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The Impact of Metabolic Syndrome and Vitamin D on Hearing Loss in Qatar

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Abstract

Aim: The aim of present study to investigate association between metabolic syndrome [MetSyn] and vitamin D deficiency on hearing loss among type 2 diabetes mellitus (T2DM) patients.

Subjects and methods: This is an observational cohort study based on 528 subjects aged between 20 and 59 years who visited the Hamad Medical Corporation with hearing difficulty during from January 2013 to July 2014. MetSyn was assessed using the revised NCEP-ATP III criteria. Vitamin D level was evaluated from reported serum 25 (OH) D. A multivariable logistic regression model was performed to evaluate the relation between selected lifestyle factors, MetSyn, vitamin D and presence of hearing loss.

Results: The mean age (± SD, in years) for metabolic hearing loss versus normal subjects was 47.7 ± 10.2 vs. 48.5 ± 9.1. Over 90% of the s patients were using phones devices and 13.4% had hearing impairment watching TV. The consanguineous marriages were observed higher in Hearing loss (32.9%) than in normal hearing (23.0%) (p=0.028). The waist circumference, hip circumference, waist hip ratio and body mass index were significantly higher among the participants with MetSyn versus without MetSyn (p<0.001). The mean of diabetes onset duration (9.03 ± 4.35 years), sleeping disorder (5.76 ± 1.32 h), cigarette smoking (16.4%) and sheesha smoking (20.7%) were higher among hearing impairment. The associated risk factors were significantly higher in T2DM with hearing loss, hypoglycemia, retinopathy, Nephropathy and Neuropathy diabetic foot ulcer, Tinnitus, Vertigo and headache than in normal hearing diabetes. There were statistically significant differences between hearing impairment versus normal hearing for vitamin D [18.91 ± 7.65 ng/ml vs 22.85 ± 9.00 ng/ml; p=0.018], magnesium, phosphorous, HDL, ceatinine, albumin, systolic blood pressure and diastolic blood pressure. Further, there were highly statistically significant differences between hearing impairment versus normal for both side right and left ear frequency in Db unit (p<0.001). Multivariable logistic regression analysis revealed vitamin D Deficiency (OR 2.59 95% CI 1.65-4.72; p<0.001), Head ache (OR 1.97 95% CI 1.30-2.85; p<0.001), sleeping disturbance (OR 1.83; 95% CI 1.23-2.71, p=0.002), systolic blood pressure (OR 1.66 95% CI 1.20-2.48; p=0.009), cigarette smoking (OR 1.90 95% CI 1.23-2.95; p=0.004), age in years (OR 1.45; 95% CI 1.30-2.54; p=0.026), nationality (Qatari) (OR 1.55 95% CI 1.10-2.17; p=0.014), diastolic blood pressure (OR 1.69 95% CI 1.14-2.52; p=0.012), age in years (OR 1.45 95% CI 1.30-2.54; p=0.026) and sheesha smokers (OR 1.79; 95% CI 1.32-3.11, p=0.038) were considered at higher risk as a predictors of hearing loss among diabetic patients.

Conclusion: The current study results suggests that the impact of metabolic syndrome and vitamin D among diabetic patients were significantly associated with the hearing loss in the Qatari's population

Keywords: Epidemiology; Metabolic syndrome; Hearing loss; Diabetes; Vitamin D; Risk factors

Introduction

Type 2 diabetes mellitus (T2DM), one of the main threats to ageing population health in the 21st century, is described as a worldwide epidemic as it affects the health and economy of almost all countries regardless of socioeconomic status or geographic location [1-3]. Diabetes mellitus is a chronic metabolicdisease with abnormal blood glucose levels affects the health and quality of patient's life [4-8]. There have also been studies that patients with Metabolic Syndrome [MetSyn] diabetes have hearing loss greater than those without [4,5]. Severeal reports stated MetSyn and vitamin D deficiency which may act as important risk factors for the hearing impairment [1,9-12]. More recently some authors have reported that hearing loss has been influenced by diabetes MetSyn [13-17], which hearing loss can affect even the simplest tasks of daily life [16]. Most of authors agree that diabetes mellitus and metabolic syndrome can lead to hearing impairment [1,10,13].

The relation between hearing loss and different health conditions among middle aged population is documented and reported in detailed [9-15]. The aim of present study to investigate association

between metabolic syndrome [MetSyn] and vitamin D deficiency on hearing loss among type 2 diabetes mellitus (T2DM) patients.

Subjects and Methods

This is an observational cohort study which was conducted during the period from January 2013 to July 2014 among diabetic patients aged between 20 and 59 years and registered in diabetic and ENT clinics of Hamad General Hospital in Qatar. IRB ethical approval was obtained from Hamad Medical Corporation.

Sampling procedure

The current sample size was determined by considering prevalence rate of 10%-12% impaired hearing loss among diabetes patients in Qatar [1,7], assuming 99% confidence interval and 2% bound on the error of estimation. The minimum sample size detected as 730 subjects. Finally, of the 730 registered with diagnosed diabetes and showed indications, only 528 (72.3%). agreed to participate this study in Hamad General Hospital.

National Cholesterol Education Program–Third Adult Treatment Panel (ATP III) [18,19].

According to ATP III criteria, a participant has the metabolic syndrome [MetSyn] if she/he has three or more of the following criteria : (1) Fasting Plasma Glucose test FPG ≥ 100 mg/dl (5.6 mmol/L) (2) Blood Pressure ≥ 130/85 mm Hg (3) Triglyceride ≥ 150 mg/dl (1.7 mmol/L) (4) high-density lipoprotein (HDL) Cholesterol: Men<40 mg/dl (1.03 mmol/L); Women<50 mg/dl (1.29 mmol/L (5) Men with waist circumference>102 cm and women with waist circumference>88 cm.

Questionnaire

The questionnaire, included socio-demographic, age, gender, nationality, education level, lifestyle habits, Body Mass Index (BMI), co-morbid symptoms, diabetic complications, systolic and diastolic blood pressures, Clinical biochemistry serum triglyceride, total cholesterol, HDL cholesterol, low density lipoprotein (LDL) cholesterol, Hemoglobin A1c (HbA1c) and FPG, were collected.

Physical examination and measurements

BMI was calculated as; weight in kilogram divided by the square of height in meters. According to World Health Organization [WHO] criteria [20], if it is greater than 25 kg/m^2, the subjects were assumed as overweight and greater than to 30 kg/m^2, the subjects were considered as obese [20]. WHO [20] International Society of Hypertension Writing Group defined standardized criteria of hypertension when Systolic Blood Pressure (SBP) ≥ 140 mm Hg or Diastolic Blood Pressure (DBP) ≥ 90 mm Hg or using anti-hypertensive medication.. Patients who walking or cycling for more than 30 min/day were classified as physically active.

Hearing evaluation procedures

Pure-tone audiometry is a behavioral test used to measure hearing sensitivity. This measure involves the peripheral hearing assessment [20,21]. The clinical digital audiometers (Grason Stadler gsi 61 clinical audiometer was used by pre-trained technicians to test patients' hearing level and calibrated according to ANSI 1996. Hearing loss evaluation described [21-23] as follows: Normal hearing: less than 25 dB in adults and 15 dB in children; Mild hearing loss: 25-39 dB; Moderate hearing loss: 40-69 dB; Severe hearing loss: 70-94 dB; and Profound hearing loss: 95+ dB.

The Statistical Package for Social Sciences (SPSS, version #22) performed for analysis. Student-t test was used to ascertain the significance of differences between two means of a continuous variable. Chi-square test Fisher's exact test (two-tailed) were performed to test for differences in proportions of categorical variables between two or more groups. Pearson's matrix correlation determines the degree to which a relationship is linear or, it determines whether there is a linear component of association between variables. A multivariable logistic regression analysis was performed to determine the impact and predictors of selected factors on the presence of hearing loss. A p-value of less than 0.05 was considered statistically significant.

Results

Variables		Metabolic Syndrome Hearing Loss ≥ 26 dB n=140	Without metabolic Normal Hearing<26 dB n=388	p-value significance
Age Group in years		47.7 ± 10.2	48.5 ± 9.1	0.403
	<35 years	13 (9.7)	31 (9.5)	
	35-44.9 years	25 (18.7)	74 (22.8)	0.05
	45-55 years	60 (44.8)	118 (51.7)	
	>55 years	36 (26.9)	52 (16)	
Gender				
	Male	55 (41)	146 (44.9)	0.446
	Female	79 (59)	179 (55.1)	
Nationality				
	Qatari	80 (59.7)	151 (46.5)	<0.001
	Non Qatari	54 (40.3)	174 (53.5)	
Educational level				
	Illiterate	22 (16.4)	59 (18.2)	
	Primary	30 (22.4)	70 (21.5)	
	Intermediate	20 (14.9)	68 (20.9)	0.298
	Secondary	43 (32.1)	100 (30.8)	
	University	19 (14.2)	28 (8.6)	
Occupation				
	Housewife	87 (64.9)	191 (58.8)	
	Sedentary	32 (23.9)	77 (23.7)	
	Manual	10 (7.55)	47 (14.5)	0.216
	Businessman	5 (3.7)	10 (3.1)	

Do you use a mobile phone frequently				
	Yes	121 (90.2)	268 (82.5)	0.044
	No	13 (9.8)	57 (17.5)	
Do you hear TV sounds normally				
	Yes	112 (86.6)	292 (89.8)	0.045
	No	22 (13.4)	33 (10.2)	
Income				
	<$2,000	49 (36.6)	112 (34.5)	
	$2,000-$4,999	48 (35.8)	127 (39.1)	0.806
	>$5,000	37 (27.6)	86 (26.5)	
Consanguineous marriage				
	Yes	43 (32.1)	71 (21.8)	0.028
	No	91 (67.9)	254 (78.2)	

Table 1: Socio demographic characteristics of the subjects with MetSyn hearing impairment comparison with normal hearing among diabetics patients (N= 528).

Table 1 shows the socio-demographic studied subjects with MetSyn hearing loss and normal hearing among T2DM. The mean age (± SD, in years) for metabolic hearing loss versus normal hearing subjects was 47.7 ± 10.2 vs. 48.5 ± 9.1. The prevalence of hearing impairment was higher in Qataris than in non-Qataris (52.1% vs. 47.9%, p<0.001). Over 90% of the studied patients were using phone devices very frequently and 13.4% had hearing impairment watching TV. The consanguineous marriages were observed higher in Hearing loss (32.9%) than in normal hearing (23.0%) (p=0.028).

Variables	Metabolic Syndrome Hearing Loss ≥ 26 dB n=140	Without metabolic Normal Hearing <26 dB n=388	P value
Waist circumference (cm) [total sample]	103.40 ± 10.06	99.85 ± 9.50	<0.001
Hip circumference (cm)	114.15 ± 10.10	112.0075 ± 91	<0.001
Waist Hip Ratio (WHR) [total sample]	0.90 ± 0.05	0.88 ± 0.06	<0.001
Body Mass index [BMI] (Kg/m^2)	28.54 ± 5.35	27.55 ± 4.08	0.024
BMI categories: n (%)			
<25	35 (25)	98 (25.3)	
25-30	56 (40)	177 (45.6)	0.387
≥ 30	49 (35)	113 (29.1)	
Exposure to sun	44 (32.0)	159 (41.0)	<0.001
Walking time per/day			
<30 min	32 (23.0)	93 (24.2)	0.817
<60 min	40 (28.8)	97 (25.3)	0.432
Hours of sleep (Mean ± SD)	5.76 ± 1.32	6.07 ± 1.31	0.02
Duration of diabetes	9.03 ± 4.35	8.06 ± 4.29	0.025
Cigarette smoking	20 (15.0)	37 (11.4)	0.478
Sheesha Smoking	27 (20.1)	41 (12.6)	0.039
Diabetes complications and symptoms			
Hypoglycemia	35 (25.3)	63 (16.2)	0.022
Retinopathy	25 (17.9)	41 (10.6)	0.025
Nephropathy	20 (14.3)	48 (12.4)	0.281
Neuropathy	18 (12.9)	25 (6.4)	0.017
Macro vascular disease	16 (11.4)	32 (8..2)	0.13
Diabetic foot ulcer	21 (15.0)	58 (14.9)	0.988
Tinnitus	71 (50.8)	155 (39.9)	0.027
Vertigo	46 (32.9)	91 (23.5)	0.03
Headache	68 (48.6)	132 (34)	0.006
Family history of morbidities			
MetSyn in first degree relatives	33 (23.6)	64 (16.5)	<0.001
MetSyn in second degree relatives	29 (20.5)	47 (12.1)	<0.001
Hypertension	40 (28.57)	71 (18.3)	0.011
CHD	30 (21.4)	59 (15.2)	0.034

Table 2: Co-morbidities and family history of morbidities according to metabolic syndrome (N=528), MS=Metabolic syndrome (ATPIII criteria).

Variables	Metabolic Syndrome Hearing Loss ≥ 26 dB n= 140 Mean ± SD	Without metabolic Normal Hearing <26 dB Mean ± SD	P value
Vitamin D (ng/ml)	19.32 ± 7.84	21.15 ± 7.74	0.018
Hemoglobin (g/dL)	12.89 ± 2.28	12.60 ± 2.03	0.296
Magnesium (mmol/L)	0.81 ± 0.10	0.87 ± 0.08	<0.001
Potassium (mmol/L)	4.57 ± 0.59	4.50 ± 0.63	0.503
Calcium (mmol/L)	1.92 ± 0.44	1.90 ± 0.40	0.62
Phosphorous (mmol/L)	1.23 ± 0.25	1.30 ± 0.56	0.048
Creatinine(mmol/L)	72.70 ± 17.67	69.18 ± 17.84	0.047
Fasting Blood Glucose(mmol/L)	9.26 ± 3.01	9.53 ± 2.93	0.355

HbA1c	8.88 ± 1.42	8.44 ± 1.57	0.003
Cholesterol (mmol/L)	4.81 ± 1.30	4.79 ± 1.02	0.821
HDL (mmol/L)	1.33 ± 0.35	1.237 ± 0.32	0.002
LDL (mmol/L)	2.80 ± 0.88	3.00 ± 0.79	0.465
Albumin (mmol/L)	45.36 ± 8.70	40.97 ± 6.52	0.044
Billirubin (mmol/L)	7.10 ± 3.71	8,47 ± 4.70	0.009
Triglyceride (mmol/L)	1.79 ± 0.62	1.59 ± 0.47	0.001
Uric Acid (mmol/L)	335.0 ± 101.7	332.0 ± 114.0	0.845
Systolic Blood Pressure mm Hg	131.1 ± 12.6	128.1 ± 11.16	0.025
Diastolic Blood Pressure mm Hg	82.6 ± 6.7	81.2 ± 7.3	0.041
Vitamin D Level	**n (%)**	**n (%)**	
Deficiency			
25 (OH) D <20 ng/ml	76 (54.3)	164 (42.3)	
Insufficiency			
25 (OH) D 20-29 ng/ml	42 (30.0)	150 (38.7)	0.049
Optimal			
25 (OH) D 30-80 ng/ml	22 (15.7)	74 (19.0)	

Table 3: Clinical biochemistry baseline value among hearing loss and normal hearing subject (N=528).

Table 2 presents the evaluation of the MetSyn hearing loss and normal hearing among T2DM. Average (standard deviation) waist circumference, hip circumference, waist hip ratio and body mass index were significantly higher among the participants with MetS as compared to those without MS (p<0.001). The mean of diabetes onset duration (9.03 ± 4.35 years), sleeping disorder (5.76 ± 1.32 h), cigarette smoking (16.4%) and sheesha smoking (20.7%) were higher among hearing impairment. The associated risk factors were significantly higher in MetSyn with hearing loss such as including hypoglycemia, retinopathy, nephropathy, neuropathy, diabetic foot ulcer, tinnitus, vertigo and headache than in normal hearing T2DM. Similarly, the history of MetSyn among first degree and second degree relatives were significantly higher among the patients with MetSyn hering loss compared to those normal hearing.

Table 3 shows baseline chemistry biomarker values among the two groups. There were statistically significant differences between hearing impairment versus normal hearing for vitamin D [18.91 ± 7.65 ng/ml vs. 22.85 ± 9.00 ng/ml; p=0.018], magnesium [0.81 ± 0.10 mmol/L vs. 0.89 ± 0.08 mmol/L; p<0.001], phosphorous [1.23 ± 0.25 mmol /L vs. 1.36 ± 0.56 mmol/L; p=0.048], HDL [1.33 ± 0.35 mmol /L vs. 1.23 ± 0.32 mmol/L; p=0.002], ceatinine [72.72 ± 17.6 mmol/L vs. 69.1 ± 17.84 mmol/L; p=0.047], albumin [45.37 ± 8.7 mmol/L vs. 40.97 ± 8.52 mmol/L; p=0.044], systolic blood pressure [131.1 ± 12.60 Hg vs. 128.2 ± 11.16 Hg; p=0.025] and diastolic blood pressure [82.69 ± 6.73 mm Hg vs. 81.23 ± 7.38 mm Hg; p=0.041].

Table 4 shows correlation matrix between hearing loss, metabolic syndrome, tinnitus, vertigo, systolic and diastolic BP and headache. As can be seen from this table the hearing loss was highly significantly correlated with variables such as metabolic syndrome, tinnitus, vertigo, systolic and diastolic BP and headache.

Table 5 presents multivariate logistic regression analysis of variables for predictors of hearing loss among diabetic patients. Vitamin D Deficiency (OR 2.59 95% CI 1.65-4.72; p<0.001), Head ache (OR 1.97 95% CI 1.30-2.85; p<0.001), sleeping disturbance (OR 1.83; 95% CI 1.23-2.71, p=0.002), systolic blood pressure (OR 1.66 95% CI 1.20-2.48; p=0.009), cigarette smoking (OR 1.90 95% CI 1.23-2.95; p=0.004), age in years (OR 1.45; 95% CI 1.30-2.54; p=0.026), nationality (Qatari) (OR 1.55 95% CI 1.10-2.17; p=0.014), diastolic blood pressure (OR 1.69 95% CI 1.14-2.52; p=0.012), age in years (OR 1.45 95% CI 1.30-2.54; p=0.026) and sheesha smokers (OR 1.79; 95% CI 1.32-3.11, p=0.038) were considered at higher risk as a predictors of hearing loss among diabetic patients.

	Hearing Loss	**Metabolic Syndrome**	**Tinnitus**	**Vertigo**	**Vitamin D**	**Systolic BP**	**Diastolic BP**	**Headache**
Hearing Loss	1.00	0.462**	0.359**	0.477**	0.333**	0.229**	210**	0.265**
Metabolic Syndrome		1.00	0.561**	0.336**	0.340**	0.186*	0.335**	0.270**.
Tinnitus			1.00	0.539**	0.246**	0.458**	0.322**	0.328**
Vertigo				1.00	0.345**	0.354**	0.478**	0.465**.
Vitamin D					1.00	0.195*	0.243**	0.281**
Systolic BP						1.00	0.554**	0.213**
Diastolic BP							1.00	.294**
Headache								1.00

Table 4: Correlation matrix between hearing loss, Metabolic Syndrome, tinnitus, vertigo, systolic and diastolic BP and headache, **Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the 0.05 level (2-tailed).

Variables	Odds Ratio (95% CI)	P value
Vitamin D deficiency	2.59 (1.65-4.72)	<0.001
Head ache	1.97 (1.30-2.85)	0.001
Sleep disturbance	1.83 (1.23-2.71)	0.002
Systolic blood pressure	1.66 (1.20-2.48)	0.009
Cigarette smoking	1.90 (1.23-2.95)	0.004
Diastolic blood pressure	1.69 (1.14-2.52)	0.012
Age in years	1.45 (1.30-2.54)	0.026
Sheesha Smoking	1.79 (1.32-3.11)	0.038

Table 5: Multivariate stepwise logistic regression analysis of the association between selected lifestyle factors and presence of hearing loss (n = 528).

Discussion

The current study has revealed hearing loss as an important consequence of diabetes indicating metabolic assessment. Nearly one fourth of the studied diabetics patients suffered from hearing loss which is similar to the findings in some other studies [1,9,10]. MetSyn is a major public health concern because it is associated with hearing loss [1]. Present study revealed evidence that vitamin D deficiency and higher prevalence of MetSyn effect hearing loss [1,16,22,23].The findings of this study concerning symptoms and risk factors are consistent with rates reported elsewhere [1,9-14].

Most recently the results presented by Sun et al. [13] from modelling the association between the presence of metabolic syndrome components and the hearing thresholds are confirmed that there was a strong linear increase in the hearing threshold with the presence of metabolic syndrome components and an increasing number of components of metabolic syndrome. This is consistent with present obtained results.

The impact of vitamin D and MetSyn which influences the hearing loss are not fully understood [1]. Several population-based studies has evaluated the association between diabetes and hearing loss [7-15] and a number of clinical studies have confirmed an association of MetSyn diabetes mellitus and hearing loss [11-15,17,22,23]. This is consistent with the current study. Audiometric data obtained in this study revealed that hearing became worse as blood sugar increased in subjects. The present study revealed a big percent of the subjects of hearing loss were diabetic (26.50%) and hypertensive (28.57%).

Other associated risk factors in our middle aged subjects with hearing loss were tinnitus (50.8%), retinopathy (17.9%), nephropathy (14.3%), neuropathy (12.9%), macro vascular disease (11.4%) , vertigo (32.9%) and head ache (48.6%). Those results are consistent with the previous reported studies [9-16]. Overall, diabetes is very complex and co-morbid disease that can affect multiple organs and physiological functions, on the biochemical and molecular levels [1,17,23]. The current investigation showed that MetSyn patients with vitamin D deficiency had poorer hearing levels when compared with normal subjects.

Conclusion

The current study results suggests that the impact of metabolic syndrome and vitamin D among diabetic patients were significantly associated with the hearing loss in the Qatari's population.

Contributors

AB designed and supervised the study and was involved in data collection, statistical analysis the writing of the paper. AOAA , KA and LG were involved in data collection, interpretation of data and writing manuscript. All authors approved the final version.

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Competing Interests

None to declare

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