Premature cardiovascular mortality and alcohol consumption before death in Arkhangelsk: an analysis of consecutive series of forensic autopsies.

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Abstract

Background: High CVD mortality among the middle-aged is a major cause of low life expectancy in Russia, especially among men. Hazardous alcohol consumption is suspected to be a powerful factor.

Methods: All men (1099) and women (519) who died between 01.01.08 and 31.08.09 from cardiovascular disease at ages of 30-70 years in the city of Arkhangelsk, Northwest Russia, were included. CVD mortality was stratified by age, gender and diagnosis. For the cases diagnosed by forensic pathologists, the blood alcohol concentration (BAC) was determined. The forensic autopsy rate was 72% for men and 62% for women.

Results: The age-standardized CVD mortality rate (all age groups) in men was higher than in women. The largest male-to-female ratio (4.3) was observed in the age-group 50-59. Alcoholic and unspecified cardiomyopathies were the most dominant CVD mortalities in women, and second in men under fifty; they accounted for 50% and 25% of deaths, respectively. About one third of men and women who died from CVD under 60 had consumed alcohol shortly before death. This occurred most frequently among the diagnostic groups: “other acute or subacute cardiac ischemia”, “atherosclerotic heart disease” and “cardiomyopathies”. Alcohol was more likely to be found at autopsy in men than women (OR 1.55; 95% CI 1.14-2.10). No such difference was found for those who died from myocardial infarction, cerebrovascular diseases and cardiomyopathies. Less than 1% of the deceased had a BAC of 4g/l or higher.

Conclusions:

Alcohol consumption before death is an important correlate of premature CVD mortality in Northwest Russia, particularly among 50-59 year-old men. The largest gender difference in mortality, highest absolute number of premature CVD deaths, and the highest proportion of alcohol-positive autopsies occurred among them. Associations with alcohol consumption considerably vary between the types of CVD diagnoses, and this should be taken into account when planning future research. Our study does not support the hypothesis that a substantial number of cardiovascular deaths are misclassified cases of acute alcohol poisoning.

Introduction

The mortality rate from cardiovascular diseases (CVD) in Russia is one of the highest in the world (1), and has been increasing since the late 1980s to 2005.(2) High levels of CVD mortality result from both high incidence of cardiovascular events and high case fatality.(3-5) However, the few population-based studies conducted in Russia have failed to demonstrate the concurrent presence of high levels of the major cardiovascular risk factors. (4;6-8) Indeed, population cardiovascular risk scores based on the conventional cardiovascular risk factors have been found repeatedly to be lower among Russians than in other European populations.(6;7). Moreover, mortality from coronary heart disease (CHD) and stroke appear to have increased in spite of a decrease in the prevalences of the major risk factor during the 1990s.(6;9) In our earlier study, we observed that hazardous alcohol consumption was associated with favorable lipid and glycemic profiles.(10) It has also been suggested that a substantial fraction of deaths attributed to cardiovascular disease could represent misclassified deaths from acute alcohol poisonings.(11)

Consumption of large amounts of spirits in a single drinking episode is widely prevalent in Russia, primarily among middle-aged men.(12-14) This drinking pattern has been shown to increase the risk of CHD(15) by way of underlying myocardial dysfunction with increased propensity to cardiac arrhythmias and diminished myocardial contractility, increased clotting tendency, and transient increase of blood pressure.(16;17) Most of the current evidence for the association between high cardiovascular mortality in Russia and hazardous alcohol consumption originates from research based on combined population-level data(18-21). Further research using a single cohort with information on the individual level is therefore warranted.

The only large individual-level longitudinal study conducted in Russia in the past 20 years was one from Novosibirsk, which failed to explain high cardiovascular mortality by hazardous alcohol consumption.(22) By contrast two large case-control studies, which were based on interviews of proxy respondents for those who died from CVD, have reported considerably higher prevalence estimates of hazardous drinking and associated risks.(23;24) Methodological challenges in Russia (25) associated with epidemiological research on this issue, combined with a lack of individual-level data and inconsistencies between the few published studies on the topic, suggest a need for additional types of input data (e.g., autopsy reports).(11;26)

Based on autopsy reports, the study by Zaridze et al. from Barnaul in Russia (11) found high (4g/l or higher) postmortem blood alcohol concentrations (BACs) in a high proportion of deaths among several types of cardiovascular causes. The authors suggested that high cardiovascular mortality could be overinflated due to considerable misattribution of fatal alcohol poisonings to cardiovascular deaths. By contrast and based on a study in Izhevsk, Russia (26), Leon et al. argue that the observed correlation between alcohol and mortality from CVD at the population-level remains nearly unchanged even after elimination of the potentially misclassified deaths. In addition, the percentage of deaths from cardiovascular disease with high BACs in Izhevsk was considerably lower than in Barnaul.

Given the lack of agreement between the mentioned studies, a further autopsy-based evaluation in another part of Russia is warranted. Moreover, there have been no studies on this topic using post-2005 data that would reflect the established decrease in cardiovascular mortality in Russia.(2)

The primary aim of the study is to determine to what extent alcohol consumption before death contributes to premature cardiovascular mortality, and how this contribution varies by age, gender and the diagnosis of cardiovascular death. A secondary aim is to use data on postmortem forensic autopsy examinations in an evaluation of the potential of misclassifying alcohol poisoning as cardiovascular death in Arkhangelsk during 2008-09.

Material and methods

Setting

The data were collected in the city of Arkhangelsk, Northwest of Russia. The population of Arkhangelsk was 354,700 in 2009, with typical Russian age and gender distributions. The mortality by age, gender and cause of death in Arkhangelsk (Table 1) was also similar to the national data.(27;28)

Death certificate

When an individual dies, a medical death certificate containing data on immediate, intermediate and underlying cause of death with the corresponding ICD-10 codes is issued. The regional and national mortality statistics is based on the underlying causes. The diagnosis in the medical death certificate may come from three different sources: forensic pathologist, hospital pathologist and other physicians. Only forensic pathologists routinely measure alcohol concentration in fluids and tissues of the deceased.

The proportion of diagnoses reported on death certificates based on forensic autopsy reports is higher in Russia than in Western European countries. In Norway, it was about 8.3% in 2005 (29), compared to 37% in Arkhangelsk.(28) The latter is congruent with other Russian studies from the 1990s.(11;30) Since 2008, forensic autopsy has become routine for all out-of-hospital deaths in Arkhangelsk, and the proportion of death certificates issued by forensic pathologists reached 69% in 2009.

Study population

All men (1099) and women (519) who died from cardiovascular disease (ICD-10 codes I00-99) at and between ages 30 to 70 years in Arkhangelsk in the period 1.01.2008 to 31.08.2009 constituted the target population. The subjects were identified through the Arkhangelsk Regional mortality register of the Regional Ministry of Health. For 1120 (69.2%) of the cases, diagnosis was based on the results of autopsies performed by forensic pathologists, and 448 (27.7%) by hospital pathologists. Only the former group was included in the calculation of odds ratios. Data on causes of death and presence of alcohol in blood and tissues were extracted from the reports of the Regional Centre of Forensic Expertise where all forensic autopsies in Arkhangelsk are performed.

Forensic examination and measurement of alcohol concentration

All sudden deaths, cases with an unclear diagnosis (includes virtually all premature out-of-hospital deaths), and those in which violence is suspected are routinely subjected to forensic examination. A summary for Arkhangelsk of all autopsies carried out during the study period are provided in Table 1. The proportion of forensic autopsies of cardiovascular deaths decreases with age and is higher for men. Measurement of alcohol concentrations in body fluids and tissues is a routine component of forensic examinations in cases of premature deaths (under age 70). Alcohol concentrations are measured by gas chromatography(31) in blood and urine and, if not detected there, in the stomach's contents and sometimes in tissue specimens (muscle, kidney, lung, liver or brain).(32) Concentrations are registered in g/l, with a detection limit of 0.0001g/l. Forensic autopsies in Arkhangelsk are in most cases preformed within 24-48 hours after death.

Absolute numbers and percentages of deaths in which alcohol was detected at forensic autopsies are reported as well as the BACs. Cases with a positive BAC and those for whom alcohol wasn't found in the blood but detected in other fluids and tissues (mostly in urine and stomach contents; a total of 40) were counted.

We stratified BACs as follows: <0.5g/l (insignificant intoxication); 0.5-2.49g/l (slight to moderate); 2.5-3.99g/l (severe); and ≥4.0g/l (potentially lethal)(33). These categories were also chosen to ensure comparability with the findings from other studies.(11;26;30)
In general, this stratification corresponds to the official one accepted in the Russian forensic system (34), which classifies a BAC of 0.5-2.5 g/l as slight to moderate intoxication, 2.5-3.0 as severe, 3.0-5.0 as heavy and potentially lethal and 5.0-6.0 as lethal poisoning.

Statistical analyses

The mortality rates by cause (Table 1) were age-standardized to the world standard population. Odds Ratios (OR) and p-values for the probability of being identified with any alcohol concentration at autopsy by gender and death diagnosis were calculated using Mantel-Haenszel methods.

Ethical approval for the study was obtained from the Ethical Committee of the Northern State Medical University in Arkhangelsk.

Results

Cardiovascular diseases in Arkhangelsk were the main cause of death at ages under 70, and were responsible for about 35% of all deaths in men and women in this age-group (Table 1). Both the absolute number of cardiovascular deaths and the age-standardized rates in men were more than twice as high as in women. The largest gender ratio in cardiovascular mortality rate (4.3) was observed for the 50-59 age-group.

CHD, cerebrovascular diseases and cardiomyopathies were the three main causes of premature cardiovascular mortality across all three age strata comprising, respectively: 62.5%, 21.5% and 9.8% in men (Table 2); and 51.4%, 25.2% and 14.5% in women (Table 3).

Deaths from myocardial infarction in the total sample constituted only 11% of all CHD deaths in men and 20% in women. The rest of the CHD diagnoses included “other acute or subacute cardiac ischemia” (ICD-10 code I24) and “chronic ischemic heart disease”(ICD-10 code I25). None of the cardiovascular deaths was coded as “sudden cardiac death” (ICD-10 code I46.1).

For ages 30 to 49, cardiomyopathy constituted one-half of all cardiovascular deaths in women and one-fourth in men. The majority of cardiomyopathies were classified as alcoholic cardiomyopathy (ACMP), specifically 90% in men and 65% in women. The etiology for other cardiomyopathies was unspecified.

For approximately one third of men and women under age 60 who died from CVD, there was evidence of alcohol consumption prior to death. This proportion was lower for older ages. Four of five cases of cardiovascular death with a BAC ≥4.0g/l were registered among men aged 50 to 59 (Table 2).

The highest proportion of deaths with detectable levels of alcohol in blood was seen among those who died from cardiomyopathies and the two CHD subgroups "other acute or subacute cardiac ischemia" and "atherosclerotic heart disease". Only 5% of male and 1% of female deaths classified as being due to cardiovascular disease had high BACs (2.5 to 3.99g/l). Among the five men with potentially lethal BACs (≥4.0g/l), three died from the CHD, one from the cerebrovascular disease, and another from essential hypertension. Only one cardiovascular female death with a BAC ≥4g/l was identified.

Alcohol was more likely to be found at autopsy in men than in women who died from all cardiovascular causes (OR 1.55; 95% CI 1.14-2.10), ischaemic heart disease (OR 2.04 (1.36-3.05) and chronic ischaemic heart disease (OR 2.02; 95% CI 1.23-3.31). No such difference was found for deaths from myocardial infarction, cerebrovascular diseases, cardiomyopathies and alcoholic cardiomyopathy (Table 4).

Discussion

This is the most recent study on the association between alcohol use before death and cardiovascular mortality in Russia. It highlights the situation in the Northern city of Arkhangelsk in 2008-9 after the rising trend of cardiovascular mortality in Russia has reversed. We have found that a high proportion of people under the age of 60 dying from cardiovascular diseases in Arkhangelsk consumed alcohol in the hours before death. This is particularly so among men aged 50 to 59 years. The largest proportion of men and women with any alcohol identified at autopsy was found for the following cardiovascular death diagnoses: “other acute or subacute cardiac ischemia” (I24), atherosclerotic heart disease (I25.1) and cardiomyopathies (I42). Cardiomyopathies, in general, and alcoholic cardiomyopathy are the largest components of premature cardiovascular mortality in women and the second largest in men under 50. We found little evidence of misclassification of deaths from acute alcohol poisoning as cardiovascular deaths.

Only few Russian studies used autopsy data to examine association between alcohol consumption and mortality. Two of them were conducted in Izhevesk (Urals Region) and were entirely focused on deaths among men of working age(26;30). The third by Zaridze et al.(11), and by far the largest study, examined 24800 male and female deaths (with 8,232 cardiovascular deaths under the age of 70) in 1990-2004 in the city of Barnaul in South Siberia. The proportion of the deceased who were subjected to the forensic examination in the corresponding age- and sex-groups in these studies was lower (25-60% in Barnaul and 50% or less in Izhevsk) than in the present study.

Strengths and weaknesses

Apart from the highest forensic autopsy rate in comparison with other publications, our study has two important additional advantages: it captures a complete set of death-events in a single city during a short time period, and employed uniform diagnostics and coding practices that remained virtually unchanged. Other strengths include: performing a study in the Northern part of Russia where no similar studies have been done, inclusion of women, comparison with Western European estimates (Norway), and being the first study using the data after 2005 when cardiovascular mortality in Russia started to decrease.(2) However, unlike the Izhevsk study we did not have any additional information about individual alcohol drinking behavior. Instead, we have had to rely on exposure to alcohol before death as indicated by the presence of alcohol in blood or other tissues. However, BAC quickly decreases after cessation of drinking, and the speed of alcohol elimination from blood in heavy drinkers may be as high as 0.2-0.3‰ per hour.(33) This limitation is common for all the aforementioned autopsy studies.(11;26;30)

Alcohol consumption before death and cardiovascular mortality

About one third of the men and women who died from cardiovascular diseases before the age of 60 consumed alcohol before death. This proportion is high, but it is considerably lower than found in Barnaul 45-50%.(11) The study from Izhevsk by Leon at al.(26) did not publish the corresponding data. However, when comparing the proportion of men who died from a cardiovascular disease with a BAC of >2.5g/l in Izhevsk and Arkhangelsk (age-group 30-49), it was two times higher in Izhevsk (17% versus 8.4%). Perhaps, these differences between Arkhangelsk and the two other settings can be attributed to geographic variations, temporal changes, socio-economic status or a more effective anti-alcohol policy. The available data suggest the presence of an East-to-West gradient from Barnaul to Izhevsk and Arkhangelsk.

A large population-based study undertaken in Arkhangelsk in 2000 found that binge drinking (i.e. a consumption of ≥80g of pure alcohol on one occasion at least once a month) was reported by 52% of men and 17% of women.(13) Vodka or other hard liquor constituted 61% of the total alcohol consumed.(35) The same study also showed that the highest population levels of gamma-glutamyltransferase (58.2 U/L) and the highest means of scores taken on the Alcohol Use Disorders Identification Test (8.0; where a score of ≥8.0 indicates hazardous or harmful alcohol consumption) were found in males aged 50 to 59.(13) In view of this fact, our finding that the absolute number of cardiovascular deaths in the corresponding age-group of men was surprisingly higher than in the age-group of 60-70 years is important. The highest number of deaths with severe and potentially lethal BAC was also found among them.

Since the detrimental effect of binge drinking on the cardiovascular system is well known (15) and is mediated by plausible physiological mechanisms(16;17), we hypothesized that the hazardous pattern of alcohol intake may accelerate the natural course of cardiovascular disease and prematurely trigger fatal cardiovascular collapse. At age of 50-59, the heart of an average man is not in perfect condition due to natural aging. Its vascular system is affected by multiple atherosclerotic plaques and slight to moderate hypertrophy or dystrophy of the myocardium.(36;37) These may decrease the threshold for acute pathological events. It is likely that for this age-group that inherent compensating mechanisms start to fail in chronic binge drinkers. This would explain the considerable increase in cardiovascular mortality which, interestingly, waned for ages 60-70 years (Table 2). By comparison the observed pattern of cardiovascular mortality is totally different in Arkhangelsk women, amongst whom the absolute number of cardiovascular deaths linearly increases with age (Table 3) as is observed in Norwegian men and women.(38)

Heterogeneity of CHD-mortality

Our findings that the proportion of deceased with any alcohol detected on autopsy was the highest among those whose cause of death was classified as “other acute or subacute cardiac ischemia” or “atherosclerotic heart disease” agree with previous findings.(11;26) A large proportion of premature cardiovascular deaths among individuals in these two groups results from acute cardiovascular events that were quickly followed by fatal outcome. The typical original clinical diagnosis reported on death certificates issued in Arkhangelsk, corresponding to the ICD-10 subcategory of “other acute or subacute cardiac ischemia” (I24) was acute heart failure, with acute cardiovascular failure for atherosclerotic heart disease (I25.1). Both point to the acuteness of the pathological process. These two large diagnostic subcategories composed about 60% of all CHD-deaths in men under seventy. Acute myocardial infarction (AMI) constituted only 11% and 20% of CHD deaths under 70, respectively in men and women; this is in line with other Russian studies.(11;26) By contrast, in Norway in 2008, of 735 male CHD-deaths at age 35-69, 472 (64%) were classified as AMI and 168 (34.1%) deaths were attributed to atherosclerotic heart disease (I25.1); the respective numbers for 187 women with CHD deaths were 137 (73.3%) and 46 (24.6%), while no deaths were classified as “other acute or subacute cardiac ischemia”.(38;38)

However, the AMI proportion we found in men is lower than that reported in other studies from Russia.(11;26) This finding was somewhat unexpected, since more than

95% of the diagnoses in our sample were based on the results of either forensic or hospital autopsy.

From this, one may conclude that the autopsy in Arkhangelsk did not detect a clot in the coronary arteries or area of myocardial necrosis in the majority of deaths classified as caused by a CHD. One could postulate that the pathological mechanism for many CHD-deaths having the ICD-10 codes I24 and I25 may be different from the one for AMI (I21-22). The pathological mechanism (a coronary thrombosis followed by myocardial necrosis) and diagnostic criteria for the AMI are well known and internationally standardized, but seem less clear for such vague diagnoses as acute heart failure and acute cardiovascular failure. Acute effects of binge drinking could plausibly enhance the underlying developmental mechanisms of the two categories of premature acute cardiac death among men.(15;16)

A total absence of deaths coded as sudden cardiac death (I46.1) among the deaths during the study period is another peculiarity of cardiovascular mortality in Arkhangelsk. We suspect that such deaths are classified as other diagnostic subcategories, most likely, the “other acute or subacute cardiac ischemia”, and “atherosclerotic heart disease”.

Premature mortality and alcoholic cardiomyopathy

ACMP is a dilated cardiomyopathy resulting from chronic toxic effects of alcohol on the myocardium and is a part of a clinical picture of advanced alcoholic disease. There are more than 10 etiological types of dilated cardiomyopathy(39) comprising more than 40 nosologies. Diagnosis of the ACMP is difficult and based on assessment of the following: history of alcohol consumption, general inspection of the body, presence of macro- and microscopic signs of cardiomyopathy (none of these signs are specific to ACMP), measurement of alcohol concentration in urine and blood, biochemical analyses of myocardium’s specimens. From the former, ACMP differs with relatively mild atherosclerotic changes and absence of coronary stenoses, advanced atrophy/hypertrophy of the cardiomyocites, the affection by alcohol of other organs (fatty liver, pancreatitis, gastritis), the urine-to-blood alcohol concentration ratio of ≥2 and the potassium/sodium ratio in the myocardium of >1. Differentiation of the ACMP from acute alcohol poisoning is more difficult. The latter is characterized by high BAC of ≥4g/l, age of death less than 40 years and very high urine alcohol concentration with a urine/blood concentration ratio of much higher than 2. Overfilled urinary bladder with signs of uncontrolled urination and other evidences of coma preceding death, support the diagnosis of alcohol poisoning.

ACMP was responsible for one third and one fifth of all female and male cardiovascular deaths under the age of 50 years in Arkhangelsk, respectively. Although the etiology of the majority of other cardiomyopathies was unspecified (ICD-10 code I42.9), it is also possible that alcohol contributed to the development of a substantial proportion of them. For comparison, of 144 men who died from a cardiovascular disease in Norway in 2008 under the age of 50, only five (2.8%) had the diagnosis cardiomyopathy and only one (0.7%) died from alcoholic cardiomyopathy. Corresponding figures for women were: 1 (2.1%) and 0 of 47 deaths.(38)

No difference in mortality from cardiomyopathy and alcoholic cardiomyopathy by age between men and women was found, suggesting that women suffering from advanced alcoholic disease had at least the same probability to die prematurely from alcoholic cardiomyopathy as men. We conclude that alcoholic and unspecified cardiomyopathies cause a large proportion of cardiovascular deaths under the age of 50, thereby contributing to the low life expectancy. Interestingly, in our sample there were deaths from alcoholic cardiomyopathy in a man aged 26 and a woman of 31. Taking into account that a duration of hazardous drinking (a daily consumption of 90-200g of alcohol) of at least 5 years (average is 15 years) is needed to develop asymptomatic cardiomyopathy, the consumption of large quantities of alcohol must have started early in life for these two individuals.(40;41)

Misclassification of cardiovascular deaths

Contrary to the Barnaul(11) study, our results are not consistent with the hypothesis that large-scale artificial inflation of the number of cardiovascular deaths results from a misclassification of acute alcohol poisonings. This conclusion concurs with the findings of both studies from Izhevsk.(26;30) This discrepancy may be due to the different coding practices between the forensic pathologists in Arkhangelsk and those in Barnaul, or reflect some real differences between regions of Russia. It seems, however, that the regional differences are unlikely to explain the entire mismatch in the high prevalence of lethal BACs in cardiovascular deaths in Barnaul, and the lower prevalences of such deaths in Arkhangelsk and Izhevsk. Data in Barnaul had been collected mostly during the 1990s, and it is possible that the phenomenon of misclassification took place at a time of the implementation of ICD-10 system. In addition, this period was characterized by severe socio-economic instability and abruptly increasing cardiovascular mortality that diminished later. Another plausible explanation is that the average forensic autopsy rate, which should be viewed as the proxy for representativeness of the sample in this type of study, in Barnaul was considerably lower than in Arkhangelsk.

One final issue. Socially isolated and marginalized individuals (homeless, alcoholics, drug abusers), who are underrepresented in virtually all large epidemiological studies from Russia, are more likely to be autopsied by forensic experts. By contrast, “average” individuals die more often in a hospital, and are thus subjected to a post-mortem examination by hospital pathologists, thereby circumventing a forensic examination. Consequently, they are likely to be somewhat underrepresented in this type of study.

Key messages

- Alcohol consumption in the hours before death is associated with a high proportion of premature cardiovascular deaths in Arkhangelsk, Russia.
- The proportion of men dying from a cardiovascular disease with identified alcohol is higher than for women.
- The difference in cardiovascular mortality and the proportion with identified alcohol is highest among 50-59 year old men.
- The proportion of men and women with identified alcohol is highest in the large group of vaguely defined CHD-deaths and in the group of cardiomyopathies.

- Alcoholic cardiomyopathy is an important component of premature cardiovascular mortality in Northwest Russia.
- We found little evidence to support the hypothesis of misclassification of fatal alcohol poisonings as cardiac deaths.

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Table 1 Mortality in Arkhangelsk by age and gender from 01.01.2008 to 31.12.2009 with a proportion of forensic examinations within the groups of diagnoses

Cause of death (ICD-10 code)	Age groups (years)	Men N (%)[2]	Men Rate per 100.000[1]	Men N(%) forensic autopsies	Women N (%)[2]	Women Rate per 100.000[1]	Women N(%) forensic autopsies
Cardiovascular diseases (I00-99)	0-49	298 (21.9)	127.2	237 (79.5)	92 (18.6)	32.6	66 (71.7)
	50-59	525 (41.7)	2524.2	393 (74.9)	175 (32.7)	591.8	120 (68.6)
	60-69	468 (48.1)	4607.7	308 (65.8)	313 (49.2)	1757.9	177 (56.5)
	≥ 70	822 (55.9)	6622.6	557 (67.8)	1930(68.4)	5345.7	1288 (66.7)
	All ages	2113(41.7)	633.3	1495 (70.7)	2510(55.9)	322.7	1651 (65.8)
Malignansies (C00-97)	0-49	86 (6.3)	36.7	30 (34.9)	80 (16.2)	31.8	44 (55.0)
	50-69	468 (21.0)	755.9	251 (53.6)	351 (30.0)	370.5	198 (56.4)
	≥ 70	364 (24.8)	2932.7	241 (66.2)	453 (16.1)	1254.7	302 (66.7)
	All ages	918 (18.1)	250.1	522 (56.9)	884 (19.7)	120.7	544 (61.5)
External causes (V01-Y98)	0-49	565 (41.5)	241.2	563 (99.6)	135 (27.3)	53.6	134 (99.3)
	50-69	371 (16.6)	599.2	368 (99.2)	123 (10.5)	129.8	122 (99.2)
	≥ 70	82 (5.6)	660.7	82 (100)	80 (2.8)	221.6	78 (97.5)
	All ages	1018(20.1)	283.0	1013 (99.5)	338 (7.5)	64.2	334 (98.8)
Alcohol poisoning (T51.0-T51.9)	0-49	97 (7.1)	41.4	97 (100)	31 (6.3)	12.3	31 (100)
	50-69	119 (5.3)	192.2	119 (100)	46 (3.9)	48.5	46 (100)
	≥ 70	11 (0.75)	88.6	11 (100)	8 (0.3)	22.2	8 (100)
	All ages	227 (4.5)	62.4	227 (100)	85 (1.9)	16.2	85 (100)
Other causes	0-49	413 (30.3)	176.3	148 (35.8)	188 (38.0)	74.6	60 (31.9)
	50-69	400 (17.9)	646.1	189 (47.3)	210 (17.9)	221.6	82 (39.0)
	≥ 70	203 (13.8)	1635.5	105 (51.7)	359 (12.7)	994.3	194 (54.0)
	All ages	1016(20.1)	315.5	442 (43.5)	757 (16.9)	144.8	336 (44.4)
All deaths	0-49	1362	581.4	978 (71.8)	495	196.5	304 (61.4)
	50-69	2232	3605.1	1509 (67.6)	1172	1236.9	699 (59.6)
	≥ 70	1471	11851.4	985 (67.0)	2822	7816.3	1862 (66.0)
	All ages	5065	1508.7	3472 (68.5)	4489	663.8	2865 (63.8)

[1]Annual mortality rates for the age groups are given as crude. The rates for “all ages” are age-standardized to the world standard population
[2]Number and percent from all deaths in the corresponding age-group

Table 2 Cardiovascular mortality among men in Arkhangelsk from 01.01.2008 to 31.08.2009 by age and postmortem data on alcohol use prior to death

Cause of death (ICD-10 code)	Age-groups (years)	N (%) of deaths[1]	N (%) of forensic autopsies[2]	Alcohol detected N (%)[3]	Blood alcohol concentration (g/l), N (%) from the number of forensic autopsies			
					<0.5	0.5-2.49	2.5-3.99	≥4.0
Cardiovascular diseases (I00-99)	30-49	238	191 (80.3)	65 (34.0)	16 (8.4)	23 (12.0)	16 (8.4)	0
	50-59	432	318 (73.6)	110 (34.6)	32 (10.1)	36 (11.3)	24 (7.6)	4 (1.3)
	60-70	429	287 (66.9)	66 (23.0)	22 (7.7)	22 (7.7)	15 (5.2)	1 (0.4)
Ischaemic Heart Disease (I20.0-25.9)	30-49	131 (55.0)	120 (91.6)	36 (30.0)	11 (9.2)	12 (10.0)	9 (7.5)	0
	50-59	282 (65.3)	244 (86.5)	84 (34.4)	26 (10.7)	26 (10.7)	20 (8.2)	3 (1.2)
	60-70	274 (63.9)	218 (79.6)	57 (26.2)	18 (8.3)	20 (9.2)	14 (6.4)	0
-Myocardial infarction (I21-22)	30-49	10 (4.2)	4 (40)	2 (50.0)	0	1 (25.0)	1 (25.0)	0
	50-59	23 (5.3)	5 (21.7)	1 (40.0)	0	1 (25.0)	0	0
	60-70	43 (10.0)	14 (32.6)	1 (14.3)	1 (7.1)	0	0	0
-Other acute/subacute IHD (I24)	30-49	24 (10.1)	24 (95.8)	9 (37.5)	1 (4.2)	3 (12.5)	3 (12.5)	0
	50-59	17 (3.9)	14 (82.4)	8 (57.1)	4 (28.6)	2 (14.3)	1 (7.1)	1 (7.1)
	60-70	9 (2.1)	5 (55.6)	3 (60.0)	2 (40.0)	0	1 (20.0)	0
-Chronic IHD (I25)	30-70	561 (51.0)	517 (92.2)	153 (29.6)	47 (9.1)	51 (9.9)	37 (7.2)	2 (0.4)
-Atherosclerotic heart disease (I25.1)	30-49	70 (29.4)	70 (100)	18 (25.7)	7 (10.0)	6 (8.6)	4 (5.7)	0
	50-59	154 (35.7)	145 (94.2)	58 (40.0)	16 (11.0)	18 (12.4)	14 (9.7)	1 (0.7)
	60-70	116 (27.0)	113 (97.4)	34 (30.1)	11 (9.7)	13 (11.5)	7 (6.2)	0
-Old myocardial infarction (I25.2)	30-49	26 (10.9)	23 (88.5)	7 (30.4)	3 (13.0)	2 (8.79)	1 (4.4)	0
	50-59	85 (19.7)	80 (94.1)	17 (21.3)	6 (7.5)	5 (6.3)	5 (6.3)	1 (1.3)
	60-70	97 (22.6)	86 (88.7)	19 (22.1)	4 (4.7)	7 (8.1)	6 (7.0)	0
Cerebrovascular diseases (I60-69)	30-49	35 (14.7)	11 (31.4)	1 (9.1)	0	1 (9.1)	0	0
	50-59	84 (19.4)	25 (29.8)	2 (18.0)	1 (4.0)	1 (4.0)	0	0
	60-70	117 (27.3)	49 (41.9)	5 (10.2)	3 (6.1)	1 (2.0)	0	1 (2.0)
Cardiomyopathies (I42.0-I42.9)	30-49	54 (22.7)	52 (96.3)	27 (51.9)	5 (9.6)	9 (17.3)	7 (13.5)	0
	50-59	42 (9.7)	39 (92.9)	21 (53.9)	5 (12.8)	7 (18.0)	4 (10.3)	0
	60-70	12 (2.8)	11 (91.7)	3 (25.0)	1 (9.1)	0	1 (9.1)	0
-Alcoholic cardiomyopathy (I42.6)	30-49	47 (19.7)	45 (95.8)	23 (51.1)	5 (11.1)	7 (15.6)	6 (13.3)	0
	50-59	35 (8.1)	34 (97.1)	18 (52.9)	3 (8.8)	7 (20.6)	4 (11.8)	0
	60-70	11 (2.6)	10 (90.9)	3 (30.0)	1 (10.0)	0	1 (10.0)	0

[1] Percent of the total number of cardiovascular deaths in the corresponding age stratum
[2] Percent of the number of deaths with the same coding in the corresponding age stratum
[3] Any alcohol detected in the blood or other tissues at forensic autopsy

Table 3 Cardiovascular mortality among women in Arkhangelsk from 01.01.2008 to 31.08.2009 by age and postmortem data on alcohol use prior to death

Cause of death (ICD-10 code)	Age-groups (years)	Number of deaths[1]	N (%) of forensic autopsies[2]	Alcohol detected N (%)[3]	Blood alcohol concentration (g/l), N (%) from the number of forensic autopsies			
					<0.5	0.5-2.5	2.5-4.0	>4.0
Cardiovascular diseases (I00-99)	30-49	77	56 (72.7)	21 (37.5)	6 (10.7)	10 (17.9)	2 (3.6)	0
	50-59	147	98 (66.7)	27 (27.6)	9 (9.2)	10 (10.2)	2 (2.0)	0
	60-70	295	170 (57.6)	23 (13.5)	10 (5.9)	7 (4.1)	3 (1.8)	1 (0.6)
Ischaemic Heart Disease (I20.0-25.9)	30-49	14 (18.2)	11 (78.6)	1 (9.1)	0	1 (9.1)	0	0
	50-59	74 (50.3)	58 (78.4)	16 (27.6)	9 (15.5)	5 (8.6)	1 (1.7)	0
	60-70	179 (60.7)	129 (72.1)	18 (14.0)	8 (6.2)	5 (3.9)	2 (1.6)	1 (0.8)
-Myocardial infarction (I21-22)	30-49	2 (2.6)	1 (50.0)	0	0	0	0	0
	50-59	13 (8.8)	3 (23.1)	0	0	0	0	0
	60-70	38 (12.9)	13 (34.2)	2 (15.4)	1 (7.7)	0	0	0
-Other acute/subacute IHD (I24)	30-49	4 (5.2)	3 (75.0)	0	0	0	0	0
	50-59	12 (8.2)	9 (75.0)	4 (44.4)	2 (22.2)	1 (11.1)	1 (11.1)	0
	60-70	11(3.7)	6 (54.5)	1 (16.7)	0	1 (16.7)	0	0
-Chronic IHD (I25)	30-70	187 (36.0)	163 (87.2)	28 (17.2)	14 (8.6)	9 (5.5)	2 (1.2)	1 (0.6)
-Atherosclerotic heart disease (I25.1)	30-49	6 (7.8)	6 (100.0)	1 (16.7)	0	1 (16.7)	0	0
	50-59	37 (25.2)	37 (100.0)	11 (29.7)	7 (18.9)	3 (8.1)	0	0
	60-70	90 (30.5)	82 (91.1)	13 (15.9)	6 (7.3)	4 (4.9)	2 (2.4)	0
-Old myocardial infarction (I25.2)	30-49	2 (2.6)	1 (50.0)	0	0	0	0	0
	50-59	9 (6.1)	8 (88.9)	0	0	0	0	0
	60-70	34 (11.5)	28 (82.4)	2 (7.1)	1 (3.6)	0	0	1 (3.6)
Cerebrovascular diseases (I60-69)	30-49	14 (18.2)	5 (35.7)	1 (20.0)	0	1 (20.0)	0	0
	50-59	34 (23.1)	9 (26.5)	1 (11.1)	0	0	0	0
	60-70	83 (28.1)	27 (32.5)	1 (3.7)	1 (3.7)	0	0	0
Cardiomyopathies (I42.0-I42.9)	30-49	37 (48.1)	37 (100.0)	19 (51.4)	6 (16.2)	8 (21.6)	2 (5.4)	0
	50-59	29 (19.7)	27 (93.1)	9 (33.3)	0	5 (18.5)	1 (3.7)	0
	60-70	9 (3.1)	9 (100.0)	3 (30.0)	0	2 (22.2)	1 (11.1)	0
-Alcoholic cardiomyopathy (I42.6)	30-49	24 (31.2)	24 (100.0)	13 (54.2)	6 (25.0)	8 (30.0)	2 (8.3)	0
	50-59	24 (16.3)	23 (95.8)	8 (34.8)	0	5 (21.7)	1 (4.4)	0
	60-70	7 (2.4)	7 (100.0)	3 (42.9)	0	2 (28.6)	1 (14.3)	0

[1]Percent of the total number of cardiovascular deaths in the corresponding age stratum
[2]Percent of the number of deaths with the same coding in the corresponding age stratum
[3]Any alcohol detected in the blood or other tissues at forensic autopsy

Table 4 Sex-specific distribution of alcohol positive and negative autopsies by death diagnosis, with OR for probability of alcohol-positive autopsy result (men vs. women)

Cause of death (ICD-10 code)	Men	Women	OR (95% CI)	P-value
Total number of autopsies	795	324		
Cardiovascular diseases (I00-99)				
Alcohol positive	241	71	1.55	0.004
Alcohol negative	554	253	(1.14-2.10)	
IHD (I20.0-25.9)				
Alcohol positive	177	35	2.04	0.001
Alcohol negative	405	163	(1.36-3.05)	
-*Myocardial infarction (I21-22)*				
Alcohol positive	4	2	1.58	0.62
Alcohol negative	19	15	(0.25-9.82)	
-*Other acute/subacute IHD (I24)*				
Alcohol positive	20	5	2.36	0.15
Alcohol negative	22	13	(0.72-7.82)	
-*Chronic IHD (I25)*				
Alcohol positive	110	25	2.02	0.005
Alcohol negative	218	100	(1.23-3.31)	
Cerebrovascular diseases (I60-69)				
Alcohol positive	8	3	1.32	0.70
Alcohol negative	77	38	(0.33-5.25)	
Cardiomyopathies (I42.0-I42.9)				
Alcohol positive	51	31	1.36	0.33
Alcohol negative	51	42	(0.74-2.48)	
-*Alcoholic cardiomyopathy (I42.6)*				
Alcohol positive	44	24	1.22	0.56
Alcohol negative	45	30	(0.62-2.41)	