# Delaying Retirement and Mortality: Evidence from Pension Reforms

Olga Malkova, University of California, Irvine

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Abstract: This study evaluates the effect of work in older ages on mortality in a novel historical context. For this purpose, it exploits a 1964 reform in Soviet Russia that allowed pensioners to keep a greater share of their pension if they continued working. In response, workers substantially delayed retirement. To estimate the effect of delaying retirement, I exploit a difference-in-differences strategy by comparing cohorts who reached pensionable age (60 for men and 55 for women) before the reform, representing my comparison group, to cohorts who reached pensionable age after the reform, representing my treatment group. I compare the evolution of mortality rates among these treatment and comparison groups six years before and twelve years after they reached pensionable age. To answer this question, I construct a novel data-set by collecting and digitizing archival data on mortality from the Soviet archives. I find that delaying retirement led to a sustained increase in mortality rates among men but led to no change in mortality rates among women. By age 62, the mortality rate among men went up by 9.7 percent, which was sustained through age 71, where the mortality rate went up by 13.9 percent.

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Pension reform is a subject of important policy discussions in many countries. Developed countries want to provide incentives to delay retirement due to concerns about the fiscal sustainability of pension systems. Developing countries are increasingly concerned about the slow progress in establishment of social security programs. In evaluating the costs and benefits of providing incentives to retire later, or providing a pension system that may discourage work at older ages, it is important to evaluate the effect of such policies on health outcomes.

Despite the policy importance of the effect of working longer on health, the literature has reached no consensus. It is difficult to estimate the causal effect of working longer on health because the decision on when to retire depends on health status: healthier workers are more likely to retire later. The literature exploiting quasi-experimental variation in retirement timing to estimate the causal relationship between work and mortality has mixed findings: Hagen (2018), Hernaes et al. (2013), and Nielsen (2019) found that working longer did not change mortality; Hallberg et al. (2015), Bloemen et al. (2017), Saporta-Eksten, Schurtz, and Weisburd (2021) found that working longer increased mortality, while Kuhn et al. (2020), and Fitzpatrick and Moore (2018) found that work decreased mortality.[1] Most of the literature linking work and health has concentrated on the effect of reforms that make early retirement less costly. The effect of work on mortality after a reform that induces a delay in retirement may be different from the same effect estimated using a reform that induces early retirement. Typically, early retirement reforms target select groups of workers in industries or occupations that need restructuring and they apply to younger workers. However, in re-designing pensions many countries are most interested in incentivizing individuals to work past the normal retirement age.

[1] Similarly, the literature finds mixed effects of retirement on other health measures. Some studies find that retirement improves health (Coe 2011, Charles 2004, Eibich 2015), while other find that retirement hurts health (Behncke 2008, Dave 2008, Heller-Sahlgren 2017, Zhang et al. 2018, Godard 2016).

This study causally evaluates the effect of delaying retirement on mortality by exploiting a natural experiment in Soviet Russia that provided financial incentives for pensioners to work longer. Men became eligible for pensions when they turned 60, while women became eligible when they turned 55. A 1964 reform allowed pensioners to keep a greater share of their pension if they continued working. In response, workers substantially delayed retirement (Malkova 2020). I exploit a difference-in-differences strategy by comparing cohorts who reached pensionable age (60 for men and 55 for women) before the reform, representing my comparison group, to cohorts who reached pensionable age in the year of or after the reform, representing my treatment group. I compare the evolution of mortality rates among these treatment and comparison groups six years before and twelve years after they reached pensionable age. I will be able to analyze the effect of working longer on men and women, which is interesting, because they were employed in different occupations, where women were in physically less demanding occupations.

A contribution of this project is the compilation of the first Soviet region-level mortality database by age and gender. I have collected mortality data from the Russian Government Archive of Economics (RGAE) in Moscow. These data were not publicly available or published in the Soviet era, and only became open to the public after the Soviet Union collapse. Thus, these data represent the most reliable source of demographic information available. As a result, it is important to collect them, digitize them and make them available to the research community.

I find that a delay in retirement led to a sustained increase in mortality rates among men, but no change in mortality rates among women. By age 64, men experienced a 0.33 percentage point increase in mortality rates representing a 9.7 percent increase. This increase is sustained through age 71; by age 71 the mortality rates went up by 0.81 percentage points representing a

13.9 percent increase. I do not find evidence of a change in mortality rates among women. This may be because women were employed in less demanding occupations.

This study makes several contributions. First, it evaluates the effect of delaying retirement on mortality in a novel historical context – Soviet Russia. The historical vantage point allows this study to estimate the long-run effect of work past pensionable age on mortality across a wide span of ages. More recent reforms cannot examine long-run effects on health due to a lack of data into the future. Moreover, this study links work and mortality in a historical context that remains understudied. Second, while previous literature focuses on reforms that make early retirement less costly or increases in the normal retirement age, this study evaluates the effect of a delay in retirement, where this delay is more voluntary than in contexts when the normal retirement age rises. Third, the context of this study is relevant for developing economies today, because older workers in Soviet Russia in 1964 were lower educated and worked in more manual occupations. Most studies concentrate on developed countries, and we have limited evidence on the effect of work and health at older ages in developing countries. In addition, this context is relevant for blue-collar workers in developed countries, as well. Given increased interest in providing more comprehensive pension systems in developing countries, their potential effects on health through the employment channel are important. Fourth, the nature of this study's natural experiment allows it to recover the effect for the whole population, because most workers were eligible for the reform. Previous studies mostly exploited reforms that applied to a small group of workers in a specific industry.

## I. Background on the Soviet Pension System and Pension Reform

Starting from 1956, the Soviet Union introduced a unified pension system, where old-age pensions were one of its components. Women became eligible for these pensions at age 55, if they had a 20-year service record, while men became eligible for these pensions at age 60, if they had a 25-year service record. The pension replacement rate depended on the value of previous earnings on a sliding scale. The replacement rate begins at 100 percent for those earning 35 rubles or less, and then gradually reduces to 50 percent for those earning 100 rubles or more. Employed pensioners were not able to receive their full pension. Pensioners were only allowed to keep 15 rubles of their pension if their current earnings did not exceed 100 rubles, and no pension if current earnings exceeded 100 rubles. This resulted in substantial benefit reduction rates – benefits lost as a share of earning while employed. The benefit reduction rate was 47.8 percent on average.

In the 1960s, the Soviet government was concerned because the labor force was smaller than it desired. The government viewed pensioners as an untapped labor resource, and decided to provide financial incentives for them to work. Effective April 1, 1964, the government allowed employed pensioners to receive a higher share of their pension. In eastern regions, employed pensioners could keep 75 percent of their pension, while in western regions, employed pensioners were allowed to keep 50 percent of their pension. This resulted in a drop of the average benefit reduction rate to 24.1 percent. Most pensioners were eligible for the reform. Individuals found out quickly about the reform, as major newspapers described the details of the reform.

The 1964 reform had substantial effects on employment among pensioners. Malkova (2020) evaluates the effect of this reform on employment rates and finds an immediate increase in employment rates: a 25.8 percent increase 1 year after the reform. The increase persists, where

employment rates increased by 47 percent among all old-age pensioners 5 years after the reform. The paper provides estimates of substantial extensive margin elasticities that range from 0.6 to 1.4. The archival data this paper collected does not include data by gender and age, as the Soviet statistics on old-age employment only include data for all individuals eligible for old-age pensions. This result of an increase in employment provides evidence that the reform led to a delay in retirement. The data available to Malkova (2020) do no allow to estimate the magnitude of the length of the delay, or the delay by gender.

## II. Construction of Soviet Mortality Statistics

This paper has created the first regional data-base of Soviet mortality. I collected and digitized archival data from the Russian Government Archive of Economics (RGAE) in Moscow on Soviet Russia. These documents were not released to the public before the Soviet Union collapse and were only used internally during the Soviet period. They became available to the public after the Soviet Union collapse and contain the most reliable data on the Soviet economy. I collected mortality counts by age, which are hand-written and tabulated on standardized reporting forms. Demographic data on the Soviet Union are believed to be quite reliable, where the registration of vital events is nearly complete (Anderson and Silver 1997, Brainerd and Cutler, Shkolnikov et al. 2001).

The Vital Statistics on the number of deaths cover the entire population of Russia. The system of registration of deaths was highly centralized. (Shkolnikov 2017). District statistical bureaus register vital events and send copies of individual records to the regional statistical offices. Regional statistical offices assemble individual deaths records and transform them into standard summary tables going to the Central Statistical Office in Moscow. The coverage of the whole population by this system became complete by about the mid-1930s.

I have collected mortality data from 1956 to 1976. These data are tabulated on standardized reporting forms and were completed by statistical agencies in each oblast. Oblasts are like states and there are 73 of them. These data include the total number of deaths in each year in 1-year age groups. These data are available by gender, by rural/urban status, by oblast and by year. As a result, I am able to obtain the number of deaths in each oblast, separately by urban and rural status, within each 1-year age groups (1 to 100), separately for men and women, and by year from 1956 to 1976. I will use these data to calculate the numerator of the mortality rate. Data for a particular year are for the total number of deaths in that year. So, I refer to data on the total number of deaths in 1965, as 1965 data, and so on. The titles of documents for each *Year* (where *Year* is from 1956 to 1976) are "Statistical Tables of Statistical Agencies about Deaths by Age and Gender by Oblasts in RSFSR for *Year*", and represent data from the annual statistical table 'forma 4' includes deaths by sex and single-year age groups at the oblast-level. See appendix figure A2 for an example of an archival reporting form.

Finally, I am in the process of collecting national data by cause of death. These data include the number of deaths in 5-year age groups by causes of death from 1965 to 1976, and by 10-year age groups by causes of death from 1962 to 1964.[2] These data will allow me to shed light on the mechanism behind the relationship between delayed retirement and mortality. In 1925, cause-of-death registration began on a regular basis through Russia, but until 1958 registration was incomplete because only medical practitioners had the right to fill in death certificates.[3] When a person dies, the family is required to obtain a medical certificate of death from the institution concerned (hospital, clinic, or the medico-legal bureau) and take it to the district registry (ZAGS),

[2] Note that data on causes of death by 5-year age groups only became available from 1965.
[3] Because rural areas had a dearth of medical practitioners, they didn't have as much coverage as cities. In 1958, the Ministry of Health and the Central Statistical Office decided to authorize feldsher to fill in the death certificate.

where they exchange it for a death certificate that is, in fact, a burial certificate. The ZAGS then addresses the medical certificate of death to the regional statistical office (at the oblast or a similar level). Three levels of causes of death can be registered on the death certificate: underlying (principal or primary), immediate, and associated (contributory or secondary). The statistical tables are based on the underlying cause. They are first established at the level of each regional statistical office, which produces an annual table by cause of death, sex and age group. The figures in these tables are then aggregated at the republic level by the State Statistical Committee. These tables are the main source of mortality data. This system has been in effect with few changes since the late 1950s, under the control of the Ministry of Health. The cause of death classifications have changed a few times. The first from 1955 to 1964 was different from ICD, but the ones afterwards are more closely related to ICD.

The data on the number of deaths have some caveats. There is an issue of age heaping at ages ending in 5 and 10, especially in the period before 1970.[4] Most of the concerns are for ages 70, 80, and 90 before 1970. However, no systematic individual-level validation of the quality of deaths records at old ages has been done, so I do not know the source of this problem. Most of my analysis is for individuals under age 70, where the problems aren't as large, but still age-heaping is present there. I have chosen not to smooth the deaths data, because it takes away too much variation.

I have also collected Census data on the number of individuals in 1-year age groups from the 1959 Soviet census. The census data also has age-heaping concerns. For this reason, I have smoothed the data at the oblast level. Because I only have population counts in 1959, I have

[4] Quote from Brainerd and Cutler. Anderson and Silver (1997): "extensive age heaping has been documented for Russia in the 1959 census as well as death registration for 1958 (Urlanis 1976)".

adjusted the size of each cohort between 1956 and 1976 using the death counts for each cohort in each year. I implicitly assume that individuals do not move across oblasts. This is not an unlikely assumption because of limited migration in the Soviet Union.[5]

I use the number of deaths data and census data to construct mortality rates in each oblast and for each cohort. The deaths data include the number of deaths for each age, so I construct the year of birth (cohort) equal to year minus age.[6] The census data include the number of individuals in each age, so I construct the year of birth (cohort) equal to year minus age minus 1, because the Census was done in January of 1959.[7] The mortality rate for individuals born in year *c* in 1959 is:

$$MR_{1959}^{c} = \frac{Deaths_{1959}^{c}}{Total_{1959}^{c}}$$

The mortality rate for individuals born in year *c* in year, *y*, after 1959 (so $y > 1959$) is:

$$MR_{y}^{c} = \frac{Deaths_{y}^{c}}{Total_{1959}^{c} - \sum_{t=1959}^{y} Deaths_{t}^{c}}$$

The mortality rate for individuals born in year *c* in year *y* before 1959 (so $y < 1959$) is:

$$MR_{y}^{c} = \frac{Deaths_{y}^{c}}{Total_{59}^{c} + \sum_{t=y}^{58} Deaths_{t}^{c}}$$

[5] Cross-regional migration rates were low because of restrictions to mobility due to the severe housing shortage and the use of residence permits (Brainerd 2017). Migration was difficult, because to gain employment a residence permit in the area was necessary, but to obtain a residence permit employment in the area was necessary.
[6] If there are 54 deaths among individuals aged 61 years old in 1965, then I assigned 54 deaths in 1965 to the cohort born in 1904 ($Deaths_{65}^{1904} = 54$).
[7] If there are 1000 individuals aged 55 years old in the 1959 census, then I assign 1000 individuals in 1959 to the cohort born in 1903 ($Total_{59}^{1903} = 1000$).

## III. Expected Effects

Financial incentives to work longer may affect health through two channels. First, financial incentives may lead individuals to work longer. This is the case of the reform studied here (Malkova 2020), because pensioners worked more after the reform. Theoretically, retirement has an ambiguous effect on health. In a classical model, Grossman (1972) show that retirement will improve health if health is viewed as a consumption good. When individuals retire, good health becomes more valuable, because there is more time to enjoy it. However, if good health is viewed as an investment good, then retirement would hurt health. If investments in health are only made to increase productivity, then when individuals do not need to work any longer, they do not need to invest as much in their health. This ambiguity of direction is shown in the previous literature that shows ambiguous effects of work on health.

Working longer may have differing effects on health depending on changes in behavior and the individual's job. If work takes away time from investing in healthy behaviors such as exercise, then working longer may increase mortality. If working longer makes individuals more active, that may reduce mortality.[8] If working longer gives individuals less time to consume harmful substances such as alcohol and tobacco, then work will decrease mortality.[9] If working longer reduces social isolation, then work may reduce mortality. If working longer makes individuals stay at strenuous jobs that are harmful to their health, then work may increase mortality.

Second, financial incentives may lead to increases in income due to an increase in work. While higher income is associated with an increase in longevity (Chetty et al. 2016), causal

[8] See Evenson et al. (2002) and Barnett et al. (2014) for evidence that retirees become more sedentary.
[9] See Ayvagari (2016) and Black et al. (2015) for evidence that smoking increases when individuals stop working.

estimates of the effect of income on mortality are mixed (Jensen and Richter 2003, Snyder and Evans 2006).[10] In this context, working longer has led to increases in income, while the individual continued working, because while pensioners continued working they were able to receive both their wages which were higher than pensions (the average replacement rate of pensions was 64 percent) and the majority of their pension. So, the income shock was more short-term, and only for the duration of working longer, whereas income equaled the pension alone once the pensioner stopped working.

Do we expect short- or long-run effects on health? Health is a stock variable that is affected by sudden shocks and long-term investments and depreciation (Grossman 1972). Health may change in the short-run due to shocks, while in the long-run from investments, depreciation and shocks accruing over time. Because mortality is such an extreme measure of health, it may take some time to adjust.

## IV. Empirical Strategy

The goal of this paper is to estimate the causal effect of a delay in retirement on mortality. For this purpose, I compare cohorts that turned pensionable age in the year of or after the reform (treatment) to cohorts that turned pensionable age before the reform (control) in an event-study framework (Jacobson, LaLonde and Sullivan 1993). Specifically, I compare the difference in mortality rates of the treatment and control groups after they turn pensionable age to the difference before they turn pensionable age in the following generalized difference-in-differences specification,

[10] Jensen and Richter (2003) find increases in mortality following sharp declines in pensions in Russia, while Snyder and Evans (2006) find that declines in social security led to decreases in mortality due to an increase in employment in the United States.

$$MR_{o,c,t} = \alpha + \gamma_o + \sum_j \delta_j Event_{j=t} + \theta Treat_c + \sum_{j \neq -1} \beta_j Event_{j=t} * Treat_c + \epsilon_{o,c,t}$$

where $MR_{o,c,t}$ is the mortality rate in oblast *o*, cohort *c*, and event time *t*. This specification converts calendar time into event time, where $t = 0$ is the year when an individual reaches pensionable age (age 60 for men, and age 55 for women).[11] $Event_{j=t}$ is an indicator for event time *t*, where event times for a balanced set of cohorts range from -7 to 12. I only present results for a balanced set of event times, but all event times are included in the regression.[12] Note that $Event_{j=-1}$ is omitted, representing the year before pensionable age (59 for men, and 54 for women). Moreover, $\delta_o$ are oblast fixed effects, while $Treat_c$ equals to 1 for a treated cohort (for men, if turn 60 in 1964; for women, if turn 55 in 1964), and 0 for a control cohort (for men, if turn 60 in 1963; for women, if turn 55 in 1963). Because working longer may have differential effects on men and women, I perform separate regressions for men and women.

The coefficient of interest $\beta_j$ measures the effect of delaying retirement on the mortality rate *j* years after turning 60 for men, and 55 for women. Estimates of $\beta_j$ where j<-1 test for parallel trends in the treatment and control groups before reaching pensionable age.

The coefficient of interest may be biased downward if the control cohort also increased their employment. This would happen if individuals who chose to withdraw from the labor force at pensionable age before 1964 decided to start working again because of the financial incentives in 1964, or if individuals who reached pensionable age before 1964 and continued working decided to retire even later because of the financial incentives in 1964. Evidence from Malkova

[11] So, for a cohort who turns age 60 in 1964 (treatment group), *t=0* in 1964, while for a cohort who turns age 60 in 1963 (control group), *t=0* in 1963.

[12] I group values of event times that are not based on a balanced set of cohorts: values of j<-7 to be equal to -8 and values of j>12 to be equal to 13.

(2020) shows that individuals mostly stay retired, and that individuals tend to retire at pensionable ages in large numbers.

Are the estimates using this empirical specification internally valid? A potential threat would be if the treatment and control cohorts are differentially affected by coincidental macroeconomic shocks. Malkova (2020) provides evidence on the evolution of the Gross National Product, labor, capital, land and total factor productivity to argue that macroeconomic shocks are unlikely to affect estimates of the effect of the 1964 reform.

## V. Results

### *A. Descriptive Evidence of Effect of Delaying Retirement on Mortality Rates*

The evolution of male mortality rates before and after age 60 provides descriptive evidence of a negative effect of working longer on mortality for men. The mortality patterns before and after pensionable age have changed after 1964, providing suggestive evidence of the effect of working longer on mortality. Figure 1 compares the evolution of mortality rates of the cohort who turned 60 in 1964 (treatment) to the cohort who turned 60 in 1963 (comparison). From age 54 (event time equal to -6) to age 59 (event time equal to -1), the mortality rates among treatment and control cohorts followed similar trends. Starting from around age 62 (event time equal to 2), a jump in the mortality rate among the treatment group appears relative to the comparison group. This increase in mortality rates in the treatment group is sustained through age 73, which is the end of my panel.

The evolution of female mortality rates before and after age 55 do not indicate an effect of working longer on mortality for women. Figure 2 compares the evolution of mortality rates of the cohort who turned 55 in 1964 (treatment) to the cohort who turned 55 in 1963 (comparison).

Mortality rates among these two cohorts appear to be evolving similarly from age 49 to age 68. This graph does not show any evidence of an effect of working longer on female mortality rates.

*B. Results of Effect of Working Longer on Mortality*

Figure 3 displays estimates from equation (1), representing the covariate-adjusted differences in mortality rates between the cohort who turned 60 during 1964 (treatment) relative to the cohort who turned 60 before 1964 (comparison). All regression results are weighted by the oblast-level number of individuals in each age group in 1963. Standard errors are clustered at the oblast-level to allow for an arbitrary correlation structure within an oblast.

The 1964 reform led to an increase in mortality rates after age 60. Consistent with descriptive evidence in figure 1, the regression results point to similar mortality rate trends before age 60 among treatment and comparison cohorts. The coefficients are positive by age 61, but statistical significance is reached with even higher positive coefficients by age 64. This increase in mortality rates persists through age 72. By age 64, mortality rates are 0.33 percentage points higher representing a 9.7 percent increase over a mean of 3.4 at age 64 among the comparison cohort. By age 71, mortality rates go up by 0.81 percentage points representing a 13.9 percent increase over a mean of 5.8 at age 71 among the comparison cohort.

Figure 4 displays estimates of the effect of working longer when using several treatment cohorts. Individuals' adjustment of employment and their subsequent changes in mortality rates may depend on how long they were aware of the financial incentives to retire later before they reached pensionable age. The increase in mortality rates is larger among cohorts born in 1904 and 1905 who were 59 and 58 in 1964 respectively. For instance individuals born in 1904 had a

1.3 percentage point increase in mortality rates by age 71 representing a 22.4 percent increase in their mortality rate.

I find no evidence of treatment effects among comparison cohorts of men who turned 60 before 1964. Appendix figure A1 shows regression coefficients when using equation (1), that measures the difference in mortality rates among men born in 1902 relative to men born in 1901, both of which are comparison cohorts. There is no evidence that the 1902 cohort had an increase in its mortality rate relative to the cohort born in 1901.

I do not find evidence that the 1964 reform changed the mortality rates among women after age 55. Figure 5 shows that mortality rates follow parallel trends among women born in 1908 (treatment; age 55 in 1964) relative to women born in 1907 (control; age 55 before 1964) 6 years before women turn age 55. After age 55, there is no jump in mortality rates in the treatment relative to the comparison cohorts among women.

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**Table 1. Treatment and Comparison Cohorts for Men**

| Age of Death | Year of Death | Age in 1964 | Birth Year | Treatment | Birth Year Label |
|---|---|---|---|---|---|
| 57 | 1964 | 56 or 57 | 1905 or 1906 | Yes | 1907 |
| 58 | 1964 | 57 or 58 | 1906 or 1907 | Yes | 1906 |
| 59 | 1964 | 58 or 59 | 1905 or 1906 | Yes | 1905 |
| 60 | 1964 | 59 or 60 | 1904 or 1905 | Yes | 1904 |
| 61 | 1964 | 60 or 61 | 1903 or 1904 | Maybe | 1903 |
| 62 | 1964 | 61 or 62 | 1902 or 1903 | No | 1902 |
| 63 | 1964 | 62 or 63 | 1901 or 1902 | No | 1901 |
| 64 | 1964 | 63 or 64 | 1900 or 1901 | No | 1900 |
| 65 | 1964 | 64 or 65 | 1901 or 1902 | No | 1901 |
| 66 | 1964 | 65 or 66 | 1900 or 1901 | No | 1900 |

Notes: This table shows how the paper assigns male cohorts in the data to the treatment and comparison groups. Age of death (column 1) and year of death (column 2) are observed in the vital statistics data. Based on these statistics, I assign age in 1964 (column 3), birth year (column 4), treatment status (column 5) and a birth year label (column 6). For instance, individuals who died at age 61 in 1964 could be age 60 or 61 in 1964, which means that their birth years could be 1903 or 1904, but for simplicity I assign them a birth year label of 1903. Because some of individuals in this cohort are age 60 at the time of treatment, they get assigned to the treatment group.

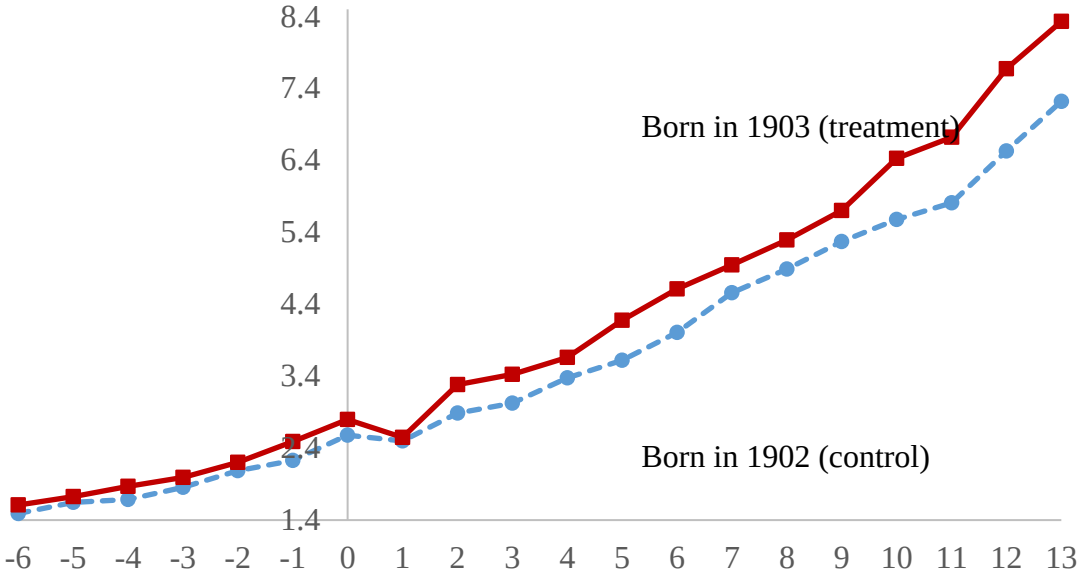
**Table 2. Treatment and Comparison Cohorts for Women**

| (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| **Age of Death** | **Year of Death** | **Age in 1964** | **Birth Year** | **Treatment** | **Birth Year Label** |
| 52 | 1964 | 51 or 52 | 1912 or 1913 | Yes | 1912 |
| 53 | 1964 | 52 or 53 | 1911 or 1912 | Yes | 1911 |
| 54 | 1964 | 53 or 54 | 1910 or 1911 | Yes | 1910 |
| 55 | 1964 | 54 or 55 | 1909 or 1910 | Yes | 1909 |
| 56 | 1964 | 55 or 56 | 1908 or 1909 | Maybe | 1908 |
| 57 | 1964 | 56 or 57 | 1907 or 1908 | No | 1907 |
| 58 | 1964 | 57 or 58 | 1906 or 1905 | No | 1906 |
| 56 | 1964 | 58 or 59 | 1905 or 1904 | No | 1905 |
| 55 | 1964 | 59 or 60 | 1904 or 1903 | No | 1904 |
| 54 | 1964 | 60 or 61 | 1903 or 1902 | No | 1903 |

Notes: This table shows how the paper assigns female cohorts in the data to the treatment and comparison groups. Age of death (column 1) and year of death (column 2) are observed in the vital statistics data. Based on these statistics, I assign age in 1964 (column 3), birth year (column 4), treatment status (column 5) and a birth year label (column 6). For instance, individuals who died at age 56 in 1964 could be age 55 or 56 in 1964, which means that their birth years could be 1908 or 1909, but for simplicity I assign them a

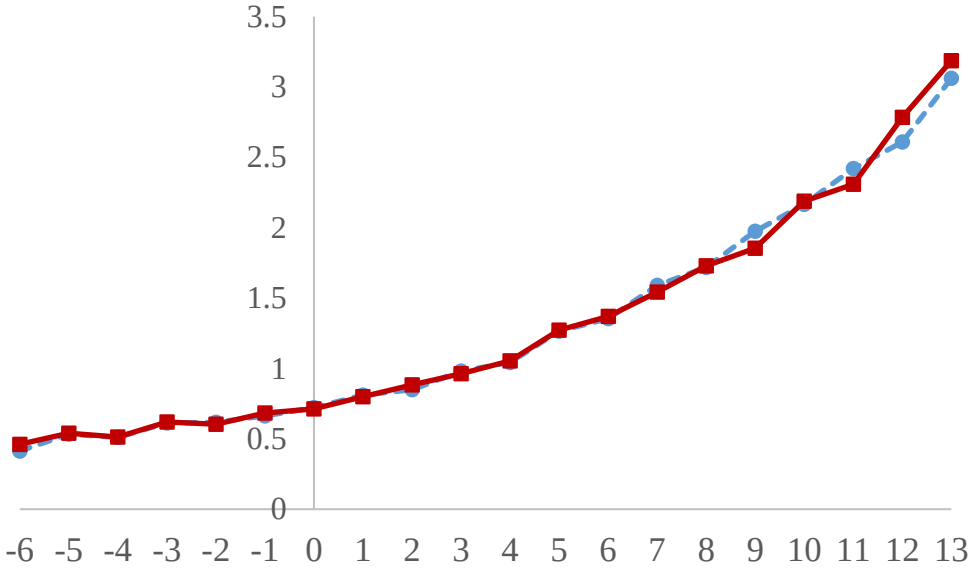
birth year label of 1908. Because some of individuals in this cohort are age 55 at the time of treatment, they get assigned to the treatment group.

**Figure 1. Evolution of the Male Mortality Rate before and after Age 60**



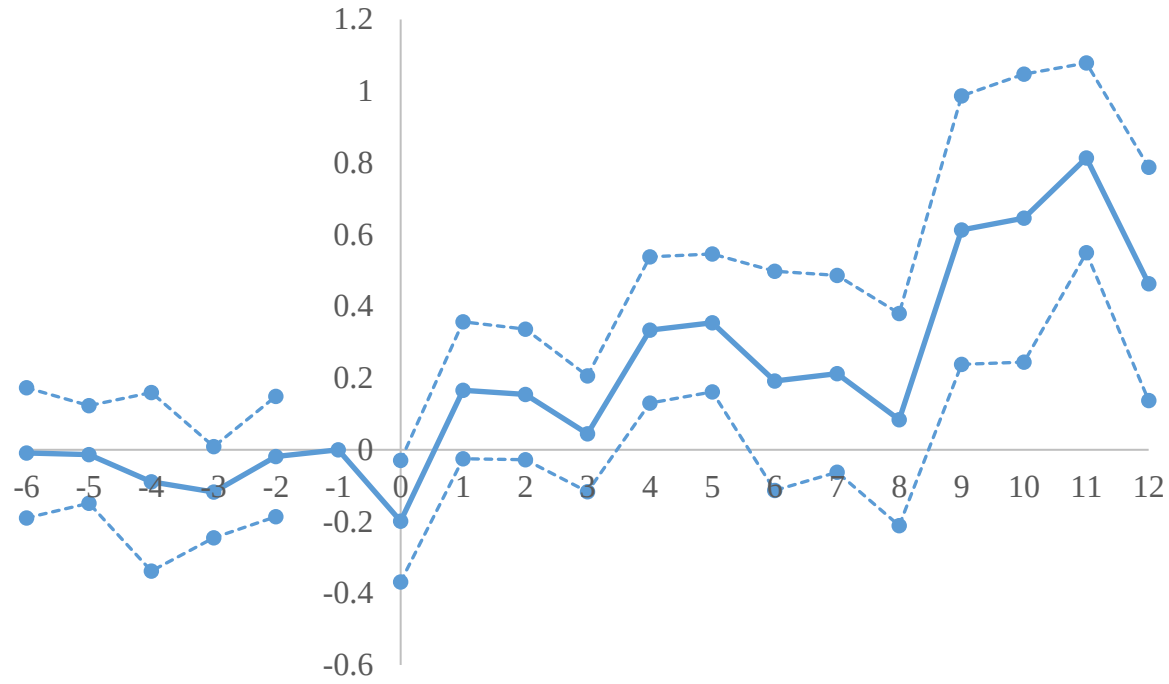

Notes: The treatment group (solid line with squares) represents the cohort born in 1903 (age 60 or 61 in 1964), while the comparison group (dashed line with circles) represents the cohort born in 1902 (age 61 or 62 in 1964).

**Figure 2. Evolution of the Female Mortality Rate before and after Age 55**



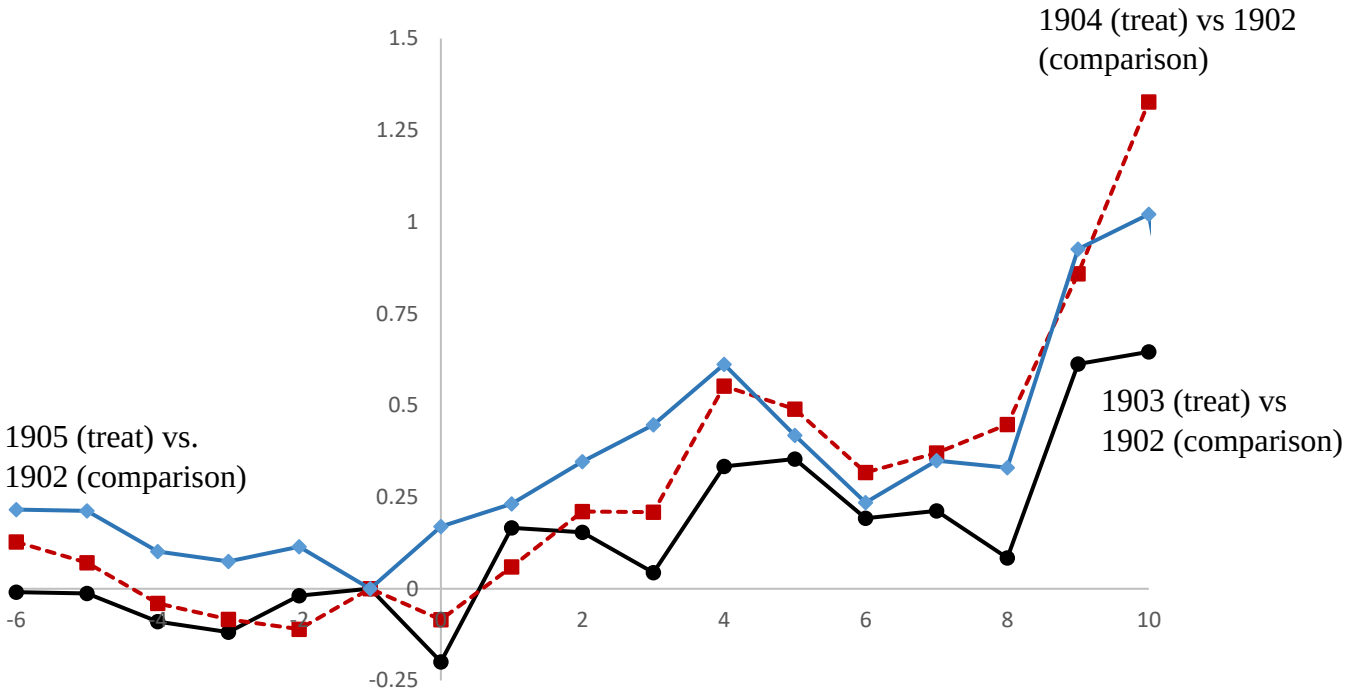

Notes: The treatment group (solid line with squares) represents individuals born in 1908 (ages 55 or 56 in 1964), while the control group (dashed line with circles) represents individuals born in 1907 (age 56 or 57 in 1964).

**Figure 3. Effect of Working Longer on Male Mortality Rates: Comparison of 1904 Cohort (Treatment) with 1903 Cohort (Comparison)**



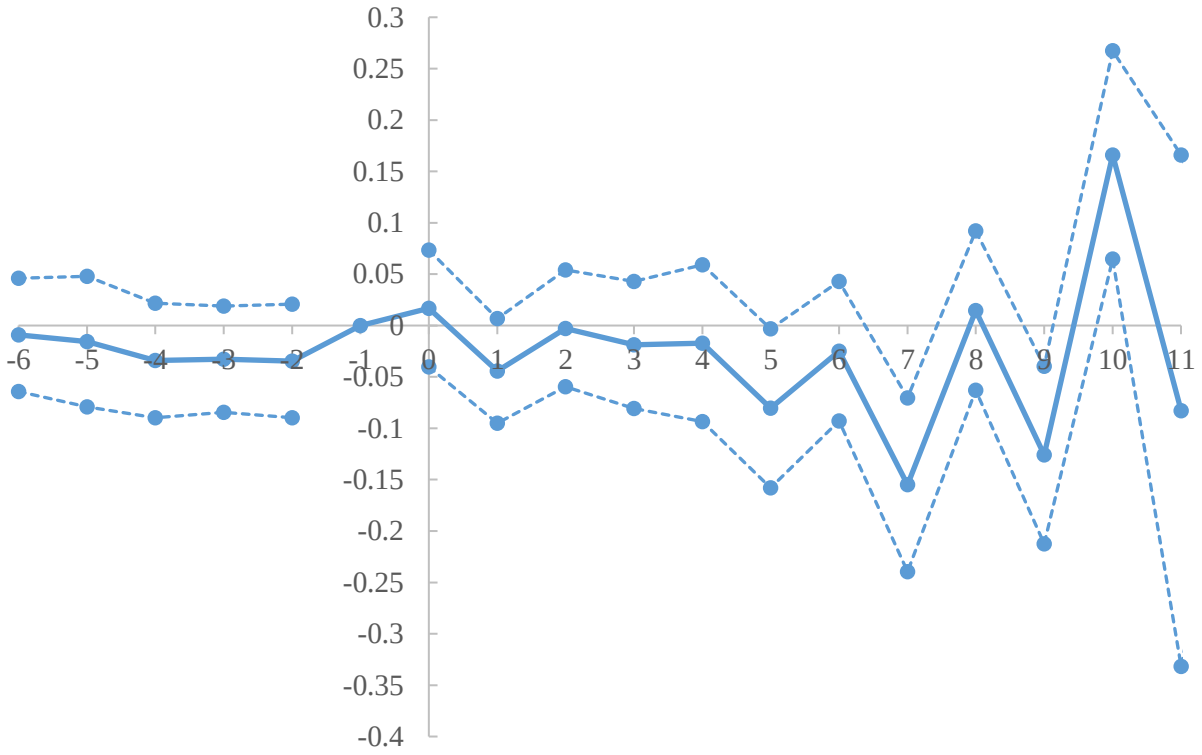

Notes: The coefficients represent the difference in mortality rates 6 years before and 12 years after turning 60 between treatment (born in 1903) and comparison (born in 1902) cohorts relative to the difference at age 59.

**Figure 4. Effect of Working Longer on Male Mortality Rates: Comparison of Several Treatment Cohorts**




Notes: The coefficients represent the difference in mortality rates 6 years before and 12 years after turning 60 between several treatment cohorts (birth years: 1903 [solid black line with circles], 1904 [dashed red line with square], and 1905 [solid blue line with diamonds]) and comparison (born in 1902) cohorts relative to the difference at age 59.

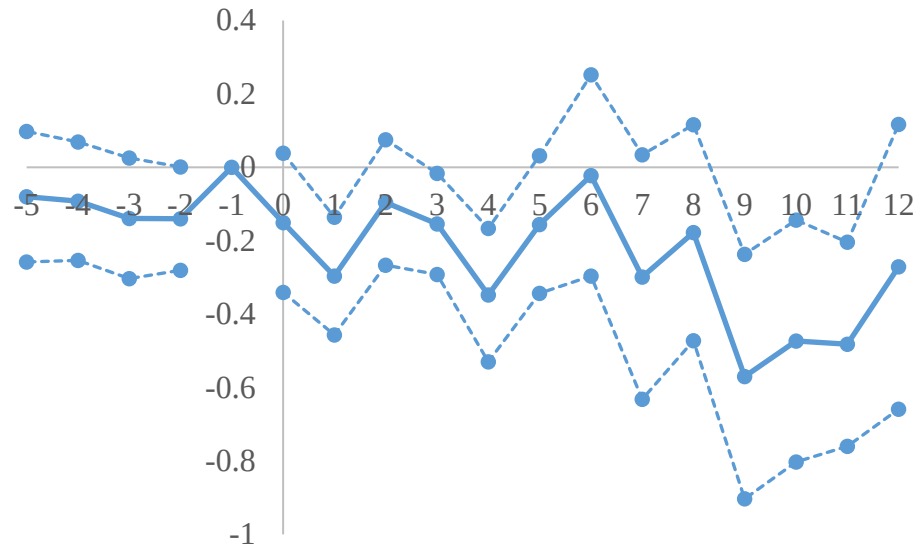
**Figure 5. Effect of Working Longer on Female Mortality Rates**




Notes: The coefficients represent the difference in mortality rates 6 years before and 12 years after turning 60 between treatment (born in 1908) and comparison (born in 1907) cohorts relative to the difference at age 59.

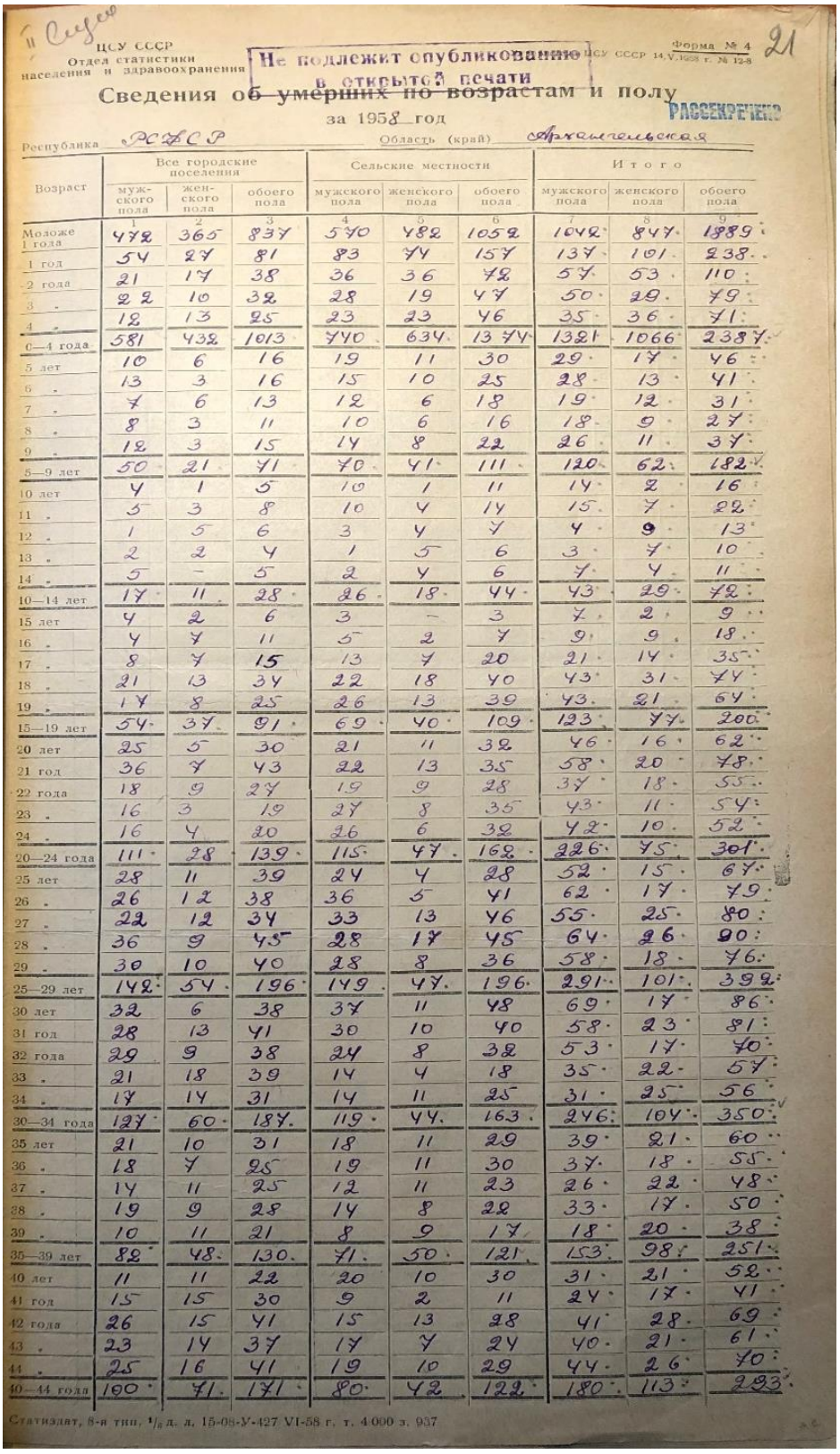
## Appendix

**Figure A1. Placebo for Men: Effect of being a Younger Cohort among Comparison Cohorts**




Notes: The coefficients represent the difference in male mortality rates 6 years before and 12 years after turning 60 between comparison cohort (born in 1902) and comparison cohort (born in 1901) relative to the difference at age 59.

**Figure A2. Archival Reporting Form of the Number of Deaths (Front)**



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21

# Сведения об умерших по возрастам и полу

за 1958 год

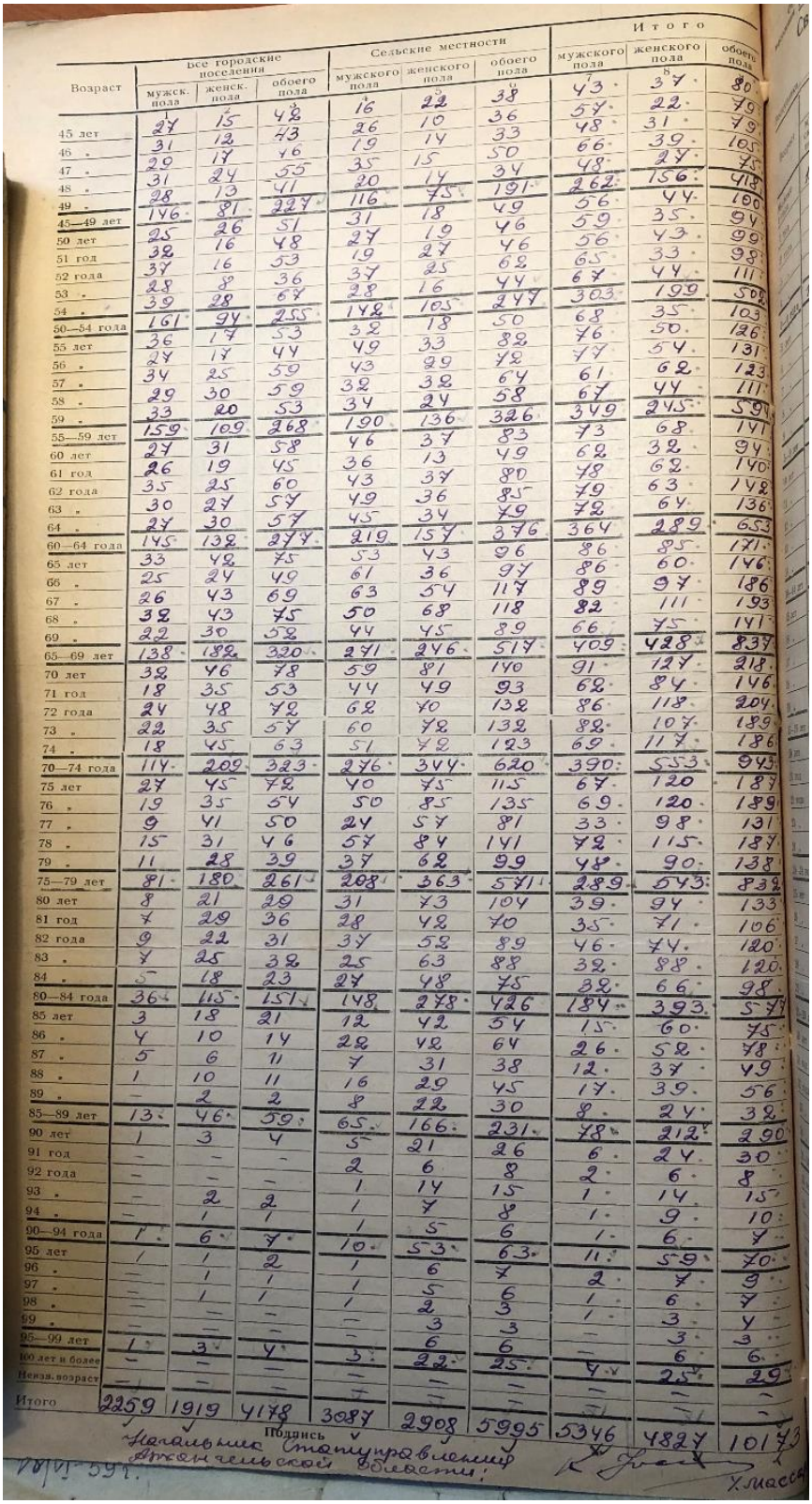
РАЗВЕКРЕЧЕНО

Республика РСФСР Область (край) Архангельская

| Возраст | Все городские поселения | | | Сельские местности | | | Итого | | |
|---|---|---|---|---|---|---|---|---|---|
| | мужского пола | женского пола | обоего пола | мужского пола | женского пола | обоего пола | мужского пола | женского пола | обоего пола |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Моложе 1 года | 472 | 365 | 837 | 570 | 482 | 1052 | 1042 | 847 | 1889 |
| 1 год | 54 | 27 | 81 | 83 | 74 | 157 | 137 | 101 | 238 |
| 2 года | 21 | 17 | 38 | 36 | 36 | 72 | 57 | 53 | 110 |
| 3 „ | 22 | 10 | 32 | 28 | 19 | 47 | 50 | 29 | 79 |
| 4 „ | 12 | 13 | 25 | 23 | 23 | 46 | 35 | 36 | 71 |
| 0—4 года | 581 | 432 | 1013 | 740 | 634 | 1374 | 1321 | 1066 | 2387 |
| 5 лет | 10 | 6 | 16 | 19 | 11 | 30 | 29 | 17 | 46 |
| 6 „ | 13 | 3 | 16 | 15 | 10 | 25 | 28 | 13 | 41 |
| 7 „ | 7 | 6 | 13 | 12 | 6 | 18 | 19 | 12 | 31 |
| 8 „ | 8 | 3 | 11 | 10 | 6 | 16 | 18 | 9 | 27 |
| 9 „ | 12 | 3 | 15 | 14 | 8 | 22 | 26 | 11 | 37 |
| 5—9 лет | 50 | 21 | 71 | 70 | 41 | 111 | 120 | 62 | 182 |
| 10 лет | 4 | 1 | 5 | 10 | 1 | 11 | 14 | 2 | 16 |
| 11 „ | 5 | 3 | 8 | 10 | 4 | 14 | 15 | 7 | 22 |
| 12 „ | 1 | 5 | 6 | 3 | 4 | 7 | 4 | 9 | 13 |
| 13 „ | 2 | 2 | 4 | 1 | 5 | 6 | 3 | 7 | 10 |
| 14 „ | 5 | — | 5 | 2 | 4 | 6 | 7 | 4 | 11 |
| 10—14 лет | 17 | 11 | 28 | 26 | 18 | 44 | 43 | 29 | 72 |
| 15 лет | 4 | 2 | 6 | 3 | — | 3 | 7 | 2 | 9 |
| 16 „ | 4 | 7 | 11 | 5 | 2 | 7 | 9 | 9 | 18 |
| 17 „ | 8 | 7 | 15 | 13 | 7 | 20 | 21 | 14 | 35 |
| 18 „ | 21 | 13 | 34 | 22 | 18 | 40 | 43 | 31 | 74 |
| 19 „ | 17 | 8 | 25 | 26 | 13 | 39 | 43 | 21 | 64 |
| 15—19 лет | 54 | 37 | 91 | 69 | 40 | 109 | 123 | 77 | 200 |
| 20 лет | 25 | 5 | 30 | 21 | 11 | 32 | 46 | 16 | 62 |
| 21 год | 36 | 7 | 43 | 22 | 13 | 35 | 58 | 20 | 78 |
| 22 года | 18 | 9 | 27 | 19 | 9 | 28 | 37 | 18 | 55 |
| 23 „ | 16 | 3 | 19 | 27 | 8 | 35 | 43 | 11 | 54 |
| 24 „ | 16 | 4 | 20 | 26 | 6 | 32 | 42 | 10 | 52 |
| 20—24 года | 111 | 28 | 139 | 115 | 47 | 162 | 226 | 75 | 301 |
| 25 лет | 28 | 11 | 39 | 24 | 4 | 28 | 52 | 15 | 67 |
| 26 „ | 26 | 12 | 38 | 36 | 5 | 41 | 62 | 17 | 79 |
| 27 „ | 22 | 12 | 34 | 33 | 13 | 46 | 55 | 25 | 80 |
| 28 „ | 36 | 9 | 45 | 28 | 17 | 45 | 64 | 26 | 90 |
| 29 „ | 30 | 10 | 40 | 28 | 8 | 36 | 58 | 18 | 76 |
| 25—29 лет | 142 | 54 | 196 | 149 | 47 | 196 | 291 | 101 | 392 |
| 30 лет | 32 | 6 | 38 | 37 | 11 | 48 | 69 | 17 | 86 |
| 31 год | 28 | 13 | 41 | 30 | 10 | 40 | 58 | 23 | 81 |
| 32 года | 29 | 9 | 38 | 24 | 8 | 32 | 53 | 17 | 70 |
| 33 „ | 21 | 18 | 39 | 14 | 4 | 18 | 35 | 22 | 57 |
| 34 „ | 17 | 14 | 31 | 14 | 11 | 25 | 31 | 25 | 56 |
| 30—34 года | 127 | 60 | 187 | 119 | 44 | 163 | 246 | 104 | 350 |
| 35 лет | 21 | 10 | 31 | 18 | 11 | 29 | 39 | 21 | 60 |
| 36 „ | 18 | 7 | 25 | 19 | 11 | 30 | 37 | 18 | 55 |
| 37 „ | 14 | 11 | 25 | 12 | 11 | 23 | 26 | 22 | 48 |
| 38 „ | 19 | 9 | 28 | 14 | 8 | 22 | 33 | 17 | 50 |
| 39 „ | 10 | 11 | 21 | 8 | 9 | 17 | 18 | 20 | 38 |
| 35—39 лет | 82 | 48 | 130 | 71 | 50 | 121 | 153 | 98 | 251 |
| 40 лет | 11 | 11 | 22 | 20 | 10 | 30 | 31 | 21 | 52 |
| 41 год | 15 | 15 | 30 | 9 | 2 | 11 | 24 | 17 | 41 |
| 42 года | 26 | 15 | 41 | 15 | 13 | 28 | 41 | 28 | 69 |
| 43 „ | 23 | 14 | 37 | 17 | 7 | 24 | 40 | 21 | 61 |
| 44 „ | 25 | 16 | 41 | 19 | 10 | 29 | 44 | 26 | 70 |
| 40—44 года | 100 | 71 | 171 | 80 | 42 | 122 | 180 | 113 | 293 |

Статиздат, 8-я тип. 1/8 д. л. 15-08-У-427 VI-58 г. т. 4 000 э. 957

**Figure A3. Archival Reporting Form of the Number of Deaths (Back)**



| Возраст | Все городские поселения | | | Сельские местности | | | Итого | | |
|---|---|---|---|---|---|---|---|---|---|
| | мужск. пола | женск. пола | обоего пола | мужского пола | женского пола | обоего пола | мужского пола | женского пола | обоего пола |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 45 лет | 27 | 15 | 42 | 16 | 22 | 38 | 43 | 37 | 80 |
| 46 „ | 31 | 12 | 43 | 26 | 10 | 36 | 57 | 22 | 79 |
| 47 „ | 29 | 17 | 46 | 19 | 14 | 33 | 48 | 31 | 79 |
| 48 „ | 31 | 24 | 55 | 35 | 15 | 50 | 66 | 39 | 105 |
| 49 „ | 28 | 13 | 41 | 20 | 14 | 34 | 48 | 27 | 75 |
| 45—49 лет | 146 | 81 | 227 | 116 | 75 | 191 | 262 | 156 | 418 |
| 50 лет | 25 | 26 | 51 | 31 | 18 | 49 | 56 | 44 | 100 |
| 51 год | 32 | 16 | 48 | 27 | 19 | 46 | 59 | 35 | 94 |
| 52 года | 37 | 16 | 53 | 19 | 27 | 46 | 56 | 43 | 99 |
| 53 „ | 28 | 8 | 36 | 37 | 25 | 62 | 65 | 33 | 98 |
| 54 „ | 39 | 28 | 67 | 28 | 16 | 44 | 67 | 44 | 111 |
| 50—54 года | 161 | 94 | 255 | 142 | 105 | 247 | 303 | 199 | 502 |
| 55 лет | 36 | 17 | 53 | 32 | 18 | 50 | 68 | 35 | 103 |
| 56 „ | 27 | 17 | 44 | 49 | 33 | 82 | 76 | 50 | 126 |
| 57 „ | 34 | 25 | 59 | 43 | 29 | 72 | 77 | 54 | 131 |
| 58 „ | 29 | 30 | 59 | 32 | 32 | 64 | 61 | 62 | 123 |
| 59 „ | 33 | 20 | 53 | 34 | 24 | 58 | 67 | 44 | 111 |
| 55—59 лет | 159 | 109 | 268 | 190 | 136 | 326 | 349 | 245 | 594 |
| 60 лет | 27 | 31 | 58 | 46 | 37 | 83 | 73 | 68 | 141 |
| 61 год | 26 | 19 | 45 | 36 | 13 | 49 | 62 | 32 | 94 |
| 62 года | 35 | 25 | 60 | 43 | 37 | 80 | 78 | 62 | 140 |
| 63 „ | 30 | 27 | 57 | 49 | 36 | 85 | 79 | 63 | 142 |
| 64 „ | 27 | 30 | 57 | 45 | 34 | 79 | 72 | 64 | 136 |
| 60—64 года | 145 | 132 | 277 | 219 | 157 | 376 | 364 | 289 | 653 |
| 65 лет | 33 | 42 | 75 | 53 | 43 | 96 | 86 | 85 | 171 |
| 66 „ | 25 | 24 | 49 | 61 | 36 | 97 | 86 | 60 | 146 |
| 67 „ | 26 | 43 | 69 | 63 | 54 | 117 | 89 | 97 | 186 |
| 68 „ | 32 | 43 | 75 | 50 | 68 | 118 | 82 | 111 | 193 |
| 69 „ | 22 | 30 | 52 | 44 | 45 | 89 | 66 | 75 | 141 |
| 65—69 лет | 138 | 182 | 320 | 271 | 246 | 517 | 409 | 428 | 837 |
| 70 лет | 32 | 46 | 78 | 59 | 81 | 140 | 91 | 127 | 218 |
| 71 год | 18 | 35 | 53 | 44 | 49 | 93 | 62 | 84 | 146 |
| 72 года | 24 | 48 | 72 | 62 | 70 | 132 | 86 | 118 | 204 |
| 73 „ | 22 | 35 | 57 | 60 | 72 | 132 | 82 | 107 | 189 |
| 74 „ | 18 | 45 | 63 | 51 | 72 | 123 | 69 | 117 | 186 |
| 70—74 года | 114 | 209 | 323 | 276 | 344 | 620 | 390 | 553 | 943 |
| 75 лет | 27 | 45 | 72 | 90 | 45 | 115 | 67 | 120 | 187 |
| 76 „ | 19 | 35 | 54 | 50 | 85 | 135 | 69 | 120 | 189 |
| 77 „ | 9 | 41 | 50 | 24 | 57 | 81 | 33 | 98 | 131 |
| 78 „ | 15 | 31 | 46 | 57 | 84 | 141 | 72 | 115 | 187 |
| 79 „ | 11 | 28 | 39 | 37 | 62 | 99 | 48 | 90 | 138 |
| 75—79 лет | 81 | 180 | 261 | 208 | 363 | 571 | 289 | 543 | 832 |
| 80 лет | 8 | 21 | 29 | 31 | 73 | 104 | 39 | 94 | 133 |
| 81 год | 7 | 29 | 36 | 28 | 42 | 70 | 35 | 71 | 106 |
| 82 года | 9 | 22 | 31 | 37 | 52 | 89 | 46 | 74 | 120 |
| 83 „ | 7 | 25 | 32 | 25 | 63 | 88 | 32 | 88 | 120 |
| 84 „ | 5 | 18 | 23 | 27 | 48 | 75 | 32 | 66 | 98 |
| 80—84 года | 36 | 115 | 151 | 148 | 278 | 426 | 184 | 393 | 577 |
| 85 лет | 3 | 18 | 21 | 12 | 42 | 54 | 15 | 60 | 75 |
| 86 „ | 4 | 10 | 14 | 22 | 42 | 64 | 26 | 52 | 78 |
| 87 „ | 5 | 6 | 11 | 7 | 31 | 38 | 12 | 37 | 49 |
| 88 „ | 1 | 10 | 11 | 16 | 29 | 45 | 17 | 39 | 56 |
| 89 „ | — | 2 | 2 | 8 | 22 | 30 | 8 | 24 | 32 |
| 85—89 лет | 13 | 46 | 59 | 65 | 166 | 231 | 78 | 212 | 290 |
| 90 лет | 1 | 3 | 4 | 5 | 21 | 26 | 6 | 24 | 30 |
| 91 год | — | — | — | 2 | 6 | 8 | 2 | 6 | 8 |
| 92 года | — | — | — | 1 | 14 | 15 | 1 | 14 | 15 |
| 93 „ | — | 2 | 2 | 1 | 7 | 8 | 1 | 9 | 10 |
| 94 „ | — | 1 | 1 | 1 | 5 | 6 | 1 | 6 | 7 |
| 90—94 года | 1 | 6 | 7 | 10 | 53 | 63 | 11 | 59 | 70 |
| 95 лет | 1 | 1 | 2 | 1 | 6 | 7 | 2 | 7 | 9 |
| 96 „ | — | 1 | 1 | 1 | 5 | 6 | 1 | 6 | 7 |
| 97 „ | — | 1 | 1 | 1 | 2 | 3 | 1 | 3 | 4 |
| 98 „ | — | — | — | — | 3 | 3 | — | 3 | 3 |
| 99 „ | — | — | — | — | 6 | 6 | — | 6 | 6 |
| 95—99 лет | 1 | 3 | 4 | 3 | 22 | 25 | 4 | 25 | 29 |
| 100 лет и более | — | — | — | — | — | — | — | — | — |
| Неизв. возраст | — | — | — | — | — | — | — | — | — |
| Итого | 2259 | 1919 | 4178 | 3087 | 2908 | 5995 | 5346 | 4827 | 10173 |

Подпись

Начальник Статуправления
Архангельской области