Chapter 5
Hygienic Evaluation of Water Quality and Health State of Children

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Abstract A lot of attention is given to the issue of supply of population and especially to children with drinking water as in national programmes as well as globally. In Moldova, risk of diseases is conditioned by nonconformed water quality which is at high levels; this has great impact especially to children, which are very sensitive to the action of environmental factors. The present work tries to elucidate health issues of children in relation with drinking water quality. Measures of diseases prevention are proposed which are conditioned by water quality, developed based of scientific researchers; these measures will be applied in the future by specialists of the Centre of Public Health of Moldova, primary health care units and local authorities.

Keywords Diseases · Hygienic indicators · Water quality · Drinking water

One of the priority issues for children's health is drinking water, especially in rural areas [1, 4]. Usually, rural areas of Moldova are supplied with water from underground sources, the quality of which in most cases do not meet hygienic standards [5, 6]. Consumption of water with excessive content of some chemical compounds or microbiologically polluted conditions risks to human health [2]. Considering immature adaptation mechanisms and the anatomical and physiological age of the growing organism we can consider children as the most vulnerable stratum of the population affected by the action of environmental factors, especially noncompliant water [4].

Water quality does not remain constant over time and can therefore vary due to many factors, either man-made (anthropogenic factors) or natural origin. A

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peculiarity of changes in water quality over time allows us to predict and monitor its impact on the health of the population [4, 6].

Setting priorities and methods for environmental factors impact mitigation, including water quality on health of the population is and continues to be one of most pressing issues of society. The most effective way to maintain satisfactory health is risk prevention at early stage, in childhood [3, 4].

The present work focuses on sources of water supply in rural areas, territorially distributed in different areas of Moldova (South Zone—Cahul; Centre Zone—Chisinau, North Zone—Briceni), children (1–17 years) in select locations, statistical data on child morbidity, seasonal weather patterns and water quality.

Investigative methods used pertain to hygiene, epidemiology, sanitary chemistry, mathematics. Morbidity was studied in aspect of morbidity after addressing complex clinical examination; drinking water quality was examined in a sanitary chemical laboratory. Accumulated data was processed using statistical methods.

Drinking water in Moldova is acute issues since water sources are territorially unevenly distributed and its quality in very frequent cases did not meet sanitary regulations.

Surveyed children use drinking water from both deep layers (artesian wells) as well as from groundwater (wells). Artesian wells are dominant in the south and groundwater wells in the north. Water from wells is characterized by high mineralization conditioned by sulfates, hydrocarbonates, and chlorides. Higher concentrations of these indices are typical for the south and north of the country.

According to statistical reports of the State Supervision Service for Public Health, the country maintained a high level of noncompliance of water quality sources and distribution systems. The share of noncompliant samples of groundwater of centralized sources in 2010 was 67.8 % compared with 58.3 % in 2008, water samples from wells noncompliant to sanitary-chemical parameters amounted to 84.2 and noncompliant microbiological parameters 41.2%.

Water from wells frequently contains an increased amounts of nitrates (75 % samples), sulfates (65.0–100.0 %) dry residue (65.0–87.0 %), boron (6 %) and fluorides (7 %).

In terms of organic pollution of water is found the most significant concentrations of nitrogen, showing excessive values across the country. Higher average values were recorded in south and north of the country, trends accounting for 173.95 and 111.15 mg/dm^3 respectively. The average concentration of nitrates in the central zone is lower representing 95.7 mg/dm^3, however beyond permissible limits, more than 1.8–2 times.

A particularity to note is the seasonal variation in water quality. Thus, organic water pollution indices are unfavorable during the warm season (summer–autumn).

Inadequate share of microbiological parameters in water samples is less in the winter, trends account from 6.3 to 12.5 %. The largest share of noncompliance was recorded in spring, representing 47.2–63.6 %, remaining at this level, with small deviations, in summer and fall.

In order to highlight peculiarities of health, possibly influenced by the chemical content and bacteriological pollution of water used for drinking purposes, one of the first steps is to analyze general and specific morbidity of children in 2003–2009 dynamics.

The evolution of general morbidity of children in Moldova shows a significant increase in both incidence and prevalence. In 2003, general morbidity of children was 5393.5 cases per 10,000 children, prevalence—7238.4 ‰, increasing significantly in 2009, 8085.3 cases or 6350.9 ‰ per 10,000 children.

Evaluation of average structure of child morbidity in the country by incidence and prevalence of nosologic groups that directly or indirectly may influence water quality have shown increased values in infectious and parasitic diseases (corresponding to 683.9 and 700.2 cases per 10,000 children). Incidence and prevalence of digestive diseases (i.e. 243.1 and 534.5 cases per 10,000 children) come second to the abovementioned. Here it is necessary to mention the chronic predominant character of most digestive diseases.

An important part of the structure of general morbidity are diseases of blood and hematopoietic organs, which are on average 223.1 and 424.9 ‰ and of the genitourinary system (105.3 and 271.1 ‰ accordingly).

There were some territorial dependent particularities of general and specific morbidity in key areas of the country: Southern, Central and North Zone.

Average morbidity of children by main nosologic groups indicate increased values in the south, compared to central and northern regions by infectious and parasitic diseases, diseases of the skin and subcutaneous tissue. In the central zone digestive, genitourinary system diseases and nervous and circulatory system diseases prevail. In northern region, respiratory, blood, osteoarticular and endocrine diseases are prevalent as well as diseases relating to nutrition.

A growing dynamic characteristic for all locations are the digestive and blood system diseases.

An important scientific value is submitted by the connection between sanitary-chemical indices of drinking water and morbidity indices.

This section has found that overall morbidity has a strong direct link with water alkalinity ($r = 0.84$) and fluoride concentration ($r = 0.75$), a direct link with average and low water content of sulphates, magnesium, nitrate and total hardness (respectively $r = 0.62$, $r = 0.57$, $r = 0.38$ and $r = 0.26$). Calcium salts in water content is in an average inverse correlation with overall morbidity.

Diseases of the circulatory system directly correlate with carbohydrate concentration in water ($r = 0.84$), and the concentration of sulfates, fluorides, magnesium, nitrates and total hardness manifest direct average dependencies (i.e. $r = 0.63$, $r = 0, 59$, $r = 0.49$, $r = 0.35$ and $r = 0.30$). With calcium salts, cardiovascular diseases manifest a low inverse relation $r = –0.26$.

The same regularity is characteristic for osteoarticular system diseases with a significantly higher correlation index for nitrates and total hardness (respectively $r = 0.58$ and $r = 0.51$).

In order to develop strategies and prioritization of disease prevention dependent on environmental factors was attempted using modern methodology to estimate

the relative risk of illness. Research conducted in this specific context revealed important features. Level of hydric relationship between exposition risk factors and threat of disease expressed by relative risk allowed us to arrange classes of diseases in the following sequence: firstly, circulatory system diseases (RR = 3.6), followed by diseases of the osteoarticular system (RR = 2.24), congenital malformations (RR = 2.1) and digestive diseases (RR = 2.03).

Based on the results of state of children health it is recommended to implement a comprehensive preventive measures directed toward improving water supply of locations, mainly primarily pre-school and pre-university educational institutions. To this end activities will be carried out of several services representatives responsible for this section: State Supervision Service for Public Health, Primary Health Care Services (PHCS) central government and local representatives of ministries and departments, local community, NGOs, educational institutions, health workers (doctors, nurses etc.) family members.

Centre for Public Health (CPH) specialists are performing health monitoring in regard to drinking water, centralized and decentralized supply systems and institutions. The activity involves monitoring, analysis, interpretation and dissemination of data on health of pupils, in particular diseases conditioned by water, drinking water, in regard to which priorities are and risks identified as well as measures for public health improvement are developed and implemented.

These activities will include hygienic measures for more favorable conditions for child water supply.

CPH specialists must organize continual intersectoral collaboration between partners including family physicians, municipalities, authoties entitled with supplying communities and child care institutions with water. There is a need for health education means by familiarizing people with the negative effects caused by improper water use and ways to improve its quality.

Main activities carried out by monitoring experts of CPH are:

- Monitoring child health indicators (morbidity, physical development, disability);
- Monitoring health of water resources, centralized and decentralized water supply;
- Study and description of drinking water useage to scoolchildren;
- Highlighting hydration risk factors for children health;
- Development of prophylactic measures and familiarization of pupils, teachers with risk factors;
- Development of a set of recommendations for medical activities for school and family doctors regarding safe drinking water.

Primary health care service activities are carried out at health centres, where special attention is paid to reflect the premorbid state, early diagnosis and treatment of WRI, and noncontagious infectious diseases, both acute and chronic, including medical monitoring of children with chronic diseases. The medical staff is required to regularly visit families and children with chronic diseases conditioned by water.

Simultaneously, family doctors work with CPH physicians in monitoring health status in relation to the environment; develop specific recommendations for improving water supply, hygienic conditions of preschool and university institutions, as well as the community in general.

Representatives of the primary health care system will focus on the following activities:

- Demonstration and assessment of hydric risk factors in the community;
- Intersectoral activities between families and CPH experts aimed at exchanging information on the subject of water related illnesses (WRI) and water quality, joint development of preventive measures;
- Conducting surveys on WRI of children;
- Conducting surveys on WRI of adults;
- Confirm the diagnosis of WRI;
- Request a consultation expert (depending on the diagnosis) for the ambulatory or stationary patient;
- Perform activities of health promotion and health education.

Central and local government is responsible for creating harmonized legislative basis with European standards concerning construction, arrangement and operation of water resources and water supply installations, water quality monitoring, initiate and support national development programs systems water supply and sanitation communities to combat WRI and health promotion. Financial planning is important to ensure material population, health and social conditions that would enable to achieve the necessary preventive measures. It is also important to ensure training and recycling of medical, pedagogical staff in combating WRI.

Main activities of local government are:

- Strengthening intersectoral collaboration between partners in the issue of health promotion and disease prevention, including WRI;
- Initiating programs to develop local water supply systems and sanitation;
- Providing preschool and pre-university institutions, communities with sufficient water quantities, permanent monitoring of this action;
- Each local administrative unit will develop a policy on the prevention of WRI;
- Coordinating the activities of individuals and businesses in implementing measures to ensure public health;
- Ensuring safe conditions and services for health protection of water sources, water quality consumed by children and adults.

Management of educational institutions shall be responsible for compliance with water quality standards, sanitary regulations on aqueducts, safe drinking water, small water systems and sanitation, housing the equipment necessary for ensuring water supply, drinking water quality, taking all preventive measures of WRI prevention, enactment of decisions made by State Supervision Service for Public Health (SSSPH).

Main activities of teachers in schools are:

- Knowledge of WRI symptoms, isolation of WRI children, parental and medical notification;
- Compliance with drinking and antiepidemic regime for the protection of child health during lessons and breaks;
- Organization of a systematic cleaning of the study room, ventilation of premises during each break;
- Thematic seminars with representatives of CPH for pupils and parents.

The medical staff of educational institutions (doctors, nurses) is responsible for compliance with sanitary regulations on drinking water and is compelled to take all preventive measures for hydric dependent diseases. Main activities of the medical staff are:

- Organizing regular medical exams and placement of sick children;
- Isolation of sick, first aid and notification of doctors or entitled authorities;
- Highlighting actual frequency of illness, take preventive measures, collaborate with parents;
- Raising awareness of teachers and parents about pupils health (pupils manifesting diarrhea, abdominal pain, fever, vomiting etc.).
- Cooperation with entitled health authorities and CPH experts;
- Health promotion and health education of students.

An important role in preventing WRI at children lies with parents, which must comply with sanitary regulations for drinking purpose in consultation with hygienists, in order to ensure necessary housing facilities with water supply.

Drinking water quality, in Moldova, in most cases does not comply with hygienic standards, in respect to sanitary-chemical indices (concentration of nitrates, sulphates, hydrogen carbonates, chlorides) as well as microbiological indices. Estimated noncompliant indices relate directly to a number of diseases that occur mainly at children due to morpho-functional peculiarities of age and immature adaptation mechanisms. Mitigation of disease risk due to noncompliant water quality requires the participation of all stakeholders, promotion and respect for preventive measures.

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