

Research Article



## INTERNATIONAL RESEARCH JOURNAL OF PHARMACY

[www.irjponline.com](http://www.irjponline.com)

ISSN 2230-8407 [LINKING]

### INNER EAR FUNCTIONS IMPAIRMENT IN CHILDREN WITH ENDOCRINE DISORDERS

**Dr. Anjani Kumar**

Assistant Professor, Department of Pediatrics, I Care Institute Of Medical Sciences And Research & Dr. Bidhan Chandra Roy Hospital, Haldia, West Bengal

**Address for correspondence**

Email: [Anjani.anni@gmail.com](mailto:Anjani.anni@gmail.com)

How To Cite: Kumar A. Inner Ear Functions Impairment In Children With Endocrine Disorders. International Research Journal Of Pharmacy, 2022,13:07:17-21.

Doi: 10.32937/2230-8407.3730

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#### ABSTRACT

**Background:** Globally, a sizable fraction of child mortality and morbidity are associated with metabolic and endocrine problems. Diabetes mellitus, growth hormone insufficiency, childhood obesity, premature puberty, and other conditions are among the comorbidities and illnesses that influence many bodily organs, including inner ear functioning.

**Aim:** The current clinical trial's objectives were to evaluate children with endocrine problems, such as growth hormone insufficiency, premature puberty, type 1 diabetes mellitus, obesity, and idiopathic short stature, for abnormalities related to hearing, particularly high-frequency hearing and accompanying tinnitus and vertigo.

**Methods:** A comprehensive otolaryngologic examination was conducted on 120 subjects with growth hormone deficiency, precocious puberty, type 1 diabetes mellitus, obesity, and/or idiopathic short stature, and 32 healthy children. Tympanometry, otoscopic ear examination, vertigo, and tinnitus were also assessed.

**Results:** 2.5% (n=3) of the patients saw PTA>20dB, 5% (n=6) saw HF<math>\tilde{A}</math>20dB, and 5% (n=6) saw both PTA and HF<math>\tilde{A}</math>20dB (p= 1.000, 0.465, and 1.000). 8.82% (n=9) had dizziness, while 18.6% (n=19) reported tinnitus. In study participants with ISS, vertigo and tinnitus were present in 22.7% (p=0.04) of cases. Vertigo with PTA and HFA value >20dB was observed in 3.06% (n=3) people in the entire study group, 5.88% (n=2) respondents with Type 1 DM, 4% (n=1) subjects with obesity, and 3.84% (n=1) subjects with GHD. The study suggests that changes in the inner ear with an unclear aetiology can result from endocrine illnesses that first appear in childhood.

**Conclusion:** To identify and address any related abnormalities at an early stage, the research recommends that all children entering endocrinology clinics get a comprehensive hearing test as well as a balancing assessment.

**Keywords:** Endocrine Disorders, Hearing pattern, metabolic disorders, pediatric, tinnitus, vertigo

#### INTRODUCTION

Globally, a sizable percentage of child mortality and morbidity are linked to metabolic and endocrine problems. In addition to their individual effects, these illnesses can have comorbidities with metabolic and endocrine problems, which increase the risk of death and morbidity as well as the diseases themselves. Numerous bodily systems and organs, including the inner ear, are impacted by these illnesses and their concomitant conditions. These conditions include early puberty, childhood obesity, diabetes mellitus, growth hormone deficiency, etc.1

Persistent hyperglycemia is a genetically-based metabolic condition known as diabetes mellitus, which is linked to a number of vascular and neuropathic consequences. Ninety percent of children are diagnosed with insulin-dependent diabetes mellitus (type-I DM), which is often discovered during adolescence. The impact and harm that

Type 1 Diabetes Mellitus causes on the retrocochlear and cochlear pathways connected to the auditory system are well-described in a number of published studies.<sup>2</sup>

Growth hormone deficiency (GHD), which affects around 1 in 4–10 thousand live births, is another illness that can show, be treated, and be identified in infancy. It manifests as low stature. The most frequent cause of paediatric visits in children is idiopathic short stature (ISS). Researchers from different backgrounds have proven the impact of growth hormone shortage on hearing. It was demonstrated that growth hormone insufficiency in humans affects the development and functioning of the auditory system.<sup>3</sup>

Also, obesity is increasing in children to adolescents globally, and approximately 1/3<sup>rd</sup> of children with obesity have one or more metabolic disorders. It has been demonstrated that obesity and related comorbidities raise the risk of hearing loss.<sup>4</sup>

Another illness known as precocious puberty affects both sexes equally, however it affects girls more. In males less than nine years old, it manifests as testicular enlargement, while in females younger than eight years old, it manifests as breast budding. The majority of paediatric patients examined in endocrinology departments have idiopathic low stature and early puberty. In children, these metabolic diseases and their comorbidities have an impact on normal inner ear and hearing capabilities.<sup>5</sup> Therefore, the current clinical trial was conducted to evaluate children with endocrine disorders, such as growth hormone deficiency, precocious puberty, type 1 diabetes mellitus, obesity, and idiopathic short stature (ISS), for hearing, including high-frequency hearing, and associated tinnitus and vertigo.

## **MATERIALS AND METHODS**

There were 120 individuals in all, with a mean age of 9.29 years and a range of ages from 6 to 17 for both men and females. Children sent to the institution's Outpatient Department's Department of Endocrinology for treatment of growth hormone insufficiency, early puberty, type 1 diabetes mellitus, obesity, and/or idiopathic short stature constituted the pool of potential participants. 32 healthy youngsters, with a mean age of 9.28 years and an age range of 6-16 years, were included in the study as controls. There were 17 boys and 15 girls, and they were free of chronic diseases.

Children with any of the following diseases met the study's inclusion criteria: deficiencies in growth hormone, children aged 6 to 16 years, obesity, type 1 diabetes mellitus, early puberty, and idiopathic low stature. Adenotonsillectomy/ear surgery history, thyroid disease, active ear effusion/inflammation, mentally retarded subjects, ear wax, current respiratory tract infection, and/or vestibulocochlear system syndrome were among the conditions that precluded study participants. The subjects received an explanation of the research design following their final inclusion. The parents of the children that were included were then asked for their informed consent. After enrollment, each subject underwent a thorough otolaryngologic examination, which was followed by an otoscopic examination of both ears. An experienced audiologist performed tympanometry using the tympanic device. This was followed by a hearing examination in an anechoic space using the following frequencies: air conduction hearing test in the 250–20,000 Hz range; HFA (High-frequency average) in the 8, 10, 12, 16, and 20 thousand Hz range; PTA (Pure tone average) in the 500–1000, 2000, and 4000 Hz range; bone conduction hearing test in the 500–4000 Hz range; and acoustic reflex recording. The study did not include those who tested positive for Type B and C tympanograms or who showed signs of hearing loss on audiometry testing. The data were presented as single-ear since there was barely any variation in the frequencies measured over a two-year period (<10dB). The normal hearing range was measured at 0–20 dB, while hearing loss was defined as being at or above 20 dB.

The Paediatric Vestibular Symptom Questionnaire<sup>6</sup> was utilised to examine vertigo, and it consisted of 10 items with scores of 3, 2, 1, and 0 for mostly, sometimes, seldom, and never. I don't know was added as an extra choice, but it was removed and received no points. Vertigo symptoms were diagnosed with ratings between 15 and 30, with values between 0 and 15 being deemed normal. If individuals reported hearing a ringing or buzzing sound, it was scored using the same criteria as vertigo. Individuals who had a score of two or three were diagnosed with tinnitus.

The statistical analysis of the gathered data was conducted using the ANOVA and t-test functions of SPSS software, version 21.0, 2012, Armonk, NY. The formulation of the results was done with a p~0.05 threshold of significance.

## RESULTS

There were 120 individuals in all, with a mean age of 9.29 years and a range of ages from 6 to 17 for both men and females. 32 healthy youngsters, with a mean age of 9.28 years and an age range of 6-16 years, were included in the study as controls. There were 17 boys and 15 girls, and they were free of chronic diseases. Table 1 provides an overview of the research individuals' demographic and illness characteristics. The youngsters under examination consisted of 64 girls and 56 males, whereas the controls were 17 females and 15 men. In the children under examination, Type-1 diabetes mellitus affected 28.33% (n=34) of the participants, GHD affected 21.66% (n=26), obesity affected 20.83% (n=25), idiopathic short stature affected 18.33% (n=220), and premature puberty affected 10.83% (n=13).

In the control group, HFA and PTA were  $4.37\pm 6.46$  Hz and  $3.13\pm 4.56$  Hz, respectively. HFA was  $5.59\pm 7.53$ ,  $4.57\pm 7.62$ ,  $7.31\pm 9.33$ ,  $6.74\pm 10.24$ , and  $4.05\pm 2.99$  in children with GHD, precocious puberty, Type-1 DM, obesity, and ISS, and PTA values were  $4.06\pm 5.11$ ,  $3.71\pm 3.11$ ,  $5.35\pm 5.99$ ,  $5.07\pm 5.99$ , and  $3.60\pm 3.67$  in the same children. While hearing loss was taken into consideration at HFA and PTA of  $>20$ dB, the normal hearing range was measured between 0 and 20dB. Out of all the study participants, 2.5% (n=3) had a PTA value more than 20 dB, 5% (n=6) had an HFA value of  $>20$  dB, and 5% (n=6) had both PTA and HFA values of  $>20$  dB. These differences, with corresponding p-values of 1.000, 0.465, and 1.000, were statistically not significant.

Concerning comparison of the control group to GHD, precocious puberty, Type1 DM, obesity, and Idiopathic short stature for  $>20$ dB, the difference was found to be non-significant statistically ( $p>0.05$ ). Individual values of these parameters are described in Table 2.

Among the 102 kids that were examined, 8.82% (n=9) experienced vertigo and 18.6% (n=19) suffered tinnitus. For GHD, precocious puberty, Type 1 DM, obesity, and idiopathic short stature, as well as the entire study population, there was no statistically significant difference observed in the individual parameter assessment for the presence of vertigo and tinnitus in study subjects. However, in children with ISS, 22.7% (n=5) of the subjects reported having tinnitus symptoms ( $p=0.04$ ). No participant with PTA and HFA value  $\sim 20$ dB had tinnitus or vertigo among those with precocious puberty and ISS. Vertigo with PTA and HFA value  $>20$ dB was observed in 3.06% (n=3) people in the entire study group, 5.88% (n=2) respondents with Type 1 DM, 4% (n=1) subjects with obesity, and 3.84% (n=1) subjects with GHD.

Similar to this, people with GHD, Type 1 DM, obesity, and the entire experimental group had PTA and HFA values of  $>20$ dB with tinnitus and vertigo in 3.84% (n=1), 2.94% (n=1), 4% (n=1), and 2.04% (n=2) of the participants, respectively (Table 3).

## DISCUSSION

The youngsters under examination in this study were 64 girls and 56 males, whereas the controls were 17 females and 15 men. In the children under examination, Type-1 diabetes mellitus affected 28.33% (n=34) of the participants, GHD affected 21.66% (n=26), obesity affected 20.83% (n=25), idiopathic short stature affected 18.33% (n=220), and premature puberty affected 10.83% (n=13). In the control group, HFA and PTA were  $4.37\pm 6.46$  Hz and  $3.13\pm 4.56$  Hz, respectively. HFA was  $5.59\pm 7.53$ ,  $4.57\pm 7.62$ ,  $7.31\pm 9.33$ ,  $6.74\pm 10.24$ , and  $4.05\pm 2.99$  in children with GHD, precocious puberty, Type-1 DM, obesity, and ISS, and PTA values were  $4.06\pm 5.11$ ,  $3.71\pm 3.11$ ,  $5.35\pm 5.99$ ,  $5.07\pm 5.99$ , and  $3.60\pm 3.67$  in the same children.

## DISCUSSION

These results were in line with research conducted in 2018 by Kılıç K et al<sup>7</sup> and in 2001 by McGaughan JM et al<sup>8</sup>, whose values were similar to those seen in the current investigation. In this study, the normal hearing range was defined as 0–20 dB, whereas hearing loss was defined as an HFA and PTA of  $\sim 20$  dB. Out of all the study participants, 2.5% (n=3) had a PTA value more than 20 dB, 5% (n=6) had an HFA value of  $>20$  dB, and 5% (n=6) had both PTA and HFA values of  $>20$  dB. These differences, with corresponding p-values of 1.000, 0.465, and 1.000, were statistically not significant.

When evaluating the control group against GHD, premature puberty, Type 1 diabetes, obesity, and idiopathic short stature for  $>20$ dB, statistical analysis revealed that the difference was not statistically significant ( $p>0.05$ ).

These results corroborated those of Hwang JH et al. (2009) and Allen DB et al. (2013), who noted comparable hearing trends in the population they studied.

Among the 102 kids that were examined, 8.82% (n=9) experienced vertigo and 18.6% (n=19) suffered tinnitus. For GHD, precocious puberty, Type 1 DM, obesity, and idiopathic short stature, as well as the entire study population, there was no statistically significant difference observed in the individual parameter assessment for the presence of vertigo and tinnitus in study subjects. However, in children with ISS, 22.7% (n=5) of the subjects reported having tinnitus symptoms (p=0.04).

No participant with PTA and HFA value ~20dB had tinnitus or vertigo among those with precocious puberty and ISS. Vertigo with PTA and HFA value >20dB was observed in 3.06% (n=3) people in the entire study group, 5.88% (n=2) respondents with Type 1 DM, 4% (n=1) subjects with obesity, and 3.84% (n=1) subjects with GHD. In a similar vein, 3.84% (n=1), 2.94% (n=1), 4% (n=1), and 2.04% (n=2) of the participants with GHD, Type 1 DM, obesity, and the entire experimental group, respectively, had PTA and HFA values of >20dB with tinnitus and vertigo. There is little information and few authors who have examined the connection between tinnitus and vertigo in patients with endocrine problems and hearing loss. Still, these results were similar to the 2020 research by Kocyigit M et al where Similar results were found by authors regarding tinnitus and vertigo in patients with metabolic and endocrine disorders.

### CONCLUSION

Within the constraints of the study, the current findings indicate that paediatric endocrine disorders may cause changes in the inner ear that have an unclear cause. To identify and address any related abnormalities at an early stage, the research recommends that all children entering endocrinology clinics get a comprehensive hearing test as well as a balancing assessment. A few disadvantages of the current study were its smaller size, shorter monitoring duration, geographical region biases, and single-institution design. Therefore, in order to draw a firm conclusion, further longitudinal studies including a bigger sample size and a longer monitoring period are needed.

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### TABLES

Characteristics	Controls	Growth Hormone Deficiency	Precocious Puberty	Type 1 Diabetes Mellitus	Obesity	Idiopathic Short Stature
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	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Number (n)	32	100%	26	21.66%	13	10.83%	34	28.33%	25	20.83%	22	18.33%
Mean age (years)	9.28		9.27		8.44		9.24		9.86		9.65	
Gender												
a) Females (64)	17	53.12%	13	50%	10	76.92%	18	52.94%	12	48%	11	50%
b) Males (56)	15	46.87%	13	50%	3	23.07%	16	47.05%	13	52%	11	50%
High-Frequency Average (Mean ± S.D)	4.37±6.46		5.59±7.53		4.57±7.62		7.31±9.33		6.74±10.24		4.05±2.99	
Pure Tone Average (Mean ± S.D)	3.13±4.56		4.06±5.11		3.71±3.11		5.35±5.99		5.07±6.04		3.60±3.67	

**Table 1: Demographic and disease characteristics of the study subjects**

Characteristics	Controls (32)		Growth Hormone Deficiency (26)		Precocious Puberty (13)		Type 1 Diabetes Mellitus (34)		Obesity (25)		Idiopathic Short Stature (22)	
	(n) (%)	P	(n) (%)	P	(n) (%)	P	(n) (%)	P	(n) (%)	P	(n) (%)	P
HFA more than 20dB	1 3.125%	-	2 7.69%	0.326	0 0%	1.000	3 8.82%	0.363	2 8%	0.314	0 0%	1.000
PTA more than 20dB	1 3.125%	-	1 3.84%	1.000	0 0%	1.000	1 2.94%	1.000	1 4%	0.578	0 0%	1.000
Both HFA and PT more than 20dB	1 3.125%	-	1 3.84%	1.000	0 0%	1.000	1 2.94%	1.000	1 4%	1.000	0 0%	1.000

**Table 2: HFA, PTA, and HFA and PTA values of more than 20dB in the study subjects**

Parameter with scores	Controls (32)		Growth Hormone Deficiency (26)		Precocious Puberty (13)		Type 1 Diabetes Mellitus (34)		Obesity (25)		Idiopathic Short Stature (22)		Total (102)	
	(n) (%)	(n) (%)	P	(n) (%)	P	(n) (%)	P	(n) (%)	P	(n) (%)	P	(n) (%)	P	
Tinnitus symptom 0/1	29 90.6%	22 84.6%		11 84.6%		27 82.35%		20 80%		17 77.2%		83 81.3%		
Tinnitus symptom 2/3	3 9.37%	4 15.3%	0.341	2 15.3%	0.265	7 20.5%	0.140	5 20%	0.094	5 22.7%	0.044	19 18.6%	0.074	
Pediatric vestibular symptom questionnaire 0/1	31 96.8%	24 92.3%		12 92.3%		30 88.2%		21 84%		21 95.4%		93 91.1%		
Pediatric vestibular symptom questionnaire 2/3	1 4%	2 7.69%	0.655	1 7.69%	0.572	4 11.7%	0.272	4 16%	0.131	1 4.54%	1.000	9 8.82%	0.263	
HFA and PTA >20dB with Vertigo	0 0%	1 3.84%	0.203	0 0%	-	2 5.88%	0.242	1 4%	0.437	0 0%	-	3 3.06%	0.347	
HFA and PTA >20dB with Tinnitus and vertigo	0 0%	1 3.84%	0.453	0 0%	-	1 2.94%	0.494	1 4%	0.437	0 0%	-	2 2.04%	0.580	

**Table 3: Tinnitus and Vertigo in the study subjects**