MEDICAL UNIVERSITY-VARNA

"PROF. DR. PARASKEV STOYANOV"

FACULTY OF MEDICINE

DEPARTMENT OF GENERAL AND CLINICAL PATHOLOGY, FORENSIC MEDICINE AND DEONTOLOGY

Dr. Deyana Georgieva Velkova

FORENSIC IDENTIFICATION BY THE AURICLE

ABSTRACT

for awarding the educational and scientific degree "doctor"

Field of higher education: 7. Health care and sports

Professional direction: 7.1. Medicine

PhD programme: "Forensic medicine and deontology

Supervisor:

Assoc. Prof. Dr. VILLIAM DOKOV, MD, PhD

Varna 2023

The dissertation is presented on 124 pages and contains 40 figures and 39 tables. The bibliography includes a total of 123 titles, of which 22 are in Cyrillic and 101 are in Latin.

The PhD student works as a forensic pathologist in the Clinic of Forensic Medicine at St. Marina Hospital, Varna.

The dissertation was discussed and proposed for defense by the departmental council of the Department of General and Clinical Pathology, Forensic Medicine and Deontology at Medical University "Prof. Dr. P. Stoyanov" - Varna on 27.04.2023 and is referred for public defense before a scientific jury in the following composition:

Scientific counsil:

Chair:

Assoc. Prof. Deyan Dzhenkov, MD, PhD

Members:

Prof. Anton Tonchev, MD, DSc

Assos. Prof. Svetlozar Spasov, MD, PhD

Assos. Prof. Alexander Alexandrov, MD, PhD

Assos. Prof. Pavel Timonov, MD, PhD

CONTENTS

LIST OF COMMONLY USED ABBREVIATIONS

AU – auricle

D – dimention (s)

R - right

L – left

M – male (men)

F – woman (women)

AG – age group

n – number of studied participants

MEAN – average value

SD± - standard deviation

MIN – minimum value

MAX – maximum value

I. INTRODUCTION

Identification of the person is one of the most complex forensic examinations, as the object of research in these cases can be corpses and corpse parts, as well as living persons. Identification can be accomplished by multiple methods depending on the object of study. In this type of examination, the forensic doctor must establish the main features of the biological profile (gender, age, height, population affiliation) and, if possible, some of the non-permanent features, such as the presence of congenital or acquired anatomical-biological features, the presence of diseases or traumas and other.

Multiple parts of the human body can be used in the forensic identification process, as long as they exhibit sufficient individuality and resilience. The most reliable method for establishing identity is DNA analysis, but with the availability of comparative material. In the absence of such, the main task of the forensic doctor is to narrow down the circle of suspected persons as much as possible.

In some forensic cases, where there is dismemberment of the body due to various reasons (explosion, plane crash, traffic accident, murder, mass disaster, etc.), only individual corpse parts can be the subject of research, which is a significant difficulty in terms of the identification of the person. This is what necessitates the continuous search for new research methods, which alone or in combination with other methods, can help identify these cases.

In recent years, numerous studies have been published in various fields of science focusing on the identification capabilities of the auricle. All of them establish that this part of the human body has a marked individuality and uniqueness, which gives grounds for it to be the subject of research not only in forensic medicine, but also in some other fields of science, such as forensics, computer technology and others. The detailed study of the anatomical and anthropological characteristics of the auricle would help reveal its identification potential for the needs of forensic medicine practice.

The current dissertation is focused on the auricle and the possibility that it can be used as a research object in the process of forensic identification of the person.

II. GOALS, TASKS AND SCIENTIFIC HYPOTHESES OF THE DISSERTATION

In connection with the dissertation, a scientific study was conducted with the main objective of establishing the main dimensions of the pinna in male and female individuals from the Bulgarian population, with the aim of using them in cases of forensic identification of the person.

During the implementation of the set tasks, the following scientific hypotheses were formed:

1. Among all individuals studied, no coincidence of all nine sizes of one study participant with those of another is found. No complete symmetry between the left and right AU was found in any of the individuals.

2. The sizes of the AU show sexual dimorphism, with those in males being larger than those in females.

3. With advancing age, the values of the dimensions of the AU increase in both sexes.

4. The sizes of the AU correspond to the human height, as the taller the person, the larger the size values.

5. The sizes of AU in the Bulgarian population differ from those in other populations.

To achieve the goal, some specific tasks of the scientific research have been formulated:

TASK 1: Establishing a total of 9 anthropometric measurements of the AU bilaterally in individuals from the Bulgarian population with a subsequent comparison of the results between the left and right AU, as well as a comparison of the data with other studies in individuals from the Bulgarian population. Creating a protocol for anthropometric examination of the auricle.

During the study, the following anthropometric dimensions were measured (Fig. 1, Fig. 2):

- Dimension 1: Physiognomic length of the ear (total length of the AU) - perpendicular distance between the highest point of the spiral (helix) and the lowest point of the lobule (lobulus auriculae). (fig.1)
- Dimension 2: Physiognomic width of the ear (total width of the AU) - perpendicular distance between the straight line marking the attachment of the auricle to the skin of the face and the tangents to the outermost point of the helix. (fig. 1)
- Dimension 3: Length of ear above tragus - perpendicular distance between the highest point of the helix and the highest point of the tragus. (fig. 1)
- Dimension 4: Tragus length - the distance between the highest and lowest point of the tragus. (fig. 1)
- Dimension 5: Length of the ear below the tragus - distance between the lowest point of the tragus and the lowest point of the lobule. (fig. 1)
- Dimension 6: Conch length - distance between the highest and lowest point of the conch (choncha). (fig. 2)
- Dimension 7: Width of the shell - distance between the most anterior and the most posterior point of the concha. (fig. 2)
- Dimension 8: Length of lobule - distance immediately below the incisura intertragica to the lowest point of the lobule. (fig. 2)
- Dimension 9: Width of lobule - distance between the point of attachment of the lobule to the skin of the face, to the outermost point of the lobule along a perpendicular line to the main axis of the auricle. (fig. 2)

For easier organization and analysis of research data, the dimensions described above will be denoted by the corresponding numbers D1 through D9. The letters R and L will be used for the right and left ears, respectively. For the male, the designation M will be used, and for the female - F. Thus, the designation R6 M will correspond to "Length of the concha of the right UM in the males".
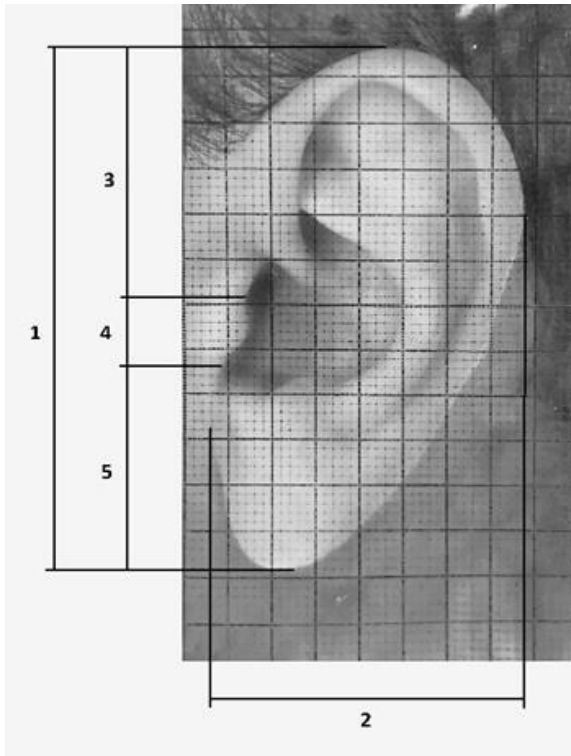
Figure 1 Designation of the anthropometric dimensions of the auricle (left): 1-length of the auricle; 2 - width of the auricle;
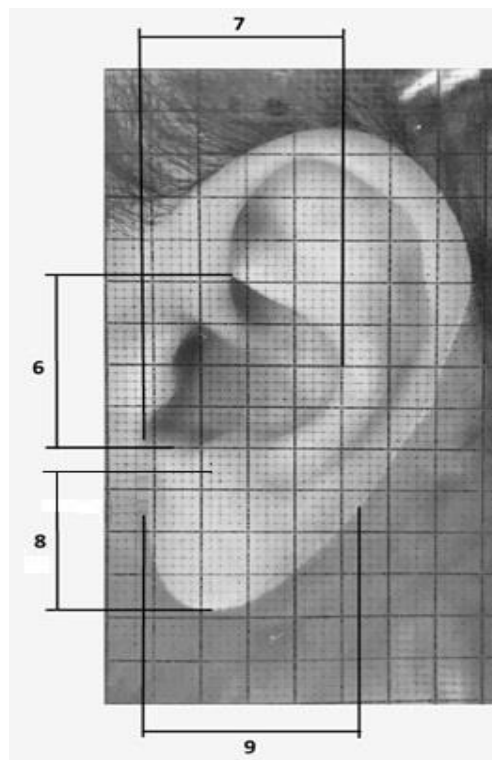*3 - length above tragus; 4 – length of tragus; 5 – length below tragus.*

Figure 2 Designation of the anthropometric dimensions of the auricle (left): 6 – length of the concha; 7 – width of the conch;
8 – lobule length; 9 – lobule width.

TASK 2: Establishing a relationship between the dimensions of the AU and sex - to carry out this task, the established dimensions in men for the right and left ears were compared with those in women.

TASK 3: Establishing a relationship between the dimensions of the AU and age - to carry out this task, the determined dimensions in men and respectively in women were divided into a total of four age groups. A comparison was then made between age groups separately for men and women, for the right and left ear, respectively.

TASK 4: Establishing a relationship between the dimensions of the AU and stature - to carry out this task, the determined sizes in men and women were divided into three groups according to stature, after which a comparison was made between the respective groups separately for men and women, respectively for right and left ear.

TASK 5: Comparison of the established dimensions of the AU in the individuals from the Bulgarian population in the present study with those in other populations - to carry out this task, the established results of the present study were compared with data from studies conducted in other populations.

III. MATERIALS AND METHODS

In connection with the dissertation work, a scientific study was conducted, previously approved by the Committee on Ethics of Scientific Research at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna. A total of 222 individuals from the Bulgarian population (123 men and 99 women) aged between 18 and 94 years old participated in the study. The participants were volunteers, outpatients of the practice "Dr. Georgi Hrisulev", where the research itself was carried out.

The selection of the participants was carried out by the main researcher (Dr. Deyana Velkova), and the main criteria were the following:

- Participants must be from the Bulgarian population

- Participants must be over 18 years of age

- Each participant must express voluntary, written consent to participate in the study, as well as express written consent to the use of some of his personal data.

- Participants must not have congenital or acquired anomalies, severe traumatic changes or other features of the auricles that would significantly alter the anatomical appearance of this area.

Before identifying an individual as a research participant, each volunteer was informed in detail about the nature, methodology and objectives of the study, as well as what personal data about them would be required, namely gender, age, height and anthropometric data of the left and right pinnae . Each participant provided written informed consent as well as a notice for the use of his personal data by filling in and signing the relevant documents according to a model approved by the Research Ethics Committee at the Medical University "Prof. Dr. Paraskev Stoyanov" - city of Varna.

The study of each participant was carried out in two stages - in the first stage, the main characteristics of the biological profile of the individual - sex, age and height - were established. Gender and age were self-reported by the participant, and height was measured on site using a wall-mounted meter installed in the outpatient clinic where the

study was conducted. The examination of the participants also included an examination of the ear area bilaterally in order to establish the normal anatomy of the pinna, the presence of congenital and/or acquired anomalies, traumatic injuries and others that constitute a prerequisite for the exclusion of the participant from the study. The established data from the first stage of the study were entered in pre-prepared forms "CLINICAL CARD OF PARTICIPANT IN SCIENTIFIC STUDY "ANTHROPOMETRICAL STUDY OF THE EAR FOUNDLE".

The second stage of the study included the anthropometric study of the auricle, which was carried out using a special photographic method (photometry). For this purpose, a special tripod was used, which has a frame with a transparent millimeter plate at one end, and a stand for a digital camera with the following parameters at the other end: 12MP, f/2.2, 29mm., 1/3", 1.22μm, PDAF. The distance between the camera lens and the millimeter plate was fixed - 20 cm., so that only the object of capture falls within the frame of the photograph (Fig. 3, Fig. 4). Participants were instructed to assume a sitting position with their head erect and to remove jewelry and other accessories from their earlobes. The recording itself was carried out in the following way: the researcher touched the frame of the tripod to the earlobe of the participant, without pressing and deforming it, and filmed both ears in turn. After the shooting, the two photos, respectively of the left and right earlobe, were printed and attached to the other documents of the respective participant. From the photographs thus prepared, thanks to the millimeter plate, the anthropometric dimensions of the pinna were measured, indicated in fig. 19 and fig. 20. All dimensions are measured and reported in millimeters

(mm), except for height, which is reported in centimeters (cm).
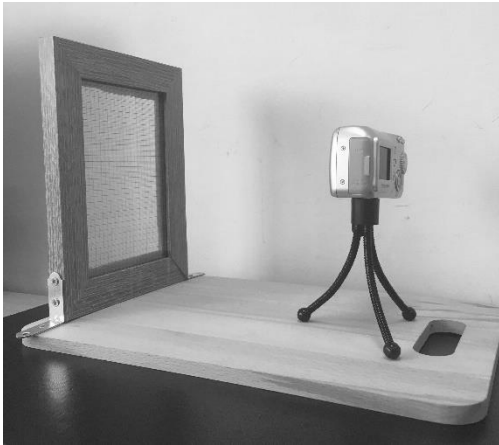
Figure 1 A tripod for photographing the auricles
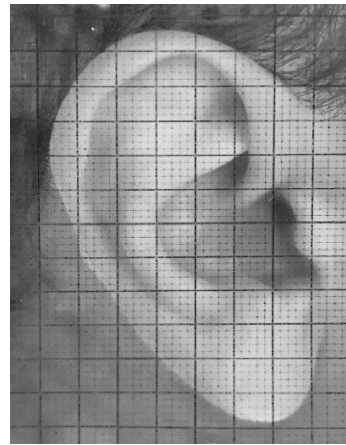
Figure 2 Photo of right auricle taken with a tripod with a millimeter clear plate.

The information collected during the study of each participant was entered into an electronic table containing the following columns: serial number of the participant; gender; age; height; the anthropometric dimensions of the right auricle, marked R1 to R9 respectively; the anthropometric dimensions of the left auricle, marked L1 to L9 respectively;

The data from the conducted scientific research were statistically processed using the MaxStat® program. The methods of analysis used, according to the specific tasks, are descriptive statistics (mean value, standard deviation, maximum and minimum values), t-test and One-way ANOVA test.

III. RESULTS AND DISCUSSION

A total of 222 participants were studied, divided into two main groups according to sex and four subgroups according to age. Four age groups were formed: 18 to 30 years, 31 to 50 years, 51 to 70 years, and over 70 years, with the last group in the range of 71 to 94 years for females and 71 to 88 years for males. The distribution of participants by groups and subgroups is presented in Fig. 5 and Fig. 6

Figure 5 Distribution of survey participants by sex.
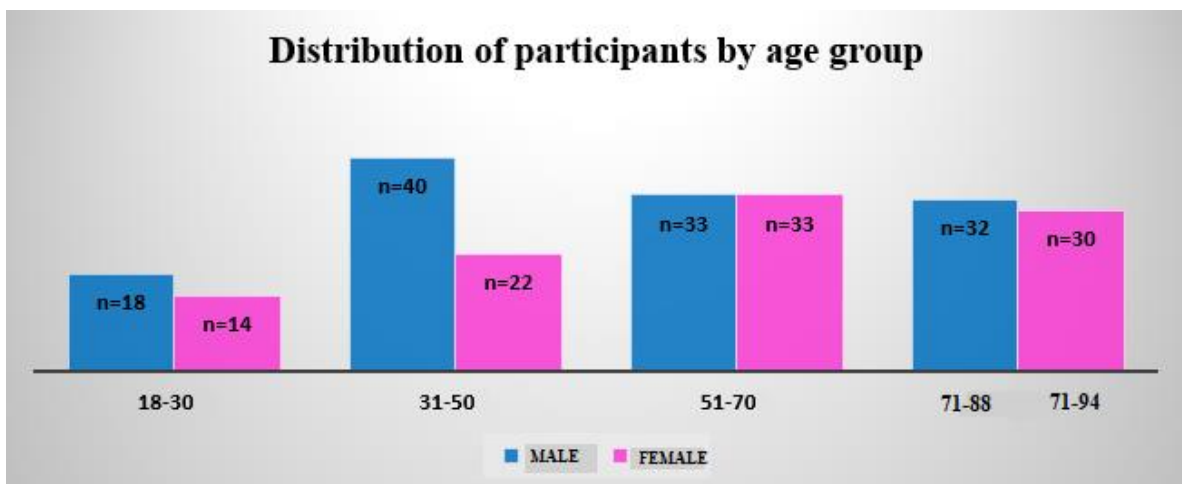
Figure 6 Distribution of survey participants by age group.

TASK 1:

Determination of a total of 9 anthropometric measurements of the AU bilaterally in individuals from the Bulgarian population with a subsequent comparison of the results between the left and right AU, as well as a comparison of the data with other studies in individuals from the Bulgarian population.

Creating a protocol for anthropometric examination of the auricle.
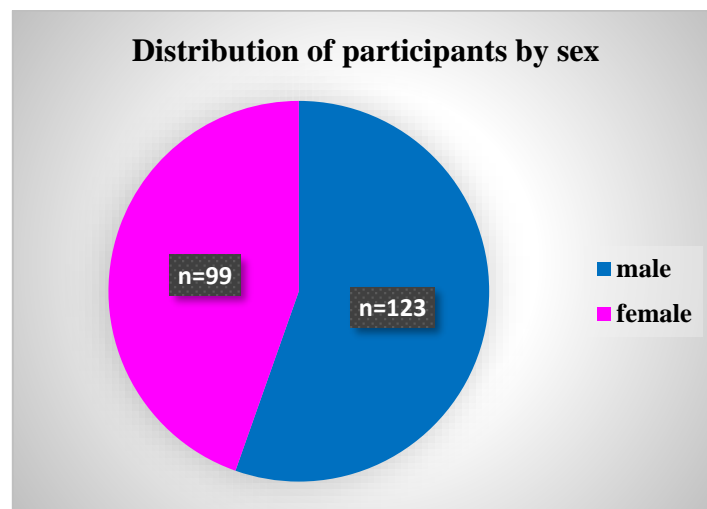
Nine anthropological measurements were taken of each auricle of all 222 study participants. Mean value, standard deviation, minimum and maximum values were calculated for each individual size, for left and right pinna respectively. The results are presented in Tables 1 and 2.

Table 1 Descriptive statistics for Dimetion 1 to 9 of the right auricle (R) in all study participants (n=222).

	R1	R2	R3	R4	R5	R6	R7	R8	R9
Mean	60,92	35,65	29,15	11,35	20,38	23,76	18,73	13,09	21,61
SD±	7,88	5,55	5,04	3,02	4,30	3,30	3,44	3,26	4,62
MIN	39	21	16	6	9	15	10	5	11
MAX	81	50	40	21	38	35	30	26	34

Table 2 Descriptive statistics for Dimesion 1 to 9 of the left auricle (L) in all study participants (n=222).

	L1	L2	L3	L4	L5	L6	L7	L8	L9
Mean	60,56	35,55	28,23	11,53	20,74	23,55	18,68	13,49	21,64
SD±	7,60	5,56	4,80	3,00	4,29	3,37	3,53	3,17	4,31
MIN	38	22	18	6	10	16	11	6	12
MAX	79	52	42	21	33	35	31	24	35

The values of each of the nine dimensions of the left and right pinna in each participant were compared to check for symmetry. Right dimensions were compared to corresponding left

dimensions, and the number of matches between the values was counted, as well as the number of participants in whom no matches were found. The results are presented in Tables 3 and 4.

Table 3 Results when comparing the right dimensions (R1-R9) with the left dimensions (L1-L9).

	R1=L1	R2=L2	R3=L3	R4=L4	R5=L5	R6=L6	R7=L7	R8=L8	R9=L9
number of participants	20	22	24	47	29	26	29	38	27

Table 4 Number of matches between the right and left dimensions in the study participants.

	R = L in one dimension	R = L in two dimensions	R = L in three dimensions	R = L in four dimensions	R = L in more than four dimensions	no match (R ≠ L)
number of participants	77	69	9	5	0	62

In the study of 222 individuals from the Bulgarian population, no repetition of any combination of the nine dimensions of the auricle in one participant with those in another was found. No such match between the nine sizes was found in both auricles of the same individual. These results show that the dimensions of the auricle have a pronounced individuality and uniqueness, which is essential for the identification of the person.

When comparing the right and left sizes, it was found that the average values for the nine sizes differed. D1, D2, D3, D6 and D7 of the right ear are larger than those of the left ear, while for the remaining sizes (D4, D5, D8, D9) the left ones are larger than the right ones.

When comparing each of the dimensions of the right versus left auricle for each individual participant, it was found that sixty-two people did not have the same values for any of the dimensions (R (1-9) ≠ L (1-9)) .

When comparing each of the sizes, it was found that a match between the right and left values was observed between 20 and 47 of the participants, with one size matching in 77 participants, two sizes the number decreased to 69, and five sizes no longer find matches. The

greatest symmetry (R = L) is found in D4, where the coincidence between the values is observed in 49 individuals, and the smallest in D1, which is found in 20 participants.

These results indicate that complete symmetry in all dimensions between the two pinnae in one individual was not found in any of the study participants. The greatest complete match between the values of right and left pinna sizes in the same individual occurred in only 5 of the participants, where there was a match in only four of the nine sizes.

A comparison was made between the results of the present study and those found in two other studies also conducted on individuals from the Bulgarian population.

These studies were conducted in the age group of 30 to 40 years, which is why the results of the participants falling in this age range were compared in the present study. The data are presented in Table 5.

Table 5 Comparison of the results of the present study with those of two other studies conducted on individuals from the Bulgarian population.

study	population	age	n=	sex	R/L	D1				D2			
						MEAN	SD±	MIN	MAX	MEAN	SD±	MIN	MAX
Yordanov Y. Et all	Bulgarian	30-40	2427	M	L	64,4	4,2	50	79	37,4	3,4	25	49
			2847	F	L	59,7	3,8	46	73	34,6	3,2	25	47
Nachva A. et. All	Bulgarian	30-40	236	M	R	64,3	4,2	55	74	35,9	3,8	27	46
			276	F	R	59,5	3,7	46	69	33,6	4	25	44
Present study	Bulgarian	30-40	34	M	R	58,94	6,76	43	75	34,09	5,30	25	44
					L	59,06	7,10	41	75	34,50	5,53	25	45
			11	F	R	48,91	8,03	39	61	28,73	6,04	21	39
					L	51,09	7,37	40	60	30,46	5,70	23	41

Both studied studies of the Bulgarian population covered only two measurements of AU, namely physiognomic length (D1) and physiognomic width of the ear (D2).

When considering the data from the study by Yordanov J et al. it was established that the object of the study was only one AU, namely the left one. Compared with the results of the present study, it can be seen that for D1 and D2, in both sexes, a significant difference in the average values is observed, such as those in the study by Yordanov J. et al. are bigger. The smallest difference in the average values is found in men according to D2 (2.9mm), and the largest - in women according to D1 (8.61mm).

The study by Nacheva A. et al. it was also performed only on one AU - the right one. Similar to the other study, here again significantly greater values of both sizes were observed in men and women compared to the results of the present study. The smallest difference in the average values is found in men according to D2 (1.81mm), and the largest - in women according to D1 (10.49mm).

The results of the present study show smaller mean values in men and women for both sizes compared to those in the studies of Yordanov J. et al. and Nacheva A. et al. It should also be noted that the number of participants in the latter is significantly larger than in the present study, which probably also affects the statistical calculations. In addition, the research methodology also differs - in the studies of Yordanov J. et al. and Nacheva A. et al. the dimensions of the AU were established by direct measurement with a caliper, while in the present study a photometric measurement method was applied. According to some sources, no significant difference is found between the two methods, but in this case it is possible that this is the case, since in the two cited studies the verification between the two methods of measurement was applied to the same individuals. (76,80)

Under Task 1, a protocol for the anthropometry of the auricles was also prepared, which facilitates work in the study of this area of the human body. In the protocol, it is possible to note the main characteristics of the biological profile (if they are known), the presence of features of the AU such as anomalies, traumas or operative interventions, as well as to enter in tabular form relevant measurements of the nine dimensions of the left and right AU.

Conclusions for Task 1:

- Among all the studied individuals, no coincidence of all nine dimensions of one research participant with those of another was found, which is an indicator of the individuality of the AU and its potential as an object of research in the process of personality identification.

- No complete symmetry was found between the nine dimensions of the left and right AU in any of the 222 individuals. This result indicates that AU differ not only between individuals, but between the two AU of the same individual.

- When comparing the results of the present study with those of two other studies in the Bulgarian population, a significant difference was found - the values of D1 and D2 in the present

study are smaller in both sexes, with the smallest difference in D2 in men, and it is the largest according to D1 in women.

TASK 2:

Establishing a relationship between the dimensions of the AU and sex.

To carry out Task 2, the results were divided into two main groups according to gender, and the values of the nine studied sizes of the right and left AU were compared. The same comparison was made, when dividing the participants by the above-mentioned age groups.

In the statistical analysis, mean value, standard deviation, minimum and maximum values were calculated and t-test was applied to establish a statistically significant difference between the two sexes ($p < 0.05$).

The data are presented in Tables 6 and 7.

Table 6 Comparison of the values of all dimensions (1-9) of the right AU (R) in both sexes. p<0.05 - statistically significant difference.

D	Sex	Mean	SD±	min	Max	t-test (p =)
R1	M	62,50	7,74	43	81	
	F	58,95	7,63	39	77	**0.0007**
R2	M	36,60	5,59	22	50	
	F	34,48	5,29	21	47	**0.0043**
R3	M	29,81	5,01	17	40	
	F	28,34	4,98	16	38	**0.0315**
R4	M	11,84	3,10	6	21	
	F	10,74	2,82	6	18	**0.0067**
R5	M	20,85	4,62	9	38	
	F	19,81	3,81	11	28	0.0741
R6	M	23,97	3,38	15	35	
	F	23,51	3,20	15	32	0.3004

D	Sex	Mean	SD±	Min	max	t-test (p=)
R7	M	18,84	3,71	10	30	
	F	18,60	3,08	12	26	0.6041
R8	M	13,24	3,27	5	22	
	F	12,90	3,26	5	26	0.4347
R9	M	22,17	4,67	12	34	
	F	20,92	4,50	11	32	**0.0447**

Table 6 Comparison of the values of all dimensions (1-9) of the left AU (L) in both sexes. p<0.05 - statistically significant difference.

D	Sex	Mean	SD±	Min	max	t-test (p=)
L1	M	62,17	7,66	40	79	
	F	58,56	7,07	38	75	**0.0004**
L2	M	36,49	5,62	24	52	
	F	34,39	5,29	22	47	**0.0050**
L3	M	28,90	5,01	18	42	
	F	27,40	4,41	18	40	**0.0205**
L4	M	11,96	3,05	6	21	
	F	10,99	2,87	6	19	**0.0164**
L5	M	21,22	4,30	11	33	
	F	20,15	4,23	10	33	0.0653
L6	M	23,94	3,68	16	35	
	F	23,07	2,89	16	30	0.0575
L7	M	18,84	3,70	12	31	
	F	18,49	3,30	11	25	0.4603
L8	M	13,68	3,17	6	23	
	F	13,26	3,16	6	24	0.3359

L9	M	22,25	4,49	13	35	
	F	20,89	3,98	12	29	**0.0189**

The results of the study show that for all nine dimensions, on both AU, the values in men are greater than those in women.

A statistically significant difference (p<0.05) was found for D1, D2, D3, D4 and D9 bilaterally. The clearest difference between the two sexes is observed in relation to D1, and the smallest – in D7.

From the obtained results, it can be summarized that the total dimensions in right and left AU, respectively D1 and D2, show a significant difference between men and women.

Similar were the results regarding the tragus and the length of the ear above it (D3 and D4) for left and right AU, where a significant difference was also found between the two sexes, but no such was observed for the length of the ear below the tragus (D5).

Identical results were also found regarding the dimensions of the lobule – its length did not show a statistically significant difference between men and women (D8), while regarding the width, such was found (D9).

The research data also show that the sizes of the concha bilaterally (D6 and D7) differ little between the two sexes.

In the next stage of the study, the results in women or men were divided into four age groups as follows:

Group 1 – 18-30 years;

Group 2 – 31-50 years;

Group 3 – 51-70 years;

Group 4 – over 70 years. Females in Group 4 ranged in age from 71 to 94 years, and males in this group ranged in age from 71 to 88 years.

After the distribution by age groups, mean value, standard deviation, minimum and maximum values were calculated. A t-test was then applied to establish a statistically significant difference between the values found in both sexes.

1. **Results for the 18-30 age group. (Group 1).**

18 men and 14 women fall into this age range, the average age being 25.28 years, respectively. and 24.64 years.

Left and right ear data are presented in Tables 8 and 9.

Table 8 Results in AG 1 (18-30 years) according to dimensions 1-9 of the right AU (R) in both sexes. Significant difference at p<0.05.

D	Sex (n=)	Mean	SD±	Min	Max	t-test (p=)
R1	M (n=18)	58.67	6.83	43	71	**0.0052**
	F (n=14)	51.93	5.47	39	60	
R2	M (n=18)	34.17	6.06	22	45	0.0679
	F (n=14)	30.64	3.86	21	40	
R3	M (n=18)	28.28	4.81	17	37	0.3650
	F (n=14)	26.71	4.71	16	31	
R4	M (n=18)	10.33	3.22	7	21	**0.0274**
	F (n=14)	8.07	1.94	6	13	
R5	M (n=18)	19.67	2.95	14	24	**0.0162**
	F (n=14)	17.14	2.54	13	22	
R6	M (n=18)	23.17	3.29	18	30	0.4017
	F (n=14)	22.29	2.30	16	24	
R7	M (n=18)	17.78	3.78	12	24	0.3116
	F (n=14)	16.57	2.50	13	23	
R8	M (n=18)	12.11	2.11	8	15	**0.0182**
	F (n=14)	10.21	2.16	7	14	
R9	M (n=18)	19.28	4.35	12	30	**0.0433**
	F (n=14)	16.36	3.18	11	21	

Table 9 Results in AG 1 (18-30 years) according to dimensions 1-9 of the left AU (L) in both sexes. Significant difference at p<0.05.

D	Sex (n=)	Mean	SD±	min	max	t-test (p=)
L1	M (n=18)	56.67	7.10	40	66	**0.0369**
	F (n=14)	51.79	4.98	38	58	
L2	M (n=18)	32.83	5.34	24	40	0.1364
	F (n=14)	30.14	4.35	22	39	
L3	M (n=18)	27.44	5.16	18	36	0.8919
	F (n=14)	27.21	4.06	18	36	
L4	M (n=18)	9.78	2.80	6	16	**0.0351**
	F (n=14)	7.86	1.88	6	14	
L5	M (n=18)	18.89	3.58	12	25	**0.0467**
	F (n=14)	16.64	2.13	14	20	
L6	M (n=18)	22.17	3.65	16	31	0.4878
	F (n=14)	21.36	2.59	16	24	
L7	M (n=18)	16.94	2.80	12	21	0.3113
	F (n=14)	15.93	2.73	12	21	
L8	M (n=18)	12.22	2.73	7	17	0.0543
	F (n=14)	10.50	1.91	8	13	
L9	M (n=18)	19.28	3.38	13	25	**0.0159**
	F (n=14)	16.36	2.98	12	22	

The results show that both in the overall study of men and women and in this age group, all mean values of all nine dimensions bilaterally are greater in men. A statistically significant difference (p<0.05) was found in 5 of 9 sizes for the right BM and 4 of 9 sizes for the left BM. The most significant difference is found in the total length of the UM, the length of the tragus and that above it, as well as the width of the lobule, respectively P1, P3, P4 and P9 bilaterally. The length of the lobule of the right UM (D8) is also significantly different between the two sexes, while for the left UM (L8) the t-test values are borderline (p=0.0543). Similar to the

results of the general examination in both sexes, no significant difference was found in this age group regarding the dimensions of the concha bilaterally (D6, D7, L6, L7).

2. **Results for the 31-50 age group. (Group 2).**

40 men and 22 women fall into this age range, with the average age being 38.15 years, respectively. and 41.05 years. Left and right ear data are presented in Tables 10 and 11.

Table 10 Results in AG 2 (31-50 years) according to dimensions 1-9 of the right AU (R) in both sexes. Significant difference at p<0.05.

D	Sex (n=)	Mean	SD±	min	max	t-test (p=)
R1	M (n=40)	59.40	7.44	43	75	**0.0208**
	F (n=22)	54.73	7.37	40	64	
R2	M (n=40)	34.75	5.22	25	44	**0.0458**
	F (n=22)	31.86	5.54	22	40	
R3	M (n=40)	29.13	4.88	18	37	**0.0221**
	F (n=22)	26.18	4.39	18	32	
R4	M (n=40)	10.45	2.90	6	18	0.5270
	F (n=22)	10.00	2.16	7	13	
R5	M (n=40)	19.83	4.84	9	34	0.2840
	F (n=22)	18.55	3.65	11	26	
R6	M (n=40)	23.15	3.40	15	31	0.4035
	F (n=22)	22.41	3.16	17	30	
R7	M (n=40)	17.73	3.43	10	24	0.7696
	F (n=22)	17.46	3.52	12	26	
R8	M (n=40)	13.00	3.63	5	21	0.5595
	F (n=22)	12.41	4.08	5	26	
R9	M (n=40)	19.75	3.84	14	28	0.2941
	F (n=22)	18.64	4.18	12	26	

Table 11 Results in AG 2 (31-50 years) according to dimensions 1-9 of the left AU (L) in both sexes. Significant difference at p<0.05.

D	Sex (n=)	mean	SD±	min	max	t-test (p=)
L1	M (n=40)	59.85	7.27	41	76	**0.0260**
	F (n=22)	55.41	7.44	40	66	
L2	M (n=40)	35.28	5.49	25	45	**0.0132**
	F (n=22)	31.64	5.14	23	41	
L3	M (n=40)	28.03	4.72	20	40	0.1005
	F (n=22)	25.96	4.59	18	37	
L4	M (n=40)	11.48	3.32	6	18	0.1562
	F (n=22)	10.32	2.42	7	15	
L5	M (n=40)	20.40	3.75	11	28	0.1895
	F (n=22)	19.14	3.26	11	24	
L6	M (n=40)	23.38	2.72	17	28	0.2329
	F (n=22)	22.46	3.16	16	28	
L7	M (n=40)	18.35	3.17	12	26	0.0566
	F (n=22)	16.73	3.10	12	22	
L8	M (n=40)	12.70	3.13	6	20	0.7589
	F (n=22)	12.46	2.74	6	17	
L9	M (n=40)	19.90	3.51	14	29	0.5088
	F (n=22)	19.32	2.85	14	27	

In Group 2, again, all sizes bilaterally were larger in men than in women. In this age group, 3 out of 9 sizes of the right UM were found, where a statistically significant difference was observed (p<0.05), and for the left UM the sizes were 2 out of 9. The total sizes of the UM bilaterally, respectively P1 and P2, show a significant difference between the two sexes. The same was observed for the length above the tragus in the right UM (D3), while in the left (L3) no statistically significant difference between values was observed in men and women. And in this age group, the dimensions for the concha bilaterally (P6 and P7) slightly differ between

men and women, with the exception of its width at the left UM (L7), where the t-test is borderline (p=0.0566).

3. **Results for the 51-70 age group. (Group 3).**

This age range includes 33 men with an average age of 60.64 years. and 33 women with an average age of 63.64 years. Left and right ear data are presented in Tables 12 and 13.

Table 12 Results in age group 3 (51-70 years) according to dimensions 1-9 of the right AU (R) in both sexes. Significant difference at p<0.05.

D	Sex (n=)	mean	SD±	min	Max	t-test (p=)
R1	M (n=33)	65.12	5.80	51	76	**0.0190**
	F (n=33)	61.61	6.06	44	71	
R2	M (n=33)	38.18	4.80	30	47	**0.0228**
	F (n=33)	35.42	4.80	23	47	
R3	M (n=33)	30.58	5.37	20	40	0.2342
	F (n=33)	29.18	3.96	20	36	
R4	M (n=33)	12.97	2.69	9	19	**0.0165**
	F (n=33)	11.27	2.91	6	18	
R5	M (n=33)	21.58	3.52	15	29	0.4990
	F (n=33)	20.97	3.72	13	27	
R6	M (n=33)	24.36	3.24	19	33	0.9702
	F (n=33)	24.33	3.33	15	32	
R7	M (n=33)	19.91	3.52	11	27	0.7029
	F (n=33)	19.61	2.87	13	24	
R8	M (n=33)	13.79	2.83	10	22	0.8995
	F (n=33)	13.70	3.00	9	21	
R9	M (n=33)	24.33	4.03	17	34	**0.0280**
	F (n=33)	22.24	3.51	17	32	

Table 13 Results in AG 3 (51-70 years) according to dimensions 1-9 of the left AU (L) in both sexes. Significant difference at p<0.05

D	Sex (n=)	mean	SD±	min	max	t-test
L1	M (n=33)	63.73	6.47	47	75	**0.0354**
	F (n=33)	60.46	5.89	45	72	
L2	M (n=33)	37.33	5.28	27	52	0.1958
	F (n=33)	35.70	4.88	24	47	
L3	M (n=33)	28.64	4.30	21	38	0.2919
	F (n=33)	27.58	3.79	18	34	
L4	M (n=33)	12.88	2.79	8	21	**0.0129**
	F (n=33)	11.27	2.28	8	16	
L5	M (n=33)	22.21	4.55	12	33	0.5633
	F (n=33)	21.61	3.91	14	30	
L6	M (n=33)	24.39	4.51	16	35	0.4715
	F (n=33)	23.72	2.76	17	30	
L7	M (n=33)	**19.15**	3.84	12	28	0.6211
	F (n=33)	**19.58**	3.05	12	25	
L8	M (n=33)	14.70	3.23	9	23	0.5408
	F (n=33)	14.24	2.76	10	20	
L9	M (n=33)	24.06	4.21	16	31	**0.0227**
	F (n=33)	21.76	3.80	15	29	

When analyzing the results obtained in Group 3, it was found that for the nine dimensions bilaterally, the mean values in men were greater than those in women, except for the width of the concha of the left AU (L7), where women had 0.43 mm -large average compared to men. In this age group, a statistically significant difference was found in 4 of 9 sizes for the right AU and 3 of 9 for the left AU. Analogously to the previous groups, the length of the AU bilaterally (R1 and L1) is significantly different between the two sexes. Such a significant difference was also observed in relation to the length under the tragus and the width of the lobule bilaterally, respectively sizes R4, L4, R9 and L9, as well as in the width of the

right AU (R2). Regarding the dimensions of the concha bilaterally, no significant difference was observed between the values in men and women.

4. **Results in the over 70 age group. (Group 4).**

This age range includes 32 men with an average age of 77.31. and 30 women with an average age of 81.07 years. Left and right AU data are presented in Tables 14 and 15

Table 14 Results in AG 4 (over 70 years) according to dimensions 1-9 of the right AU (R) in both sexes. Significant difference at p<0.05.

D	Sex (n=)	Mean	SD±	min	max	t-test (p=)
R1	M (n=32)	65.84	8.14	46	81	0.0759
	F (n=30)	62.40	6.76	51	77	
R2	M (n=32)	38.66	5.48	26	50	0.2346
	F (n=30)	37.13	4.42	27	46	
R3	M (n=32)	30.72	4.80	22	39	0.4880
	F (n=30)	29.77	5.92	18	38	
R4	M (n=32)	13.25	2.62	9	18	0.0526
	F (n=30)	11.93	2.63	8	18	
R5	M (n=32)	22.03	5.74	11	38	0.2888
	F (n=30)	20.70	3.79	11	28	
R6	M (n=32)	25.03	3.32	20	35	0.2024
	F (n=30)	23.97	3.18	16	28	
R7	M (n=32)	19.72	3.79	13	30	0.5875
	F (n=30)	19.27	2.59	13	24	
R8	M (n=32)	**13.63**	3.66	6	21	0.9919
	F (n=30)	**13.63**	2.65	9	18	
R9	M (n=32)	24.59	4.06	17	30	0.1994
	F (n=30)	23.27	3.98	16	30	

Table 15 Results in AG 4 (over 70 years) according to dimensions 1-9 of the left AU (L) in both sexes. Significant difference at p<0.05

D	Sex (n=)	Mean	SD±	min	max	t-test (p=)
L1	M (n=32)	66.56	6.82	52	79	**0.0058**
	F (n=30)	61.93	5.84	50	75	
L2	M (n=32)	39.19	4.90	28	48	0.0603
	F (n=30)	36.97	4.18	25	43	
L3	M (n=32)	31.09	5.46	20	42	**0.0445**
	F (n=30)	28.37	4.97	20	40	
L4	M (n=32)	12.84	2.36	9	18	0.7529
	F (n=30)	12.63	2.87	7	19	
L5	M (n=32)	22.53	4.45	15	33	0.1848
	F (n=30)	20.93	4.93	10	33	
L6	M (n=32)	25.16	3.45	16	32	0.0518
	F (n=30)	23.60	2.65	19	28	
L7	M (n=32)	20.19	4.18	12	31	0.6443
	F (n=30)	19.77	2.78	11	25	
L8	M (n=32)	14.66	2.78	9	21	0.4657
	F (n=30)	14.07	3.52	8	24	
L9	M (n=32)	25.00	3.98	14	35	0.0519
	F (n=30)	23.20	3.08	17	29	

Similar to the results for the previous age groups, also in Group 4 the mean values for men are greater than those for women. A statistically significant difference was observed only in two dimensions – total length and length above the tragus of the left AU (dimensions L1 and L3). In the right AU, a significant difference was not found in any of the dimensions, but in R4 the t-test values were slightly above 0.05 (p=0.0526).

In the analysis of all data for Task 2, it was found that all nine AU sizes were bilaterally larger in male subjects compared to females. Only one size is an exception, namely the width of the concha of the left AU in the age group 51-70 years (L7), where the average value for women is

greater than that for men, respectively by 0.43mm. In the last age group, according to the size R8, it is found that the values for both sexes are the same.

The study found that Dimension 1 was significantly larger in men than in women, which was observed both when comparing the overall groups of men and women and when broken down by age group. The exception is R1 in the age group over 70 years, where the t-test value is greater than 0.05 (p=0.0759).

Regarding Size 2, a statistically significant difference is found in the general groups of men and women, as well as the age groups 31-50 years. (bilateral) and 51-70 years. only with right AU.

The mean values for Size 3 in both are significantly different when comparing the general groups of men and women, as well as in the age group 31-50 years, only for the right AU and in the age group over 70 years, only for the left AU.

The results for Dimension 4 were found with a statistically significant difference between the sexes when comparing the general groups of men and women, as well as in the age groups 18-30 years. bilateral and 51-70 also bilateral.

Regarding Dimension 5, a significant difference between men and women was found only in the age group 18-30 years, for right and left AU.

When comparing the mean values of Dimensions 6 and 7 in both sexes, no significant difference was found, both between the overall groups of men and women, and among the four age groups.

The results are similar in relation to Size 8, where a statistically significant difference between the two sexes is found only in the right AU in the age group 18-30.

The mean values of Dimension 9 were significantly different in both sexes when comparing the overall groups of men and women in the right AU, as well as bilaterally in the age groups 18-30 years. and 51-70 years.

Conclusions for Task 2:

- The average values for all nine AU sizes show a difference between the two sexes, with greater values in men, except for one size of the left AU in the age group 51-70 years, where in women the value is less than 1mm greater than that in men and another size of the right AU in the age group above 71 years, where the values in both sexes are the same.

28

- AU length (D1) showed the most pronounced sexual dimorphism in all comparisons made (overall and by age group), followed by tragus length (D4), AU width (D2) and lobule width (D9)

- The dimensions of the conch (D6 and D7) do not show a significant difference between the two sexes and, accordingly, the manifestation of sexual dimorphism in this part of the AU is the weakest.

- The most statistically significant differences between the values for men and women are observed in the age group 18-30 years. (9 out of a total of 18 sizes for both AU), and with increasing age these differences gradually decrease (2 out of 18 dimensions in the age group over 70 years old).

Similar to most studies conducted in different populations, the present study found that males have larger sizes than females.

Among the literature sources, some studies are found that show that a significant difference between men and women, or gender dimorphism in the dimensions of the AU, is not found, even greater values can be found in women compared to men. In the present study, only one size was found unilaterally (L7) in the age group 51-70 years, in which the mean value in females was slightly larger than that in males, as well as one size in the age group over 71 years (R8) where the values in both sexes are the same. For all other dimensions of AU bilaterally, together and divided by age groups, all values are greater in men.

TASK 3:

Establishing a relationship between the dimensions of the auricle and age

To accomplish this task, the results were again divided into two groups by gender and four subgroups by age. A One-way ANOVA test was then applied to examine whether the heart values for both sexes for the nine measures in the two AU differed among the four age groups. In the next stage, a comparison was made between the mean values of each of the dimensions bilaterally between the adjacent age groups, i.e. compared Group 1 with Group 2, Group 2 with Group 3, and Group 3 with Group 4.

The analysis of the results on this task was carried out separately for the two sexes as follows:

1. Dependence between the dimensions of the AU and age in males.

The total number of males was 123, with an average age of 54.67 years. The distribution of individuals by age group is presented in Table 16:

Table 16 Distribution of males by age groups and average age in each group.

Age group (AG)	AG 1	AG 2	AG 3	AG 4
Age range	18-30 years	31-50 years	51-70 years	71-88 years
Average age	25,28 years	38,15 years	60,64 years	77,31 years
Number of individuals in group (n=)	18	40	33	32

After the participants' results were divided into the four age groups, descriptive statistics were prepared for each of the dimensions (1-9) bilaterally (R and L), including mean values, standard deviation, minimum and maximum values. The data are presented in Table 17.

Table 17 Descriptive statistics of the results in men - mean, standard deviation (SD), minimum (min) and maximum (max) values.

AG	AG 1 (n=18)				AG 2 (n=40)				AG 3 (n=33)				AG 4 (n=32)			
D	mean	SD±	min	max	mean	SD±	min	max	Mean	SD±	min	max	Mean	SD±	min	max
R1	58,67	6,83	43	71	59,40	7,44	43	75	65,12	5,80	51	76	65,84	8,14	46	81
L1	56,67	7,10	40	66	59,85	7,27	41	76	63,73	6,47	47	75	66,56	6,82	52	79
R2	34,17	6,06	22	45	34,75	5,22	25	44	38,18	4,80	30	47	38,66	5,48	26	50
L2	32,83	5,34	24	40	35,28	5,49	25	45	37,33	5,28	27	52	39,19	4,90	28	48
R3	28,28	4,81	17	37	29,13	4,88	18	37	30,58	5,37	20	40	30,72	4,80	22	39
L3	27,44	5,16	18	36	28,03	4,72	20	40	28,64	4,30	21	38	31,09	5,46	20	42
R4	10,33	3,22	7	21	10,45	2,90	6	18	12,97	2,69	9	19	13,25	2,62	9	18
L4	9,78	2,80	6	16	11,48	3,32	6	18	12,88	2,79	8	21	12,84	2,36	9	18

R5	19,67	2,95	14	24	19,83	4,84	9	34	21,58	3,52	15	29	22,03	5,74	11	38
L5	18,89	3,58	12	25	20,40	3,75	11	28	22,21	4,55	12	33	22,53	4,45	15	33
R6	23,17	3,29	18	30	23,15	3,40	15	31	24,36	3,24	19	33	25,03	3,32	20	35
L6	22,17	3,65	16	31	23,38	2,72	17	28	24,39	4,51	16	35	25,16	3,45	16	32
R7	17,78	3,78	12	24	17,73	3,43	10	24	19,91	3,52	11	27	19,72	3,79	13	30
L7	16,94	2,80	12	21	18,35	3,17	12	26	19,15	3,84	12	28	20,19	4,18	12	31
R8	12,11	2,11	8	15	13,00	3,63	5	21	13,79	2,83	10	22	13,63	3,66	6	21
L8	12,22	2,73	7	17	12,70	3,13	6	20	14,70	3,23	9	23	14,66	2,78	9	21
R9	19,28	4,35	12	30	19,75	3,84	14	28	24,33	4,03	17	34	24,59	4,06	17	30
L9	19,28	3,38	13	25	19,90	3,51	14	29	24,06	4,21	16	31	25,00	3,98	14	35

For a more visual presentation of data, line graphs were prepared for each of the nine sizes showing the change of mean values with advancing age, for the right and left AU, respectively (Figs. 23 - 31), with age groups indicated on the abscissa, and the ordinate indicates the range of average values.
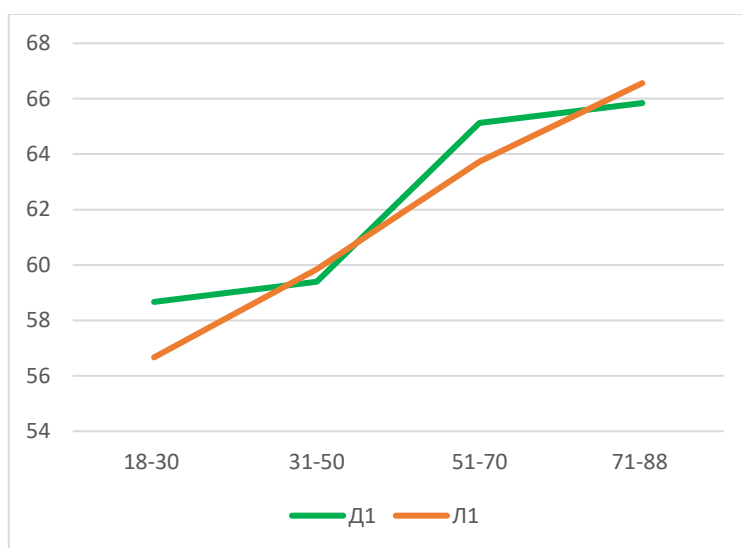

Figure 23 Change in mean of D1 with age in men – R (right - Д), L (left - Л).
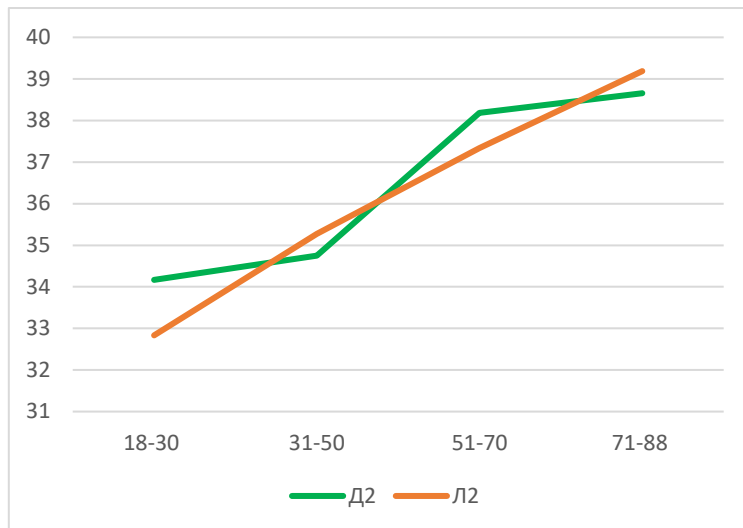
Figure 24 Change in mean of D2 with age in men – R (right - Д), L (left - Л)
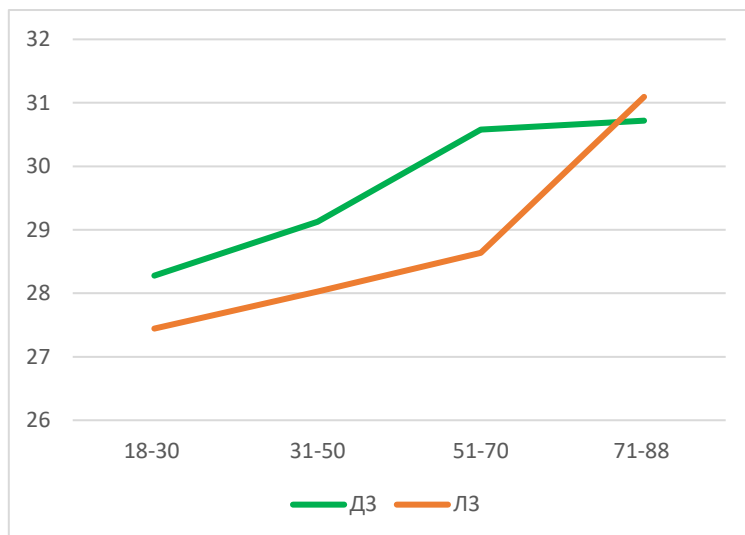
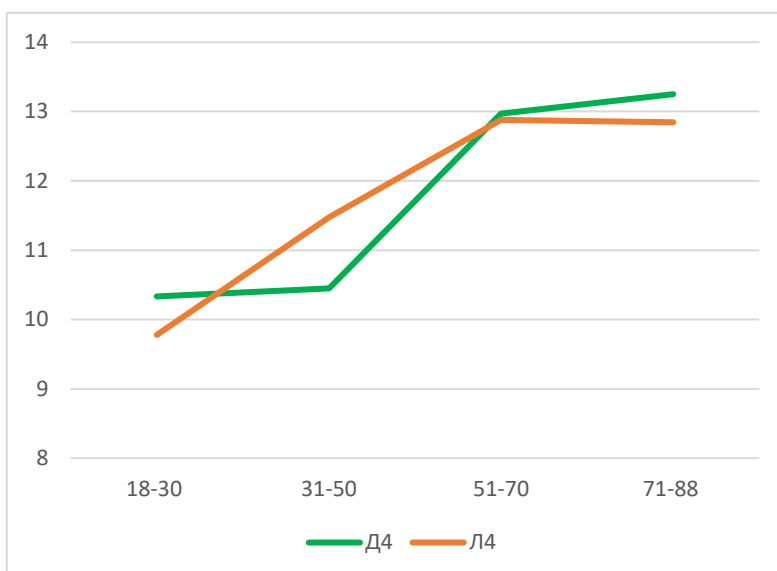*Figure 25 Change in mean of D3 with age in men – R (right - Д), L (left - Л)*

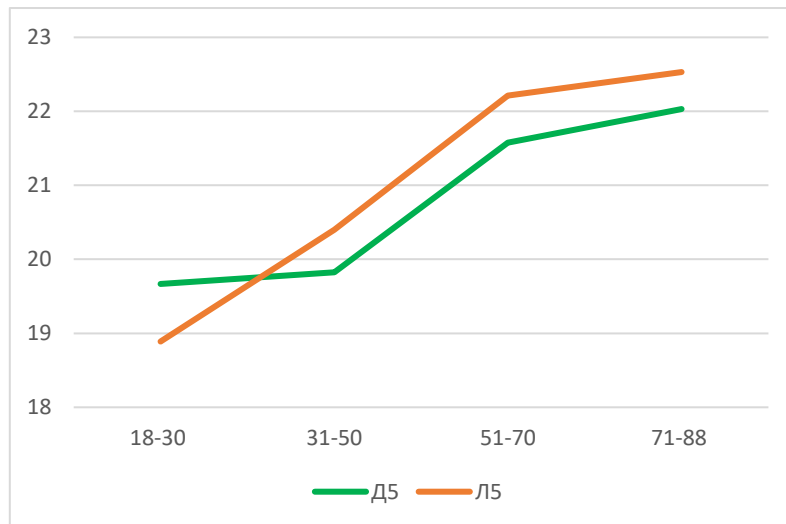*Figure 26 Change in mean of D4 with age in men – R (right - Д), L (left - Л)*

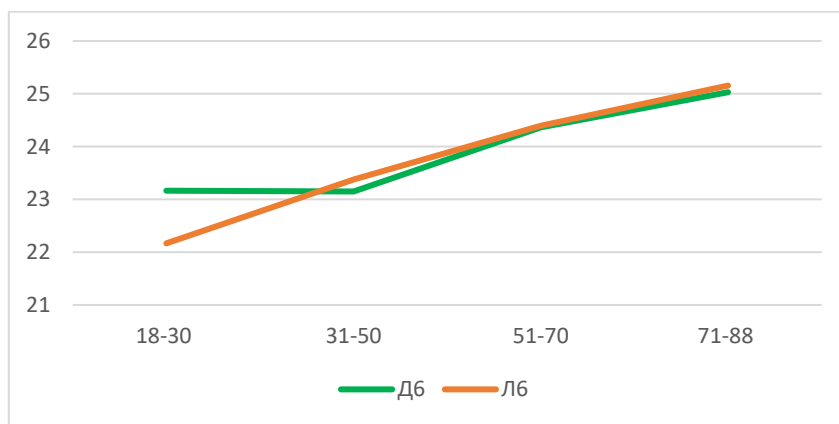*Figure 27 Change in mean of D5 with age in men – R (right - Д), L (left - Л)*

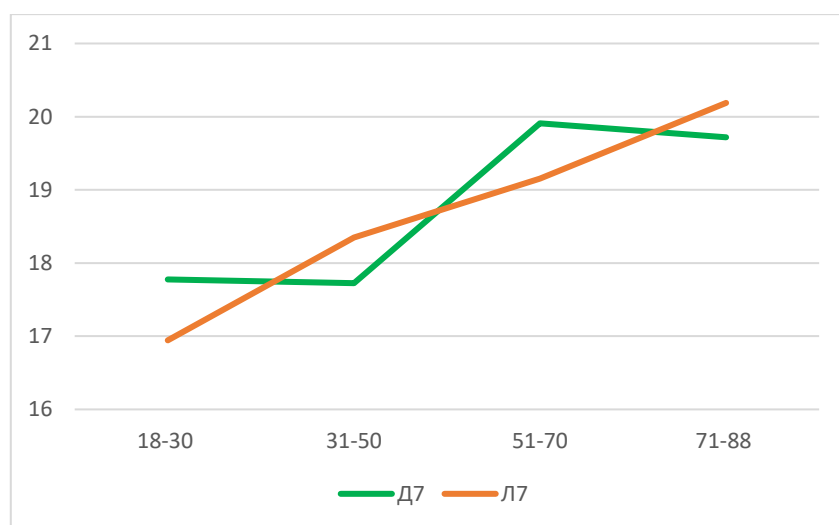*Figure 28 Change in mean of D6 with age in men – R (right - Д), L (left - Л)*

Figure 29 Change in mean of D7 with age in men – R (right - Д), L (left - Л)
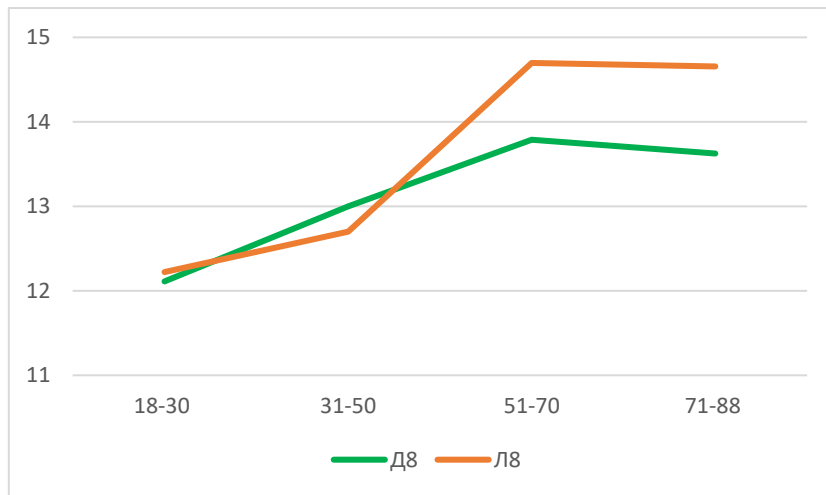
Figure 30 Change in mean of D8 with age in men – R (right - Д), L (left - Л)
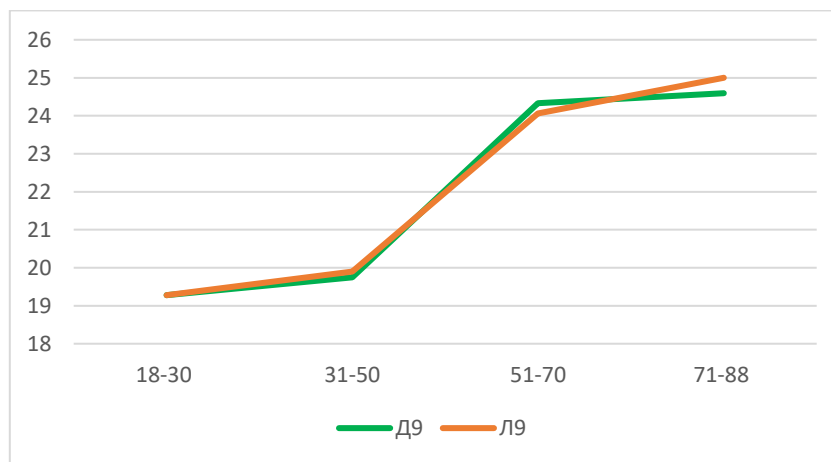

Figure 31 Change in mean of D9 with age in men – R (right - Д), L (left - Л)

To establish a significant difference between the mean values in the four age groups for each of the nine sizes, a two-way One-Way ANOVA test was applied, and values greater than 0.05 were accepted as a statistically significant difference. The test results are presented in Table 18.

Table 18 Results of the conducted One-Way ANOVA to establish a difference between the average values of the four age groups for each of the dimensions (1-9) of the AU bilaterally (R and L). Statistically significant difference at p<0.05.

D	R (p=)	L (p=)
1	**<0,0001**	**<0,0001**
2	**0,0015**	**0,0003**
3	0,2372	**0,0277**
4	**<0,0001**	**0,0008**
5	0,1081	**0,0081**
6	0,0705	**0,026**
7	**0,02**	**0,0177**
8	0,2931	**0,0021**
9	**<0,0001**	**<0,0001**

From the presented results, it is established that for each of the nine sizes bilaterally, an increase in the mean value with age is observed. During the ANOVA test, it was found that there was no statistically significant difference between the age groups for the sizes R3, R5, R6 and R8, while there was one for all the other right sizes. A significant difference between the age groups was found on the nine sizes of the left AU.

Looking at the produced graphs presented in Figure 23 through Figure 31 shows that the line paths for the right and left sizes differ for each size, with the best overlap for D9 and the least overlap for D3.

At D1 and D2 of the right AU (R1 and R2, respectively), a slight increase in the average value between AG1 and AG2, as well as between AG3 and AG4, was found, while a significant increase was observed between AG2 and AG3. For the same dimensions on the left (L1 and L2), there is a uniform increase in values among age groups. Regarding D3, a significant difference is noticed between the course of the lines for the right and left, as that of L3 is located lower and is detected with the line of R3 in the last age group. In R3, there is an almost uniform increase in the mean value between AG1 to AG3, while between AG3 and AG4 the increase is minimal. For L3, a uniform increase in values was also observed between AG1 to AG3, and a significant increase was found between AG3 and AG4. (Fig. 23, Fig. 24, Fig. 25)

For sizes R4 and R5, a slight increase in values is seen between AG1 and AG2 and between AG3 and AG4, but a significant increase is reported between AG2 and AG3. At L4 and L5, a uniform upward movement of the line between AG1 and AG3 is established. For L4, there is a slight decrease in values by 0.04mm between AG3 and AG4, while for L5 there is a slight increase. At D6, a uniform upward course of the lines is observed bilaterally, except for the part between AG1 and AG2 at R6, where the average values are almost the same. (Fig. 26, Fig. 27, Fig. 28)

The line of R7 shows an uneven course, as between AG1 and AG2, as well as between AG3 and AG4, a slight decrease in the average values can be seen by 0.05mm and 0.19mm, respectively. At the same time, a clear upward movement of the line is established between AG2 and AG3. For L7, a uniform increase in values with increasing age is observed. Regarding R8, there is a slight increase in mean values between AG1 and AG2, followed by a significant increase between AG2 and AG3. At L8, an almost uniform upward trend of the line between AG1 and AG3 is visible. For D8 bilaterally, similar to R7, a slight decrease in the mean values was found with increasing age between AG3 and AG4, respectively by 0.16 mm at R8 and by 0.04 mm at L8. Regarding D9, almost the same upward movement of the lines for right and left is visible, as between AG1 and AG2, as well as between AG3 and AG4 there is a slight increase in the average values, while between AG2 and AG3 a clear upward trend of the lines is observed. (Fig. 29, Fig. 30, Fig. 31)

In order to find out whether there is a significant difference between the individual age groups of the established average values, a t-test was conducted, and a statistically significant difference is accepted at a value of $p<0.05$. The comparison was made as follows: the values of each dimension bilaterally for AG1 were compared with the corresponding results for AG2 (AG1 vs AG2). Analogously, the values for AG2 were compared with those for AG3 (AG2 vs AG3), and accordingly the results for AG3 with those for AG4 (AG3 vs AG4). The data are presented in Table 19.

Table 19 Results of the conducted t-test to establish a statistically significant difference (p<0.005) between the values of each dimension (1-9) bilaterally (R and L) between the four age groups.

D	AG 1 vs AG 2		AG 2 vs AG 3		AG 3 vs AG 4	
	R	L	R	L	R	L
1	0,7232	0,1258	**0,0006**	**0,0199**	0,6809	0,0904
2	0,7094	0,1196	**0,005**	0,1092	0,7113	0,1475
3	0,5418	0,6753	0,2312	0,5683	0,9103	**0,0478**
4	0,8915	0,0645	**0,0003**	0,0577	0,6715	0,9566
5	0,8985	0,1559	0,0874	0,0662	0,7	0,7759
6	0,9862	0,1654	0,1255	0,237	0,4147	0,4475
7	0,9583	0,1111	**0,0093**	0,3317	0,8344	0,3017
8	0,3387	0,579	0,3123	**0,0093**	0,8412	0,9567
9	0,6792	0,5304	**<0,0001**	**<0,0001**	0,7961	0,3586

When comparing the mean values in AG1 and AG2, in all dimensions bilaterally, no statistically significant difference was found. Similar is the result of the t-test when comparing the data for AG3 and AG4, where a significant difference is found only for one size unilaterally, namely L3. When comparing the mean values between AG2 and AG3 for the right AU, 5 out of 9 statistically significant differences (p<0.05) were observed - R1, R2, R4, R7 and R9. In the case of the left AU, such a difference is also found, but only in 3 out of 9 sizes, which are L1, L8 and L9.

When summarizing the data established in men, it can be seen that for dimensions 1 and 9, a significant difference was found bilaterally between the four age groups, and when comparing them to each other, such a difference was observed between AG2 and AG3 in the left and right AU. There is also a significant difference between the groups on the dimensions D2, D4 and D7 bilaterally, but when comparing the individual groups, a statistical difference is found only between AG2 vs AG3 unilaterally, on the dimensions R2, R4 and R7. Regarding D3, D5, D6 and D8, a significant difference was observed between the four age groups only in the left AU, and when comparing them with each other, there was a statistically significant difference only between AG3 vs AG4 on L3 and between AG2 vs AG3 on L8.

Conclusions for male`s group:

- An increase in average values was found bilaterally for all nine dimensions of AU with advancing age.
- The clearest difference is found in the total length and width of the AU as well as in relation to the width of the lobule, respectively D1, D2, and D9. The smallest difference with increasing age was observed in the length of the concha (D6) and in the length of the AU below the tragus (D5).
- The most pronounced age difference is found in the range between 31 and 70 years, while before and after this period the average values do not increase significantly, and for some dimensions even a lower average value is observed in the group with older individuals , although this difference reaches 0.19mm.

1. Dependence between the dimensions of the AU and age in females.

The total number of women participating in the study was 99, with an average age of 57.39 years. The distribution of individuals by age group is presented in Table 20.

Table 20 Distribution of women by age groups and average age in each group.

Age group (AG)	AG 1	AG 2	AG 3	AG 4
Age range	18-30 years	31-50 years	51-70 years	71-94 years
Average age	24,64 years	41,05 years	60,64 years	81,07 years
Number of individuals in group (n=)	14	22	33	30

After the results of the participants were divided into the four age groups, descriptive statistics were prepared for each of the dimensions (D1-D9) bilaterally (R and L), including mean values, standard deviation, minimum and maximum values. The data are presented in Table 21.

Table 21 Descriptive statistics of results in men - mean, standard deviation (SD), minimum (min) and maximum (max) values.

AG	AG 1 (n=14)				AG 2 (n=22)				AG 3 (n=33)				AG 4 (n=30)			
D	mean	SD±	min	max	mean	SD±	min	max	mean	SD±	min	max	mean	SD±	min	max
R1	51,93	5,47	39	60	54,73	7,37	40	64	61,61	6,06	44	71	62,40	6,76	51	77
L1	51,79	4,98	38	58	55,41	7,44	40	66	60,46	5,89	45	72	61,93	5,84	50	75
R2	30,64	3,86	21	40	31,86	5,54	22	40	35,42	4,80	23	47	37,13	4,42	27	46
L2	30,14	4,35	22	39	31,64	5,14	23	41	35,70	4,88	24	47	36,97	4,18	25	43
R3	26,71	4,71	16	31	26,18	4,39	18	32	29,18	3,96	20	36	29,77	5,92	18	38
L3	27,21	4,06	18	36	25,96	4,59	18	37	27,58	3,79	18	37	28,37	4,97	20	40
R4	8,071	1,94	6	13	10,00	2,16	7	13	11,27	2,91	6	18	11,93	2,63	8	18
L4	7,857	1,88	6	14	10,32	2,42	7	15	11,27	2,28	8	16	12,63	2,87	7	19
R5	17,14	2,54	13	22	18,55	3,68	11	26	20,97	3,72	13	27	20,70	3,79	11	28
L5	16,64	2,13	14	20	19,14	3,26	11	24	21,61	3,91	14	30	20,93	4,93	10	33
R6	22,29	2,30	16	24	22,41	3,16	17	30	24,33	3,33	15	32	23,97	3,18	16	28
L6	21,36	2,59	16	24	22,46	3,16	16	28	23,73	2,76	17	30	23,60	2,65	17	30
R7	16,57	2,50	13	23	17,46	3,52	12	26	19,61	2,87	13	24	19,27	2,59	13	24
L7	15,93	2,73	12	21	16,73	3,10	12	22	19,58	3,05	12	25	19,77	2,78	11	25
R8	10,21	2,16	7	14	12,41	4,08	5	26	13,70	3,00	9	21	13,63	2,65	9	18
L8	10,50	1,91	8	13	12,46	2,74	6	17	14,24	2,76	10	20	14,07	3,52	8	24
R9	16,36	3,18	11	21	18,64	4,18	12	26	22,24	3,51	17	32	23,27	3,98	16	30
L9	16,36	2,98	12	22	19,32	2,85	14	27	21,76	3,80	15	29	23,20	3,08	17	29

For a more visual presentation of the results in the female group, line graphs were prepared for each of the nine dimensions showing the change in mean values with advancing age, for the

right and left AU, respectively (Figure 32 to Figure 40), with the abscissas labeled the age groups, and the ordinate indicates the range of average values.
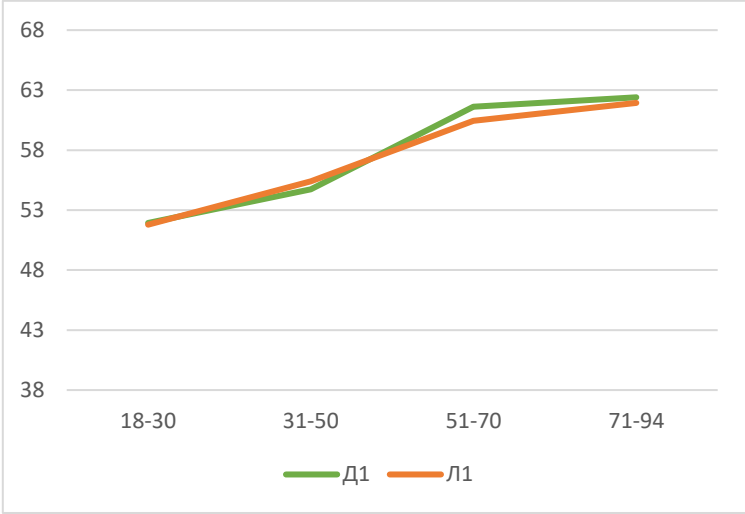

Figure 32 Change in mean of D1 with advancing age in women – right (Д), left (Л).
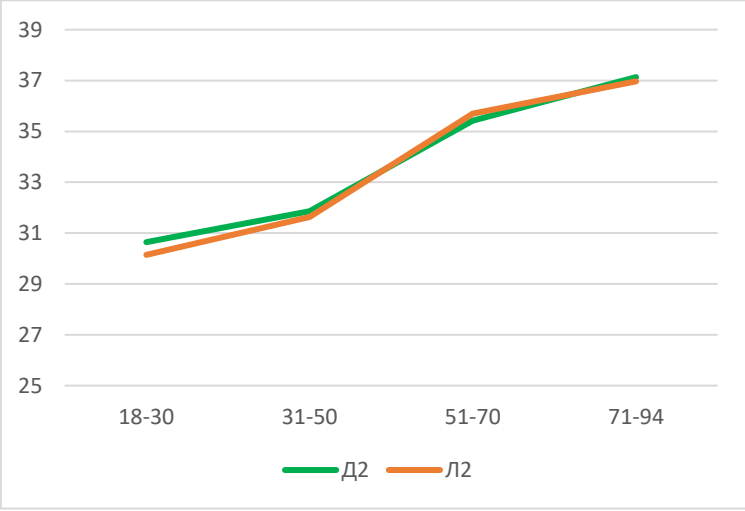

Figure 33 Change in mean of D2 with advancing age in women – right (Д), left (Л).

Figure 34 Change in mean of D3 with advancing age in women – right (Д), left (Л).

Figure 35 Change in mean of D4 with advancing age in women – right (Д), left (Л).

Figure 36 Change in mean of D5 with advancing age in women – right (Д), left (Л).
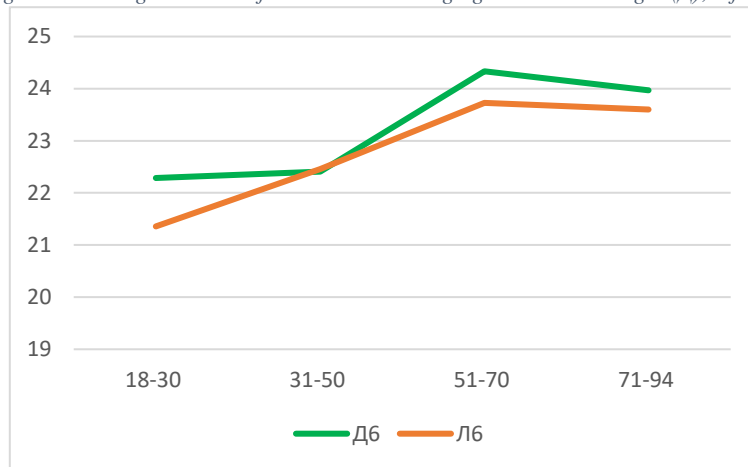
Figure 37 Change in mean of D6 with advancing age in women – right (Д), left (Л).
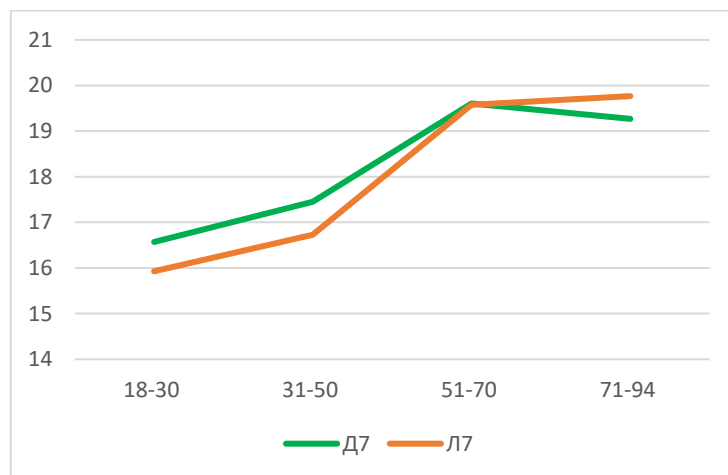
Figure 38 Change in mean of D7 with advancing age in women – right (Д), left (Л).
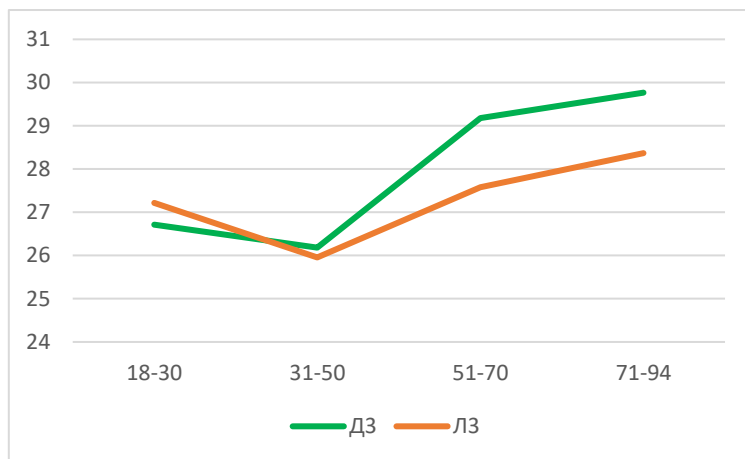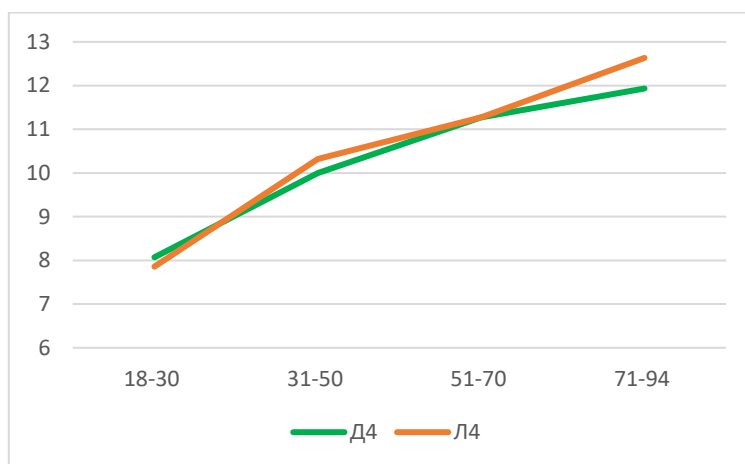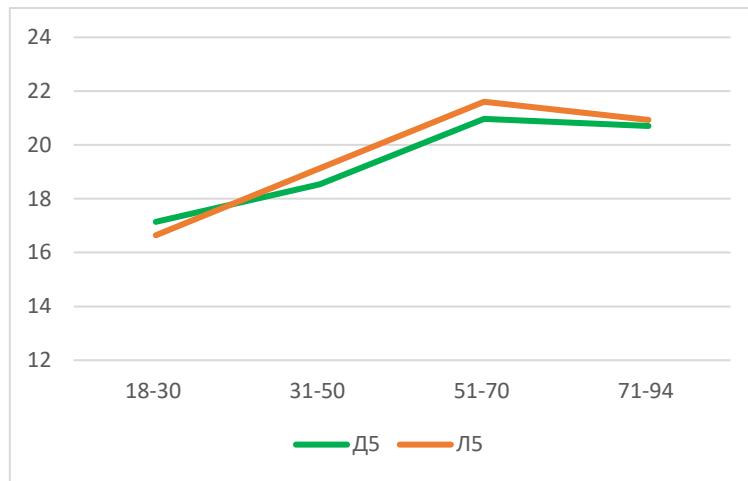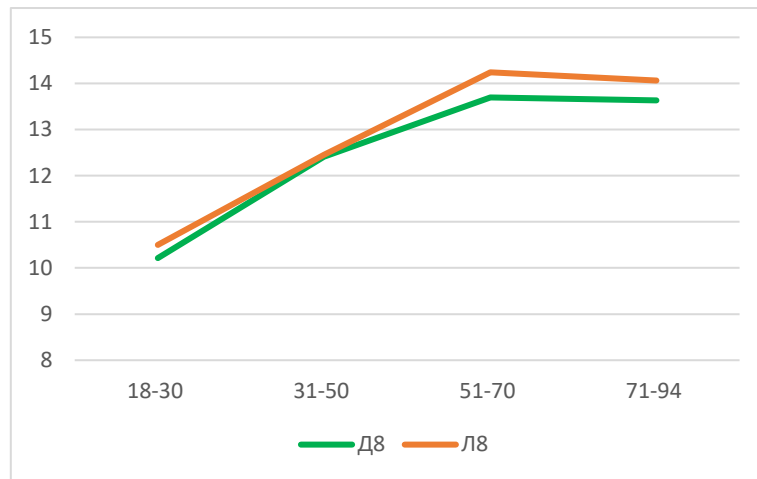
Figure 39 Change in mean of D8 with advancing age in women – right (Д), left (Л).

Figure 40 Change in mean of D9 with advancing age in women – right (Д), left (Л).

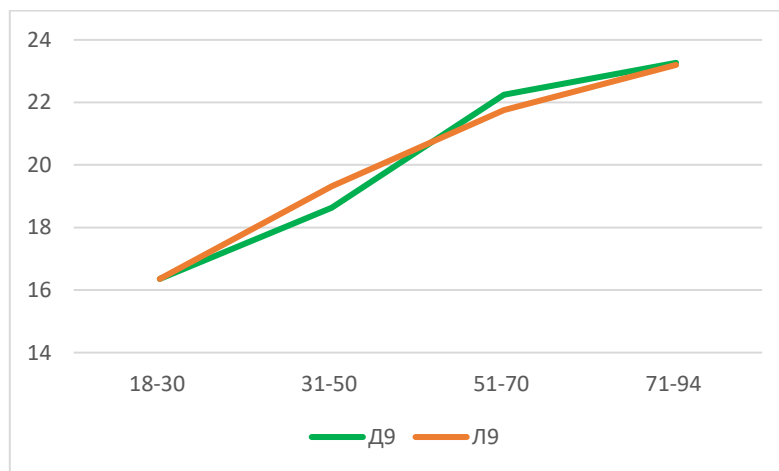To establish a significant difference between the average values in the four age groups for each of the nine dimensions, a two-sided One-Way ANOVA test was applied, and values of $p < 0.05$ were accepted as a statistically significant difference. The test results are presented in Table 22.

Table 22 Results of the conducted One-Way ANOVA to establish a difference between the average values of the four age groups in women for each of the sizes (1-9) of the AU bilaterally (R and L). Statistically significant difference at p<0.05.

D	R (p=)	L (p=)
1	**<0,0001**	**<0,0001**
2	**<0,0001**	**<0,0001**
3	**0,0266**	*0,2775*
4	**<0,0001**	**<0,0001**
5	**0,0021**	**0,0008**
6	*0,0562*	**0,0317**
7	**0,0021**	**<0,0001**
8	**0,0027**	**0,0004**
9	**<0,0001**	**<0,0001**

From the results presented, it can be seen that for each of the nine sizes bilaterally, an increase in the mean value with age is observed. During the ANOVA test, it was found that there was no statistically significant difference between the age groups in the dimensions L3 and R6, while there was a bilateral difference in all other dimensions.

When examining the prepared graphs presented in Fig. 32 to Fig. 40 it can be seen that the line paths for the right and left AU differ in each of the dimensions, with the best overlap for D1, D2 and D9, and the least for D3.

At D1 and D2 bilaterally, a slight increase in the average value is found between AG1 and AG2, as well as between AG3 and AG4, while a clear upward trend of the line is observed between AG2 and AG3. On D3, a significant difference between the course of the right and left lines is noticeable, as that of L3 is located lower and intersects with the line of R3 between AG1 and AG2. At this size, bilaterally, a reduction of the average value between the first two groups was found by 0.53 mm for R3 and 1.25 mm for L3, respectively. For R3, there is an almost uniform increase in the mean value between AG2 to AG3, while between AG3 and AG4 the

increase is minimal. For L3, an almost uniform increase in values is observed between AG2 to AG4. (Fig. 32, Fig. 33, Fig. 34)

At D4 bilaterally, a uniform upward course of the lines from AG1 to AG4 is established, with the values for left and right being almost the same with slightly lower values at R4 in the part between AG3 and AG4. A similar uniform increase in the average values is also seen for D5 bilaterally between AG1 and AG3, while between AG3 and AG4 a decrease in values is found by 0.27mm for D5 and 0.68mm for L5, respectively. At R6, a minimal increase is detected between AG1 and AG2, followed by a clear upward trend of the line between AG2 and AG3. Regarding L6, between AG1 and AG3, a uniform increase in average values can be seen. Bilaterally for D6, in the part between AG3 and AG4, a decrease in value was observed, respectively by 0.36mm for R6 and by 0.13mm for L6. (Fig. 35, Fig. 36, Fig. 37)

At D7 bilaterally, a moderate increase in the average values between AG1 and AG2 is found, followed by a strong upward trend between AG2 and AG3. Between AG3 and AG4 of L7, a very slight increase in values is visible, and for R7, between the same age groups, a slight decrease with a difference of 0.34mm is found. At D8 bilaterally, a uniform increase of the average values between AG1 and AG3 is visible, while between AG3 and AG4 a slight decrease is observed, respectively by 0.07mm for R8 and by 0.17mm for L8. Regarding D9, a uniform increase in values between AG1 to AG4 is found for both AU. (Fig. 38, Fig. 39, Fig. 40)

In order to determine whether a significant difference in the established average values is found between the individual age groups, similarly to the study in the group of men, a t-test was conducted, with a value of p<0.05 being accepted as a statistically significant difference. The comparison was made as follows: the values of each dimension bilaterally for AG1 were compared with the corresponding results for AG2 (AG1 vs AG2). Analogously, the values for AG2 were compared with those for AG3 (AG2 vs AG3), and accordingly the results for AG3 with those for AG4 (AG3 vs AG4). The data are presented in Table 23.

Table 23 Results of the conducted t-test to establish a statistically significant difference (p<0.005) between the values of each dimension (1-9) bilaterally (R and L) between the four age groups in women.

	AG1 vs AG2		(AG2 vs AG3)		(AG3 vs AG4)	
D	**R**	**L**	**R**	**L**	**R**	**L**
1	0,2306	0,1181	**0,0004**	**0,0071**	0,6247	0,3215
2	0,4769	0,3744	**0,0143**	**0,0046**	0,1479	0,2739
3	0,7324	0,4079	**0,011**	0,1595	0,6436	0,4777
4	**0,0104**	**0,0027**	0,0853	0,1436	0,3494	**0,0406**
5	0,2179	**0,0161**	**0,0207**	**0,0176**	0,7767	0,5485
6	0,9003	0,2848	**0,0368**	0,1201	0,6573	0,8529
7	0,4203	0,4365	**0,016**	**0,0014**	0,6251	0,7966
8	0,0731	**0,026**	0,1826	**0,022**	0,9294	0,8255
9	0,0907	**0,0052**	**0,0011**	**0,0132**	0,2821	0,1051

When comparing the mean values at AG1 and AG2, a statistically significant difference was found at D4 bilaterally, as well as at D5, D8 and D9 of the left AU. Regarding the comparison of AG2 with AG3, many significant differences were found, as bilaterally it was observed for D1, D2, D5, D7 and D9, and unilaterally such a difference was found for dimensions R3, R6 and L8. Comparing these two age groups showed no statistically significant difference only at D4. When comparing AG3 with AG4, only one significant difference was found, namely in size L4, while none was observed in all others.

When summarizing the data established in women, it can be seen that at D1, D2, D4, D5, D7 and D9, a significant difference between the four age groups was established bilaterally. When comparing the age groups with each other on these dimensions, at D1, D2, D5, D7 and D9 a statistically significant difference was found between AG2 and AG3, and at D4 such a difference was found between AG1 and AG2. At D4, D5 and D9, another significant difference between the age groups is observed, but unilaterally - at L4 between AG3 and AG4; at L5 and L9 between AG1 and AG2. At D8 bilaterally, a statistically significant difference was also established between all age groups, but when comparing them with each other, such a difference was found only at L8, respectively between AG1 and AG2 and between AG2 and AG3. Regarding D3, a significant difference when comparing the four age groups is found only in

R3, where a statistically significant difference between AG2 and AG3 is also visible. Similarly, at D6, a significant difference is also seen unilaterally, namely at L6, but at the same time, when comparing the age groups with each other, such a difference is found at R6 between AG2 and AG3.

Conclusions for female`s group:

- An increase in average values was found bilaterally for all nine dimensions of AU with advancing age.

- The clearest difference is found in the total length and width of the AU, as well as in relation to the width of the lobule and the length of the tragus (D1, D2, D4 and D9), followed by the length of the AU below the tragus, the width of the conch and the length of the lobule (D5, D7 and D8). Fluctuating results and a correspondingly weak difference in the mean values with increasing age were observed in D3 and D6.

- The most pronounced age difference is found in the range between 31 and 70 years, where a statistically significant difference is found in 8 of the nine dimensions, unilaterally or bilaterally.

- In the age range below 30 years, the best results are shown by the length of the tragus, followed by the length and width of the lobule. In women over 70 years of age, only one of the nine sizes, unilaterally, showed a statistically significant difference (tragus length of the left AU), while four dimensions showed a lower mean value in the group with older individuals.

Most literature sources indicate that with advancing age, the size of the AU also increases in both sexes. The present study also reached this conclusion, in both males and females.

Some authors argue that the growth of the AU with advancing age, and more specifically in terms of length, is the result of an increase in the lobule with relative preservation of the other structures of the AU. Other studies, specifically related to the study of changes in the histological structure of the ear cartilage, have concluded that with advancing age certain changes are also found in this structure, which also have an impact in terms of size of AU.

The dimensions investigated in the present study cover all major parts of the AU, each of which increases with age in both sexes. It is observed that the dimensions that cover the cartilaginous part of the AU, namely the length of the tragus, the length and the width of the conch, increase less with age, compared to the other parts and the overall dimensions of the AU. The growth of the lobule in width was found to be significant in both sexes, while in terms of length, a statistically significant difference among the studied groups was observed less often.

TASK 4:

Establishing a relationship between the dimensions of the AU and stature.

To accomplish this task, the results were again divided into two groups according to gender and into three subgroups according to the stature, with males ranging between 159cm and 196cm, and females between 150cm and 175cm. A One-way ANOVA test was then applied to examine whether the mean values for both sexes on the nine dimensions in the two AU differed among the three subgroups. In the next stage, a comparison was made between the mean values of each of the dimensions bilaterally between adjacent subgroups. The analysis of the results of this task was carried out separately for both sexes as follows:

1. **Dependence between the dimensions of the AU and stature in males.**

Male participants (n=123) were divided into three subgroups according to stature. The distribution by subgroups is presented in Table 24:

Table 24 Distribution of males in three groups according to stature and average value stature in each group.

Grouping of males according to stature	Group 1	Group 2	Group 3
Stature (cm)	159-170cm	171-180cm	181-196cm
Average value of stature in group (cm)	167.47cm	175,69cm	185,63cm
Number of individuals in group (n=)	32	67	24

After the results of the participants were divided into the three subgroups, descriptive statistics were prepared for each of the dimensions (1-9) bilaterally (R and L), including mean

values, standard deviation, minimum and maximum values. The data are presented in Table 25.

Table 25 Descriptive statistics of results in men regarding height - mean, standard deviation (SD), minimum (min) and maximum (max) values.

Group	Group 1 (n=32)				Group 2 (n=67)				Group 3 (n=24)			
D	mean	SD±	min	max	mean	SD±	min	max	mean	SD±	min	max
R1	62.59	8.20	46	79	62.82	7.57	43	81	61.50	7.84	43	75
L1	61.31	8.48	41	79	62.66	7.44	40	76	61.96	7.32	47	75
R2	37.59	4.92	28	50	36.76	5.97	22	50	34.83	5.12	25	44
L2	36.13	6.37	25	52	36.84	5.23	24	48	36.00	5.77	24	45
R3	28.69	5.29	18	39	30.52	5.03	19	40	34.83	5.12	25	44
L3	27.84	4.89	20	40	29.79	5.30	18	42	27.83	3.91	19	33
R4	12.28	2.95	7	18	11.79	3.17	6	21	11.38	3.13	8	18
L4	12.41	2.70	7	18	11.91	3.08	6	21	11.50	3.43	7	18
R5	21.63	6.02	12	38	20.48	3.96	11	31	20.83	4.27	9	29
L5	21.06	4.95	11	33	20.96	4.11	12	33	22.17	3.93	14	32
R6	23.34	3.99	15	35	24.12	2.90	16	31	24.38	3.77	18	33
L6	23.66	3.40	17	32	24.08	3.76	16	35	23.92	3.96	17	31
R7	19.22	3.88	13	30	19.00	3.81	10	27	17.88	3.13	12	23
L7	18.63	4.09	13	31	19.03	3.69	12	28	18.58	3.30	12	26
R8	13.31	3.87	7	21	13.16	3.04	6	22	13.38	3.12	5	20
L8	13.66	3.42	6	21	13.67	3.19	7	23	13.71	2.87	9	21
R9	22.97	4.73	12	30	22.48	4.82	12	34	20.25	3.71	14	28
L9	22.19	4.99	13	30	22.76	4.64	14	35	20.92	3.02	16	27

To establish a significant difference between the mean values in the three subgroups for each of the nine sizes, a two-sided One-Way ANOVA test was applied, and values of $p < 0.05$ were accepted as a statistically significant difference.

The test results are presented in Table 26.

Table 26 Results of the conducted One-Way ANOVA to establish a difference between the mean values of the three subgroups in male for each of the dimensions (1-9) of the AU bilaterally (R and L). Statistically significant difference at p<0.05.

D	R (p=)	L (p=)
1	0.7739	0.7116
2	0.1777	0.7545
3	**<0.0001**	0.0982
4	0.5508	0.5388
5	0.5170	0.4854
6	0.4583	0.8712
7	0.3555	0.8215
8	0.9554	0.9981
9	0.0698	0.2258

When examining the results of the conducted ANOVA, it is found that there is a significant difference between the subgroups only in D2 of the right AU, while no such difference is found for the other dimensions in both AU.

In order to determine whether there is a significant difference between the average height values between the individual subgroups, a t-test was conducted, with a value of p<0.05 being accepted as a statistically significant difference. The comparison was made as follows: the values of each dimension bilaterally for Group 1 were compared with the corresponding results for Group 2 (Group 1 vs Group 2). Similarly, values in Group 2 were compared with those in Group 3 (Group 2 vs Group 3).

The data are presented in Table 27.

Table 27 Results of the conducted t-test to establish a statistically significant difference (p<0.005) between the values of each dimensions (1-9) bilaterally (R and L) between the three groups in men.

D	Group 1 vs Group 2		Group 2 vs Group 3	
	R	**L**	**R**	**L**
1	0.8922	0.4238	0.4693	0.6930
2	0.4949	0.5577	0.1631	0.5152
3	0.0980	0.0829	**0.0005**	0.1019
4	0.4639	0.4379	0.5813	0.5878
5	0.2606	0.9098	0.7125	0.2132
6	0.2745	0.5949	0.7335	0.8621
7	0.7910	0.6232	0.1975	0.6028
8	0.8363	0.9825	0.7730	0.9605
9	0.6342	0.5756	**0.0428**	0.0732

When comparing the mean values of dimensions of the AU between Group 1 and Group 2, it was found that there was no significant difference between them. Regarding the comparison between the values of Group 2 versus Group 3 on two dimensions unilaterally (right AU), a significant difference is found, and these are dimensions R3 and R9, respectively, while no such difference is observed for the left AU. With regard to the change of average values with increasing height, an increase is noticeable for sizes R3, R6 and L8, but for all other sizes the values do not show a clear trend.

2. Dependence between the dimensions of the AU and stature in females.

Similar to the male group, the female participants (n=99) were also divided into three subgroups according to height, and their distribution is presented in Table 28.

Table 28 Distribution of females in three groups according to stature and average value of stature in each group.

Grouping of females according to stature	Group 1	Group 2	Group 3
Stature (cm)	150-160cm	161-170cm	171-175cm
Average value of stature in group (cm)	156,50cm	166,15cm	173,27cm
Number of individuals in group (n=)	40	48	11

After the results of the female participants were divided into the three groups according to stature, descriptive statistics were prepared for each of the dimensions (1-9) bilaterally (R and L), including mean values, standard deviation, minimum and maximum values. The data are presented in Table 29.

Table 29 Descriptive statistics of results for women in terms of height - mean, standard deviation (SD), minimum (min) and maximum (max) values.

Group	Group 1 (n=40)				Group 2 (n=48)				Group 3 (n=11)			
D	mean	SD±	min	max	mean	SD±	min	max	mean	SD±	min	max
R1	58.33	7.94	39	77	59.90	6.81	40	71	57.09	9.84	40	71
L1	58.78	6.52	45	75	59.04	7.13	38	72	55.64	8.68	40	68
R2	34.20	5.54	21	45	35.08	4.84	26	47	32.82	6.23	22	39
L2	34.18	5.17	24	43	34.94	5.12	22	47	32.82	6.52	23	45
R3	27.83	5.71	16	38	28.98	4.34	19	36	27.46	4.87	18	35
L3	27.98	4.68	18	40	27.38	4.31	18	36	25.46	3.53	19	32
R4	10.78	2.49	8	18	10.83	2.97	6	18	10.18	3.49	6	17
L4	11.13	2.38	7	15	11.08	3.20	6	19	10.09	3.05	7	15
R5	19.68	3.91	11	28	20.00	3.54	13	27	19.46	4.87	11	26
L5	19.65	4.15	10	33	20.58	4.19	13	30	20.09	4.91	11	28
R6	22.98	3.18	15	28	23.69	2.70	17	29	24.64	4.88	17	32
L6	22.85	2.72	17	28	23.25	2.86	16	30	23.09	3.73	16	29
R7	18.20	3.13	13	24	18.88	2.86	13	26	18.82	3.95	12	24
L7	18.20	3.13	11	25	18.94	3.41	12	25	17.55	3.42	12	22
R8	12.90	2.73	9	19	12.96	3.63	6	26	12.64	3.64	5	18
L8	13.00	2.97	8	24	13.52	3.28	8	20	13.09	3.53	6	18
R9	21.68	4.69	12	32	20.69	4.15	12	28	19.18	5.08	11	28
L9	20.68	3.73	14	29	21.38	4.20	12	29	19.55	3.83	14	28

To establish a significant difference between the mean values of the three groups for each of the nine dimensions, two-way One-Way ANOVA was applied, with values of $p<0.05$ accepted as a statistically significant difference.

The results of the analysis are presented in Table 30..

Table 30 Results of One-Way ANOVA to establish a difference between the average values of the three groups in women for each of the dimension (1-9) of the AU bilaterally (R and L). Statistically significant difference at p<0.05.

D	R (p=)	L (p=)
1	0.4403	0.3468
2	0.4058	0.4651
3	0.4621	0.2463
4	0.7867	0.5475
5	0.8782	0.5925
6	0.2709	0.8139
7	0.2709	0.8139
8	0.9582	0.7346
9	0.2365	0.3556

Identical to the male group, a t-test was performed to determine whether there was a significant difference between the mean height values between the individual female groups, with p<0.05 as a statistically significant difference. The comparison was made as follows: the values of each dimension bilaterally for Group 1 were compared with the corresponding results for Group 2 (Group 1 vs Group 2). Similarly, values in Group 2 were compared with those in Group 3 (Group 2 vs Group 3).The data are presented in Table 31.

Table 31 Results of the conducted t-test to establish a statistically significant difference (p<0.005) between the mean values of each size (1-9) bilaterally (D and L) between the three groups in women.

	Group 1 vs Group 2		Group 2 vs Group 3	
D	R	L	R	L
1	0.3204	0.8563	0.2635	0.1752
2	0.4272	0.4905	0.1902	0.2445
3	0.2849	0.5335	0.3087	0.1751
4	0.9216	0.9458	0.5277	0.3537
5	0.6836	0.2989	0.6696	0.7347
6	0.2588	0.5063	0.3776	0.8758
7	0.2588	0.5063	0.3776	0.8758
8	0.9334	0.4411	0.7919	0.7005
9	0.2974	0.4149	0.3020	0.1908

When looking at the results in the female group, it was found that there was no significant difference between the three groups according to height in any of the UM dimensions bilaterally. An increase in the mean value with increasing height was found only for size R6, without the difference between the three groups being significant. When comparing the groups to each other, there was also no statistically significant difference in any of the dimensions bilaterally.

Conclusions for Task 4:

- In both sexes, there is no clear increase in the average values of AU sizes with increasing height, with a few exceptions - sizes R3, R6 and L8 in men and R6 in females.

- For some of the dimensions, for both sexes, even lower mean values were found in taller individuals compared to those of shorter stature.

- According to the results obtained for Task 4, it can be concluded that no clear relationship is established between the dimensions of the AU and stature.

The data from the present study are not identical to those studies reviewed in the other populations in which a clear correlation was found between AU size and stature. In one of the studies reviewed, conducted only in women from the Indian population, the authors found that the length of the concha showed the best results. In the present study, the length of the concha (D6) also increased with height, although the increase in mean values was not quite categorical and was observed only in the right AU.

TASK 5:

Comparison of the established dimensions of the AU in the individuals from the Bulgarian population in the present study with those in other populations

To accomplish this task, the findings of the current study were compared with data from studies conducted in other populations. The data obtained from the descriptive statistics of the previous tasks were used in the comparison. Several studies were reviewed that were conducted

on individuals from eight different populations – Turkish, Dutch, Italian, Russian, Indian, Sudanese, Iraqi and Nigerian.

1. Comparison of the results of the present study with those of a study conducted in individuals from the Turkish population.

In the indicated study, AU was examined bilaterally in a total of 341 individuals from the Turkish population (150 women and 191 men) aged between 18 and 25 years. All participants were free of traumatic injuries or congenital anomalies. The research used the method of direct anthropometry using an electronic digital caliper. A total of seven AU dimensions were measured, four of which matched the dimensions used in the present study—total ear height (D1), lobule height and width (D8 and D9), and ear width (D2).

   Since the reviewed study included only young individuals aged 18-25 years, the comparison with the present study was made with the results found in men and women in AG1 (18-30 years). The data are presented in Table 32.

Table 32 Comparison of the results of the present study with those of a study conducted in individuals from the Turkish population. (Average values for sizes 1, 2, 8 and 9 bilaterally are indicated).

Population	Age	Sex	R/L	D1	D2	D8	D9
Turkish	18-25	M	D	62,90	33,10	18,40	19,80
			L	63,10	33,30	18,30	19,40
		F	D	59,50	31,20	17,90	18,90
			L	59,70	31,30	17,50	18,50
Bulgarian *(present study)*	18-30	M	D	58,67	34,17	12,11	19,28
			L	56,67	32,83	12,22	19,28
		F	D	51,93	30,64	10,21	16,36
			L	51,79	30,14	10,50	16,36

When examining the results of the two populations in relation to D1, namely the length of the AU, it is noticed that there is a significant difference in both sexes, with the average values in individuals from the Turkish population being greater compared to those from the Bulgarian population.

In the D2 of the right AU, it is found that the men of the present study have larger values compared to the men from the Turkish population, but in the left AU, as well as in both women's AU, the size is smaller in the Bulgarian population.

Regarding D8 and D9, all values in both sexes are greater in individuals from the Turkish population.

A significant difference is observed at D8 between the two populations, which is more than half a centimeter. In the reviewed study, it is stated that this distance is measured from the incisura intertragica to the most extreme part of the lobule, while in the present study, this measurement is taken below the level of the incisura and also to the lowest point of the lobule. It is likely that this difference is essential for the values found in the two populations. It should also be noted that the value of D8 is also related to whether there is adhesion and to what extent of the lobule with the scalp, since with complete adhesion this size is significantly smaller compared to the same with a free type of lobule .

When summarizing the data from the comparison of the values in the two populations, it can be said that the total length and width, as well as the dimensions of the lobule are larger in the individuals from the Turkish population compared to those found in the present study in the Bulgarian population.

2. Comparison of the results of the present study with those of a study conducted in individuals from the Dutch population.

In the mentioned study, the both AU of a total of 1353 individuals from the Dutch population (434 women and 919 men) aged between 18 and 99 years were examined, and for men, measurements were made on 908 left and 915 right AU, and for women – 429 right and 434 left AU, after which the results are presented in aggregate for both sides. Identical to the present study, the photometry method was applied here, using a frame with a measuring scale placed at a distance in front of the camera lens. A total of five AU dimensions were measured, three of which matched the dimensions used in the present study—ear length (D1), ear width (D2), and lobule length (D8).

The data from the reviewed study were not divided by age group, therefore the comparison with the present study was made with the pooled results found in men and women with the respective age ranges 18-88 years for men and 18-94 years for women. The data are presented in Table 33.

Table 33 Comparison of the results of the present study with those of a study conducted in individuals from the Dutch population. (Average values for dimesion 1, 2 and 8 are shown).

Population	Age	Sex	R/L	D1	D2	D8
Dutch	18-99	M	R+L	71,00	35,00	20,00
		F	R+L	64,00	33,00	19,00
Bulgarian (*present study*)	18-88	M	R	62,50	36,60	13,24
			L	62,17	36,49	13,67
	18-94	F	R	58,95	34,47	12,90
			L	58,56	34,39	13,26

From the presented data, it is established that according to D1, all average values for both sexes in the Dutch population are significantly greater than those in individuals from the Bulgarian population. The same is found in relation to the length of the lobule (D8).

At D2, it is noticeable that the mean values for both sexes in the participants of the present study are greater than those found in the Dutch population.

Similar to the results when comparing the data from the study of the Turkish population with those from the Bulgarian population, here too a significant difference is noticed at D8. In the study covering the Dutch population, this distance was also measured from the deepest point of the incisura intertragica, whereas in the present study, this distance was measured immediately below the level of the incisura. This is probably one of the reasons for the large difference in mean values in the two studies, but the presence or absence of lobular adhesions also matters.

As a summary of the data when comparing the mean values of the three dimensions between the two populations, it can be stated that the longitudinal dimensions (AU length and lobule length) are greater in individuals from the Dutch population, while the width of the AU appears to -large in individuals from the Bulgarian population.

3. **Comparison of the results of the present study with those of a study carried out in individuals from the Italian population.**

The cited study included a total of 843 individuals from the Italian population (497 men and 346 women) aged between 4 and 73 years. All participants have no data on traumatic injuries, congenital anomalies and diseases, as well as no operative interventions on the ear

area. In the study, the method of 3D morphometry was applied, through the use of an electromagnetic digitizer and pre-marked anthropometric points on the AU. The length (D1) and width (D2) of the AU were measured bilaterally in each of the participants.

The results of the mentioned research are divided into two groups by gender and eleven age groups as follows: 4-5 years, 6-7 years, 8-9 years, 10-11 years, 12-14 years, 15-17 years, 18-30 years, 31-40 years, 41-50 years, 51-64 years, 65-80 years. As the present study included individuals over 18 years of age, when comparing the results in the two populations, the first six age groups of the Italian population were not considered. From the present study, all four age groups were compared, respectively for men they are AG1 - 18-30 years, AG2 - 31-50 years, AG3 - 51-70 years. and AG4 – 71-88 years, and for women the groups are AG1 – 18-30 years, AG2 – 31-50 years, AG3 – 51-70 years. and AG4 – 71-94. Data from both studies are presented in Table 34.

Table 34 Comparison of the results of the present study with those of a study conducted in individuals from the Italian population. (Average values for dimension 1 and 2 are shown).

Population	Age	Sex	R/L	D1	D2	Population	Age	Sex	R/L	D1	D2
Italian	18-30	M	R	61,93	37,54	Bulgarian *(present study)*	18-30	M	R	58,67	34,17
			L	62,19	36,67				L	56,67	32,83
	31-40	M	R	64,38	39,15		31-50	M	R	59,40	34,75
			L	64,88	38,73						
	41-50	M	R	65,96	39,99				L	59,58	35,28
			L	65,77	39,12						
	51-64	M	R	67,28	38,99		51-70	M	R	65,12	38,18
			L	66,70	38,62				L	63,73	37,33
	65-80	M	R	74,16	40,53		71-88	M	R	65,84	38,66
			L	73,13	39,74				L	66,56	39,19
	18-30	F	R	56,11	34,51		18-30	F	R	51,93	30,64
			L	56,36	34,42				L	51,79	30,14
	31-40	F	R	59,43	35,72		31-50	F	R	54,73	31,86
			L	58,89	34,91						
	41-50	F	R	61,57	35,70				L	55,41	31,64
			L	60,91	36,57						
	51-64	F	R	64,80	35,32		51-70	F	R	61,61	35,42
			L	64,91	35,54				L	60,46	35,70
	65-80	F	R	64,02	36,13		71-94	F	R	62,40	37,13
			L	64,70	37,57				L	61,93	36,97

From the results presented in the table, it can be seen that all mean values for both sexes and in all age groups in the individuals from the Italian population are greater than those in the participants of the present study. Only for D2 in women in the last age groups, it can be seen that for the right AU the value of the size is greater in the representatives of the Bulgarian population, but for the same size of the left AU the average value in women from the Italian population is larger.

The results show that in terms of the total length and width of the AU, in both sexes and in all age groups, the values in the Italian population were found to be greater than those in the Bulgarian population.

4. Comparison of the results of the present study with those of a study conducted in individuals from the Russian population.

In the mentioned study, AU was examined bilaterally in a total of 290 individuals from the Russian population (190 men and 100 women) aged between 17 and 75 years. The research method used in this case is photometry, using the Iannarelli system, through which a total of twelve AU sizes have been established. When comparing the results of this study and the present study, only the total length and width of the AU (D1 and D2) were considered. The data from the reviewed study were not divided by age group, therefore the comparison with the present study was made with the pooled results found in men and women with the respective age ranges 18-88 years for men and 18-94 years for women. The data are presented in Table 35.

Table 35 Comparison of the results of the present study with those of a study conducted in individuals from the Russian population. (Average values for dimension 1 and 2 are indicated).

Population	Age	Sex	R/L	D1	D2
Russian	17-75	M	R	66,43	31,04
			L	65,83	30,77
		F	R	64,36	30,21
			L	64,79	30,77
Bulgarian *(present study)*	18-88	M	R	62,50	36,60
			L	62,17	36,49
	18-94	F	R	58,95	34,47
			L	58,56	34,39

Similar to the results of the comparison with some of the previously considered populations, here, too, the length of the AU (D1) bilaterally in both sexes has larger mean values in

individuals from the Russian population compared to those of the Bulgarian population participating in the present study. Regarding the width of the AU (D2), it can be seen that the values in the Bulgarian population are significantly greater than those in the Russian population.

From the indicated data in both studies, it can be concluded that individuals from the Russian population have larger average values regarding the length of the AU, while the width of the AU is greater in the individuals from the Bulgarian population.

5. Comparison of the results of the present study with those of a study conducted in individuals from the Indian population

The study reviewed was conducted on a total of 505 individuals from the Indian population (225 men and 280 wAomen) aged between 18 and 64 years. The method of examining the AU is identical to the one used in the present study - a special tripod with a camera and a frame with a millimeter grid was used, and the measurements themselves were made according to the corresponding photographs of the left and right AU. The studied dimensions fully correspond to those of the present study (D1-D9).

The participants in the study of the Indian population were divided into two groups according to gender and into four groups according to age, respectively 18-30 years, 31-40 years, 41-50 years. and 51-64 years. From the present study, three of the age groups were compared, respectively AG1 – 18-30 years, AG2 – 31-50 years and AG3 – 51-70 years. The latter age group was not included because it included individuals over 71 years of age, and in the Indian population study, the oldest individuals were 64 years of age. Data from both studies are presented in Table 36.

When comparing the results of the two studies, it can be seen that at D1, all average values in both sexes are greater in individuals from the Indian population, with the exception of one of the values in men in the last age group, where in the Bulgarian population it is by 0.07mm greater than that in the Indian population. The results are similar for D3, D4, D5 and D9, where also all values for both sexes are greater in the Indian population, with minor exceptions for D3 in the last age group and for D5 in the first and last age groups, while for D4 and D9 there are no such exceptions, i.e. all values in individuals from the Bulgarian population are smaller. For D2 and D8, all mean values are greater in the individuals from the Bulgarian population, except

for single values in the female gender in the first age group. Regarding D6 and D7, all mean values were significantly lower in the Indian population.

As a summary, it can be stated that the length dimensions of the AU (D1, D3, D4, D5) in the individuals from the Bulgarian population are smaller than those in the Indian population, with the exception of the length of the lobule, which has larger values in the Bulgarian population. The width of the AU and of the lobule, as well as the length and width of the concha, are smaller in individuals from the Indian population compared to those from the Bulgarian population.

Table 36 Comparison of the results of the present study with those of a study conducted in individuals from the Indian population. (Average values for sizes 1 and 9 are indicated).

Population	Age	Sex	R/L	D1	D2	D3	D4	D5	D6	D7	D8	D9
Indian	18-30	M	R	60,65	31,47	28,37	13,06	19,16	21,71	15,86	11,39	19,69
			L	60,53	31,61	28,39	12,88	19,22	22,06	16,14	11,57	20,14
		F	R	58,69	30,09	27,06	13,21	18,72	21,02	15,37	11,28	18,79
			L	58,38	30,16	27,24	13,06	18,56	21,22	15,62	11,27	18,86
	31-40	M	R	62,63	31,92	28,69	13,40	20,54	22,42	15,98	11,86	20,52
			L	62,62	32,26	28,91	13,35	20,34	22,65	16,11	12,06	20,62
		F	R	60,62	31,00	27,52	13,29	19,82	21,61	15,94	12,01	19,72
			L	60,18	30,79	27,58	12,87	19,68	21,92	16,22	11,95	19,59
	41-50	M	R	64,79	32,93	30,13	13,02	21,43	22,34	15,82	11,98	20,84
			L	64,38	33,05	30,04	13,00	21,16	22,80	16,16	11,98	20,71
		F	R	60,98	31,11	28,18	12,67	20,20	21,84	16,33	12,35	20,02
			L	61,04	31,65	27,97	12,80	20,02	21,78	16,53	12,49	20,13
	51-64	M	R	65,05	33,00	29,02	14,38	21,82	22,89	15,62	12,60	20,60
			L	64,96	32,85	29,27	14,38	21,53	23,18	15,78	12,69	0,58
		F	R	64,15	32,06	28,94	13,06	22,21	21,73	16,00	12,52	19,33
			L	61,97	31,94	28,94	13,21	21,73	21,82	16,09	12,70	19,76
Bulgarian (*present study*)	18-30	M	R	58,67	34,17	28,28	10,33	19,67	23,17	17,78	12,11	19,28
			L	56,67	32,83	27,44	9,78	18,89	22,17	16,94	12,22	19,28
		F	R	51,93	30,64	26,71	8,07	17,14	22,29	16,57	10,21	16,36
			L	51,79	30,14	27,21	7,86	16,64	21,36	15,93	10,50	16,36
	31-50	M	R	59,40	34,75	29,13	10,45	19,83	23,15	17,73	13,00	19,75
			L	59,85	35,28	28,03	11,48	20,40	23,38	18,35	12,70	19,90
		F	R	54,73	31,86	26,18	10,00	18,55	22,41	17,46	12,41	18,64
			L	55,41	31,64	25,96	10,32	19,14	22,46	16,73	12,46	19,32
	51-70	M	R	65,12	38,18	30,58	12,97	21,58	24,36	19,91	13,79	24,33
			L	63,73	37,33	28,64	12,88	22,21	24,39	19,15	14,70	24,06
		F	R	61,61	35,42	29,18	11,27	20,97	24,33	19,61	13,70	22,24
			L	60,46	35,70	27,58	11,27	21,61	23,73	19,58	14,24	21,76

6. Comparison of the results of the present study with those of a study conducted in individuals from the Iraqi population

The cited study included a total of 311 individuals from the Iraqi population (157 males and 154 females) aged between 18 and 22 years. The method used in this study is direct anthropometry through the use of a digital caliper. And in this study, the dimensions of the AU were the same as those in the present study (D1 to D9).

The reviewed study included only young individuals from the Iraqi population aged between 18-22 years, therefore the comparison with the present study was made with the results found in men and women in AG1 (18-30 years). The data are presented in Table 37.

Table 37 Comparison of the results of the present study with those of a study conducted in individuals from the Iraqi population. (Average values for dimension 1 and 9 are indicated).

Population	Age	Sex	R/L	D1	D2	D3	D4	D5	D6	D7	D8	D9
Iraqi	18-22	M	R	53,30	33,60	48,10	26,90	32,40	21,00	33,50	7,60	20,30
			L	53,40	33,50	48,30	27,00	32,00	21,20	33,60	7,80	20,30
		F	R	52,20	33,00	46,70	25,70	32,00	20,50	32,60	8,00	20,00
			L	52,20	33,00	46,80	25,70	32,20	20,80	32,70	8,40	20,10
Bulgarian *(present study)*	18-30	M	R	58,67	34,17	28,28	10,33	19,67	23,17	17,78	12,11	19,28
			L	56,67	32,83	27,44	9,78	18,89	22,17	16,94	12,22	19,28
		F	R	51,93	30,64	26,71	8,07	17,14	22,29	16,57	10,21	16,36
			L	51,79	30,14	27,21	7,86	16,64	21,36	15,93	10,50	16,36

When analyzing the data from the two studies, it can be seen that for D3, D4, D5, D7 and D9, the average values for individuals from the Iraqi population are significantly higher than those for the Bulgarian population. A similar result was observed for D1 and D2, but only in the females, as for D2 of the left AU in males, the values in the Iraqi population were also greater. Regarding D6 and D8, all results for both sexes in the Bulgarian population are greater than those in the Iraqi population.

Most dimensions in the individuals of the Bulgarian population were found to be smaller than those of the Iraqi population, except for the length of the concha and the length of the lobule, as well as for the total length and width of the AU, but only in the females.

7. Comparison of the results of the present study with those of a study conducted in individuals from the Sudanese population.

In the mentioned study, AU was examined bilaterally in a total of 200 individuals from the Sudanese population (100 women and 100 men) aged between 18 and 30 years. The study used the method of direct anthropometry through the use of a digital caliper. A total of six dimensions of the left and right AU were measured, which matched the dimensions in the present study – length and width of the ear (D1 and D2), length and width of the concha (D6 and D7), and length and width of the lobule (D8 and D9).

Data from the reviewed study of the Sudanese population were compared with those from the first age group of the present study (18-30 years). The data are presented in Table 38.

Table 38 Comparison of the results of the present study with those of a study conducted in individuals from the Sudanese population. (Average values for dimension 1, 2, 6, 7, 8 and 9 are shown).

Population	Age	Sex	R/L	D1	D2	D6	D7	D8	D9
Sudanese	18-30	M	R	61,61	34,22	26,69	18,67	17,07	20,91
			L	62,24	33,92	26,55	18,95	17,31	20,46
		F	R	57,96	32,24	24,7	17,6	17,04	19,56
			L	58,93	31,46	24,75	17,96	17,2	18,95
Bulgarian *(present study)*	18-30	M	R	58,67	34,17	23,17	17,78	12,11	19,28
			L	56,67	32,83	22,17	16,94	12,22	19,28
		F	R	51,93	30,64	22,29	16,57	10,21	16,36
			L	51,79	30,14	21,36	15,93	10,50	16,36

When comparing the results of the two studies, it was found that all values bilaterally in both sexes were greater in individuals from the Sudanese population compared to those from the Bulgarian population.

8. Comparison of the results of the present study with those of a study conducted on individuals from the Nigerian population.

In this study, the AU of a total of 217 individuals from the Nigerian population (77 women and 140 men) aged between 18 and 65 years were examined. Three dimensions of the left and right AU were measured by the method of direct anthropometry using a standard caliper. All three dimensions correspond to those of the present study – ear length (D1), lobule length and width (D8 and D9).

The data from the reviewed study were not divided by age group, therefore the comparison with the present study was made with the pooled results found in men and women

with the respective age ranges 18-88 years for men and 18-94 years for women. The data are presented in Table 39.

Table 39 Comparison of the results of the present study with those of a study conducted in individuals from the Nigerian population. (Average values for dimension 1, 8 and 9 are shown).

Population	Age	Sex	R/L	D1	D8	D9
Nigerian	18-65	M	R	56,00	11,30	13,10
			L	56,20	11,20	13,30
		F	R	56,10	10,70	13,80
			L	55,80	10,50	13,60
Bulgarian *(present study)*	18-88	M	R	62,50	13,24	22,17
			L	62,17	13,67	22,25
	18-94	F	R	58,95	12,90	20,92
			L	58,56	13,26	20,89

When comparing the results of the two studies, it was found that all mean values for the three dimensions bilaterally and in both sexes were greater in individuals from the Bulgarian population compared to those from the Nigerian population.

Conclusions for Task 5:

- The dimensions of the AU in the individuals from the Bulgarian population participating in the present study were found to be different from those in the Turkish, Dutch, Italian, Russian, Indian, Iraqi, Sudanese and Nigerian populations.

- All average values of the dimensions of the AU bilaterally for both sexes in individuals from the Bulgarian population are smaller than those in the Turkish, Italian and Sudanese populations.

- The length of the AU, as well as some of the other length dimensions studied (length of the tragus, length of the AU below and above the tragus) in the Bulgarian population were also found to be smaller compared to those in the Dutch, Russian, Indian and Iraqi populations.

- All values of left and right AU sizes in men and women from the Bulgarian population are greater than those in the Nigerian population.

- The width of the AU in individuals from the Bulgarian population was found to be greater compared to that in the Dutch, Russian and Indian populations.

Most literature sources show that there is some difference in the anthropometric dimensions of the AU in individuals from different population groups, which was also confirmed in the present study.

Several studies have shown that the longitudinal dimensions of the AU in individuals from the Indian population are among the smallest compared to several other populations (Turkish, Italian, American, Japanese, etc.). Other studies have shown that individuals from the Iraqi and Nigerian populations have smaller AU sizes than those from the Indian population. When comparing the results of the present study with one of those conducted on the Indian population, it was found that the length dimensions in the Bulgarian population were smaller, but compared to those from a study conducted on the Nigerian population, they were larger.

The above-mentioned differences between the values of the sizes of the AU in different populations, including the Bulgarian one, can be due to various reasons, and these can be both factors related to the characteristics of individuals belonging to the respective population groups, and factors related to the research methodology. As noted above, each of the studies was conducted using a different anthropometric method, and also the actual measurement of some of the distances differed. These reasons probably influence to some extent the results in different populations and the comparison of data between them.

IV. CONCLUSIONS

During the implementation of the tasks and the analysis of the results of the conducted research, the following conclusions were drawn:

Among all studied auricles in both sexes, no repetition of the values of all nine anthropometric measurements was found, which indicates the uniqueness of this part of the human body and the potential of the auricle for personality identification. Among all study participants, no complete symmetry between left and right pinna was found.

Anthropometric dimensions of the auricle show sexual dimorphism, with all nine sizes having larger values in males. When comparing the results after dividing the individuals into age groups, the values in men were also greater than those in women except for one size of the left AU in the age group 51-70 years, where in women the value was less than 1 mm larger than that in men, as well as one size of the right AU in the age group over 70 years, where the values in both sexes are the same.

The most pronounced sexual dimorphism was observed in relation to the total length of the auricle, while the weakest manifestation of dimorphism was found in relation to the dimensions of the concha.

The mean values of the two pinna sizes bilaterally in both sexes increased with age, with the rate of increase varying among age groups.

The clearest increase in mean values with advancing age in males and females was found for total auricle length and width, while the smallest increase was observed for concha length.

The most pronounced age difference is found in the range between 31 and 70 years, while before and after this period the mean values do not increase significantly, and for some dimensions even a lower mean value is observed in the group with older individuals.

The results of the anthropometric study of the pinna did not show a relationship with the height of the individuals in both sexes. In both sexes, there was no clear increase in the mean values of the nine pinna dimensions with increasing height, and for some of

the dimensions, even lower mean values were found in taller individuals compared to shorter ones. height.

When comparing the results of the present study with those obtained when studying individuals from other populations, it was found that there is a population difference in the anthropometric dimensions of the auricle.

All mean values of pinna sizes in male and female individuals of the Bulgarian population were smaller than those of the Turkish, Italian and Sudanese populations, but were larger than those of the Nigerian population.

The present study was conducted to determine whether anthropometric measurements of the pinna could be used in the forensic identification process.

The results of the study showed that the values of the nine investigated sizes differed between men and women, which could be used in determining gender, alone or in combination with other methods.

With regard to age, a dependence was also found, namely that the size of the auricle increases with age. For a more concrete determination of the rate of growth of the auricle, it is necessary to study a larger number of individuals, as well as those who are under 18 years of age. However, data from the present study could be used in combination with other age determination methods in the forensic identification process.

A comparison of AU dimensions in individuals from the Bulgarian population with those from several other populations found that they differ, particularly in terms of overall size. This shows that the dimensions of the auricle could also be used in the determination of population affiliation in the process of forensic identification.

The in-depth study of the dimensions of the auricle is essential not only for the forensic identification of the person, but also for many other fields of science.

The present study shows that the characteristics of the auricle can provide very useful personal identification information to serve forensics in cases related to the investigation of CCTV footage, the investigation of fatalities in plane crashes, explosions and other mass disasters, as well as in the cases of intentional mutilation and

dismemberment of the body. The study of the auricle could also find applicability in the creation and development of already existing automated biometric identification systems.

The normal dimensions of the pinna, characteristic of a given population, sex and age, can be essential for the diagnosis of some congenital and acquired conditions (Down's syndrome, presence of Frank's sign, etc.). The data from the present study could also be used in reconstructive surgery of the auricle, especially in cases where surgical intervention of both auricles is required.

The information collected during the present study can also be considered as a useful database for the dimensions of the auricle in healthy individuals from the Bulgarian population, which is essential for the development of anthropology in Bulgaria.

V. CONTRIBUTIONS

1. THEORETICAL CONTRIBUTIONS

1.1. A comprehensive analysis was made regarding the study of the earlobe as a means of personal identification.

1.2. For the first time in Bulgaria, an anthropometric study focused specifically on the auricle of individuals from the Bulgarian population was conducted.

1.3. The research conducted showed that the anthropometric dimensions of the auricle differ according to gender, age and population affiliation.

2. PRACTICAL CONTRIBUTIONS

2.1. Anthropometric dimensions of the pinna can be used as an additional tool in the process of forensic identification of the person, especially in terms of determining the main components of the biological profile (sex, age, population affiliation).

2.2. A protocol was created for the anthropometric examination of the auricle, which could be used in the preparation of a forensic medical examination for the identification of the person.

VI.   DISSERTATION-RELATED PUBLICATIONS AND PARTICIPATIONS

1. Velkova D., Sex differences in anthropometric study of the auricle, Varna Medical Forum, 11 (2), 168-173.

2. Velkova D. The external ear as a tool for human identification – a review. Spring Conference "Identification of the Living", British Assocciation for Human Identification (BAHID), 10th April 2021.

VII.   ACKNOWLEDGMENTS

I thank everyone who contributed to the realization of this dissertation.

I thank my supervisor, Assoc. Prof. Dr. Viliam Dokov, MD, PhD, for his patience, time and support in the process of preparing the dissertation.

I thank all my colleagues from the Clinic of Forensic Medicine at St. Marina Hospital - Varna for the support and trust in me.

I thank Dr. Georgi Hrisulev for his assistance in conducting the scientific experiment.

I thank all the participants who took part in the scientific study.

I thank my family and all my friends for their support, understanding and belief that I will succeed.