

## **Association between hearing loss and Type 2 Diabetes Mellitus in elderly people in a newly developed society**

**Abdulbari Bener**<sup>1,2\*</sup>, **Ahmad H. A. Salahaldin**<sup>3</sup>, **Sara M. Darwish**<sup>4</sup>, **Abdulla O.A.A. Al-Hamaq**<sup>5</sup>, **Loida Gansan**<sup>3</sup>

<sup>1</sup> Department of Medical Statistics & Epidemiology, Hamad General Hospital and Hamad Medical Corporation, State of Qatar

<sup>2</sup> Department Evidence for Population Health Unit, School of Epidemiology and Health Sciences, The University of Manchester, Manchester, UK

<sup>3</sup> Department of ENT, Audiology Unit, Rumailah Hospital & Hamad General Hospital, Hamad Medical Corporation, State of Qatar.

<sup>4</sup> Department of Endocrinology, Hamad General Hospital, Hamad Medical Corporation, State of Qatar.

<sup>5</sup> Qatar Diabetic Associations and Qatar Foundation, Doha, State of Qatar.

**Key words:** Epidemiology. Hearing loss. Elder age. Medical condition, Hearing loss evaluation.

*Accepted September 4 2008*

### **Abstract**

**This is a cross-sectional study. Hearing loss and its complications appear to be increasingly common in elderly people. Hearing impairment is becoming increasingly prevalent in old age and unfortunately many physicians do not view hearing loss as a significant problem and like the patient, often attribute it to normal aging.**

**The aim of this study was to determine the prevalence of hearing loss and its association with type 2 diabetes mellitus (T2DM) in elderly people in a newly developed society. Ear Nose Throat (ENT) and Endocrinology outpatient clinics of the Hamad General and Rumailah Hospitals, Hamad Medical Corporation.**

**All subjects aged more than 50 years who were visiting the Endocrinology and ENT outpatient clinics of the Hamad Medical Corporation with hearing difficulty were included in this study during the period from January 2003 to November 2006. During this study period, prevalence, hearing, audiological test, family history and medical problems associated with hearing impairment in old patients were recorded. The hearing loss was evaluated using two audiometers Grason Stadler GSI 61 and Madsen Orbiter 922.**

**The prevalence of hearing impairment was higher among men (52.6%) than in women (49.5%). Also, hearing impairment was higher in Qataris (66.3%) than in non-Qataris (33.7%). 40.5% of the studied subjects were consanguineously married couples. Very severe (71- 90 dB) and profound (90 – 120 dB) cases were found more in men (13.8% & 9.3%) than in women (10.2% & 8.2%). The associated risk factors were higher in men such as T2DM (37.8% & 25.5%), hypertension (37% vs 27%), retinopathy (31.7% vs 19.9%), Nephropathy (25.6% vs 17.9%), Neuropathy (22.8% vs 14.3%) than in women. There was a statistically significant relationship between both the genders in all the risk factors.**

**The study findings revealed that the prevalence of hearing loss was higher in elderly men than in women. Elderly individuals with hearing loss were likely to have T2DM and other risk factors like hypertension, retinopathy, nephropathy and neuropathy.**

## Introduction

Hearing loss is a common consequence of aging [1-5]. It is difficult to distinguish changes of normal aging from those of other contributing factors. Hearing impairment is one of the most important health problems of the elderly above 60 years [1-7]. It has been reported that hearing loss ranks as the third-most-prevalent major chronic disability in elderly and the prevalence of hearing loss has been documented very well by several authors [1-5,7-21].

Unfortunately, hearing impairments often receive minimal attention. Hearing loss can affect the most common and simple tasks of daily life [5-9]. The relation between hearing loss and other various health conditions and activity limitations among older people is well documented [1-17], but no any study has been conducted on this topic in the oil-rich Arabian Gulf Countries.

The aim of this study was to determine the prevalence of hearing loss and its association with type 2 diabetes mellitus in elderly people in a newly developed Arabian society.

## Subjects and Methods

This is a cross-sectional study design which was conducted during the period from January 2003 to November 2006 in the outpatient clinics of the Hamad Medical Corporation. The study target population included all patients aged 50 years and above who were visiting endocrinology outpatient clinic and referred to the ENT clinic for screening. Over all, out of 1,000 subjects, 836 (83.6%) subjects gave consent to participate in the present study. 16.4% who did not participate was due to inability to attend the scheduled appointments, lost follow-up, lack of time and lack of interest. Data were recorded on consanguinity, family history of hearing impairment, T2DM, retinopathy, nephropathy, and neuropathy from patients' medical records.

Persons were classified as diabetic if they were currently taking diabetic medication. We studied all subjects diagnosed for type T2DM in accordance with the established diagnostic criteria by American Diabetes Association [18-19]. The degree of blood sugar level in our patient population was  $10.61 \pm 3.26$  (mean  $\pm$  S.D).

### Hearing evaluation procedures:

All patients were tested by pre-trained technicians using two clinical digital audiometers (Garson Stadler GSI 61 and Madsen Orbiter 922 which are regularly calibrated to international standards) in a quiet room. Hearing impairment was defined as the inability to hear a tone of 40 dB or greater at 2,000 Hz frequency in the better ear. This

conservative cut point was chosen because 2,000 Hz falls within the auditory frequency range most important for speech discrimination. Hearing loss evaluation described as follows: normal (<25 dB); mild (26-40 dB); moderate (41-55 dB); severe (56-70 dB); very severe (71-90 dB); profound (91-120 dB); and deaf (no hearing).

Fisher exact and chi-square tests were used to compare frequencies between two or more than two categorical variables. The level  $p < 0.05$  was taken as the cutoff value for significance.

## Results

Table 1 shows the socio-demographic characteristics of the studied elderly subjects above 50 years and the prevalence of hearing loss by gender. Majority of the studied male and female patients were in the age group (50 – 59) (43.4% vs 51.3%). Over 55% of the studied patients were using mobile phones frequently. The consanguineous marriages were observed higher in males (45.2%) than in females (38.5%). The prevalence of hearing impairment was higher among males (52.6%) than in females (49.5%).

Table 2 presents the evaluation of the hearing loss by gender and its association with T2DM, and other risk factors in elderly subjects above 50 years according to gender. The prevalence of hearing impairment was higher in Qataris (66.3%) than in non-Qataris (33.7%). 40.5% of the studied subjects were consanguineously married couples. Socio-economic status showed that majority of the subjects belonged to retired group (34.4%) and 22.6% were business men. The hearing impairment was very severe in Qatari women (75%) than in men (59.3%). Very severe (71 – 90 dB) and profound (90 – 120 dB) cases were found more in men (13.8% & 9.3%) than in women (10.2% & 8.2%). Also deafness was more prevalent in males (2.8%) than in females (1.5%). As hearing became worse in men, the associated risk factors were higher in men such as T2DM (37.8% & 25.5%), hypertension (37% vs 27%), retinopathy (31.7% vs 19.9%), Nephropathy (25.6% vs 17.9%), Neuropathy (22.8% vs 14.3%), Tinnitus (68.7% vs 28.1%), Vertigo (20.7% vs 14.8%) than in women. There was a statistically significant relationship between men and women in all the risk factors except for Vertigo and Nephropathy.

Table 3 shows the patterns of the conventional audiometric curves in the studied patients by gender. Sloping audiometric curves were found to be the most prevalent ones in elderly patients (72.6% for males & 66.0% for females), followed by flat audiogram shape (16.8% for males & 13.8% for females), then inverted scoop (7% for males & 13.8% for females). There was a significant difference

## Hearing loss in elderly

found between elderly men and women in inverted scoop audiometric curve (P=0.0166).

Hearing loss among elderly population is a prevalent problem that affects their ability to understand speech in quiet, noise, and reverberation. Elderly people also experience difficulty in understanding rapid speech, heavily accented English language, and speech with few contextual cues and/or added memory demands. Hearing problems have a profound influence on the lives of the elderly. Although hearing loss in the elderly may not have a cure,

early rehabilitation helps to restore better quality of life, if the problem is detected early.

The prevalence of hearing impairment in the studied subjects was higher in males (52.6%) than females (49.5%). Nearly half of the studied elderly patients suffered from hearing loss which is similar to the findings in some other studies [1-8,10-17]. Although comparisons of prevalence rates are difficult because of different methods of assessment and age grouping, the findings of this study are consistent with rates reported elsewhere [1-4,6-8,14-15].

**Table 1: Socio demographic characteristics of the studied elderly subjects and the Prevalence of Hearing impairment by gender (N= 836).**

Variables	Males N = 454	Females N = 382	p-value significance
<b>Age Group in years</b>			
50 –59	197 (43.4)	196 (51.3)	0.025
60-69	163 (35.9)	134 (35)	
70-79	80 (17.6)	42 (11.0)	
80 and older	14 (2.4)	10 (2.6)	
<b>Nationality</b>			
Qatari	266 (58.6)	278 (72.8)	<0.001
Non Qatari	188 (41.4)	104 (27.2)	
<b>Occupation</b>			
Retired	182 (40.3)	94 (24.6)	<0.001
Business	144 (31.9)	35 (9.2)	
Clerical	81 (17.9)	34 (8.9)	
Police/Military	41 (9.1)	22(5.8)	
Housewife	0 (0.0)	197 (51.6)	
<b>Do you use a mobile phone frequently</b>			
Yes	263 (57.9)	210 (55.0)	0.440
No	191 (42.1)	172 (45.0)	
<b>Do you hear TV sounds normally</b>			
Yes	305 (67.2)	255 (66.8)	0.941
No	149 (32.8)	127 (33.2)	
<b>Consanguineous marriage</b>			
Yes	205 (45.2)	147 (38.5)	0.030
No	249 (54.8)	235 (61.5)	
<b>Hearing Impairment</b>			
Yes	246 (52.6)	196 (49.5)	0.407
No	208 (47.4)	186 (50.5)	
<b>Family history of Hearing Impairment</b>			
Negative	328 (72.2)	263 (68.8)	0.313
Mother	39 (8.6)	46 (12.0)	
Father	38 (8.4)	30 (7.9)	
Both Parents	32 (7.0)	22 (5.8)	
Siblings	17 (3.7)	21 (5.5)	

**Table 2: Evaluation of hearing loss and its association with T2DM, hypertension and other risk factors in elderly subjects above 50 years according to gender (N=442)**

Variables		Hearing loss in Males N = 246	Hearing loss in Females N = 196	p-value significance
<b>Nationality</b>	Qatari	146(59.3)	147(75.0)	0.001
<b>Occupation</b>	Non Qatari	100(40.7)	49(25.0)	<0.001
	Retired	94(38.2)	58(29.6)	
	Business	80(32.5)	20(10.2)	
	Clerical	43(17.5)	14(7.1)	
	Police/Military	26(10.6)	10(5.1)	
	Housewife	3(1.2)	94(48.0)	
<b>Do you use a mobile phone frequently</b>				0.453
	Yes	141(57.3)	105(53.6)	
	No	105(42.7)	91(46.4)	
<b>Consanguineous marriage</b>				0.067
	Yes	109(44.3)	70(35.7)	
	No	137(55.7)	126(64.3)	
<b>Type 2 Diabetes Mellitus (T2DM)</b>				0.034
	Yes	93 (37.8)	50 (25.5)	
	No	153 (62.2)	146 (74.5)	
<b>Hypertension</b>				0.008
	Yes	91 (37.0)	53 (27.0)	
	No	155 (63.0)	143 (73.0)	
<b>Retinopathy</b>				0.007
	Yes	78 (31.7)	39 (19.9)	
	No	168 (68.3)	157 (80.1)	
<b>Nephropathy</b>				0.065
	Yes	63 (25.6)	35 (17.9)	
	No	183 (74.4)	161 (82.1)	
<b>Neuropathy</b>				0.033
	Yes	56 (22.8)	28 (14.3)	
	No	190 (77.2)	168 (85.7)	
<b>Tinnitus</b>				<0.001
	Yes	169 (68.7)	55 (28.1)	
	No	77 (31.3)	141 (71.9)	
<b>Vertigo</b>				0.137
	Yes	51 (20.7)	29 (14.8)	
	No	195 (79.3)	167 (85.2)	
<b>Hearing evaluation</b>				0.041
	<b>Mild</b> (26-40 dB)	82 (33.3)	72 (36.7)	
	<b>Moderate</b> (41-55 dB)	63 (25.6)	35 (17.9)	
	<b>Severe</b> (56-70 dB)	37 (15.0)	50 (25.5)	
	<b>Very Severe</b> (71-90 dB)	34 (13.8)	20 (10.2)	
	<b>Profound</b> (90-120 dB)	23 (9.3)	16 (8.2)	
	<b>Deaf</b> (No hearing)	7 (2.8)	3 (1.5)	

*Table 3: Patterns of the conventional audiometric curves in the studied patients by gender*

Variables	Males N=246 N (%)	Females N=196 N (%)	Total N=442 N (%)
-----------	-------------------------	---------------------------	-------------------------

Cookie-bite or scoop or trough	4 (1.8)	8 (4.3)	12 (2.9)
Inverted scoop	17 (7.0)	27 (13.8)	44 (10.1)*
Flat	42 (16.8)	28 (13.8)	70(15.5)
Sloping	179 (72.6)	129 (66.0)	308 (69.6)
Rising	4 (1.8)	4 (2.1)	8 (1.9)

\*  $P = 0.0166$  (significant)

## Discussion

Hearing impairment is the fifth most prevalent chronic health condition and the second most prevalent impairment in the United States<sup>16</sup>. Both men and women are at risk for age-related hearing loss. Very severe and profound cases were found more in men than in women. Also, deafness was more prevalent in men. It is reported in the US that women of all ages have better hearing than men at frequencies above 2000Hz [22].

Histopathological studies have shown damage to the nerves and vessels of the inner ear of individuals with diabetes [23]. One population-based study [24] has evaluated the association between diabetes and hearing loss. A number of clinical studies have investigated the possible association of diabetes mellitus and hearing loss [25]. Audiometric data obtained in this study revealed that hearing became worse as blood sugar increased in subjects. Also, in our study, a good proportion of the subjects with hearing loss were diabetic (32.4%) and hypertensive (32.6%).

Other associated risk factors in our elderly subjects with hearing loss were tinnitus (50.7%), retinopathy (26.5%), nephropathy (22.2%), neuropathy (19%) and vertigo (18.1%). All the associated risk factors were higher in men and there was a statistically significant relationship in all the risk factors between men and women except for vertigo and nephropathy. A study done by Dalton et al. [26] reported that individuals with T2DM and nephropathy were more likely to have hearing loss. The associated complaint of tinnitus was very high in elderly patients with hearing loss. The endolymphatic hydrops complaint was not very common in elderly patients (1.4%).

Overall, around 31.9% had severe hearing loss and nearly 22% had moderate hearing loss which is much lower than the rate reported in a study that 60% of the patients tested

at the hearing clinic were found to have severe hearing loss [21]. But in the UK, 8% of the participants reported a severe hearing loss and 42% moderate hearing.

Sloping audiometric curves were found to be the most prevalent ones in elderly subjects (72.6% for males & 66.0% for females), followed by flat audiogram shape (16.8% for males & 13.8% for females). There was a significant difference found between elderly men and women in inverted scoop audiometric curve. Basin (Cookie-bite or scoop or trough) and Rising were the least ones among the audiometric curves in our studied subjects. Most of the audiometric curve patterns found in our patients were demonstrated by Schuknecht [27] in his reports where he described 4 types of pathological changes in presbycusis and accordingly their presumed audiometric curve patterns; first Sensory presbycusis with sloping curve, second Neural presbycusis with basin curve, third Strial presbycusis with flat audiogram and fourth Cochlear conductive presbycusis with ski-slope audiogram. Recently, it has been demonstrated another mixed form of presbycusis that involve a mixture of 2 to 4 types of above mentioned curves. Although we have demonstrated most of the curves in our study, it is difficult to determine the effect of diabetes without histopathological studies. Yet, the effect of diabetes mellitus on hearing and specially in old population will add to the pathological derangement associated with aging process.

Noise exposure was a main environment factor which was frequently associated with sensorineural hearing loss in our study population. Many elderly people accept their hearing loss, believing there is no effective treatment; other attribute it to the aging process or even deny its existence. Unfortunately many physicians do not view hearing loss as a significant problem and like the patient, often attribute it to normal aging. As reported in many studies, the present study show a strong association between hearing loss and diabetes mellitus in elderly people [28-30].

## Limitations

There are some limitations to our study that must be acknowledged. Firstly, although the total sample size was appropriate to estimate the prevalence in the population, the desired level of precision was not always obtained for some of the estimates in the age and sex groups. Secondly, despite the acceptable response rate in hearing (83.6%), the prevalence of hearing loss may have been overestimated assuming that those not examined may have been less likely to be suffering from impaired hearing or vision. Thirdly, study was carried out hospital population based sample of Qatari's population with special socioeconomic characteristics so that we cannot extrapolate the results to the whole population of the country. Finally, this study highlights the need to target inter-

vention programmes for prevention of hearing impairment to elderly people and those with little or no education as the high-risk groups.

## Conclusion

The study finding revealed that the prevalence of hearing loss was higher in men than in women. Also, the hearing impairment was higher in Qataris than in non-Qataris. Nearly half of the studied subjects were consanguineously married couples. Also, the results provided an additional evidence that hearing impairments is associated with diabetic mellitus type 2 and have significant negative impact on quality of life older persons. Sloping audiometric curves were found to be the most prevalent ones in elderly subjects, followed by flat audiogram shape.

## Acknowledgement

The project was supported and funded by the Diabetic Association and Qatar Foundation for generous support and help while this project conducted.

## References

1. Wallhagen MI, Strawbridge WJ, Cohen RD, Kaplan GA. An increasing prevalence of hearing impairment and associated risk factors over three decades of the Alameda County Study. *Am J Public Health*. 1997; 87: 440-442.
2. Cruickshanks KJ, Wiley TL, Tweed TS, Klein BE, Klein R, Mares-Perlman JA, Nondahl DM. Prevalence of hearing loss in older adults in Beaver Dam, Wisconsin. The Epidemiology of Hearing Loss Study. *Am J Epidemiol* 1998; 148: 879-886.
3. Lim JK, Yap KB. Screening for hearing impairment in hospitalized elderly. *Ann Acad Med Singapore* 2000; 29: 237-241
4. Megighian D, Savastano M, Salvador L, Frigo A, Bolzan M. Audiometric and epidemiological analysis of elderly in the Veneto region. *Gerontology*. 2000; 46: 199-204.
5. Campbell VA, Crews JE, Moriarty DG, Zack MM, Blackman DK. Surveillance for sensory impairment, activity limitation, and health-related quality of life among older adults--United States, 1993-1997. *MMWR CDC Surveill Summ*. 1999; 48: 131-156.
6. Loh KY, Elango S. Hearing impairment in the elderly. *Med J Malaysia*. 2005; 60: 526-529.
7. Maggi S, Minicuci N, Martini A, Langlois J, Siviero P, Pavan M, Enzi G. Prevalence rates of hearing impairment and comorbid conditions in older people: the Veneto Study. *J Am Geriatr Soc* 1998; 46: 1069-1074.
8. Crews JE, Campbell VA. Vision impairment and hearing loss among community-dwelling older Americans: implications for health and functioning. *Am J Public Health*. 2004; 94: 823-829
9. Dalton DS, Cruickshanks KJ, Klein BE, Klein R, Wiley TL, Nondahl DM. The impact of hearing loss on quality of life in older adults. *Gerontologist*. 2003; 43: 661-668.
10. Nondahl DM, Cruickshanks KJ, Wiley TL, Klein R, Klein BE, Tweed TS. Prevalence and 5-year incidence of tinnitus among older adults: the epidemiology of hearing loss study. *J Am Acad Audiol* 2002; 13: 323-331.
11. [www.globalaging.org/health/us/hearingloss.htm](http://www.globalaging.org/health/us/hearingloss.htm) (accessed on 17/10/2006)
12. Mills R. The auditory system. In : Pathy MSJ. Principles and practice of geriatric medicine. 2<sup>nd</sup> Edition. London: John Wiley, 1991
13. Reuben DB, Walsh K, Moore AA, Damesyn M, Greendale GA. Hearing loss in community-dwelling older persons: national prevalence data and identification using simple questions. *J Am Geriatr Soc* 1998; 46: 1008-1011.
14. Gussekloo J, de Bont LE, von Faber M, Eekhof JA, de Laat JA, Hulshof JH, van Dongen E, Westendorp RG. Auditory rehabilitation of older people from the general population--the Leiden 85-plus study. *Br J Gen Pract*. 2003; 53: 536-540.
15. Gerson LW, Jarjoura D, McCord G. Risk of imbalance in elderly people with impaired hearing or vision. *Age Ageing* 1989; 18: 31-34.
16. Jee J, Wang JJ, Rose KA, Lindley R, Landau P, Mitchell P. Vision and hearing impairment in aged care clients. *Ophthalmic Epidemiol*. 2005; 12: 199-205.
17. Herbsi KG, Humphrey C. Prevalence of hearing impairment in the elderly living at home. *J R Coll Gen Pract* 1981; 31: 155-160.
18. American Diabetes Association. Diagnosis classification of diabetes mellitus. *Diabetes Care* 2004; 27: S5-S10.
19. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabet Med* 1998; 15: 539-553.
20. Murphy MP, Gates GA. Hearing Loss: Does Gender Play a Role? *Medscape Womens Health* 1997; 2: 2.
21. Sangster JF, Gerace TM, Seewald RC. Hearing loss in elderly patients in a family practice. *Can Med Assoc J* 1991; 144: 981-984.
22. Kochkin S. Marke Trak VI: On the issue of value : Hearing aid benefit, price, satisfaction and brand repurchase rates. *Hearing Rev* 2003;10: 12-26.
23. Wackyam PA, Linthicum FH. Diabetes mellitus and hearing loss: clinical and histopathologic relationships. *Am J Otol* 7: 176-182, 1986.
24. Gates G A, Cobb JL, D'Agostino RB, Wolf PA: The relation of hearing in the elderly to the presence of cardiovascular disease and cardiovascular risk factors. *Arch Otolaryngol Head Neck Sug*.1993; 19: 156-161.
25. Ferrer JP, Biurrun O, Lorente J, Conget JL, de Espana R, Esmatjes E, Gomis R, Auditory function in young

*Hearing loss in elderly*

- patients with type 1 diabetes mellitus. *Diab Res Clin Pract* 1991; 11: 17-22.
26. Dalton DS, Klein BEK, Cruickshanks KJ, Wiley TL, Klein R, Association of NIDDM and Hearing loss, *Diabetes Care* 1998; 21: 1540-1544.
  27. Schuknecht H. F, Gacek M.R, cochlear pathology and presbycusis, *Ann Otol Rhinol Laryngol J* 1993; 102: 1-16.
  28. Kraft JR. Hyperinsulinemia: A Merging History with Idiopathic Tinnitus, Vertigo, and Hearing Loss. *Int Tinnitus J* 1998; 4: 127-130.
  29. Cullen JR, Cinnamon MJ. Hearing loss in diabetics. *J Laryngol Otol* 1993; 107: 179-182.
  30. Heid L, Claussen CF, Kersebaum M, Nagy E, Bencze G, Bencsik B. Vertigo, dizziness, and tinnitus after otobasal fractures. *Int Tinnitus J* 2004; 10: 94-100.

**Correspondence to:**

Abdulbari Bener  
Department of Medical Statistics & Epidemiology  
Hamad General Hospital, Hamad Medical Corporation  
Weill Cornell Medical College  
PO Box 3050,  
Doha, State Qatar

Office Tel: 974- 439 3765  
Office Tel: 974- 439 3766  
Fax: 974-439 3769  
e-mail: abener@hmc.org.qa  
e-mail: abaribener@hotmail.com





