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Tobacco, Alcohol and Diet as Mortality Risk Factors: The Secondary Analysis of a 25-Year Cohort Study

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Abstract

Background: Individual lifestyle risk factors have been linked to increased mortality globally; however, there is limited data on these associations in Russia. A secondary analysis of the Russia Longitudinal Monitoring Survey (RLMS) data was conducted to close this gap.

Methods: The secondary data have been obtained from a nationally-representative annual cohort survey conducted by the Higher School of Economics (HSE). In this original study, for the first time in Russia, we extracted RRs for researched risk factors. Of additional original value, we made a prospective-retrospective cohort based on a representative longitudinal survey and provided the deaths as outcomes for survival analysis. We included 56,559 respondents between 1994 and 2019 in the study. Self-reported questionnaires were used to collect data, and Cox proportional hazard models were used to compute the hazard ratios (HR).

Results: In total, 4063 deaths were reported during the analyzing period. Overall, the risk of death was more than 2.2 times higher for males than for females (HR = 2.29, 95% CI: 2.14; 2.44). Individuals who used tobacco had 3.52 times (95% CI: 3.27; 3.79) higher risk of death. People with alcohol use had a 2.08 (95% CI: 1.92; 2.25), and responders with poor nutrition had a 2.16 (95% CI: 1.79; 2.60) higher mortality risk.

Conclusion: Poor lifestyle risk behaviors, including tobacco smoking, alcohol consumption, and poor nutrition, are associated with a significantly higher risk of death in the Russian population.

Keywords: Mortality, Non-communicable diseases, NCDs, Behavioural risk factors, RLMS

1. Introduction

According to the World Health Organization (WHO), non-communicable diseases (NCDs) are responsible for about 70% of all deaths worldwide (NCDs). Low and middle-income countries are responsible for over 3/4 of all NCDs mortality. About 82% of the 16 million people die prematurely and before they reach 70 years. NCDs are Russia’s primary cause of mortality and morbidity, accounting for 87% of deaths [1].

Risk factor concepts have established the basis for preventing morbidity and death from NCDs and are widely used in clinical and public health practice [2]. In 2014, WHO launched the Global coordination mechanism for preventing and controlling NCDs [3]. Key modifiable risk factors, including smoking, alcohol consumption, unhealthy body weight, physical inactivity, and poor nutrition, have been linked to a high proportion of global mortality from all causes [1]. Non-smoking, moderate alcohol use, a healthy body weight, physical exercise, and a healthy diet, on the other hand, are associated with a reduced risk of premature death from all causes [4].

Tracking mortality rates by age and sex by cause is essential to public health surveillance [5]. Cause-specific and exposure-related mortality trends provide insights into which programs to improve public health might work, where progress is lagging, and inform about the emergence of new or unexpected
health problems. It is crucial to comprehend what circumstances, habits, or lifestyle choices contribute to decreases in life expectancy (LE) [3]. Traditionally, extensive longitudinal cohort studies with long follow-up periods are used in survival analysis and to assess associations between exposures, such as behavioral or other risk factors, and all-cause or cause-specific mortality [6]. There have been numerous studies on the effect of a healthy lifestyle on life expectancy [7]. For example, adherence to healthy lifestyle habits such as the Mediterranean diet, physical activity, moderate alcohol intake, and not smoking was associated with a decreased rate of all-cause and specific-cause mortality among older persons in a longitudinal study in Europe (HALE study) [6]. Data obtained from a nurses’ and health professionals’ follow-up study [7] also examined five low-risk lifestyle factors (i.e., non-smoking, healthy body weight, physical activity, moderate alcohol intake, and a healthy diet). Those with all five low-risk factors had a significantly lower risk of all-cause mortality (HR = 0.26; 95% CI: 0.22–0.31) than those with no low-risk lifestyle behaviors.

The association between six risk factors: tobacco smoking, alcohol use, dietary behavior, physical inactivity, sedentary behavior, and sleep — and mortality was also investigated in an Australian population-based cohort study that found a positive linear trend in mortality risk as the number of risk factors increased [8]. The most critical determinants of all-cause mortality were combinations of physical inactivity, extended sitting, long sleep duration, and combinations of smoking and excessive alcohol use, implying individual and addictive impacts of those lifestyle risk factors on mortality.

Very few studies in Russia have used longitudinal cohort data to perform analytic epidemiology. Currently, estimated cause-specific mortality in Russia is based on vital statistics reported by the civil registry offices of the Ministry of Justice of the Russian Federation (Органы записи актов гражданского состояния [ZAGS]) and examined by the Department of Russian Federal State Statistics Service (Rosstat). Medical death certificates include limited information about mortality, such as age, sex, and cause of death. Analysis of Russian Longitudinal Monitoring Survey (RLMS) data allows us to examine cause-specific and exposure-related mortality trends, as the RLMS collects expansive details about household consumption and individual health from a nationally-representative sample [9].

According to the Global Burden of Diseases study in Russia, smoking and harmful alcohol use are the primary contributors to NCD deaths, accounting for 14% of all deaths. Smoking prevalence among males (60%) is the highest in the European Region, and smoking prevalence among females has increased from 10% to 21% over the past 15 years. Russia ranks fifth in the world in the number of smokers [10]. Russia continues to have one of the highest rates of alcohol use in the world. According to a 2018 World Health Organization estimate, in the Russian Federation, heavy episodic drinking among drinkers is very high (more than 60% of current drinkers). The per-capita consumption of pure alcohol was 18.7 L per person in 2016 [11]. Such high alcohol intake and prevalence of 39% of strong spirits in total intake of alcohol is one of the leading contributors to male mortality and shortened life expectancy [11]. Alcohol consumption significantly negatively impacts the quality of life in Russia, not only for drinkers but for all inhabitants. Almost all Russian citizens are at risk from alcohol-related homicides and accidents (particularly road traffic accidents). Heavy drinking is associated with domestic violence, low marital satisfaction and higher divorce rates. Associated with which overall negatively impacts the economy and the social environment [12].

An average Russian diet includes high animal fats and low amounts of fruits, berries, and vegetables [13]. Until 1985, the average daily fat consumption in the Soviet Union was ten to fifteen per cent greater than WHO recommendations. Daily fat consumption has been nearly average since 1992, but it has remained unbalanced due to high levels of animal fat consumption. Russians of lower socioeconomic status consume more fat and fewer fruits and vegetables. According to the Global Burden of Disease (GBD) study, low intake of whole grains was the leading dietary risk factor for deaths and disability-adjusted life years (DALYs) in Russia [14]. More than half of Russians over the age of 30 are overweight or obese, which is reflected in an increase in the incidence of non-communicable diseases. Furthermore, diet-related conditions are responsible for more than half of all deaths in Russia. Since 2012, there has been a 2.3-fold increase in the prevalence of obesity among adults aged 18 and older.

The current study is a descriptive analysis to evaluate the impact of tobacco smoking, alcohol use, and poor nutrition on hazards of all-cause mortality in the Russian population. Accordingly, we established two key objectives to explore this hypothesis:

The first, to discover the descriptive information about deaths using a representative cohort study of the Russian people, including causes of death, and stratification by age group and sex. The second, to estimate the hazard ratios for three main risk factors: smoking, alcohol use, and poor nutrition that mean - the number of meals a person has per day.
To achieve this goal, we used data from a prospective cohort study, in which respondents self-reported health and behavioral risk factors and the fact and cause of death of relatives who participated in this study. We believe that improving Russia's system for monitoring risk factors could help mitigate the country's NCD burden.

2. Methods

2.1. Data

The study design is defined as survival analysis on the retro-prospective cohort study data. The original data were not collected to answer the present research questions but the respondents of the study gave permission to any use of their records making the ethical practice appropriate for our study. The data analyzed in this study was derived from 1994 to 2019 (including 24 annual rounds) of the Russian Longitudinal Monitoring Survey (RLMS). The RLMS is an annual nationally-representative repeated survey conducted by the Higher School of Economics (HSE) [9]. It consists of two large databases of the Russian population - “Households” and “Individuals”. The RLMS intended to produce a nationally-representative sample. The average sample size was 7389 in 1994–2009 and 14,842 in 2010–2019. For the Individuals’ dataset, RLMS assessed adult respondents about self-reported demographics, lifestyle, consumption habits, health status, material well-being, and microeconomics, such as expenses and income. The information about deaths was collected in Household datasets and was derived from the question: “Why is (he/she) no longer a member of your family, household?” This study merged demographic and exposure data from the ‘Individuals’ surveys and mortality data from the ‘Household’ surveys to perform a secondary analysis. See the baseline characteristics of the group of respondents in Table 1.

2.2. Classification of cause-specific mortality

Cause-specific mortality data were derived from the survey question: “Could you tell me the cause of the death of (him/her)?”. Family-member reported causes of death were categorized by the study team according to the 10th Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) into the following groups: cardiovascular diseases, cerebrovascular diseases, neoplasms, accidents, respiratory diseases, senility, and others. More details about the variables and its coding are presented in the Cohort profile paper, prepared by the authors of the current article [15].

<table>
<thead>
<tr>
<th>Table 1. Baseline characteristics of analytical population.</th>
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<tr>
<td>Characteristics</td>
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<tr>
<td>------------------------------------------------------------</td>
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<tr>
<td>Age (years), Mean (SD)</td>
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<td>Gender (n, %)</td>
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<td>Male</td>
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<td>Education (n, %)</td>
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<td>Completed secondary specialized education</td>
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<td>Completed higher education and above</td>
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<td>Nutrition status</td>
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<td>Comorbidity</td>
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<td>Diabetes or high blood sugar</td>
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<td>High blood pressure</td>
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<td>No</td>
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<td>Smoking status</td>
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2.3. Estimation of primary risk factors

This study analyzed the following risk factors: smoking, alcohol use, and poor nutrition. An individual was classified as positive for exposure to tobacco if they responded "Yes" to the survey question "Do you currently smoke?" in >70% of surveys collected. The cut-off-point was chosen based on the experimental data to preserve enough information for analysis. See the baseline statistical information about respondents in the Table 1. Similarly, an individual was classified as positive for exposure to alcohol use ("drinker") if they responded “Every day”, “4–6 times a week”, “2–3 times a week”, or “Once a week” to the survey question “How often have you consumed alcoholic beverages in the past 30 days?” in >70% of surveys collected.
2.4. Statistical analysis

The association between risk factors and life expectancy was examined using Kaplan–Meier statistics and Cox proportional hazards model, in which the underlying time variable was age. Hazard ratios (HR) are reported with 95% confidence intervals (CI). Survival curves were compared with the log-rank test. The analysis was conducted in R version 4.0.3. This is an open-source statistical analysis software available from the R-project https://cloud.r-project.org/. Trials were considered statistically significant if p < 0.05.

2.5. Ethical issues

The data used in this paper are secondary data, and we have cited all sources in full in accordance with academic and ethical standards.

3. Results

Between 1994 and 2019, the RMLS collected responses from 56,559 discrete individuals, and household respondents reported 4063 deaths: 2214 males and 1699 females. The crude death rate by gender is presented in Fig. 1. The crude death rate among males was higher than in females throughout the period of analysis. The highest death rates for both genders occurred in 1998 and 2000. Between 2000 and 2010, the rate of all-cause fatalities decreased, and there was a gradual increase in the death rate from 2010 to 2019.

Fig. 2 (A) demonstrates the number of deaths by gender and age group from 1995 to 2019. The asymmetric distribution explains gender differences in mortality patterns; most deaths before age 80 occur among males, whereas deaths in the older population predominantly occur among females.

Fig. 2 (B) shows the population survival curve. The survival time ranged from 53 to 80 years, with the median survival time estimated to be 69 years. The stratified analyses by gender revealed significantly shorter median survival times for males than females (62 versus 77 years, respectively; p < 0.001). Notably, the risk of death was more than 2.2 times higher for males than for females (HR = 2.29, 95% CI: 2.14; 2.44).

Fig. 3 shows cause-specific mortality data by gender. Males had more than double the number of fatal cases due to accidents and respiratory diseases than females. Death due to senility was more common in females, consistent with the age distribution in Fig. 3.

3.1. Risks factors

Smoking: Our analysis showed extremely significantly different survival curves (p < 0.001) between smokers and non-smokers, with average life expectancies of 55 years (43–67 years) and 76 years (53–84 years), respectively, and HR = 3.52 (95% CI 3.27–3.79) for all-cause mortality (Fig. 4A).

Alcohol consumption: Kaplan–Meier survival curves by alcohol status are presented in Fig. 4B. Drinkers and non-drinkers had roughly equal survival probabilities until 35 years old; however, survivorship significantly varied after 35 years of age (p < 0.001). The median survival time for drinkers and non-drinkers was 57 years (46–69) and 72 years (57–82), respectively. The risk of death was twice as high for drinkers than for non-drinkers (HR = 2.08, 95% CI: 1.92; 2.25).

Nutritional status: The nutritional status has been consistently categorized as Poor/Normal throughout the study, allowing for a clear comparison of the impact of different nutritional statuses on mortality risk. This consistent categorization helps to reduce potential misinterpretations and ensures that the study’s results are robust and reliable. Participants with normal nutrition had a longer median survival time than those with poor nutrition (69 years (54–80) versus 51 years (38–64), p < 0.001). Furthermore, those with poor nutrition had increased death risks for all causes than participants with normal nutrition (HR = 2.16, 95% CI: 1.79; 2.60).

4. Discussion

This study uses descriptive and analytic epidemiology to characterize cause-specific and exposure-related mortality trends in Russia from 1994 to 2019. Reassuringly, the time-dependent and cause-specific mortality trends and patterns shown by RLMS data are consistent with those reported by the Federal Russian Statistical Service “Rosstat” [10], which speaks to the quality of the nationally-

![Fig. 1. Annual crude death rate by gender from 1995 to 2019.](image)
representative RLMS dataset. The patterns of NCD cause-specific mortality shown in this study are also consistent with WHO global mortality patterns [1]. Various multi-factorial hypotheses have been proposed to explain mortality trends demonstrated repeatedly in this and other demographic studies of Russian mortality [16]. These include, but are not limited to, consideration of state policies, such as the abandonment of an anti-alcohol program in the early 1990s to the reinstatement of anti-tobacco and anti-alcohol initiatives after 2000 [17,18]. The literature also describes decreasing birth rates, per-capita income, healthcare budgets, and increases in depression, suicide, accidents, alcohol use, and tobacco use after 2010 [19], which may also contribute to the trends observed.

Our study successfully conducted the first survival analysis of behavioral risk factors in Russia using a longitudinal cohort database with a long follow-up period. Self-reported exposures to smoking and alcohol use were found to be significantly associated with all-cause mortality, which is consistent with findings of the HALE, NHANES, HUNT, and 45 and UP longitudinal cohort studies [6,20,21]. This study also showed poor nutrition to be associated with all-cause mortality, similar to the NHANES study; Kroktsad et al. [20] did not find this association, although increased dietary risk was defined from one question indicating the use of butter/hard margarine for cooking instead of vegetable oil, oil blend, or soft margarine in that cohort study.

Fig. 2. Number of deaths by gender and age group (A) and Survival curve for the overall population and stratified by gender (B).

Fig. 3. The number of deaths is stratified by cause and gender.
In the current study, we found a higher risk of death for males than for females, with males exhibiting a more than 2.2 times increased risk of death (HR = 2.29, 95% CI: 2.14; 2.44). Several factors could potentially explain this difference in mortality risk between genders, which we discuss below. The biological differences between males and females may contribute to the disparity in mortality rates. Males generally have a higher prevalence of risk factors for non-communicable diseases, such as higher blood pressure, higher cholesterol levels, and greater susceptibility to developing abdominal obesity. The hormonal differences between genders, such as the protective effects of estrogen in females, could influence the development of cardiovascular diseases and other health conditions [22].

The behavioral factors also play a role in the observed difference in mortality rates. Males, on average, tend to engage in riskier behaviors, such as higher rates of smoking and alcohol consumption, which are known to be associated with increased mortality [23]. In the Russian context, alcohol consumption, particularly of spirits, has been identified as a key factor driving the gender gap in mortality rates [24]. Furthermore, men are generally less likely to seek preventive healthcare and engage in health-promoting behaviors, which may contribute to their higher mortality risk [25].

The social and cultural factors may influence the gender differences in mortality. Traditional gender roles and expectations in Russia have been found to contribute to higher rates of risky behaviors in men, such as alcohol consumption and tobacco use [26]. Workplace contexts, particularly in male-dominated industries, may also perpetuate these behaviors and contribute to the increased mortality risk in males [27].

The higher risk of death for males than for females in this study may be attributed to a combination of biological, behavioral, and sociocultural factors. Addressing these factors through public health interventions and policy changes could help reduce the gender disparity in mortality rates and improve overall population health. Future research should continue to investigate the underlying causes of the gender differences in mortality and explore the effectiveness of targeted interventions to mitigate these disparities.

Limitations of this study stem mainly from the limitations of longitudinal self-reported survey-based cohort studies (recall bias, response bias, acquiescence bias, social desirability bias, nonresponse bias, interviewer coding error) as well as limitations of the primary RLMS datasets (frequency and quantity of data collected, sample size, periodic resampling, between round attrition). Data quality may be improved if data collection is conducted more frequently than annually. Validity of cause of death depends on family members’ knowledge, comprehension, and interpretation of often complex medical information, which may contribute to errors.
in cause-specific mortality reporting. Most importantly, survival analyses of behavioral risk factors show associations but do not account for confounders (such as educational level, Body Mass Index (BMI)), temporality, or dose–response effects, such as smoking intensity and duration, which could allow for causal inferences to be made from observational data.

Finally, taking risk factors into account may increase the risk of total mortality. Given the high mortality rate in Russia, we must take appropriate measures to prevent deaths from all causes, and measures aimed at the general public to increase exposure to information on tobacco use, alcohol consumption, and nutrition habits would have more significant public health implications than control measures aimed solely at high alcohol consumers. In addition, more research may be required to confirm the impact of these factors on mortality.

5. Conclusion

This study provides valuable insights into the relationships between gender, age, tobacco, alcohol, and diet as mortality risk factors in Russia. Our findings underscore the importance of addressing these behavioral risk factors in order to reduce the burden of non-communicable diseases and improve overall public health. To achieve this goal, a multi-sectoral approach is necessary, involving stakeholders such as policymakers, healthcare professionals, community organizations, and the media. By working together, these stakeholders can develop and implement evidence-based policies and interventions that target smoking, alcohol consumption, and poor nutrition. These efforts can potentially lead to positive changes in health behaviors, ultimately contributing to a reduction in mortality rates and an improvement in the quality of life for the Russian population. Furthermore, our study adds to the current literature by offering a comprehensive analysis of mortality trends in Russia, helping to inform future research and policy development in this field.

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Conflict of interest

The authors declare that there is no conflict of interest.

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[15] Soshnikov SS, Egorova AN, Idrisova AI, Grijbovskii AM, Atoeva MA. Cohort profile: The longitudinal study on the


