

## Genetic Variation in Relation to Demography of Male Population in Bosnia and Herzegovina

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### ABSTRACT

Until recently, it was believed that people settled in the area of today's Bosnia and Herzegovina only a few thousand years ago, that is, in the epoch of the Neolithic period 5-6 thousand years ago. Intensive archeological excavations revealed traces of men who lived in Bosnia and Herzegovina in the Early Stone Age, or more precisely, in the Middle Paleolithic. In the territory of Bosnia and Herzegovina, the material legacy of the Paleolithic is marked by the oldest monument of Paleolithic art in Southeast Europe - an engraving in the rock of the cave Badanj near Stolac, called *Horse attacked by arrows*, preserved fragmentarily, and was made around 12,000 BC.

Genetic research revealed that the first people in Bosnia and Herzegovina were present even 20,000 years ago.

A total of 2,501 people were tested in Bosnia and Herzegovina, they were classified into eight haplogroups: I, R, J, E, G, N, T and Q.

The most common haplogroup in Bosnia and Herzegovina is haplogroup I. 52% of tested people belong to this haplogroup (I1- 8% i I2 - 44%). The second most common is haplogroup R with 21% (R1a-5% and R1b-16%), followed by haplogroups E-13%, J-9% (J1-1% and J2-8%), N-3%, G-2% and haplogroups T (3 tested, 0%) and Q (1 tested, 0%).

Four haplogroups: I, R, E and J are represented in Bosnia and Herzegovina with 94%.

The movement path of haplogroup I2-M423 begins 230,000 years ago from Africa and goes from Nigeria through Chad, Sudan, Ethiopia, Yemen, Oman, Iran, Iraq, Syria, Turkey, all the way to the Balkan Peninsula. The path ends in the territory of Bosnia and Herzegovina about 18,000 years ago.

Censuses in Bosnia and Herzegovina are also presented in this work. The oldest population census of Bosnia and Herzegovina dates back to the very beginning of the seventeenth century, and was conducted during the Turkish rule in the Balkan countries, including Bosnia and Herzegovina.

The first population census in Bosnia and Herzegovina by the Austro-Hungarian authorities was carried out in 1879. Censuses were made in 1885, 1895 and 1910.

In the period 1921-2013 a total of nine censuses were carried out in B&H.

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Studying the origins of the Bosnian-Herzegovinian population is a very complex problem. It is a country that, due to its exceptional strategic and geographical position, could not be bypassed by any migration that occurred in the wider area of Europe from prehistory to the present day. One of the most important transversal roads in Europe passed through the territory of Bosnia and Herzegovina, which led from the south to the north and vice versa. These are the valleys of the rivers Neretva and Bosnia, which connected the Mediterranean and the Danube (central Europe) - two completely

different climatic, cultural, ethnic and political worlds. Thanks to its exceptional strategic geographical position, Bosnia and Herzegovina contains very rich and diverse archaeological material left behind by countless human communities from various eras who lived here or passed through on their way from Asia to Europe and vice versa. The hilly-mountainous configuration of the country, the abundance of forests, game and pastures, fertile river valleys, mineral wealth and other riches that the soil of Bosnia and Herzegovina has always abounded in, created ideal conditions for people to live. In science, it has long been stated that Bosnia and Herzegovina represents an extremely important archaeological area because there are few places where traces of the lives of

people who belonged to various racial, ethnic, cultural and geographical groups have been deposited for thousands of years. The Bosnian-Herzegovinian sites have yielded unique findings that in some cases represent the key to solving the archaeological problems of the wider part of Europe, especially the Balkan Peninsula. Such, for example, are the anthropomorphic figures excavated in Butmir near Sarajevo, which depict members of as many as three races (Negro, Caucasian and Alpine). It is a puzzle that has long been occupied by archaeologists and ethnologists.

Until recently, it was believed that people settled in the area of today's Bosnia and Herzegovina only a few thousand years ago, that is, in the epoch of the Younger Stone Age 5-6 thousand years ago. Intensive archaeological research carried out after the Second World War disproved this opinion. Archeological excavations have revealed traces of a man who lived here in the Old Stone Age, or more precisely, in the Middle Paleolithic. In the territory of Bosnia and Herzegovina, the material legacy of the Paleolithic is marked by the oldest monument of Paleolithic art in Southeast Europe - an engraving in the rock of the cave Badanj near Stolac, called Horse attacked by arrows, preserved fragmentarily, and was made around 12,000. p. n. e.

According to the distribution of the findings, it can be concluded that these ancient Bosnian inhabitants predominantly inhabited the northern (plain) part of Bosnia, primarily the areas around the Usora inlet in Bosnia near Dobož (localities: Kamen, Crkvina and Londa near Makljenovac), then around the composition of Velika and Mala Ukrina (localities: Celinjak in Popovace, Luksic, Mala Gradina, Gaj and Krcevine in Kulase, Matica Glavica in Dragalovci, Lupljanica, Krndija, etc.) - The southernmost point where such finds were found is Gradina Varvara at the Rama spring near Prozor.

In the Neolithic period, the permanent population of the territory was recorded when cultures such as Kakan and Butmir developed. After the arrival of the first Indo-Europeans, several Iron Age cultures such as the Glasnica and Central Bosnian cultural groups were recorded. Those cultures are mostly associated with several Illyrian tribes such as Desidiat, Mezei, Breuci, Dictioni, Autariate. With the arrival of the Romans, most of these tribes were Romanized by the 6th century. With the arrival of Slavic tribes in the Balkans, the territory of Bosnia and Herzegovina was inhabited by various South Slavic tribes. By the 12th century, the Bosnian Banovina was established, which would grow into the Kingdom of Bosnia at the end of the 14th century. During the reign of King Tvrtko I, it was the most powerful feudal kingdom in the region. With the death of Tvrtko I, the strength and influence of the Bosnian state slowly declines. At that time, the Ottoman Empire began its invasion of Southeastern Europe, which was a great threat to the Kingdom of Bosnia. Exhausted by internal conflicts and left to fend for itself, under the rule of the last king Stjepan Tomašević, Bosnia lost its independence in 1463. In the following century, the entire area of today's Bosnia and Herzegovina became part of the Ottoman Empire and became its westernmost province. By weakening the Ottoman Empire Empires after the Congress of Berlin, Austria-Hungary occupied Bosnia and Herzegovina, which would last until the First World War. Between the two world wars, it was part of the Kingdom of Serbs, Croats and Slovenes, that is, the Kingdom of Yugoslavia, and then part of the Socialist

Federal Republic of Yugoslavia as one of its six republics. With the breakup of Yugoslavia, he declared independence, as a result of which war broke out in Bosnia and Herzegovina, which lasted from 1992 to 1995.

Bosnia and Herzegovina is regionally and internationally known for its natural beauty and cultural heritage, cuisine, unique music, architecture and festivals, some of which are some of the largest and most prestigious of their kind in Southeast Europe.

### Censuses in Bosnia and Herzegovina

The oldest population census of Bosnia and Herzegovina dates back to the very beginning of the seventeenth century, and was carried out during the Turkish rule in the Balkan countries, including Bosnia and Herzegovina. These lists - registers were made according to sandzacs, administrative units of that time. The registers related to Bosnia and Herzegovina, located in the State Archives of the Republic of Turkey, are sorted and archived in different series of documents, and most of them are coded as Tapu defteri. In the 1950s, Turkey delivered several dozen of these lists from the State Archives of the Republic of Turkey to Bosnia and Herzegovina, and with this act a great advance was made in the study of the past of the peoples of Bosnia and Herzegovina. Notebooks related to all parts of the former Yugoslavia were stored in the Oriental Institute in Sarajevo.

### Censuses during the Time of Austria-Hungary

The first population census in Bosnia and Herzegovina by the Austro-Hungarian authorities was carried out in 1879. Censuses were carried out in 1885, 1895 and 1910.

Table 1: Censuses 1879-1910. years

Year	1879	1885	1895	1910
Number of citizens	1.158.440	1.336.091	1.568.092	1.898.044

In the observed four censuses, the number of inhabitants increased from census to census, which is presented on graph 1.

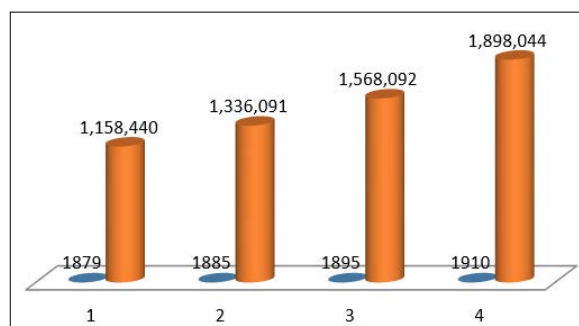


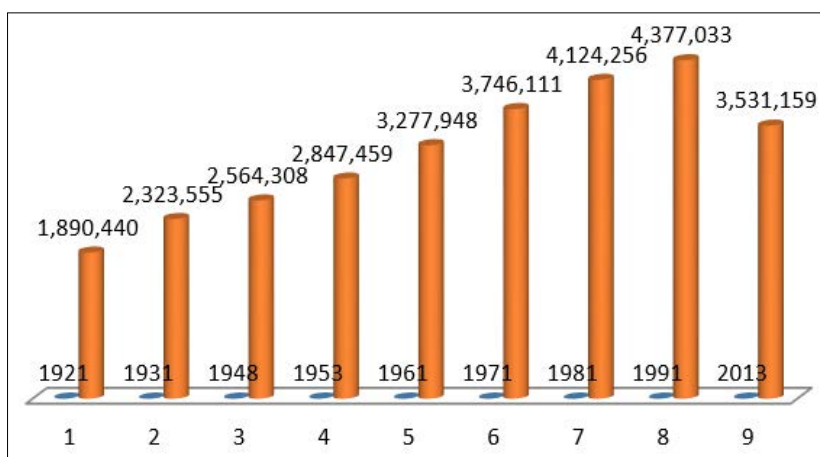
Chart 1: Censuses 1879-1910. years

### Censuses Since 1921

In the period 1921-2013. a total of nine censuses were carried out in BiH. The results of the census by census years are presented in table 2 and graph 2. The number of inhabitants increased continuously during the census period 1921-1991. years. In the 2013 census, compared to 1991, the population was 845,874 fewer, which is the reason for the war in the 1990s.

**Table 2: Censuses 1921-2013. years**

Year	1921	1931	1948	1953	1961	1971	1981	1991	2013
Number of st	1.890.440	2.323.555	2.564.308	2.847.459	3.277.948	3.746.111	4.124.256	4.377.033	3.531.159



**Chart 2: Censuses 1921-2013. year**

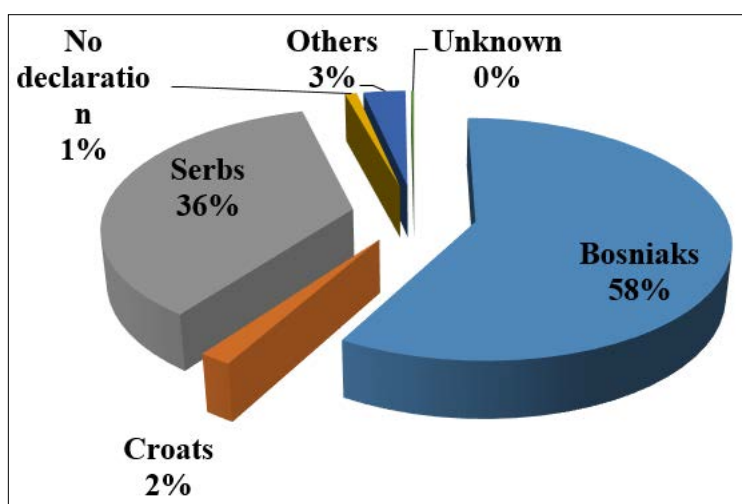
**2013 Census**

The 2013 population census in Bosnia and Herzegovina was conducted in the period from October 1 to 15, 2013, according to the situation on September 30, 2013 at midnight, which is considered the reference date of the census. The census was supposed to be organized from April 1 to 15, 2013, but due to technical deficiencies observed during the trial census conducted in 2012, it was later postponed to October (Statistical Institute of the Federation of Bosnia and Herzegovina).

According to the 2013 census, Bosnia and Herzegovina had 3,531,159 inhabitants. According to the national structure, Bosniaks had 1,769,592 (50%), Serbs 1,086,733 (31%), Croats 544,780 (15%), Others 96,539 (3%) and 27,055 (1%) did not declare.

**Table 3: National population structure in Bosnia and Herzegovina, 2013 census**

Total	Bosniaks	Croats	Serbs	No declaration	Others	Unknown
3.531.159	1.769.592	544.780	1.086.733	27.055	96.539	6.460



**Chart 3: National population structure in Bosnia and Herzegovina, 2013 census**

**Genetic Heritage of Bosnians and Herzegovians**

"Genetics as a science, in the past decade in these regions, has been characterized by a media-tempting, scientifically completely unfounded term - "genetic origin (origin) of the people". Truly, the human genome is the most beautiful book in which all the "vagaries" of the evolutionary processes are recorded and archived, which as the end result created the species known in science as Homo sapiens. A precise and detailed reading and understanding of the genome (from which we are so far away) could tell us a lot not only about the inheritance of one individual or population, but also about the comprehensive evolutionary processes that led to the emergence of modern man.

To simplify - there is no genetic origin of people, at least not in these areas. People, as a category by definition, is not the starting point of any genetic research. Namely, in population genetics, the starting category of the test, as the name suggests, is the population. A population is a group of individuals of the same species that inhabits a certain area and can breed with each other and have offspring. Therefore, the population and the people or the population and the nation can rarely, and in these areas never, "match" to the extent that an equality sign can be placed between them.

Therefore, all population-genetic research in Bosnia and Herzegovina, which has been carried out for centuries, including the ones carried out in the last decade, examined the structure of the population of Bosnia and Herzegovina as a population. Research that was obtained by examining the population in the territory of Bosnia and Herzegovina indicated that Bosnians and Herzegovina represent a genetically heterogeneous population in whose genome traces of large, long-term and intense migration flows characteristic of the area that millennia ago, and still today, represented crossroads on the migration routes of modern man. This genetic richness served to create a "genetic scenario" of the settlement of Bosnia and Herzegovina, but also of the entire region, which continues to seek confirmation or challenge by other scientific disciplines such as history, archeology, paleoanthropology... In the end, genetics is not even there to confirm nor to deny, and especially not to create nations, because genetics is not interested in nations, but in populations" [1].

### Haplogroups

**What is a haplogroup?** For a better understanding of this term, we will give a simplified explanation: like a surname that is traditionally inherited from the father's side, or "mother's maiden name" or "mother's maiden name" and so on, the haplogroup is also inherited. Haplogroups are indicated by letters, in alphabetical order, and subgroups by additional letters and numbers.

In Bosnia and Herzegovina, 2,500 people were tested (data as of February 8, 2023). The number of people tested is increasing day by day because people are increasingly interested in finding out their genetic origin. Data on the tested persons were taken from: the Bosniak DNA project, the Serbian DNA project, tests performed in the area of Stara Herzegovina and the Croatian DNA project [2-4].

### DNA Test Results

A total of 2,501 people were tested in Bosnia and Herzegovina, who were classified into eight haplogroups: I, R, J, E, G, N, T and Q.

### Haplogroups

I1 - 203	I2 - 1100	I - 1303		
R1a - 402	R1b - 122	R - 524		
J1 - 32	J2 - 195	J - 229		
E - 320	G - 47	N - 76	T - 3	Q - 1

### A total of 2.501 tested

The most represented haplogroup in Bosnia and Herzegovina is haplogroup I. 52% of the tested population belongs to this haplogroup (I1 - 8% and I2 - 44%). The second most represented is haplogroup R with 21% (R1a-5% and R1b-16%). Then followed haplogroups E-13%, J-9% (J1-1% and J2-8%), N-3%, G-2%, and

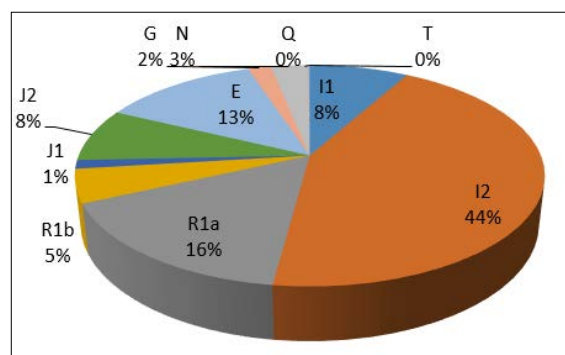
haplogroups T (3 tested, 0%) and Q (1 tested, 0%).

Four haplogroups: I, R, E and J are represented in Bosnia and Herzegovina with 94%.

The distribution of haplogroups is shown in table 4 and graph 4.

**Table 4: Haplogroups in Bosnia and Herzegovina**

I1	I2	R1a	R1b	J1	J2	E	G	N	Q	T
203	1100	402	122	32	195	320	47	76	1	3



**Chart 4: Haplogroups in Bosnia and Herzegovina**

### Representation of Constituent Nations in BiH by Haplogroups

**Haplogroup I**  
Bosniaks I - 54% (I1 - 7%, I2 - 47%), Serbs I - 51% (I1 - 9%, I2 - 42%) and Croats I - 54% (I1 - 7% and I2 - 47%) .

We can conclude that haplogroup I as well as its sub-branches I1 and I2 are equally represented in all three constitutive peoples of Bosnia and Herzegovina.

### Haplogroup R

Bosniaks R- 22% (R1a – 15% and R1b – 7%), Serbs R- 20% (R1a - 17% and R1b – 3%) and Croats R- 15% (R1a - 15%).

Haplogroup R, its subbranch R1a, is approximately equally represented in all three constitutive nations. Haplogroup R1b is most represented in Bosniaks, 7%, then in Serbs, 3%, while it is not present in Croats.

### Haplogroup E

Bosniaks E-12%, Serbs E-13% and Croats E-23%. The representation of haplogroup E is highest among Croats at 23%, while it is approximately the same among Bosniaks (12%) and Serbs (13%).

### Haplogroup J

Bosniaks J-9% (J1-1% and J2-8%), Serbs J-10% (J1-2% and J2-8%), Croats J- 8% (J1- 0% and J2 - 8%) . Haplogroup J is approximately equally represented in all three constitutive nations.

### Haplogroup N

Bosniaks N -2%, Serbs N - 4%.

### Haplogroup G

Bosniaks G – 1%, Serbs G-2%.

Haplogroup T Bosniaks 3 tested and haplogroup Q Serbs 1 tested.

### Conclusion

All three constitutive peoples are equally represented in all haplogroups. Tzo means that their paths of movement through



space and time were almost the same. The small deviation in the case of Croats is also due to the fact that the sample of those tested is small compared to two other nations.

### Path of Movement

Since its origin, Homo sapiens migrated across the planet, diversifying into different populations and cultures, which interacted and intermingled. DNA managed to gather all this information and trace the historical path of our ancestors.

The paternal line is analyzed through the study of Y-chromosome haplogroups, which enables the study of the paternal line. By studying the paternal haplogroup, you will know your "ancestral father" and the time and geographical place of origin of your Y-chromosome haplogroup, and thus your paternal lineage.

All human male lineages can be traced back to one common ancestor in Africa who lived about 230,000 years ago, nicknamed Y-Adam (Adem).

### Haplogroup I

Haplogroup I represents the oldest main haplogroup in Europe. It is assumed that it was created around 35,000 years ago. In Europe, two branches of this haplogroup can be distinguished, namely haplogroup I1 and haplogroup I2. Haplogroup I1 was created 27,000 years ago and is most represented in Northern Europe, more precisely in Scandinavia and Finland, with over 35-40%. Haplogroup I2 is the most represented in the Western Balkans, with the highest frequency in Bosnia and Herzegovina (over 44%), followed by Croatia and Serbia (40%), and Sardinia (around 39%).

The origin and distribution of haplogroups I1 and I2 indicate that Europeans who are carriers of these haplogroups are actually descendants of the so-called "old (Paleolithic) Europeans, whose ancestors inhabited this continent in the late Paleolithic. Due to climatic changes, they linked their survival during the Ice Age to certain microlocations, so that after it, independently or in groups with other "Old European populations" (carriers of haplogroups R1a and R1b) and groups of subsequently settled "Neolithic farmers" (Southeastern Europe) conquered every inch of empty space [1].

### Haplogroup I2

In this paper, we presented only one haplogroup I and its branch I2 as the oldest haplogroup present in Bosnia and Herzegovina.

Figure 1 shows the movement path of haplogroup I2-M423. The path of movement begins 230,000 years ago from Africa and goes from Nigeria through Chad, Sudan, Ethiopia, Yemen, Oman, Iran, Iraq, Syria, Turkey, all the way to the Balkan peninsula, and the path ends in the territory of Bosnia and Herzegovina about 18,000 years ago.

The numbers in the pictures below represent the time, how many thousands of years ago the members of a certain haplogroup were in a certain area.



Figure 1: Path of Movement of Haplogroup I2-M423

Figure 2 shows the trajectory of haplogroup I2-M423 in Europe



Figure 2: Path of Movement of Haplogroup I2-M423 in Europe

Figure 3 shows the trajectory of haplogroup I2-PH3414 in Europe. The ancestors of this haplogroup came to the territory of Bosnia and Herzegovina about 20,000 years ago. They stay in Bosnia and Herzegovina for about ten thousand years, and then they leave Bosnia and Herzegovina and continue their journey towards the surrounding countries: Serbia and Bulgaria, and then return to Bosnia and Herzegovina about 1,500 years ago [5-8].

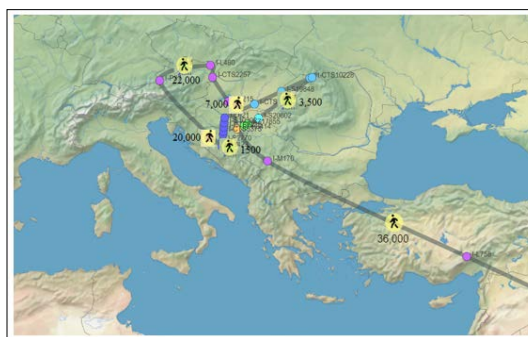


Figure 3: Path of Movement of Haplogroup I2-PH3414 in Europe

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