HEALTH OF SURVIVORS IN UKRAINE IN 25-YEARS DYNAMICS AFTER THE CHERNOBYL CATASTROPHE

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Association “Physicians of Chernobyl”

Berlin, April 4-10, 2011. Congress The Chernobyl Catastrophe: Taking Stock of 25 Years of Ecological and Health Damages
The Chernobyl reactor explosion
Radioactive pollution in the world after Chernobyl catastrophe

- 17 European countries
  - 207 thousand sq. km
- Belarus – 43, sq. km;
- RF – 56 sq. km,
- Ukraine – 53,4 sq. km
- On others Eurasian, North of America and Africa lends fall out more than 55% Chernobyl radionuclides.

The map of density $^{137}$Cs over the Europe
Chernobyl = 400 nuclear bombs, downcast on Hiroshima.

**Ratio of isotopes:** 90Sr - 1:87; 137Cs - 1:890; 131I - 1:251; 33Xe - 1:31
Загрязнение территории Украины до аварии на ЧАЭС (137Cs - слева, и 90Sr - справа) в 1986 году.

Карта загрязнения Украины цезием (137Cs) после аварии на ЧАЭС в 1986 (слева) и в 2006 (справа).
Water pollution of rivers $^{137}$Cs, $^{90}$Sr and others isotopes after Chernobyl catastrophe. Concentration of $^{137}$Cs (2-4 TBk) and $^{90}$Sr (10-20 TBk).
. Distribution of 241Pu and 241Am in Ukraine after accident
Chernobyl caused significantly lower external, but it caused the high doses on the thyroid by the incorporation of the radioiodine and other radionuclides in first stage of accident.

Cumulative soil deposition of I-131 in Ukraine due to Chernobyl accident (26 April - 7 May 1986)
These are the official figures but many believe the reality is much worse because these data do not include the 3 million people living in the capital of Kiev, which is less than 100 kilometres away from Chernobyl. Residents of Kiev were exposed to fallout from the accident including radioactive iodine. According to research conducted at the Nuclear Research Institute and the Geology Institute of the National Academy of Sciences of Ukraine, Kiev should have been classified as part of the third zone.
## RISKS ASSESSMENT DUE TO RADIATION EXPOSURE TO POPULATION

<table>
<thead>
<tr>
<th>Zone category and its designation</th>
<th>Criteria to establish limits of the zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Exclusion zone</td>
<td>The area from which the population was evacuated in 1986 (unchanged)</td>
</tr>
<tr>
<td>2. Zone of an unconditional (obligatory) resettlement</td>
<td>( \sigma_{\text{Cs}} &gt; 555 \text{ kBq}\cdot\text{m}^{-2} ) or ( \sigma_{\text{Sr}} \geq 111 \text{ kBq}\cdot\text{m}^{-2} ) or ( \sigma_{\text{Pu}} \geq 3.7 \text{ kBq}\cdot\text{m}^{-2} ), where ( D_{\text{eff}*} &gt; 5 \text{ mSv}\cdot\text{yr}^{-1} )</td>
</tr>
<tr>
<td>2. The zone of a guaranteed voluntary resettlement</td>
<td>( 185 \leq \sigma_{\text{Cs}} \leq 555 \text{ kBq}\cdot\text{m}^{-2} ), ( 5.5 \leq \sigma_{\text{Sr}} \leq 111 \text{ kBq}\cdot\text{m}^{-2} ), ( 0.37 \leq \sigma_{\text{Pu}} \leq 3.7 \text{ kBq}\cdot\text{m}^{-2} ), where ( D_{\text{eff}*} &gt; 1 \text{ mSv}\cdot\text{yr}^{-1} )</td>
</tr>
<tr>
<td>3. The zone of an enhanced radioecologic monitoring</td>
<td>( 37 \leq \sigma_{\text{Cs}} \leq 185 \text{ kBq}\cdot\text{m}^{-2} ), ( 0.74 \leq \sigma_{\text{Sr}} \leq 5.5 \text{ kBq}\cdot\text{m}^{-2} ), ( 0.185 \leq \sigma_{\text{Pu}} \leq 0.37 \text{ kBq}\cdot\text{m}^{-2} ), where ( D_{\text{eff}*} &gt; 0.5 \text{ mSv}\cdot\text{yr}^{-1} )</td>
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Two paradigms on Chernobyl consequences estimation
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<tbody>
<tr>
<td>On 1997-2010yy.</td>
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<tr>
<td>Category 1 – Invalids</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2600 children</td>
<td>59582</td>
<td>86775</td>
<td>105251</td>
<td>106824</td>
<td>106 603/</td>
</tr>
<tr>
<td>Category 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>339666</td>
<td>307 982</td>
<td>276 072</td>
<td>268815</td>
<td>111 827/</td>
</tr>
<tr>
<td>Including:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2a- 1986-1987 yy. liquidators</td>
<td>352939</td>
<td>277 135</td>
<td>197 817</td>
<td>191 167</td>
<td>236 319/</td>
</tr>
<tr>
<td>2b- survivors-evacuees</td>
<td>86726</td>
<td>80 847</td>
<td>78 255</td>
<td>77 647</td>
<td>260 807/</td>
</tr>
<tr>
<td>Category 3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>558637</td>
<td>549 649</td>
<td>537 504</td>
<td>533144</td>
<td>522 032/</td>
</tr>
<tr>
<td>Including:</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a 1988-1990 liquidators</td>
<td>69 620</td>
<td>62729</td>
<td>55 391</td>
<td>52346</td>
<td>44 879/</td>
</tr>
<tr>
<td>3b survivors</td>
<td>489 017</td>
<td>486 720</td>
<td>482113</td>
<td>480798</td>
<td>477 153/</td>
</tr>
<tr>
<td>Category 4 (inhabitants on zone under control)</td>
<td>1 169 804</td>
<td>1 150 273</td>
<td>1 081 469</td>
<td>1 065 022</td>
<td>967 361/</td>
</tr>
<tr>
<td>Category D:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>people who worked beyond the territory of the exclusion Zone</td>
<td>2530</td>
<td>2862</td>
<td>2780</td>
<td>2606</td>
<td>2262/</td>
</tr>
<tr>
<td>Children survivors (including those with thyroid gland irradiation in 1986)</td>
<td>1 083 107</td>
<td>1 264 329</td>
<td>643 030</td>
<td>617 660</td>
<td>541 641/</td>
</tr>
<tr>
<td>Total</td>
<td>3 213 326</td>
<td>3 361 870</td>
<td>2 646 106</td>
<td>2 594 071</td>
<td>2 376 218/</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>2 254 471/</td>
</tr>
</tbody>
</table>
Dynamic of birth-rate and mortality of population of the most contaminated regions and according of the groups of primary count per 1000 persons (Ministry of Health of Ukraine).

Green-birth rate; black- death rate

People on polluted territories in Ukraine suffer protracted medical and demographic crises in the form of increase of birth-rate, decrease of aging mortality, short-cut of life expectancy and qualitative changes of structure of death cause. The most heavily contaminated regions have a lower level of the human development index.
Death-rate in Chernobyl society and Ukraine.
DINAMICS OF HEALTH of survivors (state statistics)

Part of adult population which has been identified as ill by medical examination, is constantly growing and at present amounts to 94.2% for accident liquidators, 89.8% for evacuees and 84.7% for residents of radioactive contaminated territories. 79.8% of children who have been directly or indirectly affected by the accident were considered also as ill.

Red-liquidators; green-evacuees; rose-residents of contaminated regions; black—children born by survivors parents. X-correlation with accumulate collective dose of radiation
• Endocrine system;
• Immune system ("Chernobyl AIDS," increased incidence and seriousness of all illnesses);
• Respiratory system;
• Urogenital tract and reproductive disorders;
• Musculoskeletal system (including composition of bones; osteopenia and osteoporosis);
• Central nervous system (changes in frontal, temporal, and occipitoparietal lobes of the brain, leading to diminished intelligence and behavioral and mental disorders);
• Eyes (cataracts, vitreous destruction, refraction anomalies);
• Digestive tract;
• Blood and the circulatory system;
• Congenital malformations and anomalies (including previously rare multiple defects of limbs and head);
• Thyroid cancer (Chernobyl thyroid cancers rapid and aggressive, striking children and adults);
• Leukemia (not only in children and liquidators, but adult population).

Other malignant neoplasm.

It was accepted that growth of somatic illnesses among victims wasn’t linked directly to the radiation factor, but to the contrary it is dependant on the dose of radiation and time under risk as well.
Thyroid cancer in children and adolescents of Ukraine (0-18 years)
Thyroid operated cancer in Children born before accident (black), after accident (red) and children born after accident (yellow). I. Komissarenko, 2006

295 (10) patients

1990-2005y.
3124 (560) patients
Починаючи з 1990 року, зросла захворюваність на рак щитовидної залози до 60 випадків на рік, при 12 випадках у дочорнобильський період.
Це є більше, ніж у 21 раз за дочорнобильський період захворюваності.
DINAMICS OF THYROID CANCER ON CONTAMINATED REGIONS (red curve) AND IN UKRAINE (yellow curve)
OTHERS MALIGNANT TUMOURS MORBIDITY
Incidence rates of main forms of solid cancers in districts most heavily contaminated with radionuclides (2004, FGI)

<table>
<thead>
<tr>
<th>Tumour site (code ICD-9)</th>
<th>Sex</th>
<th>Period (age standardised rate ± standard error)</th>
<th>Rate ratio 2/1 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All solid cancers (140-203)</td>
<td>Males+females</td>
<td>160.83 ± 2.12</td>
<td>186.71 ± 3.17</td>
</tr>
<tr>
<td>Buccal cavity, pharynx (140-149)</td>
<td>Males+females</td>
<td>10.48 ± 0.54</td>
<td>12.08 ± 0.77</td>
</tr>
<tr>
<td>Digestive system (150-159)</td>
<td>Males+females</td>
<td>47.80 ± 1.12</td>
<td>51.14 ± 1.55</td>
</tr>
<tr>
<td>Respiratory system (160-165)</td>
<td>Males+females</td>
<td>25.63 ± 0.83</td>
<td>27.21 ± 1.12</td>
</tr>
<tr>
<td>Skin (172, 173)</td>
<td>Males+females</td>
<td>15.49 ± 0.63</td>
<td>14.71 ± 0.80</td>
</tr>
<tr>
<td>Breast (174)</td>
<td>Females</td>
<td>16.82 ± 0.97</td>
<td>25.31 ± 1.67</td>
</tr>
<tr>
<td>Female genital organs (180-184)</td>
<td>Females</td>
<td>20.83 ± 1.06</td>
<td>20.21 ± 1.59</td>
</tr>
<tr>
<td>Prostate (185)</td>
<td>Males</td>
<td>7.59 ± 0.70</td>
<td>10.90 ± 0.99</td>
</tr>
<tr>
<td>Bladder (188)</td>
<td>Males</td>
<td>8.68 ± 0.76</td>
<td>9.35 ± 0.95</td>
</tr>
<tr>
<td>Brain (191)</td>
<td>Males+females</td>
<td>3.40 ± 0.36</td>
<td>4.11 ± 0.63</td>
</tr>
<tr>
<td>Thyroid (193)</td>
<td>Males+females</td>
<td>1.70 ± 0.24</td>
<td>6.69 ± 0.76</td>
</tr>
</tbody>
</table>
Prostate cancer (ICD-9 185) incidence rates in the districts most heavily contaminated with radionuclides.

According to international evaluation, prostate cancer does not belong to radiosensitive form of cancer. Study prostate cancer incidence rate grew up rapidly in 1987 and since then was much higher than in pre-accidental period. (FGI, 2004)

Regression coefficient $b \pm SE(b)$:
- Contaminated areas: $0.33 \pm 0.10$
- The Ukraine: $0.41 \pm 0.03$
Breast cancer (ICD-9 174) incidence rates in the districts most heavily contaminated with radionuclides. Close attention should be drawn to breast cancer. After six or seven years of a stable level of breast cancer incidence rate (with small fluctuations) a sharp increase has been observed since 1992. This form of cancer belongs to radiosensitive form of malignancies and needs close attention in the future.

Regression coefficient $b \pm SE(b)$:
The Ukraine: $0.65 \pm 0.03$

Contaminated areas:
1980-1989: $0.06 \pm 0.38$
1990-1999: $1.06 \pm 0.19$
1980-1999: $0.78 \pm 0.18$
Other malignant tumor morbidity: all tumors in liquidators and evacuees people

Because of different latency period of radiogenic forms of cancer there have to be drawn close attention to cancer of breast, lung, esophagus, stomach, bowl, ovary, lymphomas (multiple myeloma) etc.

Special attention should be drawn to groups of population irradiated at the beginning of life (in utero, young age 0-9, 10-19).
<table>
<thead>
<tr>
<th>Class of diseases</th>
<th>Names of class diseases</th>
<th>An average index for examined provinces</th>
<th>An average index for other provinces of Ukraine</th>
<th>Percent difference between compared indexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td><strong>Neoplasm</strong></td>
<td>7.6</td>
<td>5.5</td>
<td><strong>+38.2</strong></td>
</tr>
<tr>
<td>3.0</td>
<td>Diseases of blood and hemopoietic organs</td>
<td>2.7</td>
<td>2.5</td>
<td><strong>+8.0</strong></td>
</tr>
<tr>
<td>4.0</td>
<td>Diseases of endocrine system</td>
<td>12.2</td>
<td>11.2</td>
<td><strong>+8.9</strong></td>
</tr>
<tr>
<td>5.0</td>
<td>Mental and behavioral disorders</td>
<td>37.5</td>
<td>41.7</td>
<td><strong>-10.1</strong></td>
</tr>
<tr>
<td>6.0</td>
<td>Diseases of nervous system</td>
<td>44.4</td>
<td>41.3</td>
<td><strong>+7.5</strong></td>
</tr>
<tr>
<td>10.0</td>
<td>Diseases of respiration organs</td>
<td>15.0</td>
<td>12.9</td>
<td><strong>+16.3</strong></td>
</tr>
<tr>
<td>11.0</td>
<td><strong>Diseases of digestion organs</strong></td>
<td>5.4</td>
<td>3.1</td>
<td><strong>+74.2</strong></td>
</tr>
<tr>
<td>14.0</td>
<td>Diseases of urogenital system</td>
<td>5.0</td>
<td>4.6</td>
<td><strong>+8.7</strong></td>
</tr>
<tr>
<td>15.0</td>
<td><strong>Congenital anomalies</strong></td>
<td>35.9</td>
<td>26.7</td>
<td><strong>+34.0</strong></td>
</tr>
</tbody>
</table>
The pre-Chernobyl period (1981-1985) – 49 cases.
The post-Chernobyl period:
1986-1990 - 75 cases (1.9-fold increase);
1991-1995- 116 cases (2.9-fold increase);
1996-2000- 85 cases (2.1-fold increase);
2001-2004 - 94 cases (2.3-fold increase).
For children under one year old – 6.2-fold growth. To account a decrease in birth rate and natural reduction of absolute quantity of children, the growth of average index 5.8 fold more is very significant.
Malignant tumour constitute 43% of all central nervous system neoplasm in children aged under 3 years.
The preliminary analysis of infant leukaemia incidence in Kyiv city after Chernobyl within 1986-1997 period showed also an increase in acute myeloid leukaemia and B-cell acute lymphoblast leukaemia [Gluzman et al., 1999].

At present leukaemia's rank first in the patterns of morbidity and mortality due to malignancies in children of Ukraine aged 0-14 years [Fedorenko et al. In: Bull National Cancer Register of Ukraine 2004].

The stable tendency towards increased rates of acute lymphoid leukaemia's has been noticed both in Ukraine as a whole and in particular regions being the most contaminated with radionuclides [Noschenko A. and al. 2001; 2002; Pushkar LO and Klimnyuk GI, 2005].

Moreover, recently several limited studies of the infant leukaemia's after Chernobyl have been performed also in several European countries with particular emphasis on the children believed as having been exposed in utero (judging by the dates of their birth) [Petridou, et al., 1996; Michaelis et al., 1997; Noschenko A. and al. 2001; 2002; D. Davidescu and all. 2004, Davis S. and al.2005].

Special attention should be drawn to groups which were in early age at the moment of Chernobyl accident (exposed in utero, 0-9, 10-19 years old).

(Resolution of Int. conf. 29 May-June 3, Kiev 2006).
GENETIC DAMAGE

• According to state statistics, the frequency of congenital malformation in the affected regions IS
• 5-fold INCREASE (2005). At the same time
• IN ALL THE GROUPS MONITORED DURING POSTACCIDENT PERIOD THE RATE OF CHROMOSOME ABERRATIONS IN PERIFERAL BLOOD LYMPHOCYTES SIGNIFICANTLY EXCEEDED PRE-ACCIDENT INDICES CHARACTERISTIC FOR SPONTANEOUS CHROMOSOME MUTAGENESIS.
Heritable effects in children with exposure in utero (Stepanova E.I. and all. 2006)

The cytogenetic examination show the higher of aberrant cells and interdependence with equivalent dose of red bone marrow:
Frequency of the chromosome aberrations per 100 cells;

The doses of red bone marrow 10—376 mSv
An increased frequency rate of chromosome aberrations was found in children who had been exposed to combined $^{131}$I and $^{137}$Cs radiation. The influence of thyroid pathology on induction of chromosome non-stability in human somatic cells was demonstrated.

A deferred cytogenetic effects has been found in successive cell generations in the progeny of irradiated parents proving for real transmission of chromosome non-stability.

(National Report of Ukraine, 2006)
Generalized Non-Cancer Illnesses
Accident clean-up workers (liquidators), including military and the civilian personnel drafted to carry out clean-up activities and construct the protective cover for the reactor.
• More than 850 000 (liquidators) people from all regions of the former USSR during 1986-1990 were involved in the clean-up works in the 30-kilometer exclusion zone. 600 000 out of them were the military. They were fighting the radioactive fire, building the sarcophagus over the 4-th destructed block of Chernobyl NPP, deactivating the production platform, burying radioactive materials and equipment - they were the first people who were overcoming the consequences immediately after the accident. Some of the activities on overcoming the Chernobyl accident consequences are still in process. These activities have carried out under extremely hard conditions so that military rules were followed.

• For today we don’t know accuracy how many liquidators were! What why for therefore it is hard to estimate the real those health risks

<table>
<thead>
<tr>
<th>LIQUIDATORS OF CATASTROPHE</th>
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<tbody>
<tr>
<td>Countries</td>
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<tr>
<td>UKRAINE</td>
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<tr>
<td>Belarus</td>
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<tr>
<td>Russian Federation</td>
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<td>Armenia</td>
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<td>Azerbaijan</td>
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<td>Georgia</td>
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<td>Kazakhstan</td>
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<td>Kyrgyzstan</td>
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<td>Latvia</td>
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<td>Lithuania</td>
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<td>Moldova</td>
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<td>Uzbekistan</td>
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<td>Tajikistan</td>
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<td>Turkmenistan</td>
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<td>Estonia</td>
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<tr>
<td>Israel</td>
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<tr>
<td>USA</td>
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</table>
construction workers who built the tunnels and shelter around destroyed reactor and in the later period on the roof of the 3rd unit of the Chernobyl NPP.

Doses of radiation to which liquidators and emergency clean-up workers were subjected are in the average range and low intensity limits of 50-200 mSv. But due to the absence of effective dosimetric control and because of complicated and uninvestigated radiation conditions many liquidators received doses of over 1Gy during the 1.5 months following nuclear accident. This would include many people, especially nuclear power plant personnel, firemen, military people, miners,

We can state that among those groups there are people in whom the ARS was never clinically established. As a whole, the information about the dosimetric state of liquidators is incomplete (only 50% of this information about received doses of radiation is available) and unclear (since it is unknown how accurate the available records about these doses may be). This data in its current state cannot be used to assess radiation risks and to analyze real radiation medical effects of the explosion and needs revision.
Dynamics of lethality from non-tumour morbidity in 1986-1987 Ukrainian liquidators during 1988-2003
Динамика распространенности заболеваний у ЛПА на ЧАЭС СБ и МВД Украины в послеаварийном периоде (в 0/00)

* - достоверность различия в сравнении с контрольной группой
Dose of radiation of lens liquidators

In fact, it is observed that the appearance of radiation-induced cataracts among all groups of survivors, and especially the liquidators, is increasing. Much lower threshold of irradiation doses is set for cataract development compared to earlier assessments.

Radiation dose and risk increased at low dose.
The risk of cataract development in liquidators
Dose cGy and age (< 40, 40-55, >55 old)
Dynamics of Cardiovascular and cerebrovascular diseases in liquidators

\[ y = 52.249x + 120.16 \]
\[ R^2 = 0.8869 \]

\[ y = 27.851x + 125.24 \]
\[ R^2 = 0.8916 \]
CEREBROVASCULAR DISEASES - ENCEPHALOPATHY SYNDROME

The postradiation brain organic syndrome is compressed by micro focal neurological signs, personality disorders, negative psychopathological symptoms, depression and cognitive deficit. Atherosclerotic changes, hypertensive vessel tonus, interhemispheric asymmetry of blood supply, angiosclerosis, as well as high frequency of stenosis were the causes of cerebral haemodynamics disorders. Brain atrophy, enlargement of ventricula, and lacunar brain abnormalities, supported the cerebral-organic nature of the disorders.
Psychological and neurological problem of liquidators

There is practically two-fold increase of the prevalence of any mental disorders (36%) in liquidators in comparison with Ukrainian general population (20.5%); dramatically increase of the prevalence of depression (24.5%) in liquidators in comparison with Ukrainian general population (9.1%). Anxiety (panic disorder) is also increased in liquidators (12.6% vs 7.1%). At that time, there is no clear cut distinction increasing of alcohol dependence in liquidators (8.6% vs 6.4%).
Evacuation! Pripyat town

Відселені з 1990 по 2000р.

Поліський район
1. с. Бобер
2. с. Бовище
3. с. Варовіч
4. с. Весняне
5. с. Вільшанка
6. с. Володимирівка
7. с. Клівина
8. с. Ковшілівка
9. с. Лісництво Яковецьке
10. с. Луб'янка
11. с. Стара Рудня

ПЕРЕЛІК
населених пунктів Київської області,
віднесених до зони відчуження та безумовного (обов'язкового) відселення
внаслідок Чорнобильської катастрофи

Евакуйовані
Чорнобильський район
1. с. Андріївка
2. с. Бенівка
3. с. Бички
4. с. Буда
5. с. Буяківка
6. с. Глинка
7. с. Городище
8. с. Городчан
9. с. Залісся
10. с. Замошня
11. с. Запілля
12. с. Зимовище
13. с. Іванівка
14. с. Іллінці
15. с. Іловиця
16. с. Кам'янка
17. с. Копачі
18. с. Корогод
19. с. Коцюбинське
20. с. Кошарівка
21. с. Кошівка
22. с. Красне (Машівська
с/П)
23. с. Красне (Товстоліська
с/Р)
24. с. Крива Гора
25. с. Купувате
26. с. Ладижичі
27. с. Лелів
28. с. Машеве
29. с. Нова Красниця
30. с. Новосілки
31. с. Новошепеличі
32. с. Опачічі
33. с. Оташів
34. с. Паришів
35. с. Плютовище
36. м. Пріп'ять
37. с. Рінця
38. с. Розд'їжде
39. с. Розсоха
40. с. Рудня-Вересня
41. с. Рудня-Іллінецька
42. с. Рудьки
43. с. Стара Красниця
44. с. Старі Шепеличі
45. с. Старосіля
46. с. Стежанка
47. с. Теремці
48. с. Тережів
49. с. Товстий Ліс
50. с. Усів
51. с. Хутір Золотнів
52. с. Чаплівка
53. с. Черевач
54. с. Чистогаливка
55. м. Чорнобиль
56. с-щ Чорнобиль-2
57. с. Ямпіль
58. ст. Янів

Поліський район

1. с. Буда-Варовичі
2. смт Вільча
3. с. Грезля
4. с. Денисовичі
5. с. Діброва
6. с. Жовтневе
7. с. Королівка
8. с. Котовське
9. с. Мартиновичі
10. с. Нова Марківка
11. с. Новий Мир
12. смт Полівське
13. с. Пухове
14. с. Рудня-Грязлянська
15. с-щ Становище
16. с. Стебли
17. с. Тараси
18. с. Фабриківка
19. с. Шевченкове
20. с. Ясен
Evacuees and Resettled survivors 164 700 thousand
INCIDENCE and PREVALENCE
The evacuated adult population disability indices since 1988 to 2003 increased from 4.6% to 103.4%. National Report, Ukraine 2006
Maps of Kiev oblast. 1 Distribution of new villages what were build (red points); 2. Contamination (Cs 137) of Kiev oblast.
Figure: Morbidity (red line). Prevalence (black line).

Regression coefficients
1. 8.09 + 3.3
2. 4.8 + 1.3
3. 210.1 + 8.2
4. 34.8 + 2.1
Children health

- 20% children of Ukraine reside on polluted territories.
- 60% children of Ukraine in 1986 had been received more than 50 mGr on thyroid gland.
- The increasing of index disability on oncology disease-38.2%, hereditary diseases - 34%, blood-8%, gastrointestinal -74.2%.
Dynamic of non-tumour diseases prevalence (per 10 000) among children and adolescent affected due to the Chernobyl catastrophe. (State data. 2009).

Presently in the structure of disease incidence of children of 0-14 years predominant are diseases of the respiratory, nervous, digestive and blood systems, skin and subcutaneous tissue diseases. The most unfavorable changes have been observed in adolescents with high doses of thyroid gland irradiation and in adolescent irradiated in utero.

532 families (113 families with children) Reside the zone of compulsory evacuation (1440 Bk on m 2, or 40 Ci on km 2).
Pregnancy and thyroid

Normal pregnancy - 25.8% (26cGy) and 12.5% (dose 36cGy) and 63.3% in control group. Children born by irradiated woman recently confined 1.5-2 - fold had more deflections in physical development. It was testified that after irradiation in utero children, investigated in 14-16 years age, accumulated the cell clones with specific types of cytogenetic anomalies (which did not lead to cell death, such as inversions, inserts, reciprocal translocations). It allows to suppose that in future we will meet with the reproductive problems in children, which were born after 1986 y. and obtained low doses of ionizing radiation in utero. This process can complicate the forming of gametal cells (the meiosis). (Glazko E.I., 2006).
Children irradiated in utero.

Thyroid Dose exposure – in the range 0.1 - 28.5 Gy (I-131,132,129, ); Dose of hole-body irradiation - 5.0 - 376.0 mSv due to external gamma –radiation and internal radiation (Cs-137 and Sr-90).

Especially high are the doses to the fetal thyroid. There were children from Pripyat (33.8%) who had been exposed in utero to thyroid doses >1 Sv; (13.2%) received in utero fetal doses of >100 mSv. (Nyagu A.I., Stepanova E.I., Repin V.S. and all., 2000, 2004)
Geometric means of the thyroid doses in utero related to the periods of cerebrogenesis at 26.04.1986 in exposed group in Pripyat

According to the model by ICRP-88 there is a strong influence of gestational age on the thyroid doses in utero: later intrauterine period at the time of exposure — higher the thyroid doses in utero.
In UTERO Thyroid doses were estimated 0.01 - 3.34 Gy.

- The mean doses according trimester of gestation:
  - Until 8 weeks – 0.0 Gy;
  - of 8 to 15 week – 0.31 Gy;
  - of 16 to 25 week - 0.8 Gy;
  - More than 25 weeks – 0.62 Gy.
Distribution of children by periods of cerebrogenesis at the time of explosion (April 26th, 1986)

Exposed group in Pripyat (n=154)
Comparison group from Kiev (n=143)

%<0.01
P>0.05

In exposed group there are less children who were at the earliest stages of prenatal development (0–7 weeks after conception) that could be explained with abortions and miscarriages due to the Chernobyl accident.
Prenatally exposed children have more neuropsychiatric disorders than the control children from Kiev for the following categories:

1) paroxysmal states; 2) organic mental disorders; 3) neurotic, stress-related and somatoform disorders; 4) disorders of psychological development; 5) childhood behavioural and emotional disorders.

(Nyagu A. and al.)
Wechsler Intelligence Scale for Children (WISC) Full scale IQ

- Lower full scale IQ

There are significant (P<0.001) differences on intelligence of exposed children:
There are significant (P<0.001) differences on intelligence of exposed children: the aptitude is more simple with low IQ and less with high IQ in exposed group.

<table>
<thead>
<tr>
<th>vIQ, scores</th>
<th>&lt;70</th>
<th>71–80</th>
<th>81–100</th>
<th>101–120</th>
<th>121–140</th>
<th>&gt;140</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acutely exposed group</td>
<td>&lt;.05</td>
<td></td>
<td>&lt;.05</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparison group</td>
<td>&lt;.01</td>
<td>&lt;.05</td>
<td>&lt;.05</td>
<td>&lt;.05</td>
<td>&lt;.05</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

- **Lower verbal IQ**
Correlations between verbal IQ of children of both groups and dose on thyroid in utero (ICRP-88)

\[ \text{VIQ} = 113.4 - 0.004 \times \text{Dose on thyroid in utero} \]

Correlation: \( r = -0.16 \) (P=0.009)

**Graph:**
- **X-axis:** Dose on thyroid in utero (mSv)
- **Y-axis:** Verbal IQ
- **Regression line:** \[ \text{VIQ} = 113.4 - 0.004 \times \text{Dose on thyroid in utero} \]

**Bar chart:**
- **Categories:** Thyroid foetal dose, Gy
  - 0.04-0.3
  - 0.31-0.6
  - 0.61-1.0
  - 1.0+
- **IQ scores:** Full Scale IQ, Verbal IQ, Performance IQ
- **Statistical significance:** <.001

*Children intelligence in proportion to the thyroid foetal dose*
Children born by exposed parents demonstrate poor health.

- The number of healthy children is 2.5-9.2%, (control group - 18.6-24.6%).
- This cohort is characterized by a retardation of biological age, immunity disorders, more often manifest external disemбриogenetic stigmata, minor malformations of internal organs and congenital malformations, enhanced mutations processes both in indicator cells and target cells. (National Report, 2006).
There is a continuous increase in the following changes in the state of health of children in various cohorts under observation:

- among children who were born to Chernobyl liquidators there has been an increase in the incidence of illnesses of the central nervous system, congenital birth defects and rare forms of genetic anomalies;
- among children who were exposed during the period of intra-uterine gestation, there is a high risk of developing chronic somatic pathologies, disorders of the thyroid gland pathologies of bone and cartilage, psychological disorders and the development of tumors;
- among those who were children or adolescents at the time of Chernobyl accident and subjected to combined exposure to cesium and iodine there have been registered the highest risk of tumors and other illnesses of the thyroid gland.

-experts predict a further increase in pathologies of the thyroid, which will make a robust contribution to the deterioration of the general health of affected populations, and the disruption of reproductive health of young women;

- in the first generation of irradiated persons who continue to live on radioactively contaminated territories, there is also an increasing risk of children born with congenital malformations and hereditary diseases.
Psychological consequences and children

Abnormal psychological development has been detected in 60-70% of exposed children and teenagers. This is two to three times higher than among the general population.

The mental state of children of all cohorts is significantly worse compared to that of controlled groups: self-sensation as a victim, lack of initiative, rental aims. More than 60% of teenagers see their futures away from home because of radiation pollution; Children from the high-risk groups are becoming the carriers of a crisis psychology (mentality) and as a result will spread a crisis relationship in society. Inadequate parental or family environments as well as the circumstances of their immediate surroundings – teachers, doctors will contribute to a heightened level of anxiety, fear and lowered self-esteem.

What why the concept of “psychological rehabilitation” should be shifted in the direction of the concept of “education and psychological correction”.
Chernobyl is not only pain of past, but the current problem and future challenge.
Post Chernobyl problems

- The full effects of the Chernobyl accident will most certainly never be known. However, 25 years after the catastrophe, it is clear that it is far greater than implied by official estimates. Our overall conclusion is that the unprecedented extent of the disaster and its long-term global environmental, health and socio-economic consequences should be fully acknowledged and taken into account by governments when considering their energy policies.
- The total environmental damage Ukraine in 2015 will amount to 201 billion dollars. U.S.

Problems that were caused by the disaster, have not disappeared. This is a demographic crisis, the deterioration of the health of hundreds of thousands of victims, lack of economic recovery and socio-psychological stress of the affected population, especially in areas of radioactive contamination.

As a result:
- 85.1% of Ukrainians negatively related to the construction of storage facility for spent nuclear waste in Ukraine.
- 63.1% believes that Ukraine should not build new nuclear power plants or units.
- 81.9% of respondents named a dangerous today Chernobyl. Of these, 48.8% believe that it is very dangerous, 33.1% - more dangerous. Safe for the moment consider the whole Chernobyl 12.4% of respondents.
- 49.5% believed the accident at the Chernobyl nuclear power plant environmental catastrophe.
Risk assessment of Chernobyl catastrophe

- Economical
- Ecological
- Radiological
- Health
- Sociopsychological
- Demographical
- Social
«... Исследования радиационных последствий Чернобыльской катастрофы важны для всего населения Земли. Если эти исследования будут плохо спланированы или их результаты будут искажены, это обернется несчастьем для очень многих людей. Мы не должны преувеличивать опасность, но и преуменьшать ее непозволительно. Небрежная работа или обман в таких исследованиях равносильны ведению войны с невинными людьми. Способность научной общественности оценить истинные последствия Чернобыльской аварии будет служить критерием нашей цивилизованности и человеческой состоятельности».
Дж. Гофман в кн.: Чернобыльская авария: радиационные последствия для настоящего и будущих поколений.1994г.

«Studies of radiation effects of Chernobyl are important for the entire population of Earth. If these studies are poorly designed or the results will be distorted, it will result in disaster for many people. We should not exaggerate the danger, but downplay its inexcusable. Sloppy job or deception in such studies are equivalent to waging war against innocent people. The ability of the scientific community to assess the true impact of the Chernobyl accident will serve as a criterion of our civilization and human consistency». J. Hoffman in the book.: The Chernobyl accident: radiation effects on present and future generations.1994y.
Чернобыль: фактор человека

Альфа и Омега
Начало и Конец
Купол церкви в Красные.

Величина потери может быть измерена на уровне цивилизации, которая погибла и приходит в упадок в теме Ректора. Она может быть найдена только путем сложения бесчисленного количества Маленьких вещей.

Население Припяти было эвакуировано 36 часов после аварии на 1986 году. Люди было оставлено в доме только на три дня.

Это фото Ленина было в школе в Красные. Кочерга протопнула фотографию между глазами, на пленке осталась светлым.

Церковь в Красные сейчас покинута и находится в запустении.

Советский флаг все еще висит над входом в школу в Красные. Разбросанные книги - в основном, биографии Ленина. Надпись на доске гласит: "Светит оттеняется..."

Разбросанные принадлежности, так как в деревне Машево, свидетельствуют о трагедии, с которой было связано население.

**Радиационная карта Киева**

Сотрудники взяли на велосипедах Кирова в тот мост 26 апреля 1986, чтобы смотреть как горит реактор.

Подготовка к майским праздникам была в разгаре, когда произошла трагедия.

Радиационная карта Киева

*Данные предоставлены Чернобыль ИнтерИнформом.*