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GENERATION LENGTH IN THE YAKUT POPULATION IN 18th-19th CENTURIES

The intergenerational time interval in the Sakha people (Yakuts) was determined by an analysis of genealogical data of 712 families from Namsky, Verkhnekolymsky, Srednekolymsky, Nizhnekolymsky and Elgetsky districts recorded in the 18th – 19th centuries. The male generation interval in the Yakuts averaged 35.7 years, the female generation interval was 30.5 years, which is much higher than the mean general intervals used earlier in population-genetic studies for calculating the time of genetic divergence by the Y chromosome (31-32 years) and mtDNA (25-28 years).

Keywords: generation length, Yakuts, population.

Introduction. Generation interval (sometimes referred to as the generation length) is the most important parameter for calculating the mutation rate at microsatellite repeats in the Y chromosome and autosomal loci, in mitochondrial DNA, as well as for calculating the time of genetic divergence. In early genetic studies, the mean generation interval of 25 and 30 years was used for the paternally inherited Y chromosome; 20 years – for the maternally inherited mtDNA; and 20 and 25 years – for autosomes [15]. In particular, in the Zhivotovsky's fundamental work on assessing the mutations rate at the Y chromosome STR loci in populations with short-term documented histories – in Polynesians of New Zealand and Gypsies of Bulgaria, the male generation interval was estimated as ~25 years [19]. This value has been used by many authors to calculate the time of the most recent common ancestor in the reconstruction of the genetic history of various ethnic groups [1,10-12,14]. Later, an estimate of about ~30 years was considered more reasonable for male generation interval, and ~25–28 years – for female generation interval [1,15]. Only in one study of the genetic history of the Iberian population by the Y-chromosome, the male generation length was assumed to be 35 years [16].

However, one should take into account differences in marriage traditions and demographic characteristics in various populations (age of first marriage, adult mortality rate), which can greatly affect the intergenerational time interval. In order to clarify this indicator for the Yakut population, we determined the male and female generation intervals according to the genealogical data of the Yakuts of the 18^{th} – 19^{th} centuries.

Materials and Methods. The generation intervals were calculated by a direct count in deep-rooted pedigrees of Central and Northern Yakuts, restored according to the census records of 1768, 1795, 1816, and 1858; church registers for the period from 1768 to 1918; and the materials of the 1917 census [6-9]. The sample included genealogical data of 120 families of the Modut *nasleg* (community) [8, Tables 1-14] and 64 families of the Khatyryk nasleg [9, Tables 1-2] of Namsky district; 58 families of the I Baidun nasleg [6, Tables 88-93] and 96 families IV Myatyuzhsky nasleg [6, Tables 94-101] of Verkhnekolymsky district; 187 families of the II Baidunsky nasleg [6, Tables 1-12] and 90 families of the I Kangalassky nasleg [6, Tables 14-22] of Srednekolymsky district; 55 families of the I Myatyuzhsky nasleg of Nizhnekolymsky district [6, Tables 102-104); and 42 families of the Indigirka Yakuts of Elgetsky* disctrict [7, tables 2, 4]. **Note*. Elgetsky district was founded after 1770; it occupied a vast territory in the basin of the upper, middle and lower reaches of the Indigirka River. Since the 1930s, most of the territory of Elgetsky district has been part of modern Abysky and Momsky districts, and the smaller part belongs to Allaikhovsky district. The name of Elgetsky district is almost forgotten today.

The male generation interval I_m (father-child), which is of interest for the study of the Y-chromosome, is calculated as the mean age of the father at birth of all his children. The female generation interval I_f (mother-child), which is used in the study of mtDNA, is defined as the mean age of the mother at birth of all her children. For the population as a whole, the generation interval in a given time period is equal to the weighted average of the total generation intervals for the families included in it. The overall human generation interval required for studies using autosomal loci is calculated by the formula $I_o = (I_f + I_m)/2$ [15]. These generation intervals, I_m, I_f, and I_o, depend only on the reproductive adults; people who do not have children cannot influence these indicators. Thus, childhood mortality and infertility do not affect the values of the generation interval of a population.

In addition to the intergenerational

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Table 1

Generation lengths in 8 naslegs of Yakutia in 18th-19th centuries

District: Nasleg	Number of families	Father-child	Father-son	Mother-child	Mother-daughter	Overal generation interval
Namsky:						
Modut	120	36.0	34.7	30.3	29.9	33.2
Khatyryk	64	33.4	34.6	29.2	29.4	31.3
Verkhnekolymsky:						
I Baidunsky	58	36.0	34.6	29.8	31.3	32.9
IV Myatyuzhsky	96	35.5	36.1	31.3	31.1	33.4
Srednekolymsky:						
II Baidunsky	187	36.1	37.2	31.5	31.3	33.8
I Kangalassky	90	37.2	36.7	30.7	30.1	34.0
Nizhnekolymsky:						
I Myatyuzhsky	55	33.0	33.0	28.7	28.9	30.9
Elgetsky	42	38.9	37.6	30.9	32.8	34.9
Total	712	35.7	35.6	30.5	30.4	33.1

time intervals of father-child and mother-child used in the most genealogical studies, we also calculated the average father-son and mother-daughter intervals as more adequate indicators for calculating the rate of mutation of STR loci in the Y chromosome and in mtDNA.

Results and Discussion. Table 1 presents the mean male and female generation intervals in residents of 8 naslegs of Namsky, Verkhnekolymsky, Srednekolymsky, Nizhnekolymsky and Elgetsky distircts of Yakutia. The mean male generation intervals ranged from 33.0 to 38.9 years for various naslegs, female intervals – from 28.9 to 32.8 years. There were no significant differences in the generation lengths between the indigenous inhabitants of Namsky district and the northern Kolyma Yakuts. The maximum values of male generation interval (38.9 years) were recorded in families of the Indigirka Yakuts of Elgetsky district, which is apparently due to the fact that the sample included the genealogies of the two most noble families of Efimovs and Sleptsovs, which are distinguished by numerous offspring and currently constitute the main part of the Yakut population of Abyisky district [7]. When comparing the values between the generation lengths of father-child and father-son, mother-child and mother-daughter, no significant differences were found. For the entire studied sample of Yakuts, the male generation interval averaged 35.7 years, the female one – 30.5 years, with the overall generation length at 33.1 years.

The generation lengths calculated by us for the Yakut population significantly exceed the mean global values proposed earlier by Fenner, which were calculated on the basis of the United Nations (2000)

Table 2

Mean age of parents at first and last birth in Yakutia in 18th-19th centuries

District: Nasleg	Fathers		Mothers	
	1	2	1	2
Namsky:				
Modut	29.8	43.0	28.4	32.2
Khatyryk	30.5	40.5	23.7	33.9
Verkhnekolymsky:				
I Baidunsky	30.0	40.7	24.5	35.1
IV Myatyuzhsky	31.2	40.0	26.0	34.4
Srednekolymsky:				
II Baidunsky	30.5	42.5	27.6	35.1
I Kangalassky	30.2	42.1	25.3	34.9
Nizhnekolymsky:				
I Myatyuzhsky	27.4	39.2	23.1	33.7
Elgetsky	31.0	44.7	25.0	38.0
Total	29.9	41.4	26.2	34.2

Note: 1 is the average age at birth of the first child, 2 is the average age at birth of the last child

analysis of the mean-age-at-first-marriage data for 191 countries (84% of all countries in the world) and data from the Council of Europe (2002) [15]. Additional sources of information for this work were the results of national censuses, special surveys conducted in 1970 – 1998, and ethnographic data collected in the 19th and 20th centuries from the study of 157 hunter-gatherer societies from Africa, Eurasia, Australia, Northern, and South America. In developed countries, the author estimated the male generation length at 30.8 years, the female one – 27.3 years; in less developed countries – 31.8 and 28.3 years; and in the populations of hunter-gatherers – 31.5 and 25.6 years, respectively. Fenner proposed to use the value of generation length equal to 31-32 years for studying the divergence of populations by the Y-chromosomes, 25-28 years – for mtDNA, and 28-30 years – for autosomes [15]. The differences in the data for the Yakut population could be explained by the fact that in the Fenner's study, the generation intervals were estimated by indirect methods based on such parameters as age at first and last births, rate of mortality, and the average difference between the ages of men and women at first marriage. At the same time, it should be noted that direct methods for estimating generation lengths from genealogical data of several population are more accurate than indirect ones.

The values obtained by us for the Yakut population are comparable with the data of Tremblay for the French-Canadian population of Quebec, where the

mean values of the generation lengths for the Y-chromosome were estimated at 35 years, for mitochondrial DNA – 29 years, and for autosomal loci – 32 years [20]. Tremblay and Vézina analyzed the demographic parameters of the Quebec population from the 17th to the 20th centuries, just as we did, by direct methods of analyzing genealogical data and came to the conclusion that the Catholic population of Quebec then lived in conditions characteristic of many ancient populations: the demographic context included natural birth rates without contraceptive use, high mortality, and a relatively young age at marriage. Both populations, Yakut and Canadian, are characterized by developing in relatively isolated conditions, high birth rates, and the accumulation of rare hereditary diseases [2-4, 17].

It is known that the main factor affecting the intergenerational time interval is the average age of first marriage: the higher the age at which people get married, the longer the intervals between generations [20]. In tribes where traditions do not restrict early sexual intercourse outside marriage, the age of menarche is taken as the starting point of the reproductive period. However, it has been shown that in the first years after menarche there is a low birth rate and children born to women under 20 years of age account for a small proportion of all children [18]. In the sample of Yakuts of the 18th – 19th centuries studied by us, the proportion of children born to women under 20 was only 12%. The generation interval is also affected by the adult mortality rate in different age groups: people who die earlier leave fewer children and the intergenerational time interval in their lineages is shorter. On contrary, long-lived people have more children, greater genetic contributions to subsequent generations, and longer generations on average.

The mean age of a Yakut mother at birth of her first child in the 18th – 19th centuries was 26.2 years, and for a Yakut father – 29.9 years, while for the Canadians of Quebec it was 22.8 and 26.2 years, respectively [20]. Based on these data, one would expect that the generation length of the Yakuts should be on average ~3.5 years longer than that of the Canadians, but since this was not observed, it is sensible to assume that the mortality among Yakuts at a young age was higher than in the Canadian population, which led to smoothed differences and approximately equal values in the generation lengths for the both populations.

It should be noted that the mean age of the mother at birth of her first child among the Yakuts (26.2 years) turned out to be much higher than those in 11 hunter-gatherer tribes of Africa, Australia, Asia and America (on average 19.4 years) and in 40 less developed countries (average 20.5 years) [15]. The value obtained by us, apparently, cannot be explained by the late entry of women into marriage, since in the 19th - early 20th centuries, the mean marriage age for Yakut women ranged from 16 to 21 years; for Yakut men – from 17 to 25 years [5]. The discrepancy with data for other populations rather indicates a high infant mortality rate among young Yakut mothers and the fact that these early-dead children may not have been included in the censuses and church registers. Therefore, our calculated age of 26.2 years should be attributed to the mean age of the mother at birth of her first *surviving* child. At the same time, the mean age of the mother at birth of her last child among Yakuts (34.2 years) turned out to be comparable with the same indicator in hunter-gatherer populations – an average of 34.6 years, and in less developed countries – an average of 36.1 years. [15].

In Helgason et al. (2003), generation intervals were calculated for 131,060 modern Icelanders and their ancestors born between 1698 and 1742 and between 1848 and 1892 [13]. The authors noted a trend towards a decrease in the generation lengths over the past 300 years. For the female and male lineages extending up to 1848 – 1892, the generation lengths were 28.12 and 31.13, respectively. In the female and male lineages connecting modern Icelanders with their ancestors born in 1698 – 1742, the corresponding intervals were 28.72 and 31.93. To determine whether the same trend is observed in the Yakut population, we calculated the generation lengths for people born in the 18th century, and in the first and second halves of the 19th century (Table 3). It was found that the female generation interval among the Yakuts gradually decreases from 32.33 in the 18th century to 28.50 in the second half of the 19th century; the male generation interval remained high in the 18th century (36.79) and the first half of the 19th century (37.01), but significantly reduced in the second half of the 19th century (32.3). We assume that marriage traditions and the age of first marriage could hardly have changed over such a short period of evolution of the Yakut ethnos; therefore, the gradual decrease in mortality at a young age could have influenced the decrease in the generation length to a greater extent. From historical data it is known that this period from the mid-18th century until the late 19th century in Yakutia was characterized by the eradication of slavery, a stronger policy of Christianization, and improving of living conditions of the population [3].

Table 3

The generation intervals in Yakut population by time periods in 18th-19th centuries

Period	Generation interval	
	Father-child	Mother-child
18th century	36.79	32.33
1st half of 19th century	37.01	30.54
2nd half of 19th century	33.51	28.50

Conclusion. Thus, the results obtained indicate higher intergenerational intervals for the Yakuts in comparison with other populations: an average of 35.7 years for male generations and 30.5 years for female generations. There is a tendency towards a gradual decrease in the generation lengths in the Yakut population in the period of the 18th – 19th centuries.

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GENETIC AND CLINICAL MARKERS OF LACTASE DEFICIENCY IN ADOLESCENTS OF THE CENTRAL AND SOUTHERN REGIONS OF EASTERN SIBERIA

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Research objective: to establish the genotype frequency of single nucleotide polymorphisms rs4988235 and rs182549 of the MCM6 gene depending on the ethnicity of adolescents in Eastern Siberia (Russians, Khakasses, Tuvans) and to identify the relationship between lactase deficiency (LD) and the clinical characteristics of recurrent abdominal pain (RAP).

Materials and Methods: 449 adolescents aged 11-18 years old were examined at schools in three cities of Siberia (Krasnoyarsk, Abakan, Kyzyl) and in-patient hospital in Krasnoyarsk. Lactase deficiency (LD) was diagnosed by the hydrogen breath test (HBT) after oral lactose load using the Gastrolyzer apparatus (Bedfont, UK). In schoolchildren, genomic DNA was isolated from saliva samples by the sorption method using the DIAtom DNA Prep kits (IsoGen, Russia). In inpatient children, DNA was isolated from whole blood by the sorption method from 0.1 ml of a suspension of leukocytes using the DNA-Sorb-B kit (103-20, AmpliPrime, Russia). Genotyping for the carriage of allelic variants rs4988235 and rs182549 of the MCM6 gene was performed on the basis of TaqMan allelic discrimination technology using real-time polymerase chain reaction (RT-PCR) on a detecting thermal cycler «Rotor-Gene 6000» (Corbett Life Science, Australia).

Results: The CC genotype of the rs4988235 polymorphism of the MCM6 gene occurs almost 5 times more often (93%) with a positive HBT than with a negative HBT (22%), p<0.001. Moreover, carriage of the rs4988235*CC genotype has a high sensitivity for LD diagnostics, i.e. 93 (81-99) %, with a relatively low specificity of 77 (69-85) %, which is likely to be due to the presence of secondary LD. A significantly higher prevalence of CC genotypes of both polymorphisms associated with LD has been observed in Mongoloid adolescents (Khakas - 82% and Tuvans - 91%), compared with Russian adolescents - 49%, p<0.001. There was no relationship between genetic markers of LD and RAP, verified according to the J. Apley and N. Naish criteria.

Conclusion: A high diagnostic significance of the rs4988235*CC genotype for LD diagnostics in Siberian adolescents was established. The CC genotype prevalence of both polymorphisms, associated with LD, in Russian adolescents (49%) does not differ from European data, whereas these genotypes were found in the great majority of Mongoloids examined (82-91%), which can be considered to be "paradoxical", given that the southern regions of Central Siberia are characterized by a historically high level of dairy farming development.

Keywords: lactase deficiency, adolescents, hydrogen breath test (HBT), genetic polymorphisms, recurrent abdominal pain.

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Introduction: Lactase deficiency (LD) is the most common variant of disaccharidase deficiency. LD is realized to be the reduced intestinal lactase activity, i.e. the parietal digestion enzyme that breaks down lactose, composed of glucose and galactose. There are primary (infant), primary constitutional (adult, late), and secondary hypolactasia.

Lactose, the main carbohydrate in