**Abstract**

It is known that women’s reproductive function is highly sensitive to the influence of unfavorable factors of the environment. Persistent organic pollutants, to which the majority of organochlorine pesticides are attributed, may penetrate through the placental barrier and considerably affect the course and termination of pregnancy. In this respect the pollution of the environment by POPs is the major ecological problem closely related to the health issues and needs in-depth study.

The sociohygienic and monitoring investigations were done (2008-2010) in Ashtarak district of Aragatsotn marz (province) of Armenia to study the levels of organochlorine pesticides in human organism, as well as their possible unfavorable impact on certain indices of reproductive health and newborns’ physical development. The results of monitoring showed that organochlorine pesticides levels do not decrease and a high constancy of determination in samples of breast milk of rural population is observed. At the same time, the increase in number of samples (77%) with concurrently determined pollutants (DDT, DDE, γ-HCH) was recorded. According to data/responses of Questionnaires, in a part of respondents (3-17%) the current pregnancy and delivery proceeded with complications, in anamnesis of the parturient women (7-17%) different disorders of reproductive function (miscarriage, preterm delivery) were registered as well. The total number of respondents with reproductive function problems ranged from 13% to 27%. The results of comparative analysis of organochlorine pesticides levels in breast milk samples of females from pre-mountain (Ashtarak district) and valley (Artashat district) regions of Armenia demonstrated that the determination frequency, concentrations, as well as the total amounts of organochlorine pesticides had higher statistical significance in Artashat district.

The comparison and analysis of official statistical data (2010) revealed that in Artashat district as compared to Ashtarak district higher values of certain indices were recorded to testify pregnancy/delivery course disorders. According to the responses, among parturient women of Artashat district the high frequency of pregnancy/delivery complications (53-63%) and different disorders of reproductive function were revealed, as well as calculated odds ratio values were of statistical significance.

The content of organochlorine pesticides in breast milk of parturient women with complicated course of pregnancy and delivery was higher in comparison with women recently confined in normal course.

The presented study makes a part of a complex sociohygienic, monitoring investigations on environmental quality, and the results obtained would further serve as a platform for working out recommendations on reduction of the environmental pollution and improvement of human health protection issues in Armenia.

**Keywords:** environment, pollution, pesticides, monitoring, persistent organic pollutants, reproductive function, rural population, risk.

**Introduction**

Nowadays the researchers are worried by the steady increase of chemical hazards to the environment and humans. The objective reasons consist in the increase of chemicals production and use, the increased number of newly synthesized chemicals,
extension of human activity spheres, in which different chemical compounds are widely applied, as well as the raise of chemicals availability, including those with high biological activity. As a result, the abovementioned factors contribute to increase of the anthropogenic burdens on the environment and human organism [Topical problems on toxicology and radiobiology, 2011].

The variety of conditions for chemicals impact to humans contribute to manifestation of different forms of the toxic process such as development of acute, subacute and chronic forms of intoxication, reproductive function disorders and carcinogenesis initiation, changes in organism reactivity towards the impact of both numerous man-caused and environmental agents [Topical problems on toxicology and radiobiology, 2011].

It is mentioned that the deterioration of human health observed during the last decades is associated namely with the negative influence of chemical factors of the environment. The researchers consider that registered peculiarities of disease course, chronic nature and pathomorphism, as well as changes in structure and nature of pathologies to a greater extent are formed due to anthropogenic ecological misbalances and intensive pollution of the human habitat. The environmental factors rarely act as the initial cause of health disorders; mostly the diseases develop under the effect of a bulk of low-intensive factors characterized by modifying effect as well.

It is proved that non-specific changes may prevail over the specific ones caused by the impact of chemical factors of the environment [Belyaeva N. et al., 2007; Kurlyandskiy B. et al., 2007; Dunaev V. et al., 2008; Mudryi I., 2008]. Various effects of pesticides to human health are developed onto common widely spread pathologies characterized by the increased frequency of agrochemical burdens prevalence. Their impact on human health is considered as chemical component of anthropogenic origin that is enhancing the effect of other etiological agents [Pavlov A. et al., 1991; Borisenko N., Khizhnyak I., 1992; Panina N., 2010]. It is known that women’s reproductive function is highly sensitive to the influence of unfavorable factors of the environment. To a sufficient extent, the changes in reproductive health indices may represent the environment status characterizing mutagenicity and embryotoxicity of agents and their ability to depress adaptation mechanisms of an organism [Kuzmin D., 2007]. Pesticides and fertilizers are also considered among known agents contributing to development of malignant neoplasms, including those of female reproductive system [Shikhnabieva N. et al., 2008]. In women settled at territories polluted by pesticides the reproductive health disorders such as late menarche, monthly period disorders, miscarriages, as well as the gynecological, obstetrical and perinatal pathologies of high frequency, abnormalities in terms and rates of physical and sexual development of girls are more frequently registered [Panina N., 2010].

Persistent organic pollutants (POPs), among which the majority of organochlorine pesticides are considered, may have the adverse influence on human organism producing a wide range of toxic effects, may penetrate through the placental barrier and considerably affect the course and termination of pregnancy [Saxena M. et al., 1980; Pavlov A. et al., 1991; Longnecker M. et al., 2001; Fenster L. et al., 2006]. In this respect the pollution of the environment by POPs is the major ecological problem closely related to the health issues and needs in-depth study [Revich B., Shelepchikov A., 2008].

Based on the abovementioned, the investigations aimed at the study of organochlorine pesticides levels in human organism and their possible unfavorable impact on reproductive health and newborn child’s physical development were conducted.

Material and Methods

According to the posed aims, the sociohygienic and monitoring investigations among rural population of Ashtarak district in Aragatsotn province of Armenia were done in 2008-2010 to study the possible unfavorable impact of organochlorine pesticides carriage on certain indices of reproductive health (course and termination of pregnancy) and newborn child’s physical development.

Face-to-face interviews by a specially developed Questionnaire were conducted among rural female population from different villages (Dzorap, Aragatsotn, Karbi, Parpi, Mugni, etc.). Randomly selected thirty recently confined women (for each year) participated in interviews. During investigations, the female population from 31 villages were questioned that makes approximately 30% of total rural communities of the marz. The Questionnaire embraced issues related to personal information,
description of pregnancy and delivery course with indication of occurred complications, premature delivery, stillbirth, miscarriage and birth defects, as well as newborns physical development data (sex, weight, height, head and chest circumference), respondents’ possible contacts with pesticides or participation in farm works, etc.

Concurrently, in the same group of respondents monitoring of organochlorine pesticides content in breast milk samples was conducted to study residue levels of γ-HCH and DDT with its metabolites (DDE and DDD).

To determine the levels of organochlorine pesticides residues during the first 2-3 days after the delivery the samples of breast milk were taken and kept under the appropriate cold conditions until analytical studies. The determination of organochlorine pesticides in breast milk of nursing mothers was done by gas-liquid chromatography methods with electron capture detector on “Tsvet” gas-liquid chromatograph [Klisenko M. et al., 1992] at determination sensitivity of 0.0007 mg/l. The findings were processed with the use of standard statistical programs such as Biostat and Excel. The obtained data validity was estimated at significance level equal to $p\leq0.05$.

RESULTS AND DISCUSSION

The results of organochlorine pesticides monitoring in breast milk samples of women recently confined (Ashtarak district) testify to continued presence of their residues in biomedia of the studied cohort. Determination frequency of main contaminants (γ-HCH and DDE) was high and ranged from 80 to 100% (Table 1).

The analysis of organochlorine pesticides levels in breast milk depending on delivery sequence (primipara – secundipara) was conducted to study the dynamics of their accumulation in human organism (Table 2). As to data obtained in 2010, the levels of organochlorine pesticides content, including DDT, both in primipara and secundipara breast milk samples were one order higher. It should be mentioned that the detection frequency of DDT in breast milk of secundipara was higher than in primipara: 82.4% and 53.9%, correspondingly. However, revealed differences in the content of individual organochlorine pesticides (DDE, γ-isomer of HCH) and in total amount of organochlorine compounds depending on delivery sequence did not reach the statistical significance.

The analysis of newborns physical development indices depending on delivery sequence and organochlorine pesticides content in the breast milk of their mothers did not reach the statistical significance: physical development of these newborns corresponded to the physiological norm.

According to data obtained in 2010, the residual amounts of organochlorine pesticides were higher than in earlier years; this latter is an evidence of the increasing levels of anthropogenic pollutants burden on human organism. Thus, the average concentrations of individual organochlorine pesticides detected in 2010 compared with data obtained in 2008 and 2009 manifold (2-8 times) exceeded: 3.5 and 5.3 times for γ-isomer of HCH, correspondingly; 2 and 3 times for DDE; 4 and 2.5 times for DDT. Further...
thermore, the total amount of organochlorine compounds exceeded 3- and 8-fold, correspondingly. At the same time, the quantity of samples (77%) containing concurrently determined several pollutants (DDT, DDE, γ-HCH) increased and in one sample the residues of four organochlorine compounds were detected in parallel: γ-isomer of HCH, DDT, DDE and DDD (traces) (Figure 1). It should be mentioned that in three samples the traces of DDT were determined. In comparison with earlier years of investigations, the frequency of DDT detection considerably increased (70%) (Figure 2). The obtained data testify to impairment of the environment in terms of its pollution by organochlorine compounds considered as persistent organic pollutants.

The interviews were conducted in the same groups of respondents, parturient women of Ashtarak district, to study the possible unfavorable effect of organochlorine pesticides on reproductive function of rural female population, Ashtarak district of Aragatsotn marz, Armenia (in %).

**Table 2.** The organochlorine pesticides content in breast milk of rural female population depending on delivery sequence, Ashtarak district, Armenia (X±Sx)

<table>
<thead>
<tr>
<th>Years</th>
<th>Pesticide</th>
<th>Primipara µg/l</th>
<th>Secundipara µg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>γ-HCH</td>
<td>2.70±1.1049</td>
<td>3.157±1.821</td>
</tr>
<tr>
<td></td>
<td>DDE</td>
<td>3.062±0.862</td>
<td>2.48±0.559</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5.76±1.524</td>
<td>5.175±1.982</td>
</tr>
<tr>
<td>2009</td>
<td>γ-HCH</td>
<td>2.0±0.2</td>
<td>2.0±0.16</td>
</tr>
<tr>
<td></td>
<td>DDE</td>
<td>1.8±0.35</td>
<td>1.8±0.37</td>
</tr>
<tr>
<td></td>
<td>DDT</td>
<td>0.4±0.2</td>
<td>0.24±0.05</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3.9±0.5</td>
<td>3.9±0.46</td>
</tr>
<tr>
<td>2010</td>
<td>γ-HCH</td>
<td>1.1±0.4</td>
<td>1.0±0.15</td>
</tr>
<tr>
<td></td>
<td>DDE</td>
<td>1.1±0.5</td>
<td>1.0±0.15</td>
</tr>
<tr>
<td></td>
<td>DDT</td>
<td>1.1±0.5</td>
<td>1.0±0.15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>15.8±3.3</td>
<td>16.4±2.4</td>
</tr>
</tbody>
</table>

**Figure 1.** Distribution of organochlorine pesticides in breast milk samples of rural female population, Ashtarak district of Aragatsotn marz, Armenia (in %).

**Figure 2.** The frequency of organochlorine pesticides detection in breast milk samples of rural female population, Ashtarak district of Aragatsotn marz, Armenia (in %).

**Figure 3.** Certain indices of reproductive function of rural female population, Ashtarak district of Aragatsotn marz, Armenia (in %).
function of human organism. Data of sociohygienic study on the course of pregnancy and delivery was summarized and presented as Figure 3.

As to responses, the number of parturient women with complications of current pregnancy/delivery ranged from 3% to 17%. Moreover, in a part of respondents (7-17%) different disorders of reproductive function (miscarriage, preterm delivery) were registered in anamnesis as well. The total number of respondents with any problem(s) of reproductive health was in the range of 13-27%.

It should be added that according to conducted interviews, none of the respondents had professional contact with pesticides. However, a part of rural female population (50-63%) indicated application of different pesticide formulations on homestead land and truck farms (Figure 4), among which were the respondents (21-47%), who mentioned trade names of applied pesticides (bayleton, dimethoate, arrivo, chloriphos, karate); persons, who used personal protection means during pesticides application, formed 47%-60% of this group.

In order to study the levels of environmental pollution in different regions of the Republic of Armenia the comparative analysis of organochlorine pesticides content in breast milk samples of rural female population from Ashtarak district (Aragatsotn marz) was done versus results of the same research conducted in Artashat district (Ararat marz) (Table 3).

Data presented in Table 3 testify that concentrations of both DDE and DDT, as well as their sum values obtained in Artashat district were significantly higher in comparison with those in Ashtarak district (p=0.02; 0.007 and 0.004, correspondingly). In 2009, the frequency of DDT determination in Artashat district was also significantly higher (70%) versus the same results obtained in Ashtarak district (43%). Represented findings confirm the evidence of intensive and wide application of agrochemicals in farms of Ararat valley, as well as the anxiety on continuous application of organochlorine pesticides in plant cultivation, poultry farming, and cattle breeding.

FY 2010 data of administrative statistical reports on delivered medical care to pregnant and parturient women in observed districts (Artashat and Ashtarak) and their comparison were summarized as well (Figure 5).

According to findings obtained in Artashat district versus Ashtarak district, the higher values of certain indices of pregnancy/delivery course were registered (per 1000 deliveries): the higher figures of total cases of complicated labors (471.6 and 214.0, correspondingly); difficult labors (156.8 and 7.0); disorders/anomalies of labor activity (98.61 and 83.72); miscarriages number, including those due to abnormality of fetus development (110.0/8.9 and 62.8/2.3). The obtained results confirm the anxiety over problems relevant to pregnancy and delivery issues. These findings comply with literature data and testify that the carriage of organochlorine pesticides may pose an additional risk of the negative impact on human reproductive function.
The pollution of the environment by organochlorine pesticides considered as persistent organic pollutants is the major ecological problem closely related to the health issues, because these compounds, as it is known, have an unfavorable effect on human organism manifesting the toxic impact of a wide range, including the adverse effect on human reproductive function.

Monitoring results showed that the levels of organochlorine pesticides do not decrease and keep on high constancy of determination in the biomedia of rural population (Ashtarak district, Aragatsotn marz). At the same time the number of samples (77%) containing concurrently determined several pollutants (DDT, DDE, γ-HCH) increased as well. According to Questionnaire responses, the considerable part of respondents (50-63%) indicated application of different pesticide formulations (bayleton, dimethoate, arrivo, chloriphos, karate) on homestead land and truck farms, while individuals, who used personal protection means during pesticides application formed 47%-60% of questioned groups. However, none of the respondents mentioned the application of any organochlorine pesticides.

In a part of interviewed persons (3-17%) the current pregnancy and delivery proceeded with compli-

### Table 3.

The average content of organochlorine pesticides in the breast milk of rural female population, Armenia, 2008-2010 (X±Sx)

<table>
<thead>
<tr>
<th>Years</th>
<th>Pesticide</th>
<th>Average concentration, μg/l</th>
<th>Determination frequency, %</th>
<th>Average concentration, μg/l</th>
<th>Determination frequency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>γ-HCH</td>
<td>2.96±1.3</td>
<td>83</td>
<td>3.29±0.89</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>DDE</td>
<td>2.75±0.5</td>
<td>80</td>
<td>13.0±2.6*</td>
<td>p=0.00002</td>
</tr>
<tr>
<td></td>
<td>Total amount of organochlorine compounds</td>
<td>5.425±1.3</td>
<td>83</td>
<td>22.412±8.3*</td>
<td>p=0.00011</td>
</tr>
<tr>
<td>2009</td>
<td>γ-HCH</td>
<td>2.0±0.1</td>
<td>100</td>
<td>2.4±0.3</td>
<td>p=0.05</td>
</tr>
<tr>
<td></td>
<td>DDE</td>
<td>1.8±0.26</td>
<td>100</td>
<td>4.2±0.7*</td>
<td>p=0.006</td>
</tr>
<tr>
<td></td>
<td>DDT</td>
<td>0.32±0.1</td>
<td>43</td>
<td>0.37±0.09</td>
<td>p=0.05</td>
</tr>
<tr>
<td></td>
<td>DDT+DDE</td>
<td>1.9±0.28</td>
<td>100</td>
<td>4.5±0.85*</td>
<td>p=0.006</td>
</tr>
<tr>
<td></td>
<td>Total amount of organochlorine compounds</td>
<td>3.9±0.35</td>
<td>100</td>
<td>6.8±0.89*</td>
<td>p=0.005</td>
</tr>
<tr>
<td>2010</td>
<td>γ-HCH</td>
<td>10.6 ± 1.0</td>
<td>100</td>
<td>14.7 ± 3.0</td>
<td>p=0.05</td>
</tr>
<tr>
<td></td>
<td>DDE</td>
<td>5.4 ± 1.3</td>
<td>100</td>
<td>11.7 ± 2.0*</td>
<td>p=0.02</td>
</tr>
<tr>
<td></td>
<td>DDT</td>
<td>0.8 ± 0.2</td>
<td>70</td>
<td>3.9 ± 1.0*</td>
<td>p=0.007</td>
</tr>
<tr>
<td></td>
<td>DDT+DDE</td>
<td>5.5 ± 1.6</td>
<td>100</td>
<td>13.7 ± 2.2*</td>
<td>p=0.004</td>
</tr>
<tr>
<td></td>
<td>Total amount of organochlorine compounds</td>
<td>16.1 ± 1.9</td>
<td>100</td>
<td>45.1 ± 17.0</td>
<td>p&gt;0.05</td>
</tr>
</tbody>
</table>

**Note:** * differences are statistically significant (p<0.05).
cations and in anamnesis of the parturient women (7-17%) different disorders of reproductive function (miscarriage, preterm delivery) were registered as well. The total number of respondents with reproductive function problems ranged 13-27%.

It should be mentioned that in Artashat district the determination frequency, concentrations and total amounts of organochlorine pesticides were at statistically high levels. Analysis of administrative statistical reports on medical care delivered to pregnant and parturient women revealed the higher values of certain indices testifying the pregnancy/delivery course disorders in Artashat district compared to the same findings obtained for Ashtarak district. According to Questionnaire data, among parturient women of the mentioned district the high frequency of complicated pregnancy and labor cases (53-63%) and different disorders of reproductive function (miscarriages, premature labor) were revealed; calculated values of odds ratio were of statistical significance as well. The content of organochlorine pesticides in parturient women with complicated course of pregnancy and delivery was higher in comparison with women recently confined in normal course.

The obtained results correspond to literature data and testify that the presence of organochlorine pesticides in human organism may pose an additional risk for development of different health disorders, including those of human reproductive function. All these findings give grounds for strengthening the issues on control and regulation of plant protection chemicals application in Armenia. In order to improve the current practice and manner of agricultural management it would be necessary to implement measures aimed firstly at awareness raising of individual farmers on rules and regulations related to pesticides safe application, issues relevant to hazards of organochlorine compounds, as well as necessity to observe established hygienic norms and regulations.

The presented findings confirm the topical nature of issues relevant to pollution of the environment by organochlorine pesticides, their carriage, and possible delayed effects of these compounds on human organism. The abovementioned emphasize the necessity to proceed with investigations, as no tendency to reduction of residual amounts of these compounds in both the environment and biomedia is observed until present.

The presented study makes a part of a complex sociohygienic, monitoring investigations on environmental quality, and the results obtained would further serve as a platform for working out recommendations on reduction of the environmental pollution and improvement of human health protection issues in Armenia.

REFERENCES


