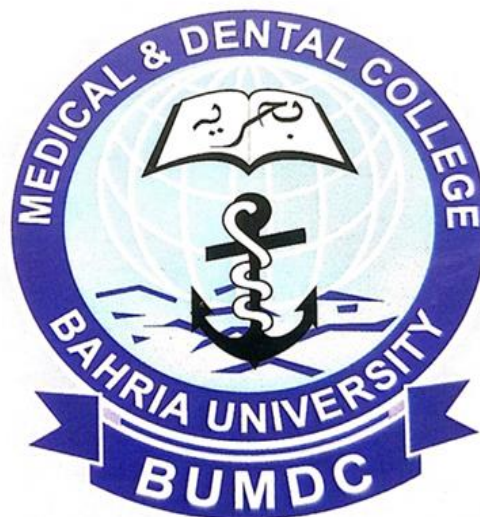


**MORPHOLOGICAL VARIATIONS IN EAR  
OSSICLES WITH AGE IN CORRELATION WITH  
HEARING THRESHOLDS**



**DR MARIYA AZAM KHATTAK**

06-113192-002

A thesis submitted in fulfilment of the  
requirements for the award of the degree of  
Master of Philosophy (Anatomy)

Department of Anatomy

**BAHRIA UNIVERSITY MEDICAL & DENTAL  
COLLEGE**

SEPTEMBER 2021

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Dedicated to my family,  
especially my mother for her endless prayers.



## ACKNOWLEDGEMENT

I would like to express my genuine and everlasting gratefulness to Almighty Allah, as with His help this project is successfully completed.

I would like to express my sincere appreciation to my supervisor, Prof. Dr. Ambreen Usmani for her valuable time, support, advices, ideas and continuous motivation by supervising my work and appreciating my work which helped me in completing this MPHIL research, since it was impossible for me without her guidance. Hence, I pay my heartiest thanks to her.

I would like to thank my co-supervisor, Surg. Capt. Dr. Sohail Aslam who made my research possible by removing all the barriers and difficulties I was facing during my data collection period. It was an honor working with such a great doctor who has all the expertise in his field. I am really thankful for his endless support.

I am also indebted to my teachers, Prof. Dr. Aisha Qamar and Assoc. Prof. Dr. Yasmeen Mehar for bearing with an average student like me and turning me into a knowledgeable one. It would not have been possible without them.

I would also like to thank my colleges and batch mates for their constant moral support especially Dr. Rida Rubab whose continuous help has finally made me reach the finish line. I am also grateful to all the technicians and staff members of Bahria University of Medical and Dental College (BUMDC) and PNS Shifa Hospital Karachi for their assistance and cooperation.

Finally, I wish to thank my family and friends, Dr. Izrum Shafi Rajput and Dr. Syed Wajahat Hasib who have always encouraged me and supported me to go on whatever the difficult situation is. They have shown their understanding towards my difficulties and given me advices to enhance my commitment in this research.

Thank you.

## ABSTRACT

Enhancements in computed tomography (CT) scans have concomitantly amplified interest in ear ossicle variations. Anatomical variations are normally present as morphological structures in humans. The ossicles present in the middle part of the ear are for the conduction and enhancement of sound waves received in the external and pass to the internal ear. Despite the fact that the length of ear ossicles spans to its authoritative size in fetal life and hardly any alteration occurs after birth yet numerous investigations have indicated that there are morphological changes for the most parts of the bones with age bringing about the varieties in each individual and difference in hearing thresholds in each person. These variations need to be added to anatomical information for the future procedures relating to ear ossicles as it must be planned carefully to avoid complications in prosthesis. Apart from cadaveric studies there was no evident data which could help in appreciating these variations for making immediate decisions when planning any surgical procedure relating to this structure. The objectives of this study were to determine the morphological variations in ear ossicles and to evaluate its association with age, gender, ethnicity and hearing thresholds. A descriptive cross-sectional study including 50 participants was conducted at PNS Shifa Hospital, Karachi between January-June 2021. This study involved males and females arranged in 5 groups on the basis of age. In A group (10-20), B group (21-30), C group (31-40), D group (41-50) and E group (51 onwards) year old participants were included. A detailed history was taken after informed consent from each participant and a thorough examination of ear was conducted. Following this subjects meeting the inclusive criteria were prepared for high resolution CT scan of petrous temporal bone. The scans were reviewed to study the ear ossicles (malleus and incus) for possible morphological variations and after that hearing thresholds were recorded using Pure Tone Audiometer. The results of study showed that mean width of malleus head in group A was 2.91 mm, in B was 2.97 mm, in C was 3.09 mm, in D was 3.0 mm and in E was found to be 3.12 mm. The mean length of manubrium in group A was 4.32 mm, in B was 4.47mm, in C was 4.43 mm, in D was 4.29 mm and in E was found to be 4.44 mm.

The total mean total length of malleus was 7.47 mm in group A, 7.58 mm in group B, 7.67 mm in group C, 7.60 mm in group D and 7.61 mm in group E. The mean width of incus in group A was 4.54 mm, in group B was 4.19 mm, in group C was 4.49 mm, in group D and E was 4.50 mm. The total mean of incus length was 6.44 mm in group A, 6.37 mm in group B, 6.60 mm in group C, 6.71 mm in group D and 6.78 mm in group E. The mean value of width of the malleus head was 3.036 mm, length of manubrium was 4.472 mm and total length of malleus was 7.760 mm while mean value of Incus width was 4.440 mm and total length of incus was 6.604 mm observed in males. The mean value of width of the malleus head was 3.0 mm, length of manubrium was 4.308 mm and total length of malleus was 7.412 mm while mean value of Incus width was 4.448 mm and total length of incus was 6.556 mm observed in females. The comparison of gender showed that the morphological measurements in males were different and greater than in females when compared in 5 parameters. The morphological variations were correlated with age which showed variation in shape but not in size. The correlation of variations with gender were significant while amongst participants in which 10 were Sindhi, 10 Punjabi, 10 Balochi, 10 Pashtun and 10 Hindko. Chi-square tests were performed for comparing percentages of independent samples of ethnicity and the differences between them were evaluated but the p value did not show any significance. The variations in ear ossicles compared with hearing thresholds were insignificant while when compared with age groups they were significant. The total length of incus were found to be most varied structure among all parameters and was considered to be statistically significant with a p value of (0.0001).

**KEY WORDS:**

Anatomical variations, Ear, Ear ossicles (malleus, incus, and stapes), CT scan, Hearing thresholds, Pure Tone Audiometer, Measurement.

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**LIST OF ABBREVIATIONS**

<b>S NO</b>	<b>ABBREVIATION</b>	<b>FULL FORM</b>
<b>1</b>	<b>3-D</b>	Three- dimensional
<b>2</b>	<b>CAA</b>	Congenital aural atresia
<b>3</b>	<b>CAS</b>	Congenital aural stenosis
<b>4</b>	<b>CT</b>	Computed tomography
<b>5</b>	<b>Db</b>	Decibel
<b>6</b>	<b>EO</b>	Ear ossicles
<b>7</b>	<b>FP</b>	Foot plate
<b>8</b>	<b>HFUS</b>	High frequency ultrasound
<b>9</b>	<b>HRCT</b>	High resolution computed tomography
<b>10</b>	<b>ISJ</b>	Incudostapedial joint
<b>11</b>	<b>IUL</b>	Intra uterine life
<b>12</b>	<b>MH</b>	Malleus handle
<b>13</b>	<b>MM</b>	Millimeter
<b>14</b>	<b>PTA</b>	Pure Tone Audiometer
<b>15</b>	<b>PTB</b>	Petrous temporal bone
<b>16</b>	<b>RW</b>	Round window
<b>17</b>	<b>TM</b>	Tympanic Membrane
<b>18</b>	<b>TT</b>	Tensor tympani muscle
<b>19</b>	<b>WHO</b>	World health organization

