

Mortality of Individual Age Cohorts of the Altai Territory Population from Malignant Neoplasms

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Keywords: malignant neoplasms, mortality, cohort analysis

Abstract: An analysis of the dynamics of cancer mortality indicators in several generations at the same age periods has been performed. The results obtained during the longitudinal analysis of cancer mortality in individual generations of the region's population are consistent with the results of a study of age-related and standardized mortality from malignant neoplasms. And these results indicate the extraordinary impacts on the population of the Altai Territory at the turn of the 40-50s, which were accompanied by a significant increase in cancer mortality in different generations depending on the age at which these generations lived in 1950 (after 10-15-20-25-40 years). The source of the impact was the activity of a nuclear test site in the Semipalatinsk region. The severity of the impacts is evidenced by the fact that their consequences manifested themselves in a very heterogeneous and unstable population, which is the population of the region.

1. Introduction

The Altai Krai is one of the territories of Russia, which is located in close proximity to the test sites of the Semipalatinsk nuclear test site (the distance from the epicenters of the explosions to the nearest settlements in a straight line is 150-170 km). And the territory of the region is under the influence of southwestern winds (from the landfill) for a significant part of the year. The test of the first nuclear device on August 29, 1949 had the greatest influence on the radiation situation in the region, and especially for its southwestern part. Its "contribution" to the total collective dose to the population of a number of territories of the region amounted to 60-95% [1, 2, 3].

2. Materials and Methods

Tracking the dynamics of indicators of cancer mortality in several generations at the same age intervals allowed us to conduct a comparative analysis and identify both the distinctive features and the general patterns of the phenomenon under study in separate cohorts. In addition, the registration of significant increases in mortality among representatives of individual cohorts at a certain age, relative to their peers from other cohorts, made it possible to assume, as well as approximately establish the time period of the life of this generation, in which it was subjected to additional oncogenic effects [4, 5].

3. Results

Data on the age-specific mortality of children of the Altai Territory from malignant neoplasms (MN) for cohorts formed by the birth years of deceased people show the following. The oncological mortality of children aged 0-4 years increases starting from the cohort of 1956-60 years of birth. It reaches a maximum (statistically significant fluctuation of the indicator) in the cohort born in 1961-65 years (16.23⁰/0000).

Children of subsequent births died less often from oncopathology.

At the age of 5-9 years, an increase in regional indicators of oncological mortality begins in the cohort of 1951-1955 years of birth, reaching a maximum in the generation of 1956-1960 years of birth ($10.55^0/0000$) with an excess of the rate among urban children in most cases. Among rural children of this age (1976-1980 years of birth), the figure is higher than among urban children, as well as at the age of 0-4 years. The generation of children born in 1976-1985 years had high levels of cancer mortality at the age of 5-9 years. In this case, there is a secondary effect. That is, they were the children of parents who were directly exposed to the radioactive fallout in the 50s.

At the age of 10-14 years, the maximum oncological mortality rate was observed in the cohort of 1956-1960 years of birth due to the implementation of the primary effect. Also, people born in 1971-1980 (descendants of directly exposed people) gave additional cancer mortality at this age. The following fact deserves additional attention. Among rural children of this age, a generation born in 1976-1980, mortality from malignant neoplasms is significantly (twice) higher than among urban.

Comparison of mortality rates from MN by generations at a young age, from 15 to 44 years, found that the first rises in cancer mortality are observed on average 15-20 years after the first exposure to radiation (the early 50s) in all age groups. The second increase in the mortality rate from malignant neoplasms is recorded in generations that are also shared by a period of 15-20 years.

At the age of 15-19 years, high marginal rates of cancer mortality were recorded in cohorts starting from 1946-1950 years of birth, then, especially high levels of cancer mortality were recorded in the generation of 1951-55 years of birth, as well as in the next two generations 1956-1960 and 1961-1965 years of birth (parents). And the secondary effect is registered, starting with those born in 1971-1975 and 1976-1980 years (their descendants).

At the age of 20-24, the cohorts of 1946-50 (village) and 1951-1955 (region) years of birth are significantly distinguished. Although the levels of cancer mortality in subsequent generations are high, they tend to decrease. And then, a surge in cancer mortality again manifests itself among those born in 1971-1975 years, and it is especially pronounced among rural residents (up to $20.5^0/0000$), which should be regarded as a secondary effect (descendants of the irradiated).

When comparing mortality from MN in the same age periods of different generations, it is found that at 25-29 years old, the highest mortality rate (out of 9 compared generations) was observed in those born in 1936-1940 years ($29.3^0/0000$, at the beginning of the 50s, their age was 10-14 years, that is, the lag was 15 years). In the considered age period, the oncological mortality rate of this generation was 2.0 times higher than that of the previous generation (born in 1931-1935 years) and 1.5 times higher than that of the next generation (born in 1936-1940 years). At the age of 25-29 years, a high mortality rate is also registered in people born in 1946-1950 years ($24.9^0/0000$).

At the age of 30-34 years, a surge in mortality from MN was noted among residents of the region born in 1931-1935 years (at the beginning of the 50s, they were 15-19 years old), its level exceeds the same indicators at this age for others generations by 1.5-3.3 times. The oncological mortality rates of those born at the turn of the 40s and 50s years (in 1946-1950 and 1951-55, especially in rural areas up to $40.76^0/0000$) occupy the second and third-ranking places (out of 6 compared generations). They exceed the level of the previous and subsequent generations by 1.5-2 times.

At 35-39 years old, among six generations, the level of cancer mortality of a generation born in 1926-1930 years is significantly distinguished ($80.94^0/0000$). At the beginning of the 50s, they were 20-24 years old, that is, a surge was recorded after 15 years.

At the age of 40-44, the highest levels of cancer mortality continue to be recorded among the generation born in 1926-1930 years ($106.79^0/0000$). That is, the effect is obviously prolonged, and, in this case, the lag is 20 years. Also, people born in 1936-1940 years, then, upon reaching the age of 40-44 years old, suffered high losses from oncopathology ($95.01^0/0000$). At the time of exposure, they were 10-14 years old, that is, the lag was 30 years old. In addition, people born in 1946-1950 years and at this age also continue to have high levels of cancer mortality ($99.99^0/0000$). High mortality rates from malignant neoplasms at this age are also observed among those born in 1951-1955 years ($97.56^0/0000$).

A cohort analysis of cancer mortality among people aged 45-49 reveals a pronounced surge among those born in 1926-1930 years (302.2⁰/0000), which is 1.6-1.8 times higher than the levels of the other five compared generations. And again, at this age, the generation of 1946-1950 years of birth responded with high levels of cancer mortality. Constantly (throughout the 45-year interval), a relatively high mortality rate from MN among the generation born in 1946-1950 years, attracts attention.

At the age of 50-54 years, the highest levels of cancer mortality were noted among the generation born in 1921-1925 years (in the 50th year, they were 25-29 years old, that is, there was a surge after 20 years), and the generation born in 1911-1915 years (lag was 15 years). And the prolongation of the effect was observed in the generation of 1936-1940 years of birth.

At the age of 55-59 years, a significant ($P < 0.01$) increase in cancer mortality rates is recorded in cohorts born in 1926-1930 years (494.1⁰/0000, a lag of 25 years), generation born in 1931-35 years (488.6⁰/0000, a lag of 40 years) and especially in the generation of 1936-1940 years of birth (up 546.03⁰/0000).

In the age group of 60-64 years, persons of the generation of 1911-1915 years of birth (644.3⁰/0000, a lag of 25 years), 1926-1930 years of birth (694.4⁰/0000, a lag of 40 years) and in 1931-1935 years of birth (687.8⁰/0000, a lag of 45 years) responded with an increased level of cancer mortality.

At the age of 65-69, fluctuation of cancer mortality was noted in the cohort of those born in 1906-1910 years (772.99⁰/0000, a lag of 15 years), in the generation of 1921-1925 years of birth (809.27⁰/0000, a lag of 40 years) and among those born in 1926-1930 years (938.14⁰/0000).

At the age of 70 years and older, an increase in cancer mortality rates was recorded among generations of 1891-1895 years of birth (at the beginning of the 50s, they were 55 years old or more, and they gave a "surge" in mortality after 15 years). Among generations born in 1901-05 years (at the beginning of the 50s, they were 45 years old or more, a lag of 25 years); among those born in 1911-1915 years (810.8⁰/0000, a lag of 35 years); born in 1916-1920 years (897.6⁰⁰/0000, a lag of 40 years) and among those born in 1921-1925 years (907.36⁰/0000, a lag of 45 years).

At the same time, the analysis of mortality rates from all malignant neoplasms gives only an idea of the total contribution of oncological diseases to the general structure of irretrievable health losses and the general level of oncological tension in the environment. Individual nosologies forming this class of diseases have significant differences in pathogenesis, etiology, and epidemiology. Different age and professional groups of the population are not equally affected by their occurrence and development; the possibilities for their diagnosis and treatment vary significantly.

When comparing the mortality of the population from malignant neoplasms of the digestive organs, at the same age periods for different generations, it authors find that at 25-29 years, the highest mortality rate (out of 10 compared generations – 7.0⁰/0000) was observed among those born in 1936-1940 years (at the beginning of the 50s, their age was 10-14 years, a lag of 15 years), as well as in those born in 1946-1950 years (6.8⁰/0000). At the age of 30-34 years, the highest mortality was observed among those born in 1931-1935 (at the beginning of the 50s, they were 15-19 years old, a lag of 15 years). In the age group of 35-39 years, the generation of 1941-1945 years of birth is distinguished by high mortality rates. At the age of 40-44 and 45-49 years, the generation of 1926-30 years of birth (at the beginning of the 50s, its representatives were 20-24 years old, a lag of 20-25 years) and born in 1916-20 years (at the beginning of the 50s, they were 30-34 years old) are markedly distinguished by high mortality rates. At the age of 65-69 years, the generation born in 1906-10 significantly exceeds the mortality rates of other generations (473,6⁰/0000, at the beginning of the 50s, they were 40-45 years old, lag is 25 years).

Representatives of different generations show an increase in mortality rates from gastric cancer at different age periods, and these time rises are 10-15-25 years from the beginning of the 50s. At the age of 30-34 years, the highest rate (14,2⁰/0000) was observed among those born in 1931-35 years (a lag of 15 years), in the age groups of 50-54 and 55-59 years old, its highest value was noted among those born in 1911-1915 years. (respectively, 143.0⁰/0000, a lag of 15 years; and 135.9⁰/0000, a lag of 20 years), at the age of 65-69 years, its greatest value is noted in the generation of 1906-1910 years of birth (300,5⁰/0000, a lag of 25 years). Throughout the 40-year analyzed interval, there were always higher levels of mortality from stomach cancer at a young age, compared with the next two generations born in 1931-1935 and 1936-1940 years.

A comparison of mortality rates from malignant neoplasms of the respiratory system among individual generations of urban men (the most indicator group) showed that at the age of 25-29 years, a “surge” in the indicator ($5.5^0/0000$) was recorded in the generation born in 1941-1945 years (at the beginning of the 50s, they were 5-9 years old). Consequently, the lag was 20 years. In the age group of 30-34 years, the peak indicator ($12.2^0/0000$) was observed in those born in 1931-1935 years (a lag of 15 years). Upon reaching the age of 35-39 years, generations of 1931-1935 ($14.9^0/0000$, a lag of 20 years) and 1946-1950 years of birth ($14.3^0/0000$, a lag of 30 years) have responded with high mortality rates from malignant neoplasms of the respiratory system. At the age of 40-44 years, no statistically significant fluctuation of indicators was recorded. At the age of 45-49, mortality from malignant neoplasms of the respiratory organs in those born in 1926-30 years ($167.8^0/0000$) was higher than that of their peers from the previous (2.2 times) and subsequent (1.7 times) generations. This generation stayed at the considered age in 20-25 years from the beginning of the 50s. At the age of 50-54, people born in 1911-1915 are distinguished by high mortality rates from malignant neoplasms of the respiratory system relative to the next generation ($187.0^0/0000$); in the 50s, they were 35-39 years old, that is, the lag was 15 years. It is also noted that at this age (50-54 years), there is a constant growth trend in mortality rates for men in 4 cohorts (birth years from 1921 to 1940). In the age group of 55-59 years, high levels of the indicator among the generation of 1926-1930 years of birth are recorded ($371.1^0/0000$), that is, relative to the beginning of the 50s, the burst of the indicator is delayed by 35 years. The same generation of men has high mortality rates from lung cancer and at the age of 60-64 years ($586.1^0/0000$). Although, people born in 1931-1935 years gave the maximum yield of cancer mortality at this age ($604.3^0/0000$). At the age of 65-69 years, fluctuations of the indicator were noted among generations of 1906-1910 ($555.3^0/0000$, lag is 15 years) and 1921-1925 years of birth ($608.9^0/0000$, a lag of 40 years), but people born in 1926-30 years gave the highest levels at this age ($683.5^0/0000$). Among men aged 70 years and older, the generation born in 1911-15 years had the highest mortality rates ($656.8^0/0000$) of the seven cohorts considered (lag is 35 years).

A clear picture also opens up in cohort analysis of mortality of women from lung cancer (such a risk factor for the development of malignant neoplasms of the respiratory system as tobacco smoking is less present). Already in the age group of 20-24, women born in 1966-1970 years revealed a tendency to increase mortality from lung cancer ($3.9^0/0000$). At the age of 25-29 years, a fluctuation of the indicator in a cohort of women born in 1946-50 years is also noted ($2.4^0/0000$). In the next age group (30-34 years), higher mortality rates among women born in 1946-1950 and 1951-1955 years ($3.3^0/0000$ and $3.7^0/0000$) stand out. At the age of 35-39 years, the cohort of 1951-55 years of birth and the cohort of 1931-1935 years of birth continues to be distinguished by high rates ($5.7^0/0000$, from the beginning of the 50s, the set aside period is 20 years). In the age group of 40-44 years, high mortality rates from lung cancer are observed in women born in 1946-1950 ($8.2^0/0000$) and in 1926-1930 years ($8.7^0/0000$, a lag of 20 years). From the age of 45-49, the generation of women born in 1921-1925 years is constantly characterized by high mortality rates from lung cancer, that is, 20 years from the beginning of the 50s. This generation has high levels of indicators, especially at the age of 50-54, 60-64, 65-69 years, that is, the effect of implementation was prolonged in time. At the age of 70 years and older, the cohort of women born in 1916-1920 years had the highest levels of this indicator ($97.6^0/0000$, lag is 40 years).

In the period of 25-44 years, generations born in 1946-1950 years (up to $27.7^0/0000$ at the age of 40-44 years), as well as women born in 1951-1955 years (up to $24.5^0/0000$ at the age of 40-44 years) are distinguished by high mortality rates of women from breast malignancies. At the age of 45-49, the highest mortality rates from breast cancer ($39.9^0/0000$) were recorded in the cohort born in 1926-30 years, that is, 25 years after the beginning of the 50s, higher than in the previous one (1921-1925 years, in 2.4 times) and the subsequent (1931-1935 years, in 1.8 times) cohorts. In the age range (50-54 years), the cohort born in 1921-1925 years responded with a maximum burst ($45.5^0/0000$), that is, also 25 years after the beginning of the 50s. High levels of indicators are also recorded among women born in 1941-1945 years ($47.4^0/0000$).

In the age group 25-29 years, relatively high mortality rates of women from genital malignancies were noted in the generation born in 1921-1925 years ($6.5^0/0000$). And at the same age, indicators increased in those born in 1936-1940, 1941-1945, 1946-1950, and 1951-1955 years. At the age of 30-34 years, a surge in the mortality rates of women from genital cancer was recorded in the generation born in 1931-1935 ($10.1^0/0000$), that is, 15 years after the beginning of the 50s, as well as in the cohort 1961-1965 years of birth ($10.3^0/0000$). Fluctuation with relatively high rates at this age is characteristic for cohorts born in 1946-1950

and 1956-1960 years. At the age of 35-39 years, high levels of cancer mortality from this cause continue to persist in women born in 1931-1935 years ($13.6^0/0000$, a lag of 20 years) and sharply increase (up to $10.4^0/0000$) among the generation born in 1936-1940 years (relative to the beginning of the 50s, a lag is 25 years). At this age, compared to the previous one (30-34 years), the mortality rate of women in the cohort of 1951-1955 birth years increased by 6.4 times! (up to $9.6^0/0000$). Also, high mortality rates at this age continue to persist among the generation of women born in 1956-1960 years ($10.3^0/0000$).

In the age group of 40-44 years, the fluctuation of the indicator was recorded in the generation of 1921-1925 years of birth ($45.7^0/0000$), which is 2.4-4.9 times higher than in the next five generations. By the beginning of the 50s, these women were 25-29 years old; that is, a surge in cancer mortality was realized in 15 years. The same generation continues to have high levels of indicators in the next age group of 45-49 years ($36.7^0/0000$), although, here, the maximum concentrations were observed in the cohort born in 1926-1930 ($66.5^0/0000$, lag is 25 years). The cohort of women born in 1946-1950 also responded with increased mortality rates at this age ($33.3^0/0000$) (in 2.0 times higher than the previous generation at this age). And in the subsequent age group (50-54 years), high levels of cancer mortality among those born in 1921-1925 years continue to persist ($104.1^0/0000$, lag is 25 years). Relative to the previous age, the increase was 2.8 times, relative to the previous generation, the increase was 1.6 times, and relative to the next was 3.0 times. In the 55-59 age group, the mortality rates from genital cancer among women in the six cohorts examined were mostly flat, although here, the generation of 1926-1930 years of birth is somewhat distinguished ($81.7^0/0000$). At the age of 60-64, the maximum level of this indicator ($125.3^0/0000$) was observed in women of the generation born in 1911-1915; at the beginning of the 50s, they turned 35-39 years old, that is, the maximum effect manifested itself after 25 years. And this same generation continued to die most intensively at the age of 65-69 years ($142.7^0/0000$). Also, after 25 years, in the age group of 70 years and older, the maximum mortality rates from malignant neoplasms of the genital organs were also found in women of the cohort born in 1901-1905 years ($144.9^0/0000$).

Mortality from malignant neoplasms of the blood, as a part of mortality from all causes of this class in a whole (both sexes) population of the region (its urban and rural areas), belongs to a fairly stable place, and its shares in the structure of the general indicator for the class in the indicated territories amounted to the following amount: 4.3; 5.7 and 3.5% were in 1959-1960, and 4.5; 4.8 and 4.2% in 1999. The dynamics of intensive mortality rates were generally negative, ranging from $4.8^0/0000$ in 1959-1960 to $9.5^0/0000$ in 1999. And their standardization shows their high levels precisely in the 60s among residents of urban and rural areas and the subsequent relatively smooth increase in levels in the 70-90s. In all territories of the Territory, mortality rates for men from this cause exceeded those in women (by 1.2-1.7 times). The mortality rate of urban residents was higher than that of the villagers by 1.1-1.9 times.

4. Discussion

The data obtained during the longitudinal analysis of cancer mortality in individual generations of the region's population are consistent with the results of a study of age-related and standardized mortality from malignant neoplasms. And these data indicate extraordinary effects on the population of the Altai Territory that took place at the turn of the 40-50s. They were accompanied by a significant increase in cancer mortality in different generations depending on the age at which these generations lived in 1950, and after 10- 15-20-25-40 years.

5. Conclusion

The source of the impact was the activity of a nuclear test site in the Semipalatinsk region. The severity of the impacts is evidenced by the fact that their consequences manifested themselves in a very heterogeneous and unstable population, which is the population of the region. According to the concept currently adopted, these consequences will remain in at least two subsequent generations. This makes it necessary to create a system for diagnosing, monitoring, predicting public health, and rehabilitation of the population affected by the fallout of radioactive substances during nuclear tests.

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