, 14.7% in adults between 18-65 years, and 49.1% ina dults >65 years. Factors associated with greater risk of moderate hearing loss in the better ear were: presence of a middle ear condition (aOR 2.39, 95% CI 1.49-3.85), and socioeconomic status (household income)(aOR 1.64, 95% CI 1.23-2.19). Age was also associated with increased risk, with adjusted odds ratios varying with age category. Prevalence of wax occlusion and outer and middle ear disease was 12.2% and 14.2% respectively. Prevalence of hearing loss, outer, and middle ear disease appear comparatively high in the Philippines when compared to rates reported in high income countries. Higher proportions of severe to profound hearing loss were also identified, indicating that there is both an increased prevalence and severity of hearing loss in this population.

What we Already Know

- Prevalence of hearing loss and ear disease is higher in low and middle income countries.
- Large epidemiological studies in high income countries have exposed a variety correlates of hearing loss, including age, socioeconomic status, behavioural and medical risk factors.
- Few large epidemiological studies of hearing loss are conducted and published in low and middle income countries.

What This Article Adds

- This is the first peer reviewed article describing the prevalence of ear disease and hearing loss in a medium to large survey of the Philippines.
- Prevalence rates of ear disease and hearing loss were generally higher than would have been predicted based on literature from neighbouring regions.
- This study is the first to describe evidence suggesting that the proportion of more significant hearing loss is higher in low and middle income countries.

Introduction

Hearing loss is a significant contributor to the global burden of disease for both adults and children.[1, 2] The World Health Organization (WHO) estimates that there are 466 million people worldwide with a moderate or greater hearing loss, approximately 80% of whom reside in low and middle income countries (LMICs).[3] Hearing loss in LMICs has a high prevalence and a significant proportion of this burden is either preventable or treatable. Yet, when compared to other health conditions, little attention is paid to hearing loss prevention and remediation programs in these regions.[4]

A number of large, high quality, epidemiological studies have investigated the prevalence of hearing loss in high income countries.[5-8] While studies also exist for LMICs, their number and quality vary across regions (see Stevens[9] for a review). Fewer, large, high quality, published studies exist reporting the prevalence of hearing loss across Asia (see Pascolini and Smith[10] for a review). Three peer-reviewed studies exist in the local region surrounding the Philippines; one from a high income country, Korea,[11] and two from LMICs, Thailand[12], and China.[13] Data from both Korea[11] and China[13] appear to show prevalence estimates comparable to other high income countries. Prasansuk's[12] study in Thailand, although

containing methodologically limitations, suggested a relatively high prevalence of hearing loss, with the estimates approximately three times those reported in high income countries.[7] Without epidemiological data on the prevalence and characteristics of hearing loss, prevention and management initiatives are unlikely to take place, and any efforts which are made may be misaligned to population needs.[4]

The present study reports epidemiological data on hearing loss, including prevalence estimates from a cross-sectional survey, collected in the Philippines in 2011. The Philippines represents a region with slower economic growth, and slower change in income inequality than many of the countries in the surrounding region.[14, 15] Given the relationship between the social conditions of a population and their health outcomes,[16] we would expect a greater prevalence of hearing loss in the Philippines than both high income countries, and possibly even many of the neighbouring LMICs. The objectives of this study are to, report the prevalence of ear disease, hearing loss, and its correlates in a quasi randomised sample from the Philippines.

Materials and Methods

Recruitment

A national cross-sectional survey of hearing loss and ear disease was conducted in the Philippines in 2011, led by staff from the University of Santo Tomas Faculty of Medicine and Surgery. The regions surveyed were chosen based on a three-staged stratified cluster design. The first step involved stratification into one of three geographical areas of the Philippines (Luzon, Visayas, and Mindanao). In the second step, for each of the three areas one province was randomly selected. In the third step, for each province, up to ten municipalities (barangays) were randomly selected, no attempt was made to match population densities in

the selected municipalities to the Philippine population as a whole. Households were recruited from the chosen barangays by a quasi-random walk method. Survey teams of 2-4 members, including an audiologist and ENT surgeon, supported by student audiologists, started out from a well-populated local landmark and then approached every third house as they walked. A coin toss was used to decide survey team direction at intersections. At each household surveyed, all residents in each household were invited to participate in the study, regardless of age. If all members of a household declined to participate, these households were not included in the sample and the researchers continued to the next household in the method described above. In total, 747 households agreed to participate in the survey with the average total occupants for each household 5.9 persons, although often not all occupants were available or consented to participate in the survey. Although sampling was randomised in an attempt to increase representativeness and reduce bias, selection of municipalities was not adjusted based upon population estimates leading to potential bias in population estimates.

The total survey population included 2896 individuals. Eligibility for the current study included the ability to complete audiometric assessment, a subsample of 2275 were able to fulfil this criteria and were included in the study.

Materials and Apparatus

Two questionnaires were administered as part of the study. The first requested demographic information including; the number of household members, employment, income, sanitation, water supply and housing structure was administered. The second questionnaire was administered by the survey team and requested information relating to self-reported history of hearing loss, ear disease, or family history of hearing loss. Results of the subsequent ear examinations and assessment were also recorded on this form. For otoscopy, a Heine Mini

3000 was utilised. Audiometric results were obtained with either the Interacoustics AS208 Portable Screening Audiometer or the Path Medical Solutions Sentiero under supra-aural headphones (TDH39 and Sennheiser HAD 280 respectively). Training was provided to all staff conducting the survey to ensure the consistency of data collected

Procedure

Written consent (in some cases verbally translated into the appropriate regional dialect) was obtained from the person identified as the head of the household. The head of the household was then asked to complete a demographic questionnaire on behalf of their family/household and was interviewed by a member of the survey team to complete the second hearing loss and ear disease questionnaire. Otoscopy was undertaken by the audiologist, student audiologist or ENT surgeon, and results recorded. Wax occlusion was considered to have occurred when over 80% of the canal was obstructed (as approximated via otoscopy). Pure tone or play audiometric assessment was conducted by an audiologist in a quiet area of the participants own residence. Participants were tested to threshold (0dBHL minimum, 100dBHL maximum) at; 1000, 2000, 4000 and finally 500 Hertz (Hz), air conduction only (bone conduction was not conducted due to concerns regarding the noise floor). Participants responded by raising their hand or by play response. Following completion of the assessment, where required, ear toileting and referral for follow up care were made by the survey team.

Data analysis

All data was entered into IBM© SPSS© Statistics Package version 21[17] for data analysis. Hearing loss was reported as a four frequency average (4FA) of PTA at 500, 1000, 2000 and 4000Hz and is presented for the better ear. Unilateral hearing loss is reported and was analysed separately, here worse ear thresholds were of interest. Unilateral hearing loss was

defined as, better ear 4FA PTA < 25dB, and worse ear 4FA ≥ 25dB. Hearing loss was categorised according to the WHO recommendations,[18] with a 4FA PTA of; ≤25dBHL indicating no impairment, 26-40dBHL indicating a mild impairment, 41-60dBHL indicating a moderate impairment, 61-80dBHL indicating a severe impairment, and >80dBHL indicating a profound impairment. Table 1 reports the demographic data of the sample, indicating that, although the sample matched the population in terms of age and socio-economic status, the sample did not match the Filipino population well in terms of gender and rural/urban distribution. All data was weighted to correct for the sample/population gender disparity for all subsequent analysis, including prevalence estimates and regression. Weighting to correct the samples rural/urban incongruity was not undertaken due to the extent of the disparity and is considered as a limitation of the paper in the discussion section.

Binary logistic regression was run with all relevant predictor variables including; age category, gender, middle ear status (any outer or middle ear condition vs no outer or middle ear condition), wax status (≥75% occlusion of canal versus <75% occlusion), income group (lowest versus all other groups), number of occupants of household, rurality (rural versus urban), relevant interaction effects were also included, consisting of; gender by rurality, middle ear status and income. The final model was selected based on Bayesian information criteria values. For the purposes of regression analysis, “hearing loss” was defined as a moderate or worse hearing impairment in the better ear for both adults and children. The reasons for the focus on moderate or worse hearing loss in the better ear are three-fold. Firstly, this conforms to the WHO definition of disabling hearing loss in adults (although not in children).[18] Secondly, the negative impacts of these more disabling levels of hearing loss are more consistently and clearly shown in the literature.[19] Thirdly, as testing was conducted in participants place of residence, elevated noise floors were common and the use of a lower

threshold for disabling hearing loss is likely to lead to high false positive rates (see slight to mild impairment prevalence figures in Table 2).

Table 1. Selected Unweighted Demographic Characteristics of the Sample

Demographic Characteristic		**Frequency**	**Percentage (%)**
Sex	Male	865	38
	Female	1410	62
Age	<18 years	778	34.1
	18-65 years	1308	57.6
	>65 years	189	8.3
Rurality	Rural	1744	76.7
	Urban	531	23.3
Income (Pesos)	Lower (≤5,000)	1256	55.2
	Higher (>5000)	1019	44.7
Family history of hearing loss*	Positive	247	10.9
	Negative	2007	88.2

*Note 11 cases of missing data relating to family history of hearing loss.

Table 2. Weighted Distribution of Hearing Loss Category by Demographic Variables

	Better Ear Four Frequency Average (0.5, 1, 2 and 4kHz) HTL									
Variable	No Impairment (HTL <25dB)		Slight/Mild Impairment (HTL = 25-40dB)		Moderate Impairment (HTL 41-60dB)		Severe Impairment (HTL 61-80dB)		Profound Impairment (HTL >80dB)	
	n	%	n	%	n	%	n	%	n	%
Whole Sample	1181	51.9	752	33.1	259	11.4	68	3	14	0.6
Age (yrs)										
<10	285	65.4	111	25.5	31	7.1	9	2.1	0	0
10-19	316	70.5	103	23	24	5.4	5	1.1	0	0
20-29	199	62.6	96	30.2	19	6	4	1.3	0	0
30-39	166	52.7	106	33.7	37	11.7	5	1.6	1	0.3
40-49	110	44.7	94	38.2	36	14.6	6	2.4	0	0
50-59	66	28.6	127	55	26	11.3	11	4.8	1	0.4
60-69	27	17.6	72	47.1	37	24.2	11	7.2	6	3.9
70-79	8	8	41	41	38	38	11	11	2	2
>80	4	14.8	2	7.4	11	40.7	6	22.2	4	14.8
Gender										
Male	605	53.2	354	31.1	135	11.9	38	3.3	5	0.4
Female	576	50.7	400	35.2	124	10.9	29	2.6	8	0.7
Income[a]										
Lower	649	52	429	34.4	134	10.7	29	2.3	7	0.6
Higher	532	51.8	325	31.6	126	12.3	38	3.7	7	0.7
Rurality										
Rural	908	52	582	33.3	194	11.1	51	2.9	12	0.7
Urban	273	51.6	172	32.5	66	12.5	16	3	2	0.4

[a] "Lower" <5000 Pesos, "Higher"≥5000 Pesos

Results

The participants in the current study included 2,275 adults and children recruited as part of a national cross sectional survey of hearing impairment in the Philippines. This group constitutes a subset of the larger survey population (of 2896 individuals) including all those cognitively able to complete pure tone audiometry (PTA). The participants' demographic details are shown in Table 1.

Otoscopic assessment results showed that wax occlusion was common in the population with a prevalence of 17.8%, with perforation (6.2%) and abnormal tympanic membrane (defined as dull, retracted or red/bulging)(5.1%) being the next most common ear conditions respectively. Ear canal conditions such as otorrhea (3.4%), infection (3.1%), and foreign body (<1%) were less common. Overall prevalence of outer or middle ear disease (excluding wax occlusion) was 17.8%.

To facilitate comparison with other research hearing loss prevalence estimates are reported in this paper using a number of different age categorisations. Firstly overall prevalence of moderate or worse hearing loss in the whole population was 15%, with a prevalence of 7.5% in children <18 years, 14.7% in adults between 18-65 years, and 49.1% in adults >65 years. Prevalence is also reported by decade in Table 2. Prevalence estimates stratified by gender, income, and rurality are also shown in Table 2. The prevalence of unilateral hearing loss across the whole sample was 20.2 %, with the majority of those having only a mild impairment in the worse ear (18.9%), and only a small proportion having a moderate (1%) or severe to profound unilateral impairment (0.2%).

Binary logistic backwards regression was used to assess the relationship between the presence of a moderate or worse hearing loss in the better ear against all relevant demographic predictor variables (independent variables)(see Table 3.). Number of occupants in the household and all interaction variables did not add to the model and were not significantly related to the dependant variable and thus do not appear in the Table 3. Due to a high degree of correlation between socio-economic status related variables, only two SES related variables (income and number of house occupants) were used in the regression presented. When investigating income in the regression, due to the small numbers of

respondents in the mid to higher level income groups, these groups were collapsed to form a higher income (≥ 5000 Peso) and a lower income group (<5000 Peso). Note that the lower income threshold of 5000 Pesos approximates the Philippine Statistics Authorities estimate of the poverty line.[20] To avoid low number of individuals per category and resultant statistical noise, age was categorised by collapsing across decade from 20-49 and then by decade from 50 years of age and above. Analysis was conducted separately for children (≤19 years of age) and adults (>19 years of age).

No significant predictors of disabling hearing loss were identified for children (≤ 19 years of age) χ^2 (6) =4, p>0.1 with a 0.01% (Nagelkerke's R^2) of variance explained by the model. In adults, after controlling for all other factors, only three variables; age, outer or middle ear condition, and income were found to be significant predictors of hearing loss, χ^2 (8) =173.3, p<0.001. A modest 19% (Nagelkerke's R^2) of the variance was explained by the model. Those with middle or outer ear conditions (with the exception of wax which was tested separately) were 2.39 times as likely to have a significant hearing loss as those without such conditions. Those with a higher income were 1.64 times as likely as those with a low income to have a moderate or worse hearing loss. Finally, there was also a sharp rise in the odds of having a moderate or worse hearing loss as age increased (Table 3.).

Table 3. Adjusted Odds Ratios of Moderate or Greater Hearing Loss by Demographic Characteristics

Factor †		**OR (95% CI)**
Middle ear in better ear	No	1 [reference]
	Yes	2.39 (1.49-3.85)***
Wax in better ear	No	1 [reference]
	Yes	1.62 (0.99-2.63)
Income (Peso)	Lower <5,000	1 [reference]
	Higher ≥ 5,000	1.64 (1.23-2.19)***
Gender	Female	1 [reference]
	Male	1.28 (0.99-2.63)
Age (years)	20-49	1 [reference]
	50-59	1.41 (0.94-2.12)
	60-69	3.9 (2.63-5.78)***
	70-79	7.9 (5.04-12.45)***
	≥80	22.1 (8.76-55.61)***

†Variables excluded from model include; number of occupants in household and all interaction variables.

***Significant at p<0.001, **Significant at p<0.01, *Significant at p<0.05

Discussion

This is the first peer reviewed study to investigate the prevalence of hearing loss and ear disease in a quasi-random sample of the Filipino population. The overall prevalence of

moderate or worse hearing loss in the population, and the prevalence of outer and middle ear disease in the population is high compared to figures in high income countries.

Prevalence of wax occlusion and middle ear disease, both of which can cause significant hearing loss and its sequelae,[21] was high in the current study compared to WHO data from the South-East Asia Region.[22] There are a number of published hearing loss prevalence studies in the region surrounding the Philippines; of these, the data from the Thai population best approximates those of the current study.[12] While the study does not include data with age gradations, data on the total prevalence of moderate, severe and profound hearing loss in the better ear show; 11.4% for moderate hearing loss and 2.2% for severe to profound loss. The current study reports very similar estimates, with prevalence's of 11.4% and 3.6% for moderate and severe to profound hearing loss respectively (see Table 2.). It should be noted that a very large, recent study of self-reported hearing loss in a Thai population suggested a prevalence significantly lower than shown in the previous report.[23] Recruiting participants from those enrolling in open university courses in that study and the use of self-reported hearing loss make interpretations of these conflicting results difficult. Comparative data from a Chinese population suggests a much lower prevalence, closer to the later study from Thailand, with 4.1 and 1.9% with moderate and severe to profound hearing loss respectively.[24] Stevens et al.[9] provide estimated prevalence data for disabling hearing loss across the entire SEAR region. The estimates are close to the current studies prevalence estimates for the 18-65 year old age group, but compared to the current study, overestimate the prevalence for older adults, and vastly underestimate the prevalence in children.

Although the previously discussed research focuses primarily on adult populations, there is a correspondingly large amount of data on paediatric populations as well. Uimonen, et al.[25]

found rates of just less than 2/1000 in 5-15 year olds, figures similar to those found in Van Naarden, Decoufle and Caldwell[26] of 1.1/1000 for children 3-10 years of age. The estimates in the current study are well over an order of magnitude higher (76/1000 in children <18 years of age).

The relatively high prevalence of hearing loss in both adults and children is likely being driven by a number of factors. Lack of access to preventative ear healthcare and poor general access to health services,[27] infectious disease and vaccination rates,[28] lifestyle factors such as smoking,[29] poor maternal nutrition,[30] lax enforcement of noise exposure regulations and poor health knowledge[31] are just of few of the possible explanations for the disparity in hearing outcomes seen between LMICs such as the Philippines and high income countries.

In order to facilitate comparison with data from a previous study of hearing loss prevalence in an older Australian population,[32] hearing threshold data for those 55 years or older was reclassified into mild (4FA= 26-40dBHL), moderate (4FA= 41-60dBHL), or marked (4FA>60dBHL). Of those with a hearing loss of any level, the proportion falling into each category was then calculated. Of those in the Blue Mountains and Philippines samples: 71.5, and 54.2% were mild, 24.5 and 31.7% were moderate, and 4 and 14% were marked respectively. This finding suggests that, not only is there a higher prevalence of hearing loss in the Filipino population, but that of those with a hearing loss, there is a greater share of the population with disabling levels of loss than in a high income comparison population. Interpretation of data in a Chinese population presented by Wang et al.[24] suggest a similar pattern (with proportions of 62%, 26%, and 12% for mild, moderate, and marked hearing loss respectively).

It is unclear whether the pattern of greater proportions of severe to profound hearing loss is characteristic of all, or at least many developing countries, as this appears to be the first time such a comparison has been made in the literature. It is probable that these differences are in part reflective of variations in the proportions of the various aetiologies underlying hearing loss in LMICs and high income countries. It is hypothesised that this finding may reflect higher rates of vaccine preventable illnesses in the region, some of which may be catastrophic for hearing function, and much higher rates of un/under treated chronic middle ear disease which may combine with age or noise related hearing loss to produce more disabling levels of hearing loss than may be seen in the higher income contexts.

The current study failed to find a significant relationship between gender and hearing loss prevalence, although there was a trend for increased prevalence. A fairly robust relationship is commonly reported in the literature, with males showing a higher prevalence, although figures do vary regionally.[33] The findings of the current study are hard to interpret, but may reflect some sampling bias. Males were more likely to be absent from home during the survey data collection and hence females were over-represented in the sample, weighting of the data was undertaken prior to analysis but may have failed to adequately account for the sampling bias. The lack of data on noise exposure in the current study may also have influenced results here.

Previous epidemiological studies have found associations between socioeconomic status (SES) and hearing loss, with lower SES linked to greater prevalence of hearing loss.[5, 8] Unlike much of the previous literature the current study did find a significant relationship between SES (household income) and hearing loss but in the opposite direction, with those from higher income households having an increased risk of disabling hearing loss. This may,

in-part, be due to that way which income was classified in the current study; with the lowest income group compared to those in all other higher income groups combined. It is possible that males in high income households were more likely to be working in noisy industry than their very low income compatriots. Larger studies allowing non-clustered income groups or alternative measures of SES, and the inclusion of questions relating to noise exposure would elucidate the link between SES and hearing loss in the Filipino population more clearly.

There was a clear and unsurprising relationship between age and hearing loss, with hearing loss becoming increasing likely above 60 years of age in particular (see Table 3.). This finding is in line with previous epidemiological studies of hearing loss.[5, 8] Similarly, there was an unsurprising significant and strong relationship between outer or middle ear condition and hearing loss in the adult population of the current study. This, combined with the relatively high prevalence of outer and middle ear disorders in both adults and children in the current study highlights the importance of addressing ear disease in LMICs so as to limit the significant impact and burden of disease imposed by such conditions.[34]

There are a number of limitations of this study which should be considered. The problems with sampling may reduce the representativeness of the sample population, particularly in regards to the over representation of rural and female participants. The conduct of hearing assessments with minimal control over noise make prevalence estimates of slight or mild hearing loss unreliable. Lastly, the lack of data on known correlates of hearing loss such as exposure to cigarette smoke, various health conditions, and history of noise exposure limit the explanatory power of our analysis.

The current study indicates that prevalence of moderate or worse hearing loss in the Filipino population is high across all age groups when compared to prevalence estimates reported in high income countries, and falls within the higher range of prevalence estimates reported in LMICs. Another key finding is that higher proportions of more significant hearing loss were also found when compared to reports from high income countries. The high prevalence of easily preventable ear disease such as wax occlusion and outer and middle ear disease suggest that some simple hearing health care initiatives, such as giving basic ear care and hygiene training to local doctors/health care workers could have a significant impact, particularly in children and the elderly. Future studies should aim to address some of the limitations identified in this study, particularly obtaining data on other relevant health conditions and workplace and recreational noise exposure.

References

1. Smith A. Demographics of hearing loss in developing countries. In: McPherson B, Brouillette R, editors. Audiology in Developing Countries. New York: Nova Science Publishers; 2008. p. 21-50.
2. Tucci DL, Merson MH, Wilson BS. A summary of the literature on global hearing impairment: current status and priorities for action. *Otol. Neurotol.* 2010;31(1):31-41.
3. World Health Organization. WHO global estimates on prevalence of hearing loss: WHO; 2018. https://www.who.int/deafness/Global-estimates-on-prevalence-of-hearing-loss-Jul2018.pptx?ua=1. Accessed 6th April, 2020.
4. Mencher GT. Challenge of Epidemiological Research in the Developing World: Overview: Reto a la investigacion epidemiológies en el mundo en desarrollo: Una revision. *Int. J. Audiol.* 2000;39(4):178-83.
5. Cruickshanks KJ, Wiley TL, Tweed TS, Klein BE, Klein R, Mares-Perlman JA, et al. Prevalence of hearing loss in older adults in Beaver Dam, Wisconsin. The epidemiology of hearing loss study. *Am. J. Epidemiol.* 1998;148(9):879-86.
6. Gopinath B, Rochtchina E, Wang JJ, Schneider J, Leeder SR, Mitchell P. Prevalence of age-related hearing loss in older adults: Blue Mountains Study. *Arch. Intern. Med.* 2009;169(4):415-8.
7. Davis AC. The prevalence of hearing impairment and reported hearing disability among adults in Great Britain. *Int. J. Epidemiol.* 1989;18(4):911-7.
8. Agrawal Y, Platz EA, Niparko JK. Prevalence of hearing loss and differences by demographic characteristics among US adults: data from the National Health and Nutrition Examination Survey, 1999-2004. *Arch. Intern. Med.* 2008;168(14):1522-30.

9. Stevens G, Flaxman S, Brunskill E, Mascarenhas M, Mathers CD, Finucane M. Global and regional hearing impairment prevalence: an analysis of 42 studies in 29 countries. *The European Journal of Public Health*. 2013;23(1):146-52.
10. Pascolini D, Smith A. Hearing Impairment in 2008: a compilation of available epidemiological studies. *Int. J. Audiol.* 2009;48(7):473-85.
11. Hong JW, Jeon JH, Ku CR, Noh JH, Yoo HJ, Kim D-J. The Prevalence and Factors Associated with Hearing Impairment in the Korean Adults: The 2010–2012 Korea National Health and Nutrition Examination Survey (Observational Study). *Medicine*. 2015;94(10):e611.
12. Prasansuk S. Incidence/Prevalence of Sensorineural Hearing Impairment in Thailand and Southeast Asia: Incidencia/prevalencia de los trastornos auditivos sensorineurales en Tailandia y el Sudeste Asiatico. *Int. J. Audiol.* 2000;39(4):207-11.
13. Bu X, Liu C, Xing G, Zhou L, Liang C, Zheng Y, et al. WHO Ear and Hearing Disorders Survey in four provinces in China. *Audiol. Med.* 2011;9(4):141-6.
14. Gerson PR. Poverty, income distribution, and economic policy in the Philippines: International Monetary Fund; 1998. https://www.imf.org/en/Publications/WP/Issues/2016/12/30/Poverty-Income-Distribution-and-Economic-Policy-in-the-Philippines-2515. Accessed 6th April, 2020.
15. Balisacan AM, Fuwa N. Changes in spatial income inequality in the Philippines: an exploratory analysis: Research Paper, UNU-WIDER, United Nations University (UNU); 2004. https://www.wider.unu.edu/publication/changes-spatial-income-inequality-philippines. Accessed 6th April, 2020.
16. Marmot M. Social determinants of health inequalities. *The Lancet*. 2005;365(9464):1099-104.
17. IBM Corp. IBM SPSS Statistics for Windows. Armonk, NY: IBM Corp; 2012.
18. World Health Organization. Grades of hearing impairment: WHO; 2015. http://www.who.int/pbd/deafness/hearing_impairment_grades/en/. Accessed 6th April, 2020.
19. Arlinger S. Negative consequences of uncorrected hearing loss--a review. *Int. J. Audiol.* 2003(42 Suppl 2):2S17-20.
20. Philippines Statistics Authority. Poverty incidence among Filipinos registered at 24.9%, as of first semester of 2013: PSA; 2014. https://psa.gov.ph/content/poverty-incidence-among-filipinos-registered-249-first-semester-2013-psa. Accessed 6th April, 2020.
21. Guest J, Greener M, Robinson A, Smith A. Impacted cerumen: composition, production, epidemiology and management. *QJM*. 2004;97(8):477-88.
22. World Health Organization. State of hearing and ear care in the South East Asia Region: WHO Regional Office for South East Asia; 2009. http://apps.searo.who.int/PDS_DOCS/B1466.pdf. Accessed 6th April, 2020.
23. Yiengprugsawan V, Hogan A, Harley D, Seubsman S-a, Sleigh AC, Team TCS. Epidemiological associations of hearing impairment and health among a national cohort of 87 134 adults in Thailand. *Asia Pacific Journal of Public Health*. 2012;24(6):1013-22.
24. Wang Y, Chong–ling Y, Shi–wen X, Xiao–hong X, Fei L, Yu–qing L, et al. A Report of WHO Ear and Hearing Disorders Survey in Guizhou Province. *Journal of Otology*. 2010;5(2):61-7.
25. Uimonen S, Huttunen K, Jounio-Ervasti K, Sorri M. Do we know the real need for hearing rehabilitation at the population level? Hearing impairments in the 5-to 75-year-old cross-sectional Finnish population. *Br. J. Audiol.* 1999;33(1):53-9.
26. Van Naarden K, Decouflé P, Caldwell K. Prevalence and characteristics of children with serious hearing impairment in metropolitan Atlanta, 1991–1993. *Pediatrics*. 1999;103(3):570-5.

27. Swanepoel D, Clark JL. Hearing healthcare in remote or resource-constrained environments. *The Journal of Laryngology & Otology*. 2019;133(1):11-7.
28. Cherukupally SR, Eavey R. Vaccine-preventable pediatric postmeningitic sensorineural hearing loss in southern India. *Otolaryngology–Head and Neck Surgery*. 2004;130(3):339-43.
29. Dawes P, Cruickshanks KJ, Moore DR, Edmondson-Jones M, McCormack A, Fortnum H, et al. Cigarette smoking, passive smoking, alcohol consumption, and hearing loss. *Journal of the Association for Research in Otolaryngology*. 2014;15(4):663-74.
30. Dawes P, Cruickshanks KJ, Moore DR, Fortnum H, Edmondson-Jones M, McCormack A, et al. The effect of prenatal and childhood development on hearing, vision and cognition in adulthood. *PLoS One*. 2015;10(8).
31. Han Z-X, Lei Z-H, Zhang C-L, Xiong W, Gan Z-L, Hu P, et al. Noise monitoring and adverse health effects in residents in different functional areas of Luzhou, China. *Asia Pacific Journal of Public Health*. 2015;27(2_suppl):93S-9S.
32. Sindhusake D, Mitchell P, Smith W, Golding M, Newall P, Hartley D, et al. Validation of self-reported hearing loss. The Blue Mountains hearing study. *Int. J. Epidemiol.* 2001;30(6):1371-8.
33. Mathers C, Smith A, Concha M. Global burden of hearing loss in the year 2000: WHO; 2000. http://www.who.int/entity/healthinfo/statistics/bod_hearingloss.pdf. Accessed 6th April, 2020.
34. Monasta L, Ronfani L, Marchetti F, Montico M, Brumatti LV, Bavcar A, et al. Burden of disease caused by otitis media: systematic review and global estimates. *PLoS One*. 2012;7(4):e36226.