UNIVERSITY OF PLOVDIV "PAISII HILENDARSKI"
FACULTY OF BIOLOGY
DEPARTMENT OF DEVELOPMENTAL BIOLOGY

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HUMAN PHENOTYPIC DIVERSITY IN A COMPLEX OF DESCRIPTIVE AND BEHAVIORAL CHARACTERISTICS

EURO ABSTRACT

of a dissertation

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"**DOCTOR**"

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The dissertation contains 202 pages in A4 format, including 37 tables and 38 figures. The bibliographic reference includes 456 references, of which 451 are in Latin and 5 are in Cyrillic.

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Date of official PhD defense: March 13, 2025,
11:00 a.m., auditorium 15 of the Faculty of Biology

Scientific jury:
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INTRODUCTION

Within the population, the individual is characterized by a specific combination of gene variants, which also determines his uniqueness as a combination of prominent traits. These phenotypic features show similarity within the genealogy, but due to combinatorial heredity and the diverse role of the environment for its manifestation, each human organism, on the one hand, is distinguished by individuality, but on the other hand – contributes to the enrichment of phenotypic diversity in the human population.

Phenotypically manifested characteristics result from the expression of individual genes, complex intergenic interactions, or interactions between genotype and environment.
An individual's genetic identity, together with epigenetic factors acting during individual development, underlie its complex phenotypic expression (Giri & Mohapatra, 2017). Polymorphism in human populations is a direct consequence of genetic variability and interactions with environmental factors, which also reflects the diversity in the expression of complex behavioral phenotypes, including basic personality characteristics. Together with an individual's set of descriptive traits, these characteristics underlie significant phenotypic diversity within individual populations (Rahim et al., 2008).
The traits characterizing a person's personality and behavior during ontogenesis are of scientific interest to psychogenetics. In the course of its development, through the application of various approaches to genetic analysis, more and more efforts are being made to study both the genetic conditioning of individual psycho-emotional and personality traits, as well as the mechanisms of interaction between genotype and environmental factors that contribute to specific aspects in the appearance of such complex phenotypes.
Personality traits reflect people's characteristic patterns of thinking, feeling, and behaving. Trait psychology is based on the idea that people differ in the place they occupy on a set of basic dimensions of personality characteristics that are consistently evident over time and across different situations.

There are many theories about the types of personality traits, but the five-factor model of personality is emerging as one of the most widely used in psychology. The construct is valuable in that, rather than focusing on individual traits that detail each aspect of personality, it refers to broader-ranging factors that encompass multiple components.
The present dissertation examines the phenotypic diversity in a Bulgarian population, focusing on selected genetically determined descriptive and multifactorial behavioral traits considered complex. Given the complexity of the researched matter, such studies are rare not only on a national (Aleksandrova-Karamanova, 2016) but also on an international scale (Schmitt et al., 2007). At this stage, there are no studies on the frequency of occurrence of descriptive and psychological signs, as well as the dependencies between them among the elderly population in Bulgaria. The lack of significant scientific data of a similar nature determines the relevance and originality of the present dissertation work.

The literature review shows the presence of conflicting data and a lack of sufficient details regarding the distribution of descriptive characteristics of monogenic and polygenic nature in human populations. There are also insufficient studies related to the frequency of occurrence and the strength of expression of the basic features of the personality, as well as their dependencies with morphogenetic signs. Sporadic and unsystematized, including for Bulgaria, are the available data regarding peculiarities in the manifestation of multifactorial signs, among which genetic predispositions and diseases of social significance, as well as individual

creative characteristics, and their potential relationship with the five main personality factors have not been studied in their entirety .
The use of diverse approaches and methodological variations, the study of samples differing in composition, age, gender and origin, as well as their analysis based on various indicators, practically do not lead to in-depth and multi-layered conclusions regarding established trends and dependencies.
At the same time, the complex study of descriptive signs and genetic predispositions together with personality phenotypes is a way to clarify the complex mechanisms of adaptation to the changing environment and the search for objective approaches to ensure the well-being of the individual.
Characterization of descriptive and psychological phenotypes in a complex are rare worldwide, and have not been conducted in Bulgaria. **This circumstance motivates the aim and objectives of the present study.**

Purpose and tasks

The aim of this dissertation is to study, characterize and analyze the phenotypic diversity in a representative sample of the Bulgarian population, focusing on a complex of selected descriptive and behavioral characteristics and the potential dependencies between them.

The set goal requires solving the following specific tasks:

1. Selection of descriptive and behavioral characteristics with monogenic, polygenic and multifactorial control and methodological tools for their analysis;
2. Selection and application of an appropriate package of statistical approaches, providing a comparative analysis of the phenotypic diversity in the studied population;
3. Research and analysis of the structure of the studied population depending on the gender and age of the individuals;
4. Analysis of the distribution of the studied descriptive, immunological and multifactorial signs within the studied population;
5. Analysis of the distribution of basic personality characteristics in the studied population;
6. Research and analysis of prominent trends and established statistically significant relationships between the studied descriptive and psychological phenotypic characteristics;
7. Presentation of a complex phenotypic profile of the studied Bulgarian population.

Material and methods

945 individuals differing in gender and age were included in the present study. Of all of them through a suitable toolkit data were collected and processed regarding selected descriptive morphological signs, the five basic personality characteristics, some diseases with a genetic predisposition (astigmatism, myopia, high blood pressure, migraine, allergies), as well as the manifestation of musical or other talent.
Of the total of 945 individuals included in the study, 29.1% were men and 70.9% were women, aged between 16 and 90 years.
In the studied sample, all persons are of Bulgarian ethnic origin, with a registered place of residence on the territory of the entire country**.**
Given the goals and tasks of the planned research, the following methods were used:

- Data collection, carried out in consultation with and under the control of a lead researcher, regarding the occurrence of descriptive traits (monogenic and polygenic) selected for analysis, as well as blood type data;

- Surveys to collect data on prominent signs with a genetic predisposition (multifactorial diseases diagnosed by a doctor and creative talents, including myopia and astigmatism, high blood pressure, migraines and allergies, musical and other talents);
- Survey using the "Big 5" questionnaire – "Markers for the big five factors" (Goldberg, 2001, http://ipip.ori.org/), in its adapted version for the Bulgarian population (Aleksandrova-Karamanova, 2016) with the aim of studying the five basic personality characteristics – extraversion, agreeableness, conscientiousness, emotional stability and openness to experience (intellect/imagination);
- Statistical analysis using IBM SPSS Statistics software package, version 22.0;
- A set of technical tools and specialized software for blind researchers.

Results and discussion

Gender and age – descriptive statistics

Analysis of the age distribution among the study participants showed a mean value of 32.3 years (standard deviation 14.5). The minimum age of the persons in the sample is 16 years, and the maximum is 90 years. 6 age groups were formed – 16-25, 26-35, 36-45, 46-55, 56-65 and 66+ years, where the group of young people is predominant – 68.1% are between 16 and 35 years old (Fig. 1).

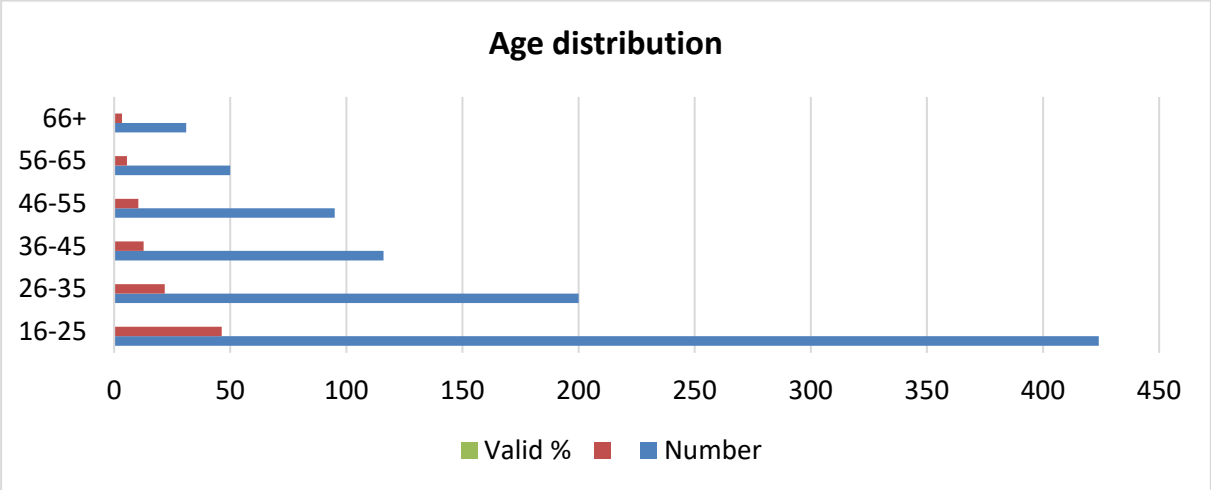


Figure 1. Distribution of study participants by age

Descriptive characteristics

Part of the descriptive (scopic) signs of the person have studied monogenic control, and another part – with polygenic determination or multifactorial conditioning. The genes responsible for their expression are autosomally localized.

Most often, monogenic inheritance implies that in case of homozygosity for the dominant allele and in case of heterozygosity there is a phenotypic expression of the dominant trait, and in case of homozygosity for the recessive allele – an expression of the recessive trait. Polygenic determination manifests itself in different variants depending on the type of specific gene interaction and the available allelic variants of the interacting genes. Traits with a multifactorial etiology are the result of an interaction between the genotype and the environment, in which the role of the two groups of factors is different. The group refers to normal or pathological characteristics with t. called hereditary predisposition.

Microscopic head and facial features

In the present study, 17 descriptive features representing nonmetric features of the face and head, including two refractive visual anomalies, were examined.

The descriptive feature ***face shape*** it appears mainly in two phenotypic variants – oval and square (rectangular) face. In the studied Bulgarian sample, 75.5% of the participants have a phenotypic expression of the dominant trait – oval shape, and 24.5% – with an expression of the recessive – rectangular shape (Fig. 2).

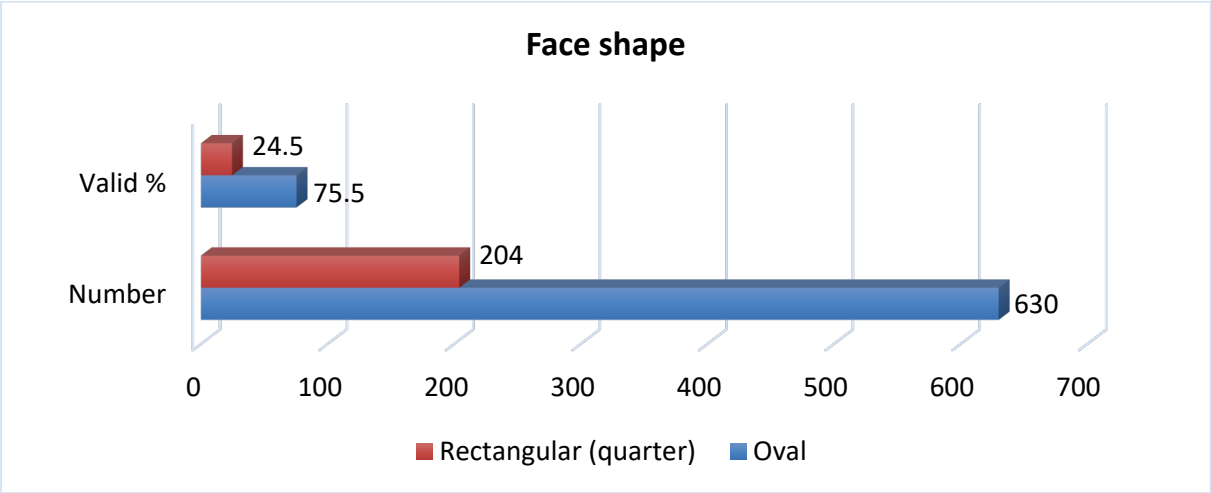


Figure 2. Distribution of the participants in the studied sample according to the descriptive feature *face shape*

The scoping sign ***chin shape*** appeared among the study participants in two variants – rounded and straight, with a phenotypic frequency of 74.6% and 25.4%, respectively (Fig. 3).

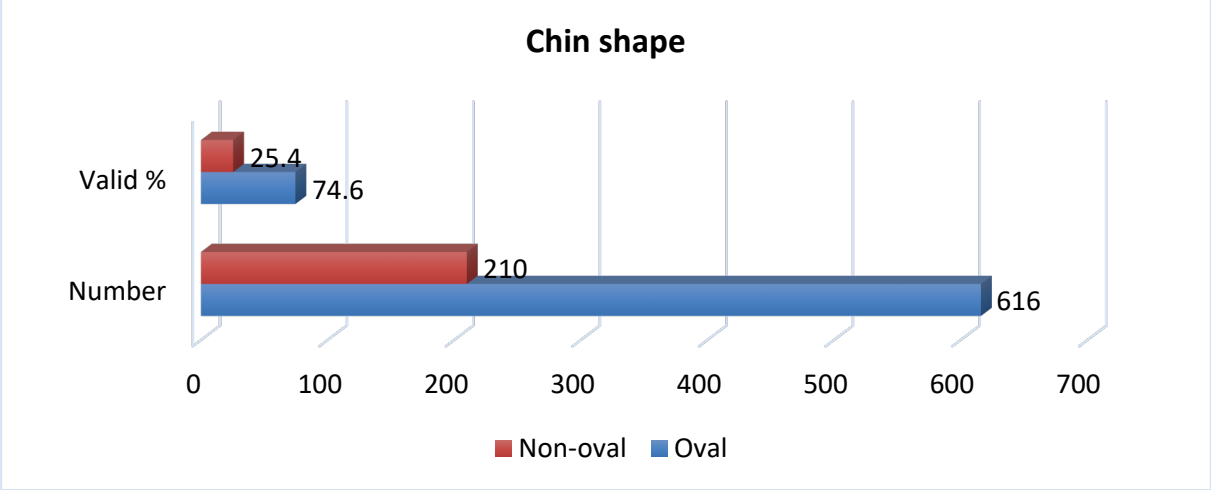


Figure 3. Distribution of the participants in the studied sample according to the descriptive feature *chin shape*

The sign ***cleft chin*** is under the control of a dominant allele and therefore manifests itself phenotypically in both homo- and heterozygous combinations. Within the studied sample, the recessive trait was evident in 80.2% of individuals. Participants with a cleft chin were 19.8%.

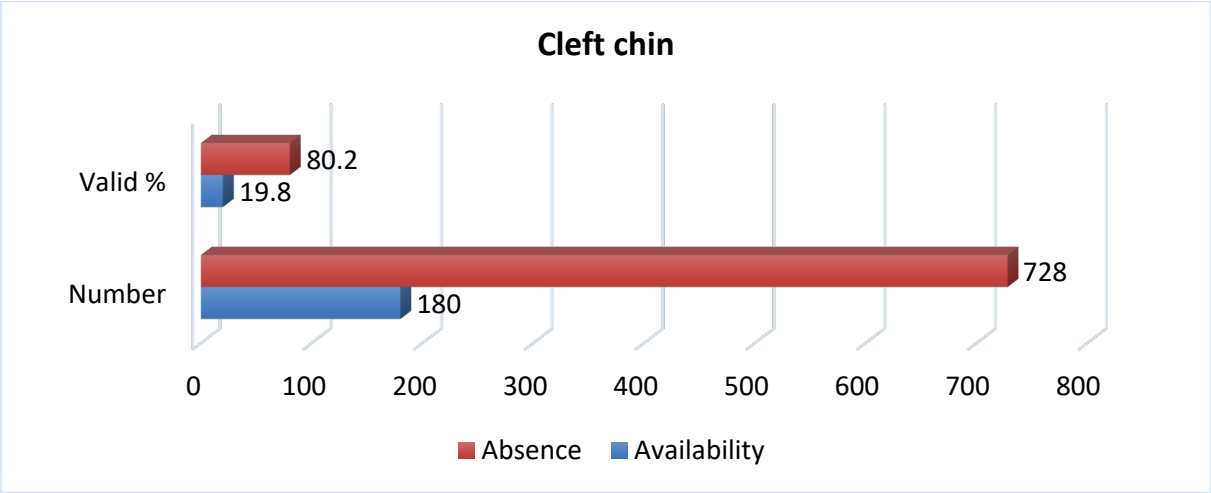


Figure 4. Distribution of the participants in the studied sample according to the descriptive feature *cleft chin*

The presence of ***dimples on the cheeks*** as a descriptive facial feature results from the expression of a dominant allele of a gene demonstrating inheritance in complete dominance. The results of the present study show that this sign occurs in almost 36% of the study sample (Fig. 5). Experimental data indicate a high proportion of individuals homozygous for the recessive allele and a high frequency of the recessive allele in the gene pool of the Bulgarian population.

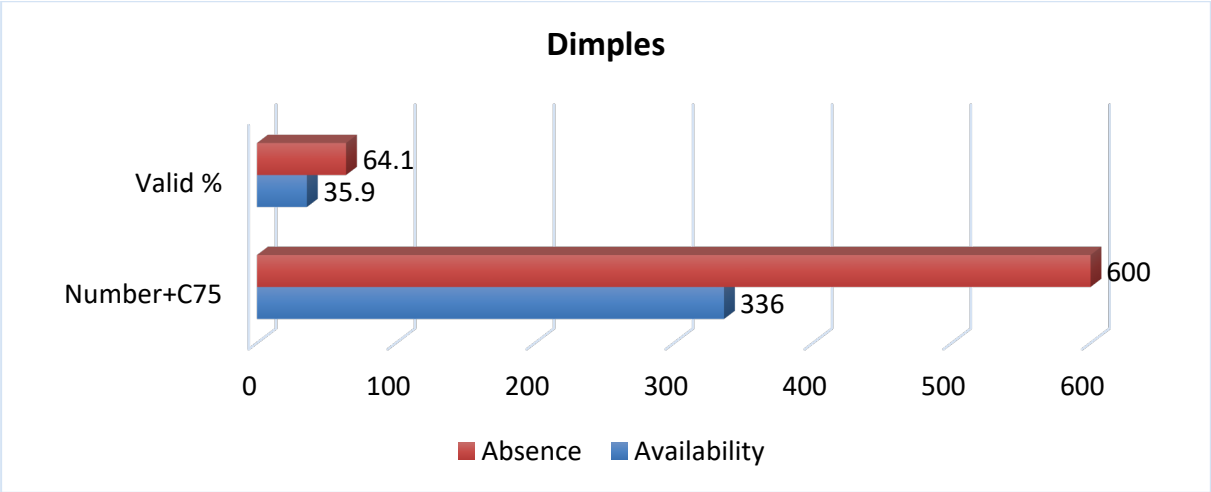


Figure 5. Distribution of the participants in the studied sample according to the descriptive feature presence of *dimples on the cheeks*

The presence of ***freckles on the face*** is characterized by differences in their localization – lateral face (on the cheeks) or in the forehead area. Within the framework of the present study, the absence of freckles was reported in 85% of the participants, and these should be individuals homozygous for the recessive alleles of both genes (Fig. 6).

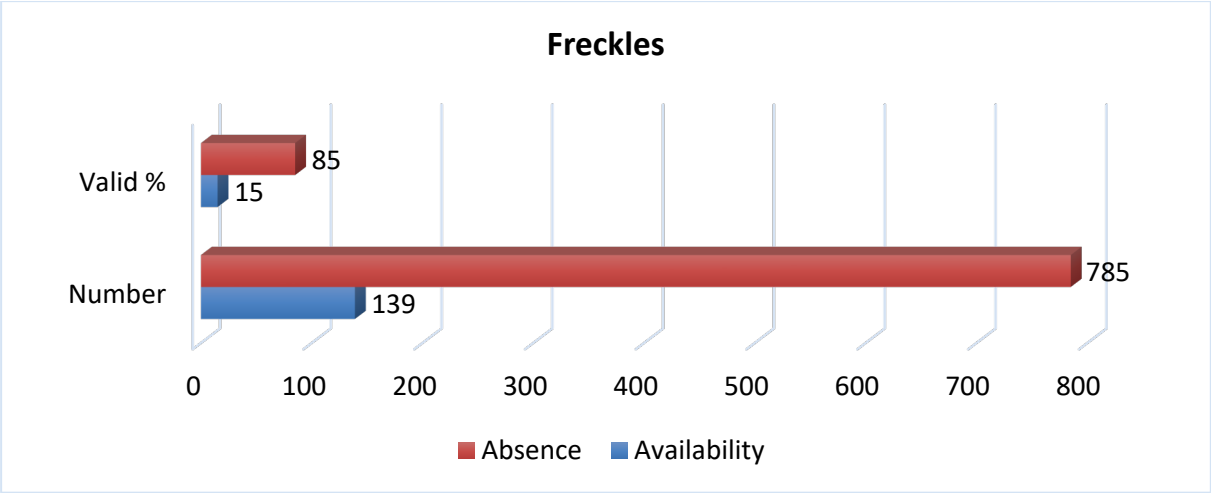


Figure 6. Distribution of the participants in the studied sample according to the descriptive feature presence of *freckles on the face*

Having a distance greater than 1 mm between the central incisors is known as ***diastema***. It is more often manifested in relation to the upper than the lower incisors. The trait occurs due to both genetic and environmental causes. Genetic control is incompletely elucidated – monogenic with complete dominance of the allele for lack of expression is possible *diastema* or polygenic – involving more genes. The results of the study indicate that almost 89% of the persons included in the experimental sample do not have a manifestation of *diastema* and only 11% of them have this phenotypic trait (Fig. 7).

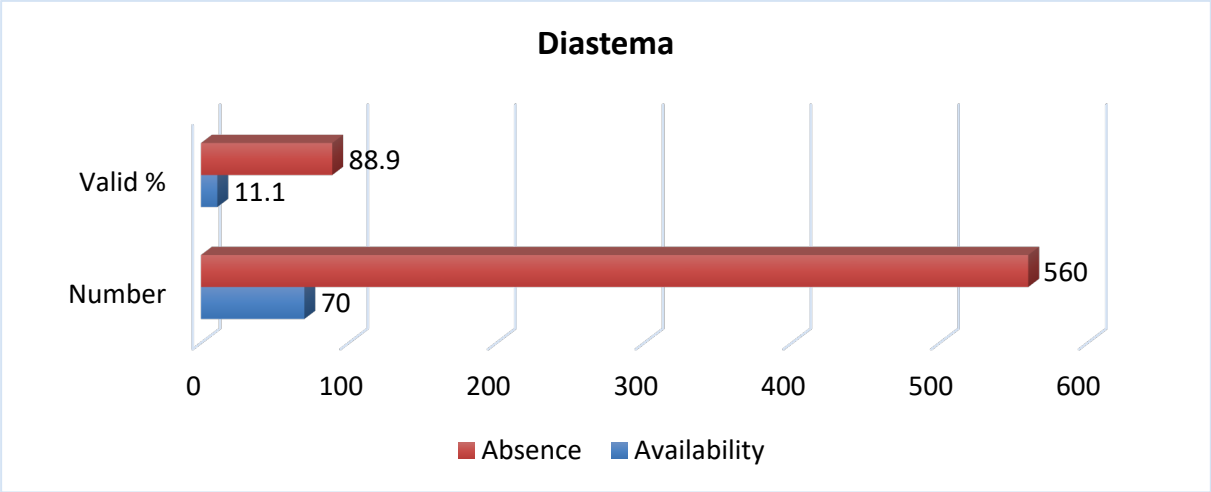


Figure 7. Distribution of the participants in the studied sample according to the descriptive feature presence of *diastema*

The frequency of the symptom found in the present study is significantly lower than that reported in the materials of other authors.

The flexibility of language appears as a scopic sign in two aspects – ability to bend the tongue like a funnel (*rolling type*) and as a folder (*folding type*). The phenotypic expression of the two traits demonstrates control by two separate genes in complete dominance inheritance. In the studied sample, 61% of the participants are from *rolling flexible tongue* and 77.4% –

with *a flexible folding language* (Figs. 8 and 9). What is special about the phenotypic expression of these two traits is that the ability to bend the tongue like a funnel is under the control of a dominant allele, and its ability to bend like a folder is under the control of a recessive allele in a homozygous combination.

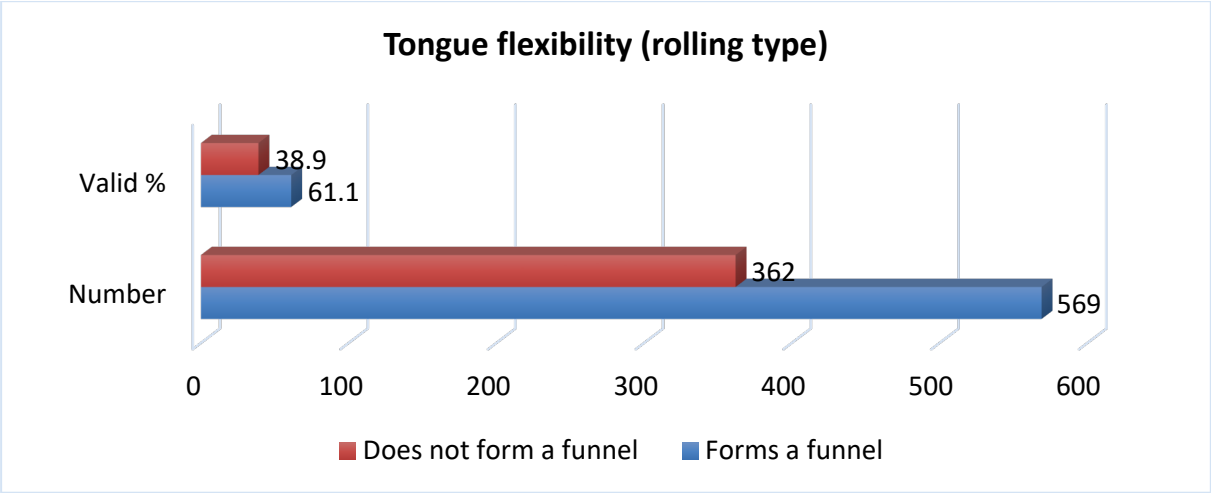


Figure 8. Distribution of the participants in the studied sample according to the descriptive feature *tongue flexibility (rolling type)*

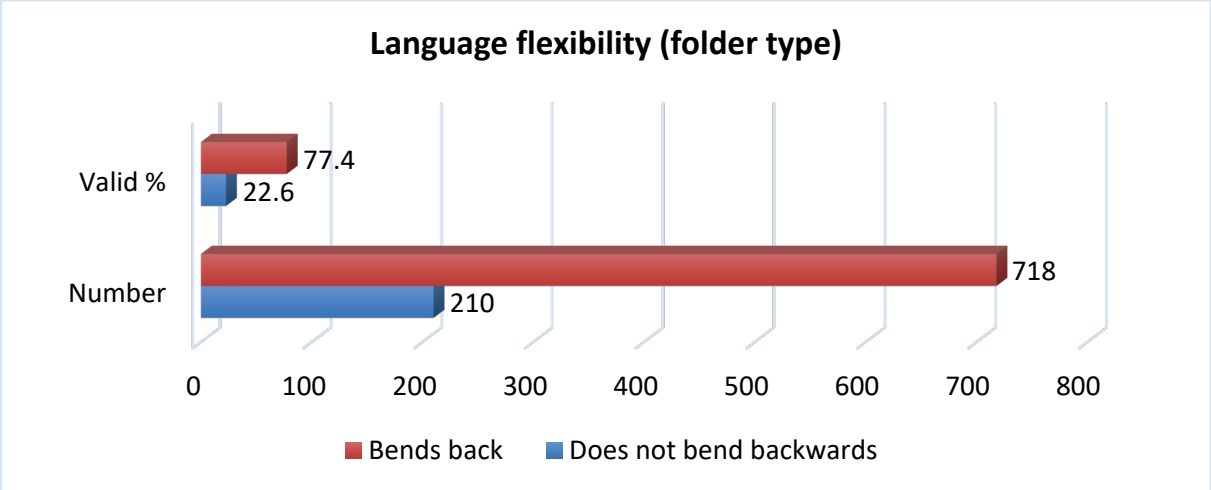


Figure 9. Distribution of the participants in the studied sample according to the descriptive feature *language flexibility (folder type)*

The descriptive feature ***ear lobe*** is controlled by a single gene, in which the dominant allele in homo- and heterozygous combination determines the expression of *free lobe* (presence of an earlobe), and the homozygous combination on the recessive allele – on *attached lobe* (lack of ear pendant). The results of our survey show that 71.8% of the participants are with *free lobe* on the ear and 28.2% – with *attached* (Fig. 10).

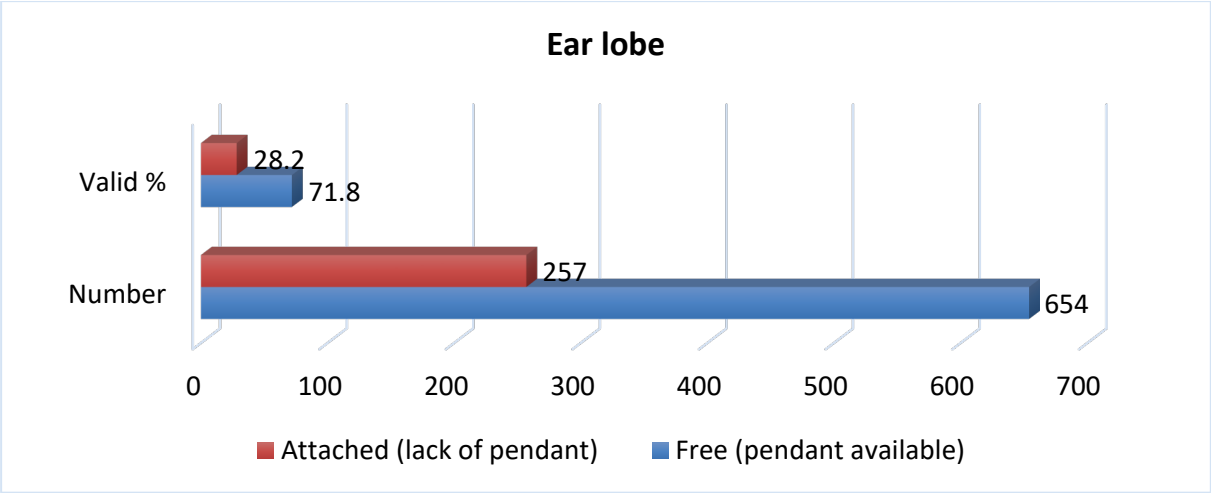


Figure 10. Distribution of the participants in the studied sample according to the descriptive feature *ear lobe*

For different people, the line that limits the placement of the hair follows two main alternatives – ***hairline forming spitz on the forehead and a straight line***. The dominant allele of the corresponding gene is responsible for the appearance of *straight hairline*. In the studied sample, 64% of individuals have a pronounced dominant phenotype – in a homozygous or heterozygous genotypic combination, and 36% are homozygous for the recessive allele (Fig. 11).

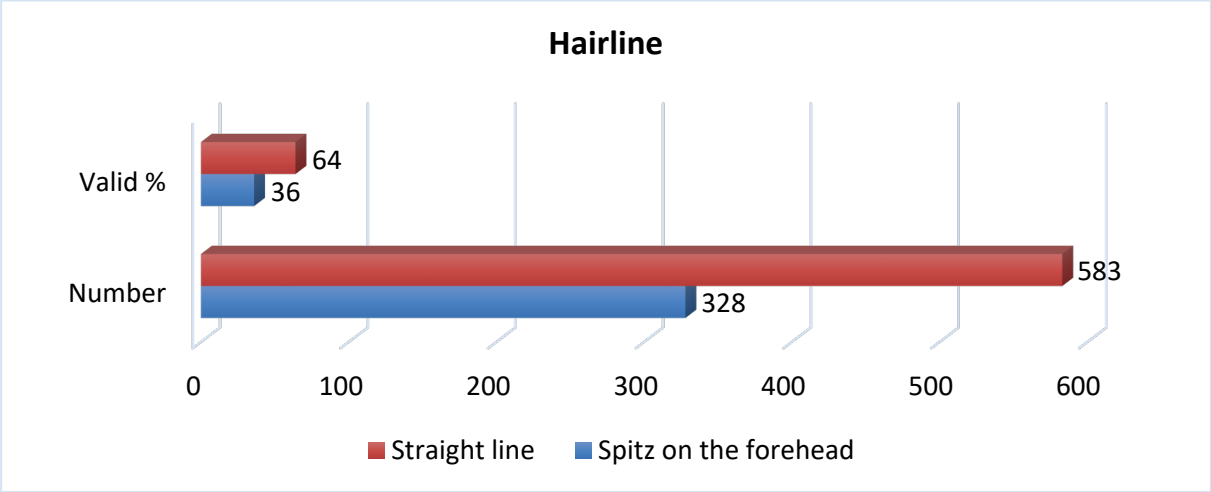


Figure 11. Distribution of the participants in the studied sample according to the descriptive feature *hairline*

What is it ***hair type – curly, wavy or straight*** – depends on the genotypic allelic combination of the corresponding gene controlling inheritance in incomplete dominance.
The two homozygous genotypes are responsible for the phenotypic expression of *curly and straight hair*, and the heterozygous genotype – for the appearance of *wavy hair*. Straight (50.4%) and wavy (37.7%) hair predominate in the studied Bulgarian population, which is evidence of the significantly higher frequency of the allele for straight hair. Individuals with curly hair who matched homozygotes for the curly hair allele had a genotypic frequency of 11.9%.

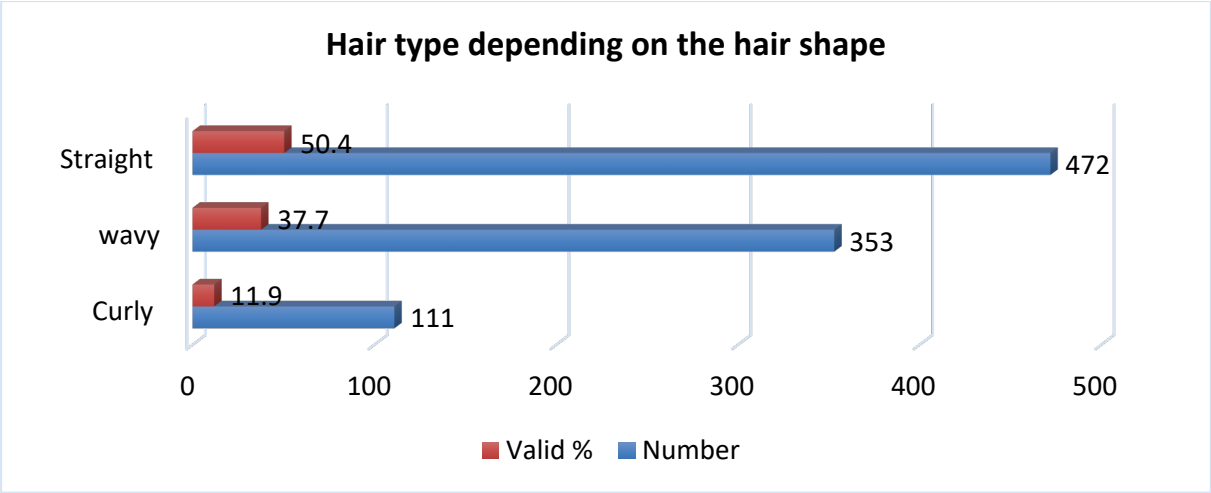


Figure 12. Distribution of the participants in the studied sample by descriptive feature *hair type depending on the shape of the hair*

Unlike the monogenic characteristics of hair discussed so far, hers ***color*** has a more complex genetic control carried out by a minimum of four genes with different localization. The genotypic combinations of their different alleles lead to a diverse phenotypic expression – *black, very dark brown, dark brown and brown, light brown, honey blonde, light blonde, very light blonde and platinum blonde*.

In the studied Bulgarian sample, the highest percentage of individuals have very dark brown, dark brown and brown hair color (44.2%), followed by individuals with light brown hair (33.8%), those with honey blonde to light blonde (9.9%) and with platinum blonde (under 1%) hair. Here it should be taken into account that the grouping can be considered in another way and that then the percentage of people with brown hair (brown and light brown) is the highest in the studied population. The greater diversity in the expression of this descriptive trait is definitely due to polygenic inheritance with pronounced elements of additivity (Fig. 13).

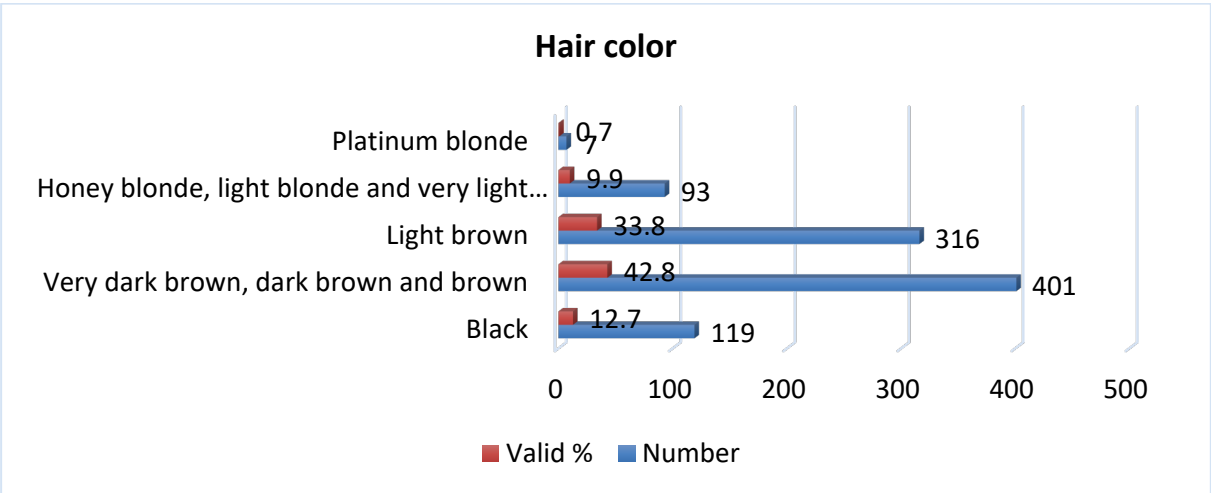


Figure 13. Distribution of the participants in the studied sample according to the descriptive feature *hair color*

From a descriptive point of view on its face ***placement of the eyebrows*** to different people they may be *separated or touching* (connected, concluded). This scopic characteristic depends on a gene whose dominant allele is responsible for *parted eyebrows*. Among the study participants, 11.1% had touching eyebrows, and the remaining 88.9% had *parted eyebrows* (Fig. 14).

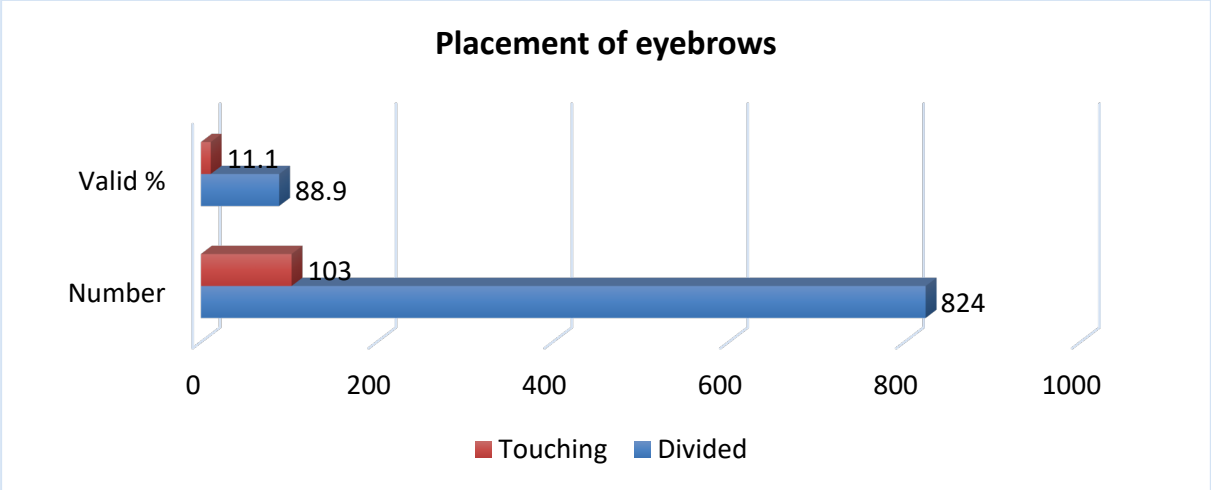


Figure 14. Distribution of the participants in the studied sample according to the descriptive feature *placement of eyebrows*

The line available to the eyes might be *straight or inclined*. There are no definitive data on genetic control, but the hypothesis of monogenicity with inheritance under complete dominance is admissible. As can be seen from the obtained results (Fig. 15), more than 87% of the persons included in the analysis have *eyes located in a straight line* and a little under 13% are with *slanted eyes*.

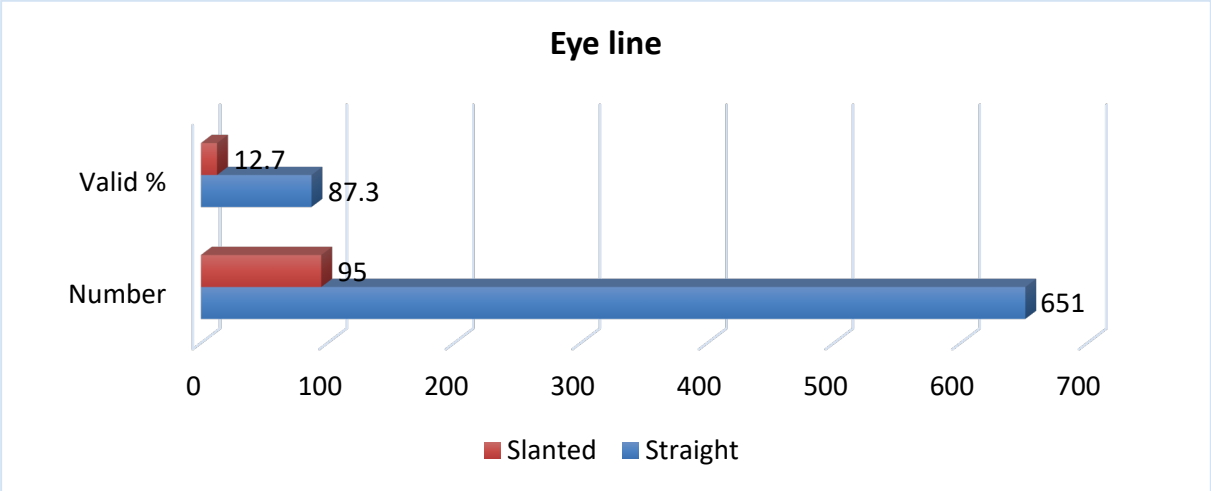


Figure 15. Distribution of the participants in the studied sample according to the descriptive feature *eye line*

Eye color is a complex sign. At least two genes are responsible for its appearance, and when their alleles interact phenotypically different color variants are manifested – from dark brown to blue. The participation of other genes, as well as complex interactions in the gene complex responsible for eye color, leads to the presence of different color shades, including the phenotypic manifestation of green and mottled eyes.

In the studied Bulgarian sample, it turns out that the highest frequency of meeting persons with brown eyes (51.8%), followed by those with green and mottled eyes (17.7%), with blue eyes (16.6%) and with dark brown eyes (13.8%) – Fig. 16.

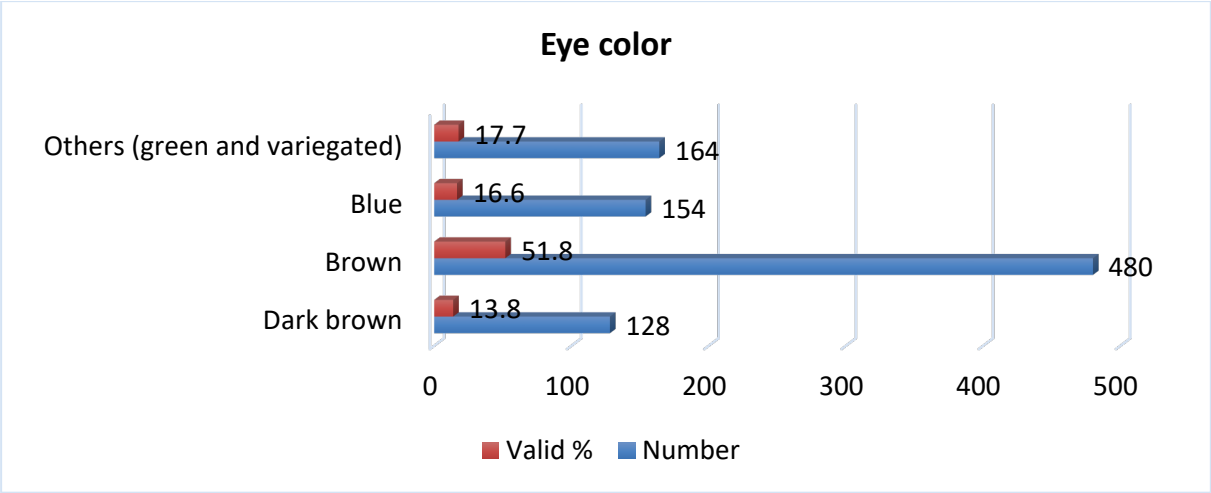
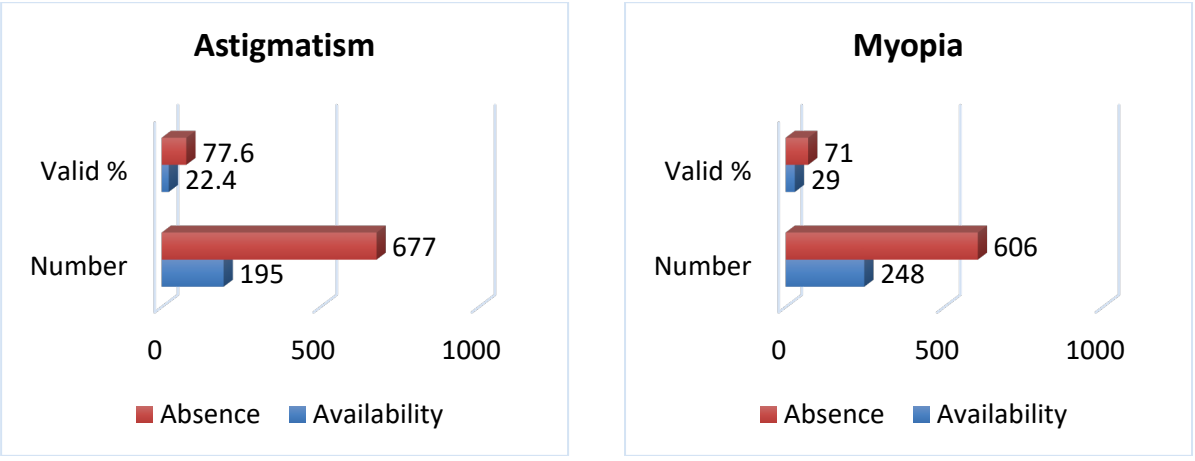


Figure 16. Distribution of the participants in the studied sample according to the descriptive feature *eye color*

This great diversity in terms of the phenotypic expression of the trait is the result of its polygenic control, possibly of multiple allelic expression and complex, currently not well understood intra-allelic and intergenic interactions. It is striking that over 34% of the individuals included in the study have light eyes – blue, green or mottled – which is related to both amorphous allelic action (mutated alleles become inactivated and lose their ability to determine a given trait, as is the case with allele responsible for the appearance of blue eyes – the result not of synthesis of blue pigment in the eye, but of lack of synthesized pigment), as well as with polymer and modifying interactions, influencing the significant phenotypic diversity in the appearance of green and mottled eyes.

Among the genetically determined characteristics of the eyes are also some deviations from the norm.

Astigmatism is one of the common refractive errors. In the studied sample, its frequency is 22.4% (Fig. 17). Its appearance is related to polygenic control and the participation of genes with different localization in the genome.



Figures 17 and 18. Distribution of participants in the studied sample depending on the appearance of *astigmatism and myopia*

Short-sightedness (myopia) is also a common refractive error of multifactorial etiology, which in the present study was reported at a frequency of 29% among the study sample (Fig. 18).

Descriptive characteristics of the hand

In the course of the present study, seven signs related to particularities of the hand, palms, and fingers were examined.

Dominant right or left hand is a characteristic motor feature of the individual. The sign is expressed in the preferential (leading) use of the right or left hand at work. Although in human populations there are also individuals in whom the use of both hands is equal or similar, in the present study it is reported that for 88.2% of the participants the right hand is the leading one, and for the remaining 11.2% – the left hand (Fig. 19).

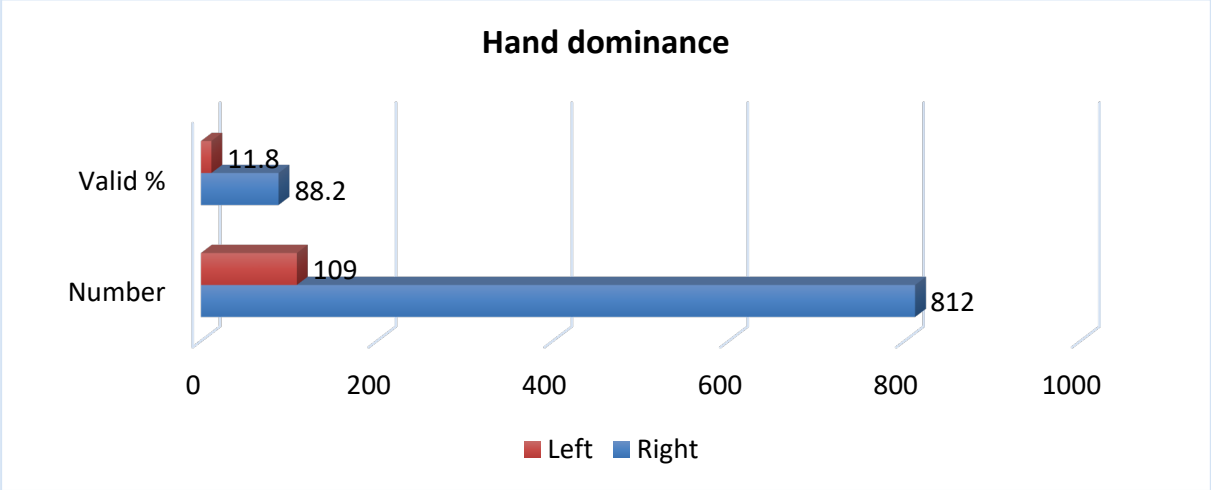


Figure 19. Distribution of participants in the studied sample depending on *hand dominance*

The preference for using the left or right hand is manifested in the performance of activities such as writing, throwing a ball, specific professional engagement, etc. In general, about 10% of people are left-handed dominant, but the frequency of this trait varies in different human populations from 0.5% to 24%. Although the genetic conditioning of the trait is indisputable, different theories are discussed for its specific genetic control.

According to Marchant & McGrew (1998), more than 85% of the world's population is right-handed. The results of the subjects, representatives of the population of Lesotho in South Africa, show that 82.38% are right-handed and 17.62% are left-handed (Asita et al., 2022). According to Umoyen et al. (2021) 97.05% of Nigerians are right-handed dominant. Similar are the results for India, where for 97.6% of the individuals studied, the right hand was reported as dominant (Usha, 2016).

According to some researchers *hand dominance* follows a monolocus or bilocus pattern of inheritance, and according to others there is evidence that the trait is under the control of a large number of genes, between 30 and 100, each individually having little effect on its construction. Conducted studies show the existence of specific connections between this symptom and the work of the brain. It can also be considered and discussed that the appearance of this polygenic characteristic is also influenced by environmental factors because, for example, some cultures actively discourage left-handedness (Ocklenburg et al., 2013).

People differently ***cross their arms***, placing the left hand over the right or vice versa. Although the trait can be influenced through conscious training or conscious learning, its unconscious manifestation is most likely genetically determined. In the studied Bulgarian sample, 57.8% of the participants put *your right hand over your left* when crossing and 42.2% – on the contrary – put *left over right* (Fig. 20).

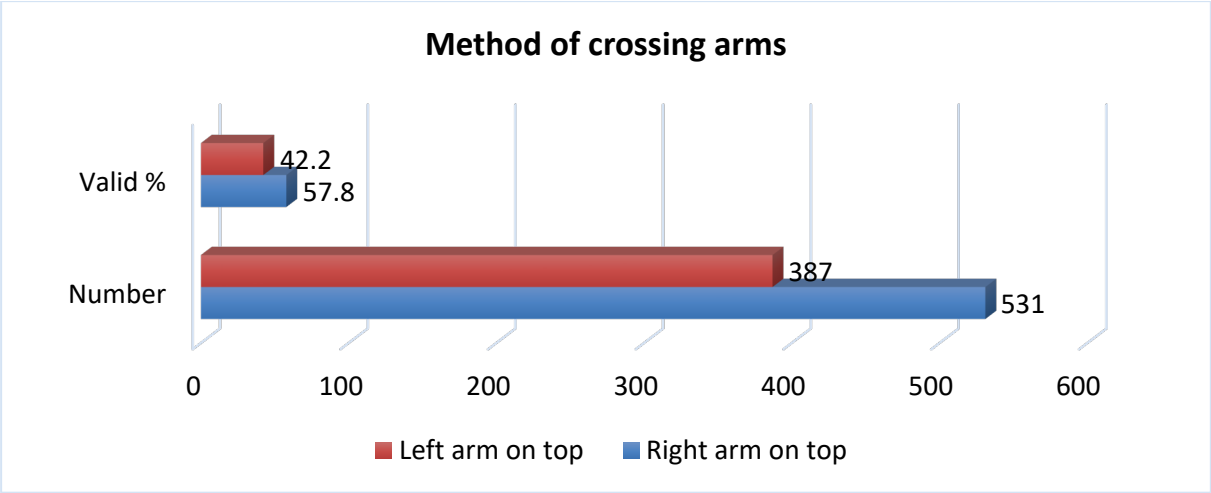


Figure 20. Distribution of participants in the studied sample depending on the method of *crossing arms*

Hair on the back of the palm was present in 24.3% of individuals in the study population (Fig. 21).

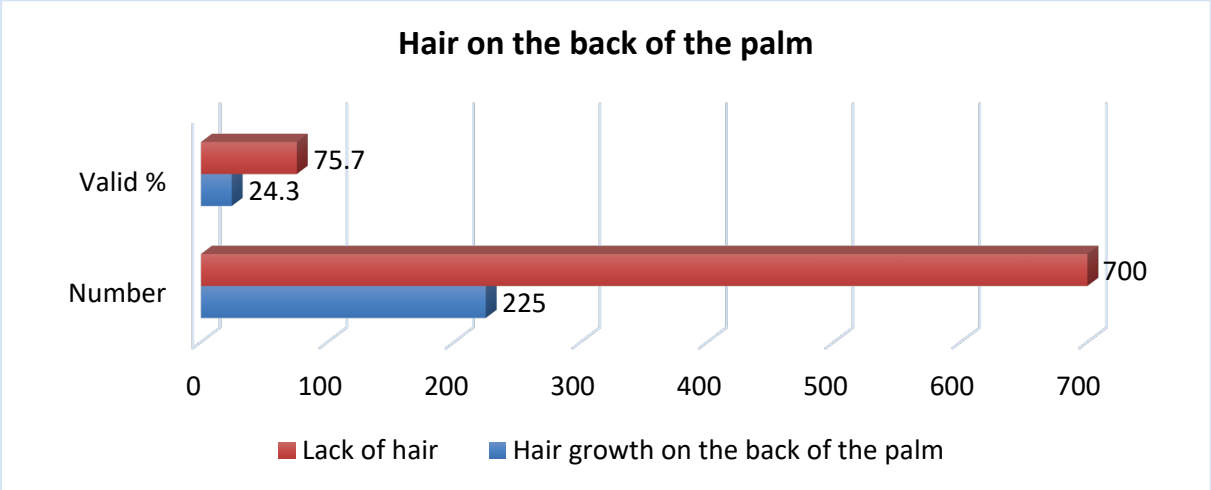


Figure 21. Distribution of the participants in the studied sample according to the descriptive feature *hair on the back of the palm*

The reported type of disintegration corresponds almost completely to monogenic inheritance with complete dominance – 75.7% of individuals have a lack of such hair.

The hair on the middle phalanges of the fingers as a phenotypic sign is reported in 31.7% of the studied Bulgarian sample (Fig. 22). These are representatives of both sexes, but without a statistically significant difference, the majority of them are men.

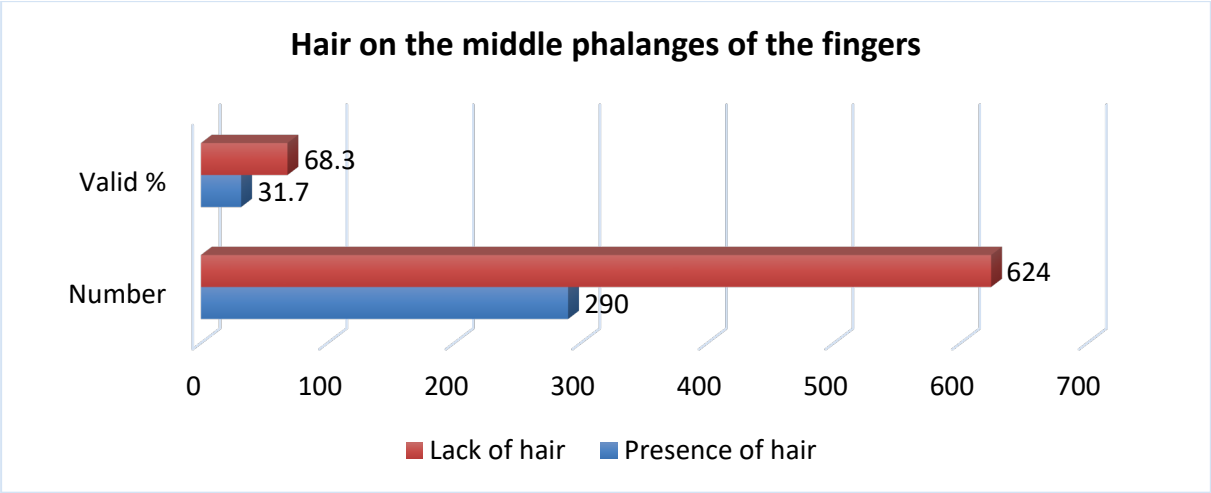


Figure 22. Distribution of the participants in the studied sample according to the descriptive feature *hair on the middle phalanges of the fingers*

Within the experimental sample the sign ***type of crossing the thumbs of the hand*** is prominent in its two alternative variants with frequency as follows: 46.6% for the position of *right thumb on left* and 53.4% for the position of *left thumb on right* (Fig. 23).

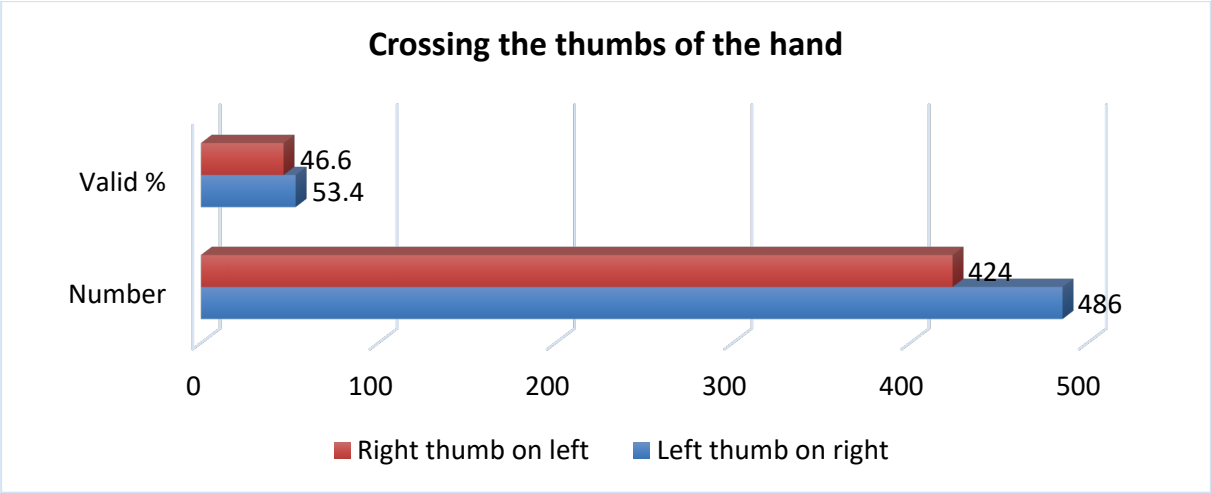


Figure 23. Distribution of participants in the studied sample depending on the type *crossing the thumbs of the hand*

A descriptive feature related to the mobility of the hand is ***the flexibility of the thumb***, which is determined by its ability to bend at an angle of no more than 30° or at an angle of almost 90°. The trait is assumed to be under monogenic control. The results of the study in the Bulgarian population show that the individuals with a flexible thumb are 33.4%, and those whose thumb does not bend more than 30° are almost twice as many – 66.6% (Fig. 24).

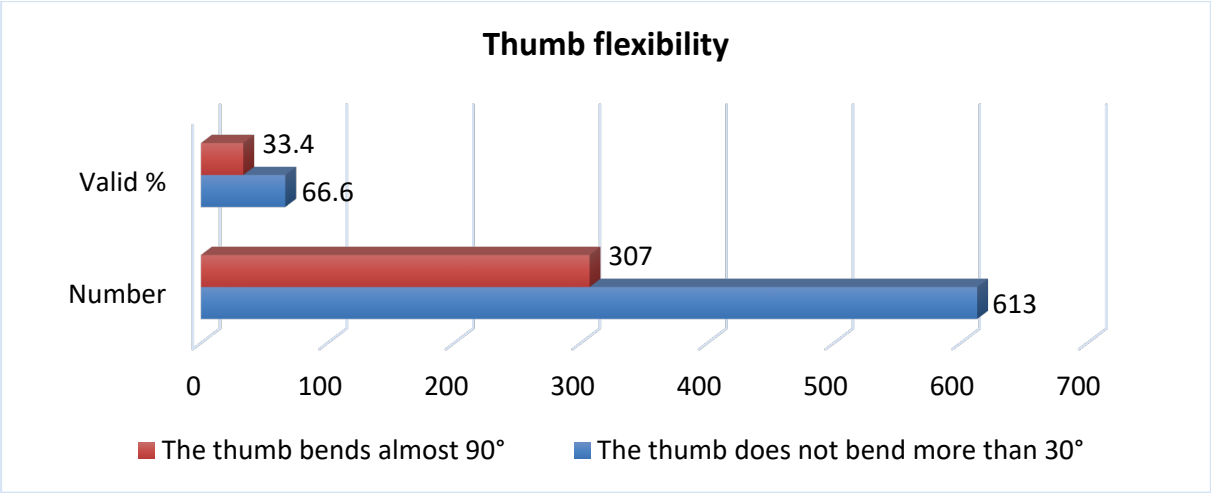


Figure 24. Distribution of the participants in the studied sample according to the descriptive feature *thumb flexibility*

The bent little finger is the result of a curve at the top of the little finger inward toward the ring finger. And with regard to this scopic sign, the implementation of monogenic control with complete dominance is assumed – the dominant allele in a homozygous and heterozygous genotypic combination is responsible for the appearance of *straight little finger*. As can be seen from the obtained results, 72.7% of the participants are right, and 27.3% – with *bent little finger* (Fig. 25).

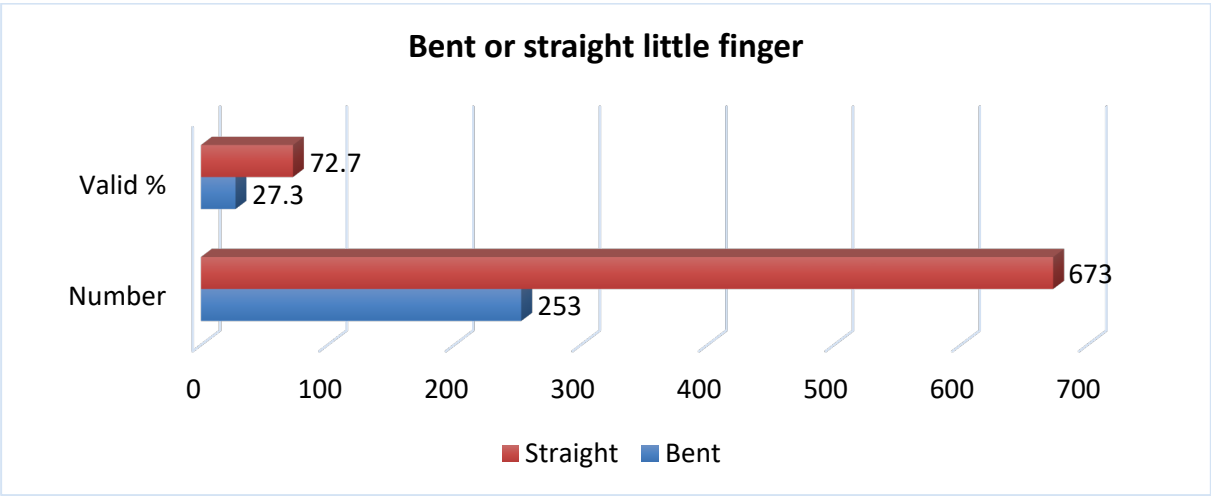


Figure 25. Distribution of the participants in the studied sample according to the descriptive feature *bent or straight little finger*

Other signs – descriptive polygenic, immunological and multifactorial

The variations in ***skin color*** are one of the most striking examples of human phenotypic diversity. The sign *skin color* in humans, it has polygenic control and polymeric inheritance with the participation of 3 polymeric genes. Interactions between their alleles lead to the manifestation of diverse phenotypes with varying *skin color* as very dark, dark and medium dark, light and very light into three categories depending on the number of dominant polymer alleles in the individuals' genotype. Within the current study, 61.3% of participants were light and very light skinned, 37.2% were dark and medium dark skinned, and 1.5% were very dark skinned (Fig. 26).

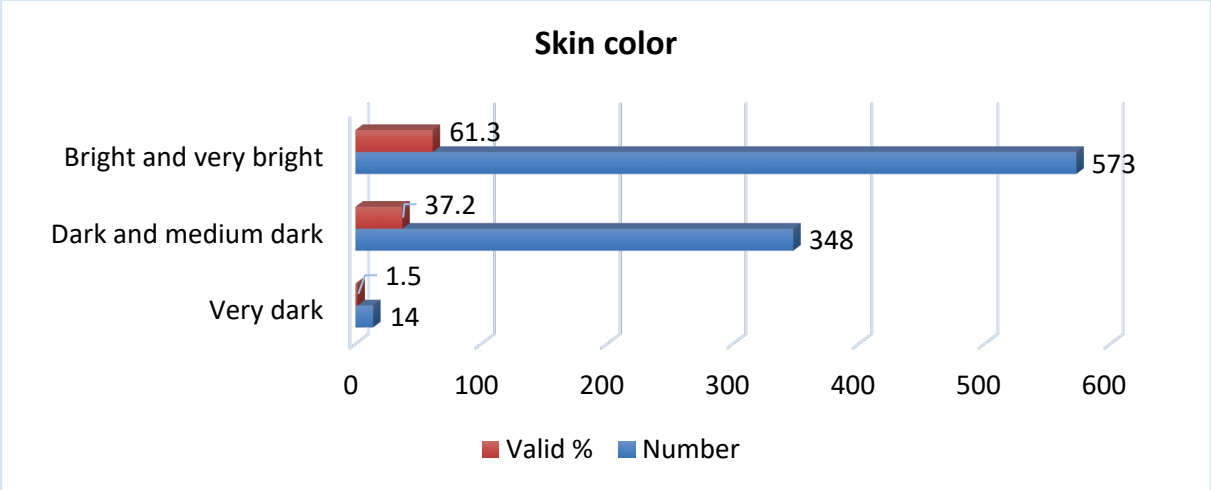


Figure 26. Distribution of the participants in the studied sample according to the descriptive feature *skin color*

AB0 blood group affiliation of the individuals in the experimental sample shows a frequency of meeting individuals with blood group A 37%, blood group 0 – 30.5%, blood group B – 18.7% and blood group AB – 13.8% (Fig. 27).

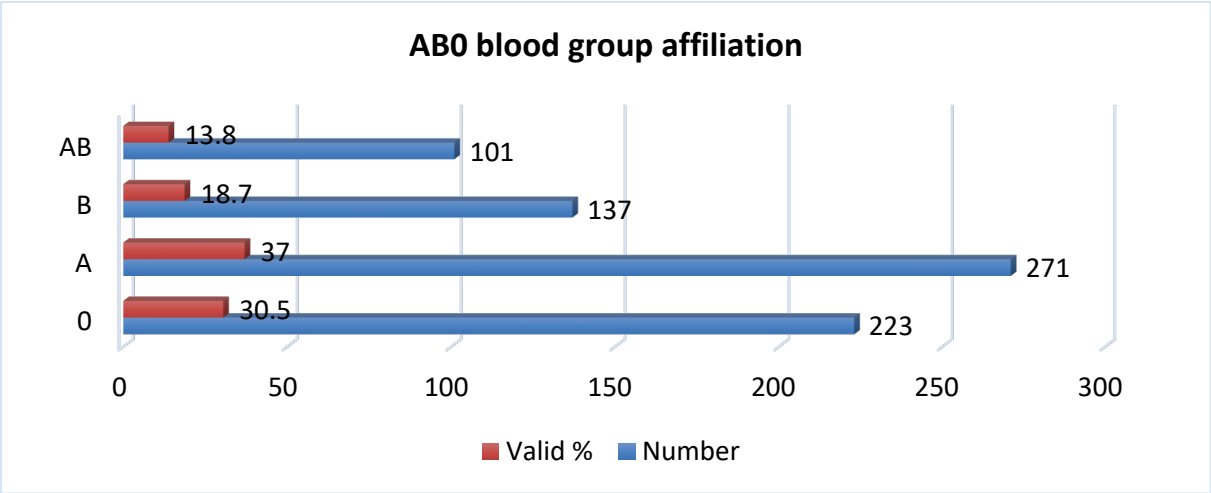


Figure 27. Distribution of participants in the studied sample depending on *AB0 blood group affiliation*

Rh blood group affiliation is under monogenic control with a dominant Rh+ allele occurring in homozygous and heterozygous combinations. The blood group Rh- as a phenotypic manifestation is the result of homozygosity for the recessive allele. In the studied Bulgarian sample, 79.6% of the participants have Rh+ phenotype and 20.4% – with Rh- phenotype, which corresponds to the monogenic type of inheritance with complete dominance (Fig. 28).

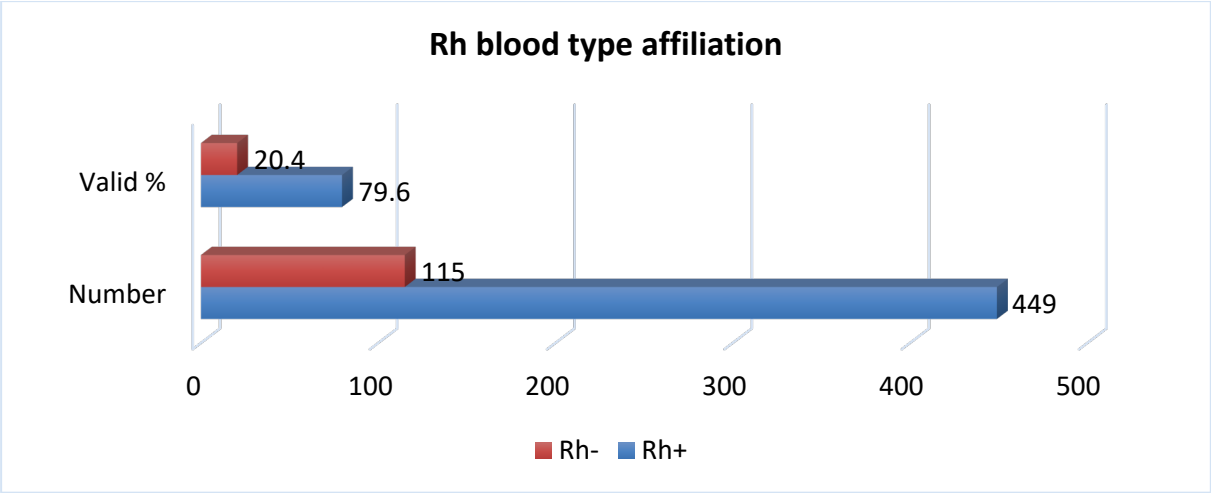


Figure 28. Distribution of participants in the studied sample depending on *their Rh blood type*

Included in the study were multifactorial signs appearing as socially significant diseases (*hypertension, migraine and allergies*), which are characterized by an etiology based on both genetic and environmental factors. Their frequency of occurrence in the studied Bulgarian population is presented in Fig. 29, 30 and 31, from which it is evident that *hypertension* has a frequency of 9.9%, migraine – with a frequency of 10.4% and allergies – with a frequency of 21.1%.

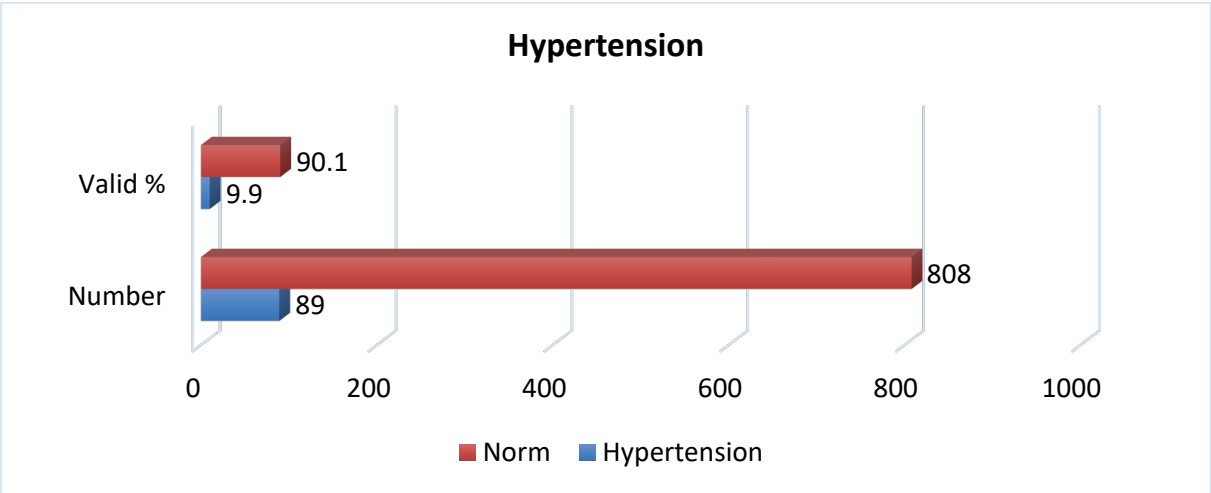


Figure 29. Distribution of participants in the studied sample depending on the appearance of *hypertension*

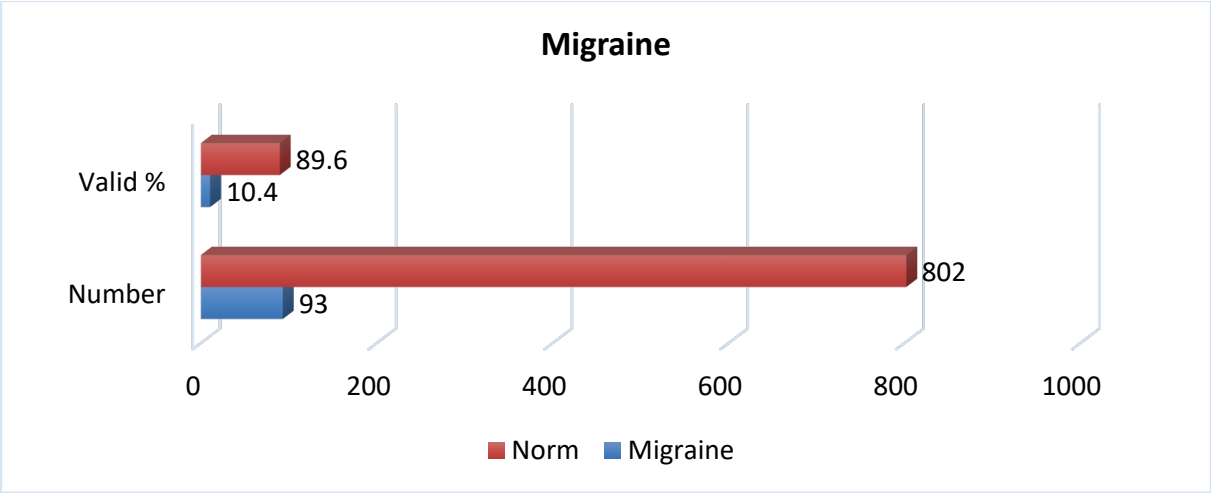


Figure 30. Distribution of participants in the studied sample depending on the appearance of *migraine*

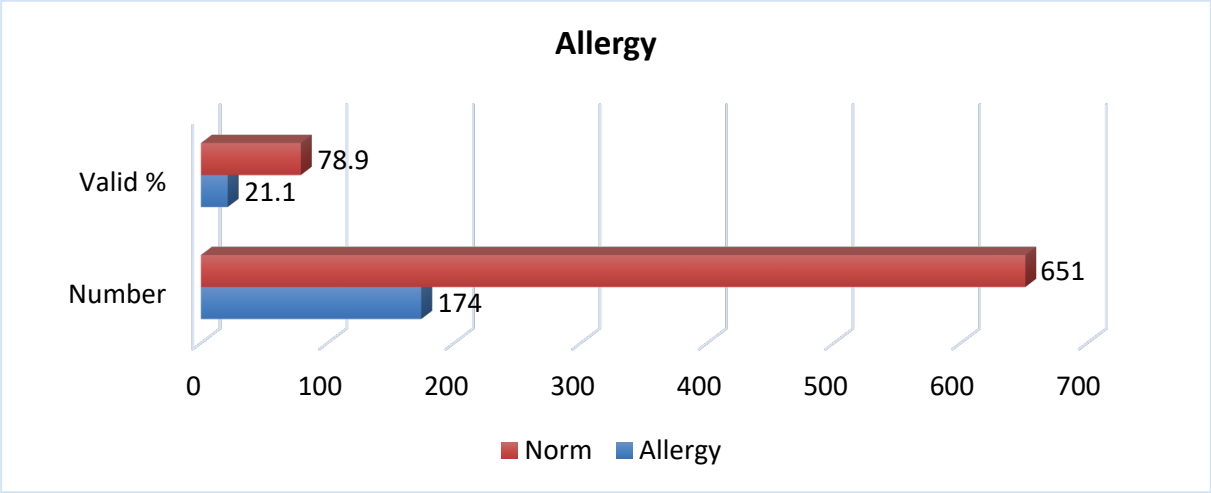


Figure 31. Distribution of participants in the studied sample depending on the appearance of *allergy*

Among the group of polygenic multifactorial characteristics of a person are the prominent ones ***gifts and talents***, which are a basic and distinct indicator of the creative potential of individuals. Among the participants in the current study, 24.6% have a pronounced musical talent (Fig. 32) and 35.3% have other creative characteristics (Fig. 33).

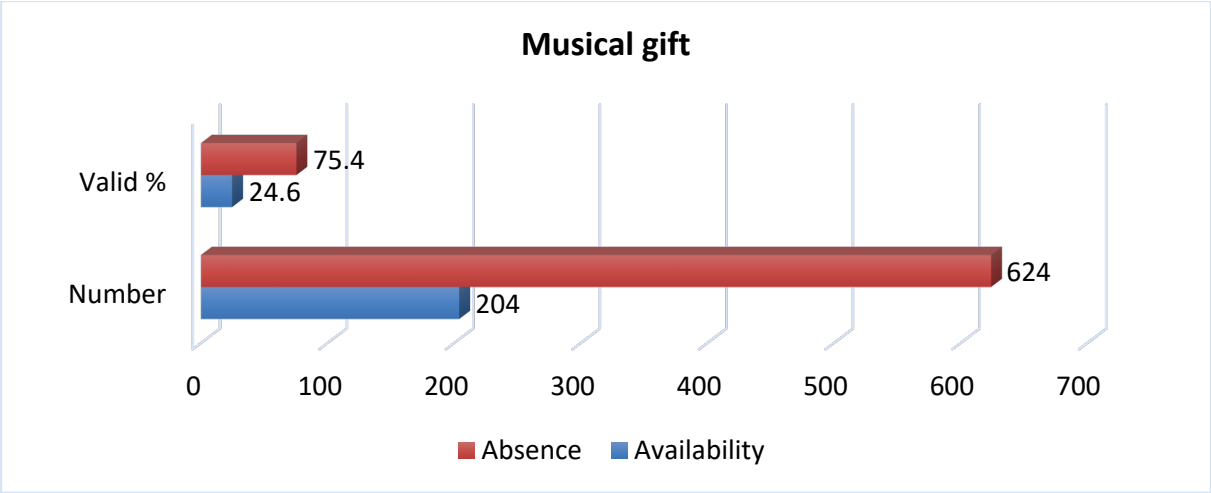


Figure 32. Distribution of participants in the studied sample depending on the appearance of *musical gift*

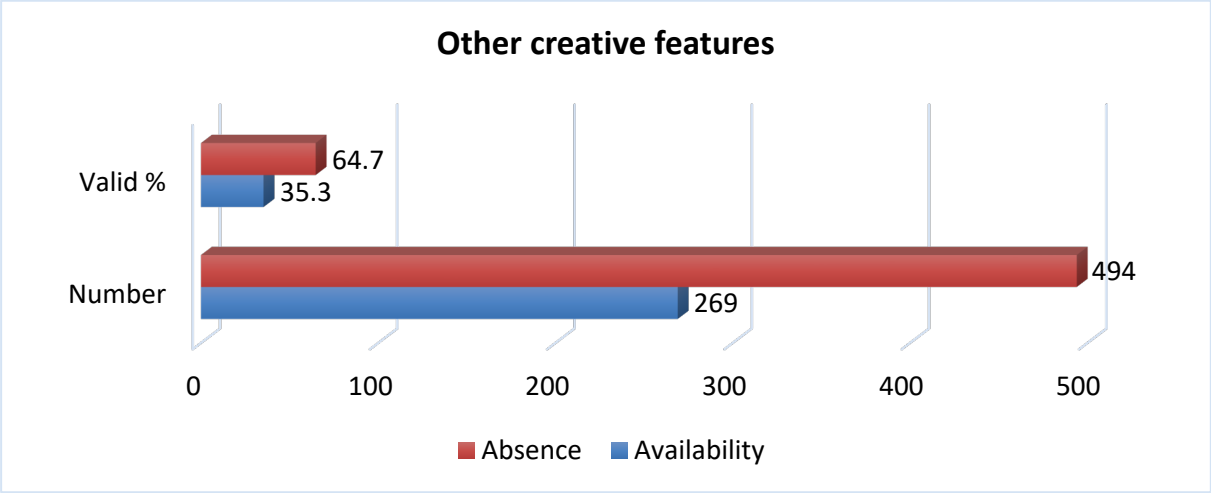


Figure 33. Distribution of participants in the studied sample depending on the appearance *other creative features*

Basic personality characteristics – descriptive statistics

The degree of expression of the basic personality traits among the studied persons is represented by groups depending on the strength of expression in Figures 34, 35, 36, 37 and 38. The grouping is based on a five-point scale representing the possibility of collecting points on each of the studied characteristics . The distribution for each of the basic characteristics is reported in 5 groups as follows: (1) low expression of the corresponding trait; (2) rather low expression of the trait; (3) trait expression in the middle (intermediate expression); (4) rather high expression of the trait; (5) high expression of the trait. When reporting the results, it is logical to comment on the combined data from groups 1 and 2 and from groups 4 and 5.

Research data show that on the scale of extraversion – ***introversion***, the highest percentage of participants have the characteristics of introverted personalities (Fig. 34). This is a total of 58.8% of the surveyed persons. The reported data indicate that 19.8% of the surveyed persons have a point indicator in the middle – neither predominantly extroverted nor predominantly

introverted. A total of 21.4% of participants in the study make up the subgroups of extroverted and somewhat extroverted individuals.

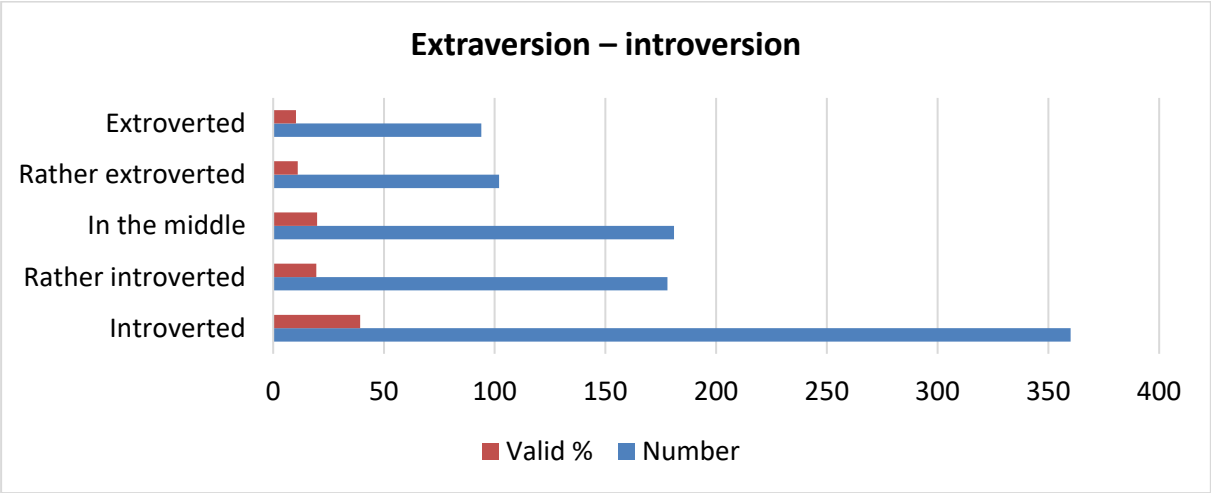


Figure 34. Distribution of the examined persons on the five-point scale depending on the expressiveness of the indicator *extraversion*

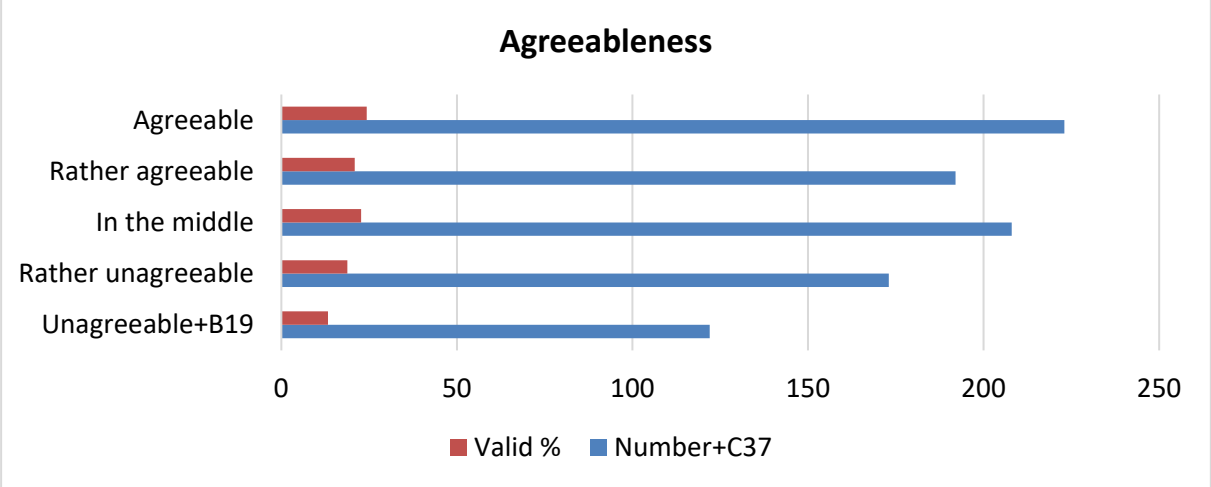


Figure 35. Distribution of the examined persons on the five-point scale depending on the expressiveness of the indicator *agreeableness*

In terms of scale ***agreeableness – non agreeableness*** the results obtained for the Bulgarian population indicate the highest overall percentage (45.2%) of benevolent and somewhat benevolent participants. Their responses correspond to higher levels of expression of this characteristic. Cases falling in the middle of the agreeableness scale were 22.7%, and those with low levels of agreeableness (pooled into groups – unfriendly and somewhat unfriendly) made up a total of 32.1%. Agreeableness as an individual's personality trait affects socially desirable questions and answers. It is possible that this feature of the basic quality is a concomitant reason for the reported greater proportion of participants with a high degree of its expression. However, the logical explanation of the obtained results should be connected with the specific result reported, namely that a greater part of the studied persons are benevolent as individuals (Fig. 35).

In Fig. 36 presents the data regarding the scale distribution ***consciousness – unconsciousness***. As can be seen from the results, the highest score for this indicator was registered with a total of 64.1% of the participants. A total of 15.7% were registered for the group of unconscious and somewhat unconscious, and 20.1% with the manifestation of the symptom in the middle (Fig. 36).

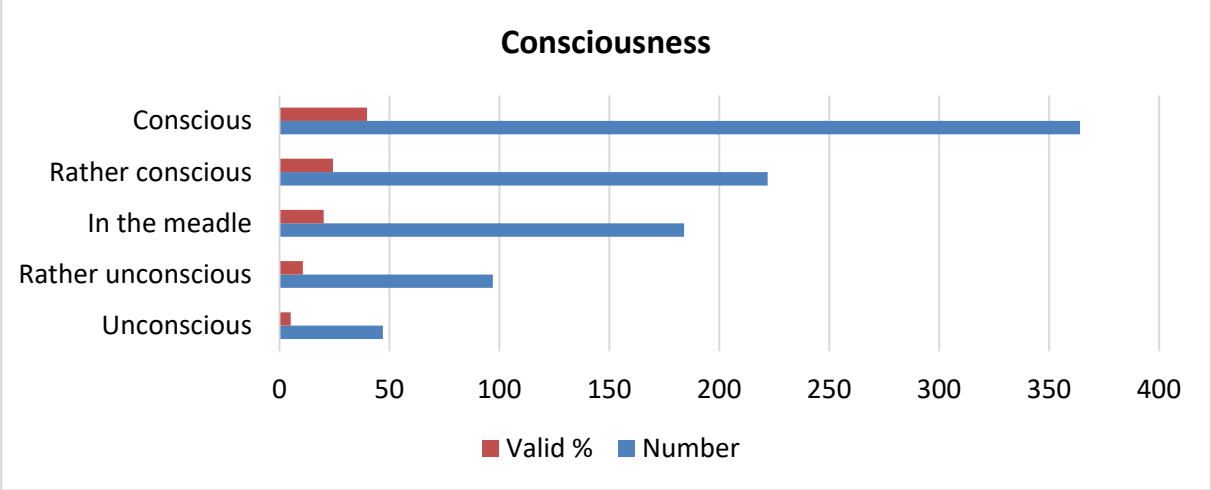


Figure 36. Distribution of the examined persons on the five-point scale depending on the expressiveness of the indicator *consciousness*

The data on the base characteristic ***emotional stability*** are presented in Fig. 37, from which it is evident that a larger share of the studied sample (47.7% in total) is represented by emotionally unstable (neurotic) and rather emotionally unstable individuals. The share of the emotionally stable and rather emotionally stable is significantly smaller – a total of 33%, and of those whose trait is pronounced along the trail – 19.3% (Fig. 37).

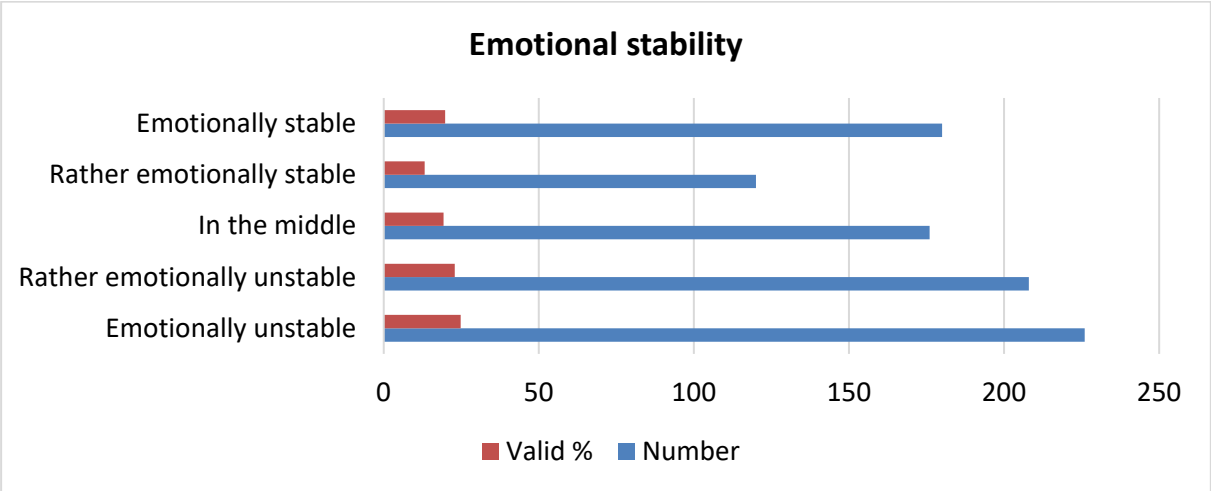


Figure 37. Distribution of the examined persons on the five-point scale depending on the expressiveness of the indicator *emotional stability*

The personality indicator ***openness to experience*** has the highest expression at a total of 44.3%. In 31.6% of the participants, a low and rather low level of expression of this characteristic is reported, and in 24.1% the expression is in the middle of the scale (Fig. 38).

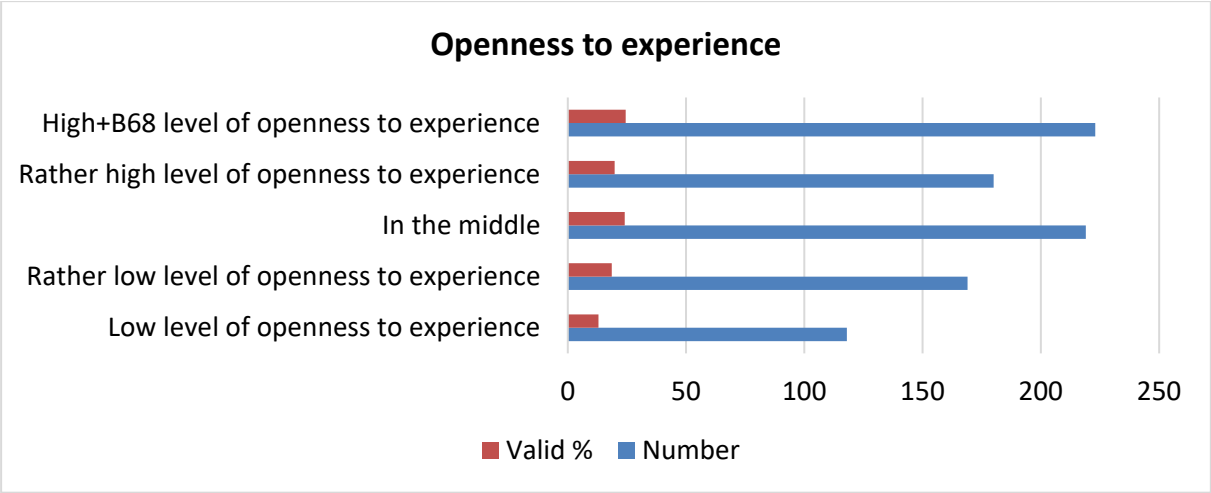


Figure 38. Distribution of the examined persons on the five-point scale depending on the expressiveness of the indicator *openness to experience*

In Table. 1 presents data on the quantitative dimensions of the studied personality characteristics. Theoretically, the lowest value on the scales is 10 and the highest is 50.

Table 1. General quantitative dimensions of the studied personality indicators

Indicators	**Extraversion**	**Agreeableness**	**Consciousness**	**Emotional stability**	**Openness to experience**
Number	915	918	914	910	909
Average	32.98	40.25	37.99	29.15	37.58
Median	33.00	41.00	39.00	29.00	38.00
Fashion	32	39	39	31	35
Art. deviation	7.906	6.351	7.108	9.166	6.353
Minimum	10	11	15	10	10
Maximum	50	50	50	50	50

It is evident from the presented data that the lowest values on the scale (10) were recorded for three of the five basic personality characteristics – *extraversion*, *emotional stability* and *openness to experience*, and maximum (50) – for all. In terms of metrics *agreeableness* and *consciousness* the lowest score reported by survey participants was higher than 10. Reported mean scores for the five basic personality traits ranged from 29.15±9.2 (for emotional stability) to 40.25±6.4 (for agreeableness) and indicated that among them, agreeableness was most strongly expressed, followed by conscientiousness and openness to experience (intellect/imagination). Their high averages could also be related to their social desirability. The lowest was the average reported value for expression of emotional stability (Table 1). This could be due to the age characteristics of the individuals, since a larger part of the studied sample is represented by young people (16-35 years old), in whom emotions are more pronounced and change more often.

Based on the obtained results regarding the manifestation of the main personal characteristics, it can be summarized that in the studied Bulgarian population there is a predominance of persons with pronounced introversion, agreeableness, awareness and openness to experience, who in their distinct part are also emotionally unstable.

Analysis of the relationships between the studied descriptive, immunological and polygenic characteristics and the basic personality traits

From a psychogenetic point of view, possible dependencies of the studied basic personality phenotypes with the other studied descriptive, immunological and polygenic characteristics are of interest. The established ones are presented in a series of tables.

Table 2. Established relationships between basic personality characteristics and studied monogenic, polygenic and multifactorial signs

Signs	Personality traits	Appearance type	N	Average value	P
Face shape	Agreeableness	Rounded	608	40.41	0.012
		Rectangular	200	39.10	
Chin shape	Extraversion	Rounded	600	32.49	0.055
		Rights	201	33.74	
	Consciousness	Rounded	598	38.19	0.069
		Rights	201	37.12	
Chin cleft	Agreeableness	+	174	38.98	0.003
		–	709	40.58	
	Consciousness	+	176	36.49	0.002
		–	704	38.34	
Dimples on the cheeks	Consciousness	+	326	37.37	0.047
		–	579	38.35	
	Openness to experience	+	321	38.18	0.041
		+	321	38.18	
Freckles	Agreeableness	+	136	39.40	0.084
		–	762	40.41	
	Consciousness	+	134	36.97	0.070
		–	760	38.14	
Diastema	Agreeableness	+	69	38.97	0.059
		–	550	40.48	
	Consciousness	+	68	35.97	0.013
		–	548	38.26	
Flexibility of the tongue (funnel)	Extraversion	+	548	33.37	0.066
		–	356	32.38	
	Openness to experience	+	550	37.94	0.041
		–	348	37.05	
Language flexibility (folder)	Extraversion	–	205	32.16	0.086
		+	696	33.24	
	Agreeableness	–	200	38.50	0.00
		+	704	40.73	
	Openness to experience	–	198	35.93	0.00
		+	698	38.03	

Table 2 (continued). Established relationships between basic personality characteristics and the studied monogenic, polygenic and multifactorial signs

Signs	Personality traits	Appearance type	N	Average value	P
Lobe of the ear	Agreeableness	Free	641	40.61	0.004
		Attached	249	39.25	
	Openness to experience	Free	643	37.86	0.021
		Attached	242	36.76	
Hairline	Emotional stability	Spitz	316	**28.25**	0.048
		Rights	566	**29.51**	
Hair type	Agreeableness	Curly	108	40.08	0.012
		Wavy	346	**41.04**	
		Rights	455	**39.71**	
	Emotional stability	Curly	104	29.01	0.027
		Wavy	342	**28.11**	
		Rights	456	**29.87**	
	Openness to experience	Curly	109	38.11	0.016
		Wavy	339	**38.24**	
		Rights	452	**37.00**	
Hair color	Agreeableness	Black	113	39.61	0.000
		Dark brown and brown	390	**41.08**	
		Light brown	310	**40.15**	
		Shades of blonde	98	**38.12**	
	Openness to experience	Black	115	37.63	0.008
		Dark brown and brown	381	**37.97**	
		Light brown	308	**37.79**	
		Shades of blonde	97	**35.55**	
Placement of eyebrows	Agreeableness	Separated	802	**40.40**	0.034
		Connected	99	**38.96**	
	Consciousness	Separated	795	**38.16**	0.008
		Connected	102	**36.18**	
Eye line	Consciousness	Rights	625	**38.53**	0.001
		Slanted	93	**35.92**	
	Emotional stability	Rights	622	**29.65**	0.059
		Slanted	94	**27.74**	
Eye color	Openness to experience	Dark brown	119	38.18	0.009
		Brown	463	**37.24**	
		Blue	150	**36.63**	
		Others*	160	**38.79**	
Astigmatism	Consciousness	Availability	189	**36.89**	0.033
		Norm	660	**38.13**	

Table 2 (continued). Established relationships between basic personality characteristics and the studied monogenic, polygenic and multifactorial signs

Signs	Personality traits	Appearance type	N	Average value	P
Hand dominance	Agreeableness	Right	789	**40.30**	**0.053**
		Left	107	**39.04**	
	Consciousness	Right	788	**38.14**	**0.025**
		Left	106	**36.49**	
	Emotional stability	+	783	**28.87**	**0.052**
		–	106	**30.71**	
Hair on the back of the palm	Extraversion	+	223	**32.16**	0.064
		–	673	**33.29**	
	Emotional stability	+	218	**30.42**	0.012
		–	673	**28.62**	
Hair on the middle phalanges of the hand	Openness to experience	+	283	**38.75**	0.00
		–	599	**37.08**	
Bent/straight little finger	Consciousness	Bent	247	**36.87**	0.004
		Right	649	**38.40**	
	Emotional stability	Bent	247	**28.15**	0.050
		Right	646	**29.49**	
Rh factor	Emotional stability	+	434	**28.77**	0.0
		–	110	**30.65**	
Migraine	Emotional stability	Availability	89	**25.52**	0.000
		Norm	775	**29.46**	
Allergies	Openness to experience	Availability	166	38.43	0.087
		Norm	628	37.49	
Musical gift	Agreeableness	Availability	196	**41.29**	0.035
		Missing	608	**40.19**	
	Openness to experience	Availability	194	**39.04**	0.008
		Missing	604	**37.26**	
Other creative features	Extraversion	Availability	260	**34.11**	0.016
		Missing	480	**32.64**	
	Openness to experience	Availability	257	**39.67**	0.00
		Missing	480	**36.39**	

The descriptive signs presented so far and their relationships with the five main personality characteristics are being studied for the first time in the Bulgarian population. Although there are partial studies in this area of behavioral genetics, such associations have not been investigated worldwide. The applied statistical approaches of comparison and subsequent comparative analysis prove to be a suitable basis for scientific forecasting and complex phenotypic characterization of the individual. From the point of view of population analyses, the study provides a broad basis for interpreting the relationship between descriptive and emotional-psychological personality traits, which is done for the first time and clearly characterizes its original character.

The established statistically significant relationship between Rh blood group phenotypes and emotional stability as part of the basic personality panel is reported for the first time, both in relation to the Bulgarian sample and in the context of available scientific information worldwide, which emphasizes the original nature of the present study.
It can be summarized that high blood pressure and myopia are in a statistically significant relationship with the age of the individuals. There is a general trend for older people to have more health problems for all diseases considered.
Migraine, astigmatism and myopia were statistically significantly related to the sex of the individuals and were expressed in a higher percentage of women compared to men.

Table 3. Frequency of occurrence in the studied sample of **musical and other talents** depending on the factor **floor** – p data for: musical talent – 0.556; other talents – 0.318; analysis is by the χ2-test

Floor	**An appearance**	**Musical talent**		**Friend talent**	
		N	**%**	***N***	**%**
A man	Availability	61	**26.3**	70	**32.4**
	Missing	171	73.7	146	67.6
Wife	Availability	143	**24.3**	195	**36.2**
	Missing	445	75.7	343	63.8

The survey data based on the χ2 test showed that the occurrence of *musical and other talents* among the examined persons is not statistically dependent on gender (Table 3). Nevertheless, it is found that a slightly higher frequency of appearance of *musical talent* occurs among men and a slightly higher frequency of appearance of *other talents* – among women (Table 3).

Table 4. Frequency of occurrence in the studied sample of **musical and other talents** depending on the factor **age** – p data for: musical talent – 0.729; other talents – 0.001*; * – existence of a statistically significant relationship ($p \leq 0.05$), established by the χ2-test

Age (years)	**An appearance**	**Musical talent**		**Other talents***	
		N	**%**	***N***	**%**
16-25	Availability	95	25.7	142	41.3
	Missing	274	74.3	202	58.7
26-35	Availability	43	24.7	51	33.1
	Missing	131	75.3	103	66.9
36-45	Availability	20	19.2	33	34.0
	Missing	84	80.8	64	66.0
46-55	Availability	25	28.1	24	29.6
	Missing	64	71.9	57	70.4
56-65	Availability	12	25.5	4	9.1
	Missing	35	74.5	40	90.9
66+	Availability	6	20.0	10	33.3
	Missing	24	80.0	20	66.7

The presented comparative results characterize features of the creative potential in the studied Bulgarian sample and have an original character. Although studies with such a complex design are rare worldwide, which is why the results obtained cannot be compared with similar ones, it is important to emphasize the socially significant fact that the

relationships between individual creativity and basic personality characteristics can be used to solve problems related to education, as well as to reveal opportunities for personal development and well-being.

Conclusions and conclusions

The results obtained in the course of the present study, their complex analysis and their discussion give grounds for formulating the following conclusions and conclusions:

1. The present paper examines, characterizes and summarizes data on the distribution of a total of 29 monogenic, polygenic and multifactorial signs (descriptive, immunological, with genetic predisposition and basic personality characteristics) in a representative, heterogeneous by gender and age sample of the Bulgarian population;
2. In the studied Bulgarian population, the following phenotypic variants of descriptive head and facial signs and features of the hand, palms and fingers are more common: rounded shape of the face and chin; absence of cleft chin, dimples on cheeks, freckles on face and diastema of upper incisors; ability to bend the tongue as a funnel and as a folder; free earlobe; straight hairline; predominant straight and wavy hair; predominantly brown and light brown hair; spaced eyebrows; straight line available to the eyes; right hand dominant; right hand over left hand crossing; lack of hair on the back of the palm and on the middle phalanx of the fingers; left thumb over right thumb crossing; flexibility of the thumb no more than 30° and a straight (unbent) little finger. There is diversity in eye color with decreasing frequency as follows: brown; green and variegated; blues and dark browns.
3. The generalized analysis regarding the appearance of other signs – descriptive polygenic, immunological and multifactorial among the studied Bulgarian population shows that with a higher frequency of occurrence are persons with light and very light and with dark and medium dark skin. The established distribution according to the blood group phenotype is as follows: for the AB0 system – blood group A – 37%, 0 – 30.5%, B – 18.7% and AB – 13.8% and for the Rh system – Rh+ – 79.6% and Rh- – 20.4%. The frequency of the multifactorial diseases astigmatism, myopia, hypertension, migraine and allergies was 22.4%, 29%, 9.9%, 10.4% and 21.1%, respectively. Hypertension and myopia have a statistically significant positive relationship with age. Migraine, astigmatism, and myopia were statistically significantly more common in women than in men.
4. In the studied representative sample, 24.6% of the persons with prominent musical talent, and 35.3% of those with other prominent talents, which is an indicator of significant creative potential. No differences were found between the two sexes, but there was a statistically significant positive correlation between the expression of other talents and the age category 16-25 years.
5. Based on the results obtained regarding the manifestation of the main personality characteristics, it can be summarized that in the studied Bulgarian population there is a predominance of persons with pronounced introversion, agreeableness, awareness and openness to experience, who for the most part are also emotionally unstable.
6. Specific statistically significant relationships were established between most of the studied descriptive, immunological and multifactorial signs, on the one hand, and the basic characteristics of the personality, on the other hand, which allows the preparation of a complex phenotypic profile for the studied Bulgarian population.
7. **In the complex phenotypic profile of the studied Bulgarian population, the following trends and dependencies are outlined**:

- higher average levels on the indicator ***extraversion*** are counted in individuals with a straight chin, a flexible tongue (funnel type and folder type), lack of hair on the back of the palm, and prominent creative characteristics other than musical talent;
- higher average levels on the indicator ***agreeableness*** considered for those with round/oval face shape, no cleft chin, flexible tongue (folder type), no freckles, no diastema, loose earlobe, wavy hair, dark brown and brown hair, parted eyebrows, dominant right hand, marked musical talent;
- higher average levels of the indicator ***consciousness*** are reported in individuals with a rounded chin, no cleft, no dimples, no freckles, no diastema, parted eyebrows, straight eye line, normal vision (no astigmatism), dominant right hand, straight little finger;
- higher average levels on the indicator ***emotional stability*** are counted in individuals with a straight hairline, straight hair, straight eyeline, dominant left hand, hair on the dorsal side of the palm, straight little finger, Rh- blood group, not suffering from migraines;
- higher average levels on the indicator ***openness to experience*** (intellect/imagination) are reported in individuals with dimples on the cheeks, flexibility of the tongue (funnel type and folder type), loose earlobe, wavy hair, dark brown and brown hair, green and mottled eyes, hair on the middle phalanges of fingers, allergies and a pronounced creative potential (musical talent and other creative characteristics).

Dissertation Contributions

Contributions of an original scientific nature:

1. For the first time, through a systematized interdisciplinary approach, the phenotypic diversity in a representative sample of the Bulgarian population was examined at the population level, as monogenic, polygenic and multifactorial signs were studied in a complex, including descriptive, immunological, with genetic predisposition and basic characteristics of the personality;
2. For the first time, scientific information has been presented regarding the frequency of occurrence of selected monogenic, polygenic and multifactorial signs in the studied Bulgarian population, and a comparative analysis of the distribution of multifactorial signs according to gender and age has been made.
3. The established statistically significant relationship between the Rh blood group factor and emotional stability as part of the basic personality panel is reported for the first time, both in relation to the Bulgarian sample and in the context of available scientific information worldwide, which emphasizes the original nature of the study.
4. For the first time, a comparative characterization of the creative potential and its connections with the basic characteristics of the personality in a Bulgarian population is presented, and the proposed design for complex studies of creativity in the context of the Big Five personality factors is characterized by originality in the field of psychogenetics in general and hides potential for subsequent build-up studies.
5. The prepared complex phenotypic profile with an emphasis on established trends and statistically significant dependencies between psychological, on the one hand, and descriptive, immunological and multifactorial signs, on the other, is an original contribution to the knowledge of polymorphism among the Bulgarian population;

Contributions of a confirmatory nature

6. The distribution of AB0 and Rh blood group phenotypes in the studied population is confirmed by other authors;
7. The data of other researchers regarding the prevalence of the studied diseases with genetic predisposition among the Bulgarian population, the increasing frequency of some of them with increasing age, as well as possible associations with gender, are confirmed.

Methodological contributions

8. An optimal and effective complex of statistical methods – descriptive, comparative and analytical – was applied to clarify the relationships between the studied monogenic, polygenic and multifactorial signs, including scopic, immunological, with genetic predisposition and basic personality characteristics.
9. A complex of technical means – equipment and software – is applied and described to help blind researchers, providing opportunities for research and analytical activity in the course of scientific developments of a different nature.

Contributions of an applied nature

10. The complex design of the study and the achieved results, established trends and dependencies regarding the prepared phenotypic profile of the studied Bulgarian population can be successfully used to solve problems in the field of education, as well as to reveal opportunities for personal self-improvement and well-being.

List of publications related to the dissertation work

1. **Ivanov S.I.** and Ivanova E.N. (2023). A look at the population variability in the appearance of some human descriptive and personality traits in Bulgaria. Ecologia Balkanica. 15 (1) 89-94 https://eb.bio.uni-plovdiv.bg/?page_id=532 SJR-202, Q4
2. Panayotova G.K., **Ivanov S.I.**, Ivanova E.N. (2022). Sex, Age and Blood Group Structure of Myopia and Astigmatism in South Bulgaria Population. Ecologia Balkanica. 14 (2) 85-92 chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/; http://web.uni-plovdiv.bg/mollov/EB/2022_vol14_iss2/085-092_eb22128.pdf SJR 0.202 Q4
3. **Ivanov S.I.**, Panayotova G.K., Ivanova E.N. (2022). Characterization of allergies – gender, age and blood group structure in a reproductive population from southern Bulgaria. Supplement Journal of IMAB, 2022, Section Medicine. 1-4. DOI: https://doi.org/10.5272/jimab.2022Supplement1 SJR 0.225 $Q3_{2020}$
4. Ivanova E. N., **Ivanov S. I.**, Panayotova G. K. (2021) Study on Diversity in Some Human Phenotypic Characteristics. In: Proceedings of the 5th Balkan Scientific Conference on Biology 15-16 April 2021, Plovdiv, Bulgaria Kostadinova, S., Mollov, I., Dzhambazov, B., Naimov, S., Vassilev, K. & Georgiev, B. (Eds.) 49 – 55. Plovdiv University Press, 2021 e ISBN 978-619-202-658-5; https://balkanbiouni-plovdiv.bg, snowflakes https://balkanbio.uni-plovdiv.bg/?page_id=46

List of additional publications

1. Ivanova E. N., Alexandrova-Karamanova A., **Ivanov S.**, Lazarova D. , Bozhinova B., Karadzhova E. 2018 . Balkan Ecology, 10 (2) 205-211. SJR 2018 – 0.1 Q4
2. Ivanova E. N., Alexandrova-Karamanova A., **Ivanov S.**, Grozeva S., Georgieva M., Dimitrova T., Hayverova T. 2018. Characteristics of personality in people with different talents. Ecologia Balkanica, 10 (2) 199-204. SJR 2018 – 0.1 Q4
3. Panayotova G.K., **Ivanov S.I.**, Ivanova E.N. (2022). Characterization of hypertension and migraine in relation to sex, age and AB0 blood group affiliation. Journal of IMAB – Annual Proceeding (Scientific Papers). 28. 4644-4649. 10.5272/jimab. 2022284.4644. SJR 0.225 $Q3_{2020}$

Participation in scientific forums

1. Ivanova, E.N. & **Ivanov, S.** (2022). Phenotypic variability of some human descriptive and behavior characteristics. III. International Agricultural, Biological & Life Science Conference 29 – 31 Ayugust, 2022, Edirne, Turkey – poster presentation
2. Ivanova, E.N. & **Ivanov, S.** (2022). Looking at the relationship between human Rh factor and basic personality characteristics. Third National Young Scientists Conference on Biology, Plovdiv, Bulgaria, 1st November 2022 – poster presentation
3. **Ivanov S. I.**, Panayotova G., Ivanova E. N. (2022) Characterization of allergies – gender, age and blood group structure in a reproductive population from Southern Bulgaria. Joint Forum SEEC-IMAB 12-th South-East European Conference of chemotherapy, infections and cancer and 32-st Annual Assembly of International Medical Association Bulgaria (20-23 October, 2022) at the section Biomedicine
4. **Ivanov S. I.**, Ivanova E. N. (2021) Study on diversity in some human phenotypic characteristics. 5th Balkan Scientific Conference on Biology, 15-16 April 2021, Plovdiv, Bulgaria Ivanova E. N., Alexandrova-Karamanova A., Ivanov S., Lazarova D., Bozhinova B., Karadzhova E. 2018. Some health problems and their relationship to the Big-five personality traits. Third Anniversary Scientific Conference on Ecology 2-3 November 2018, Plovdiv, Bulgaria.
5. Ivanova E. N., Alexandrova-Karamanova A., **Ivanov S.**, Lazarova D., Bozhinova B., Karadzhova E. 2018. Some health problems and their relationship to the Big-five personality traits. Third Anniversary Scientific Conference on Ecology 2-3 November 2018, Plovdiv, Bulgaria.
6. Ivanova E. N., Alexandrova-Karamanova A., **Ivanov S.**, Grozeva S., Georgieva M., Dimitrova T., Hayverova T. 2018. Characteristics of personality in people with musical talent and other talents. Third Anniversary Scientific Conference on Ecology 2-3 November 2018, Plovdiv, Bulgaria.

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3. Goldberg L. R. (2001). Analyses of Digman's child-personality data: derivation of big-five factor scores from each of six samples. Journal of personality. 69(5): 709-744. doi:10.1111/1467-6494.695161.
4. Rahim N. G. , Harismendy O., Topol J. E. & Frazer K. A. (2008). Genetic determinants of phenotypic diversity in humans. Genome Biology volume 9, Article number: 215 (2008). doi: 10.1186/gb-2008-9-4-215.
5. Schmitt D. P., Allik J., McCrae R. R., Benet -Martínez V. (2007). The Geographic Distribution of Big Five Personality Traits: Patterns and Profiles of Human Self-Description Across 56 Nations March 2007 · Journal of Cross-Cultural Psychology 38(2):173-212 DOI:10.1177//0022022106297299.