Article

Facial Soft Tissue Thickness Values for Romanian Adult Population

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Abstract: Introduction: Forensic identification practice requires a multitude of methods for positive identification, among which the facial reconstruction occupies a high place. For this to be done in the best way possible, it is mandatory that each population have their own database regarding soft tissue thickness. Objective: The present research is focused on creating such a database for the Romanian adult population and on exploring the statistical distribution and correlation of craniometric landmarks, overall, and in groups defined according to sex and weight categories. This might provide support in estimating the values of missing landmarks or other variables (e.g., age, sex) for unidentified bodies. Methods: Twelve craniometric landmarks were measured on 100 cadavers less than 24 h after death. Results and discussions: Of the 12 anatomical landmarks, only one appears to manifest statistically significant differences between sexes, and seven landmarks appear to vary significantly among the weight categories. Additionally, some evidence of interpopulation differences in the average soft tissue thicknesses were observed by the comparison of these data with similar studies from Caucasian groups with different geographic origin. Additionally, correlations between facial landmarks were examined, overall and between sexes.

Keywords: soft tissue thicknesses; facial reconstruction; Romanian adult cadavers; forensic anthropology

1. Introduction

The thickness of the soft tissues at the level of the facial massif represents an important landmark in anthropological forensic practice, especially for the possibility of performing cranio-facial reconstruction. Cranio-facial reconstruction is a useful technique and is used in the field of forensic anthropology, the result of which is the creation of an image starting from the skull arranged for anthropological analysis [1,2]. It has multiple important uses, primarily when the forensic anthropologist has only one skull at his disposal that cannot give you much information about the person to whom it belonged; it is also important in the investigations of victims of genocide, and victims of mass disasters (wars, natural or intentional accidents, etc.) [2–4].

The history of cranio-facial reconstruction places it somewhere in the early nineteenth century; however, the method became notorious with the works of Gerasimov (1968). In its primary stages, cranio-facial reconstruction was a more artistic method, depending on the researcher's skills as a sculptor. Additionally, the cranio-facial reconstruction method

began by modeling clay or plasticine to restore the depth of soft tissue on the skull of the deceased. This tissue depth (thickness of the cranio-facial soft tissues) is established by measuring it at certain points and interpreting those measurements. The key to cranio-facial reconstruction lies in the understanding that each head/skull has distinct features that gives the individuality of a person. It is also important for each population to hold such values of soft tissue thickness, as each population is characterized by unique and individual traits [4,5].

The points measured to estimate the values of the thickness of the facial soft tissues are called craniometric landmarks (or facial landmarks) These landmarks are key points of the face with a certain biometric and geometric significance. These can have a skeletal or a soft tissue base, depending on where it is located, on the bone or directly on the skin. In the first case, they are called craniometric landmarks of hard tissue, and in the second case, they are called craniometric landmarks of soft tissue [4–7].

The establishing of the soft tissue thicknesses values, as well as the relationship between soft and hard tissue, can be made by means of radiological data—X-ray, computed tomography, nuclear magnetic resonance, ultrasound—which can be in vivo, or on cadaveric material, the last one being a direct method via needle puncture [1,8–12]. International literature is characterized by vast research regarding soft tissue thicknesses values. Thus, a number of countries (France, Brazil, Portugal, etc.) have conducted and are conducting numerous research to establish soft tissue thicknesses values and to develop methods for craniofacial reconstruction (based on computed-tomography images, cadavers, X-ray, etc.), specific to each population [1,8–13].

Despite all these developments, the Romanian population does not have any research data regarding the soft tissue thicknesses values to allow for an accurate craniofacial reconstruction. The importance of these data for Romania is, first, for the alignment at the international standard of the forensic identification process, and, second, to help the development of research in forensics. Another important aspect is the fact that Romania is a country with a predisposition for disasters with multiple victims because it is a country with an important seismic activity.

This study examines the distribution of values and the relationships among twelve craniometric landmarks for a dataset containing information on 100 Romanian adults. Data centrality, overall and on sexes, is compared with results from previous studies on similar populations (Caucasians) and data collection techniques. Identifying the landmarks with significant differences between sexes and among weight categories can provide valuable support in estimating the missing values when data collection is incomplete and/or the bodies are unidentified. Thus, the main purpose of this study was to develop and propose standard values for the thickness of cranio-facial soft tissues for the adult population of Romania.

2. Materials and Methods

2.1. Selection of the Study Sample, Criteria for Inclusion and Exclusion

In order to estimate the standard values for the thickness of the facial soft tissues of the adult population of Romania, an exploratory study with a descriptive experimental approach was developed on 100 subjects consisting of cadaveric bodies of adult deceased persons who were subjected to forensic autopsy in a delimited territory on the North-East region of Romania. The type of study was a prospective one.

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethic Committee of "Grigore T. Popa" Medicine and Pharmacy University.

The inclusion criteria were represented by corpses with characteristics of skeletal maturity, with the absence of cranio-facial malformations or other modifications of the facial massif that could have influenced the measurements made. The cadaveric bodies with an PMI (postmortem interval) of more than 24 h or in an advanced state of decomposition were excluded from the study, including those that had traumatic marks at the level of the facial massif.

2.2. Recording Information in the Database

For the analyzed study group, regarding the personal data, we recorded the sex, age, height measured postmortem and the constitution of the cadaver according to body mass index (BMI) (underweight means a BMI < 18.5; normal weight means a BMI between 18.5 and 24.9; and overweight that means a BMI > 25).

2.3. Working Methodology

As a working methodology, the authors conducted the study on cadaveric material, having at their disposal deceased persons whose autopsy is mandatory and is carried out completely. The corporeal material included in the study is an important source of research in forensic anthropology, as it allows researchers to work on known parameters, in this case, the waist, sex and known age of deceased people.

The study was conducted on 100 bodies, including 52 males and 48 females aged between 22 and 85 years. As a working material in the study, the cadaveric bodies and one skin thickness measuring instrument length 0–30 mm, with the possibility of measuring up to 30 mm (Figure 1), were used. The instrument used for measuring is a manual caliper, which has a needle with which it pricks, the sting at the level of the craniometric landmarks being performed perpendicularly. The craniometric landmarks were located via palpation.

Figure 1. Skin thickness measuring instrument length 0–30 mm.

Measurements, which were taken in horizontal (supine) position, were made at the level of 12 craniometric landmarks of the facial massif, of which 8 on the midline, respectively, of 4 bilateral craniometric landmarks (left side, respectively, on the right side). Table 1 is a description of the craniometric landmarks included in the present study [7,13].

Table 1. Description of craniometric landmarks used for the measurements.

Anatomical Landmarks	Description
Midline landmarks	
1. Supraglabella	The most anterior point of the forehead, above the glabella în the mid-sagital plane
2. Glabella	The most proeminent point between the supraorbital ridges în the mid-sagital plane
3. Nasion	Midpoint of the frontonasal suture
4. Rhinion	The midpoint of the internasal suture on its most inferior and anterior portion
5. Mid-philtrum	The lowest point of the interior margin of the pyrifom aperture at the base of the nasal spine projected onto the sagittal plane
6. Supramental	Centred in the fold of chin
7. Pogonion	The most proeminent point in the midline of the mental protuberance
8. Gnation	Most inferior point of the mandible in the midsagital plane

Table 1. *Cont.*

Anatomical Landmarks	Description
Bilateral landmarks	
9. Supraorbital l_mid-supraorbital (left) r_mid-supraorbital (right)	Centre upper part of the margin of the orbit
10. Infraorbital l_mid-infraorbital r_mid-infraorbital	Centre lower part of the margin of the orbit
11. mid-zygomatic l_mid-zygomatic r_mid-zygomatic	Perpendicular point to the lateral orbit border, centred between the lower border of the orbit and the lower portion of the zygomatic process
12. zygion l_zygion (left) r_zygion (right)	The most lateral point of the zygomatic arch

2.4. Statistical Analysis

The distribution of facial landmarks and other personal data was examined using Exploratory Data Analysis for the entire dataset, between sexes, and within three weight categories. Correlations among landmarks were computed on the entire dataset and on sexes. Inferential statistics techniques, such as the Fisher's exact test, the Mann–Whitney (Wilcoxon) test, and the Kruskal–Wallis test, helped assess the variability of facial landmarks among categories/groups defined by sex or by weight category. All tests were non-parametric since the distributions of all facial landmarks are not normal, as reported by the Shapiro–Wilk test of normality (see Section 3).

Data were prepared and analyzed with R programming language [14]. The *tidyverse* ecosystem of packages (*dplyr*, *tidyr*, *readr*, *stringr*) [15] was the main tool for data preparation tasks. Exploratory data analysis relied mainly on two packages, *gtsummary* [16] and *ggplot2* [17] (which is part of the tidyverse). Tables 2 and 3 were generated with packages *gtsummary* and *flextable* [18].

Table 2. Descriptive characteristics of parameters studied in relation to sex.

Variable	Statistic	Overall, N = 100	Female, N = 42	Male, N = 58	*p*-Value [1]
age_years	Median (IQR)	52 (42, 65)	54 (38, 67)	52 (42, 59)	0.4
height_mm	Median (IQR)	168 (165, 176)	165 (160, 167)	174 (168, 178)	<0.001
weight_category					0.4
a.Underweight	n (%)	50 (50%)	21 (50%)	29 (50%)	
b.Normal weight	n (%)	42 (42%)	16 (38%)	26 (45%)	
c.Overweight	n (%)	8 (8.0%)	5 (12%)	3 (5.2%)	
supraglabella	Median (IQR)	2.80 (2.00, 3.00)	2.80 (2.15, 3.00)	2.75 (2.00, 3.00)	0.3
glabella	Median (IQR)	3.10 (2.80, 3.30)	3.10 (2.73, 3.20)	3.10 (2.92, 3.30)	0.7
nasion	Median (IQR)	3.15 (2.77, 3.92)	3.00 (2.62, 3.50)	3.40 (2.92, 4.00)	0.030
rhinion	Median (IQR)	2.00 (1.88, 2.50)	2.10 (1.83, 2.58)	2.00 (1.90, 2.50)	0.5
mid_philtrum	Median (IQR)	5.00 (4.25, 5.60)	5.20 (5.00, 5.40)	4.80 (4.00, 5.60)	0.11
supra_mentale	Median (IQR)	5.60 (4.27, 7.00)	6.00 (4.20, 6.50)	5.60 (4.53, 7.07)	0.8
pogonion	Median (IQR)	4.00 (3.10, 5.45)	4.60 (3.18, 5.60)	3.50 (3.10, 5.00)	0.4
gnathion	Median (IQR)	3.40 (2.80, 4.30)	4.05 (2.85, 4.60)	3.05 (2.73, 3.90)	0.11
l_mid_supraorbital	Median (IQR)	3.00 (2.80, 3.50)	3.00 (2.80, 3.98)	3.00 (2.90, 3.50)	0.7
l_mid_infraorbital	Median (IQR)	2.50 (2.10, 2.90)	2.40 (2.10, 2.90)	2.55 (2.30, 3.00)	0.4
l_zygion	Median (IQR)	3.10 (3.00, 3.53)	3.10 (3.00, 4.00)	3.10 (2.92, 3.50)	0.3
r_mid_supraorbital	Median (IQR)	3.00 (2.50, 3.10)	3.00 (2.50, 3.62)	2.90 (2.50, 3.10)	0.5
r_mid_infraorbital	Median (IQR)	2.55 (2.08, 2.80)	2.50 (2.00, 2.80)	2.60 (2.10, 2.80)	0.8
r_zygion	Median (IQR)	3.10 (2.90, 3.70)	3.20 (3.00, 3.60)	3.00 (2.83, 4.00)	0.2
l_mid_zigomatic	Median (IQR)	3.10 (2.80, 3.90)	3.15 (3.00, 4.00)	3.10 (2.50, 3.60)	0.057
r_mid_zigomatic	Median (IQR)	3.10 (3.00, 3.60)	3.10 (2.62, 3.80)	3.10 (3.00, 3.60)	0.6

[1] Wilcoxon rank sum test; Fisher's exact test.

**Table 3.** Descriptive characteristics of parameters studied in relation to BMI categories.

Variable	Statistic	Overall, N = 100	a.Underweight, N = 50	b.Normal weight, N = 42	c.Overweight, N = 8	*p*-Value [1]
			Weight Category			
age_years	Median (IQR)	52 (42, 65)	52 (42, 65)	52 (45, 58)	67 (22, 67)	0.8
sex						0.4
Female	n (%)	42 (42%)	21 (42%)	16 (38%)	5 (62%)	
Male	n (%)	58 (58%)	29 (58%)	26 (62%)	3 (38%)	
height_mm	Median (IQR)	168 (165, 176)	168 (165, 176)	168 (166, 176)	162 (159, 185)	0.7
supraglabella	Median (IQR)	2.80 (2.00, 3.00)	2.45 (2.00, 2.98)	2.80 (2.30, 3.10)	3.60 (2.80, 4.30)	0.002
glabella	Median (IQR)	3.10 (2.80, 3.30)	3.10 (2.60, 3.45)	3.00 (3.00, 3.18)	3.70 (3.10, 4.20)	0.038
nasion	Median (IQR)	3.15 (2.77, 3.92)	3.50 (2.92, 4.38)	3.00 (2.70, 3.20)	4.10 (3.20, 5.00)	<0.001
rhinion	Median (IQR)	2.00 (1.88, 2.50)	1.90 (1.80, 2.22)	2.25 (2.00, 2.60)	2.20 (1.90, 2.40)	0.001
mid_philtrum	Median (IQR)	5.00 (4.25, 5.60)	5.00 (3.92, 5.80)	5.20 (4.70, 5.40)	5.30 (5.00, 5.60)	0.3
supra_mentale	Median (IQR)	5.60 (4.27, 7.00)	5.00 (4.32, 6.38)	6.00 (3.62, 7.00)	6.95 (5.60, 9.10)	0.051
pogonion	Median (IQR)	4.00 (3.10, 5.45)	3.75 (3.00, 5.30)	4.00 (3.10, 5.80)	4.20 (4.00, 4.20)	0.6
gnathion	Median (IQR)	3.40 (2.80, 4.30)	3.00 (2.60, 4.10)	3.15 (2.83, 4.12)	5.35 (5.10, 5.60)	<0.001
l_mid_supraorbital	Median (IQR)	3.00 (2.80, 3.50)	3.00 (2.90, 3.80)	3.00 (2.80, 3.20)	8.95 (2.10, 13.80)	0.2
l_mid_infraorbital	Median (IQR)	2.50 (2.10, 2.90)	2.40 (2.10, 2.77)	2.70 (2.35, 2.90)	4.60 (1.90, 7.00)	0.11
l_zygion	Median (IQR)	3.10 (3.00, 3.53)	3.10 (3.00, 3.50)	3.00 (2.90, 3.48)	4.05 (3.00, 5.00)	0.061
r_mid_supraorbital	Median (IQR)	3.00 (2.50, 3.10)	2.80 (2.50, 3.10)	3.00 (2.70, 3.10)	3.95 (2.10, 4.80)	0.4
r_mid_infraorbital	Median (IQR)	2.55 (2.08, 2.80)	2.30 (1.90, 2.80)	2.50 (2.40, 2.77)	4.90 (2.70, 7.00)	0.002
r_zygion	Median (IQR)	3.10 (2.90, 3.70)	3.10 (2.90, 3.50)	3.00 (2.62, 4.00)	4.10 (2.10, 5.00)	0.5
l_mid_zigomatic	Median (IQR)	3.10 (2.80, 3.90)	3.05 (2.50, 3.50)	3.10 (3.00, 3.90)	6.40 (3.10, 8.00)	0.003
r_mid_zigomatic	Median (IQR)	3.10 (3.00, 3.60)	3.10 (3.00, 3.50)	3.10 (2.62, 3.75)	4.55 (3.10, 6.00)	0.2

[1] Kruskal-Wallis rank sum test; Fisher's exact test.

All statistical tests were performed in base R. The correlation plot was produced with the *corrplot* package [19]. Statistical test results and charts were obtained using the *ggstatsplot* package [20] which computes and displays the following parameters for each test: the statistics, the *p*-value, the effect size, and the 95% confidence interval of the effect size.

3. Results

Figure 2 presents the overall distribution (as density curves) of all numerical variables in the 100-case dataset. Some variables, such as *glabella* and *l_mid_supraorbital* are more concentrated around their central values, whereas others, such as *nasion* and *supraglabella*, are more scattered. The Shapiro–Wilk test of normality (not shown) reveals that *age_years* is the only numeric variable with a normal distribution. This determines the types of tests to be chosen when assessing the statistical significance of the differences among groups or the correlation among variables.
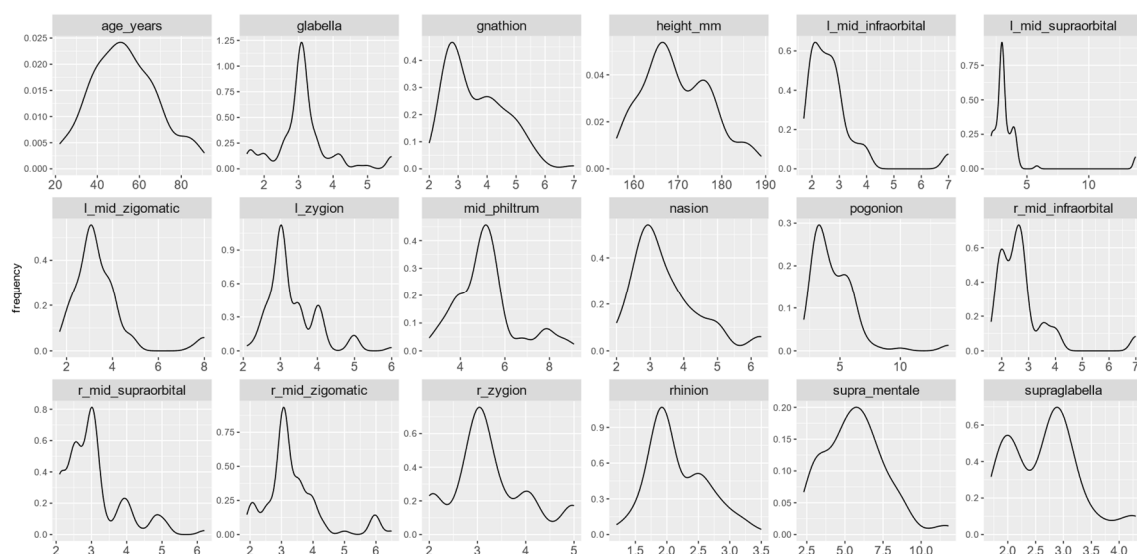

Figure 2. Overall distribution of each numeric variable.

Tables 2 and 3 provide descriptive statistics by grouping the results by sex (Table 2) and weight category (Table 3). The last column in both tables refers to the *p*-value of the statistical tests concerning group differences (Wilcoxon rank sum test and Kruskal–Wallis test).

Table 2 provides the descriptive statistics when grouping the results by sex. Last column in the table contains the *p*-value of the statistical tests concerning group differences (the Wilcoxon rank sum test). Of the 100 (deceased) people in the dataset, 48 were females and 52 males. Overall median age was 52 years (54 for females and 52 for males). The difference on age distribution between females and males was not statistically significant (*p*-value = 0.4). By contrast, Table 2 suggests that the differences on height between females and males are statistically significant (*p*-value < 0.001).

According to Table 2, only one landmark appeared to manifest statistically significant differences between sexes, i.e., *nasion*. For *l_mid_zygomatic*, at 0.05 significance level (alpha), the difference is not significant. Because the Shapiro–Wilk normality test reports W = 0.896, *p*-value < 0.001 for *nasion*, and W = 0.755, *p*-value < 0.001 for *zygomatic*, the statistical differences between sexes on both variables were assessed with the non-parametric Mann–Whitney test—see Figure 3.
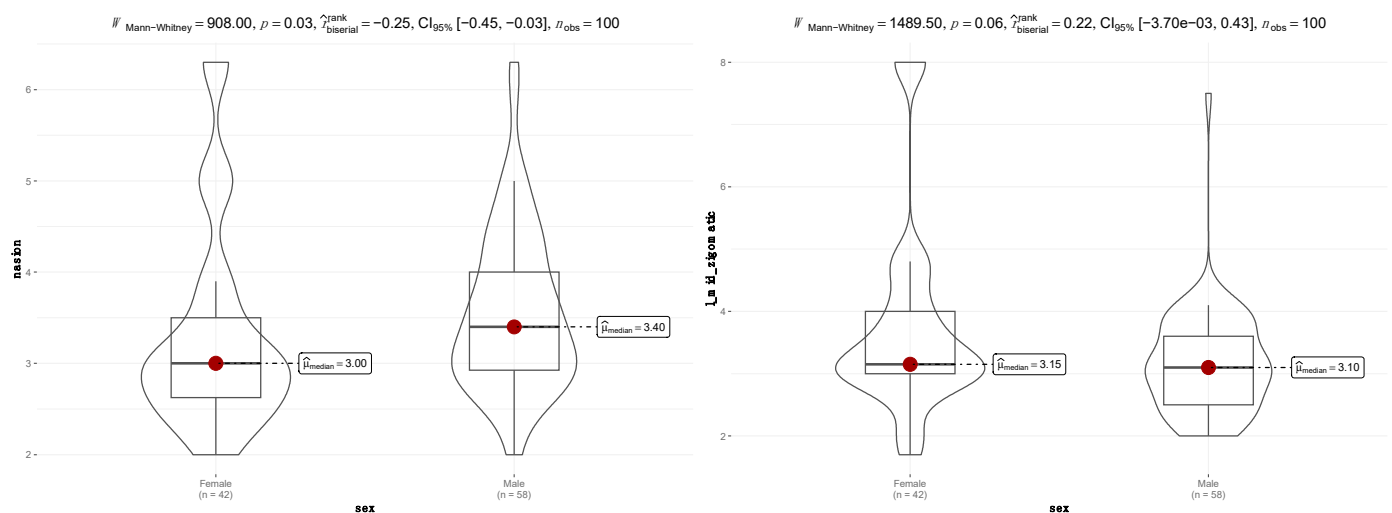
Figure 3. Non-parametric tests for assessing the differences between sex on nasion (**left**) and l_mid_zigomatic (**right**).

For variable *nasion* (Figure 3 (left)), the Mann–Whitney test assesses the null hypothesis that, for randomly selected values of *nasion* for females (X) and values of *nasion* for males (Y), the probability of X being greater than Y is equal to the probability of Y being greater than X. The *p*-value (0.03) is smaller than the 0.05, and the effect size is medium (−0.25 CI95% [−0.45, −0.03]); thus, there is sufficient evidence to reject H0. *Nasion* median is larger for males than females (3.49 vs. 3.00) and the differences between the two distributions are statistically significant. As for variable *l_mid_zygomatic* (Figure 3 (right)), not only the *p*-value exceeds 0.05, but also the 95% confidence interval of the effect size covers the value of zero; therefore, the differences between sexes for *l_mid_zygomatic* are not significant.

Next, the mean values of the facial landmarks were compared with values found in other studies concerning similar populations using the same method of data collection. Figure 4 displays the comparative average facial soft tissue thicknesses measured using needle puncture methods on female and male cadavers from three different geographic origins, Portugal, Romania, and Spain, based on the paper published by [9,21]. The chart includes eight landmarks, since only these are common in both our study and the study concerning Portugal and Spain [9].
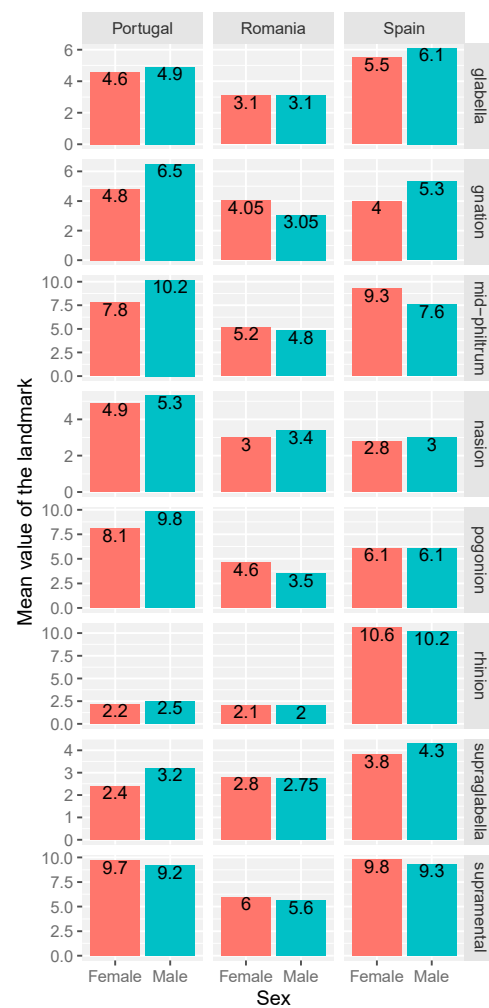
Figure 4. Comparison of average facial soft tissue thicknesses measured using needle puncture methods on cadavers from groups with different geographic origin.

Based on another paper concerning the population of Brazil [22], Figure 5 compares the mean values (of the the same eight-landmark set) between Brazil and Romania, without grouping according to sex (as the data on sex were not available for Brazil).
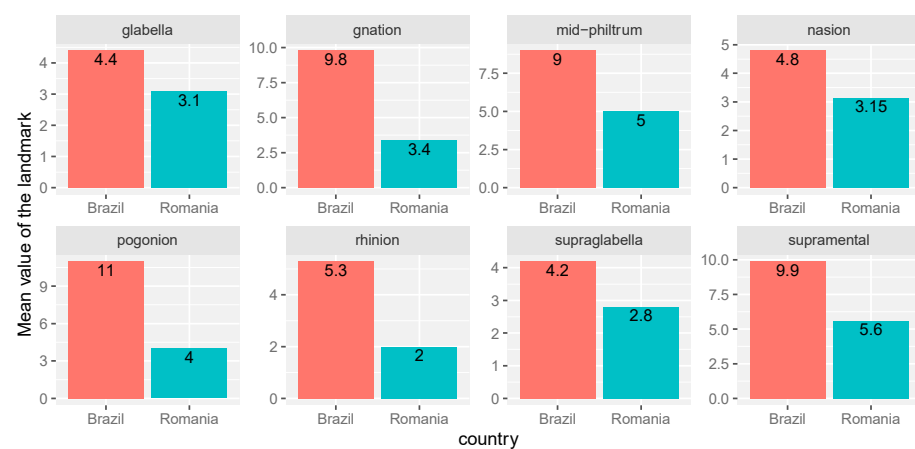
Figure 5. Comparison between Romanian and Brazilian adult population using the same method for the measurements.

The next topic of interest for the Romanian dataset was to assess if the distribution of values referring to the facial landmarks varies significantly among weight categories. Table 3 contains the descriptive statistics of the "Romanian" dataset variables, overall and grouped by the three weight categories. The last column in Table 3 refers to the *p*-value of the statistical tests concerning the differences among categories. Since, in this study, three weight categories were included, and the distribution of facial landmarks was non-normal, the Kruskal–Wallis test was preferred (instead of ANOVA).

The overweight group was smaller since it is represented by only 8 observatios, compared to 50 observations for the *underweight* group, and 42 for the *normal weight* group. The median age was considerable larger for the *overweight* group (67 vs. 52 for both *underweight* and *normal weight* groups). Nevertheless, as the last column in the table shows, the differences among the three groups, as assessed through the non-parametric Kruskal–Wallis test, do not appear to be statistically significant (*p*-value = 0.8).

Regarding the sex vs. weight category frequency table, Table 3 shows that the overall females/male's proportion (42/58) is preserved by the *underweight* group but reversed in the *overweight* group. The Fisher's exact test assessed as non-significant the association between weight category and sex.

Seven landmarks appear to vary significantly among the three weight categories: *supraglabella, glabella, nasion, rhinion, gnation, r_mid_infraorbital, l_mid_zygomatic*, whereas for *supramentale*, the difference is close to the significance level (*p*-value = 0.051).

Another subject of interest was to examine the bivariate correlation among numerical variables, so that whenever the value of a given facial landmark is missing, it could be inferred based on its association with other landmarks and/or additional personal variables. As the distribution of all variables (except *age years*) is not normal, the non-parametric Spearman coefficient was preferred instead of the parametric (Pearson) one. Figure 6 displays the correlation plot, as produced by the *corrplot* package.
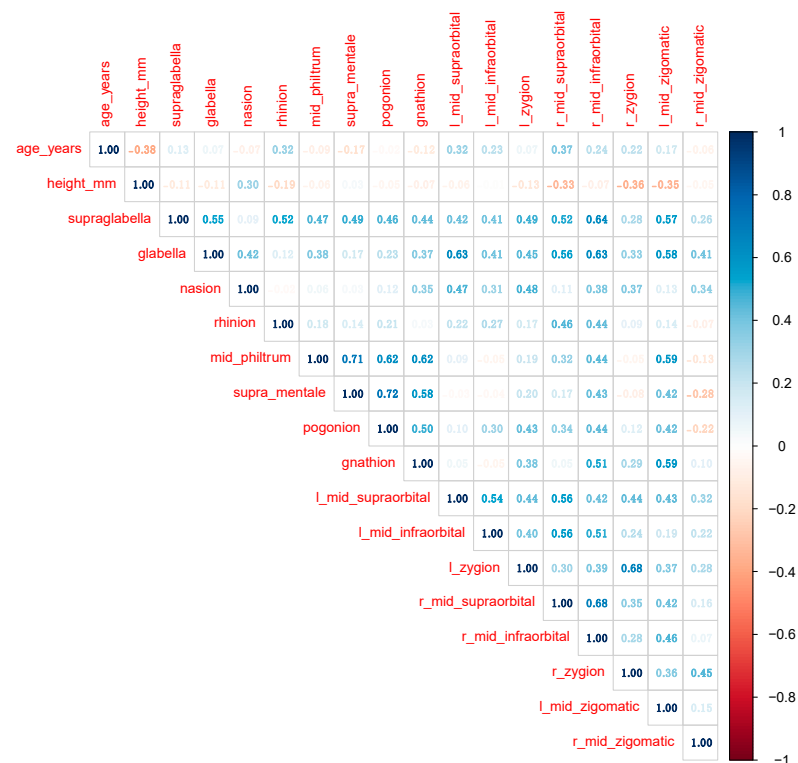

Figure 6. Non-parametric correlation among numerical variables.

The largest positive correlation coefficients were recorded for the following pairs of variables: *pogonion* and *supra_mentale* (0.72); *mid_philtrum* and *supra_mentale* (0.71); *r_mid_infraorbital* and *r_mid_supraorbital* (0.68); *l_zygion* and *r_zygion* (0.68); *r_mid_infraorbital*

and *supraglabella* (0.64); *glabella* and *l_mid_supraorbital* (0.63); *glabella* and *r_mid_infraorbital* (0.63); *mid_philtrum* and *pogonion* (0.62); *gnathion* and *mid_philtrum* (0.61).

Negative correlations were considerable weaker. The largest negative values of the Spearman correlation coefficient were recorded between the following pairs: *age_years* and *height_mm* (−0.38); *height_mm* and *r_zygion* (−0.36), *height_mm* and *l_mid_zigomatic* (−0.35); *height_mm* and *r_mid_supraorbital* (−0.33).

To find if there are major variations on the correlation between females and males, Table 4 presents the Spearman correlation coefficients (absolute values) larger than 0.50 (*corr_overall*), and the same coefficient for *female* group (*corr_females*) and the *male* group (*corr_males*). The last column (*ratio_ls*) is the ratio between the larger and the smaller coefficient of both sexes and assesses the gap of the correlations between sex.

Table 4. Spearman correlation coefficients larger than 0.50, overall, and by sex.

x	y	corr_overall	corr_females	corr_males	ratio_ls
pogonion	supra_mentale	0.72	0.75	0.72	1.042
mid_philtrum	supra_mentale	0.71	0.70	0.71	1.014
l_zygion	r_zygion	0.68	0.80	0.62	1.290
r_mid_infraorbital	r_mid_supraorbital	0.68	0.82	0.58	1.414
r_mid_infraorbital	supraglabella	0.64	0.86	0.51	1.686
glabella	l_mid_supraorbital	0.63	0.79	0.51	1.549
glabella	r_mid_infraorbital	0.63	0.71	0.59	1.203
mid_philtrum	pogonion	0.62	0.75	0.55	1.364
gnathion	mid_philtrum	0.62	0.35	0.68	1.943
l_mid_zigomatic	mid_philtrum	0.59	0.48	0.55	1.146
gnathion	l_mid_zigomatic	0.59	0.69	0.40	1.725
glabella	l_mid_zigomatic	0.58	0.74	0.47	1.574
gnathion	supra_mentale	0.58	0.36	0.69	1.917
l_mid_zigomatic	supraglabella	0.57	0.57	0.57	1.000
glabella	r_mid_supraorbital	0.56	0.64	0.43	1.488
l_mid_supraorbital	r_mid_supraorbital	0.56	0.64	0.47	1.362
l_mid_infraorbital	r_mid_supraorbital	0.56	0.56	0.57	1.018
glabella	supraglabella	0.55	0.63	0.51	1.235
l_mid_infraorbital	l_mid_supraorbital	0.54	0.47	0.61	1.298
rhinion	supraglabella	0.52	0.55	0.45	1.222
r_mid_supraorbital	supraglabella	0.52	0.68	0.46	1.478
gnathion	r_mid_infraorbital	0.51	0.47	0.50	1.064
l_mid_infraorbital	r_mid_infraorbital	0.51	0.57	0.48	1.188
gnathion	pogonion	0.50	0.25	0.59	2.360

Generally, for the largest values of the correlation coefficient, the gap between sexes is small. The largest gaps were recorded for the *gnation-pogonion* pair of variables (*ratio_ls* = 2.36), for *gnation-mid_philtrum* (*ratio_ls* = 1.94) and for the (*gnation*, *supra_mentale*) pair (*ratio_ls* = 1.91).

4. Discussion

One of the main problems regarding the forensic anthropological methods of craniofacial identification is the reliance on the use of the average values of the thickness of the soft tissues as control in the techniques of three-dimensional and two-dimensional facial approximations [8,23].

The importance of the present study lies in the fact that it creates a dataset for facial soft tissue thicknesses for the North-East region of Romania, a country that does not have such a dataset. In our study, we observed that there are no significant differences between men and women and the values found increase significantly for overweight people, compared to underweight and normal weight that show similar values. The particularity of the study consists of creation of this dataset with good results involving the facial soft tissue thicknesses values and the instrument used for measurements taken.

As we mentioned in introduction part, there are numerous methods which are used for establishing values for soft tissue thicknesses. Some of these methods are invasive, including needle puncture on cadavers, and some of them are non-invasive, using imagistic methods (X-ray, computed tomography, ultrasound, magnetic resonance imaging, etc.) [1,8–13,24,25].

Regarding the needle puncture method, which was also used in the present study, it was the first method used to measure facial soft tissue thicknesses by Welcker in 1883, and has suffered some modifications since then [26,27]. In comparison with the imagistic methods, the needle puncture method has some advantages, especially regarding the fact that it enables direct physical measurements on the subject and the possibility of palpation the craniometric landmarks for a better visualization of them. However, some disadvantages of the method do exist, those regarding the impossibility of keeping the data material for other measurements or the appearance of postmortem changes. According to the literature, the postmortem changes do not affect the values of soft tissue thicknesses [9,11,22]. Additionally, the Australian research group mentions the fact the there are no differences between the measurements made on cadavers and the measurements made using the ultrasound method on living persons [1,11]. Another postmortem modification is rigor mortis. Concerning rigor mortis, there are some studies which conclude that there is no modification in soft tissue thicknesses measurement during the stages of this cadaveric change. In our study, we chose the needle puncture method because the cadaver is always a good study material, and it gives you the advantages of having the whole cadaver with known important parameters (age, sex, weight, etc.). Another motivation in favor of choosing the needle puncture method is the fact that it is cheaper, easy to use and does not depend on the imaging technique, since there are situations sometimes in which the computed-tomographic images do not include the entire cephalic extremity.

There are researchers that use different instruments as material, such as a tweezer needle or soot needle with subsequent measurement on the osteometric board, or fine steel markers with stops and silicone calipers [9,11,22]. In our study, we used an instrument for measuring skin thickness length 0–30 mm. This type of instrument helps us to measure the length directly when we insert the needle. In this way, we have prevented any possible error caused by handling the rubber stops while removing the needle. Therefore, we can state that in the present study, the tool we used to measure the thickness of soft tissues brings a novelty in the field. It is important to note that our study sample consists of fresh cadavers which have not been embalmed. This characteristic brings more credibility for our results, because according to the literature, embalming causes increases in tissue thickness, and after the tissues become fully embalmed, most tissues decrease in thickness [23–25].

Taking into account the phenotypic variation observed in European and South American populations, and considering that the effectiveness of the probability of obtaining the likeness of a person is related to access to data collected from genetically related individuals, this paper tries to contribute with data on the average thicknesses of soft tissues for the adult population of Romania, for which, until this study, there were no publicly available records of this nature. The analysis of central tendency of landmark values for the entire dataset was complemented with the examination of differences among two types of groups. First, it was examined whether knowing the sex of the body provides a better estimation of the facial landmark. Next, this study considered the constitutional aspect of individuals according to the BMI (body mass index) in relation to facial landmarks, since previous studies provide data on BMI relationship with the anthropometric characteristics.

From the point of view of the constitutional aspect, in the present study, we have divided the constitutional type of the individuals included in the study group into three categories (underweight with a BMI < 18.5, normal weight with a BMI between 19–2.5 and overweight with a BMI > 25) according to the specialized literature [9,22,24].

Given that the physiognomy of individuals changes depending on their nutritional state, it is significant to have access to this type of data. Additionally, the constitutional

aspect of the deceased person is important to be considered to establish the average values of the thickness of the soft tissues of the face.

According to the results (Table 2), in the case of the adult population of modern, present-day Romania, in the North-East region of Romania, it is noticed that there are only small and statistically unsignificant differences between males and females in the case of the craniometric landmarks considered in the present study. The most representative differences are found corresponding to the *craniometric landmark nasion*, with the statistical analysis showing that in males the thickness of the soft tissue is higher than in females (Figure 3). In some cases, it has even been revealed that females have soft tissue thicknesses at certain craniometric landmarks slightly higher than males; however, they do not show statistically significant differences. Overall, Romania's adult population presents *the thickest average values* for *rhinion*. Thus, we can state that for most of the differences between the craniometric landmarks under discussion, they are not statistically significant.

Regarding the average values of the thickness of soft tissues in the craniometric landmarks measured on the Romanian population, it is observed, according to Table 3, that there are statistically significant differences between the constitutional types for the craniometric landmarks *gnathion, supraglabella, nasion, rhinion, right mid-infraorbital, left mid-zygomatic* and *glabella*. Their values are increased as the constitutional type becomes more overweight, which is also confirmed in the literature for other populations described. The lowest values, regardless of the constitutional type, are observed at the level of the craniometric landmarks *glabella* and *rhinion*, the differences among BMI categories being statistically not significant for *rhinion*. For *gnathion, supraglabella, left zygon, right zygon, left mid-zygomatic, right mid-zygomatic,* and *left_mid-infraorbital*, there are similar values for the first two constitutional types (underweight and normal weight), values that increase significantly for people of overweight constitution. On the other hand, the value of the craniometric *mid-philtrum* landmark is less sensitive to the constitutional type, which can be explained by the fact that the difference in the thickness of the soft tissue depending on the constitutional type is seen more at the dimensions of the nose, respectively of the nasal opening. Following the analysis of the measurements made on cadaveric bodies, it is also observed that there are no differences between the values of the craniometric landmarks arranged on the side of the face; therefore, at least on cadaveric bodies, the facial asymmetry regarding the adult population of Romania is not highlighted.

Figures 4 and 5 show a comparison between the values of the thickness of the soft tissue of the craniometric landmarks arranged medial between the population of Romania (the present study) and the Portuguese, Spanish and Brazilian populations, on which similar studies have been carried out using the method of puncture on corpses [8,9,11,22–24].

Regarding the comparison made between the average values of the thickness of soft tissues between the adult population of Romania, respectively, the Spanish and Portuguese adult population (Figure 4), we can notice some differences. For the craniometric landmarks *nasion, gnathion* (especially for the females) and *supraglabella*, small differences are revealed between the adult population of Romania and Spain, while for the craniometric landmarks *glabella, mid-philtrum, pogonion, rhinion* and *supramental* there are relatively large differences between the two populations. Analyzing the comparison made between the adult population of Romania and the adult population of Portugal, we can notice small differences between the craniometric landmarks *glabella, nasion, rhinion* and *supraglabella*, while for *gnathion, mid-philtrum* and *supramental*, we can notice larger differences.

Analyzing Figure 5, we can see large differences between the craniometric landmarks considered (*glabella, gnathion, mid-philtrum, nasion, pogonion, rhinion, supraglabella,* respectively *supramental*). We noticed that Brazilians have significantly higher average values than the Romanian population. Even though the Brazilian population is white, it is part of the American population, being part of the Hispanic group. Our comparison between the Romanian and Brazilian populations confirms the results of a study showing that multiple facial anthropometric measurements are significantly higher in African Americans and Hispanics than in Caucasians [25]. According to the literature and with each specific

population study carried out, it is revealed that ethnicity has an impact on the aspects of the face and certainly on the thickness of the facial soft tissues [24–27].

Inferring the values of facial landmarks (when they are missing) based on data centrality (overall, and on groups defined by sex and weight category) could be enhanced or complemented by examining the correlation among landmarks and with other numeric variables. Figure 6 shows the correlations among numerical variables in the dataset, whereas Table 4 focuses on the variability of the strongest correlation coefficients between sexes.

In Figure 6, we can observe good correlation between the craniometric landmarks which are in the midline with the ones that are bilateral but on the same floor of the face (upper floor of the face); we can also observe that the vertical dimensions from the lower floor of the face are generally with largest positive correlation with each other. The correlation analysis we performed does not show good correlation between the age and the soft tissue at different craniometric landmarks; this aspect is in contradiction with the literature, which states that growth changes are age-dependent [26].

The correlation analysis present in this study requires, however, further research in which we would like to perform some mathematical models and some regression equations to be able to predict the soft-tissue depth at specified areas of the face based on craniometric dimensions. On the other hand, we wanted to highlight the fact that if one of the craniometric landmarks is not measured, it is possible to calculate another based on this correlation between them. This aspect is extremely important in facial reconstructive surgery. For the same importance, based on Figure 6, Table 4 shows us the sex difference between the craniometric landmarks that present a good correlation.

From the abovementioned, it follows that it is very important to establish the geographical origin of the skull used for cranio-facial reconstruction, here referring to a very correct analysis of the facial profile (the shape of the skull, face, orbits, jaws, etc.) [27–29]. The present study refers only to the adult population of Romania, with the values determined in this work not being considered in order to perform cranio-facial reconstruction in children (juvenile). Our study highlights the presence of inter-population variations as well as the need to carry out as many population-specific studies as possible. The resulting variations on the adult population of Romania between the sex and the weight categories may be a consequence of the size of the dataset; however, future research directions will be made, with the addition of new observations, and these differences will be reassessed. Additionally, because the age range of the study sample is quite large and the age is an important factor that affects facial soft tissue thicknesses, the present study has some limitations regarding age differences. This aspect will be corrected through another study, a more complex one with a larger size of the dataset. The present study can also be considered a preliminary study, necessary for a population of Eastern Europe, especially in the given context, the presence of the conflict in Ukraine and the subsequent need to identify the victims of this conflict.

5. Conclusions

Cranio-facial reconstruction is sometimes used as the only method of establishing the identity of an individual; therefore, it is especially important to have databases on the thickness of soft tissues, with these measurements being indispensable for performing cranio-facial reconstructions, regardless of the method used for it.

The present study provides a database for the thickness of soft tissue for 12 craniometric landmarks (8 on the midline, respectively 4 bilaterally) and represents the first of its kind for the adult population of Romania. It makes important contributions in the field of forensic anthropology, and implicitly in the field of cranio-facial reconstruction. The statistical analysis of the measurements performed shows that there are no major differences between the sex for the thickness of the soft tissue at the facial level, so that for a cranio-facial reconstruction, unique values can be used.

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