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## THE INCIDENCE OF RURAL POPULATION ASSOCIATED WITH THE QUALITY OF DRINKING WATER SUPPLY A CASE STUDY FROM BUKHAR-ZHYRAU DISTRICT IN KARAGANDA REGION

AO OMAROVA, <https://orcid.org/0000-0002-2087-3824>

Karaganda Medical University, Karaganda c., Republic of Kazakhstan



Omarova AO

Along with the ongoing activities, the problem of providing the population with drinking water of guaranteed quality and in sufficient volume remains relevant for rural regions.

**The research objective** was to study the overall and infectious incidence of the rural population in Karaganda Region related to the water factor.

**Material and methods.** The object of this research was the overall and infectious incidence of the rural population of the Republic of Kazakhstan and Karaganda Region (Bukhar-Zhyrau District). The sources of information were the following: statistical compilations The Public Health in the Republic of Kazakhstan and the Activities of Health Organizations for the period from 2007 to 2017; information obtained from the Reports on certain infectious and parasitic diseases for the period from 2008 to 2018 of the Department of Public Health of Karaganda Region of the Committee for Public Health Protection of the Ministry of Healthcare of the Republic of Kazakhstan; domestic and foreign literature. Epidemiological diagnostics, statistical method, and the method of mean absolute increment for predicting the exposure to diseases were used to analyze the incidence.

**Results and discussion.** The values of the overall incidence among rural population of Karaganda Region for 2007-2017 were higher than the republican level, but the dynamics is declining. The epidemiological feature of the overall incidence in Karaganda Region was a high proportion of adult female population.

Territorial Public Health Departments do not register all the infections recognized by World Health Organization as water-related diseases. Nevertheless, the dynamics of registered intestinal infections associated with water in Bukhar-Zhyrau District has a tendency to rise. The group of acute intestinal infections predominated in the structure of water-related intestinal infections.

**Conclusion.** It is not possible to establish a clear cause-and-effect link between the risk to the public health and the impact of the water factor for a number of reasons: the official data on the incidence and the assessment of drinking water quality can not show the actual picture in rural areas of the region.

**Key words:** Karaganda Region, incidence, rural population, water-related diseases.

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### Т Ұ Ж Ы Р Ы М

#### АУЫЗ СУМЕН ҚАМТАМАСЫЗДАНДЫРУ САПАСЫНА БАЙЛАНЫСТЫ АУЫЛ ТҰРҒЫНДАРЫНЫҢ СЫРҚАТТАНУШЫЛЫҒЫ ҚАРАҒАНДЫ ОБЛЫСЫНЫҢ БҰҚАР-ЖЫРАУ АУДАНЫНЫҢ МЫСАЛЫНДА

A.O. ОМАРОВА, <https://orcid.org/0000-0002-2087-3824>

Қарағанды медицина университеті, Қарағанды қ., Қазақстан Республикасы

Ағымдағы іс-шаралармен қатар халықты сапалы ауыз сумен жеткілікті көлемде қамтамасыз ету мәселесі ауылдық жерлер үшін өзекті болып қалуда.

**Зерттеу мақсаты.** Қарағанды облысының ауыл тұрғындарының су факторына байланысты жалпы және жұқпалы сырқаттанушылығын зерттеу болды.

**Материал және әдістері.** Зерттеу нысаны Қазақстан Республикасы және Қарағанды облысы (Бұқар-Жырау ауданы) ауылдық тұрғындарының жалпы және жұқпалы сырқаттанушылығы болды. Ақпарат көздері 2007 жылдан 2017 жылға дейінгі «Қазақстан Республикасының халқының денсаулығы және денсаулық сақтау ұйымдарының қызметі» статистикалық жинақтары; Қазақстан Республикасы Денсаулық сақтау министрлігінің Қоғамдық денсаулық сақтау Комитетінің Қарағанды облысы бойынша Қоғамдық денсаулық сақтау Департаментінің 2008 жылдан 2018 жылға дейінгі «Жекеленген инфекциялық және паразиттік аурулар туралы есептерден» алынған мәліметтер; отандық және шетелдік әдебиеттер болды. Сырқаттанушылықты талдау үшін эпидемиологиялық диагностика әдісі, статистикалық әдіс, сондай-ақ сырқаттанушылық қаупін болжау үшін орташа абсолюттік өсу әдісі пайдаланылды.

**Нәтижелері және талқылауы.** 2007-2017 жылдар аралығындағы Қарағанды облысының ауыл тұрғындарының жалпы сырқаттанушылық көрсеткіштерінің мәні республикалық деңгейден жоғары болды, бірақ динамикасы төмендеуде. Қарағанды облысының жалпы сырқатта-

**Contacts:** Alua O Omarova, third-year PhD student of 6D110200 "Public Health" specialty; Karaganda Medical University, Gogol Street 40, Karaganda, index 100008, e-mail: [alua\\_1912@mail.ru](mailto:alua_1912@mail.ru)

**Контакты:** Омарова Алуа Ораловна, PhD докторант 3 года обучения специальности «Общественное здравоохранение»; Медицинский университет Караганды, ул. Гоголя, 40, Караганда, индекс 100008, e-mail: [alua\\_1912@mail.ru](mailto:alua_1912@mail.ru)

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нушылығының эпидемиологиялық ерекшелігі – әйел жынысты ересек тұрғындар үлесінің жоғары болуы.

Аумақтық Қоғамдық денсаулық сақтау Департаменттерінде Дүниежүзілік денсаулық сақтау ұйымы сумен байланысты аурулар деп таныған барлық инфекциялар тіркелмейді. Дегенмен, Бұқар-Жырау ауданында тіркелген сумен байланысты ішек инфекцияларының динамикасы өсу үрдісіне ие болған. Сумен байланысты ішек инфекцияларының құрылымында жедел ішек инфекцияларының тобы басым.

**Қорытынды.** Халықтың денсаулығына қауіптілігі мен судың әсер етуі арасында нақты себеп-салдарлық байланыстарды орнату бірқатар себептер бойынша мүмкін емес, атап айтқанда, сырқаттанушылық және ауыз судың сапасын бағалау бойынша қолда бар ресми деректер облыстың ауылдық жерлеріндегі нақты бейнені көрсете алмайды.

**Негізгі сөздер:** Қарағанды облысы, сырқаттанушылық, ауыл тұрғындары, сумен байланысты аурулар.

## РЕЗЮМЕ

### ЗАБОЛЕВАЕМОСТЬ СЕЛЬСКОГО НАСЕЛЕНИЯ В СВЯЗИ С КАЧЕСТВОМ ПИТЬЕВОГО ВОДОСНАБЖЕНИЯ НА ПРИМЕРЕ БУХАР-ЖЫРАУСКОГО РАЙОНА КАРАГАНДИНСКОЙ ОБЛАСТИ

А.О. ОМАРОВА, <https://orcid.org/0000-0002-2087-3824>

*Медицинский университет Караганды, Караганда, Республика Казахстан*

Наряду с проводимыми мероприятиями проблема по обеспечению населения питьевой водой гарантированного качества и в достаточном объеме остаётся актуальной для сельских регионов.

**Целью исследования** явилось изучение общей и инфекционной заболеваемости сельского населения Карагандинской области, связанной с водным фактором населения.

**Материал и методы.** Объектом исследования были общая и инфекционная заболеваемость сельского населения Республики Казахстан и Карагандинской области (Бухар-Жырауский район). Источниками информации являлись статистические сборники «Здоровье населения Республики Казахстан: деятельность организаций здравоохранения» за период с 2007 по 2017 годы; сведения, полученные из «Отчетов об отдельных инфекционных и паразитарных заболеваниях» за период с 2008 по 2018 годы Департамента охраны общественного здоровья Карагандинской области Комитета охраны общественного здоровья Министерства здравоохранения Республики Казахстан; отечественная и зарубежная литература. Для анализа заболеваемости были использованы метод эпидемиологической диагностики, статистический метод, а также метод среднего абсолютного прироста для прогнозирования рисков заболеваний.

**Результаты и обсуждение.** Значения показателей общей заболеваемости сельского населения Карагандинской области за 2007-2017 годы были выше республиканского уровня, но динамика идет на спад. Эпидемиологической особенностью общей заболеваемости в Карагандинской области явился высокий удельный вес взрослого населения женского пола.

Территориальные департаменты охраны общественного здоровья регистрируют далеко не все инфекции, признанные Всемирной организацией здравоохранения как заболевания, связанные с водой. Тем не менее, динамика зарегистрированных кишечных инфекций, связанных с водой, в Бухар-Жырауском районе имеет тенденция к подъёму. В структуре кишечных инфекций, связанных с водой, преобладала группа острых кишечных инфекций.

**Выводы.** Установить четкую причинно-следственную связь между риском здоровью населения и воздействием водного фактора не является возможным по ряду причин, а именно, имеющиеся официальные данные по заболеваемости и оценке качества питьевой воды не в состоянии отразить реальную картину в сельских регионах области.

**Ключевые слова:** Карагандинская область, заболеваемость, сельское население, болезни, связанные с водой.

**Для цитирования:** Омарова А.О. Заболеваемость сельского населения в связи с качеством питьевого водоснабжения на примере Бухар-Жырауского района Карагандинской области // Медицина (Алматы). – 2019. - №4(202). – С. 8-13

The quality and safety of drinking water remains one of the most important public health problems [1, 2]. Water can be a source of both infectious and parasitic diseases. Each year 842,000 cases of diarrhea resulting from unsafe water, poor sanitation and hygiene (WASH) have a fatal outcome, including 361,000 deaths of children under 5 years of age [3]. 411,041 cases of parasitic diseases caused by contaminated

water have been registered ever in the USA during the period of 1990-2012 [4, 5]. Undoubtedly, the number of water-related diseases and those followed by deaths in low- and middle-income countries is much higher. However, it is impossible to make a comparison due to the lack of accurate data [5].

About 10% of the total disease in the world can be prevented by improving WASH and water management [6]. According to

the results of a meta-analysis [7] based on numerous studies of good quality, it was found that proper hygiene reduced diarrhoeal diseases by 37%, adequate sanitary conditions by 32% and quality of water supply by 31%, while sufficient water supply made up about 25%, and the impact of several areas was estimated at 33%.

**The research objective** was to study the overall and infectious incidence of the rural population in Karaganda Region related to the water factor.

#### MATERIAL AND METHODS

The study was carried out in the Bukhar-Zhyrau district (49°57.21' N – 73°43.01' E, 500–700 m elevation, 14,576 km<sup>2</sup>), located in the central part of Kazakhstan. This district has the largest number of the rural residents in Karaganda region (61,157 people in 2018) as well as it has all types of water supply (centralized, decentralized and tankered).

The object of this research was the overall and infectious incidence of the rural population of Karaganda Region (Bukhar-Zhyrau district). The sources of information were the following: statistical compilations *The Public Health in the Republic of Kazakhstan and the Activities of Health Organizations* for the period from 2007 to 2017; information obtained from the *Reports on certain infectious and parasitic diseases* for the period from 2008 to 2018 of the Department of Public Health of Karaganda Region of the Committee for Public Health Protection of the

Ministry of Healthcare of the Republic of Kazakhstan (СРПМ МН РК); domestic and foreign literature.

Epidemiological diagnostics, statistical method, and the method of mean absolute increment for predicting the exposure to diseases were used to analyze the incidence.

Intensive and extensive incidence rates, the mean (M), the standard deviation (s), Student's t-test (t), the predicted incidence rate over the next three years (y<sub>2019</sub>, y<sub>2020</sub>, y<sub>2021</sub>) and the average increment rate ( $\bar{T}$ increment) were calculated.

The obtained data was analysed aided with STATISTICA 13.3 (StatSoft, Tulsa, OK, USA) software.

#### RESULTS AND DISCUSSION

##### 1. Comparative analysis of the overall incidence in the Republic of Kazakhstan and Karaganda Region for the period 2007-2017 (epidemiological characteristics)

An analysis of the overall incidence in the Republic of Kazakhstan for the period of 2007-2017 (Figure 1) revealed that the peak had been recorded in 2009 and amounted to 60,107.7 per 100,000 people. The incidence rate reached its minimum in 2014 (52031.5 per 100,000 people) due to a steady decline from 2010 to 2014. However, starting from 2015, the incidence among the population began to grow and reached 57896.9 per 100,000 people in 2017, which may indicate both a deterioration of public health in the country and an improvement in diagnostics level in hospitals.

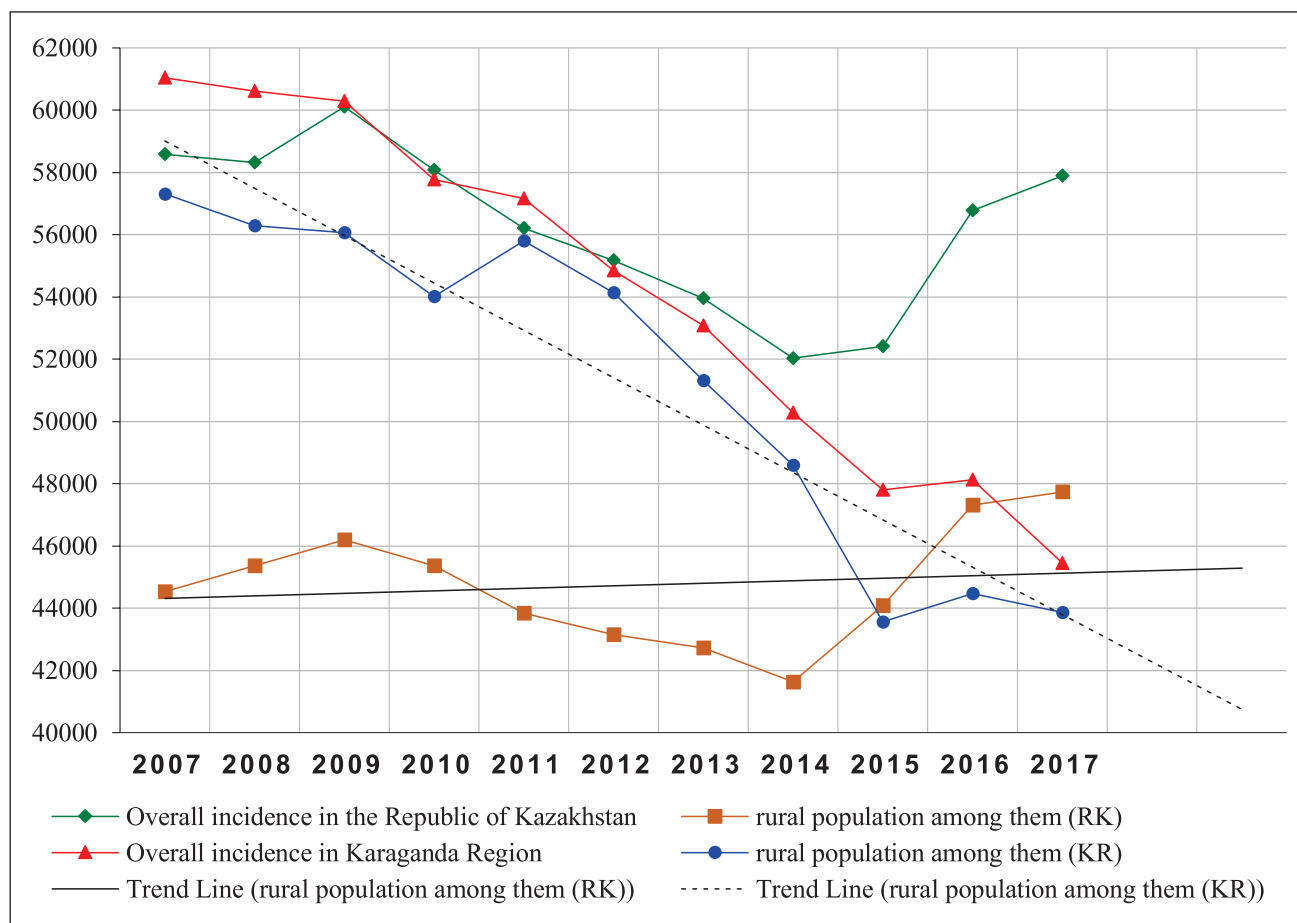


Figure 1 – Long-term dynamics of the overall incidence in the Republic of Kazakhstan and Karaganda Region for the period of 2007-2017 (per 100,000 people)

Karaganda Region was characterized by a reduction in the overall incidence among the population for the entire study period. This rate was 61,037.8 per 100,000 people in 2007 and 45,447.3 per 100,000 people in 2017, with a decline of 1.3 times.

In the Republic, there is a relative stability of the overall incidence of villagers with small fluctuations around the mean ( $M=44717.7$ ,  $s=1896.4$ ). However, the disease dynamics among the rural population of Karaganda Region is linearly decreasing over the period under review. It was 57,310.6 per 100,000 people in 2007, and then it decreased to 43,849.7 in 2017 ( $M=51400$ ,  $s=5372.3$ ). Therefore, the regional incidence rate is statistically significantly different from the republican one, since  $t=3.627$ ,  $p=0.005$ .

When analyzing the age and gender composition of patients in rural areas of Karaganda Region, it was found that women over the age of 18 became ill more often: for the last analyzed year, the main share was composed of females (54.2%). The adult population prevails in the age structure (18 & = 53.2%). The proportion of patients from 15 to 17 years old and children under the age of 14 was 7.3% and 39.5% respectively.

## 2. The incidence of the rural population in Bukhar-Zhyrau District of Karaganda Region due to fluctuations in microbiological water quality indicators

We selected some diseases related to water-borne intestinal infections from the number of infectious diseases recorded in the territorial Public Health Departments of the CPHP MH RK and provided the data to Table 1. Cases of *Cholera*,

*Typhoid fever*, *Paratyphoid fever A, B, C* and *Bacterial carriers of typhoid and paratyphoid fever* were not registered in the Bukhar-Zhyrau District between 2008 and 2018.

Retrospective analysis of the long-term dynamics of water-related intestinal infections in the Bukhar-Zhyrau District from 2008 to 2018 (Figure 2) revealed that there had been a downward trend in the incidence from 2009 to 2011. This figure amounted to 56.8 per 100,000 people in 2011, which was the minimum value for the studied period. The incidence began to grow in 2011 and reached its peak in 2017 (371.4 per 100,000 people). The predicted incidence rate was  $y_{2019}=308.8$ ,  $y_{2020}=321.9$  and  $y_{2021}=335.1$ . The average increment rate for the period of 2008-2018 ( $\bar{T}increment$ )=21.8%.

The proportion of *group of acute intestinal infections* was prevalent in the structure of water-related intestinal infections and made 49.78% of all registered cases among the population in 2018 (Figure 3).

Taking into account some fluctuations in microbiological indicators of water quality, the risk assessment findings are contradictory, which is due to inadequate control and insufficient number of epidemiological data. This is exacerbated by the lack of data on hygiene factors related to the quality of water supply and their interaction. In general, the greatest bacteriological risk is associated with the use of drinking water that is heavily contaminated with sewage. The risk of microbial contamination can not be completely eliminated, since water-related diseases can also be transmitted from person to person by other routes. It also contributes to the reservoir of patients and carriers of infection [8, 9].

Table 1 – Incidence rate of water-related intestinal infections in the Bukhar-Zhyrau District (per 100,000 people)

	Bacillary dysentery		Bacterial carriers of dysentery		Other intestinal infections of established etiology		Bacterial and viral intestinal infections of unknown etiology		Group of acute intestinal infections	
	Total	0-14 years old	Total	0-14 years old	Total	0-14 years old	Total	0-14 years old	Total	0-14 years old
2008	15.77	51.47	12.62	44.12	45.74	191.18	52.05	198.53	113.56	441.18
2009	10.02	23.62	1.67	7.87	80.13	338.58	46.74	204.72	136.89	566.93
2010	0	–	1.68	0	28.52	128.0	1.68	8.0	30.20	136.0
2011	3.34	7.75	0	–	20.03	77.52	5.01	23.26	28.38	108.53
2012	0	–	0	–	80.70	376.0	0	–	80.70	376.0
2013	0	–	0	–	80.52	296.0	37.14	144.0	114.66	440.0
2014	0	–	0	–	99.68	330.99	55.38	204.23	155.06	535.21
2015	0	–	0	–	114.24	467.15	41.39	167.88	155.63	635.04
2016	0	–	0	–	116.32	408.76	9.38	36.50	125.70	445.26
2017	0	–	0	–	103.03	394.72	28.92	98.68	131.95	493.40
2018	1.90	4.61	0	–	140.96	517.35	43.81	152.16	184.77	674.12

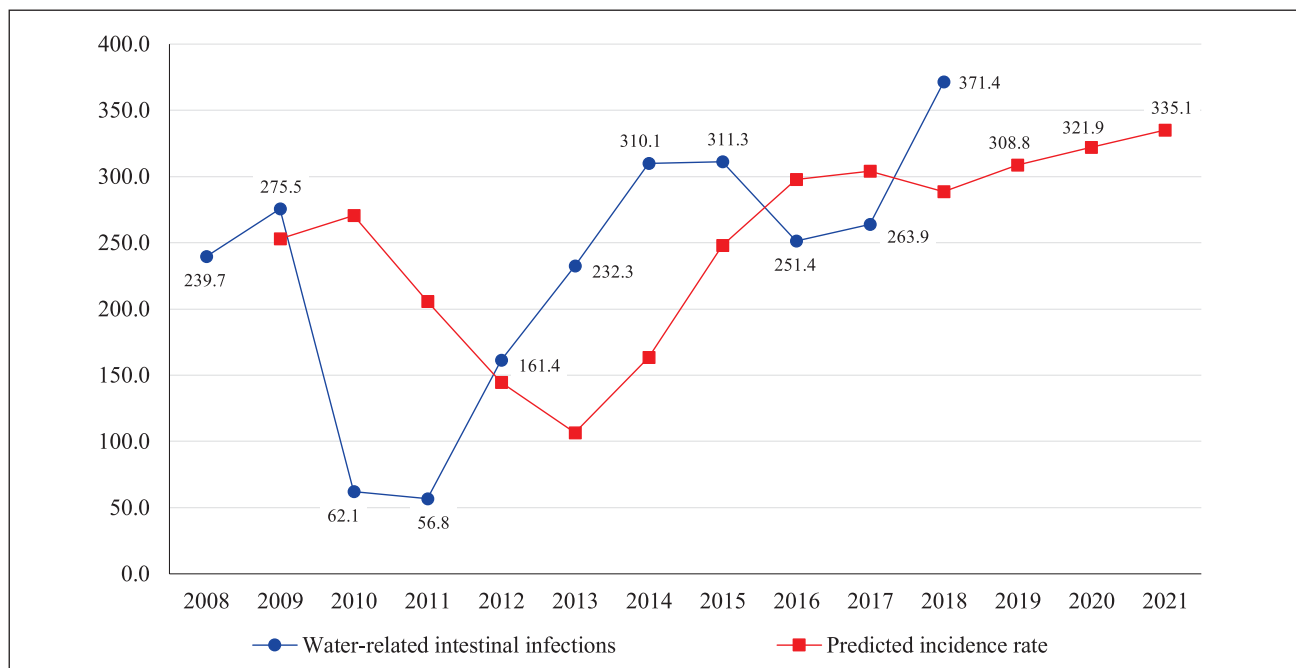


Figure 2 – Long-term dynamics of water-related intestinal infections in the Bukhar-Zhyrau District from 2008 to 2018 (per 100,000 people)

Chemical pollution of water is a low-intensity factor that does not cause acute effects. Standards for chemicals in water lose all their significance in the face of massive bacterial contamination. Therefore, the chemical factor has a lower priority in comparison with microbial, the consequences of which can be immediate and large-scale. Another remote effect associated with chemical components is that the recommended values refer to the average exposure levels. Occasional small excesses are acceptable, and the consequences of them must be carefully considered in the light of local conditions. This follows from the definition of recommended values for chemicals [8, 9].

### 1. Modern features of intestinal infectious diseases

The state of public health is an integral indicator of the environmental influence on the human body [10]. Among the socially significant problems are infectious diseases. They are threatening and destructive factors for humanity and cause enormous economic damage daily [8, 11]. Infectious diseases lie in the 13th place in the structure of the overall incidence in Kazakhstan. In the structure of mortality, this class is inferior to diseases of the circulatory system, digestive organs, respiratory organs, neoplasms and others [12]. However, the main cause of a significant part of diseases of the respiratory system, digestive organs, cardiovascular system and neoplasms are various infectious agents [11].

In recent times, doctors have paid particular attention to the consequences of past infectious diseases [11, 13]. It is commonly known that the consequences of acute infectious diarrheal diseases develop some time after the acute phase

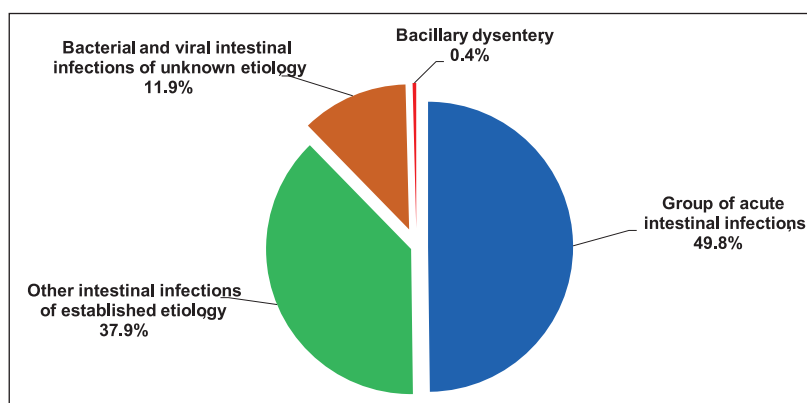


Figure 3 – Structure of water-related intestinal infections in the Bukhar-Zhyrau District in 2018

and lead to gastroenterological, rheumatological, neurological and other diseases. However, these diseases are registered as independent nosological forms due to the lack of clear clinical and laboratory diagnostic criteria. For instance, it was established that intestinal infections preceded the development of reactive arthritis [11, 14].

The priority in preventing the risk of intestinal infections is to protect water supply systems from contamination by faeces, which may contain a variety of pathogenic bacteria, viruses, protozoa and helminths [5]. The following segments of population are the most exposed to water-related diseases [15]:

- infants and young children;
- people with fragile health;
- patients with severe burns;
- patients who underwent surgery;
- people exposed to radiation;
- elderly people.

In 2002, the World Health Organization (WHO) published

the first science-based assessment of the global disease associated with WASH [16, 17]. According to these data, WASH-related hazards hold a specific place in the structure of mortality and disability. In 2012, 6.3% of all deaths in the world were associated with WASH, of which 25% were children under 14 years of age. This indicator was 16 times higher in developing countries compared to developed ones (8.0% and 0.5% respectively). In Kazakhstan, the mortality rate associated with WASH in 2012 was 1.6 (0.9% of all deaths in the country), where 18.7% were diarrheal diseases.

Over the same year, it was found that 9.1% of disabilities worldwide were associated with WASH-related hazards, and 22% of them were children under 14 years of age. This indicator was also much higher in developing countries than in developed ones (10% vs. 0.9%). In Kazakhstan, the disability rate associated with WASH was 55.0 (1.5%), of which 28.2% were diarrheal diseases.

### CONCLUSION

The values of the overall incidence among rural population of Karaganda Region for 2007-2017 were higher than the republican level, but the dynamics is declining. The epidemiological feature of the overall incidence in Karaganda Region was a high proportion of adult female population.

Territorial Public Health Departments of the CPHP MH RK do not register all the infections recognized by WHO as water-related diseases. Nevertheless, the dynamics of registered intestinal infections associated with water in Bukhar-Zhyrau District has a tendency to rise. The group of acute intestinal

infections predominated in the structure of water-related intestinal infections.

It is not possible to establish a clear cause-and-effect link between the risk to the public health and the impact of the water factor for a number of reasons: the official data on the incidence and the assessment of drinking water quality can not show the actual picture in rural areas of the region.

Consequently, understanding the prevention of disease associated with unsatisfactory or insufficient water supply as well as poor sanitation and hygiene provides the basis for making scientifically grounded decisions. To do this, we need data on estimation of diseases related to water, sanitation and hygiene at both the state and local levels. It is also necessary to develop an online research database on the relationship between environmental factors and human health as exemplified by World Health Organization. This database will be an important tool for deciding how to prevent the disease at the state level.

### Research transparency

Research did not have a sponsorship. The authors are absolutely responsible for presenting the release script for publication.

### Declaration about financial and other relations

All authors took part in elaboration of article conception and writing the script. The release script was approved by all authors. The authors did not get the honorary for the article.

### Conflict of interest

The authors declare no conflict of interest.

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