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Hearing impairment and ear pathology in Nepal

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Abstract
A stratified random cluster sample of 15,845 subjects was performed in two regions of Nepal to determine the prevalence and main causes of hearing impairment (the most common disability) and the prevalence of ear disease. Subjects reporting current ear pain, or ear discharge, or hearing impairment on direct questioning by a Nepali health worker (primary screening failed), had otoscopy and audiometry (using the Liverpool Field Audiometer) performed, and a questionnaire administered relating to past history. In every fifth house subjects who passed the primary screening (1,716 subjects) were examined to assess the false negative rate of screening. An estimated 16.6 per cent of the study population have hearing impairment (either ear worse than 30 dB hearing threshold level (HTL) 1.0–4.0 kHz, or 50 dB HTL 0.5 kHz), and 7.4 per cent ear drum pathology, equivalent to respectively 2.71 and 1.48 million people extrapolated to the whole of Nepal. Most hearing impairment in the school age group (55.2 per cent) is associated with otitis media or its sequelae. Probably at least 14 per cent of sensorineural deafness is preventable (7 per cent infectious disease, 3.9 per cent trauma, 0.8 per cent noise exposure, 1 per cent cretinism, and 1 per cent abnormal pregnancy or labour). Most individuals reporting current ear pathology (61 per cent) had never attended a health post, and of those receiving ear drop treatment, 84 per cent still had serious pathology. Of subjects who reported ear drop treatment at any time, 31 per cent still had serious pathology. The use of traditional remedies was prevalent.

In conclusion this study shows high prevalences of hearing impairment and ear drum pathology. To reduce hearing impairment in Nepal, particularly in the school age group, a priority should be the effective treatment of otitis media.

Key words: Deafness; Ear diseases; Data collection; Nepal.

Introduction

Hearing impairment has attracted less public concern in developing countries than visual impairment (Wilson, 1985; White, 1988) ignoring the educational or social disability of hearing impairment, and the easily treatable or preventable causes. During the 1980s it was estimated that there were 4.5 million people in the world with profound deafness (average threshold >90 dB) and 180 million with partial deafness (30–90 dB), most of whom live in developing countries (Wilson, 1985). Different aspects of deafness and its causes have been assessed in developing countries, mostly in Africa (Roland, 1960; Hatchuel and Beron, 1965; Farid and Girgis, 1966; Clifford, 1968; Couldrey, 1968; Holborow *et al.*, 1982; McPherson and Holborow, 1985; Brobby, 1988; White, 1988; Prescott and Kibel, 1990), but also in the West Indies (Hinchcliffe and Miall, 1965), Asia and the Pacific (Kapur, 1967; Kakar, 1975; Lewis *et al.*, 1977; Noh and Kim, 1985; Wilson, 1985; Eason *et al.*, 1986; Gray, 1989) and Mexico (Ensign *et al.*, 1960). However few of these studies involve very large numbers (>10,000), all age groups, and house to house surveying techniques. In a sample survey of disability in Nepal during 1981 (Prasad, 1981), profound or severe hearing loss was the largest disability (33 per cent of the estimated 420,722 disabled people). However the study did not use audiometry, and gave no estimate of the wide range of possible underlying pathologies.

To address these issues a large scale study was performed to assess the prevalence of significant ear pathology, hearing impairment and its causes in Nepal. The emphasis was to assess individuals reporting hearing impairment, ear discharge, or pain in the ear i.e. those individuals who would possibly seek medical services. In addition a large population was screened to assess those not reporting hearing impairment and ear pathology.

Study design and methodology

The study design consisting of a primary screening questionnaire, secondary examination, and the examination of a large control population, was suggested by the late Professor Kenneth Newell (Liverpool School of Tropical Medicine) for logistic reasons, and to give an emphasis to subjects reporting ear or hearing problems.

This study was performed by the Britain–Nepal Otology Service (BRINOS) in collaboration with the ENT Department at Tribhuvan University Teaching Hospital (TUTH). The Hearing Impairment Research Group, Department of International Community Health, Liverpool School of Tropical Medicine, and Community Medicine Department of TUTH acted as advisors for the study. Some of the methods and a summary of the results were presented at the Section of Otology of the Royal Society of Medicine (6 March 1992).
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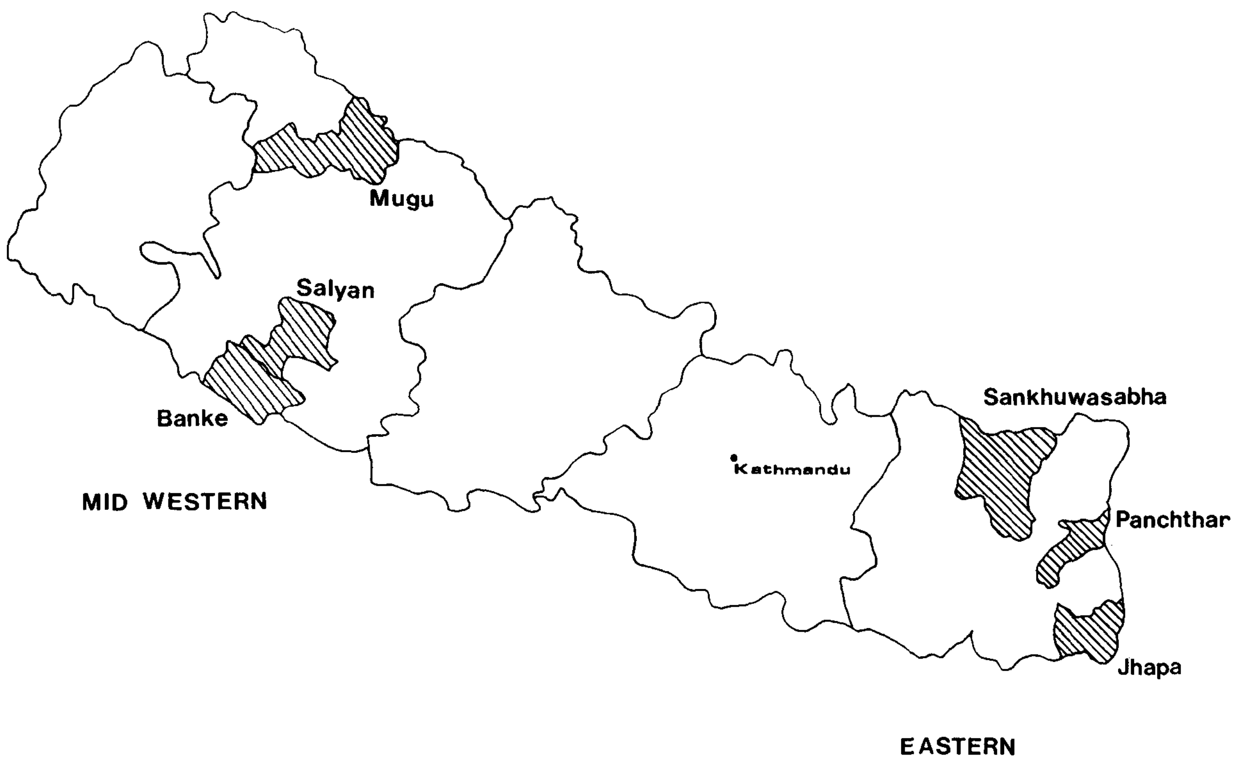

FIG. 1
Map of Nepal showing district sample sites.

Selection of sample sites

Nepal is divided into five development regions (which split the country into vertical sections from east to west). These are further subdivided in stages of geographical terrain (terai or plains, hills, and mountains), administrative districts, Village Development Unit (VDU, or group of villages) and ward (village or part of village). A sample size calculation estimated that a minimum of 6,000 subjects aged five and over would be needed for each region to assess factors of age, sex, terrain, and prevalences of 1 per cent. Random number tables were used to select stages within two regions (Eastern, Mid-Western) in a multistage sampling procedure (with stages of district, VDU, and ward). A stratified random cluster sample (48 ward clusters) of 15,845 subjects of all ages was thus performed in six districts of two geographical regions of Nepal (see Fig. 1).

Data collection

A Nepali health worker (SPR, SRT) asked subjects if they had current ear pain, ear discharge, or hearing impairment. If any of these symptoms were reported (primary screening failed), then otoscopy (PL, RPSG) and audiometry using the Liverpool Field Audiometer (AB, RPSG) was performed, and a questionnaire administered by the health workers relating to past history and sensorineural deafness. In subjects with hearing impairment the Rinne test (Hinchcliffe, 1981) was performed (PL, RPSG), and a simple assessment of speech (normal/abnormal) was made (SPR, SRT). Subjects having hearing impairment since early childhood (before age four) were examined (PL, RPSG, SPR, SRT) to assess cretinism, blindness, cerebral palsy, and mental subnormality. In every fifth house all who passed the primary screening (1,716 subjects) were also examined to assess the false negative rate of the primary screening and to provide a control population for questionnaire answers.

Liverpool field audiometer

The reliability and use of the Liverpool Field Audiometer (LFA) has been described (Bridges *et al.*, 1992; McPherson and Knox, 1992). It delivers warble tones at 0.5, 1.0, 2.0, and 4.0 kHz at three decibel levels (HTL), 30, 50, and 80. A 30 dB tone at 0.5 kHz is unreliable for screening in field conditions with background noise, resulting in very high false positive rates (Bridges *et al.*, 1992; McPherson and Knox, 1992). Thus hearing the 50 dB HTL tone at 0.5 kHz was regarded as normal for screening purposes. For the other frequencies (1.0–4.0 kHz) hearing the 30 dB tone was regarded as normal. Since some responses are not numeric (e.g. >80 dB) a mean cannot be calculated for each individual, and thus a median (1.0–4.0 kHz) was used to express average results.

Error from interobserver variability and data entry

Interobserver agreement (percentage agreed observations/total observations) for examination of external canal and ear drum in 127 consecutive subjects at the ENT department of TUTH was 99.2 per cent and 98 per cent respectively. In 100 subjects (i.e. 800 frequency assessments) Liverpool Field Audiometry disagreed in only 14 out of 800 observations or >98 per cent interobserver agreement. One per cent of families' randomly chosen computerized records (5,438 data entries) had 26 errors

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TABLE I

REPORTED PREVALENCE (I.E. TRUE POSITIVE RESPONSES TO THE PRIMARY QUESTIONNAIRE) AND ESTIMATED TOTAL PREVALENCE (I.E. CORRECTED FOR FALSE NEGATIVE RESPONSES) OF SUBJECTS WITH HEARING IMPAIRMENT AND EAR PATHOLOGY IN STUDY POPULATION

	Hearing impairment Age group				Ear pathology Age group		
	5–15	16–45	>45	Total	0–15	>15	Total
Crude data							
Estimated total	396	1051	816	2263	648	526	1174
Reported	215	385	336	936	360	265	625
Prevalence (%)							
Estimated total	8.32	15.44	39.73	16.62	9.28	5.94	7.41
Reported	4.52	5.66	16.36	6.87	5.15	2.99	3.94

(or 0.48 per cent). Thus interobserver variability and data entry errors are not likely to have much impact in this study.

Analysis and results

General approach

Estimation of subjects not reporting hearing impairment or ear pathology, and the breakdown of pathology in these individuals, was done at district level, by age group, but not by sex (the sex distribution did not differ significantly between districts). A correction was also made for those individuals failing the primary questionnaire who could not be examined. Referring to individuals 'reporting' hearing impairment or ear pathology is a simplification, signifying those subjects failing the primary questionnaire who had hearing impairment or ear pathology respectively.

Prevalence of hearing impairment and ear drum pathology

Table I shows the prevalence of hearing impairment (either ear >30 dB HTL 1.0–4.0 kHz or >50 dB HTL 0.5 kHz) and current ear pathology (i.e. excluding evidence of past infection, e.g. tympanosclerosis). An estimated 16.6 per cent of the study population aged five and over had hearing impairment, and 7.4 per cent of the study population had ear pathology, equivalent to 2.71 million people and 1.48 million people extrapolated by age group and terrain to the whole of Nepal. Hearing impairment increases with age, whereas ear pathology decreases with age. Using combined data from both ears chronic tubotympanic pathology represents the majority (86.1 per cent) of ear drum pathology (44.9 per cent mild retraction or secretory otitis media, 41.2 per cent serious chronic suppurative pathology), and acute otitis media a small minority (4.1 per cent). However there is also significant chronic attico-antral disease (9.7 per cent). Table II shows hearing impaired subjects classified according to degree of hearing impairment and age. Profound deafness (better ear median 1.0–4.0 kHz >80 dB HTL) was found in 0.43 per cent of the study population. A similar number (0.5 per cent) had grossly abnormal speech.

Causes of hearing impairment

Table III shows the estimated causes of hearing impairment in the study population using combined data from both ears. Hearing impairment was categorized as sensorineural (no abnormality of the ear drum; Rinne not negative), conductive deafness due to otitis media (ear drum abnormality; Rinne negative), mixed or unclear aetiology (ear drum abnormal; Rinne not negative) and otosclerosis (ear drum normal, Rinne negative). In the school age group a majority of hearing impairment was associated with an abnormal ear drum i.e. with otitis media or its sequelae (otitis media and mixed groups combined).

Factors associated with sensorineural deafness

Table IV shows the factors contributing to sensorineural deafness (i.e. in subjects reporting hearing impairment, excluding those with ear drum abnormalities or Rinne negative). Considering a history of deafness following any event 7.1 per cent of sensorneural deafness is possibly explained by infective causes, 3.9 per cent trauma, 0.8 per cent noise exposure, cretinism 1 per cent, mental retar-

TABLE II

SUBJECTS WITH HEARING IMPAIRMENT CLASSIFIED ACCORDING TO MEDIAN LIVERPOOL FIELD AUDIOMETRY (LFA) READING (MEDIAN OF 1–4 KHZ) IN THE BETTER EAR, AND ACCORDING TO AGE GROUP. (REPORTED HEARING IMPAIRMENT QUOTED IN BRACKETS WHERE DIFFERENT FROM TOTAL)

LFA median (better ear)	Age group 5–15	16–45	>45	Total	Total prevalence per 1000
30	66 (27)	210 (51)	221 (66)	497 (144)	36.5 (10.6)
50	46	184 (91)	217 (127)	447 (264)	32.8 (19.4)
80	12	70 (52)	96 (81)	178 (145)	13.1 (10.6)
>80	17	33	8	58	4.3
Normal	255 (113)	554 (158)	274 (54)	1083 (325)	79.5 (23.9)
Total	396 (215)	1051 (385)	816 (336)	2263 (936)	
Total prevalence Per 1000	83.2 (45.2)	154.4 (56.6)	397.3 (163.6)	166.2 (68.7)	

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TABLE III

CLASSIFICATION OF CAUSES OF HEARING IMPAIRMENT (CORRECTING FOR SUBJECTS NOT REPORTING HEARING IMPAIRMENT) IN INDIVIDUAL EARS (USING COMBINED DATA FROM BOTH EARS), ACCORDING TO AGE GROUP AND PERCENTAGE CAUSE WITHIN EACH AGE GROUP

	Age group			
	5–15	16–45	>45	Total
Sensorineural (SN)	228	1206	1223	2657
Percentage	42.8	78.0	89.9	77.2
Otitis media (OM)	212	190	62	464
Percentage	39.8	12.3	4.6	13.5
Mixed/unclear (MX)	82	104	57	243
Percentage	15.4	6.7	4.2	7.1
Otosclerosis (OS)	11	46	19	76
Percentage	2.1	3.0	1.4	2.2

dation 1 per cent, and abnormal labour or pregnancy 1 per cent. Chronic cough is associated with an excess 10.6 per cent of the sensorineural hearing impaired population, and diarrhoea with a 2.5 per cent excess, when compared to the control population.

Treatment of subjects

Most subjects reporting current ear pathology (60.7 per cent) had not attended health posts. Of those reporting current ear pathology who had treatment (n = 369), many used traditional remedies (e.g. oil (42 per cent), leaves (4.3 per cent), animal urine (1.4 per cent), or other remedies (10.6 per cent)), and 66.1 per cent had antibiotic ear drop treatment at health posts, of whom the majority (84.8 per cent) still had serious ear drum pathology (i.e. excluding secretory otitis media or mild retraction). Considering the estimated 5 per cent of the study population who reported ear drop treatment at health posts at any time (n = 793), 326 (41 per cent) still had ear drum pathology of which the majority (75.8 per cent) was serious.

Discussion

The main limitation of this study is the false negative rate using the primary questionnaire as a screening tool. However most false negative responses represented less serious pathology (mild hearing loss, mild tubotympanic retraction, secretory otitis media) and were estimated with reasonable confidence by using a large control population. Although the restricted geographical terrain of the sample sites is another significant limitation, a large sample with many clusters (48) was achieved, which should represent reasonably well the populations of the regions. Other limitations of the study, in particular the lack of serological diagnosis (White, 1988), use of the Rinne test rather than bone conduction thresholds (Browning, 1986), and use of the 50 dB tone at 500 Hz for screening purposes (Bridges *et al.*, 1992), were dictated by the remote and noisy nature of the sample sites.

The major findings in this study are the high prevalences of hearing impairment and chronic otitis media, and the high percentage of deafness due to otitis media in the school age group. Other developing countries have similar prevalences of hearing impairment, for example 10.4 per cent with hearing impairment in rural India (Wilson, 1985). Comparison with developed countries is difficult due to the different age distribution of the population. However the prevalence of hearing impairment in the better ear in the 16–45 age group of the present study (7.3 per cent) is more than three times the estimated comparable figure (approximately 2 per cent) from the British population (Davis, 1989). If anything the present study underestimates mild hearing impairment given that using the 50 dB tone at 500 Hz for screening in conditions of background noise will miss some individuals with isolated mild hearing impairment at this frequency (Bridges *et al.*, 1992).

Comparison with other studies of otitis media is also limited by differing age groups, surveying techniques and diagnostic criteria (e.g. current or past infection). High prevalences of ear pathology (5 per cent or greater) and percentage of deafness due to otitis media (15 per cent or greater), particularly in the younger age groups, have been reported in Asia and the Pacific (Kapur, 1967; Lewis *et al.*, 1977; Noh and Kim, 1985; Wilson, 1985; Eason *et al.*, 1986), Africa (Roland, 1960; Hatchuel and Beron, 1965; Farid and Girgis, 1966; Clifford, 1968; Couldrey, 1968;

TABLE IV

ANALYSIS OF POSSIBLE FACTORS ASSOCIATED WITH SENSORINEURAL DEAFNESS IN THE 519 INDIVIDUALS WITH ISOLATED SENSORINEURAL DEAFNESS. HISTORY OF DEAFNESS FOLLOWING THE EVENT IS NOTED (WITH PERCENTAGE OF SENSORINEURAL DEAF POPULATION IN BRACKETS). COMPARISON IS ALSO MADE WITH THE HISTORY OF THE FACTOR IN THE CONTROL GROUP, AND WHERE SIGNIFICANTLY DIFFERENT TO THE CONTROL GROUP THE ODDS RATIO QUOTED (IF POSSIBLE)

	Deafness following (%)	Control history comparison (MH chi square)	*P*	Odds ratio (95% confidence interval)
Diarrhoea	N/A	6.74	<0.01	2.98 (1.25–6.00)
Cough	N/A	6.71	<0.02	1.56 (1.22–1.99)
Malaria	13 (2.5)	11.41	<0.0005	1.61 (1.22–2.17)
Meningitis	1 (0.2)	0.68 (YC)	N/S	N/A
Mumps	4 (0.8)	0.03 (YC)	N/S	N/A
Measles	4 (0.8)	0.77	N/S	N/A
Fever	15 (2.9)	3.31	= 0.06	1.27 (0.98–1.62)
Noise (chronic)	2 (0.4)	8.71 (YC)	<0.01 (F)	5.71 (1.58–25.48)
Blow to head	20 (3.9)	22.1	<0.0001	4.64 (2.22–8.1)
Noise (sudden)	2 (0.4)	6.83 (YC)	<0.01 (F)	N/A
Abnormal labour	3 (0.6)	8.67 (YC)	<0.01	9.75 (1.44–52.11)
Rash in early pregnancy	2 (0.4)	1.34 (YC)	N/S	N/A
Cretinism	5 (1.0)	9.28 (YC)	<0.002 (F)	N/A
Mental retardation	5 (1.0)	9.28 (YC)	<0.002 (F)	N/A

MH = Mantel–Haenzel summary chi-square. F = Fisher exact statistic; YC = Yates corrected chi square.

White, 1988; Prescott and Kibel, 1990), New Mexico (Ensign *et al.*, 1960), and to a lesser extent in West Africa and Jamaica (Hinchcliffe and Miall, 1965; Holborow *et al.*, 1982; McPherson and Holborow, 1985). The exact pattern of pathology may differ between developing countries, for example significant attico-antral disease (10 per cent) in the present study unlike the low prevalence of attico-antral disease in the deaf of West Africa (Holborow *et al.*, 1982). Thus although the pattern of pathology may differ, Nepal is not unusual among developing countries in having high prevalences of deafness and ear disease and a high percentage of deafness due to otitis media in the school age group.

Considering sensorineural deafness, at least 14 per cent is likely to be preventable. However since history alone is likely to underestimate the extent of hearing impairment caused by infectious agents (White, 1988) it is probable that considerably more than 15 per cent is preventable. It is also possible that improving the general health of the population will reduce the contribution from sensorineural deafness, since chronic cough and diarrhoea are associated with a significant minority of sensorineural deafness in the present study.

An important finding is that 61 per cent of individuals reporting ear drum pathology had not attended their health post. Furthermore the use of traditional remedies was prevalent, and of those subjects reporting ear pathology who had chloramphenicol ear drop treatment, the majority (84 per cent) still had significant ear drum pathology. This figure may overestimate treatment failure since it does not include possibly successful past treatment. However, of those reporting ear drop treatment at any time, 41 per cent still had ear pathology, of which the majority (75.8 per cent) was serious, i.e. still unacceptably high treatment failure. The latter figures may conversely underestimate treatment failure since some of these individuals may not have had otitis media. Thus a priority in the prevention of deafness, particularly in the vulnerable school age group, must be the effective treatment of otitis media in developing countries. The question then arises as to which is the most cost effective way of treating otitis media: what combination of aural toilet (which could be taught to health workers, and then in turn to parents), antibiotic drops, short courses of oral antibiotics, or longer more conventional courses of antibiotics should be used? There is a little evidence from other countries that aural toilet is important, and that antibiotic drops or oral antibiotic (clindamycin) may not provide additional benefit (McPherson and Holborow, 1985; Eason *et al.*, 1986). These subjects need further urgent study.

In conclusion this study shows high prevalences of hearing impairment and chronic otitis media. A large proportion of deafness in younger age groups is associated with otitis media, which is not being effectively treated using ear drops alone. The easiest way to prevent a significant proportion of deafness in Nepal, particularly in the school age group, and thus a priority in health intervention, should be effective treatment of otitis media.

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