Original Article

Evaluation of Anthropometric Measurement Results and the Relationship Between Individual Identity and Geographic Belonging Through Artificial Neural Networks from a Mental Health Perspective

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Abstract

Background: Identity verification and geographical belonging are significant issues with mental health implications, particularly in forensic contexts. Anthropometric measurements offer potential insights into these relationships. **Aim:** This study aims to evaluate the significance of anthropometric measurement results and the relationship between an individual's identity and their geographical belonging through artificial neural networks from a mental health perspective. **Methods:** Study Population: The study population consisted of female individuals who visited or were brought to the forensic medicine outpatient clinic of a public hospital located in the center of Balıkesir Province between June 2023 and October 2023. Sample: The sample consisted of 100 voluntary female participants who agreed to take part in the study. The participants' geographical origins were inquired, and anthropometric measurements were conducted. Measurement results were recorded in an artificial neural network program using participant code names and evaluated using the Matlab program. **Results:** It was found that lip prints, fingerprints, and the angle of the mandible contained varying amounts of usable data in both the training and testing phases. The system developed by the researchers achieved a high success rate with an R-value of 1 during the training process and 0.97 during the testing process. **Conclusion:** In future research addressing identity verification as a social issue from a mental health perspective, solutions may involve improving the performance of this system by utilizing different artificial neural network models, learning algorithms, and activation functions.

Keywords: *Anthropometric measurement, artificial neural networks, geography, mental health*

Introduction

The advancement of technology has rapidly popularized the use of new techniques in the field of forensic sciences.[1] It is believed that the planning, implementation, and development of new techniques and methods can elevate identity verification studies to new dimensions.[2]

In forensic anthropology, the anthropometric method used in the initial stage of identity verification encompasses direct and indirect metric (measurable) measurements made between specific anatomical regions on living individuals, cadavers, and radiological samples, aiming to determine race, age, height, and gender.[3,4] The anthropometric method is employed in the determination of both measurable (metric) and non-measurable (non-metric) factors.[5] Anthropometric measurements, being a simple, cost-effective, and non-invasive technique, provide insights into an individual's and society's health, strength, mobility, nutrition, and welfare levels throughout all stages of

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development. Additionally, they can be used to create databases for clinical applications.[3,4]

Anthropometric data can vary based on factors such as the cause of death, race, age, height, gender, hereditary factors, nutritional status, socio-economic status, diseases, and seasons among individuals. Additionally, they provide important information about the geographical region to which individuals belong.[6,7] The acquired data can be beneficial to scientists and law enforcement agencies in various aspects, such as estimating the geographical origin of human remains, both fragmented and intact,[8] identifying victims and perpetrators in criminal cases,[9] profiling suspects, and determining innocence.[10-12] These variations in anthropometric measurement results can be used to establish measurement standards specific to the populations living in a particular geographical region.

Crime is increasing worldwide.[13] From a mental health perspective, the importance of identity verification in forensic sciences is growing in the context of identifying perpetrators and victims in the rising crime incidents. Moreover, it is believed that raising awareness among families, communities, and professionals on this matter and providing education to enhance the careful collection of evidence are necessary.

The aim of the planned study is to contribute to scientific knowledge and expand the scientific community's understanding by shedding light on the identifiability of individuals based on anthropometric measurements grouped according to their geographical origin using artificial neural networks. This study is unique due to the absence of research that evaluates identity verification from a mental health perspective, despite it being a societal, social, and legal issue, as observed through experiences and literature reviews.

The study began with an introduction containing general information, followed by an explanation of the methodology, process, limitations, and the stages the research went through. In the subsequent section, the results arising from the analysis of the data were explained, and finally, the study was concluded with the presentation of recommendations.

Materials and Methods

Research design

In the quantitative research methodology, the universe of the prospective study, characterized by descriptive and correlational features, consisted of female individuals who visited or were brought to the Balıkesir Atatürk City Hospital Forensic Medicine Outpatient Clinic. Prior to the implementation, face-to-face meetings were conducted with female individuals. The purpose of the study was explained, and after obtaining their voluntary consent, face-to-face anthropometric measurements were carried out at the Balıkesir Atatürk City Hospital Forensic Medicine Outpatient Clinic. The measurements obtained from the volunteer individuals were recorded in the artificial neural network program created by the researchers and stored on their respective computers. The names of volunteer individuals were registered in the program using code names such as A1 and A2.

Research process

Each individual participating in the research was provided with an informed consent form containing information about the study. Their consent was obtained by reading the form and obtaining their signatures. Women aged 18 and above were included in the study, and careful attention was paid to infection control measures due to the use of lipstick in obtaining lip prints. The inclusion criteria were as follows: women who had their lipstick, those willing to participate in the study and continue it, those with no allergic sensitivity or immune system problems, and individuals with no inflammation, trauma, malformation, deformity, surgical scars, or active lesions on their face, hands, and feet.

Individuals under the age of 18, women who did not have their lipstick, men, those unwilling to participate in the study and continue it, those with allergic sensitivity or immune system problems, and individuals with inflammation, trauma, malformation, deformity, surgical scars, or active lesions on their face, hands, and feet were not included in the study.

Research limitations

The study aimed to obtain anthropometric data from the included individuals to predict their geographical origins and evaluate this from a mental health perspective. However, the study is limited by the following factors:

- Lack of knowledge about the content of artificial neural networks
- Potential difficulty in applying artificial neural networks to different systems
- Findings obtained from measurement tools
- The use of the Matlab program
- The sample group
- The specific institution included in the study
- Theoretical knowledge.

These limitations restrict the study's generalizability to only the sample group in the current research.

Ethics committee approval

The protocol of this study was conducted in accordance with the principles outlined in the Helsinki Declaration. To

conduct the research, ethical approval was obtained from the Balıkesir Atatürk City Hospital (Date 02.06.2023) as "Ethics Committee Approval" Individuals included in the sample were provided with information about the research, and informed voluntary consent forms were obtained.

Data collection tools

The participants' anthropometric measurements were taken by the researchers and recorded on computers owned by the researchers. Lip and fingerprint patterns, as well as measurements of the lower jawbone and the angle of the mandible, were evaluated.

Anthropometric measurements

Anthropometric measurements of the volunteers who agreed to participate in the study were conducted and recorded by a forensic medicine physician.

Lip print

Before examining the lip prints taken on white paper, both upper and lower lips were divided into three quadrants: middle, right outer, and left outer. The lip print structure in each quadrant was examined using a magnifying glass. Lip print patterns were classified according to the hexagonal classification system created by Suzuki and Tsuchihashi (1970).[14] According to this classification:[14]

- Type 1: Straight lines that run vertically along the entire length of the lip.
- Type 2: Similar to Type 1, but interrupted lines that do not run along the entire length of the lip.
- Type 3: Branched lines.
- Type 4: Crossed lines.
- Type 5: Reticular.
- Type 6: Data were categorized according to the lip print type that could not be included in any of the classifications.

Fingerprint

In determining the type of fingerprint, data obtained from the volunteers' right index fingers were used. In this study, the projection shape of the fingerprint ink on paper, obtained from the right index finger, was deemed sufficient for determining the shape of the fingerprint. Fingerprint types were identified using fingerprint ink and paper. Fingerprints taken on paper were individually examined to determine the fingerprint type. Subsequently, the data were transferred to an electronic medium.

Henry (1999)[15] examined the general structure of fingerprints and classified fingerprints into five categories:

- Loop fingerprint
- Whorl fingerprint
- Arch fingerprint
- Tented arch fingerprint (left twin, right plain loop)
- Tented arch (right loop), tented arch (left loop), whorl, arch, tented arch.

Angle of the mandible

The angle between the line connecting the most caudal point of the mention to the most posterior point and the line connecting the most posterior point of the gonion reflected the mid-sagittal plane, was measured with a goniometer using the point of condyle and the most posterior point of the gonion.[16]

Determining the geographical origin

Each anthropometric measurement result, transferred to the researcher's computer using code names, was evaluated about Turkey's 7 geographical regions defined in the artificial neural network program created in Matlab.

Statistical analysis

Measurements of the volunteers participating in the study were taken according to the methods specified in the Anthropometric Standardization Reference Manual (ASRM) and the International Biological Programme.[17] The data obtained from the measurements were transferred to the computer from the survey forms using individuals' code names and analyzed using the Matlab program.

In cases where the standard deviation of the population from which the sample was drawn is unknown, the *t*-test, which tests single-sample and two-sample hypotheses, was applied to test the significance of the difference between two means in independent groups.[18]

Training and testing of the artificial neural network model

The data obtained from the cases included in the research were evaluated by an artificial neural network consisting of 35 artificial neurons with 1 hidden layer created by the researchers using the Matlab program [Figure 1].

The data of the cases, including lip prints, fingerprints, and the angle of the mandible, were transferred as input data to the artificial neural network, and based on this data, the network was asked to make predictions about which of Turkey's seven geographical regions the individual belonged to. In the system created by the researchers, it was known that the artificial neural network would yield better results with less data, so 70% of the data was trained using the Levenberg–Marquardt method [Figure 2].

15% of the data obtained from the cases were subjected to testing. During the data analysis phase, the lowest error rate was found to be 5.92989 e-6 during the training process, 1.89048 e-1 during the validation process, and 2.76099 e-1 during the testing process. The *R*-value determined during the training process was 9.99999 e-1, and during the testing process, the *R*-value was found to be 9.72922

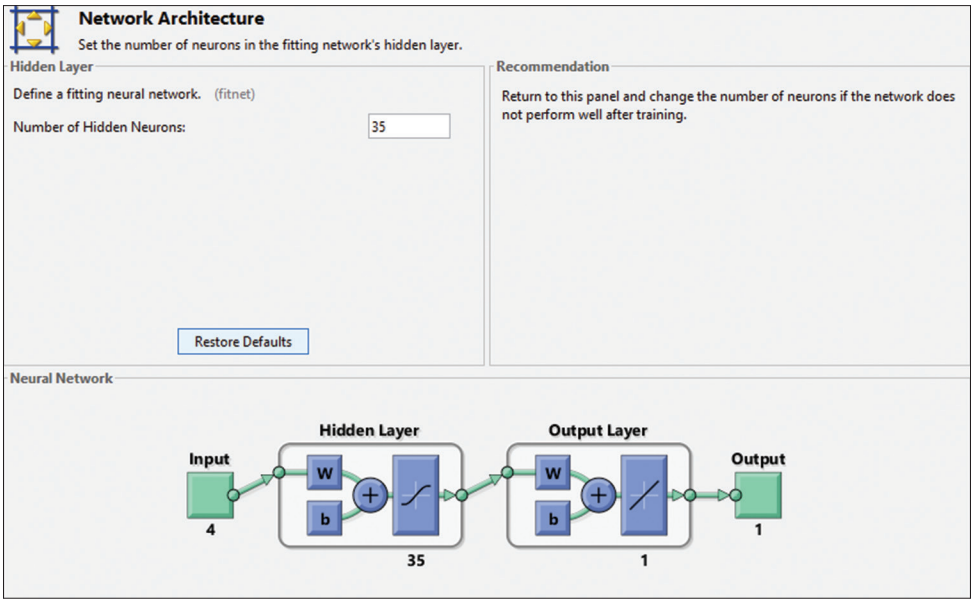

Figure 1: Artificial neural network with 1 hidden layer and 35 neurons

e-1. It was observed that the R^2 value was close to 1 in both the training and testing processes [Figure 3].

The system created by the researchers using artificial neural networks achieved an *R*-value of 1 during the training process, while this value was 0.97 during the testing process. It is observed that this value is higher during the training process compared to the testing process, but in both processes, the *R*-value is significantly high [Figure 4].

Findings

Within the scope of our study, lip, and fingerprint data were collected and evaluated from the participants.

Findings related to lip and fingerprint

The average age of the cases included in the research was 23.76; the youngest age was 18, and the oldest age was 33 [Table 1].

The distribution of participants in their respective geographical regions is as follows: 15% in the Mediterranean Region, 5% in the Eastern Anatolia Region, 28% in the Aegean Region, 15% in the Southeastern Anatolia Region, 6% in the Central Anatolia Region, 5% in the Black Sea Region, and 26% in the Marmara Region [Table 2].

In the lip print examinations conducted, it was found that the most frequently observed lip print type was Type IV; the lip print of 7 individuals was Type II, 27 individuals had Type III lip print, 43 individuals had Type IV, and 23 individuals had Type V [Table 3].

In the fingerprint examinations conducted based on the measurement results obtained from the participants, it was determined that 39 had a loop-type fingerprint, 29 had an arch-type fingerprint, 25 had a simple whorl-type, and 7 had a double whorl-type fingerprint [Table 4].

Table 1: Age distribution of cases

	Age
Mean	23.76
Median	23
Minimum	18
Maximum	33

Table 2: Distribution of cases by geographic region

	Geographic Region
Mediterranean	15
Eastern Anatolia	5
Aegean	28
Southeastern Anatolia	15
Central Anatolia	6
Blacksea	5
Marmara	26

Table 3: Distribution of cases by lip print type

	Lip Print Type
Tip II	7
Tip III	27
Tip IV	43
Tip V	23

Findings related to angulus mandibula angle

Based on the measurement results obtained from the participants, it was found that in 1 case, the angulus mandibula angle was <118°, in 54 cases it was between 119° and 122°, in 37 cases it was between 123° and 126°, and in 8 cases, it was >127° [Table 5].

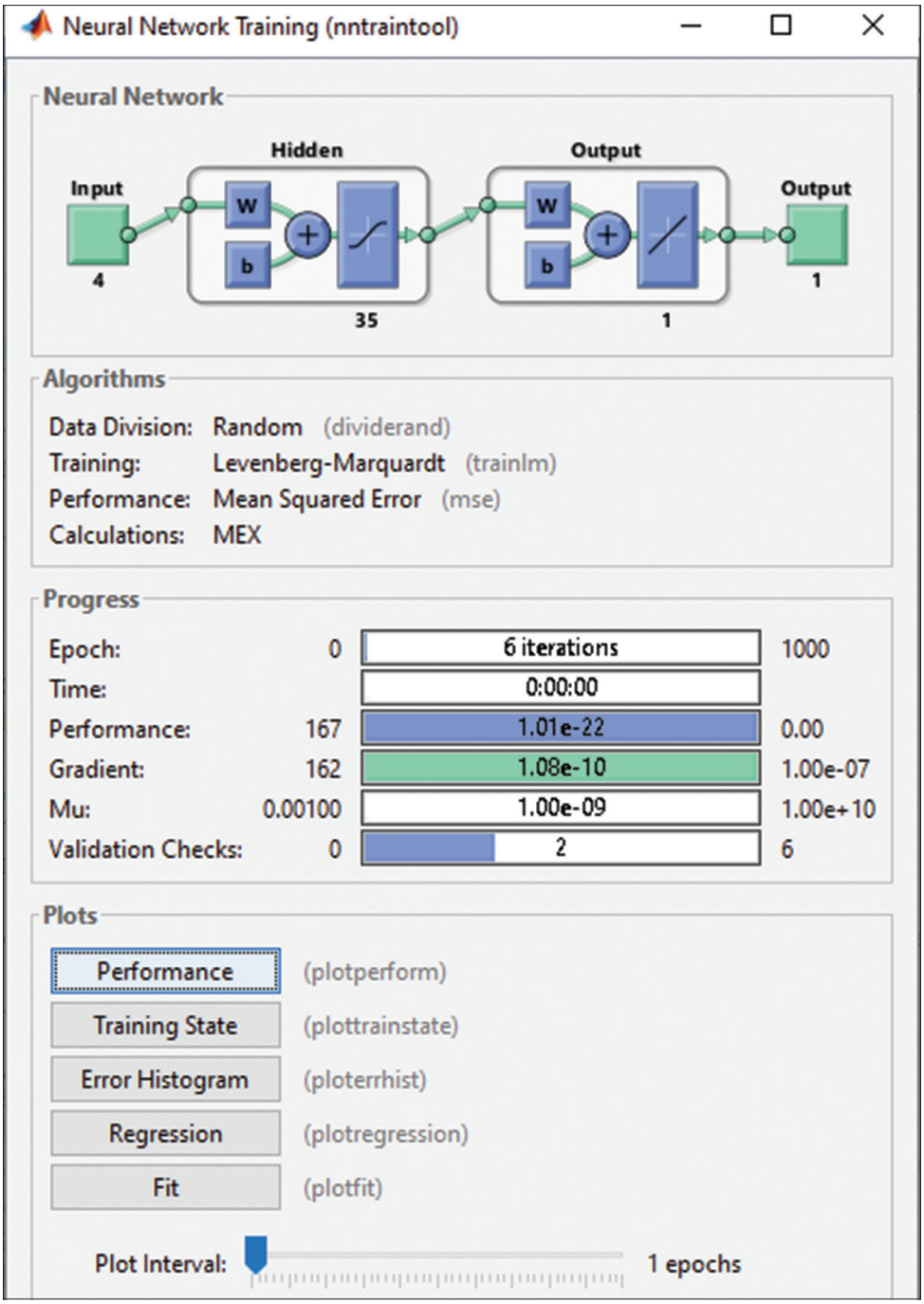

Figure 2: Artificial neural network trained with the levenberg–marquardt method

Distribution of lip prints, fingerprints, and angulus mandibula angle findings by respective geographic regions

Among the 15 individuals from the Mediterranean Region, 12 had an angulus mandibula angle between 118° and 122°, 1 had an angle between 123° and 126°, and 2 had an angle greater than 127°. Among individuals from the Mediterranean Region, 9 had loop fingerprints, 5 had whorl fingerprints, and 1 had a simple spiral pattern. Additionally, 2 individuals had Lip Print Type III, 6 had Type IV, and 7 had Type V.

In the Eastern Anatolia Region, 2 out of 5 individuals had an angulus mandibula angle between 118° and 122°, while 3 had an angle between 123° and 126°. Among individuals from the Eastern Anatolia Region, 4 had loop fingerprints, and 1 had a simple double spiral pattern. Furthermore, 1 individual had Lip Print Type IV, and 4 had Type V.

Among the 28 individuals from the Aegean Region, 18 had an angulus mandibula angle between 118°and 122°, and 10 had an angle between 123° and 126°. Among individuals from the Aegean Region, 7 had loop

fingerprints, 5 had arch fingerprints, 15 had simple spiral fingerprints, and 1 had a double spiral fingerprint pattern. Furthermore, 2 individuals had Lip Print Type II, 9 had Type III, 13 had Type IV, and 4 had Type V.

In the Southeastern Anatolia Region, 5 out of 15 individuals had an angulus mandibula angle between 118° and 122°, 9 had an angle between 123° and 126°, and 1 had an angle greater than 127°. Among individuals from the Southeastern Anatolia Region, 1 had a loop fingerprint, 6 had arch fingerprints, 5 had simple spiral fingerprints, and 3 had a double spiral pattern. Additionally, 5 individuals had Lip Print Type II, and 10 had Type III.

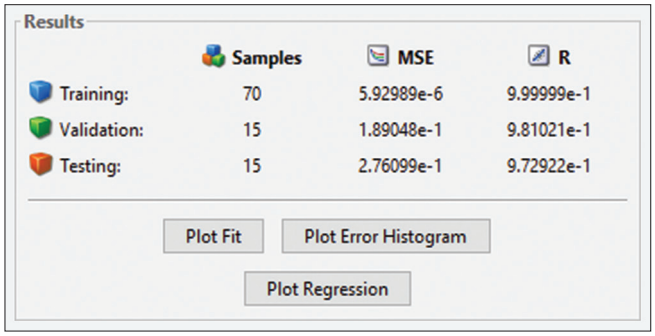

Figure 3: Lowest error rates (MSE) and R values determined in the training, validation, and testing processes

Table 4: Distribution of cases by fingerprint type

Parmak İzi Türü	
Loop	39
Arch	29
Simple Whorl	25
Double Whorl	7

Table 5: Distribution of cases by angulus mandibula angle

Angulus Mandibula Angle	
<118°	1
119°–122°	54
123°–126°	37
>127°	8

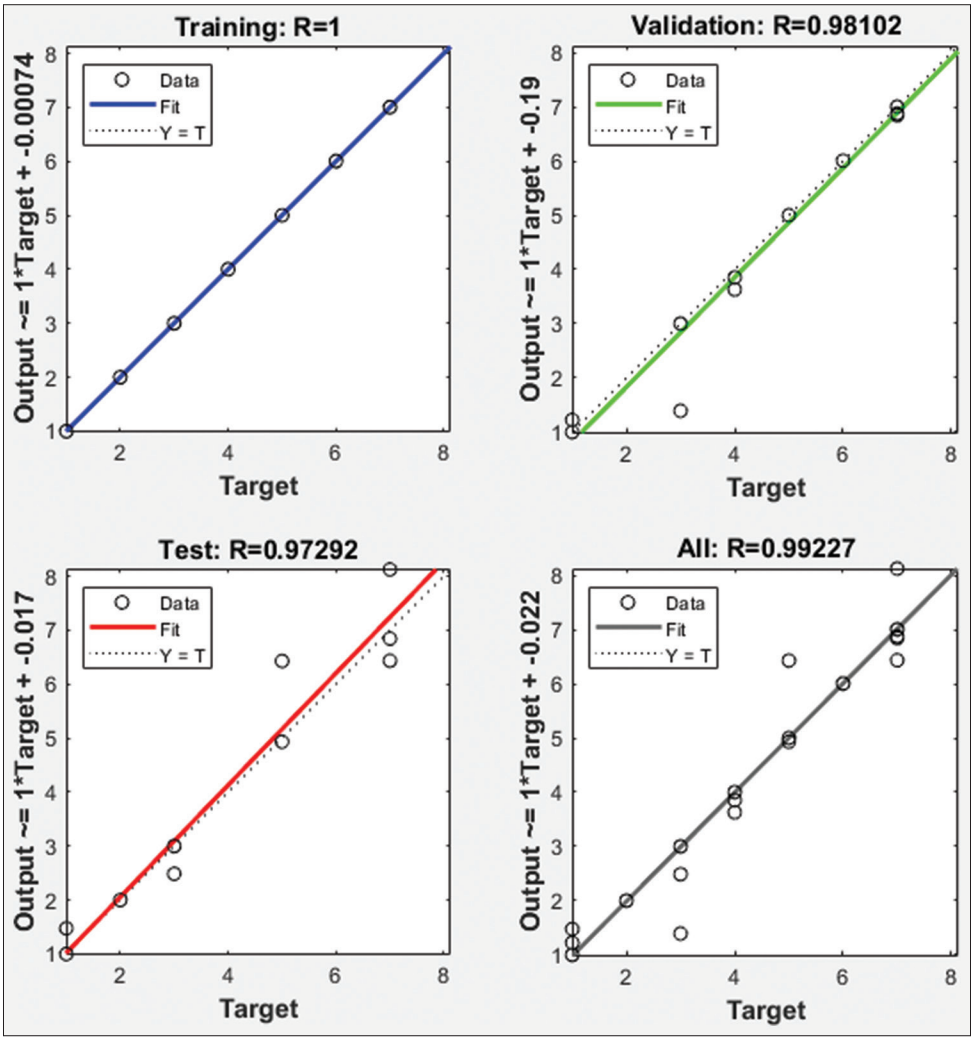

Figure 4: Graph of R values determined in the training, validation, and testing processes by the system created with artificial neural networks

Among the 6 individuals from the Central Anatolia Region, 1 had an angulus mandibula angle between 118° and 122°, 3 had an angle between 123° and 126°, 1 had an angle greater than 127°, and 1 had an angle less than 118°. Among individuals from the Central Anatolia Region, 4 had simple spiral fingerprints, and 2 had a double spiral pattern. Furthermore, 2 individuals had Lip Print Type III, 1 had Type IV, and 3 had Type V.

Of the 5 individuals from the Black Sea Region, 1 had an angulus mandibula angle between 118° and 122°, 3 had an angle between 123° and 126°, and 1 had an angle greater than 127°. Among individuals from the Black Sea Region, 3 had arch fingerprints, and 2 had loop fingerprints. Moreover, 1 individual had Lip Print Type III, and 4 had Type IV.

Of the 26 individuals from the Marmara Region, 15 had an angulus mandibula angle between 118° and 122°, 8 had an angle between 123° and 126°, and 3 had an angle greater than 127°. Among individuals from the Marmara Region, 20 had loop fingerprints, and 6 had arch fingerprints. Additionally, 3 individuals had Lip Print Type III, 18 had Type IV, and 5 had Type V.

Discussion

When the national and international literature is reviewed, it is observed that certain factors can lead to morphological differences among individuals. However, individuals tend to adapt to their geographical regions, and their anthropometric measurement results can be evaluated within the context of some standard values specific to the community to which they belong.

Regarding anthropometric measurements, it has been determined that there is a limited number of studies in the literature, and especially, few studies have been conducted from 1917 to the present day. The first study related to anthropometric measurements in Turkey was conducted by Nafi Atuf (Kansu) in 1917.[19,20] The first study covering all of Turkey was carried out in 1937 upon the request of Mustafa Kemal Atatürk, under the leadership of Afet İnan and Şevket Aziz Kansu, with the participation of the General Directorate of Statistics and other institutions, involving 64,000 adult individuals (General Directorate of Statistics, 1937; İnan, 1947, as cited in Güleç *et al*., 2009).[21] Another study was conducted by Çiner in 1960, involving 1,838 women aged between 20 and 40, and in 1960–1961, Hertzberg and colleagues conducted a NATO study involving 915 Turkish military personnel.[22] Since the 1970s, there have also been studies in some regions of Turkey aimed at determining local growth standards and examining the impact of sociocultural differences on growth.[23-29]

The research was conducted using a program based on artificial neural networks to assess the impact of lip prints, fingerprints, and mandibular angle measurements on the geographical region of origin, and its evaluation from a mental health perspective does not appear to have been encountered in the literature.

The distribution of lip print findings according to the respective geographic regions

Although it is claimed that lip print patterns can exhibit similarities among individuals,[30] most studies suggest that lip prints, unlike fingerprints, are unique to each individual, and the probability of two different individuals having identical lip print structures is virtually non-existent.[31-34] This is because significant variations are observed in certain characteristics of lip prints, such as the number of lines, their localization on the lips, branching patterns, intersections, and their locations among individuals and populations.[30] Therefore, although lip prints are rarely considered in forensic cases, their significance in identifying individuals cannot be overlooked.

Studies have been conducted on various ethnic groups in India. For example, in a study involving the Brahma community, it was found that women often have lip prints containing two or more types together. In another ethnic group in India, the Jat community, lip prints in women are generally found to contain multiple types.[35] Gondivkar and colleagues (2009)[36] claimed that in their research with 140 individuals of Indian origin, the most common type observed on both lips was the branched lines (Gondivkar *et al*., 2009).[36] Koneru *et al*. (2013)[37] also mentioned that in their research conducted in the Karela and Manipuri communities in India, straight lines were prevalent in women.[37] It is also noted that branched lines and the equilateral rectangle pattern are common in different ethnic groups in India.[35]

A study conducted with 150 students in Kathmandu emphasized that the most common lip print type in women is the branched lines (Karki, 2012).[38] Ragab and colleagues (2013),[30] in their research on the Egyptian community, stated that the most frequently observed lip print type is the vertical straight line, particularly prominent in the lower middle quadrant.[30] In another study, it was found that branched lines are the most commonly observed lip print type in the Portuguese community.[39]

In our study, the dominant lip print type was observed to be Type IV. When considering the studies in the literature, it is evident that lip print types can be used for geographical region determination in forensic identification, and a standardized classification can be established.

Fingerprint evidence is crucial in identifying individuals as each person's fingerprints are unique and unaltered by aging.[40] Due to its simplicity and low cost, fingerprinting is widely used for identity verification today.[40]

In studies related to fingerprint analysis, it is emphasized that fingerprints provide conclusive evidence for identity verification.[40] When evaluating studies conducted on fingerprint analysis in Turkey, it is noted that the fingerprints of the perpetrator were identified through a gas lamp in a murder case that occurred in 1916. The first recorded instance of fingerprint identification in the literature is associated with the fingerprints found in a murder case that took place in the rural area of Aines in Argentina in 1891.[41]

Sir Francis Galton compared the fingerprint patterns of the English, Galician, Jewish, and Basque populations but could not detect significant differences. He attributed this to the insufficient number of cases. Cummins and Midlo stated that the frequency of papillary patterns in fingerprints differed among Hindus, Arabs, Syrians, and Egyptians. Karev noted differences in fingerprints among races in the northern region of Bulgaria. In Turkey, Alp-Neyzi evaluated fingerprint patterns and observed differences among races. Bonnevie conducted a study with parents and children, finding that figure and papillary counts and delta values matched genetically.[41] There is also a study in the literature that uses artificial neural networks to record, categorize, and analyze fingerprints.[42]

In our study, it was observed that the predominant fingerprint type among the cases was the loop type. Based on this result, it can be suggested that classification based on fingerprint types according to geographical regions can be employed for identity determination. According to studies in the literature, it is possible to categorize fingerprints according to geographical regions using programs developed using artificial neural networks. Therefore, it can be stated that programs developed based on artificial neural networks in this regard would support the field, and there is a need for an increase in such studies.

Examination of angulus mandibula angle findings based on geographic regions

Each population exhibits unique physical characteristics. According to the literature, variables such as the size, width, angles, symmetry, and tissue thickness of facial structures can provide information about an individual's age, gender, any congenital birth anomalies they may have, chronic illnesses, and ethnic background.

There are numerous national and international studies related to the human face.[43-51] However, in many studies conducted to date, the relationship between gonial angle values and age and gender has been assessed.[52-57]

South African women tend to have larger lips, wider noses, and narrower eyes in their average facial portraits. Indian women, on the other hand, tend to have thinner lips and noses, with a shorter distance between the eyes and eyebrows. Turkish women often have more prominent eyes and lips in their average facial features. Dutch women tend to have pronounced cheekbones and wider faces in their average facial portraits. British women may have shorter lips, thinner chins, and equal distances between their eyes and the distance between their noses and lips in their average facial portraits. Italian women may have larger eyes, with thinner noses and upper lips in their average facial features. Japanese women tend to have wider spaces between their eyebrows and eyes, with slimmer features.[58]

In the individuals from the Mediterranean Region, the angulus mandibula angle was mostly between 118°-122°. Similarly, in individuals from the Eastern Anatolia Region, the angle was mostly between 118°-122°. In the Aegean Region, the angle was mainly between 118° and 122°. For those from the Southeastern Anatolia Region, the angulus mandibula angle was predominantly between 118° and 122°. In the Central Anatolia Region, the angle was mostly between 118° and 122°, with three cases having angles between 123° and 126°. In the Black Sea Region, the angulus mandibula angle was primarily between 118° and 122°. In the Marmara Region, the angle was also mostly between 118° and 122°.

From a mental health perspective, it is anticipated that the findings from this study can serve as a valuable guide in forensic procedures and identity verification. However, further research is needed to establish a standard for angulus mandibula angle related to geographical regions to achieve success in forensic investigations and identity determination.

It has been noted that the anthropometric measurements of the Turkish population differ from those of Asian, European, and North American populations.[59] The use of artificial neural networks is gaining importance and becoming widespread in various fields worldwide. While genetic factors lead to variations in anthropometric measurements among populations, there are some standard values that exist. However, research related to the determination of these standard values is quite limited.

Conclusion and Recommendations

Due to the limited sample size and the specific time frame of the study, the data obtained from the cases

may differ from the overall population, but it can still contribute to the establishment of a standard for anthropometric values in different geographic regions. Therefore, while the findings have regional characteristics, they are also of particular importance due to Turkey's cosmopolitan nature. The participants who underwent anthropometric measurements may have had parents or ancestors who migrated from different regions. When the results of this study are examined, it is evident that individuals can be associated with their respective geographic regions based on their different body measurements. Hence, similar studies conducted in different regions may show similarities and serve as reference studies. This is because climate, living conditions and quality, dietary habits, daily life requirements, and their fulfillment can vary in each region. These variations can have an impact on an individual's physique, and therefore, regional distinctions need to be made and the study needs to be expanded to provide strong data for healthcare professionals. Therefore, from a mental health perspective, we anticipate that implementing the following measures based on the findings of the research would be beneficial:

Establishing a database of anthropometric measurements with a much larger sample size for analysis.

- Determining the anthropometric standard values of the regions to be analyzedto achieveg international standards.
- Creating an education and test database.
- Ensuring that the created database is easily accessible on a platform for those interested in the subject.
- Selecting an appropriate artificial neural network training model and training the data with this model.
- Designing various alternative techniques to compare the obtained results with the results from this study.
- Analyzing, comparing, and evaluating the data.
- Incorporating region-specific anthropometric measurements into the establishment of data-based systems and application procedures.
- From a mental health perspective, we believe that the use of artificial neural networks should be increased to increase the number of empirical studies based on evidence.

The study, being a first of its kind in our country, has the potential to be improved, advanced, and further detailed in certain aspects, creating a new research field. From a mental health perspective, addressing identity verification as a societal issue, future studies can focus on enhancing the performance of this system through the development of various artificial neural network models.

Summary of Relevance

Problem

The identification process is important in forensic cases, especially in disaster situations. In disaster situations, the prolongation of this process causes difficulties for the victim's relatives and institutions.

What is Already Known

Anthropometric measurements continue to be used as one of the basic and economical methods of identification and remain reliable.

What This Paper Adds

An important contribution to the field of forensic science. In this study, the method we created with artificial neural networks accurately predicted the geographical regions to which the cases belonged, using the data obtained through anthropometric measurements. It is thought that with the method we have produced, the process will be accelerated, especially in disaster situations and in cases where all other identification is required.

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Conflicts of interest

There are no conflicts of interest.

References

1. Sadek NO, Hikal AN, Zaki WF. Real time facial expression recognition based on hierarchal SVM. Egypt Com Sci J 2014;38:ISSN-1110-2586.
2. Stull KE, Tise ML, Ali Z, Fowler DR. The accuracy and reliability of measurements obtained from three-dimensional volumetric rendered ımages from computed tomography. Int J Legal Med 2014;238.
3. Akın G, Özkoçak V, Gültekin T. The ımportance of somatoscopy and anthropometry techniques in forensic sciences. Hitit Univ J Soc Sci Instit 2017;10:703-14.
4. Ulcay T, Kamaşak B. Evaluation of craniometric measurements in human skulls. J Health Sci Med 2021;4:38-44.
5. Galan Y, Zoriy Y, Briskin Y, Pityn M. Orienteering to optimize the psychophysical wellbeing of young teens (13 to 14 years old). J Phys Educ Sport 2016;16:914-20.
6. Steadman DW, Haglund WD. The scope of anthropological contributions to human rights ınvestigations. J Forensic Sci 2005;50:JFS2004214-8.
7. Yücel AH, Özandaç Polat S, Kabakçı AG. Examination of lower extremity anthropometric measurements of Çukurova University students aged 18-22 by gender. J Harran Univ Med Fac 2017;14:1-11.
8. Koç F, Çetli E. The use of finger ratios (2D: 4D) in the health sciences. In: Gerçek Ş, Demirci T, Özkoçak V, editors. Current Debates in Social Sciences. IJOPEC Publication; 2019. s. 6-11.
9. Purkait R. External ear to aid of personal ıdentification: A commentary. Indian J Phys Anthropol Hum Genet 2014;33:233-43.

10. Yadav MM, Nigam K, Srivastava A, Kumar P. Recent advancements in ear biometrics: A review. Int J Eng Sci Res Technol 2016;5:ISSN: 2277-9655.
11. Francisco RA, Evison MP, da Costa Junior ML, Silveira TCP, Secchieri JM, Guimarães MA. Validation of a standard forensic anthropology examination protocol by measurement of applicability and reliability on exhumed and archive samples of known biological attribution. Forensic Sci Int 2017;279:241-50.
12. Baryah N, Krishan K, Kanchan T. The development and status of forensic anthropology in India: A review of the literature and future directions. Med Sci Law 2019;59:61-9.
13. Öztuna Ş, Gürhan N. Health communication skills and violence: An example from tokat province. MEYAD Akademi 2023;4:57-79.
14. Suzuki K, Tsuchihashi Y. New attempt of personal identification by means of lip print. J Indian Dent Assoc 1970;42:8-9.
15. Henry CJK, Dyer S, Gusain-Coveiri A. New equations to estimate basal metabolic rate in children aged 10-15 years. Eur J Clin Nutrit 1999;53:134-42.
16. Olbrisch C, Santander P, Moser N, Klenke D, Meyer-Marcotty P, Quast A. Three-dimensional mandibular characteristics in skeletal malocclusion: A cross-sectional study. J Orofac Orthop 2022. doi: 10.1007/s00056-022-00419-1.
17. Tanner JM, Hiernavix J, Jarman S. Growth and physique studies. In: Weiner JS, Lourie JA, editors. Human Biology. A Guide to Field Methods, I.B.P. Handbook No. 9, Blackwell Sci. Publ. Oxford; 1969. p. 1-76.
18. Özdamar K. Paket Programlar ile İstatistiksel Veri Analizi [Statistical Data Analysis with Package Programs]. Eskişehir: Kaan Kitabevi; 1999. [In Turkish].
19. Duyar İ. İnsanın Fiziksel Boyutlarındaki Değişmeler ve Ergonomik Açıdan Önemi. 5. Ergonomi Kongresi. İstanbul. 1995. p. 180-9. Available from: https://www.researchgate.net/publication/27566657_Insanin_fiziksel_boyutlarindaki_degisimler_ve_ergonomik_acidan_onemi_Changes_of_human_body_dimensions_and_their_implications_in_ergonomics. [Last accsessed 2024 Feb 20].
20. Duyar İ, Erişen Yazıcı G. Nafi Atuf (Kansu) ve Türkiye'de Yapılan İlk Büyüme Araştırması. Çocuk Sağlığı ve Hastalıkları Dergisi 1996;39:777-85. Available from: https://www.researchgate.net/publication/283258066_Nafi_Atuf_Kansu_ve_Turkiye'de_yapilan_ilk_buyume_arastirmasi_Nafi_Atuf_Kansu_and_the_first_growth_study_in_Turkey. [Last accsessed on 2024 Feb 20].
21. İstatistik Umum Müdürlüğü. Türkiye Antropometri Anketi, Neşriyat No: 151. İstanbul: Hüsnütabiat Basımevi. 1937 (aktaran Güleç vd. 2009).
22. Hertzberg HTE, Dupertius EC, White WCM, Damon A. Anthropometric Survey of Turkey, Greece and Italy. New York: Macmillan. 1963.
23. Özok AF, Uğur İ. Türk Sanayi İşçileri Üzerine Antropometrik Bir Araştırma. TÜBİTAK Mühendislik Araştırma Grubu. Proje no: MAG-533. 1981.
24. Kayış B, Özok AF. İlkokul Öğrencilerinin Boyutsal Ölçülerinin Saptanması. TUBİTAK, YAE, h. 128, Ankara. 1986.
25. Kayış B. Türk Erkek Toplumunun Antropometrik Ölçülerinin Belirlenmesi. TÜBİTAK, a71, Ankara. 1989.
26. Küçüködük Ş, Pişkin B, Gürses N, Koçak H, Acar S, Baysal K, Bilgiç A. Samsun 7-11 Yaş Grubu Çocuklarının Vücut Ölçümleri. Ondokuz Mayıs Üniversitesi Tıp Fakültesi Dergisi 1989;6:485-99.
27. Koçoğlu G. 1960–1985 Yılları Arasında Erişkin Erkeklerin Boy Uzunluğundaki Değişiklikler. J Nutr Diet 1990;19:209-16.
28. Güleç E, Akın G, Sağır M, Özer BK, Gültekin T, Bektaş Y. Anadolu İnsanının Antropometrik Boyutları: 2005 Yılı Türkiye Antropometri Anketi Genel Sonuçları. Ankara Üniversitesi Dil ve Tarih Coğrafya Fakültesi Dergisi 2009;49:187-201. Available from: https://dergipark.org.tr/tr/pub/dtcfdergisi/issue/66778/1044246. [Last accsessed on 2024 Feb 20].
29. Güleç E, Akın G, Sağır M, Özer BK, Gültekin T, Bektaş Y. Anadolu İnsanının Antropometrik Boyutları. Ankara Üniversitesi Bilimsel Araştırma Projesi. Mart. BAP (Proje No: 20030901018) ve TÜBİTAK SBB (Proje No: SBB3032).
30. Ragab AR, Abd El-Aziz El-Dakroory, Abdel Rahman RH. Characteristic patterns of lipprints in Egyptian population sample at Dakahlia Governorate. Int J Legal Med 2013;127:521-7.
31. Alverez Segui M, Miquel Feucht M, Castello Ponce A, Verdu Pascual F. The stability of lip pattern characteristics over time. Forensic Sci Int 2000;112:41-7.
32. Ball J. The current status of lip prints and their use for identification. J Forensic Odontostomatol 2002;20:43-6.
33. Saraswathi TR, Mishra G, Ranganathan K. Study of lip prints. J Forensic Dental Sci 2009;1:28-31.
34. Kumar GS, Vazhavendhan, Vendhan P. A study of lip prints among Pondicherry population. J Forensic Dent Sci 2012;4:84-7.
35. Vats Y, Dhall JK, Kapoor AK. Gender variation in morphological patterns of lip prints among some North Indian populations. J Forensic Dent Sci 2012;14:19-23.
36. Gondivkar SM, Indurkar A, Degwekar S, Bhowate R. Cheiloscopy for sex determination. J Forensic Dent Sci 2009;1:56-60.
37. Koneru A, Surekha R, Nellithady GS, Vanishree M, Ramesh DNSV, Patil RS. Comparison of lip prints in two different populations of India: Reflections based on a preliminary examination. J Forensic Dent Sci 2013;5:11-5.
38. Karki RK. Lipprints: An identification aid. Kathmandu Univ Med J (KUMJ) 2012;10:55-7.
39. Costa VA, Caldas IM. Morphological patterns of lip prints in a Portuguesa population: A preliminary analysis. J Forensic Sci 2012;57:1318-22.
40. Hemanth J, Balas VE, editor. Biologically Rationalized Computing Techniques For Image Processing Applications. Springer; 2018. p. 116. ISBN 9783319613161.
41. Çıngı Hİ. Kan bağı bulunan aile bireyleri arasında parmak izi benzerliğinin araştırılması. 2022.
42. Baltacı Ö. Yapay sinir ağları ve parmak izi analizi yöntemi ile kimlik tayini. (Yayınlanmamış yüksek lisans tezi). Dokuz Eylül Üniversitesi, Fen Bilimleri Enstitüsü, İzmir. 2011.
43. Ercan I, Ozdemir ST, Etoz A, Sigirli D, Tubbs RS, Loukas M, *et al*. Facial asymmetry in young healthy subjects evaluated by statistical shape analysis. J Anat 2008;213:663-9.
44. Ngeow WC, Aljunid S. Craniofacial anthropometric norms of Malays. Singapore Med J 2009;50:525.
45. Berneburg M, Dietz K, Niederle C, Göz G. Changes in esthetic standards since 1940. Am J Orthod Dentofacial Orthop 2010;137:450.e1-9.
46. Sforza C, Grandi G, Binelli M, Dolci C, De Menezes M, Ferrario VF. Age-and sex-related changes in three-dimensional lip morphology. Forensic Sci Int 2010;200:182.e1-7.
47. Kishi N, Tanaka S, Iida S, Kogo M. Comprehensive evaluation of three-dimensional philtral morphology. J Craniofac Surg 2011;22:1606-11.
48. Emelike N, Garba S, Dalori B, Numan A. Anthropometric study of Lip-Nose complex in adult Igbo's resident in Maiduguri. J Dent Med Sci (JDMS) 2012;1:29-31.

49. Shin K-J, Gil Y-C, Song W-C, Koh K-S, Choi H-G. Morphometric analysis of the upper lip in Koreans. Facial Plast Surg 2014;30:587-92.
50. Moshkelgosha V, Fathinejad S, Pakizeh Z, Shamsa M, Golkari A. Photographic facial soft tissue analysis by means of linear and angular measurements in an adolescent Persian population. Open Dentist J 2015;9:346.
51. Bagheri H, Sirinturk S, Govsa F, Pinar Y, Ozer MA. Digitalized analysis of philtral anatomy for planning individual treatment. Surg Radiol Anat 2017;39:1183-9.
52. Al-Shamout R, Ammoush M, Alrbata R, AL-Habahbah A. Age and gender differences in gonial angle, ramus height and bigonial width in dentate subjects. Pak Oral Dental J 2012;32:81-7.
53. Chole RH, Patil RN, Balsaraf Chole S, Gondivkar S, Gadbail AR, Yuwanati MB. Association of mandible anatomy with age, gender, and dental status: A radiographic study. ISRN Radiol 2013;453763. doi: 10.5402/2013/453763.
54. Bhardwaj D, Kumar JS, Mohan V. Radiographic evaluation of mandible to predict the gender and age. J Clin Diagn Res 2014;8:ZC66-9.
55. Leversha J, McKeough G, Myrteza A, Skjellrup-Wakefield H, Welsh J, Sholapurkar A. Age and gender correlation of gonial angle, ramus height and bigonial width in dentate subjects in a dental school in Far North Queensland. J Clin Exp Dent 2016;8:e49.
56. Bhuyan R, Mohanty S, Bhuyan SK, Pati A, Priyadarshini S, Das P. Panoramic radiograph as a forensic aid in age and gender estimation: Preliminary retrospective study. J Oral Maxillofac Pathol 2018;22:266.
57. Larrazabal-Moron C, Sanchis-Gimeno JA. Gonial angle growth patterns according to age and gender. Ann Anat 2018;215:93-6.
58. Seçkin F, ve Bülbül M. Altın Oranın Uygulandığı Kadın Suretlerinin İnsanlık Tarihi Açısından İncelenmesi. Temel Eğitim 2019;1:45-59.
59. Bilkay C, Dursun A, Özgüner G, Öztürk K, Candan B, Sula O. TÜRK Toplumunda Tibia Proksimalinin Morfometrik Özellikleri ve Klinik Önemi morphometric features of the proximal tibia ın Turkish society and ıts clinical significance. Int J Basic Clin Med 2016;4:109-17.