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Research Article

Russian mortality beyond vital statistics: Effects of social status and behaviours on deaths from circulatory disease and external causes - a case-control study of men aged 20-55 years in Udmurtia, 1998-99

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Max Planck Institute for Demographic Research

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Abstract

Analyses of routine data have established that the extreme mortality fluctuations among young and middle-aged men are the most important single component of both temporal changes in Russian life expectancy at birth and in the gap between male and female life expectancy. It is also responsible for the largest share of the life expectancy gap between Russia and other industrialised countries. A case-control study has been used to identify factors associated with mortality among men aged 20 to 55 in the five major cities of the Udmurt Republic in 1998-99. Men dying from external causes and circulatory disease are taken as cases. Matched controls were selected from men of the same age living in the same neighbourhood of residence. Information about characteristics of cases and controls was obtained by interviewing proxies who were

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family members or friends of the subjects. After exclusion of those deaths for which proxy informant could not be identified, a total of 205 circulatory disease and 333 external cause cases were included together with the same number of controls. Educational level was significantly associated with mortality from circulatory diseases and external causes in a crude analysis. However, this could largely be explained by adjustment for employment, marital status, smoking and alcohol consumption. Smoking was associated with mortality from circulatory disease (crude OR=2.44, 95% CI 1.36-4.36), this effect being slightly attenuated after adjustment for socio-economic factors and alcohol consumption. Unemployment was associated with a large increase in the risk of death from external causes (crude OR=3.63, 95% CI 2.17-6.08), an effect that was still substantial after adjustment for other variables (adjusted OR=2.52, 95% CI 1.43-4.43). A reported history of periods of heavy drinking was linked to both deaths from circulatory disease (crude OR=4.21, 95% CI 2.35-7.55) and external cause mortality (crude OR=2.65, 95% CI 1.69-4.17). Adjustment for other variables reduced the size of these odds ratios, but they remained strikingly large for circulatory disease (adjusted OR=3.54, 95% CI 1.76-7.13) and considerable for external causes (adjusted OR 1.75, 95% CI 1.02-3.00). These may be underestimates of the true effects as nearly all of them increased when employment status (which can in part at least be seen as being on the causal pathway) was excluded from the final model. In summary, however, our key finding is that a history of heavy drinking in the recent past is strongly associated with risk of death from circulatory disease. This provides the first individual-level evidence in support of the hypothesis that episodic heavy drinking is key to explaining the heavy burden of circulatory disease mortality among Russian men of working age.

1. Introduction

Mortality rates in Russia today are very high in comparison with those in other industrialised countries (Shkolnikov, McKee and Leon, 2001, Shkolnikov, Meslé and Leon, 2001). In 1999 life-expectancy at birth among men was 60 years and among women was 72 years. The very low level of average length of life, the enormous mortality gap between the sexes and unfavourable trends over time are mainly due to excess male mortality at working ages from external causes of death (injuries, violence and poisonings) and circulatory disease. For men the probability of death between ages 20 and 60 is about 45% in Russia compared to approximately 10% in a western country such as the UK.

Detailed analyses of routine mortality data have established that these high mortality rates and their dramatic fluctuations that have occurred since the mid-1980s, when alcohol consumption fell precipitously because of the wide-ranging anti-alcohol restrictions of 1985, are real and not due to artefact (Leon et al., 1997). Despite understandable scepticism (Bobak and Marmot, 1999), there is considerable justification (McKee, Shkolnikov and Leon, 2001) to implicate high levels of alcohol consumption, particularly episodic heavy drinking as an important proximate risk factor driving these mortality fluctuations. However, data on alcohol consumption patterns in Russia are fragmentary or indirect (Nemtsov, 2000) and suffer from all the usual concerns about reporting bias. Nevertheless, these data suggest that mortality variation over time parallels variations in alcohol consumption (Zohoori et al., 1998, Russian Longitudinal Monitoring Survey, 2001) and what evidence exists on the prevalence of episodic heavy drinking suggests that it is common (Bobak et al., 1999).

The fluctuations in life-expectancy over the past 15 years have been particularly pronounced among people of working age but have not affected all parts of Russia equally. The mortality crisis of the mid-1990s appears to have been most intense in the large metropolitan centres, such as Moscow and St Petersburg, possibly due to the greater pace of economic and social change and the consequent societal disruption that occurred in these settings (Walberg et al., 1998). There is also good evidence, parallel to that from other countries, that socio-economic position (particularly as measured by educational level) is related to mortality rates and that the mortality increase of the early 1990s was concentrated among the least educated (Shkolnikov et al., 1994). Notably strong educational gradients are observed for alcohol related deaths, including acute alcohol poisoning and other external causes of death (Chenet et al., 1998).

One of the most striking features of the mortality fluctuations has been the way in which some causes of death have been more affected than others. For example, deaths from external and alcohol-related causes have shown particularly marked variation. Circulatory disease has shown a similar pattern, although the amplitude has been

proportionally less. In contrast mortality from cancer has shown relatively stable trends that have not been perturbed by the events of the 1990s.

The fluctuations in circulatory disease mortality have provided a particular challenge to conventional epidemiological assumptions about the aetiology of this group of conditions, in particular the cardio-protective nature of alcohol consumption, possibly mediated by an "improved" lipid profile. We have previously argued that this apparent contradiction may be explained by the heterogeneity of conditions encompassed by the term "coronary heart disease" and their associated risk factors (McKee, Shkolnikov and Leon, 2001). One of these conditions is sudden cardiac death, which is a much more frequent manifestation of "coronary heart disease" in Russia than in the west. Episodic heavy drinking gives rise to a distinctive set of physiological responses (high LDL and low HDL cholesterol, clotting, arrhythmias, and hypertension) that increase the risk of sudden cardiac death (McKee and Britton, 1998) and is associated specifically with sudden death in epidemiological studies (Britton and McKee, 2000).

The hypothesis that episodic heavy drinking may lead to an increased risk of sudden death is biologically plausible and is supported by individual-level data from other countries such as Finland (Kauhanen et al., 1997). However, there is no direct individual-level evidence for this relationship in Russia. Further analyses of the Russian vital statistics are unlikely to be able to look at this issue in more depth. To go further requires individual-level data on mortality in relation to the drinking habits of working-age Russian men. This is necessary in order to test the hypothesis that alcohol consumption has a central role in explaining the mortality patterns of Russian men.

At a more general level, irrespective of the role of alcohol, it is also important to explore the social determinants of mortality among Russian men of working age. While there can be no doubt that the massive social, economic and political disruptions of the past 15 years have influenced Russian mortality rates as a whole, how these have affected mortality risk for different groups within the population has not been adequately investigated.

Given the seriousness of the mortality situation in Russia it is surprising that there have been very few individual-level investigations of mortality in Russia published in the past decade. This paucity of studies reflects the difficulties of undertaking research in a context where resources and infrastructure are limited and research funds are not readily available. The Lipid Research Clinics studies comparing cardiovascular disease in the USSR/Russia with the United States of America are an exception (Davis et al., 1994, Dennis et al., 1993). These analyses, however, look at mortality among middle-aged subjects screened in the 1970s, and thus can throw little light on the impact of conditions in the 1990s on mortality especially among people aged less than 60 years for whom the mortality crisis was most acute. Of relevance to this paper, however, they

did show that sudden cardiac death was responsible for a substantial share of the educational gap in male mortality from cardiovascular disease and that these deaths are relatively independent of the level of total and LDL cholesterol (Shestov et al., 1993).

Even if a cohort study recruited at a younger age than the LRC studies had been set up at the end of the 1980s in Russia it is questionable whether it would have been able to capture the acute effects that seem to characterise Russian mortality during the 1990s. The population-level studies on mortality in Russia mentioned above, show that abrupt changes in social conditions (such as the anti-alcohol campaign of the mid-1980s or unexpected and radical socio-economic transformations of the early 1990s) resulted in strong and almost *immediate* changes in mortality. Thus a valid study of this phenomenon should be able to capture these unusually short "exposure-response" intervals. The classic cohort study, in which disease endpoints are related to a single set of baseline exposure measurements, that are increasingly far in the past as follow-up proceeds, is not going to be able to capture these events adequately other than in the first few years of the study. What is necessary is a design where information about the exposures in the days and months prior to each death can be collected, and then related to mortality risk. A case-control study in which information about recent exposures is obtained from relatives and friends of the study subjects provides an efficient design that is able to overcome the limitations of conventional cohort studies.

In this paper we report the findings of such a case-control study in the Udmurt Republic, in Russia. The aims of the study were to investigate the association of individual-level socio-economic and behavioural characteristics with mortality from circulatory disease and injuries, poisonings and violence among working age men in Russia. This paper extends our preliminary reports on the study that were restricted to deaths from all causes combined (Shkolnikov and Chervyakov, 2001) and to deaths from circulatory disease (Shkolnikov, Meslé and Leon, 2002).

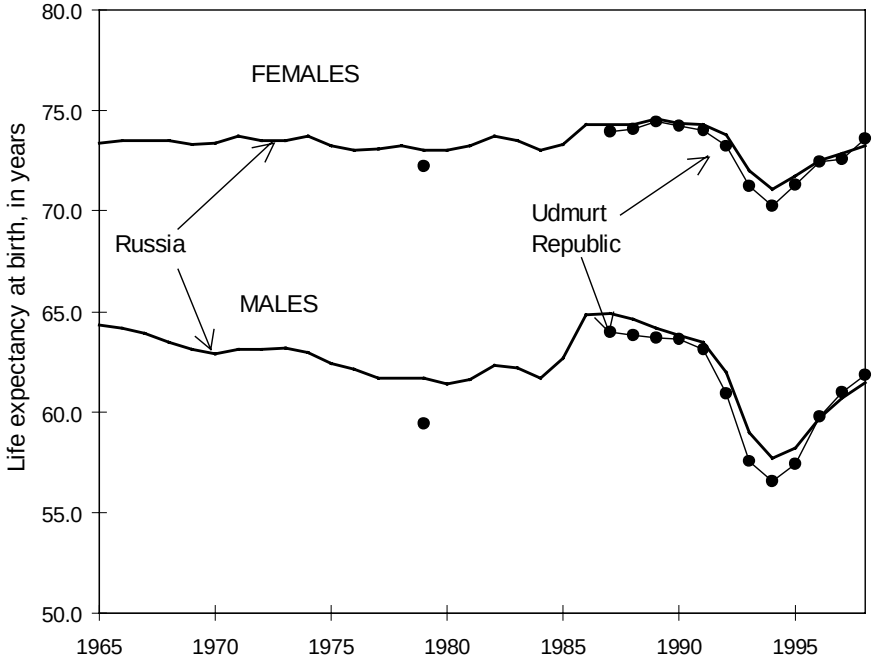
2. Design and methods

The study was set up to investigate the risk of death from specific causes (circulatory disease and external causes) in Russian men of working age (20-55 years) in relation to their current socio-economic circumstances, personal characteristics and behaviours.

2.1. Study setting

The study was conducted in the Udmurt Republic, a part of the Russian Federation, which in 1998 had a population of 1.6 million, 70% of whom lived in cities. Its capital,

Izhevsk (population 650,000), is located 1,300 km south east of Moscow in the middle Urals. The target population for the study were those living in the republic's five major cities : Izhevsk, Votkinsk, Sarapul, Glazov, and Kambarka. The mortality profile of the Udmurt Republic (henceforth referred to as Udmurtia) is similar, in most respects, to that of Russia as a whole. In 1998-99 life expectancy at birth in this region was slightly higher (by 0.3 years) than the national average (Figure 1), with similar patterns of mortality by cause of death (Table 1), with the exception of suicide, which in Udmurtia is much higher than the Russian average.



Source: Shkolnikov and Chervyakov, 2001.

Figure 1: *Trends in life expectancy at birth: Udmurt Republic and Russia as a whole.*

Table 1: *Male age standardized* rates of death from principal classes of causes of death in the Udmurt Republic and Russia in 1998 and in an average western population** in 1992-1994, per 100 000*

Cause of death	Udmurtia	Russia	"West"	Udmurtia / Russia	Udmurtia / "West"
Infectious diseases	29.53	34.49	16.24	0.86	1.82
Neoplasms	255.78	291.17	313.13	0.88	0.82
Circulatory diseases	844.00	924.66	439.47	0.91	1.92
Respiratory diseases	168.60	105.78	124.60	1.59	1.35
Digestive diseases	55.93	54.53	44.55	1.03	1.26
Other diseases	83.62	66.34	96.90	1.26	0.86
Injuries, poisonings and violence	326.83	305.12	80.49	1.07	4.06
All causes combined	**1856.16**	**1847.02**	**1115.37**	**1.00**	**1.66**

* The WHO European standard of the population age structure is used
** The notation "West" corresponds to average mortality rates for France, Germany, Japan, the USA, and the UK.
Source: Shkolnikov and Chervyakov, 2001.

2.2. Case-control design

We used a case-control design to investigate how mortality risk is influenced by the behaviours and circumstances of study subjects in the immediately preceding 1-2 years. Information about the circumstances and characteristics of the cases and controls was obtained by questionnaire interviews with family members, friends or neighbours.

2.3. Case definition and selection

Cases were selected among the 1,336 deaths of men aged 20-55 years occurring in the period August 1998 to March 1999 in the five major cities of Udmurtia. Information about these deaths, including cause of death and last address, was obtained from the medical death certificates. In order to obtain information about the socio-economic circumstances of the deceased these medical death certificates were matched with the corresponding civil death records, which contained information such as education and marital status. This matching procedure was successful for 1023 deaths, 768 of which were from either circulatory disease or external causes as defined in Table 2.

A suitable informant was found and successfully interviewed for 538/768 (70%) of these deaths. These comprised 205 deaths from circulatory disease and 333 from external causes.

Information on marital status and educational level of the deceased was not recorded on the civil death certificate from 1999 onwards. For the 495 deaths from circulatory disease and external causes that occurred in 1998 the distribution of included and excluded deaths by marital status and education is shown in table 4. As might be expected, those included were more likely to be currently married than those excluded. This must reflect in part the fact that currently married men were most likely to have fixed addresses and would have family informants living at their last address. The distribution of those included compared to those excluded was also shifted towards those with higher levels of education.

Table 2: *Underlying cause codes for circulatory disease and external causes*

	1998		1999	
Class of causes of death	Brief classification of the Goskomstat* of 1988	ICD-9	Brief classification of the Goskomstat of 1999	ICD-10
Circulatory diseases	84-102	390-459	115-147	I00-I99
External causes of death (accidents and violence)	160-175	E800-E999	239-254	V01-V89

* State Statistical Committee of the Russian Federation

2.4. Control definition and selection

Each case was individually matched to a control (N=538) on the basis of age (+/- 1 year) and place of residence (same block of houses or flats) based on information from electoral lists of 1997. Usually, there was little or no choice because only a few men met the matching criteria. If no suitable informant was found in the same block then a suitable informant from a neighbouring block of houses was used. Finally, all controls were recruited from within the same neighbourhood as their corresponding cases. Just under 90% of potential control informants who were approached agreed to be interviewed.

Table 3: *Percentage distribution of case deaths due to external causes and circulatory diseases by age, causes and ethnic background according to inclusion status. Men aged 20 to 55 Udmurt Republic 1998-99.*

Characteristics	% distribution of eligible deaths included N=538	% distribution of eligible deaths excluded N=230
Age in years		
20-39	38	44
40-55	62	56
Causes of death		
Diseases of the circulatory system	38	30
Including:		
- IHD*	*24*	*18*
- Other heart diseases**	*7*	*6*
- Other circulatory diseases	*7*	*6*
External causes of death	62	70
Including:		
- Transport accidents	*7*	*6*
- Poisonings by alcohol	*10*	*11*
- Suicide	*22*	*18*
- Homicide	*10*	*15*
- Other accidents and violence	*13*	*20*
Ethnic background		
- Slavic***	72	67
- Udmurts	17	20
- Tartars	8	9
- Other	3	4
Total	100	100

* Deaths due to atherosclerosis, acute forms of the ischeamic heart disease other than myocardial infarction including stenocardia, and ill-defined acute IHD were prevalent among IHD deaths.

** Other heart diseases include cardiomyopathies, cardiac arrhithmias, myocarditis, pericarditis, conduction disorders, and heart failure. In 1998 this group of causes corresponded to items 96 and 97 in the old Russian classification of causes of death and to codes 415-429 in ICD-9. In 1999 this group of causes corresponded to items 131, 132 in the new Russian classification of causes of death and to codes 126-128, 130-151 in ICD-10.

*** Russians, Ukrainians, and Belorussians. 97% of this group are Russians.

Table 4: *Percentage distribution of case deaths due to external causes and circulatory diseases by ethnic background and education according to inclusion status. Men aged 20 to 55 Udmurt Republic 1998*[*]

Characteristics	% distribution of eligible deaths included N=350	% distribution of eligible deaths excluded N=165
Marital status		
- Married	68	49
- Never married	19	25
- Widowed	1	2
- Divorced	12	24
Education		
- University and incomplete university**	11	7
- Specialised secondary	22	17
- Secondary	52	59
- Lower level	15	17
Total	100	100

* In 1999 the State Statistical Committee (Goskomstat) ceased to register educational level and marital status of the deceased in death records. Hence this table is based on deaths occuring in 1998 only.

** Incomplete university education comprises 7% of this group.

2.5. Questionnaire, interview and informant type

A standard interviewer-administered questionnaire was used to collect information about study subjects (cases and controls) from informants in their own homes. Informants could be either family, friends or neighbours. The questionnaire for case informants comprised of 155 questions and that for control informants 143 questions. These covered a range of issues including educational attainment, employment status, marital status and problems in family relations and health-related behaviours including alcohol and tobacco consumption. In this paper we restrict ourselves to a sub-set of the variables whose validity is likely to be high, excluding in particular variables which required subjective interpretations from proxy informants. The specific questions used to assess the variables under consideration are given in the appendix. Further information on other questions, together with exploratory analyses is available elsewhere. (Shkolnikov and Chervyakov, 2001).

Informants for the 538 cases were interviewed in the period June-August of 1999. The interviews for the 538 matched controls were conducted in the same way in the period August-October of 1999. The distribution of interviews by informant type for cases and controls is shown in Table 5. Not surprisingly there was a marked difference between cases and controls. Compared to controls, cases of death from external causes were much less likely to have wives as informants (37% *vs.* 51%). For the cases of death from circulatory disease this difference was much less pronounced (51% *vs.* 56%). This is despite the fact that the included case deaths were far more likely to be married than those excluded (Table 4).

Table 5: *Percentage distribution of informant type by case-control status*

Informant	Circulatory disease		External causes	
	Cases N=205	Controls N=205	Cases N=333	Controls N=333
Wife	50.5	56.0	37.0	51.3
Mother	11.4	11.4	25.6	21.1
Father	1.6	1.1	4.9	1.3
Sister	2.2	1.6	5.5	3.2
Brother	4.3	1.6	2.9	1.9
Daughter	10.3	10.9	7.8	5.8
Son	6.0	6.0	2.3	3.2
Mother/father in-law	1.2	2.2	0.0	0.3
Other *	12.5	9.2	14.0	11.7
Total	100	100	100	100

* Other relatives, friends or neighbours

2.6. Selected causes of death

In this paper we analyse two aggregate causes of death: circulatory disease and external causes (injuries, poisonings and violence). The circulatory disease category largely comprises deaths that were certified as being due to ischaemic heart disease. The external cause group is more heterogeneous being comprised of deaths from a range of causes including acute alcohol poisoning, suicide and homicide (Table 3). While it would be desirable to conduct separate analyses for each of these causes, our study lacked the statistical power to do this, hence the analysis of the aggregate categories. It should be noted, however, that the literature generally suggests that a number of these components of external causes share overlapping aetiologies, particularly with respect to the links with socio-economic position and alcohol.

2.7. Statistical analysis

The data were analysed using the STATA statistical package (StatCorp, 1999). The estimates of the strength of association between the variables of interest and mortality were expressed as odds ratios with 95% confidence intervals derived by fitting models using conditional logistic regression in which account was taken of the one to one matching of cases with controls.

3. Results

3.1. Exposure distribution by case-control status

The frequency distribution of cases and their matched controls by the included variables is shown in Table 6 by cause of death of the cases. The age distributions of cases and controls are the same because of close matching on age. The distribution of deaths from circulatory disease is considerably older than that from external causes. All of the other variables in this table are derived from the responses of informants at interview, and thus reflect their knowledge of and personal views about the subjects.

The case deaths from circulatory diseases were reported to have been less likely that their matched controls to be in full time employment, married and have university-level education and far more likely to be pensioners due to disability. They were also were more likely than controls to have smoked in the past year (Note 1), have drunk

Table 6: *Percentage distribution of cases and controls by cause and selected variables**

	Circulatory disease				External causes			
	Cases (N=205)		Controls (N=205)		Cases (N=333)		Controls (N=333)	
Age (years) **								
20-29	4.3	*9*			23.2	*77*		
30-39	12.5	*26*			29.7	*99*		
40-49	48.6	*99*			36.5	*122*		
50-55	34.6	*71*			10.6	*35*		
Social status								
Employment status								
- Full time employed or student	49.5	*102*	73.1	*150*	59.7	*122*	80.7	*165*
- Unemployed/no regular employment	26.0	*53*	15.9	*33*	35.8	*73*	15.2	*31*
- Disability pensioners	24.0	*49*	11.0	*23*	4.5	*9*	3.6	*7*
- Not reported	0.5	*1*	0.0	*0*	0.0	*0*	0.5	*1*
Marital status								
- Married (or living as married)	78.8	*162*	82.2	*169*	67.1	*138*	80.6	*165*
- Divorced and widowed***	13.0	*27*	9.6	*20*	14.2	*29*	5.5	*11*
- Never married	8.2	*17*	8.2	*17*	18.7	*38*	13.9	*28*
- Not reported	0.0	*0*	0.0	*0*	0.0	*0*	0.0	*0*
Education								
- University and incomplete university	15.4	*32*	23.6	*48*	11.6	*24*	17.7	*36*
- Secondary specialised	17.8	*36*	18.8	*39*	15.8	*32*	15.8	*32*
- Secondary and lower	65.4	*134*	57.1	*117*	71.3	*146*	66.5	*136*
- Not reported	1.4	*3*	0.5	*1*	1.3	*3*	0.0	*0*
Behaviours								
Smoking in last year								
- No	18.3	*38*	33.2	*68*	19.7	*40*	27.4	*56*
- Yes	81.2	*166*	66.8	*137*	80.3	*165*	72.3	*148*
- Unknown	0.5	*1*	0.0	*0*	0.0	*0*	0.3	*1*
Frequency of alcohol intake in last year								
- Less than 2-3 times/week	60.1	*123*	76.4	*157*	57.7	*118*	77.1	*158*
- 2-3 times/weeks or more	33.2	*68*	20.2	*41*	38.7	*79*	19.0	*39*
- Not reported	6.7	*14*	3.4	*7*	3.6	*7*	3.9	*8*

Table 6 (cont.): *Frequency distribution (%) of cases and controls by cause and selected variables*

	Circulatory disease				External causes			
	Cases (N=205)		Controls (N=205)		Cases (N=333)		Controls (N=333)	
Had periods of heavy drinking								
- No	41.3	*85*	74.0	*152*	54.5	*112*	72.9	*149*
- Yes	45.8	*94*	19.7	*40*	38.4	*79*	23.9	*49*
- Not reported	12.9	*26*	6.3	*13*	7.1	*15*	3.2	*7*
More alcohol in last year than previous year								
- No	47.5	*97*	62.5	*128*	40.0	*82*	58.4	*120*
- Yes	41.4	*85*	30.3	*62*	50.0	*103*	35.2	*72*
- Not reported	11.1	*23*	7.2	*15*	10.0	*21*	6.4	*13*
Been under arrest for more than 3 days****								
- No	68.3	*140*	91.9	*188*	75.4	*155*	87.4	*179*
- Yes	21.6	*44*	6.7	*14*	21.0	*43*	9.0	*18*
- Not reported	10.1	*21*	1.4	*3*	3.6	*7*	3.6	*7*
Health status								
Health seriously affects normal activities								
- No	54.8	*112*	69.7	*143*	71	*146*	73.8	*151*
- Yes	44.2	*91*	29.8	*61*	25.1	*51*	25.5	*52*
- Not reported	1	*2*	0.5	*1*	3.9	*8*	0.7	*1*
Difficulty in climbing stairs to the 5th floor								
- No	69.2	*142*	93.3	*191*	92.9	*190*	92.3	*189*
- Yes	17.3	*35*	4.3	*9*	3.2	*7*	1.9	*4*
Not reported	13.5	*28*	2.4	*5*	3.9	*8*	5.8	*12*
Evaluated health: bad or very bad								
- No	75.5	*155*	89.4	*183*	88.8	*182*	92.9	*190*
- Yes	23.1	*47*	10.6	*22*	9.3	*19*	6.8	*14*
- Not reported	1.4	*3*	0	*0*	1.9	*4*	0.3	*1*

* Frequencies given in italics
** Age distribution of cases and controls are the same because of matching
*** Widowed men compose only 11% of this group
**** In Russia the police are not allowed to hold anyone under arrest for more than three days without opening a criminal case.

alcohol frequently, have had periods of heavy drinking and to have increased their alcohol consumption in the past year relative to pervious years. Turning to health problems, circulatory disease cases were more likely than controls to have been perceived as having their normal activities (including their capacity to climb stairs) limited by poor health. Informants also reported circulatory disease cases to be more likely than controls to be in "bad" or "very bad" health. This could mean that a men dying from cardiovascular causes were more likely to have a prior history of poor health. However this difference could also be due to response bias – with the health of the cases being perceived as being worse than the currently alive controls precisely because they were now dead. For this reason we have excluded these health status variables from further analysis.

The external cause deaths were also less likely than their controls to be in employment, married, and have university-level education. They were also more likely to smoke, drink frequently and have periods of heavy drinking. It is striking, however, that the health status (as reported by informants) of external cause deaths was not especially different to that of their matched controls, in contrast to the differences seen for circulatory disease cases and their controls with respect to health status.

3.2. Mortality odds ratios

Odds ratios of death by social status and behavioural factors were estimated from conditional logistic regression for circulatory disease and external causes separately and are presented in tables 7, 8 and 9. Because of matching by age, these estimates are not confounded by age. Each table is based on the sub-set of case-control pairs where there is no missing (not reported) information for any of the variables in the table. For each cause the parameters estimated from two models are presented. Model 1 estimates are crude (unadjusted for other variables). Model 2 estimates are adjusted for all other variables in the table.

Social status. Table 7 shows mortality odds ratios from circulatory disease and external causes to be related to employment status, with the lowest risk being associated with the baseline category of being in employment or a student. Marked elevations of risk are associated with being unemployed, an affect that remains after adjustment for marital status and educational level. However, it is notable that for circulatory disease the highest odds ratios are for men who were not working because they were on a disability pension. Adjustment for other social status variables in the table reduced this four-fold excess by a small amount. In contrast, these men did not appear to have any substantial increased risk of death from external causes. This is consistent with a disability pension being a marker for pre-existing circulatory disease.

With respect to marital status, not being married was associated with an increased risk of mortality from external causes only. This was particularly so for divorced or widowed men. Educational level showed the predictable inverse association, with odds ratios increasing as level of education declined for both circulatory disease and external causes going up as level of education declined.

Table 7: *Mortality odds ratios (95% confidence interval) by cause in men aged 20-55 by social status variables*

	Circulatory diseases, 201 pairs		External causes, 328 pairs	
Social status variables	Model 1: No adjustment	Model 2: Adjustment for other variables	Model 1: No adjustment	Model 2: Adjustment for other variables
Employed or student	1.00	1.00	1.00	1.00
Unemployed	2.45 (1.36-4.43)	2.63 (1.46-4.73)	3.49 (2.19-5.54)	3.01 (1.91-4.77)
Disability pensioner	4.21 (2.10-8.44)	4.14 (2.03-8.46)	1.79 (0.74-4.35)	1.56 (0.63-3.84)
Married	1.00	1.00	1.00	1.00
Divorced or widowed	1.36 (0.68-2.70)	0.90 (0.42-1.94)	3.30 (1.75-6.25)	2.53 (1.30-4.92)
Never married	1.09 (0.49-2.41)	0.74 (0.31-1.77)	2.07 (1.16-3.69)	1.68 (0.91-3.13)
University	1.00	1.00	1.00	1.00
Secondary specialised	1.39 (0.73-2.65)	1.44 (0.71-2.91)	1.57 (0.86-2.85)	1.39 (0.73-2.65)
Secondary and lower levels	1.80 (1.07-3.02)	1.59 (0.91-2.77)	1.69 (1.04-2.74)	1.41 (0.84-2.36)

Note : Model 1 is based on exactly the same set of observations as model 2. (Values of all the variables used in the right part of regression equation are non-missing).

3.2.1. Behavioural factors

The mortality odds ratios in Table 8a are based on a smaller set of case-control pairs than Table 7 as those in which informants failed to provide an answer to questions about drinking habits or behavioural factors in Table 8a were excluded. One possible explanation might be that associations between external cause mortality and alcohol could be mainly due to acute alcohol poisoning. To investigate this possibility analyses excluding the 10 deaths from acute alcohol poisoning were conducted (Table 8b). The mortality odds ratios obtained are very similar to those for external causes as a whole.

Smoking was associated with an increased risk of circulatory disease that remained pronounced after adjustment for other variables in the table. As might be expected, smoking was less strongly associated with an increased risk of death from external causes, and this ceased to be statistically significant after adjustment for the other variables in the table.

Table 8a: *Mortality odds ratios (95% confidence interval) by cause in men aged 20-55 by behavioural variables*

Behavioural variables	Circulatory diseases, 140 pairs		External causes, 249 pairs	
	Model 1: No adjustment	Model 2: Adjustment for other variables	Model 1: No adjustment	Model 2: Adjustment for other variables
Smoking				
No	1.00	1.00	1.00	1.00
Yes	2.44	2.03	1.68	1.27
	(1.36-4.36)	(1.06-3.88)	(1.10-2.56)	(0.80-2.01)
Alcohol 2-3 times/ week or more				
No	1.00	1.00	1.00	1.00
Yes	1.57	0.86	2.61	1.95
	(0.91-2.72)	(0.43-1.71)	(1.69-4.03)	(1.23-3.11)
Periods of heavy drinking				
No	1.00	1.00	1.00	1.00
Yes	4.29	3.51	2.69	1.85
	(2.40-7.67)	(1.86-6.64)	(1.72-4.22)	(1.13-3.04)
Being under arrest for 3 days or more				
No	1.00	1.00	1.00	1.00
Yes	4.67	2.84	2.58	1.78
	(1.93-11.27)	(1.11-7.29)	(1.52-4.38)	(1.00-3.15)

Note : Model 1 is based on exactly the same set of observations as model 2. (Values of all the variables used in the right part of regression equation are non-missing).

There are two alcohol-related variables in Table 8a. It is striking that for circulatory disease the mortality odds ratios are substantially larger for a history of periods of heavy drinking compared to being a regular consumer of alcohol. The strength of association with periods of heavy drinking was only slightly diminished on adjustment for the other variables in the table, while the adjusted odds ratio for frequent drinking (2-3 times per week or more) showed weak evidence of a protective effect. In contrast both regular and heavy drinking were associated with an increased risk of death from external causes. Finally, with respect to Table 8a, although it was a relatively uncommon characteristic, a reported history of having been arrested was associated with elevated risks of mortality from circulatory disease and to a lesser degree with mortality from external causes.

Table 8b: *Mortality odds ratios (95% confidence interval) for external causes without deaths from accidental poisoning by alcohol in men aged 20-55 by behavioural variables*

	External causes, 239 pairs	
Behavioural variables	Model 1: No adjustment	Model 2: Adjustment for other variables
Smoking		
No	1.00	1.00
Yes	1.58	1.21
	(1.02-2.44)	(0.76-1.94)
Alcohol 2-3 times/week or more		
No	1.00	1.00
Yes	2.92	2.12
	(1.83-4.64)	(1.28-3.58)
Periods of heavy drinking		
No	1.00	1.00
Yes	2.65	1.75
	(1.64-4.28)	(1.02-2.99)
Being under arrest for 3 days or more		
No	1.00	1.00
Yes	2.44	1.66
	(1.41-4.23)	(0.95-2.99)

Note : Model 1 is based on exactly the same set of observations as model 2. (Values of all the variables used in the right part of regression equation are non-missing).

3.3. Fully adjusted model

Table 9 shows the estimated crude (Model 1) and fully-adjusted (Model 2) odds ratios for the sub-set of case-control pairs where there was no missing information for any of the social status and behavioural questions that were examined separately in the two previous tables. In addition there is a third model (Model 2a) which is the same as the fully-adjusted one (Model 2) except that employment status is excluded. As discussed further below this has allowed us to look at the extent to which Model 2 estimates are over-adjusted, on the assumption that employment status is in part at least an endogenous variable: that is it is an indicator of current health status.

The pattern of associations seen for the unadjusted estimates (Model 1) in the table are very similar to those observed in Tables 7 and 8, providing reassurance that cases-control pairs used in Table 9 are not a biased sub-set. Adjustment for all social status and behavioural variables (Model 2) had little impact on the increased risk of death from circulatory disease associated with being a disability pensioner. The inverse association of circulatory disease with education was attenuated after full adjustment to a greater degree than seen when adjusted for employment and marital status only (Table7). The effect of smoking on circulatory disease mortality was reduced after full adjustment although it remained substantial. Regular drinking (2-3 times per week) showed no association with mortality from cardiovascular disease. In contrast, there remained a very substantial elevated risk associated with a reported history of periods of heavy drinking.

The increased risk of mortality from external causes associated with unemployment was reduced after full adjustment (Model 2) but remained substantial. There was no association in the unadjusted or adjusted model with having a disability pension. The odds ratios of external causes associated with being single, widowed or divorced were larger than for circulatory disease, but full adjustment resulted in them becoming no longer statistically significant. Full-adjustment for social status and behavioural variables eliminated any effect of education on external cause mortality. Both regular drinking and periods of heavy drinking were associated with elevated odds ratios for external causes. However, full-adjustment reduced these effects substantially, with only periods of heavy drinking having 95% confidence intervals that excluded unity.

Table 9: *Mortality odds ratios (95% confidence interval) by cause in men aged 20-55 for composite model including social and behavioural variables*

	Circulatory diseases, 134 pairs			External causes, 247 pairs		
	Model 1: No adjustment	Model 2: Adjustment for other variables	Model 2a: Model 2 with employment status excluded	Model 1: No adjustment	Model 2: Adjustment for other variables	Model 2a: Model 2 with employment status excluded
Employed or student	1.00	1.00		1.00	1.00	
Unemployed	1.91	1.58		3.63	2.52	
	(1.03-3.56)	(0.77-3.26)		(2.17-6.08)	(1.43-4.43)	
Disability pensioner	3.81	3.59		1.45	1.13	
	(1.77-8.16)	(1.47-8.75)		(0.58-3.65)	(0.42-3.04)	
Married	1.00	1.00	1.00	1.00	1.00	1.00
Divorced or widowed	1.10	0.97	1.15	3.54	1.93	2.16
	(0.49-2.45)	(0.37-2.57)	(0.46-2.88)	(1.71-7.35)	(0.85-4.39)	(0.97-4.80)
Never married	1.17	1.56	1.80	2.19	1.99	1.91
	(0.50-2.79)	(0.53-4.50)	(0.59-5.18)	(1.13-4.22)	(0.95-4.17)	(0.91-3.80)
University	1.00	1.00	1.00	1.00	1.00	1.00
Secondary specialised	1.89	1.29	1.34	1.46	1.14	1.09
	(0.63-4.69)	(0.48-3.63)	(0.52-3.45)	(0.76-2.81)	(0.55-2.39)	(0.53-2.24)
Secondary / lower levels	2.19	1.21	1.33	1.58	1.10	1.15
	(1.14-4.19)	(0.55-2.67)	(0.63-2.79)	(0.95-2.63)	(0.55-2.39)	(0.66-2.00)
Smoking						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	2.44	1.99	2.15	1.68	1.24	1.31
	(1.36-4.36)	(0.99-3.95)	(1.09-4.24)	(1.10-2.56)	(0.76-2.02)	(0.81-2.10)
Alcohol 2-3/ week or more						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.65	1.02	0.93	2.61	1.51	1.81
	(0.95-2.88)	(0.49-2.12)	(0.51-1.76)	(1.69-4.03)	(0.91-2.51)	(1.12-2.90)
Periods of heavy drinking						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	4.21	3.54	3.64	2.65	1.75	1.64
	(2.35-7.55)	(1.76-7.13)	(1.89-7.02)	(1.69-4.17)	(1.02-3.00)	(0.97-2.76)
Being under arrest for 3 days or more						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	4.67	2.20	2.53	2.72	1.52	1.71
	(1.93-11.27)	(0.83-5.82)	(0.96-6.64)	(1.59-4.67)	(0.81-2.82)	(0.95-3.07)

Note: Model 1 is based on exactly the same set of observations as model 2. (Values of all the variables used in the right part of regression equation are non-missing).

3.4. Employment status as an endogenous variable

Employment status had three 3 categories: employed or student, unemployed and disability pensioner. As already noted, being a disability pensioner is undoubtedly, and unsurprisingly a marker of morbidity and ill-health or disability of some sort. A proportion of those who were classified as unemployed could likewise be there precisely because their poor health had been a factor in them becoming unemployed. Thus adjusting for this variable in Model 2 might in part involve adjusting for pre-existing health status, which would attenuate the strength of association between any causal factors and mortality. Put another way, being unemployed or in receipt of a disability pension could be on the "causal pathway" between a causal exposure and mortality.

As can be seen by comparing the estimates from Model 2a with those in Model 2, it is clear that excluding employment status does indeed lead to an increase in the majority (but not all) of the odds ratios as might be predicted if employment status is in part an endogenous variable. However, the broad conclusions drawn from the fully adjusted model (Model 2) are not altered. In particular the key finding that periods of heavy drinking are associated with an increased risk of circulatory disease mortality is clear in both Model 2 and 2a. However, given that employment status may also be in part a true potential confounder – in that the fact of being unemployed may have an adverse effect on health (rather than vice versa) – we believe that a conservative interpretation of the results is appropriate and that most emphasis should be given to the estimates in Model 2.

3.5. Sensitivity analyses

A series of analyses were conducted to see to what extent estimates were sensitive to the types of informant. The number of case-control pairs where the informant type was the same for case and control was 91 for circulatory disease and 121 for external causes. When analyses (not shown here) were restricted to this subset, the results were substantively the same and very close in terms of mortality odds ratios as seen in the full analyses (see Shkolnikov, Meslé and Leon, 2002 for more details) Note 2). The results were also similar (not shown) when analyses were restricted to the 161 case-control pairs of circulatory disease deaths and 240 case-control pairs of external cause deaths for whom informants were restricted to first degree relatives only.

4. Discussion

The results of this study provide the best insights available so far into the associations between socio-economic circumstances, smoking and different patterns of alcohol consumption and the short-term (<1 year) risk of death from circulatory disease and external causes among working-age men in Russia today. Before considering the detailed findings of the study its evident weaknesses need to be discussed.

4.1. Generalisability

The majority of deaths among men aged 20-55 years in Udmurtia in the study period were from either circulatory disease (mainly ischaemic heart disease) or external causes. Of the 768 deaths from one or other of these causes we were only able to include 538 in the analyses. Those excluded differed somewhat from the ones included in terms of specific causes of death. For example, deaths from suicide, homicide and some other causes (such as drownings) were disproportionately excluded. Ideally, this would be dealt with by conducting separate analyses for each sub-component of circulatory and external cause deaths. However, this study is too small to take this approach, lacking the statistical power to provide precise estimates of effect at this level of disaggregation by cause.

A related issue concerns the identification of suitable case informants to the study. As is evident from Table 4, the deaths that were excluded were disproportionately weighted towards the unmarried – particularly the divorced. It was particularly difficult to find informants for cases who were either single or divorced. They either lived alone, or potential informants were unwilling to be interviewed, or they were more likely to have no private place of permanent residence. Thus our study will have differentially excluded deaths among men who were the most isolated, vulnerable and deprived. It should be noted, however, that such individuals are generally underrepresented in most epidemiological studies in which personal contact is involved, regardless of design.

Having established that the cause and social composition of the deaths from circulatory disease and external causes included in the study is unlikely to be fully representative of all deaths from these causes among working age men in Udmurtia in the late 1990s, what are the implications for the validity of our results? It is clear that the results cannot be fully generalised to all deaths from the causes of interest in Udmurtia. In other words, the study does not have full external validity. However, the question of whether, given the subset of deaths we have included, our results are a valid measure of the association of mortality with socio-economic and behavioural factors is

a matter of internal validity. For a case-control study this is in part about whether there is likely to have been selection bias in the recruitment of appropriate controls.

4.2. Selection bias

In principle, to avoid selection bias, one needs to recruit controls who are representative of the population from which the cases are drawn. In this study for each case a matched control was drawn from an electoral list to be of the same age and to have a residential address in the same housing block as stated on the death certificate of their matched case. A weakness of the protocol, however, is that no check was made to see that the cases also appeared on the electoral list.

Implicitly, many of the factors determining whether an informant could not be found for a case would also operate for controls. For example, being single or divorced reducing the likelihood that an informant was less likely to be found would apply regardless of case-control status. One exception would be if the death of the case precipitated the move of their family or friends from their residence soon after their death, although it is not easy to anticipate how this might bias the estimates of effect made in this study. In general, however, it seems that the selective recruitment of case informants that has given rise to problems with external validity may operate in a similar way with controls, hence avoiding selection bias from this source.

4.3. Proxy informants and information bias

There is a literature on the validity of exposure information from proxy informants in epidemiological, usually case-control, studies (Walker, Velema and Robins, 1988, Nelson et al., 1990). These have found that, for a range of exposures, including smoking (Nelson et al., 1990, Nelson et al., 1994) and frequency of alcohol consumption (Nelson et al., 1994, Graham and Jackson, 1993), there is good agreement between proxy and index subjects. This is particularly so for binary exposures, such as those analysed in this study. Few studies have attempted to evaluate the quality of proxy data on heavy or episodic drinking, although one study (Nelson et al., 1994) found that proxy-index agreement on this was lower than for frequency of alcohol consumption.

The use of proxies can introduce both random (non-differential) and systematic (differential) misclassification (Nelson et al., 1990). If the misclassification of exposure is non-differential this will reduce the effective sample size and thus reduce precision. There are several ways in which the mode of information collection differed between

cases and controls and that could introduce systematic effects. Firstly, the case informants were interviewed between 3 and 12 months after the death of the case. Informants were thus being asked to recall circumstances some months in the past, while control informants were essentially describing the circumstances and behaviours of the controls at that moment in time. This may have introduced greater misclassification of cases compared to controls simply due to the passage of time.

Secondly, certain issues arise because a wide mixture of informants was used. As documented in the literature,[22] the relationship of the informant to the subject does have an effect on the completeness and validity of the information obtained. The distribution by informant-type varies between cases and controls (Table 5), particularly for external causes, as factors that are causally implicated (such as marital status and household composition) will influence availability of informants. However, the finding that similar results were obtained in the sensitivity analyses based on sub-sets of the data where either both members of a case-control pair had the same informant-type or informants were restricted to first degree relatives, suggests that any bias due to informant type is minor.

Finally, it is an inevitable feature of this case-control design that the information collected from case informants will be affected in a different way to that collected from control informants as the fact of death itself will have influenced the perceptions of family, friends and neighbours about the deceased. Interpretation of results must thus consider the extent to which such recall bias may potentially explain the findings. This however, is a general problem that all case-control studies have to contend with irrespective of whether proxy informants are used or not.

4.4. Circulatory disease mortality

The majority of circulatory disease deaths in the study are from ischaemic heart disease. Smoking is an important risk factor for this condition (Doll et al., 1994) and thus it is reassuring that it is associated with an increased risk of circulatory mortality in this study. The data also make sense in that being a disability pensioner is associated with a substantially elevated odds ratio for circulatory disease as morbidity associated with heart disease is likely to lead to giving up work and going onto a disability pension. The absence of a parallel effect for external cause deaths is what would be expected.

What is most striking are the contrasting effects of regular and heavy drinking on the risk of death from circulatory disease. Regular drinking (2-3 times per week or more) is associated with an increased risk in the crude analyses. However, when adjusted for all other risk factors it shows no effect at all. A reported history of heavy drinking is associated with a very substantial increased risk of death from circulatory

disease that is only slightly attenuated by adjustment for all the other risk factors analysed. In terms of proportions, 46% of deaths from circulatory disease were reported to have a history of heavy drinking compared to 20% of matched controls. This is consistent with the hypothesised role of episodic heavy drinking in causing high mortality from circulatory disease in Russia (McKee, Shkolnikov and Leon, 2001). While the question itself does not precisely specify "episodic heavy" drinking (i.e. a large amount of alcohol in one drinking session), having experienced "periods of heavy drinking" is likely to be a good proxy measure. These results, however, do not provide unambiguous proof of the role of episodic heavy drinking in cardiovascular mortality in Russia. They do, nevertheless, provide the best individual-level evidence to date in support of this hypothesis.

Educational level has been found to be related to mortality from a range of causes in Russia (Shkolnikov et al., 1998) including circulatory disease. In this study there is a clear inverse gradient apparent in the unadjusted data. However, after adjustment for behavioural factors (drinking and smoking) the association with educational level becomes considerably attenuated. This suggests that these factors are important mediators of the educational gradient observed in other studies.

4.5. External cause mortality

Being unemployed is the factor most strongly associated with mortality from external causes in this study. Some of this effect is accounted for by the other variables in the analysis, most importantly, the behavioural ones (drinking and smoking). However, even after adjustment, those who were unemployed were over two and half times more likely to die from external causes as those in employment. These results are consistent with the broader literature (Wright and Kariya, 1997).

The frequency of suicide is especially high in Udmurtia and deaths from suicide comprise a third of all external cause deaths in the study. Unemployment has been found to be associated with suicide in a range of studies in other countries (Moser et al., 1986, Johansson ad Sundquist, 1997). It is also implicated in intentional violence (Kyriacou et al., 1999, Poole et al., 1997), which contributes to the overall category of external causes.

Periods of heavy drinking and being reported to have drunk regularly are also associated with an increased risk of death from external causes, although after adjustment for other variables these effects are reduced and are only statistically significant for heavy drinking. It is notable, however, that the effect of heavy drinking was far less pronounced for external causes, where the mechanisms are self evident, than for circulatory disease deaths, where the association is more controversial.

Finally, external causes are known to show an inverse socio-economic gradient in Russia (Chenet et al., 1998) and elsewhere (Drever and Whitehead, 1997). We also observe an inverse gradient in this study, although it is not as strong as has been reported in other studies of Russian mortality (Shkolnikov et al., 1998, Chenet et al., 1998). This may in part reflect the matching by neighbourhood that is used in our design, where some of the effects of educational level on mortality from external causes may be due to area rather than individual-level effects. After adjustment for the other variables in the analysis, and in particular the behavioural ones, the educational gradient is effectively eliminated. Alcohol in particular is likely to play an important role mediating the link between educational level and external cause mortality.

Not being married is associated with a significantly elevated risk of death from external causes, which becomes statistically insignificant after adjustment for behavioural variables.

5. Summary

This study is the first one to investigate the social and behavioural factors implicated in mortality from circulatory disease and external cause mortality in men of working age in Russia after the collapse of communism. Despite a number of methodological shortcomings, the associations seen between mortality from these two causes and known risk factors are consistent with what would be expected from the literature. The single most novel finding is that a history of heavy drinking is strongly associated with risk of death from circulatory disease. This further emphasises the importance of measuring not only total amount of alcohol consumed but also the pattern of consumption in epidemiological studies.

Although far from definitive, this provides the first individual-level evidence in support of the hypothesis that episodic heavy drinking plays an important role in explaining the heavy burden of circulatory disease mortality among Russian men today. The role of alcohol as an important mediator of the link between adverse socio-economic circumstances is also apparent, although it does not explain all of the association between unemployment and mortality from external causes. Further studies of this sort, avoiding the shortcomings identified in this paper, are a priority in order to further dissect the social pathology of mortality in Russia today and its proximal mediators.

The results of this study reinforces the importance of policies aimed at reducing alcohol abuse in Russia. Evidence from other countries, in particular Finland and Sweden, suggests that this will require an integrated package of policy interventions, including taxation of alcohol sales, restricting opportunities to purchase alcohol, both in

terms of numbers of outlets and their opening times, increasing awareness among the public, health professionals and the hospitality and retail sectors of the harm caused by excessive alcohol consumption, strengthening prevention and treatment services building on the network of general practitioners and specialised clinics, and support for non-governmental organisations concerned with the harmful consequences of alcohol. At the same time, it is essential to understand that alcohol is deeply embedded in the Russian society and its abuse is fuelled by a complex of socio-psychological and socio-cultural factors that reflect both the totalitarian past and contemporary socio-economic challenges.

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Notes

1. In accordance with other studies, a very high prevalence of smoking was detected among the Udmurt men aged 20 to 55. About 80% of cases and 70% of controls were smoking. It suggests that the importance of smoking for the whole population would be very high. Our prior analyses showed that in terms of population attributable risk smoking is the most important single factor of the cardiovascular mortality among men in Russia. (Shkolnikov, Meslé and Leon, 2002).
2. Some of more subjective variables, which have been important at initial stages of analysis had to be finally excluded due to the informant type bias. Typically these were variables of more subjective character like bad relations with wife or reported periods of depression. Even for these variables the direction of mortality odds rations was the same with and without a control for the type of informant, but there was a substantial difference in the values of the odds ratios.

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Appendix

Questions from the study questionnaire used in the regression analyses

Q38. What was educational level of deceased?
- Basic
- Incomplete secondary
- Secondary
- Secondary specialised
- Incomplete high
- High (or university)
- Not sure

Q40. During the last year did he work, studied or he was retired?
- Had two or several permanent jobs
- Had one permanent and several additional jobs
- Worked from time to time, had partial employment
- Was unemployed
- Was a student
- Was disabled, retired due to disease
- Other (please specify briefly)
- Not sure

Q52. What was his marital during the lasty year? Was he
- Married
- Lived in unregistered marriage
- Divorced or separated
- Widowed
- Never married

Q79. Can you, please, tell me whether he smoked during the last year?
- Yes
- No
- Not sure

Q87. How often did he drink alcohol during the last year?
- Nearly daily
- 4-6 times a week

- 2-3 times a week
- About once a week
- 2-3 times a month
- About once a month
- More rarely
- Did not drink alcohol at all
- Not sure

Q88. Did he drink during the last year more than in earlier years?
- Much less
- A little less
- About the same
- A little more
- Much more
- Did not drink at all
- Not sure

Q94. Have he ever had a period in his life when he drunk a lot?
- Yes
- No
- Not sure

Q96. Have the police arrested him for more than three days?
- Never
- Yes, once
- Yes, several times
- Refuse to answer
- Not sure