Impact of virgin land development on morbidity and mortality from diphtheria in Kazakhstan

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Abstract. Authors consider the development of virgin and fallow lands in Kazakhstan in the 1950s–1960s which led to an unprecedented anthropogenic intrusion into the environment. The huge concentration of people in the northern steppe regions of Kazakhstan led to the spread of dangerous infectious diseases among which diphtheria was of particular concern of the health authorities of the republic. Authors made an attempt to analyze the issues of the spread of this disease in Tselinny district in the early 1960s and the history of its control in this article. The basic methods of medical services to prevent spreading of this infectious disease have been identified. The authors concluded that imperfect of medical service, violation of the regulations on vaccination and revaccination, inefficiency of medical and sanitary education of the population of virgin areas as well as other factors were the causes of diphtheria resistance against measures of sanitary and epidemiological services of the republic.

1 Introduction

One of the priority tasks of socio-economic development of the Republic of Kazakhstan is the maintenance of the health of the nation. The growing anthropological burden on the environment has changed the ecological appearance of most of our territory, turning it into a zone of increased ecological crisis, which undoubtedly entailed irreparable consequences in terms of maintaining a healthy generation. The increasing anthropological burden on the environment has changed the environmental appearance of most of our territory turning it into a zone of increased ecological crisis which undoubtedly entailed irreparable consequences in terms of preserving a healthy generation.

Environmental problems have deep roots going back to the time when the northern regions of Kazakhstan became a place for the development of virgin and fallow lands [1–9]. During this period (1950s–1960s) a large number of specialists from all regions of the Soviet Union started coming to Tselinny district (hereinafter the District – the authors) whose activities certainly had an impact on the environment. The virgin lands began to differ from other areas of the republic in their economy and the contingents of the served population. The District became a densely-populated place with a developed diversified

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agriculture dominated by grain and livestock farming [10–13]. It is no coincidence that the large influx of people led to a surge of infectious diseases among which diphtheria had a special place. Diphtheria is one of the acute infectious diseases affecting the cardiovascular, nervous and urinary systems [14].

2 Materials and Methods

During preparing this article the authors used general scientific methods, such as comparison, analysis, synthesis, and critical verification of sources. Since the article is interdisciplinary in nature at the junction of the humanities and natural biological disciplines, the authors also used interdisciplinary research methods (physical methods, laboratory results, results of skin tests to assess the reaction of the human body to diphtheria). The authors also used the historical-genetic method which allowed to analyze the dynamics of diphtheria during reporting period.

3 Discussion of the results

3.1 Assessment of diphtheria morbidity in Tselinny district

Epidemics of infectious diseases have been the greatest tragedies in human history. The District wasn't exception in this regard. The virgin campaign led to the spread of dangerous infectious diseases which were combated permanently.

The incidence rate decreased by 39.6% compared to the previous year in 1961. Such a significant decrease can be explained by the fact that child population registration and preventive vaccination coverage have improved which has led to an increase in the layer immune to the infectious agent. The absolute morbidity figure decreased by 39.6% the intensive index also decreased by almost half and was 4.7 (in 1960 – 8.2) over the comparable period [15].

Morbidity by the regions from the total number of cases in Tselinny district was:
for Tselinograd – 14.94%
in Kustanai – 40.33%
in Pavlodar – 24.51%
in North Kazakhstan – 16.02%
for Kokchetav region – 20.33%.

The above figures show that the largest number of cases was registered in Kustanai and Pavlodar regions. Rates of morbidity per 100,000 people in the District are:
Tselinograd region – 2.3
Kustanay region – 4.3
Pavlodar region – 6.9
North Kazakhstan region – 4.8
Kokchetav region – 5.5

Pavlodar region was in the 1st place, Kokchetav region had the 2nd place and North-Kazakhstan region was in the 3rd place in terms of intensive indicators. All of them exceeded the regional figure. The data we have shown indicate that the incidence of diphtheria in the District was at a fairly high level [16].

Along with shortcomings in vaccination, diagnosis and hospitalization one of the important reasons for the high incidence rate was a significant migration of the population. According to the statistical office the population growth in the District amounted to about 130,000 people in 1961 and the largest population growth in the District was noted in the Kustanai and Tselinograd regions. See table 1.

Table 1. Distribution of patients by months.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
1960	358	265	245	179	189	137	134	148	171	143	198	290	2457
indicator	14.1	10.9	9.9	7.3	7.0	5.6	5.4	6.2	6.9	5.8	8.0	11.3	
1961	165	115	123	94	75	72	82	87	187	142	200	148	1485
indicator	11.1	7.8	8.3	6.3	5.0	4.8	5.6	5.9	12.6	9.6	13.6	9.6	

The table shows that there was a clear seasonality of diphtheria. The minimum of diseases was observed in May and June and lower compared to the maximum rise 2.5 times. The growth of diphtheria in the colder months is probably due to the accumulation of children in closed rooms and the mass interaction of schoolchildren with each other. This assumption is confirmed by the fact that schoolchildren accounted for slightly more than 1/3 of all cases in the District. Also, there is the influence of the climate factors. Cold, high humidity and sharp fluctuations in temperature contributed to the weakening of the body's resistance, predisposing to catarrhal phenomena and microbial proliferation [17]. See Table 2.

Table 2. Indicators of morbidity by regions.

Regions	1960 year	1961 year	Indicator per 10,000 1961	Indicator per 10,000 1960
Kokchetav	627	302	5.5	11.9
Tselinograd	365	359	4.3	4.7
Kustanai	561	364	6.9	11.3
Pavlodar	470	238	4.8	9.9
North Kazakhstan	317	166	2.8	6.4
Tselinograd city	117	56	6.9	

The high proportion of adult cases of diphtheria attracts attention. See Table 3.

Table 3. Distribution of patients by their occupation.

	Workers	Officers	Collective farm workers	Medical employees	Organized children	Unorganized children	Students	Non-workers	Others	Total
Number	27	17	4	4	103	770	517	7	36	1485
%	1.8	1.3	0.2	0.2	7.0	51.9	34.7	0.5	2.4	100

Children who were not organized in groups gave the main incidence of disease in absolute numbers. The share of morbidity among these children has hardly changed compared with 1960. In most cases, the sources of infection were not identified [18]. This can be seen from the following Table 4.

Table 4. Distribution of patients by source and route of infection.

During the incubation period	Taken from the train	Contact with:			Not detected	Total
		Ill person	Convalescents	Disease carrier		
30	2	338	31	315	774	1485

Analysis of these data shows that infectious sources were not identified in more than half of the cases. Insufficient detection of the source was due to the poor quality of epidemiological examination which was often carried out by mid-level medical workers.

Only 70% of the foci were examined by doctors. Among identified cases the most important remained contact with ill people and bacterial carriers. Probably the number of bacterial carriers was even greater but the laboratory bacteriological diagnosis of diphtheria was not of high quality. There were cases when the simultaneous material sampling from the pharynx and nose of the patient was not performed, modern and more sensitive methods of bacteriological examination (sowing on dishes with tellurite culture and determination of toxigenicity) were not used, laboratory studies were not conducted in all cases. All this led to a low percentage of the excretion rate from sick people and especially carriers [19]. See Table 5.

Table 5. Information on localization of infection.

	1	**2**	**3–5**	**6–10**	**Number**
Number of foci with 1 or more cases	1121	113	39	1	1295
The number of cases in these foci	1121	226	124	14	1485
In % of the total number of foci	86.6	8.7	3.0	0.08	

Although diphtheria was mostly sporadic the foci remained high which was mainly due to the late hospitalization of patients. See Table 6.

Table 6. Timing of hospitalization of patients.

	From 1 to 5 days	**From 6 to 10 days**	**From 11 to 16 days**	**From 17 to 25 days**	**Later 25 days**	**Total**
Tselinograd city	6	1	2	2	–	11
Tselinograd region	20	5	2	–	1	28
Pavlodar region	12	7	5	6	4	34
Kokchetav region	24	11	5	13	–	53
by the District	62	24	14	21	5	126

In 50% of the cases recurrent cases in the foci appeared at long intervals from the first case which made it very difficult to identify the sources. See Table 7.

Table 7. Laboratory diagnostics.

Name of the region	**Total number of ill people**	**Including**		**From the examined**		**Bacteriological methods of laboratory examination**
		examined	**not examined**			
Tselinograd city	56	56	–	37	19	56
Tselinograd region	166	164	2	99	65	164
Pavlodar region	364	341	23	127	214	341
North Kazakhstan	238	230	8	151	79	230
Kokchetav region	302	293	9	199	94	293
Kustanai region	359	297	62	183	114	297
by the District	1485	1381	104	796	585	1381

The percentage of bacteriologically confirmed cases was 57% and the percentage of bacteriologically confirmed cases was low in some areas [18].

It should be noted that in rural areas there was an extremely high mortality rate which was 5 times higher than in the city. The mortality rate in urban areas was 2.3 and in rural areas 1.3 in 1961. The high lethality rate in the District as a whole was determined primarily by the high lethality rate in rural areas. This was evidence of the poor quality of medical care in the countryside, late doctor visits, late hospitalization, misdiagnosis, incorrect or late treatment of patients as a result of insufficient qualifications of rural health workers. This is also evidence of poor vaccination work in rural areas because high mortality and a large proportion of severe forms of diphtheria were possible only when the level of immunity among children was low. 32% of dead were not vaccinated against diphtheria in Tselinograd region, 72% in Kustanai region [17]. See Table 8.

Table 8. Mortality by Months.

Regions	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Tselinograd city	–	–	–	–	–	–	–	–	1	–	–	–
Tselinograd region	1	3	2	3	–	–	–	–	3	3	2	2
Pavlodar region	1	4	4	1	2	–	1	–	2	–	4	2
North Kazakhstan	3	–	1	–	2	–	–	1	4	3	1	2
Kokchetav region	2	2	3	2	2	2	2	3	2	3	–	–
Kustanai region	4	3	2	5	–	1	1	3	5	2	8	2
by the District	11	12	12	11	6	4	4	7	17	11	15	8

High mortality was noted during autumn and winter months. At the same time the highest morbidity was also noted. The incidence of diphtheria differed by regions [19]. Below we will consider the incidence of diphtheria in Kustanai and Kokchetav regions.

3.2 Experience in reducing the incidence of diphtheria in Kustanai city

The most unfavorable groups in terms of diphtheria incidence were the younger age groups from 2 to 7 years old. Child mortality from diphtheria was still very high (13 cases) in 1961. This was especially true in Ruzaevsky district where there were six deaths from diphtheria in six months.

The reasons of the high mortality rate were the late seeking of medical assistance by parents, the absence of medical workers, road lessness and the late hospitalization of patients. Epidemiological examination of foci was carried out by employees of sanitary and epidemiological departments. Contact patients were examined for bacilliform carrier. As a result 850 people were examined in Zerendinsky district and 58 people with bacilliform carriers were identified. 56 people with bacilliform carriers were identified in Ruzaevsky district [20].

Analyzing the incidence of diphtheria since 1951 (the years of organization of the city sanitary and epidemiological station) we can say that there was a lack of diphtheria morbidity in Kustanai city by 1961. Thus, the intensive rates of diphtheria morbidity per 1,000 children over a 10-year period were as follows:

1951 year – 10.8
1952 year – 19.3
1953 year – 15.9
1954 year – 10.1
1955 year – 8.4
1956 year – 21.7
1957 year – 17.0
1958 year – 7.3

1959 year – 5.2 1960 year – 1.

The highest rise in the incidence of diphtheria was observed since 1956, i.e. with the beginning of the development of the virgin land, when the composition of the child population of the city sharply changed due to the increased migration of the population arriving to the virgin land.

During this period the importance of anti-diphtheria vaccinations was still underestimated in Kustanai. Vaccination work was neglected. This work was not planned and was not systematically monitored. City sanitary-epidemiological station made an inspection of the documentation of anti-prophylactic vaccinations. They found that about 50% of children were not covered by anti-prophylactic vaccinations in 1956.

The epidemiological wave of diphtheria in the pre-vaccination period had striking features – a sharp autumn-winter rise, group diseases in children's institutions and schools [21]. See Table 9.

Table 9. Comparative data on the incidence of diphtheria in children's institutions of the city.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1956	7	10	16	14	7	13	38	11	38	66	59	36
1957	44	44	11	16	18	14	10	14	16	20	72	58
1958	35	24	22	14	4	8	3	7	6	10	27	23

Autumn and winter months accounted for 70–80% of the total annual morbidity in 1956–1957. The change in the child population of the city was particularly reflected at schools where “long chains” of diphtheria cases began to be registered [21]. See Table 10.

Table 10. Incidence of school infections in 1956 and 1957.

Schools	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
№ 8	2	–	–	–	–	1	–	–	–	3	9	1	16
№ 9	3	–	–	–	–	–	–	2	1	2	–	1	9
№ 10	2	–	1	1	1	–	–	–	1	–	4	1	11
№ 15	1	4	–	3	–	–	–	–	1	1	–	3	13
№ 16	3	–	2	1	1	–	–	1	–	1	4	5	18
№ 17	–	–	–	2	–	–	–	–	–	2	1	2	7
№ 49	1	–	–	–	–	–	–	1	–	5	5	1	13

The total incidence of diphtheria was 60% among schoolchildren and 35% of the cases occurring among unorganized children in 1956–1957. It was found that children who had not been vaccinated against diphtheria were enrolled to the first grades. There were up to 60–70% of children in the first grade who had not been vaccinated or received an initial revaccination. Age-related revaccinations were also not conducted in a timely manner [18].

The health authorities took extreme measures in order to stop the chain of diphtheria in schools: they disbanded classes for 12 days and organized simultaneous examination of students and all teaching and serving staff to identify bacilliform carriers and to sanitize them in schools. It was created a team consisting of city epidemiologists and doctors from the medical-preventive department of the Children's Counseling Center to monitor the coverage of school students with anti-prophylactic vaccinations.

During 3 years inspections were conducted to verify the coverage of anti-prophylactic vaccinations and the timeliness and correctness of their administration in the autumn and spring in each school. Such inspections began in the autumn of 1956. Inspections were carried out by carefully checking passport data, vaccination dates from the diphtheria vaccination log, medical cards and class registers.

In order to strengthen anti-toxic immunity to diphtheria among school students’ health authorities switched to shortened intervals of 2 years between age revaccinations in the context of a high percentage of late coverage of anti-diphtheria vaccinations reaching up to

30–40%. The number of vaccinations against diphtheria increased considerably during this period: about 5,000 vaccinations were given during the fourth quarter of 1956, including about 60% due to the coverage of schoolchildren of the first grade [19].

The results of the work already had an impact in 1958: firstly, the annual incidence of diphtheria was reduced by 46% compared to the previous two years and secondly the incidence of diphtheria was distributed equally between students and unorganized children.

The coverage of anti-prophylactic vaccinations in schools of the city has improved. The percentage of school students covered by anti-prophylactic vaccinations was 70–75% in 1957:

in 1958 г. – % coverage – 87%

in 1959 г. – % coverage – 93.3%

in 1960 г. – % coverage – 99.1%.

With the improvement of anti-diphtheria vaccination coverage in schools, the incidence of diphtheria began to decrease, and outbreaks were no longer reported. In 1958, the incidence of diphtheria among students decreased – 2 times, in 1959 – 3 times, in 1960 – 5 times compared to 1956–1957. In order to study immunity to diphtheria among students the schools of the city twice performed the Schick Test [22].

Among 500 elementary school students 2.3% were positive in 1959. The Schick Test was administered to 2,000 elementary school students in 1960. Positive reactions were obtained in 5.3 cases – 6.9%, i.e., despite late vaccination coverage, due to shortened intervals between age revaccinations, immunity to diphtheria among students became strained.

There were already isolated cases of diphtheria in schools (there were only two contact cases) in 1960.

The next stage in the work of the health authorities was monitoring of the coverage of anti-diphtheria vaccinations at the areas of the children's clinics. This work was carried out in order to increase anti-toxic immunity to diphtheria among unorganized children. This work could not begin until 1958, as the sanitary and epidemiological stations had been busy solving the problem in schools for the previous 2 years [21].

Children's counseling areas began to plan vaccinations for each month. The causes of diphtheria among children were identified and their vaccinations were studied. District health workers were imposed fines in the case of negligence in carrying out measures against disease and for failing of anti-epidemic measures in diphtheria foci.

The children's consultation at the epidemiological department organized a filing cabinet on the timing of vaccinations for unorganized children since 1958. The card index was arranged according to the principle of grafting from the second half of 1959. In 1960 the city had 67.4% decrease in diphtheria compared to 1959, 76.5% decrease compared to 1958 and 87.5% decrease compared to 1957. During study of diphtheria cases in 1960 it was found that 58% of the cases involved unvaccinated or improperly vaccinated children and the toxic form was usually observed in the unvaccinated. The incidence among vaccinated people was 0.008%, among unvaccinated people it was 0.3%, i.e., unvaccinated people were ill more often in 3.5 times [15].

There were no reports about cases of diphtheria in nurseries, children's homes and kindergartens in 1960. The incidence was 0.09% of the total number of kindergarten children, 0.3% in kindergarten, 1.4% in schools, and 0.7% in boarding schools. The incidence of diphtheria among organized children was 0.16% and among unorganized children 0.13% per 1,000 children. The incidence of diphtheria was 2.4% due to children's institutions in 1960. No cases of outbreaks were recorded at the areas.

The lack of medical staff was a hindrance to the work. For example, there were only 7 doctors for 25 pediatric areas in Kustanai. The rest of the areas were run by nurses who had difficulties with diagnostic. A large staff turnover had a negative impact on the quality of

preventive work at the areas. For example, four doctors and eight nurses were replaced at area No. 5 between 1959 and 1960. Eight doctors and three nurses changed at area No. 21. There are many such examples.

Also, the large packaging of grafting material hindered the work. Since inoculations were still carried out at home there was a significant overspending of bacteriological preparations in a large percentage of cases which had a negative effect on the supply of diphanatoxin. There were long interruptions in the supply of diphtheria vaccine preparations to the city in 1961. There were no departments for hospitalization of patients with mixed infections and complications from measles and whooping cough in the city. Due to insufficient beds at hospitals a large percentage of pneumonia patients were not hospitalized. All of this made the work of district health workers excessively difficult and took time away from conducting preventive work on the areas.

3.3 Diphtheria morbidity in the Kokchetav region

The situation was difficult in the Kokchetav region. The sources of infection usually remained undetected – 46.7%. From the identified sources 62.2% were contact with patients. 23,321 people were examined for bacilliform carrier: 10 water supply workers, 18,680 contact people, 842 food service workers, 1,397 child care workers and 2,392 children entering child care in 1960. Among 23,321 examined people 412 were carriers of diphtheria. The main number of them was in contact – 402. All bacilliform carriers of diphtheria were sanitized. They were subjected to laboratory examination after treatment. Preventive vaccinations against diphtheria were carried out in the region: vaccinations – 55957; revaccinations – 58039. The ratio was 1:1.

164 people fell ill with diphtheria. The disease was mostly of moderate seriousness in 1960. There were 53 cases of the toxic form out of 627 cases during the year. The coefficient of severity was 1:10.5.

Sanitary and epidemiological service work brought certain positive results. 125 cases of diphtheria were registered in the region during the four months of 1961. Compared to the same period the incidence decreased by 78 cases or 61.6% [16].

Despite the overall reduction of diphtheria in the region as a whole there was an increase in the incidence of diphtheria by 95% in Ruzaevsky, Zerendinsky, Kellerovsky, Krasnoarmeysky districts. The result of the failure in implementation of the entire set of measures to combat diphtheria was that infection increases in Kellerovsky by 130%, Kokchetavsky by 75%, Ruzaevsky by 12%. At the same time in Enbekshilder, Aryk-Balyk, Chistopolsky districts the disease incidence was not registered at all and in other districts by single cases in 1961.

The most disadvantaged groups were the younger age groups which was the result of still insufficient prevention activities. Of 125 cases of diphtheria 12 were died: 5 in Ruzaevsky district, 3 in Kazansky district, 2 in Zerendinsky district, 1in Krasnoarmeisky and 1 in Kellerovsky districts. The lethality rate was 9.6% in the region. The mortality rate for 1961 was much higher – 3.8 compared to 1960 [16].

The hospital was opened in the Ruzaevskii district to treat bacilliform carriers. Form No. 63 card was introduced in all district centers. Vaccination records were kept in journals if this form was not available.

In some areas paramedics were assigned to organize vaccinations and where it was not possible nurses did this work. An inoculation room was opened in Kokchetav.

However, the diphtheria situation was so serious that a diphtheria committee headed by a regional pediatrician was organized under the regional health department. There was organized a specialization for district doctors in the diagnosis, clinic and treatment of diphtheria on the basis of the infectious diseases department. Laboratory technicians were

specialized in the diagnosis of diphtheria on the basis of the regional bacteriological laboratory. However, the situation with this infectious disease was still complex and required efforts to control it.

4 Conclusion

The health authorities did some work to combat diphtheria which resulted in a slight decrease in the incidence of the disease in the republic in 1961. At the same time the situation with the incidence of diphtheria in most regions remained unsatisfactory. Sanitary and epidemiological stations and departments of District hospitals, regional and District pediatricians and diphtheria committees did not provide sufficient methodological and organizational guidance on vaccination. A number of places did not keep complete records of children under 12 years of age and did not have data on the numbers of unvaccinated and revaccinated children. Some medical institutions had not organized preventive vaccination cards according to form No. 63 in the republic. Many heads of doctor's stations and feldsher's offices did not have specific lists indicating the timing and nature of the next vaccination for each child in their area. Most children continued to be vaccinated at home without any prior medical examination with violations of the intervals and dosage of bacterial preparations.

In the work of bacteriological laboratories for the diagnosis of diphtheria there were violations of the instructions of the Ministry of Health of the KazSSR. There was not done work to identify and sanitize bacilliform carriers and measures were not taken to improve the storage conditions of bacterial preparations. Sanitary and educational work among the population on the prevention of diphtheria was unsatisfactory.

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