A PROCEDURE TO FIND NORMS ON THE SIZES OF EAR PLUGS -A PILOT PROJECT

REG.NO : 3

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An Independent Project Submitted
In Part Fulfilment For
The Degree of Master of Science
(Speech & Hearing)

UNIVERSITY OF MYSORE

To

Amma & Acha.

C E R T I F I C A T E

This is to certify that the Independent Project entitled "A Procedure to Find Norms On the Sizes of Ear Plugs" - A Pilot, Project, is the bonafide work in part fulfilment for M.Sc, in Speech and Hearing, of the student with Register No.3

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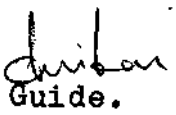
C E R T I F I C A T E

This is to certify that the Independent Project entitled "A Procedure to Find Norms On the Sizes of Ear Plugs"- A Pilot Project, has been prepared under my supervision and guidance.



Guide.

D E C L A R A T I O N

This Independent Project is the result of my own study undertaken under the guidance of Dr.(Miss) Shailaja Nikam, Professor and Head of the Department of Audiology, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore Reg.No: 3

Dated:

ACKNOWLEDGEMENTS

I express my gratitude to Dr. (Miss) S.Nikam, Head of the department, Audiology, All India Institute of Speech and Hearing, Mysore, for her indispensible guidance in conducting this study and for allowing me to use the required instruments.

My sincere thanks to Mrs.S.Sharma, statistician, Central Institute of Indian Languages, Mysore, for her expert advice.

My due thanks to Mr.Nagaraj, Prosthetic Dental Mechanic, All India Institute of Speech and Hearing, Mysore, for helping me make the ear moulds.

I thank my classmates who helped me in my testing and Miss. Falguni Pathak who cleared many a doubt.

My sincere thanks to my subjects for their kind cooperation.

Last but not least, my thanks to Pushpa, for having typed my project neatly.

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INTRODUCTION

Noise has been known to have both psychological as well as physical effects on man. Annoyance is the main psychological effect (Broadbent, 1957; Parbrook, 1963). The exposure to noise leads to hearing loss is a well established fact (Rudmose, 1957; Jensen, 1978). Various ways and means have been considered and used, in order to reduce the hazards of noise. Noise can be controlled at its source, during transmission; and at the ear. At the ear this is done by means of ear protectors. "Ear protectors can be divided into four categories according to their position relative to the ear: ear plugs, semi-inserts, ear-muffs and helmets."

Inserts or plug type protectors fit directly into the ear Canal. Higher sound attenuation results when ear plugs are used correctly. Marston and Goetzinger (1972) found their ear-plugs, which were inflatable ones to attenuate sounds by as much as 25 to 40 dB. Also ear-plugs are unobtrusive, and do not interfere with head covers, masks, goggles, or other devices worn on the head. Being small they can be easily carried about by the indivicual, when he does not require to wear it. Of all the ear protectors, ear-plugs are the least

expensive. In high heat areas, they allow better air circulation around the head, than do other types of ear protectors.

It is essential that ear plugs fit the individual correctly in order for it to serve its purpose. "Proper fit depends on its ability to make contact along the entire circumference of the ear canal walls" (Vassallo and Sataloff, 1978), meaning that they should form a proper seal. Marston and Goetzinger (1972) reported that their inflatable ear-plugs (inflated with water) provided greater attenuation than that reported for other well designed fluid fitted ear-plugs, when measured in a comparable manner. This, they stated, could have been due to the air tight seal, and the increased air pressure inherent in their model. Even small increases in pressure in the canal could decrease sensitivity by significant amounts below 2kHz.

There are three main types of ear-plugs: formable, custom - moulded and pre-fabricated (Croushor Jr.).

Formable Ear—Plugs:—

Fitting is not a problem with these types since the size and shape of the canal can be molded with the material provided the quantity of the material is

adequate to fill the ear canal entrance. They are made from materials such as very fine glass fibres (Swedish wool), wax-impregnated cotton, sponge rubber, moldable silicons, and plastic tube materials that have the consistency of putty.

Usually they have only one time use. Though they are in expensive initially, it becomes expensive to continue using, them over a period of time. The user may complain of a sticky feeling on use and at times some of the material may remain in the canal after the plug is removed. Also infections from the hand may spread to the canal as the material has to be premolded in the hand before insertion.

Custom Molded Device:—

Here two or more materials which are seperately packed are mixed together before insertion, into the ear canal and outer ear. Upon curing, a permanent custom fit for the ear is obtained. This type of device lasts longer, but is rather expensive when compared to the other types of ear-plugs.

Pre-fabricated Devices:-

Silicon, rubber plugs have been used and are said to have a long life. The pre-fabricated ear-plugs can

be a 'universal fit' type, where several sizes are designed to fit a wide variety of ear canal shapes and sizes. Also they can be manufactured with two or more, on the same stem with progressively larger diameters to accomodate practically any size ear canal. Since they are manufactured in large quantities they are relatively inexpensive.

In 1944 the Harvard Psycho - Acoustic laboratory developed the V-51 R ear-plugs. Three sizes were made- small, medium and large. They were supposed to afford a comfortable fit to 98% of adult male ears* But the figure 93% was found to be too high. Blackstock and Von Gierke (1956) from the Aero Medical Laboratory, developed two more sizes - extra small and extra large which were approximately 10% smaller and larger in size respectively. These five different sized ear-plugs were found to fit about 95% of the adult male population.

Royster and Royster (1980) found that the size of the ear canal varied in races. They found black females exhibited the smallest mean ear canal diameter; white females and black males had similar mean ear canal diameter; and white males exhibited the largest mean ear canal diameter.

The purpose of the present study was to determine a procedure to standardize sizes for in-the-ear type

of protectors. Though standard sizes have already been determined at the Harvard Psycho Acoustic Laboratory (1944) and Aero Medical Laboratory (1956), whether they are applicable to the Indian population has not yet been verified.

These norms will aid the manufacturers of the ear protectors to have a certain reference point in their production.

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METHODOLOGY

Based on the studies which suggest that an air tight seal for ear-plugs, for better attenuation of sound, a procedure has been developed to find standard sizes for the 'in-the-ear' type of ear protectors.

Subjects:-

An incidental sample of seventy five male subjects was selected for the study. The age range was from 20 years to 50 years. They were divided into three groups, based on their age, to ensure a more homogenous group with regard to age. The groups were as follows: 20 - 29 years, 30 - 39 years and 40 - 50 years. Each group comprised of twenty five subjects. A incidental sample was chosen.

The following factors were also noted for each individual:

a) The height in centimeters,

b) The head circumference in centimeters, which was measured in the following way - "The tape was applied firmly over the glabella and supra orbital ridges anteriorly and that part of the occiput posteriorly which would give the maximal circumference" (Vaughan, 1966).

Instruments and Procedure:-

An impedance bridge (Madsen ZO - 73) was used to note whether or not it was possible to obtain an air-tight seal in the subject's ears, using the five probe - tips of different sizes provided along with the instrument (ie. white, blue, green, yellow and red, white being the largest and red being the smallest). The probe - tip or tips that brought about a seal in each ear of an individual was noted.

If an individual did not obtain an air-tight seal with any of the supplied probe - tips, he was examined by means of an otoscope to rule out any ear problem, such as a perforation of the ear drum, which could have precluded getting an air-tight seal.

To make certain whether the probe - tips that fitted each individual was related to the diameter of the ear canal, the following procedure was Carried out in ten of the subjects. The criterion for choosing these subjects was based on the head circumference, ie. those five having the largest head circumference, and those five having the smallest head circumference.

Moulds were made for the right and left ear canals of each individual, using a cold cure material. With the

aid of a vernier callipers, the anterior - posterior diameter, and inferior - superior diameter was found for each mould at the point of narrowest constriction (approximately 1 cm from the concha). It was measured at that point, presuming that the tip most probably lodged itself there.

Data collected was recorded by hand in a tabular form.

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RESULTS_AND_DISCUSSION

The data collected was subjected to statistical analysis. This was done in two parts.

Part I:-

The correlation between the following factors were determined:

a) the ages of the individuals and the probe tips that fit the right and left ears.
b) the heights of the individuals and the probe tips that fit the right and left ears.
c) the head circumference and the probe tips that fit the right and left ears.

All the possible combinations of the five probe tips (white, blue, green, yellow and red) were determined. Thirty two such combinations were found and were ranked. One indicated that none of the probe tips fit the ear thirty two indicated that all the probe tips fit the ear.

The seventy - five subjects were ranked based on a) the probe tip rank of the right ear, b) probe tip rank of the left ear, c) their ages, d) heights, and e) weights. If there were ties in the ranking, then average rank value was assigned to the tie items.

Using the formula $P = 1 - \frac{6 \times \Sigma D^2}{N(N^2-D)}$ (Garrett, 1979), the rank difference correlations were obtained.

Results:-

The correlations of the ages, heights and head circumference with the left and right ranked probe tips were not statistically significant at either the +01 or +05 levels (Table I). A 0.873 correlation was found between the ranked probe tip sizes of the right and left ears, which was statistically significant at the .01 level (Table I).

The probe tips brought about an air tight seal in 95% of the adult male population tested.

TABLE - I

The Correlation of the Right and Left ear probe tips with that of the age, height and Head circumference

	Age	Height	Head circumference
Right ear	-.175	-.004	.01
Left ear	-.087	.205	.280

Discussion:-

It was thought that if there was a correlation between the ages, heights or head circumferences with that of the probe tips that fitted the ears, it would form an easy method to recommend an adequately fitting ear protector to an individual. But the results show that no such prediction is possible.

Air tight seal could not be obtained in four individuals. This might be due to - 1) excessive hair growth in the external auditory ear canal and 2) the ear canal being too large for the probe tip.

Part II:

The correlation of the following factors was determined:
a) the age, height, and head circumference with the average diameter (ie. average of anterior - posterior and superior - inferior diameters) of the left and right ear moulds.

b) the ranked probe tips of the right ear with the anterior-posterior diameter, superior - inferior diameter and the average diameter of the right ear mould.

c) the ranked probe - tips of the left ear with the anterior-posterior diameter, the superior - inferior diameter and the average diameter of the left ear moulds.

The product - moment correlation was found for -

(a) with the formula $r = \frac{\Sigma xy}{N\sigma_x\sigma_y}$ (Garrett, 1979).

(b) The rank difference correlation was found for (b) and (c) using the formula $P = 1 - \frac{6 \times \Sigma D^2}{N(N^2 - 1)}$ (Garrett, 1979)

Results:-

No statistically significant correlation was found between the age, height and head circumference with the average diameter of the ear mould in either of the two ears, for the ten individuals.

Statistically, significant correlation was found between the left ear ranked probe tips with the superior - inferior diameter of the left ear mould (significant of .01 level, Table II). No statistically significant correlation was found between the ranked probe tips and the anterior - posterior diameter for either of the ears, and with the superior - inferior diameter of the right ear. But positive correlation was found at the .05 level, between the ranked probe tips and the average diameter of the ear mould, (ie. average of the superior - inferior and anterior - posterior diameters) in both the ears, (Table II).

TABLE II Correlation of the age, height and head circumference with that of the average diameter of the right and left ear mould

	age	height	head circumference
Right mould average diameter	.005	.004	-.002
Left mould average diameter	.299	-.170	-.342

TABLE III Correlation of the right and left probe tips with that of the anterior-posterior, superior-inferior and average diameter of the left and right ear moulds

		Right ear probe tips	Left ear probe tips
Right ear mould	Antr.-Postr. Diameter	.284	
	Supr.-Infr. Diameter	.527	
	Average Diameter	.648*	
Left ear mould	Antr.-Postr. Diameter		.324
	Supr.-Infr. Diameter		.803'
	Average Diameter		.69*

* - Significant at the .05 level.

' - Significant at the .01 level.

Discussion:

There was no significant correlation between the average diameter of the ear canal with that of the height, age and head circumference. This further substantiates the findings in part I.

The fact that there is a correlation between the ranked probe tips and the average diameter of the ear canals, suggests that the probe tips can be used to determine the average diameter of the ear canal in 95% of the adult male population. The selection of insert typee ear protectors depend on the diameter of one's ear canal. Thus using the five probe tips provided along with the impedance bridge ZO 73* the required insert ear protectors for 95% of the adult male population can be determined.

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SUMMARY AND CONCLUSION

The present study was undertaken to standardize a procedure to find the sizes of "in-the-ear" type of ear protectors. Seventy five adult male subjects (age range from 20 years to 50 years) were tested. The subjects were tested to see if air tight seals could be obtained with the five probe tips (white, blue, green, yellow and red) provided along with the impedance bridge ZO 73. The manometer section of the impedance bridge ZO 73 Was used to determine the air tight seal. The height, age and head circumference were obtained for each individual. For ten of the subjects, earmoulds were made using cole cure procedure. The anterior - posterior, superior - inferior and average diameters of the earmoulds were measured at the point of narrowest constriction, using a vernier calipers.

The data was analyzed statistically. In the light of the findings the following conclusions were drawn.

1. There was no significant correlation between the ages, heights, and head circumference with that of the ranked probe tips that fitted the right and left ears.

2. The probe tips brought about an air tight seal in 95% of the adult male population*

3. There was no statistically significant correlation between the ages, heights and head circumferences with average diameter of the ear moulds in the left and right ear for the ten individuals tested.

4* Statistically significant positive correlation was found between the ranked probe tips and the average diameter of the ear canals for the ten individuals tested. This implies that the probe tips can be used to predict the average diameter of the ear Canal in 95% of the adult male population. This information may aid in the selection of insert type of ear protectors.

Limitations of the studv:—

With jaw movements, the air tight seal obtained with the probe tips is likely to be lost.

Recommendations:

Further research should be conducted, where the air-tight seal of the probe tips, inspite of jaw movements should be obtained. Possibly, just one of the several probe tips that brought about a seal in each of the ears, is likely to do the same inspite of jaw movements.

A similar study should be conducted on a female population.

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