Destructive Effects
Section 3   www.AtomicBombMuseum.org/3_health.shtml

HEALTH EFFECTS

Counting the Dead

Chaotic conditions made accurate accounts most difficult. Some victims were vaporized instantly, many survivors were horribly disfigured, and death from radiation was uncertain—it might not claim its victims for days, weeks, months, or even years.

The initial death count in Hiroshima, set at 42,000–93,000, was based solely on the disposal of bodies, and was thus much too low. Later surveys covered body counts, missing persons, and neighborhood surveys during the first months after the bombing, yielding a more reliable estimate of 130,000 dead as of November 1945. A similar survey by officials in Nagasaki set its death toll at 60,000–70,000. (Its plutonium bomb was more powerful, but its destructive range was limited by surrounding hills and mountains).

Additional counts indicated high levels of short-term mortality in both cities:
—Over 90% of persons within 500 meters (1,600 ft.) of ground zero in both cities died.
—At 1.5 km (almost one mile), over 2/3 were casualties, and 1/3 died.
—Of those at a distance of 2 km (1.2 mi.), half were casualties, 10% of whom died.
—Casualties dropped to 10% at distances over 4 km (2.4 mi.).

Most persons close to ground zero who received high radiation dosages died immediately or during the first day. One-third of all fatalities occurred by the 4th day; two-thirds by the 10th day; and 90% by the end of three weeks.

While casualty rates exceeded death rates, they both were highest near ground zero and declined at similar rates by increasing distance from ground zero. But the cumulative death rates (%) in both cities rose dramatically during the first two weeks, then leveled off in subsequent weeks.
Figure 11. Relation of casualty (0---0) and mortality (*---*) rates to distance from ground zero. (*Impact*, p. 86. Fig. 11)

Figure 12. Cumulative death rate of atomic bomb victims. (*Impact*, p. 86. Fig. 12)

**Injury Phases**

A. First two weeks: mainly **burns** from rays and flames, and **wounds (trauma)** from blast and falling structures.

B. 3rd week through 8th week: symptoms of damages by **radioactive rays**, e.g., loss of hair, anemia, loss of white cells, bleeding, diarrhea. Approximately 10% of cases in this group were fatal.
C. 3rd and 4th months: “some improvement” in burn, trauma, and even radiation injuries. But then came “secondary injuries” of disfiguration, severe scar formations (keloids), blood abnormalities, sterility (both sexes), and psychosomatic disorders.

D. Even now, after over half a century later, many aftereffects remain: leukemia, A-bomb cataracts, and cancers of thyroid, breast, lungs, salivary glands, birth defects, including mental retardation, and fears of birth defects in their children, plus, of course, the disfiguring keloid scars.

Stages of A-bomb illness

1. Acute stages: overall, from initial exposure to 4th month
   i) Atomic thermal burns: Numerous A-bomb casualties (deaths) occurred almost simultaneously with explosion, but both injury and mortality rates fell with increased distanced from ground zero

   —primary (flash burns)

* Marked thermal burns on soldier exposed within 1 km of ground zero. His waist was protected by a thick waist band. *(Impact, p. 96, Plate 22)*

   —secondary (scorch, contact, and flame burns)
* Exposed skin of a woman seared by intense heat was blown away by fierce wave (but white blouse deflected the intense heat). Most of those suffering severe burns over more than 20% of their bodies died on the spot or a short time later. (HIMAT)

2. Atomic bomb trauma
   — primary injury (blast injury)
   — secondary injuries sustained from flying debris, burial under rubble, and blast compression

3. A-bomb radiation illness
   — Radiation injury penetrates deeply into human body and injures cells, and thus molecules, resulting in cell death, inhibited cell division, abnormalities of intracellular molecules and membranes.

*The black star in the middle shows the tracks of alpha rays emitted by a particle of plutonium 239 in the lung tissue of an ape. These rays do not travel very far, but once in the body, they can penetrate more than 10,000 cells within their range. This set of alpha tracks (magnified 500 times) occurred over a 48-hour period. The plutonium particle that emitted them has a half-life of 24,400 years. (DT, 39)
—Actively regenerating and proliferating cells are most sensitive to radiation, e.g., young blood cells, lymphocytes, spermatogonia (of testicles), follicle cells (of ovaries) are most sensitive; next are mucosal epithelial cells of the mouth, the esophagus, and stomach, and epithelial cells of the eye lens, and cells forming the hair bulb. (Note: epithelial tissues cover surfaces or line cavities, as well as perform various secreting, transporting, or regulatory functions.)

4. Radiation blood injury—lethal dosage: severe illness occurs with 1,000 rads, causing destruction of bone marrow, marked drop in white cell counts, anemia, bleeding, destruction of stomach and intestinal fluids (mucosa). Most victims died within 30 days. (Note: “rad” indicates a unit of absorbed radiation.) Immediate disorientation and coma occur with 10,000 rads, and death follows within hours.

*Estimated air dose of gamma rays: Hiroshima: 10,300 rads; Nagasaki: 25,100 rads.
*Estimated neutron dosages: Hiroshima, 14,100 rads; Nagasaki: 3,900 rads.

Degree of shielding can reduce dosage danger.
—acute radiation illness: extensive data show relation of distance to damage.
—three main symptoms are loss of hair, spotty skin discoloration (purpura), and “acute atomic illness,” though there are many other symptoms.

5. Blood injuries: especially damage to bone marrow and lymphatic tissue. Severe cases subjected to 450–650 rads died within 14 days. Of all blood injuries, severe cases died within 40 days after exposure.

*General conditions of blood injury:
—From day of exposure: nausea, vomiting, general malaise.
—from 10th to 14th day: loss of hair, marked malaise, persistent fever, decrease of white blood cells, followed by anemia, decrease of blood platelets, gingivitis (bleeding gums), oropharyngitis, and skin purpura.
—In persons surviving over 20 days: drop of red cell count, but symptoms began to improve with gradual recovery of white cell and platelet counts.

6. Secondary radiation illness: people beyond the direct effects of primary radiation (near ground zero) suffered effects of radioactivity in fallout. Actual numbers are unknown, but besides local residents, affected persons included relief and first-aid teams. One survey lists 57,839 early entrants and 9,184 engaged in rescue activity for Hiroshima, and respective numbers of 21,315 and 3,035 for Nagasaki.

Unhealed scars

Persons who suffered thermal burns within 1.0 to 2.0 kilometers of ground zero suffered serious flame and contact burns in addition to moderate flash burns, which resulted in marked scar formation.

The majority of thermal injuries within 2.0–3.0 km of ground zero were flash burns that left simple, thin scars at first. But the flash-burn scars altered markedly by thickening to become keloids after 3 to 4 months.

1. Keloids
Keloid is an overgrowth of scar tissue on the wound surface of a thermal burn during the reparative stage. It forms an irregularly shaped protrusion that resembles the shell and legs of a crab, thus the term “keloid” (from Greek for crab), in contrast to a simple heaping up of scar tissue (hypertrophic scar). The latter is usually caused by a secondary burn, and a keloid results from a primary thermal burn. Plastic surgery was performed on many to remove keloid scars, though recurrence of these scars was not uncommon.
*Keloid scars on a woman’s back. (HPMM)

*Close-up of previous photo. (HPMM)
Table 20. Days of Development of Keloids after the Bombing

<table>
<thead>
<tr>
<th>Days after Bombing</th>
<th>Number of Persons with Keloids</th>
<th>Distribution Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1−30</td>
<td>11</td>
<td>4.6</td>
</tr>
<tr>
<td>31−60</td>
<td>81</td>
<td>33.8</td>
</tr>
<tr>
<td>61−90</td>
<td>86</td>
<td>35.9</td>
</tr>
<tr>
<td>91−120</td>
<td>27</td>
<td>11.2</td>
</tr>
<tr>
<td>121−150</td>
<td>17</td>
<td>7.1</td>
</tr>
<tr>
<td>151−180</td>
<td>3</td>
<td>1.2</td>
</tr>
<tr>
<td>181−210</td>
<td>2</td>
<td>0.8</td>
</tr>
</tbody>
</table>


*Days of development of keloids. (*Impact*, 122. Table 20)

Table 21. Changes of Clinical Findings of Keloids in a Representative Case

<table>
<thead>
<tr>
<th>Time of Observation</th>
<th>Bulged Skin</th>
<th>Color</th>
<th>Tonus of Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 1945</td>
<td>Started to swell</td>
<td>Red</td>
<td>Tensive</td>
</tr>
<tr>
<td>May 1946</td>
<td>Reached maximum elevation</td>
<td>Red</td>
<td>Marked tension</td>
</tr>
<tr>
<td>July 1946</td>
<td>Flattened partly</td>
<td>Reddish purple</td>
<td>Majority of keloids still tensive; some wrinkled</td>
</tr>
<tr>
<td>October 1946</td>
<td>Small keloids flattened out</td>
<td>Purple</td>
<td>Tension slightly diminished</td>
</tr>
<tr>
<td>January 1947</td>
<td>Big keloids shrank and wrinkled</td>
<td>Purplish blue</td>
<td>Wrinkled</td>
</tr>
</tbody>
</table>


*Clinical changes of keloids. (*Impact*, 122. Table 21)

2. A-bomb cataracts

In a cataract the ocular lens becomes opaque. This condition appeared a few years after the atomic bombings; the first was found in 1948 in Hiroshima; and the next, the following year in Nagasaki. Occurrence was related to age at time of exposure and distance from ground zero. Severe cases appeared earlier than mild cases.
In Hiroshima, 85 of 98 A-bomb cataract cases were discovered in 869 survivors exposed within 1.0 km of ground zero. Between June 1953 and October 1954, some 116 patients with A-bomb cataracts were found among 435 survivors seen at the ophthalmology clinic of Hiroshima Red Cross Hospital. Of these, 87 were exposed within 2.0 km of ground zero; 30 were exposed beyond that distance.

3. Leukemia.
Leukemia is a malignant tumor or cancer of the blood cells, with an excessive overgrowth of young white cells. Consequently, there is a decrease in red cells and platelets, followed by anemia and a tendency to bleed. Furthermore, white cells lose their normal function, which leads to a decline in the individual’s resistance to infection and death. While it is possible with medication to achieve periods of remission, there is unfortunately no radical treatment or cure.

By 1975 a total of 1,838 cases were diagnosed as leukemia in Hiroshima and Nagasaki. Of these, 512 were exposed within 10 km from ground zero. Incidence peaked in 1951-52 in both cities.

![Graph showing number of leukemia cases among Hiroshima survivors exposed within 2,000 meters of ground zero, according to year of onset.](image)

**Figure 19.** Number of leukemia cases among Hiroshima survivors exposed within 2,000 meters of ground zero, according to year of onset. (Adapted from Ohkita 1976)

*Frequency of A-bomb cataracts in Hiroshima victims exposed in infancy. (HN, 208)*

![Graph showing crude incidence of leukemia among A-bomb survivors and controls in the RERF Cohort Sample by dose and city.](image)

**Figure 20.** Crude incidence of leukemia among A-bomb survivors and controls in the RERF Cohort Sample by dose and city (October 1950–December 1971). (Ishimaru, Ōtake, and Ichimaru 1977)

*Crude incidence of leukemia among A-bomb survivors and controls, in 1950-1971 sample. (Impact, 130).*

4. Cancers
a) thyroid: first case reported in 1957. High incidence among females. Some cases first discovered by autopsy.

b) breast: cases much higher among those exposed than in non-exposed. Exposure to 100 rads or more made risk 3.3 times that of those unexposed. Peak incidence was found higher among women ages 20-30.

c) lung: First case noted in Hiroshima in 1954, with 37 cases in Nagasaki soon added. A 1972 large-scale survey revealed 3,778 lung cancers in 10,412 deaths, with correlation of high risks to high radiation dosage.

5. Chromosome changes

- Chromosomes are present in constant numbers in the nuclei of cells, and can be seen as visible entities during cell division. The count in humans is a constant 46.
- Chromosome aberrations were first noted in exposed survivors in Hiroshima and Nagasaki in 1960.
- Subsequent systematic surveys revealed a high frequency of aberrations in blood cells and lymphocytes in fetuses exposed to large radiation doses in utero (in the womb) or soon after birth.
- Although chromosome aberrations increased with higher radiation doses, frequency of aberrations was consistently high at all dose ranges. As late as 1985, chromosomal aberrations in somatic (body) cells persisted among exposed survivors.

6. Exposure in utero and microcephaly

- A Nagasaki survey of 98 pregnant women exposed at a distance of 2.0 km from ground zero and 113 pregnant women exposed at 4.0 and 5.0 km from ground zero, showed a high percentage of neonatal and infantile deaths for those exposed within a 2.0 km range, as well as signs of acute radiation illness such as loss of hair, bleeding tendency, and inner mouth lesions. Mental retardation was noted in 25% of newborn survivors.

Besides high mortality rates, retarded growth and development was also indicated. Most notable in those exposed within 1.0–5.0 km of ground zero was retarded stature, underweight, and smaller head circumference, a condition called microcephaly, one of the most pathetic aftereffects of the atomic bombings, especially when accompanied by mental retardation.

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*Microcephaly (small head circumference), retarded stature and weight among those exposed within 1.0–5.0 km of ground zero. (Impact, p. 140)

7. Genetic surveys have not yielded positive evidence of genetic hazards due to atomic bomb radiation. Even so, possible A-bomb-induced effects such as spontaneous abortions, stillbirths, congenital malformations, and more, require continued study.