Transactions on Biomedicine and Health vol 5, © 2001 WIT Press, www.witpress.com, ISSN 1743-3525

Study on the rate of the urolithiasis in the Aral Sea Area and the quality of potable water

D. L. Arustamov[1], D. Kh. Fayzieva[2], R. B. Nurullaev[1] and Yu. Yu. Klyopov[1]
[1]*Research Center of Urology, Ministry of Health, Uzbekistan*
[2]*Institute of Water Problems, Academy of Sciences, Uzbekistan*

Abstract

The Aral Sea Area is the stage of one of the most staggering man-made environmental disasters. The Aral Sea, once the fourth-largest inland body of water, is reduced to half its size and one-third of its volume as a result of overirrigation and cotton monoculture. Overirrigation also creates increasing soil salinity and degradation of drinking water sources. While the consequences for ecology and agriculture have been extensively researched, relatively little research is devoted to the public health consequences of the Aral Sea disaster. Of the health effects, high rates of urinary tract diseases in the Aral Sea Area are frequently mentioned.

Urologic diseases were specified as the most problematic groups of pathology for this territory, with the tendency to increasing during the period for last several years. Kidney and urinary tract diseases have special interest for studying the existence of an environmental effect, in this case the impact of water quality on human health in the Aral Sea Area. Among the problems frequently mentioned are the high level of total dissolved solids and total hardness in the potable water. The epidemiological study has been conducted with regard to the diseases of the urinary tract in order to better understanding the most important environmental health problems of the population of this area.

A study of the association between the water quality and diseases of the kidney and urinary tract is necessary for assessment of the contribution of environmental causes to the morbidity that is necessary for recommending of grounded preventive strategies.

1 Introduction

Against epidemiologic information on the pathology of the cardiovascular system, mental, oncologic diseases, epidemilogy of urologic diseases is perceived as less developed. This corresponds to rather low proportion (2-3%) of diseases of kidneys and the urinary tract among other diseases. Nevertheless, urologic diseases affect patients of all age-groups, they result in multiple complications, disability and invalidism, death of a large part of labour-able population and cause great economic damage to the society [1]. About 2% of population is considered to be ill with urologic diseases [2], where infections of the urinary tract (UTI) composed 60-80%, urinary-stone diseases (USD) or urolithiasis 4,9-30%, [3]. According to multiple population studies in the USA, 5 to 15% of population will have symptomatic stone disease by the age of 70 years [4]. The environmental impact on the urologic morbidity rate may be more or less evident in respect to urolithiasis as hot and dry climate and other regional peculiarities, hardness of potable water, in particular, may contribute to increased rate of stones in the kidneys and urinary tract. Urolithiasis, has a special interest for studying the existence of an environmental effect, in this case the impact of water composition on human health in the Aral Sea Area. There are several important factors in this region: 1) water – high level of total hardness, contamination and lack of potable water; 2) the climate and geographic peculiarities – aridity, soil salinity, etc.; 3) demographic, socio-economic factors, the infrastructure, the health services. According to the findings of studies on urological morbidity the prevalence of urolithiasis in the Aral Sea Area rose which is, in particular, due to hardness of water. Most of the studies evaluate the morbidity on the basis of patients' self-presentation [5], [6], [7], [8]. This approach based on the data of visitation of patients to the medical facilities does not meet the requirements to real indicators and the search of possible causing factors. At the same time there are some studies based on epidemiologic examination of representative selected parts of the population, they were made in 1989-1998 [9]. Prevention actions need the findings of fundamental and population study on environmental epidemiology. However, to reveal the cause-effect relation of these diseases with environmental factors is rather difficult. As a whole, urologic morbidity in the Aral Sea Area needs further in-depth research and evaluation. That is why an epidemiologic survey of the representative group of population of the village Gandimiyon of the Khoresm province situated in this region had been carried out. The goal of the survey was to study the rate of the urologic disease signs, mostly urolithiasis. The study had been made from May 2000 till April 2001.

2 Materials and methods

2.1 The epidemiologic survey methods

The village Gandimiyon is one of typical settlements of the Khiva district of the Khorezm province where the main source of potable water is the river Amudarya.

The village is divided into 12 small settled parts ("elats"). At the time of survey 17,279 people were living there. The most important problem of the settlement economy as well as the whole population and a separate resident alike is limited water resources and deterioration of potable water quality due to a high level of total dissolved solids.

The data of 1,817 residents of the village had been analyzed. The selection was made by the method of random sampling [10]. The selections were expected to use for in-depth study of the prevalence of urologic pathology taking into account the risk factors. Every respondents were interviewed using the special questionnaire including a wide range of social, demographic, medical data and other relevant determinants (age, sex, educational level, employment status, occupation, diet, alcohol use, smoking status, familial history on kidney and urologic diseases). The routine urological examinations were made (physical methods, ultrasound examination by a mobile ultrasound scanner Aloka-260 and microscopic examination of fresh urine with the binocular microscope Leyka. The quantity of crystals in urine was evaluated by the Goryaev's counting chamber. The analysis of urine were made by diagnostic strips Uriscan^{TM} including determination of pH, glucose, keton bodies, nitrites (the sign of urinary infections), urobilinogen, billirubin, protein. The database was formed through a specially designed set of applied programs written in the Visual Basic and Delphy for the Windows. Interviewing of the examinees was made directly in the automatized working place of the 4 interviewers connected by the local network. The laboratory data were recorded and later were also introduced in computers.

2.2 Study of potable water quality

The system of the Khiva tap water is functioning irregularly and most of local population has to use open wells. There are 50 of them on the village territory. According to the local physicians recommendation four wells were chosen for water sampling as they are used most often as drinking water sources. Chemical analyses of the water were made in the laboratories of the Central Asian Research Institute of Hydrology and Meteorology and the Institute of Nuclear Physics of the Uzbekistan Academy of Sciences. The water samples were analyzed for the level of Total Dissolved Solids (TDS), calcium, magnesium, chlorides, sulphates, sodium, potassium, nitrates, nitrites, orthophosphates, hydrocarbonates, pH and heavy metals. The analysis had been made by the ionchromatography, titration, gravimetry, atomic-absorption and neutron-activation methods.

3 Results

The signs of urolithiasis were the presence of stone at the time of examination (n=1), events of stone are sand excretion (n=5) as well as surgeries to remove stones in the urinary tract in the history (n=7).

Table 1 shows that the prevalence of crystalluria (crystals in urine) of different extent and urolithiasis in those examined was 63.6%. Crystalluria, degree I (up to

2,000 in 1 ml) was observed in 45.9% of those examined, degree II (up to 10,000 in 1 ml) – in 16.3% and degree III (over 10,000 in 1 ml) – in 1.9%.

Table 1: Prevalence and structure of urolithiasis and crystalluria in the examined population

Age	Sex	N	Urolithiasis	Crystalluria	% *
0-4	M	25	-	17	68.0
	F	14	-	8	57.1
5-9	M	58	-	32	55.1
	F	70	-	51	72.9
10-14	M	48	-	24	50.0
	F	66	-	50	75.8
15-19	M	64	2	35	57.8
	F	52	-	44	84.6
20-29	M	260	2	90	35.4
	F	149	-	136	91.3
30-39	M	159	2	69	44.7
	F	118	-	106	89.9
40-49	M	110	-	59	53.6
	F	99	1	86	87.9
50-59	M	198	1	110	56.1
	F	19	-	18	94.7
60-69	M	178	2	114	65.2
	F	19	1	15	84.2
70-79	M	78	3	53	71.8
	F	8	-	6	75.0
80-89	M	19	-	14	73.7
	F	1	-	1	100.0
90 +	M	3	-	3	100.0
	F	2	-	2	100.0
Total		1817	13 (0.7%)	1143 (62.9%)	63.6

Note: *Prevalence of urolithiasis and crystalluria (%) was calculated to the total number of reported cases of these conditions in each age and sex group.

Abnormal crystallization is recognized to be one of the leading factors of actual stone formation. Supposing a certain pathogenetic similarity of crystalluria and urolithiasis it is expedient to evaluate joint prevalence of their signs. This joint indicator was 63.6%. On increasing the degree of crystalluria the prevalence of urolithiasis decreased.

The crystallization of stone – forming salts is due to an abnormal urinary composition that is either metabolic or environmental in origin [11]. The signs of urolithiasis associated with history data the presence of stones or the results of direct examinations were observed only in 0.7 % of those examined.

According to the data of water analysis, an overall total hardness standards exceeding characterized by the presence of calcium and magnesium ions in water has been detected. Examination of open wells water samples revealed the high level of total hardness varied from 14.3 to 26.8 mg*eq/litre. Total hardness figures prove an exceeding of the WHO and Uzbekistan (7.0 mg*eq/litre) standards on drinking water in all selected sampling points. For tap water total hardness indices were 7.6 - 14.7 mg*eq/litre. All this figures prove an exceeding of the WHO and Uzbekistan drinking water standards on total hardness.

A significant overall exceeding of total dissolved solids - TDS standard (1000 mg/l), in open wells has been detected as well, which was on the level of 1459 - 3300 mg/L. TDS of tap water varied from 930 to 1600 mg/L.

4 Discussions

The incidence and prevalence rates of urolithiasis may be affected by genetic, nutritional and environmental factors. According to Tarasov and Martynenko, dry hot climate, iodine deficiency, high incidence of gastrointestinal diseases and peculiarities of nutrition of the population are referred to the etiological factors of the urolithiasis [12], [13]. The average incidence of the disease was greater among those who arrived to the desert zone than in the indigenes [12].

There exist a lot of research indicating the importance of exogenous effects for the development of this disease. For instance, there was a study on the link of the environmental situation and urolithiasis prevalence pattern in Kazakhstan, where the high prevalence of urolithiasis had been established. The conclusion is that it occurs in the regions with developed industry and serious environmental situation (increased content of active pollutants in biosphere) had been made. Environmental pollution along with other factors can play a role in the genesis of the disease and eventually determine the prevalence rates [14]. Nutritional-environmental factors themselves may cause stone formation, or exaggerate metabolic risk factors. Strenuous physical exercise or excessive sweating in a hot climate may cause stones by urinary concentration, changed urinary pH, and hypocitraturia. A diet rich in animal protein concentrations increases urinary uric acid and calcium, and lowers citrate [15].

The research undertaken in some areas of Uzbekistan has indicated that the most suitable design for the research of urolithiasis prevalence is a retrospective integrated epidemiological research (RIER), which would involve both detection of urolithiasis cases and possible relationship of the prevalence and the environmental factors. According to our calculations based on comparison of the literature data and our own findings obtained by RIER, the difference between reported and actual rate of urinary stone diseases is 10-fold (in some areas, e.g., the Aral Sea Area, much higher). It means, that patients with early non-complicated forms and stage of the disease are not under the care of urologists, who often have to treat late, complicated cases. This method of the calculation of prevalence was more reliable than the one based on the consultation rate, i.e.

based on the number of patients sought health care at health care facilities. According to the outcomes of the integrated research undertaken by Juldashov F., in 1998, urolithiasis incidence in the environmentally unfavourable Aral Sea Area is 77 cases per 1000 of population [9]. But the results of our investigations show low level of urolithiasis in Gandimiyon i.e., 7 cases per 1000 population (0.7%).

Rather demonstrative are the results of the potable water study indicating unfavourable situation in respect to such parameters as total dissolved solids (TDS) and total hardness. It is difficult enough to establish the links between water quality and urolithiasis prevalence, however, among a lot of causes of prevalence of this polyetiologic disease the water factor plays, probably, not the least role. According to Mirshina and Iskandarova, total hardness of the water used by population for drinking plays an important role in development of urolithiasis [6], [8]. The direct relationship between the salinity of drinking water and urolithiasis incidence in the studied towns rayons of the Aral Sea Area, where the correlative coefficients were +0.84 in Nukus, +0.7 in Beruni, and 0.67 in Amudarya rayon has been revealed [6].

It should be emphasized that there are controversial data on the effect of water hardness on urolithiasis development. If in some areas the interrelation between the level of water hardness and urolithioasis prevalence was revealed, there are reports on the absence of such dependence. Pivovarov and Konashevsky insist on the reverse dependence: decrease of the number of urolithiasis cases associated with increase of water hardness while higher prevalence of this disease was recorded in the areas with softer water [16]. As it is seen, it is impossible to give clear explanation of these phenomena as the nutrition factor in our opinion is one of the most important factors (predeterminant) of the disease development.

5 Conclusions

According to the findings of the present study the prevalence of signs of urolithiasis as the one of the most important urologic diseases in the Aral Sea Area was established on the basis of examination of the representative selection of population. Prevalence of urolithiasis was revealed in 0.7 %. Presented here studies on the quality of water and urolithiasis prevalence in the village Gandimiyon of the Khorezm province did not confirm the locally dominating opinion on the impact of increased levels of water hardness on calculi formation in the urinary tract. Interrelation of the water quality as well as another confounding environmental and nutritional factors with urolithiasis requires further studies on the basis of environmental epidemiology of this disease in the Aral Sea Area.

Acknowledgements

The authors express their gratitude to the international humanitarian organization, Medecins Sans Frontieres -MSF, the Netherlands for consultation and technical support of the study carried out within the Operational Research Program in the Aral Sea Area.

References

[1] Grachev, A.D. & Larionov, A.S., Prospects of studying of urologic diseases prevalence in the RSFSR, *Urology and Nephrology*, No 3, pp. 16-19, 1990.
[2] Skoverdyak, L.A., Prevalence of kidney diseases and the urinary tract and the scope of therapeutic and preventive care. *Thesis of dissertation for a Candidate of Medicine Degree,* Moscow, 1975.
[3] Gorbachev, A.G., Medical and labour-ability expertize in urologic diseases. Leningrad, Meditsina, pp. 18-21, 1986.
[4] Resnick, M. I. & Persky, L, Summary of the National Institutes of Arthritis, Diabetes, Digestive and Kidney Diseases Conference on Urolithiasis: State of the Art and Future Research Needs, *The Journal of Urology*, Vol. 153, pp. 4-9, 1995.
[5] Doschanov, E., The role of ecologic factors in development of nephrourolithiasis in the Aral Sea Area, *Thesis of dissertation for a Candidate of Medicine Degree*, Moscow, 1991.
[6] Mirshina, O.P., Hygienic grounds of actions on developing of drinking water supply system and improving of water use conditions of the Aral Sea area population. *Thesis of dissertation for a Candidate of Medicine Degree*, Tashkent, 1996.
[7] Kozhabekov, B.S., A complex study of epidemiologic and etiologic aspects, early diagnosis, evaluation of therapy and methaphylaxis of urolithiasis. *Thesis of dissertation for a Doctor of Medicine Degree.* Almaty, 1998.
[8] Iskandarova, Sh.T., Modern medical and hygienic approaches to the Environmental Health research in the Republic of Uzbekistan, *Thesis of dissertation for a Doctor of Medicine Degree.* Tashkent, 1999.
[9] Juldashov, F., Incidence of urinary stone disease in Uzbekistan and ways of its reduction, *Thesis of dissertation for a Doctor of Medicine Degree.* Tashkent, 1998.
[10] *Manual of epidemiology for district health management.* – World Health Organization, Geneva, 1989.
[11] Pak, C.Y.C., Skurla, C., & Harvey, J., Graphic display of urinary risk factors for renal stone formation. *Journal of Urology*, V 134, pp. 867-870, 1985.
[12] Tarasov, N.I., The incidence of urolithiasis in the arid zones. *Urology and Nephrology*, No 4, pp. 47-49, 1976.
[13] Martynenko, N.G., Incidence and endemicity of urolithiasis in Daghestan. *Urology and Nephrology*, No 5, pp.34-38, 1974.
[14] Sarsebekov, E.K., The Prevalence of urolithiasis in some regions of Kazakhstan. *Health Care of Kazakhstan*, No 4, pp.11-13, 1993.
[15] Robertson. W.G., Urinary tract calculi. *In: Nordin BEC, Need AG, Morris HA, eds. Metabolic bone and stone disease.* New York, Churchill Livingstone, 249 –131, 1993.
[16] Pivovarov, Yu. P., & Konashevsky A.V., Chemical composition of drinking water in forecasting of the prevalence of endemic urolithiasis. *Hygiene and Sanitation*, No 6, pp. 11- 13, 1989.