PREVALENCE OF DISEASES AMONG CHILDREN POPULATION
IN DNEPROPETROVSK REGION (UKRAINE),
CORRELATED WITH DETERIORATION OF DRINKING WATER QUALITY

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In Ukraine 72.3% of water supply systems do not comply with sanitary norms due to a lack of sanitary protection zones, 17.4 % of water supply systems lack of necessary treatment facilities and 18.2% do not have disinfecting facilities [4]. In some regions 30-70% of pipes are worn out [14]. Many rural water systems lack treatment and disinfecting facilities [19]. Only a quarter of rural areas have a centralized water supply [20]. The rest of population use decentralized water sources such as wells [23]. In 2013, 12.6% of drinking water samples from the centralized system did not comply with sanitary requirements due to sanitary and chemical indicators; 4.1% of samples were unsatisfactory due to bacteriological indicators [26]. For decentralized water samples, these percentages were 31.9% and 20.6%, respectively [29].

The purpose of our research was to study dynamics prevalence of diseases among children' population in the separate rural tacsons of Dnepropetrovsk region; to carry out correlation analysis between some indicators of drinking water quality and prevalence of diseases.

Material and methods. Research indicators of prevalence of diseases was carried out in the 6 types of tacsons of Dnipropetrovsk region (Ukraine) during 2008 – 2013 years. We carried out correlation analysis between some indicators of drinking water quality from centralized (totally 38 260 indicators) and decentralized water sources (totally 24586 indicators) with indicators of prevalence of diseases among children population (totally 522720 indicators). Descriptive statistics including mean and standard deviation was calculated for quantitative variables. Beyond descriptive statistics, correlation analyses were used to examine the association between knowledge, attitudes and practices and each of the background characteristics. A p-value <0.05 was considered as statistically significant. Statistical processing was carried out with the use of package STATISTICA 6.1 (serial number AGAR 909E415822FA).

Results and their discussion. Most widespread in the 1 tacson among children population were diseases of respiratory organs (54.94%), digestion organs (6.49%), skin and hypoderm (4.11%), endocrine system (3.20%), blood and hematopoesis organs (2.92%), nervous system (2.71%), anemia (2.88%). It had been shown that the lowest level I class of diseases was observed among children population in the 3 tacson (269.13 ± 11.94) $\%_{00}$ (p< 0.05), with negative growth rates both in the rural districts (- 45.4 %) and in the region (- 55.8 %) (Fig. 1).

The greatest level prevalence I class of diseases was observed in 2 tacson (696.72 ± 69.81) $\%_{00}$, with positive growth rates: on the districts (+41.3%) and in the region (+14.4%). Thus, prevalence of all class of diseases exceeded an average district indicator: in 2 tacson (on 1.41 times); in 4 tacson (on 1.02 times); in 5 tacson (on 1.17 times); an average regional indicator was increased in 2 tacson (on 1.14 times). Prevalence of oncological diseases in dynamics during 2008 - 2013 years was characterized by a reliable decline by the tacsons of Dnipropetrovsk region: from (43.09 ± 5.38) in the 1 tacson to (39.30 ± 3.16) cases on 10 000 children population (p<0.05). However, the greatest level of prevalence II class of diseases was observed in 3 tacson: (69.40 ± 3.42) $\%_{00}$ (p<0.001), with positive growth rates on the districts (+62.1%), and in the region (+16.5%). The greatest increase prevalence of the blood and hematopoetic organs diseases takes place among children population in 2 tacson: on the districts (+10.0%), and in the region (+33.1%); in 5 tacson: on the districts (+7.1%), in the region (+29.6%); in 6 tacson: on the districts (+15.8%), in the region (+42.7%). Prevalence of anemia in all tacsons of the region was the following: 2.88% - in the 1 tacson;
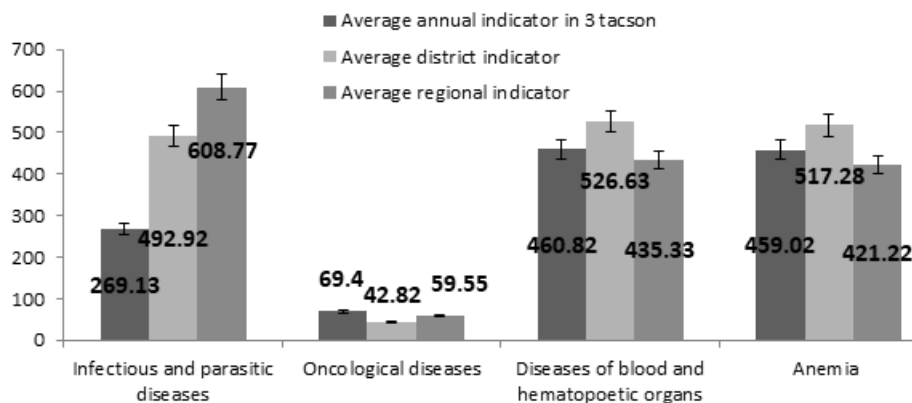

*Fig. 1. Prevalence of diseases (I, II, III classes) among children population
at the age up to 14 y.o. in the 3 tacson of Dnepropetrovsk region during 2008 - 2013 years*
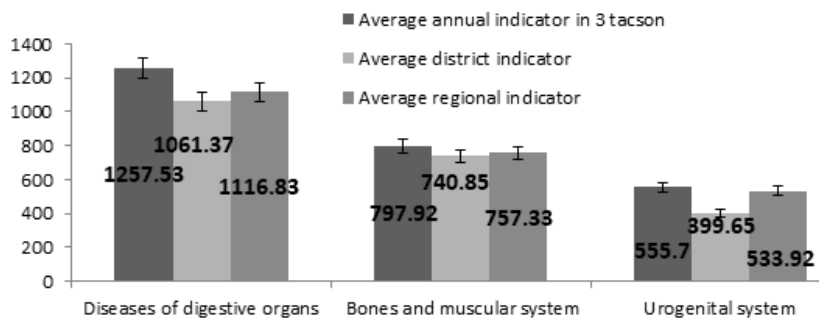
*Fig. 2. Prevalence of diseases (XI, XIII, XIV) classes among children population
at the age up to 14 y.o. in the 3 tacson of Dnepropetrovsk region during 2008-2013 years*

3.77% - in 2 tacson; 2.66 % - in 3 tacson; 2.61% - in 4 tacson; 3.59% - in 5 tacson; 4.51% - in 6 tacson.

For the bones and muscular system diseases was characterized a positive growth rates in the next tacsons: in 2 tacson – (from +22.8 to+20.1)% on the districts and in the region; in 3 tacson: (from +7.7 to +5.4)%; in 4 tacson: (from +22.2 to+9.6)%. It should be noted, that the most expressed increase for prevalence of urogenital system diseases was observed among the peasants in 1 - 3 tacsons, the less expressed increase this class of diseases was in 4 - 6 tacsons. The higher prevalence XIV class of diseases was revealed for children in 3 tacson: $(555.70 \pm 16.46)\%_{00}$ ($p<0.001$), with a positive growth rates both on the districts and in the region: from +39.0 to +4.1 % (Fig. 2).

Analysis of a cross-correlation connection has been showed, that on a prevalence of infectious and parasitic diseases among the children up to 14 y.o. was influenced salt composition of drinking water from decentralized sources: in 1–2 tacsons – dry residue, chlorides, sulfates ($r=0.87$, $p<0.001$); in 4 tacson – general inflexibility, dry residue, chlorides, sulfates, calcium, magnesium ($r=0.73-0.89$, $p<0.001$); in 5 – 6 tacsons – general inflexibility ($r=0.82$, $p<0.001$). The high significant cross-correlation connection was characterized between prevalence of anemia at the children with content of Mg, Fe ($r=0.76$, $p<0.001$). In 2 tacson prevalence of blood and hematopoetic organs diseases ($r=0.87$, $p<0.001$) and anemia ($r=0.95$, $p<0.001$) were strongly correlated with content of Ca, Mg, Fe. In 2 - 6 rural tacsons prevalence of endocrine diseases at the children was correlated with all indicators of salt composition of water, except Ca, Mg, Fe in 2 tacson ($r=0.87 – 0.95$, $p<0.001$); in 3 tacson – with general inflexibility and Fe ($r=0.71$, $p<0.001$), in 5–6 tacsons – with Fe ($r=0.87 – 0.95$, $p < 0.001$). In water of the 1 tacson prevalence of these diseases correlated only with a dry residue ($r=0.74$, $p<0.001$).

In 3–6 tacsons was revealed a high significant cross-correlation connection between prevalence of blood and hematopoetic organs diseases ($r=0.87$, $p<0.001$) and anemia ($r=0.95$, $p<0.001$) among 14 y.o. peasants – with content of iron in the drinking water. Prevalence of congenital anomalies of blood circulation system was correlated with iron in water of the 6 tacson ($r=0.74$, $p<0.001$). Prevalence of oncological diseases at the children up to 14 y.o. was strongly correlated with all indicators of salt composition in 5–6 tacsons, except content of iron ($r=0.76-0.81$, $p<0.001$). Primary, prevalence of anemia among rural children in 1 tacson was strongly correlated with all inorganic components of drinking water: Zn, Cu, Mn, F, Al, nitrogen ammonia, nitrites, except pH, nitrates, oxidability ($r=0.76$, $p<0.001$); in the 2, 4, 5 tacsons – with all these inorganic components ($r=0.74-0.95$, $p<0.001$). Similar trend was observed for the prevalence of blood and hematopoetic organs diseases among children in the 2, 4, 5, 6 tacsons ($r=0.87$, $p < 0.001$). Finally, prevalence of endocrine system diseases was correlated with pH in the 3 tacson ($r=0.71$, $p<0.001$); prevalence I class of diseases was correlated with pH, nitrates, oxidability in 4 tacson ($r=0.74 – 0.89$, $p<0.001$) and in 5 tacson ($r=0.70 – 0.83$, $p<0.001$). Congenital anomalies of blood circulation system were correlated with Zn, Cu, Mn, F, Al, nitrogen ammonia, nitrites in the 6 tacson ($r=0.74$, $p<0.001$).

Nitrate concentration above the recommended value of 10 mg/L is dangerous to pregnant women and poses a serious health threat to infants less than three to six months of age because of its ability to cause methaemoglobinaemia or blue baby syndrome in which blood loses its ability to carry sufficient oxygen [7,12,13]. Malomo et al [21] reported nitrate concentrations up to 124 mg/L and nitrite up to 1.2 mg/L in shallow groundwater near pollution source in southwest Nigeria. These concentrations were unusually high. The common concentrations are a little above 10 mg/L for NO_3^- and 0.06 mg/L for NO_2^- as reported by previous investigators [2,18]. Nitrate is one of the most widespread chemical contaminants in aquifers around the world [25]. Results from several epidemiologic studies have suggested an association between prenatal exposure to nitrates in drinking water and birth defects in offspring, including neural tube defects (NTDs) [5,9,10], central nervous system defects overall [1], oral cleft defects [10], musculoskeletal defects [22], and congenital heart defects [8]. In these studies, was noteworthy that previous associations observed between birth defects and nitrates in drinking water were often observed at levels below the current allowable maximum contaminant level for nitrate (10 mg/L as nitrate-nitrogen or 45 mg/L as total nitrate) set by the U.S. Environmental Protection Agency [24]. Results from this large population-based case–control study suggest that prenatal nitrate intake from drinking water is associ-

ated with NTDs, oral cleft defects, and limb deficiencies in offspring [6]. Most of the hand-dug well water samples in the vicinities of pollution source and those in the residential areas contained Pb, Cd, and coliform levels above the WHO limits. The high coliform index, increased metal levels and organic loads of the water samples were indices of pollution from seepages and run offs of the polluted environment where these wells were located [3].

In our research work was found out, that congenital anomalies of the blood system correlated with nitrogen ammonia and nitrites in combination with heavy metals (Zn, Cu, Mn, F, Al) in the 6 rural tacson. The given fact is correlated with numerous literature reviews [6–12] on the one hand. On the other hand, we firstly revealed that combine action of chemical substances in water should caused different diseases at the children population. The most typical correlation links were occurred between Fe and diseases of blood and hematopoetic organs; or presence in water (Ca+Mg+Fe) – was correlated with anemia. In the given case Ca and Mg in the normal concentrations could caused toxic action of Fe, which carried out to anemia. Such action is called additive or combine action.

In our opinion, different combinations of salt composition of well water (dry residue+chlorides+sulfates, or general inflexibility+dry residue+chlorides+sulfates +Ca+Mg) correlated with prevalence of infectious and parasitic diseases. Similar trend was shown at work [3], but authors did not take into account a combine action of chemical substances in water. The given study focused on the separate action of biological factor – a high coliform index, and separate action of chemical factor – high level of heavy metals and organic compounds in water samples.

In the work [28] was found that lack of chlorine and presence of E. coli in samples drawn from outside (flame-sterilized) taps, were associated with reports of gastrointestinal illness (GII), consistent with a smaller pilot study. In a cross-sectional survey in Russia, Egorov et al. [11] found that decreases in chlorine residuals in the distribution system were associated with increased self-report of GII. Researchers documented associations between reported low water pressure and GII in an analysis of data from a case-control study in Europe [17]. It was found no association between GII and turbidity, consistent with one previous study that did not identify an association between treated water turbidity and GII captured in emergency department visits in urban Atlanta [27]. In our study, we determined association between general inflexibility in 3 tacson and dry residue in 1 tacson with I class of diseases. We did not found correlation between water turbidity, chlorine, low water pressure and GII, which was correlated with the following works [11,17,27,28].

In our point of view, it should be explained that public bodies in the rural tacsons did not used chlorination of water in wells. As a result, chlorine is absent, level of turbidity is normal. According to the results of our research, we found out that in the majority of rural settlements – from 1 to 6 tacsons – different combinations of salt composition carried

out. It could be explained by the local geological structure of the soil composition, which having a great influence to the chemical and mineral composition of wells water.

On the other hand, high risk of oncological diseases was associated with high level of chlorine, which is typical for open water sources. In our study, our research was focused on the rural settlements. Majority of water sources in the rural tacsons of Dnepropetrovsk region, which covered both systems of water supply, as well as centralized and decentralized, were represented by underground water sources – wells.

In our previous publications [15,16] was proved, that in the decentralized water supply sources all tacsons, except 6 tacson, had an unfavorable self-purification processes and incompleteness of nitrification activity. Therefore the average annual indicators in the water samples, carried out in 1–5 tacsons, increased in dynamics by the nitrogen ammonia: from (0.24 ± 0.05) to (0.43 ± 0.20) mg/dm^3, i.e. in 2.0 times, in comparison with content of nitrates: (5.95 ± 0.06) to (14.72 ± 5.57) mg/dm^3, which increased in 2.5 times ($p < 0.001$). Unfavorable nitrification activity in the decentralized drinking water sources in all tacsons of Dnipropetrovsk region, except 6 tacson, in 2008–2014 years was shown incompleteness of the self-purification water in the rural settlements, causing primary morbidity among peasants as well as the blood and blood – forming organs, methemoglobinemia among infants due to a consumption of water from wells.

We recommended collective installations of drinking water purifiers, primarily in the medical–preventive and children's educational institutions in all rural tacsons of Dnipropetrovsk region.

The numerous literature reviews demonstrated correlation between nitrates in drinking water and congenital anomalies, such as birth defects in offspring, including neural tube defects [5, 9, 10], central nervous system defects overall [1], oral cleft defects [10], musculoskeletal defects [22], and congenital heart defects. In our study was proved correlation between combine action of nitrogen ammonia, nitrites and heavy metals (Zn, Cu, Mn, F, Al) in the 6 rural tacson with congenital anomalies of the blood system. In the majority of rural tacsons in Dnepropetrovsk region was shown correlation between prevalence of infectious and parasitic diseases and different combinations of salt composition in wells water: dry residue + chlorides + sulfates, general inflexibility + dry residue + chlorides + sulfates + Ca + Mg. In our opinion, it could be explained by geochemical composition of underground water sources in the different types of soil – from 1 to 6 rural tacsons.

Firstly in Ukraine, we proved that the most typical association had been occurred between high level of Fe – diseases of the blood and hematopoetic organs, and anemia. It was found out that combine action of Ca + Mg + Fe having a great influence to the cases of anemia among the children population in Dnepropetrovsk region. For another nosological unit was characterized combine action of pH + nitrates + oxidability in the 4, 5 tacsons with prevalence

I class of diseases (r=0.74–0.89, p<0.001). In some rural tacsons, for example, pH having a strong correlation link with diseases of endocrine system (r=0.71, p<0.001). Prevalence of oncological diseases at the children, living in the 5–6 rural tacsons, was strongly correlated with all chemical indicators of salt composition of drinking water, except Fe (r=0.76-0.81, p < 0.001).

Conclusions. It was found out, that the first places by the prevalence I class of diseases was revealed at the children, up to 14 y.o., living in the 2 tacson (4.57 %), 5 tacson (3.79 %), 4 tacson (3.77 %); for the II class – in the territory of 3 (0.40 %), 5 (0.34 %), 1 tacsons (0.31 %); for the III class – in the 6 (4.58 %), 2 (3.80 %), and 5 tacsons (3.70 %); for anemia - in the 6 (4.51 %), 2 (3.77 %) and 5 tacsons (3.59 %).

Statistically significant cross-correlation connection was demonstrated for some indicators of water quality in the decentralized sources (Zn, Cu, Mn, pH, F, Al, nitrogen ammonia, nitrites, nitrates, oxidability) and prevalence among 14 y.o. children of oncological diseases, blood and hematopoetic organs and urogenital system diseases, anemia, congenital anomalies of blood circulation system (p<0.001).

Recommendations. The results of the conducted researches allowed scientifically to ground complex approach from making healthy the basic sources of the centralized water-supply of rural population; to form the complex of measures, directed on the necessity of near-term introduction system of monitoring indexes of health at the rural population, with application of estimation non-carcinogenic risks; to outline an immediate necessity from using additionally treated bottled water in the rural tacsons of Dnepropetrovsk region, which does not have an access to quality drinking water. Priority directions of prophylactic measures are recommended on the improvement quality of drinkable tap water by the equipment of collective settings from additionally treated bottled water, in the first turn, in the hospitals, child's educational establishments in the rural districts of Dnepropetrovsk region. In 2015 year the majority of collective settings from water purification of drinking-water were located in the hospitals and child's educational establishments in the 1 tacson: 14 settings in Kryvorozskyi district with a power (111 – 749.3) m³/year, 7 settings in Novomoskovskyi district (154.4–585) m³/year; in the 3 tacson: 9 settings – in the Dnepropetrovsk district (152.5 – 419.2) m³/year.

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SUMMARY

PREVALENCE OF DISEASES AMONG CHILDREN POPULATION IN DNEPROPETROVSK REGION (UKRAINE), CORRELATED WITH DETERIORATION OF DRINKING WATER QUALITY

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Purpose of research was to study dynamics prevalence of diseases among children' population in the separate rural tacsons of Dnepropetrovsk region; to carry out correlation analysis between some indicators of drinking water quality and prevalence of diseases. Research indicators of prevalence of diseases was carried out in the 6 types of tacsons of Dnipropetrovsk region (Ukraine) during 2008 – 2013 years (totally 522720 indicators). It was proved that (I, II, III, XI, XIII, XIV) classes of diseases takes the first place by the prevalence of diseases in the majority of rural tacsons. Correlation between higher salt content of the potable water taking from decentralized sources and content of some heavy metals (Zn, Cu, Mn) and some substances (pH, F, Al, nitrogen ammonia, nitrites, nitrates, oxidability) and the prevalence of diseases among children: tumors (r=0.87); diseases of blood and hematopoetic organs (r=0.74–0.95); anemia (r=0.79–0.87); diseases of genitourinary system (r=0.79–0.82); congenital anomalies (r=0.87), including circulatory system (r=0.74–0.95) was revealed in the separate tacsons of Dnepropetrovsk region (p<0.001).

Keywords: rural tacsons; prevalence of diseases, classes of diseases; sources of water supply; potable water.

РЕЗЮМЕ

РАСПРОСТРАНЁННОСТЬ ЗАБОЛЕВАНИЙ СРЕДИ ДЕТСКОГО НАСЕЛЕНИЯ В ДНЕПРО-ПЕТРОВСКОЙ ОБЛАСТИ (УКРАИНЕ), КОР-РЕЛИРУЮЩАЯ С УХУДШЕНИЕМ КАЧЕСТВА ПИТЬЕВОЙ ВОДЫ

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Цель исследования – изучение динамики распространённости заболеваний среди детского населения сельских таксонов области и корреляционный анализ показателей качества питьевой воды с некоторыми показателями распространённости болезней. Изучено общее количество (522720 показателей) распространённости болезней среди детей в 6 типах таксонов Днепропетровской области (Украина) за 2008-2013 гг. Доказано, что болезни I, II, III, XI, XIII, XIV классов являются приоритетными по распространенности в большинстве сельских таксонов. Показана корреляционная связь между повышенным солевым составом питьевой воды из децентрализованных источников, содержанием отдельных тяжёлых металлов (Zn, Cu, Mn) и некоторыми веществами (pH, F, Al, азот аммиака, нитриты, нитраты, окисляемость) с распространённостью среди детей новообразований (r=0,87); болезней крови и органов кроветворения (r=0,74–0,95); анемии (r=0,79-0,87); болезней мочеполовой системы (r=0,79-0,82); врожденных аномалий (r=0,87), в том числе системы кровообращения (r=0,74-0,95) в некоторых таксонах Днепропетровской области (p<0,001).

რეზიუმე

ავადობის გავრცელებადობა, სასმელი წყლის ხარისხის გაუარესებასთან კორელაციაში დნეპროპეტროვსკის ოლქის (უკრაინა) ბავშვთა მოსახლეობაში

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სახელმწიფო დაწესებულება "დნეპროპეტროვსკის სამედიცინო აკადემია", დნეპრო, უკრაინა

კვლევის მიზანს წარმოადგენდა დაავადებათა გავრცელების დინამიკის შეფასება დნეპრო-პეტროვსკის ოლქის სოფლის ტაქსონების ბავშვთა მოსახლეობაში და სასმელი წყლის ხარისხის მაჩვენებლების კორელაციური ანა-ლიზი დაავადებათა გავრცელების ზოგიერთ მაჩვენებელთან. დნეპროპეტროვსკის ოლქის 6 ტიპის ტაქსონებში შესწავლილია ბავშვებში დაავადებათა გავრცელების საერთო რაოდე-ნობა (522720 მაჩვენებელი) 2008-2013 წლებში. დადგენილია, რომ I, II, III, XI, XIII, XIV კლასების დაავადებები, გავრცელების თვალსაზრისით, პრი-ორიტეტულია სოფლის ტაქსონების უმეტესობაში. დნეპროპეტროვსკის ოლქის ზოგიერთ ტაქსონში ნაჩვენებია კორელაციური კავშირი დეცენტრალი-ზებული წყაროებიდან მიღებულ სასმელ წყალში მარილების შემცველობის მომატებას, ცალკეული მძიმე ლითონის (Zn, Cu, Mn) და ზოგიერთი ნივ-თიერების (pH, F, Al, ამიაკის აზოტი, ნიტრიტები, ნიტრატები, ჟანგურობა) შემცველობასა და ბავშ-ვებში ახალწარმონაქმნების (r=0,87), სისხლისა და სისხლმბადი ორგანოების დაავადებების (r=0,74-0,95), ანემიების (r=0,79-0,87), შარდსასქესო სისტემის დაავადებების (r=0,79-0,82), თანდაყოლი-ლი ანომალიების (r=0,87), მათ შორის – სისხლის მიმოქცევის სისტემის ანომალიების (r=0,74-0,95) გავცელებას შორის (p<0,001).

ПРОБЛЕМЫ ИММУНОПРОФИЛАКТИКИ И СОЛИДАРНОЙ ОТВЕТСТВЕННОСТИ НА УРОВНЕ ПЕРВИЧНОЙ МЕДИКО-САНИТАРНОЙ ПОМОЩИ

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Современная практика здравоохранения диктует необходимость совершенствования государственной политики в области охраны здоровья детского населения. Дети - это наши инвестиции в общество будущего. От их здоровья и того, каким образом мы обеспечиваем их рост и развитие, включая период отрочества и до достижения ими зрелого возраста, зависит уровень благосостояния и стабильности в последующие десятилетия (WHO, 2005-2015). Двадцатый век внес существенный вклад в исследование и разработку новой этики в отношении ребенка, признав его в качестве самостоятельного субъекта прав и выделив его особый социальный статус.

Ребенок рассматривается как личность со своими законными интересами и правами, которые государство и общество, мир взрослых должны поддерживать и реализовывать в приоритетном порядке. Во Всемирной декларации прав человека (1948 г.) Организация Объединенных Наций провозгласила, что дети имеют права на особую защиту и помощь, дети должны быть полностью подготовлены к самостоятельной жизни в обществе и воспитаны в духе идеалов, провозглашенных в Уставе ООН (Конвенция о правах ребенка, ст. 24 одобрена Генеральной Ассамблеей ООН 20 ноября 1989 г.) [2].

В современных условиях динамичного развития общества и предъявляемых требований к качеству оказываемых услуг, совершенствование системы охраны здоровья детей является стратегической задачей государства [7]. В обеспечении охраны здоровья детей приоритетной задачей является вакцинопрофилактика. Это стратегическое направление профилактической медицины как во всем мире, так и в Казахстане. Вакцинация доказала свою безопасность, свидетельством чего является тот факт, что Казахстан в 1993 году зарегистрирован свободной зоной от полиомиелита. Передача полиомиелита, намеченного для глобальной ликвидации, остановлена во всех странах, кроме двух - Афганистан и Пакистан.

По оценкам, иммунизация позволяет ежегодно предотвращать от 2 до 3 миллионов случаев смерти от дифтерии, столбняка, коклюша и кори. Однако при улучшении глобального охвата иммунизацией можно предотвратить еще 1,5 миллиона смертных случаев. На протяжении последних лет глобальный охват вакцинацией — доля детей в мире, получающих рекомендуемые вакцины — держится на одном уровне.

В 2015 г. около 86% (116 миллионов) детей грудного возраста в мире получили три дозы вакцины АКДС, защитившие их от инфекционных заболеваний, причиня-