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Prevalence of Caries Among Siberian Tatars of the Omsk Region in the 17th to Early 20th Centuries

This study addresses the prevalence of caries in Ayaly and Kaurdak-Sargat groups of Siberian Tatars living in the Omsk Region of the Irtysh. Judging by dental remains from the Okunevo VII and Bergamak II cemeteries (16th–17th centuries), the frequency of caries among those people was similar to that in the late medieval population of northwestern Siberia. The diet of both these populations apparently consisted mostly of meat. However, a somewhat higher frequency of caries among Siberian Tatars indicates a greater amount of carbohydrates. Later (18th to early 20th century) Tatars of Chertaly I, Toksay I and II, Tyulchakovo, and Letniy Kaurdak) exhibit a frequency of caries similar to that found in 18th–19th century Russian peasants of the western Urals, possibly evidencing a similar proportion of refined carbohydrates in the diet. The difference between earlier and later Tatar groups attests to an increasing role of agriculture due to the immigration of Russians; and, later, of Tatars from the Volga-Ural region.

Keywords: *Dental pathology, caries, Siberian Tatars, diet, agriculture.*

Introduction

The Siberian Tatars constitute one of the largest Turkic-speaking ethnic groups of Western Siberia. They populate mostly the middle flow of the Irtysh River and its inflows, including Tobol, Pyshma, Iset, Vagay, Tura, Ishim, Tara, Uy, Tuy. This area includes southern forest, forest-steppe, and, partially, steppe climatic zones (see *Figure*). Ethnographers have described several sub-ethnic groups among Tobol-Irtysh Tatars: Tuymen-Tura, Tobol, Kaurdak-Sargat, and Ayaly (Tomilov, 1981: 5–6). Analysis of anthropological data has not revealed any substantial morphological differences between the above-mentioned groups; thus they can be considered as a unified complex of mixed Caucasoid-Mongoloid populations (Bagashev, 1993: 15–40, 143).

The reconstruction of the diet of Siberian Tatars based on the status of their dental health, which is put forward in this study, is the first one to employ such a comprehensive dental sample. Specifically, the prevalence of caries was examined. This dental disease has multiple etiologies, among which the leading factor is diet, and, particularly, an increase in the consumption of carbohydrates. According to existing views, caries develops when the physiological balance between the mineral component of the tooth and bacterial dental calculus is broken. The regular consumption of the food enriched with easily digestible carbohydrates creates favorable conditions for secretion of organic acids, bacterial metabolic products. This, in turn, leads to demineralization of enamel and the onset of caries (Fejerskov, Nyvad,

Kidd, 2008; Baelum et al., 2008). Thus, the prevalence of this pathological condition in a population is one of the most important sources of information about diet, health, social stratification, and the type of economic activity (Varrela, 1992; Watt, Lunt, Gilmour, 1997; Barthelemy et al., 1999).

The aim of this study is to investigate the prevalence of caries among the Ayaly and Kaurdak-Sargat Tatars, trace the temporal dynamics of this indicator in different chronological groups of Siberian Tatars, and put our results in the context of caries rates in other populations of Western Siberia. Further, we set out to reconstruct the type of economic activity, and the pattern and structure of diet in the studied groups.

Geographical location of the Siberian Tatars' cemeteries employed in the present study.
1 – Toksay I; *2* – Toksay II; *3* – Okunevo VII; *4* – Bergamak II; *5* – Chertaly I; *6* – Letniy Kaurdak; *7* – Tyulchakovo.

Materials and methods

The Ayaly group of Tobol-Irtysh Tatars was studied using samples from the following cemeteries: Okunevo VII (16th–17th cc), Bergamak II (17th c), Chertaly I (18th–19th cc), Toksay I (18th–19th cc) and II (19th to early 20th cc) (Mogilnikov, 1997; Matyushchenko, 2003; Tikhonov, Tataurov, 1996; Melnikov, 1991; Zdor, Tataurov, Tikhomirov, 2000: 19–66; Bagashev, 1993: 7–10). The Kaurdak-Sargat group was studied via the skeletal remains from Tatar cemeteries of Tyulchakovo (Sargat Tatars) and Letniy Kaurdak (Kaurdak Tatars) dated to the 19th to early 20th centuries (Bagashev, 1993: 7–10) (see *Figure*; Table 1). According to the 1897 census, these cemeteries belonged to native Siberian Tatars. In some villages, a negligible number of Central Asian migrants were living alongside the Tatars (Patkanov, 1911: 17, 73, 106).

Sex and age of the individuals were determined using the standard protocol (Alekseyev, Debets, 1964: 29–39). Edentulous skulls of senile individuals, as well as the skulls of adolescents with immature dentition, were not included in the sample.

The assessment of the dental rows was carried out using the categories described by J.E. Buikstra and D. Ubelaker (1994: 47–49). All available teeth were included in the sample and were examined in daylight. A dental probe was used when necessary. Caries was diagnosed if a cavity, even if very small, was visually observable. As the influence of the soil could not have been accounted for reliably, focal changes of the color of enamel (blemishes) were not scored as caries lesions. In case of the absence of the third molar, a genetically determined agenesis or a lack of eruption was suspected. But if its antagonist displayed traces of attrition, the tooth was scored as lost ante-mortem. All the teeth available for examination were divided into two groups: the first included anterior teeth (incisors and canines); the second, masticatory teeth (premolars and molars)*.

Prevalence of caries was scored in two different ways: as "dental count", i.e. the observed caries rate (OCR), and as "individual count"—the percentage of individuals in a sample having at least one tooth affected by caries. The rates based on these approaches, as some scholars point out, cannot perfectly reflect the real prevalence of the disease in ancient populations (Lukacs, 1992, 1995; Kerr, Bruce, Cross, 1988; Duyar, Erdal, 2003). But the abundance of comparative data on various times and

*Such a separation is partially explained by the different functions of these groups of teeth and hence different susceptibility to caries (Whittaker et al., 1981; Kerr, Bruce, Cross, 1988; Erdal, Duyar, 1999). On the other hand, the anterior teeth, unlike masticatory ones, are often lost during either excavation or transportation and storage. As the prevalence of caries depends largely on the pattern of the post-mortem tooth loss, mixing of the teeth of both groups will lead to an artificially increased prevalence if the anterior teeth are poorly preserved, or to a decreased rate if many masticatory teeth are absent. However, in the former case, the change in caries frequency will be minimal, as the anterior teeth are only rarely affected by caries (Duyar, Erdal, 2003).

Table 1. **Description of the dental sample**

Site	Date	Number of individuals		Number of teeth	
		♂	♀	♂	♀
Okunevo VII	16th–17th cc	16	12	288	182
Bergamak II	17th c	7	17	123	191
Chertaly I	18th–19th cc	13	12	196	174
Toksay I	18th–19th cc	14	6	273	134
Toksay II	19th to early 20th c	14	7	313	166
Letniy Kaurdak	19th to early 20th c	20	15	348	271
Tyulchakovo	19th to early 20th c	28	16	565	313
Total		112	85	2106	1431

cultures, obtained using these counting methods, is their undoubted merit. In this study, the populations of Western Siberia were compared using both "dental" and "individual" counts.

In order to approximate the rates of caries in the groups of Siberian Tatars to real values as closely as possible, correction coefficients were used. The first of these was the caries correction factor (CCF) developed by J.R. Lukacs (1995). The prevalence of caries in the teeth lost post-mortem was assessed using the proportional correction factor (PCF) proposed by I. Duyar and Y.S. Erdal (2003) (See Table 2). The latter method has many merits but some flaws as well: it assumes that teeth were lost owing to caries or severe attrition only. But there might have been other causes for the ante-mortem tooth loss, such as periodontal disease, traumas, etc. (Lukacs, 1992; Lukacs, Minderman, 1992; Lukacs, Pal, 1992).

The samples of Siberian Tatars were divided into three chronological groups: 1) 16th–17th cc (Okunevo VII, Bergamak II); 2) 18th–19th cc (Chertaly I, Toksay I); and 3) 19th to early 20th century (Toksay II, Tyulchakovo, Letniy Kaurdak). The statistical significance of differences between these groups was assessed using the χ^2 criterion, the representation error using the following formula:

$$s\% = \sqrt{\frac{p \times (100 - p)}{n}},$$

where s% stands for the mean sampling error (%), p is the percentage of a variant in the general population, and n is the number of individuals in a sample (Lakin, 1990: 101–105).

Results

In total, 3537 permanent teeth from 197 individuals were examined, of which 2106 belonged to males and 1431 to females (see Table 1). The highest level of OCR was observed in Tyulchakovo (Sargat Tatars), the lowest in Okunevo VII, Bergamak II, Toksay I and II; while Chertaly I and Letniy Kaurdak displayed intermediate values (Table 3). The percentage of individuals having at least one tooth affected by caries was the highest in Toksay I and Tyulchakovo, the lowest was in Okunevo VII and Bergamak II, and the intermediate in Chertaly I, Toksay II, and Letniy Kaurdak (Table 3).

The lowest values of PCF are found in Toksay I, Okunevo VII, and Bergamak II, and higher values in Toksay II, Chertaly I, Letniy Kaurdak, and Tyulchakovo (Table 4). In the Okunevo VII and Bergamak II samples, PCF was higher in females, while in all other populations, it was higher in males.

Most of the caries lesions detected in the studied samples are observed in masticatory teeth. The females of Toksay I are an exception: in this sample, only two incisors of one individual were affected. But this is probably because of the low size of the sample (five individuals).

The comparison of caries rates in the groups of Siberian Tatars dated to the 16th–17th centuries (Okunevo VII, Bergamak II) and in the later groups has revealed a statistically significant increase of its prevalence in more recent samples ($\chi^2 = 5.53$). However, Siberian Tatars of the 18th–19th centuries (Chertaly I, Toksay I) display statistically significant differences neither from the earlier nor from the later population of the studied region ($\chi^2 = 0.36$ and $\chi^2 = 0.36$).

Discussion

The comparison of the groups of Siberian Tatars of the 16th–17th centuries (Okunevo VII and Bergamak II) with other populations of the northwestern Siberia using the "individual count" revealed their closest similarity to the hunters and fishers from the sites of Zeleny Yar (13th c), Bederevsky Bor III (13th–14th cc), Saygatinsky-4 (13th–14th cc), and Bederevsky Bor II (17th c). The OCR in Okunevo VII and Bergamak II was slightly higher than in the above-mentioned northwestern Siberian populations, while it was close to the rate in a sample of the Selkups from Vargananzhino (19th to early 20th cc). Notably, in the latter, the "individual count" was higher than in the Siberian Tatars of the 16th–17th cc (see Table 3). The geographical location of the northwestern Siberian sites listed above virtually excludes the possibility that their own agricultural activity was a source of carbohydrates for these populations. Only the intensification of the trade and exchange contacts of northern hunters and fishermen with the population of the southwestern Siberia in Late Medieval times has made the products of agriculture more accessible to people from the North (Zykov, 2006). This, in turn, probably led to the increase in caries rates in the latter. The high frequency of carious lesions in more recent groups of Selkups (Bederevsky Bor III, Vargananzhino) is most probably related to the consumption of "flour" foods, export of which has increased manyfold during the period of Russian colonization of Siberia (Razhev, Rykun, Svyatova, 2011). Thus, it can be concluded that the diet of Siberian Tatars who left the cemeteries of Okunevo VII and Bergamak II found the closest parallel in the Late Medieval northwestern Siberian population. Meat probably predominated in the diet. The Siberian Tatars were pastoralists and fishermen, the northwestern Siberian people were fishers and hunters. But the higher prevalence of caries in the former points towards a higher consumption of carbohydrates.

The "individual count" in the late groups of Siberian Tatars (Chertaly I, Toksay I (18th–19th cc); Toksay II, Tyulchakovo, Letniy Kaurdak (19th to early 20th cc)) was substantially higher than that of the Late Medieval northwestern Siberian hunters and fishermen and of the Siberian Tatars from Bergamak II and Okunevo VII. Rather, it is similar to the Russian population of the 18th–19th cc from Revda, Verkhoturye, Kamensk-Uralsky, to the Selkups from Vargananzhino (19th to early 20th cc) and Ust-Balyk (17th to early 20th cc), and to the Tobol Tatars from Ostrovnye Yurty (19th to early 20th cc). The closest similarity, according to

Table 2. **Data used for calculation of the proportional correction factor (PCF)**

Indicator	Okunevo VII			Bergamak II			Chertaly I			Toksay I			Toksay II			Letniy Kaurdak			Tyulchakovo		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Number of teeth examined	117	352	469	82	232	314	99	271	370	145	262	407	190	289	479	206	413	620	311	567	878
Number of teeth with carious lesions	1	10	11	0	7	7	1	12	13	3	5	8	1	8	9	1	20	21	2	43	45
Number of teeth lost post-mortem	103	92	195	142	87	229	173	125	298	54	43	97	42	41	83	179	105	284	153	109	262
Number of teeth lost ante-mortem	1	34	35	0	0	0	18	52	70	3	8	10	14	55	69	18	84	102	50	158	208
Number of teeth with carious lesions penetrating into the pulp	0	1	1	0	0	0	2	6	8	0	1	1	0	6	6	1	10	11	0	23	23
Total number of teeth with open pulp	0	1	1	1	1	1	4	6	10	2	2	4	2	6	8	2	10	12	2	23	25

Note: A – anterior teeth, B – masticatory teeth, C – all teeth.

Table 3. **Prevalence of caries in different populations grouped according to their occupational activity***

Sample	Base of economy	Number of individuals	Caries rate ("individual count"), %	Number of teeth	Caries rate ("teeth count"), %
8th to early 12th cc					
Zeleny Yar	Hunting, fishery	1	0	16	0
Nekh-Uriy-3.5	"	7	0	53	0
Saygatinsky-1	"	19	0	227	0
Saygatinsky -3	"	13	0	192	0
Saygatinsky-6	"	40	2.5 ± 2.5	603	0.2 ± 0.2
Ust-Balyk	"	4	0	41	0
Late 12th–16th cc					
Bederevsky Bor I	"	9	0.0	151	0
Bederevsky Bor III	"	9	11.1 ± 10.5	158	0.6 ± 0.6
Saygatinsky -1	"	2	0	14	0
Saygatinsky -3	"	5	0	36	0
Saygatinsky -4	"	65	7.7 ± 3.3	987	1.0 ± 0.3
Zeleny Yar	"	9	11.1 ± 10.5	98	1.0 ± 1.0
Ust-Balyk	"	9	0	107	0
17th to early 20th cc					
Native population					
Bederevsky Bor II	"	33	12.1 ± 5.7	659	0.6 ± 0.3
Ust-Balyk	"	2	50.0 ± 35.4	55	5.5 ± 3.1
Fort Nadym	"	4	0	36	0
Vargananzhino	"	12	50.0 ± 14.4	1049	1.4 ± 0.4
Russian population					
Verkhoturye	Agriculture	22	54.5 ± 10.6	448	5.8 ± 1.1
Kamensk-Uralsky	"	18	77.8 ± 11.5	747	3.7 ± 0.7
Revda	"	13	53.8 ± 13.8	281	6.0 ± 1.4
Siberian Tatars					
Ostrovnye Yurty	"	34	57.1 ± 8.5	818	3.3 ± 0.6
Okunevo VII	…	28	10.7 ± 5.8	469	2.3 ± 0.7
Bergamak II	…	24	16.7 ± 7.6	314	1.9 ± 0.8
Chertaly I	…	25	28.0 ± 9.0	370	3.5 ± 1.0
Toksay I	…	20	45.0 ± 11.1	407	1.3 ± 0.6
Toksay II	…	21	28.6 ± 9.9	479	1.4 ± 0.5
Letniy Kaurdak	…	35	31.4 ± 7.8	619	3.3 ± 0.7
Tyulchakovo	…	44	47.7 ± 7.5	878	5.1 ± 0.7

*Compiled after (Razhev, Rykun, Svyatova, 2011; Slepchenko, 2015).

Table 4. **Proportional correction factor (PCF) for populations with different occupational activities**

Sample	Period	*N*	PCF, %
Rural population of Ibiza (Punic period) (Márquez-Grant, 2009)	6th–2nd cc BC	66	12.8
Antandros (Erdal, Duyar, 1999P	7th–2nd cc BC	60	18.5
Iznik (Ibid.)	13th c AD	365	14.9
Erzurum (Ibid.)	20th c AD	62	24.0
Ostrovnye Yurty (Slepchenko, 2015)	19th to early 20th cc	36	11.6
Okunevo VII	16th–17th cc	28	3.8
Bergamak II	16th–17th cc	24	5.5
Chertaly I	18th–19th cc	25	12.7
Toksay I	18th–19th cc	20	2.8
Toksay II	19th to early 20th cc	21	11.6
Letniy Kaurdak	19th to early 20th cc	35	14.8
Tyulchakovo	19th to early 20th cc	44	17.5

both "individual count" and OCR, is observed for the late groups of Siberian Tatars from Chertaly II and Tyulchakovo. This observation might suggest that the proportion of easily digestible carbohydrates in the diets of those two groups of Siberian Tatars was similar to that of Russian population from Urals, but much higher than in paleopopulations of the 16th–17th cc from Bergamak II and Okunevo VII.

Data on the prevalence of caries adjusted using the correction factors are still scarce. Thus, available reference data from Siberia are lacking, and we were only able to compare our groups with geographically remote populations. The comparison of the PCF in different groups of Siberian Tatars has shown that the samples from Okunevo VII, Bergamak II, and Toksay I display very similar values, while in all other groups it is more than three times higher. This points towards a substantial change in the diet of Siberian Tatars in the 18th–19th cc, relating to an increase of the consumption of digestible carbohydrates. The comparison of the chronological groups leads to the following conclusions. According to caries rate, the lowest amount of easily digestible carbohydrates was consumed by the Siberian Tatars of the 16th–17th cc, and the highest in the 19th to early 20th cc. The difference between the chronological groups is statistically significant. The samples from Toksay I and Chertaly I (18th–19th cc) probably represent the transitional time between the periods of low and substantial consumption of carbohydrates. Since these burial-grounds are not precisely dated, it can be hypothesized from the observed caries rates that the first site is more ancient, because the PCF in its sample is similar to that of the earlier populations. The second cemetery is probably more recent. However, other explanations of the apparent difference in caries rates between Toksay I and Chertaly II, such as different subsistence strategies or a different accessibility of carbohydrates, cannot be ruled out.

The PCF in the late populations of Siberian Tatars is mostly similar to that in the rural population of Ibiza Island of the 6th–2nd cc BC and the populations of Anatolian farmers from Antandrus (7th–2nd cc BC), Iznik (13th c AD), and Erzurum (20th c AD). It is known that the diet of the rural population of Ibiza consisted predominantly of agricultural products and only small amount of meat (Márquez-Grant, 2009). Thus, in the recent groups of Siberian Tatars, the products of agriculture probably predominated in the diet, while the products of cattle-breeding and fishing were supplementary foods. The lower values of the PCF in Okunevo VII and Bergamak II, as compared to the farmers from Anatolia and Ibiza, seem to confirm the hypothesis as to the main role of the products of cattle-breeding and fishing for those groups of Siberian Tatars, and the supplementary role of agricultural products (see Table 4).

An explanation of the difference in caries rates between the early and late chronological groups of Siberian Tatars can also be found in historical and

ethnographic data. Many researchers note that in the economy of the Tara Tatars in the 17th century agriculture "was only an ancillary occupation" (Volkov, 1965: 113). V.I. Shunkov points out that the farming of all Siberian Tatars of that time "was primitive and, according to its economic importance, was only an aid to hunting and herding" (1956: 34). Thus, the relatively low frequency of caries in the Okunevo VII and Bergamak II samples might be related to a decreased consumption of agricultural products as compared to the later populations. In the economy of the Ayaly Tatars, who buried at those cemeteries, cattle-breeding, hunting, and fishing also played the leading role.

The further gradual increase of caries rates in Siberian Tatars, beginning from the end of the 17th century, is most probably related to the intense immigration of ethnically Russian population, and later—Tatars from the Volga-Ural region, to the Irtysh region. In 1667, the peasants from Tara city asked the government to relocate them to new lands because their own arable had been exhausted. They were asking to let them go to the Tara River, where "the land is good" and "has never been ploughed". A settlement there was created by 1670. The *Inventory Book of 1701* of the Tarsky Uyezd, which contains information about the Birgamatskaya (spelling of that time) Sloboda, has been preserved until the present time (Berezhnova, (s.a.)). The appearance of Russian peasants, and later—Kazan Tatars, led to a gradual increase in farming production in the area inhabited by Siberian Tatars. Hence, agricultural products became more available. Such intensification of agricultural activity was earlier described for Baraba Tatars in the second half of the 19th to the first third of the 20th century (Myagkov, 2008). R.K. Satlykova (1976) and F.T. Valeev (1980: 70–103) report that agriculture started playing the leading role in the economy of Siberian Tatars in the late 19th to the early 20th century. This was probably one of the main reasons for the increase in caries rates among Tatars of Siberia in that period.

Other reasons for that increase are the improvement in quality of flour and the consumption of sugar. Notably, the peak of consumption of the refined carbohydrates mentioned above in Europe in the middle of the 19th century coincided with a substantial increase in caries prevalence. According to researchers, the industrial production of sugar and availability of the flour of higher quality had increased the cariogenicity of diet and, consequently, the frequency of caries (Moore, Corbett, 1975; Moore, 1993; Saunders, De Vito, Katzenberg, 1997).

Our results for the OCR and PCF have shown that anterior teeth were less affected by caries than masticatory teeth. Other researchers have arrived to similar conclusions (Kerr, Bruce, Cross, 1988). This is a natural result of the complexity of the occlusal surface of molars and premolars (presence of fissures), a longer contact with food items during mastication, and a longer retention of plaque and small fragments of food.

Conclusions

According to both observed caries rate (OCR) and the percentage of individuals in a sample having at least one tooth affected by caries ("individual count"), the Siberian Tatars of the 16th–17th centuries from Okunevo VII and Bergamak II demonstrate the closest similarity with the Late Medieval population of northwestern Siberia. The diet of both northwestern Siberians and the Tatars probably included only minimal amounts of flour-dishes, but the higher prevalence of caries in the latter points towards a higher proportion of carbohydrates in their diet.

According to the same measures of the prevalence of caries, the groups of Siberian Tatars from Chertaly I, Toksay I and II, Tyulchakovo, and Letniy Kaurdak (18th to early 20th cc) were similar to the ethnically Russian population from Revda, Verkhoturye, and Kamensk-Uralsky (18th–19th cc), Selkups from Vargananzhino (19th to early 20th cc) and Ust-Balyk (17th to early 20th cc), and the Tobol Tatars from Ostrovnye Yurty (19th to early 20th cc). This observation suggests a similar, and substantial, amount of digestible carbohydrates consumed by the groups of Siberian Tatars and Russians from Urals listed above.

The comparison of the populations of Siberian Tatars carried out using the proportional correction factor (PCF) for caries rate has detected a more pronounced and statistically significant difference between the early (16th–17th cc) and late (18th to early 20th cc) groups. This finding points towards a substantial change in the structure of diet during the 18th–19th centuries relating to an increased consumption of easily digestible carbohydrates, which, in turn, indicates an increased role of agriculture and its products in the economy and diet of Siberian Tatars. The intense colonization of the Irtysh region by Russian peasants in the 17th century, and later by Tatars from the Volga-Ural region, led to a gradual increase in farming-production in the area inhabited by Siberian Tatars; after which, agricultural products became increasingly available.

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