Alcohol and Alcoholism, 2018, 53(6) 742–752
doi: 10.1093/alcalc/agy054
Advance Access Publication Date: 3 August 2018
Article

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Distilled Spirits Overconsumption as the Most Important Factor of Excessive Adult Male Mortality in Europe

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Received 28 April 2018; Revised 25 June 2018; Editorial Decision 29 June 2018; Accepted 3 July 2018

Abstract

Aims: To explain comprehensively variations in adult male mortality rate in Europe, and in particular, high mortality in some East European countries with particular focus on specific patterns of alcohol consumption.

Short summary: Per capita distilled spirits consumption is found to be the strongest determinant of the adult male mortality rate in Europe as soon as the unrecorded alcohol consumption is taken into account. It turns out to be much stronger than the other tested significant determinants such as per capita health expenditures, smoking prevalence, consumption of hard drugs and per capita consumption of vegetables and fruit.

Methods: Ordinary least squares (OLS) multiple regression with adult male mortality rate as a dependent variable, and various indicators of alcohol and drug consumption as well as logarithm of gross domestic product (GDP) per capita, logarithm of total per capita health expenditures, latitude (climatic factors), per capita fruit and vegetable consumption, smoking prevalence as independent factors.

Results: Per capita distilled spirits consumption turns out to be the strongest determinant of the adult male mortality rate in Europe as soon as the unrecorded alcohol consumption is taken into account. It turns out to be much stronger than the other tested significant determinants of the adult male mortality rate such as per capita health expenditures, smoking prevalence, consumption of hard drugs and per capita consumption of vegetables and fruit. Still, higher per capita wine consumption has turned out to be a marginally significant determinant of the higher adult male mortality rate in some tests. Latitude, beer and soft drug consumption have turned out insignificant in this study.

Conclusions: Spirits consumption is a major risk factor of adult male mortality, with significantly greater impact compared to beer and wine. Therefore, reduction in distilled spirits consumption in hard liquor drinking areas should be a major target in health policy.

INTRODUCTION

Since the beginning of the 20th century, life expectancy in the countries of the world has grown significantly due to technology development, economic growth, advances in medicine and sanitary control measures, as well as the reduction of war death toll since the end of the World War II (Chesnais, 1992: 54–57; White, 2004). Life expectancy in the European Region of the World Health Organization has tended to increase generally, and has reached 75 years for men and 81 years for women (Statista, 2018). At the same time, in some East European countries life expectancy for men in particular has deviated significantly given their income levels (see Fig. 1).

Thus, life expectancy for men was in 2015 68.6 years in Belarus, 67.5 for Kazakhstan, 66.7 in Kyrgyzstan, 69.1 in Latvia, 69.9 in Lithuania, 67.2 in Moldova, 65.5 in Russia and 66.4 in Ukraine. In contrast, male life expectancy was relatively high in Bosnia and Herzegovina (74.2), or Albania (76.2) despite the fact that GDP per capita levels there ($10 902 [All the GDP data are here and elsewhere in constant 2011 international dollars at purchasing power parities.] in Bosnia and $11 025 Albania in 2015) are much lower than in Belarus ($17 230) or Kazakhstan ($23 523) (World Bank, 2018a).

Improving public health in the European region and worldwide requires understanding of these health inequalities.

The economic development is a major determinant of population mortality levels, which is measured in the this article with the GDP per capita (at purchasing power parity). On the other hand, it has been shown that the most important role is played by the share of GDP spent on healthcare. Therefore, we included both GDP per capita, per capita health expenditures, and health expenditures as a share of GDP to the analysis. At the same time, the total health expenditures per capita level strongly affects life expectancy, in both children and adults, and this pattern is relevant for any society (Fig. 2). This connection is substantiated by a number of statistical analyses of a number of countries of the world for dozens of years (see, e.g. Crémieux *et al.*, 1999; Gupta *et al.*, 2002; Cutler *et al.*, 2006; Baltagi and Moscone, 2010).

Earlier research suggests that excessive mortality in some East European countries is strongly related to dangerous patterns of alcohol consumption (see, e.g. Nemtsov, 1995, 1998, 2002; Leon *et al.*, 1997, 2007, 2009; Brainerd and Cutler, 2005; Rehm and Gmel, 2007; Marquez, *et al.*, 2005; McKee *et al.*, 2001; Men *et al.*, 2003; Shkolnikov *et al.*, 2004a; Razvodovsky, 2008; Furtunescu *et al.*, 2009; Grabauskas *et al.*, 2009; Levchuk, 2009; Zaridze *et al.*, 2009; McCartney *et al.*, 2011; Radisauskas *et al.*, 2011; Neufeld and Rehm, 2013; Pridemore *et al.*, 2013, 2014; Grigoriev *et al.*, 2014; Tuusov *et al.*, 2014; Bobak *et al.*, 2016; Horvat *et al.*, 2018).

At the same time, alcohol consumption in the Eastern Europe is, on average, about as high as in the West European countries. Therefore, a number of researchers argued that high levels of distilled spirits consumption is the major explanatory factor of high mortality in East Europe. This claim is supported by time series analysis and cross-sectional (ecological) research (Khaltourina and Korotayev, 2005, 2006a,b, 2008, 2015; Korotayev and Khaltourina, 2005, 2006; Razvodovsky, 2010; Treisman, 2010), case-control (Shkolnikov and Chervyakov, 2000; Shkolnikov *et al.*, 2004b; Zaridze *et al.*, 2014) and cohort studies (Denisova, 2010), mostly based on the Russian data. The point that the distilled spirits consumption can be a very strong determinant of the adult male

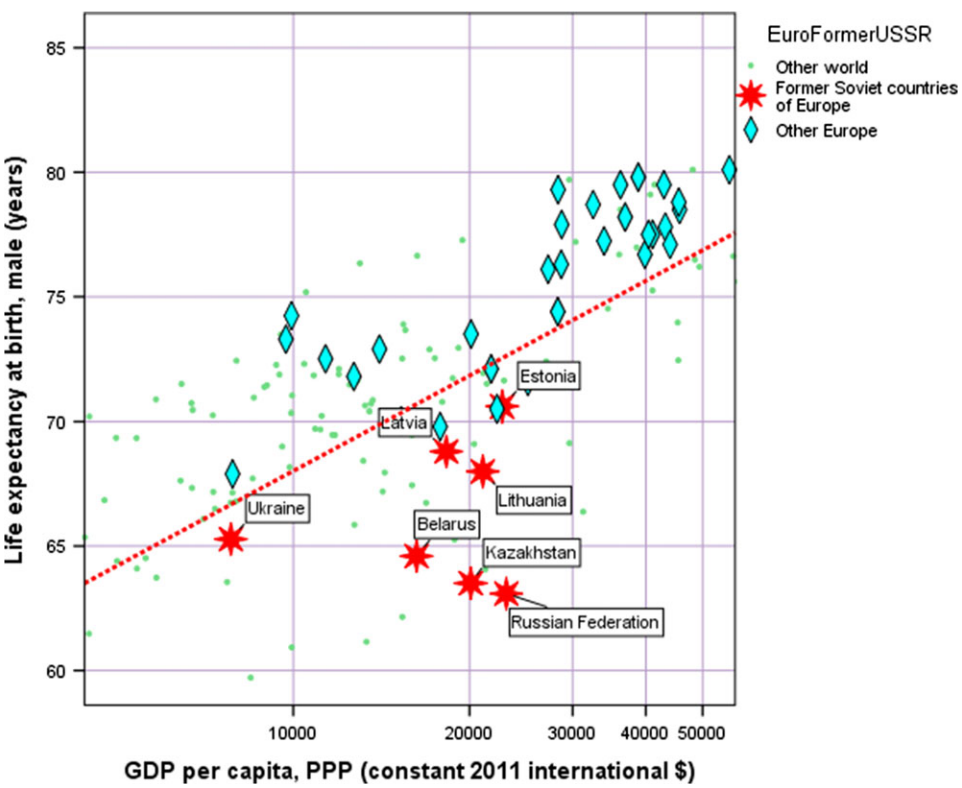

Fig. 1. Correlation between the logarithm of GDP per capita at PPP (in constant 2011 international dollars) and life expectancy at birth, male in 2010. Scatterplot with a fitted regression line. (World Bank, 2018a, 2018b).

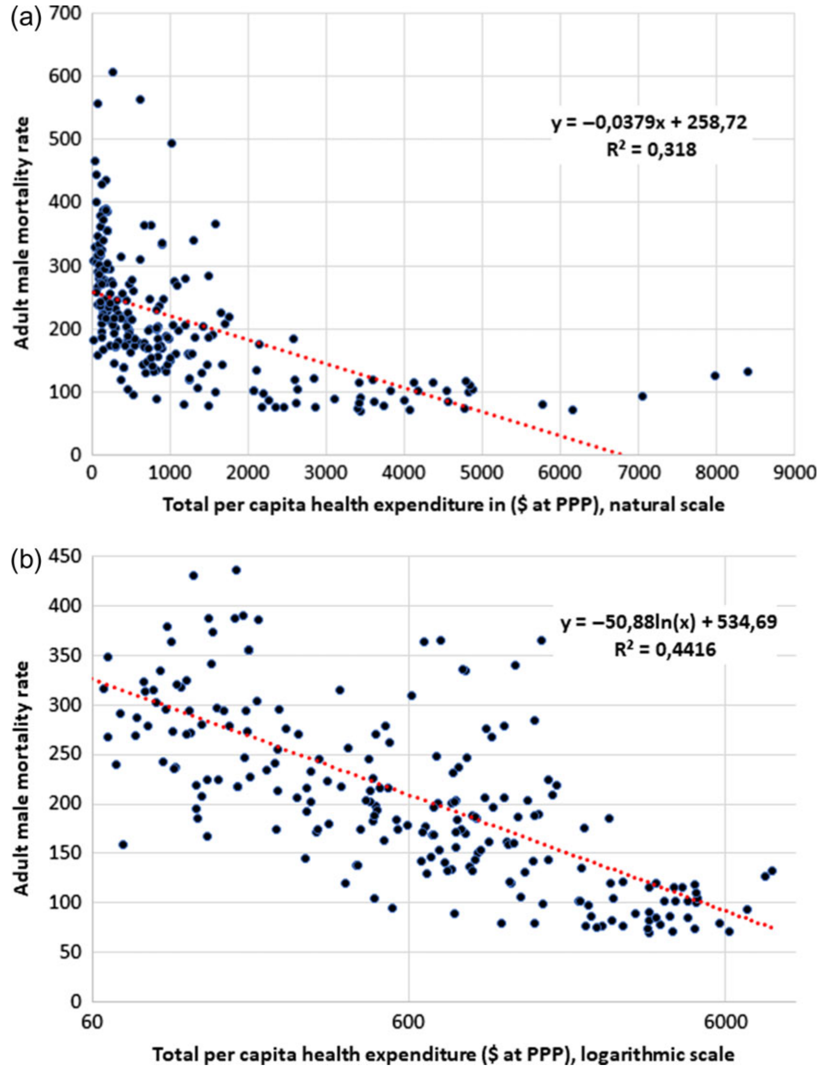

Fig 2. Correlation between the total per capita health expenditure for countries of the world in 2010: (**a**) linear regression; (**b**) logarithmic regression.

mortality at the level of Europe is also implied by the research of Rehm *et al.* (2006) that will be discussed in more detail below.

Similarly, tobacco is one of the major risk factors of all-causes mortality for men in working ages. Tobacco-attributable mortality is higher in East Europe than in West Europe and in the world in a whole (WHO, 2011).

Healthy nutrition is another major determinant of population health. The WHO (2017) recommends to consume at least 400 g (five portions) of fruits and vegetables a day. Observational research consistently shows fruit and vegetable consumption is associated with lower risks of all-cause mortality. A cohort study in the three East European countries confirmed that disease burden due to low fruit and vegetable consumption is higher in Central and Eastern Europe and the former Soviet Union than any other parts of the world (Stefler *et al.*, 2016) as it was proposed earlier by other researchers (Ginter, 1995; WHO, 2009; Zatonski, 2011). Poor nutrition could aggravate cardiovascular morbidity in this region.

At the same time, fruit and vegetable consumption could be a component of the benefit of living in more Southern environment, which also includes higher levels of insolation, and, as a result better vitamin D plasma level, which is beneficial (Gaksch *et al.*, 2017), higher physical activity throughout the year (Wu *et al.*, 2017), and possibly, some effects of genetic adaptations to cold climate. Therefore, we include both fruit and vegetable consumption and latitude into the analysis.

Finally, the studies show high risks of mortality among users of some narcotic drugs, and opiates in particular (Hser *et al.*, 1994; Hulse *et al.*, 1999; Gossop *et al.*, 2002), while the effects of cannabis use on mortality is much lower, even though cannabis users suffer from accidents and suicides provoked by losing of self-control (Andreasson and Allebeck, 1990; Sidney *et al.*, 1997; Calabria *et al.*, 2010). Thus, we include data on various types of drug use into this study.

METHODS

To identify hard liquor and other significant factors of adult male mortality in Europe, we perform a cross-national test of the adult male mortality rate predictors. Unfortunately, microdata in the form of cohort studies is available for some but not all countries and these data are not compatible between the cohort studies.

The main methodology is OLS multiple regression with adult male mortality rate as a dependent variable, and various indicators of alcohol consumption as well as logarithm of total per capita health expenditure, unemployment rate, smoking prevalence, injected drugs prevalence and latitude (as a proxy for climate factor) as independent variables. These tests are performed for two different years—2005, when health inequality among men in Europe was highest, and in 2010, the latest year when the whole set of data is available for all the European countries whose materials have been used in the present study: Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Montenegro, the Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Ukraine and UK. We have decided to perform the tests for two different years to increase the validity of the results.

Data on adult male mortality rate have been obtained from the World Development Indicators Database (World Bank, 2018a). Note that the World Bank employs the following definition of the adult male mortality rate: 'Adult mortality rate, male, is the probability of dying between the ages of 15 and 60—that is, the probability of a 15-year-old male dying before reaching age 60, if subject to age-specific mortality rates of the specified year between those ages' (*Ibidem*).

The following independent variables have been studied (see Appendix for their descriptive statistics).

Data on (1a) recorded and (1b) unrecorded per capita (15+) alcohol consumption (in litres of pure alcohol), have been obtained from the World Health Organization Global Information System on Alcohol and Health (GISAH) (World Health Organization, 2018). Note that the WHO provides estimates of unrecorded alcohol consumption for 2 years only (2005 and 2010). That is why we were able to perform our multiple regression analysis for those 2 years only. The data on beverage-specific estimates of unrecorded alcohol consumption have been taken from the following publications: Lachenmeier (2012); Lachenmeier *et al.* (2009); Leifman (2001); Lemmens (2000); Meier *et al.* (2013); Nordlund and Österberg (2000); Norstrom (1998); Radaev (2016); Rehm *et al.* (2006); Rehm *et al.* (2016); Sierosławski *et al.* (2013); Škrinjarić *et al.* (2017); Solodun *et al.* (2011); Vital *et al.* (2016).

Data on total per capita health expenditure (in 2011 international dollars at purchasing power parities) have been obtained from the World Development Indicators Database (World Bank, 2017b, 2018a). Note that we have used a logarithm of the total per capita health expenditure as the preliminary analysis suggested that adult male mortality rate demonstrates a substantially stronger negative correlation with the logarithm of this variable rather than with the variable itself (Fig. 2).

Data on smoking prevalence among males (% of adults) and unemployment rate among males (% of male labor force) (modeled ILO estimate) have been obtained from the World Development Indicators Database (World Bank, 2017c, 2017d).

Data on percentage of population aged 15–64 years consuming opiates as well as people who inject drugs (prevalence (%) among population aged 15–64) have been obtained from the *World Drug Reports* (United Nations Office on Drugs and Crime, 2006–2011) and United Nations Office on Drugs and Crime Statistics Database (United Nations Office on Drugs and Crime, 2018). Note that the data on the latter variable is not available in this database for 2005.

Data on fruit and vegetable consumption was obtained from the UN Food and Agriculture Organization (FAO, 2018). Potato and bananas were excluded due to their high starch content.

Latitude has been used for the capitals of the countries, as metropolitan areas tend to be more populous. However, the first tests detected multicollinearity problems between this variable and consumption of vegetables and fruit; hence, we had to exclude this variable from our regression tests.

RESULTS

We start our tests with a regression model with adult male mortality rate per 1000 male adults as independent variable and with the following regressors (see Table 1):

- Total per capita health expenditure, logarithm
- Consumption of vegetables and fruit (kg) per capita per year

Table 1. Regression model of adult male mortality rate (per 1000 male adults) for European countries, 2005 and 2010 (with the influence of alcohol consumption measured through the recorded consumption)

Element of model	2005				2010			
	Unstandardized coefficients		Standardized coefficients	*P*-value (one-tailed)	Unstandardized coefficients		Standardized coefficients	*P*-value (one-tailed)
	B	Standard error	*β*		*B*	Standard error	*β*	
Constant	350.6	176.3		0.029	503.81	138.02		<0.001
Total per capita health expenditure, logarithm	−104.8	44.7	−0.33	0.013	−142.92	34.42	−0.51	<0.001
Consumption of vegetables and fruit (kg) per capita per year	−0.43	0.16	−0.27	0.006	−0.33	0.14	−0.21	0.014
Smoking prevalence, males (% of adults)	4.09	1.36	0.41	0.003	2.64	0.98	0.32	0.007
Opiates (Percentage of population age 15–64 years consuming)	51.55	23.81	0.22	0.02	66.74	23.66	0.24	0.005
Alcohol recorded per capita (15+) consumption (in litres of pure alcohol)	5.73	4.23	0.14	0.09	6.82	3.68	0.16	0.039

Notes: for the year 2005 model $R = 0.877$; $R^2 = 0.770$; $P < 0.001$; for the year 2010 model $R = 0.921$; $R^2 = 0.848$; P 0.001. 'Unemployment' has demonstrated a correlation with a sign that has turned out to be opposite to the predicted. That is why this variable has been excluded from the regression analyses.

- Smoking prevalence, males (% of adults)
- Opiates (Percentage of population age 15–64 years consuming)
- Alcohol recorded per capita (15+) consumption (in litres of pure alcohol)
- Unemployment rate, male (%).

As we see, the first model for the year 2005 accounts for 77% of the variation of the adult male mortality rate in the European countries in 2005 and for 85% in 2010. For both years this model suggests logarithm of total per capita health expenditure and smoking prevalence as the strongest determinants of the adult male mortality in Europe. They are followed by per capita consumption of vegetables and fruits and prevalence of opiates consumption. For both 2005 and 2010 recorded per capita alcohol consumption turns out to be the weakest determinant, whereas for 2005 it appears only marginally significant.

This situation changes dramatically as soon as we start taking into account not only recorded but also unrecorded alcohol consumption (see Table 2).

The substitution of recorded alcohol consumption with total (recorded + unrecorded) consumption increases the explaining power of the model in a rather substantial way. However, what appears more important is that the power of alcohol factor in this case increases dramatically. The total (recorded + unrecorded) alcohol consumption turns out to be an unequivocally significant determinant of the adult male mortality rate.

What is more, as we have seen in Tables 1 and 2, with recorded consumption, alcohol is the weakest determinant among the five

Table 2. Regression model of adult male mortality rate (per 1000 male adults) for European countries, 2005 and 2010 (with the influence of alcohol consumption measured through the total [recorded + unrecorded] consumption)

Element of model	2005				2010			
	Unstandardized coefficients		Standardized coefficients:	*P*-value (one-tailed)	Unstandardized coefficients		Standardized coefficients	*P*-value (one-tailed)
	B	Standard error	*β*		*B*	Standard error	*β*	
Constant	96.6	165.9		0.282	329.2	150.3		0.02
Total per capita health expenditure, logarithm	−60.68	37.41	−0.19	0.058	−100.4	33.4	−0.36	0.003
Consumption of vegetables and fruit (kg) per capita per year	−0.36	0.13	−0.23	0.006	−0.32	0.13	−0.21	0.01
Smoking prevalence, males (% of adults)	4.64	1.16	0.47	<0.001	2.75	0.92	0.34	0.004
Opiates (Percentage of population age 15–64 years consuming)	38.47	20.15	0.17	0.033	67.18	22.04	0.24	0.003
Alcohol total (recorded and unrecorded) per capita (15+ years) consumption (in litres of pure alcohol)	10.96	2.99	0.33	<0.001	7.92	2.97	0.25	0.007

Note: for the year 2005 model $R = 0.913$; $R^2 = 0.834$; $P = <0.001$; for the year 2010 model $R = 0.931$; $R^2 = 0.866$; $P = <0.001$.

Table 3. Regression Model of Adult Male Mortality Rate (per 1000 male adults) for European Countries, 2005 and 2010 (with the influence of recorded alcohol consumption measured through beer, wine and spirits separately)

Element of model	2005				2010			
	Unstandardized coefficients		Standardized coefficients	*P*-value (one-tailed)	Unstandardized coefficients		Standardized coefficients	*P*-value (one-tailed)
	B	Stand. error	*β*		B	Stand. error	*β*	
Constant	342.88	175.6		0.031	473.24	130.76		0.001
Total per capita health expenditure, logarithm	−87.5	45.5	−0.28	0.033	−126.6	33.85	−0.45	<0.001
Consumption of vegetables and fruit (kg) per capita per year	−0.39	0,231	−0.25	0.054	−0.20	0.18	−0.13	0.135
Smoking prevalence, males (% of adults)	3.15	1.72	0.32	0.039	1.66	1.02	0.2	0.06
Opiates (Percentage of population age 15–64 years consuming)	39.45	25.77	0.17	0.069	56.63	22.98	0.21	0.011
Beer, recorded per capita consumption (in litres of pure alcohol per adult per year)	−4.65	6.92	−0.07	0.254	−1.69	5.86	−0.03	0.372
Wine, recorded per capita consumption (in litres of pure alcohol per adult per year)	4.61	6.57	0.08	0.245	4.12	4.86	0.09	0.203
Spirits, recorded per capita consumption (in litres of pure alcohol per adult per year)	18.53	10.78	0.29	0.049	20.31	7.13	0.37	0.005

Note: for the year 2005 model $R = 0.888$; $R^2 = 0.789$; $P = <0.001$; for the year 2010 model $R = 0.937$; $R^2 = 0.879$; $P = <0.001$.

Table 4. Regression model of adult male mortality rate (per 1000 male adults) for European countries, 2005 and 2010 (with the influence of alcohol consumption measured through the total [recorded + unrecorded] consumption of beer, wine and spirits separately)

Element of model	2005				2010			
	Unstandardized coefficients		Standardized coefficients	Significance (one-tailed)	Unstandardized coefficients		Standardized coefficients	Significance (one-tailed)
	B	Standard error	*β*		*B*	Standard error	*β*	
Constant	88.072	140.977		0.269	248.662	122,968		0.028
Total per capita health expenditure, logarithm	−40.182	33.753	−0.127	0.123	−69.414	28.006	−0.247	0.011
Consumption of vegetables and fruit (kg) per capita per year	−0.192	0.147	−0.124	0.102	−0.118	0.135	−0.075	0.197
Smoking prevalence, males (% of adults)	2.737	1.140	0.279	0.012	1.294	0.813	0.159	0.063
Opiates (Percentage of population age 15–64 years consuming)	14.244	17.979	0.061	0.218	26.267	20.746	0.095	0.11
Beer, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	0.333	4.704	0.005	0.472	1.800	4.704	0.030	0.353
Wine, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	6.385	3.154	0.160	0.027	3.512	2.746	0.098	0.108
Spirits, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	25.259	4.610	0.640	<0.001	21.793	4.392	0.622	<0.001

Note: for the year 2005 model $R = 0.951$; $R^2 = 0.904$; $P = <0.001$; for the year 2010 model $R = 0.961$; $R^2 = 0.923$; $P = <0.001$.

factors under study; with the substitution of recorded alcohol consumption with total (recorded + unrecorded) consumption, alcohol becomes the third strongest factor for 2010 and the second strongest factor for 2005.

Yet, the strength of alcohol factor increases even more as soon as we replace total alcohol consumption with the consumption of beer, wine and spirits treated separately (see Table 3).

As we see, when we take recorded consumption of beer, wine and spirits separately, only the consumption of spirits turns out to be a statistically significant determinant of adult male mortality rate in Europe. Note also that, both for 2005 and 2010, recorded per capita spirits consumption turns out to be the second strongest determinant yielding only to smoking prevalence (in 2005 dataset) and per capita health expenditure (in 2010). However, per capita spirits consumption becomes the unequivocally strongest determinant of an adult male mortality rate in Europe as soon as we take into account the WHO estimates of unrecorded consumption (see Table 4).

As soon as we take into account both recorded and unrecorded consumption of spirits, per capita spirits consumption becomes by far the strongest determinant of the adult male mortality rate in Europe both in 2005 and 2010 datasets. Note also that in this case per capita wine consumption turns out to be a much weaker but still significant determinant of adult male mortality rate in 2005 dataset (whereas it is marginally significant in 2010 dataset). Opiates consumption turns out an insignificant determinant in 2005 dataset whereas it is marginally significant in 2010 dataset. Note however that percentage of people who inject drugs is still a significant determinant for 2010 dataset (Unfortunately, the UN Office of Drugs and Crime does not provide respective data for 2005.) (see Table 5).

Note that in this case per capita spirits consumption still remains the strongest determinant followed by smoking prevalence, percentage of people who inject drugs, logarithm of per capita health consumption, and per capita fruit and vegetable consumption (all of these variables still turn out to be significant determinants of adult male mortality rate in Europe).

On the other hand, if we take into account predominantly wine and beer drinking countries of Europe (according to the classification by Rehm *et al.* (2006) [Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, UK.]), the same regression suggests that in those countries the wine consumption might be a stronger determinant of adult male mortality than the consumption of distilled spirits, whereas the beer consumption appears as a marginally significant determinant of the adult male mortality rate (see Table 6).

This is hardly surprising. Indeed, in those European countries where the major part of consumption of alcohol takes place in the form of wine or beer and only a small part of alcohol is consumed as distilled spirits, the contribution of beer and, especially, wine seems much more significant than at the level of Europe as a whole where the distilled spirits' contribution grossly outweighs the one of wine and especially beer. This does not contradict at all the main results of our analysis. In those European countries where the consumption of alcohol is high and it is consumed as distilled spirits we observe the highest adult male mortality, much higher than in those countries where the same amounts of alcohol are consumed as wine or beer (note that this pattern is clearly visible both before and after the introduction of the relevant controls). For example, according to the WHO (2018), in 2010 the alcohol consumption in Portugal (14,1 l) or the Czech Republic (13,9 l) was only a bit lower than in Russia (14,6) and even a bit higher than in Ukraine (13,4). However, in Portugal alcohol was consumed predominantly as wine, in the Czech Republic it was consumed as beer and in Russia and Ukraine it was largely consumed as distilled spirits. As a result, the adult male mortality rate in Russia (367 [It appears appropriate

Table 5. Regression model of adult male mortality rate (per 1000 male adults) for European countries, 2010 (with the influence of alcohol consumption measured through the total [recorded + unrecorded] consumption through beer, wine and spirits separately and injected drugs)

(Element of model	Unstandardized coefficients		Standardized coefficients	Significance (one-tailed)
	β	Standard error	β	
Constant)	176.309	110.181		0.06
Total per capita health expenditure, logarithm	−45.442	25.037	−0.170	0.04
Consumption of vegetables and fruit (kg) per capita per year	−0.213	0.123	−0.144	0.05
Smoking prevalence, males (% of adults)	1.342	0.806	0.174	0.05
People Who Inject Drugs (Prevalence (%) among population aged 15–64)	32.937	15.503	0.174	0.02
Beer, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	4.474	4.505	0.075	0.17
Wine, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	2.983	2.785	0.076	0.15
Spirits, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	19.966	4.154	0.555	<0.001

Note: $r = 0.956$; $R^2 = 0.913$; $P < 0.001$.

Table 6. Regression model of adult male mortality rate (per 1000 male adults) for wine and beer drinking European countries, 2010

Element of model	Unstandardized coefficients		Standardized coefficients	Significance (one-tailed)
	β	Standard error	β	
(Constant)	205.2	77.2		0.02
Total per capita health expenditure, logarithm	−49.5	20.2	−0.359	0.015
Consumption of vegetables and fruit (kg) per capita per year	−0.108	0.090	−0.237	0.12
Smoking prevalence, males (% of adults)	0.393	0.520	0.142	0.23
People Who Inject Drugs (Prevalence (%) among population aged 15–64)	15.61	14.7	0.144	0.15
Beer, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	4.686	2.615	0.309	0.05
Wine, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	8.095	2.196	0.556	0.001
Spirits, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	8.86	3.42	0.362	0.012

Note: $r = 0.902$; $R^2 = 0.814$; $P < 0.001$.

to recollect at this point that adult male mortality rate is 'the probability of dying {per thousand} between the ages of 15 and 60—that is, the probability of a 15-year-old male dying before reaching age 60, if subject to age-specific mortality rates of the specified year between those ages' (World Bank, 2017a); thus, the adult male mortality rate as high as 200 in the present year means that, out of 1000 present day 15-year-old males, 200 will die before reaching age 60, if subject to age-specific mortality rates of the present year between those ages].) or Ukraine (309) this year turned out to be almost three times as high as in the Czech Republic (135) or Portugal (121). However, high levels of alcohol consumption (albeit in the form of beers or wines) in Portugal and the Czech Republic still matters, and in 2010 the adult male mortality rate in the Czech Republic and Portugal still turned out to be substantially higher than, say, in Norway (80) or Malta (76), both of which managed to consume per capita, on the one hand, much less wine than Portugal, and, on the other hand, much less beer than the Czech Republic. However, the difference stemming from the difference in the consumption of either wine or beer is much less pronounced than the one resultant from the difference in the consumption of the distilled spirits. More studies of the effects of spirits, wine and beer consumption on adult male mortality rates are needed to determine their impacts with greater precision.

DISCUSSION AND CONCLUSION

Our analysis adds to the evidence that distilled spirits consumption is a major factor of adult male mortality, with a significantly greater impact compared to beer and wine. This must be due to higher alcohol concentration leading to higher rates of intoxication. Therefore, the reduction in distilled spirits consumption in hard liquor drinking areas should be a major target in health policy.

In fact, this problem is not confined to Slavic or Finnish language speaking populations, as higher mortality in spirits consumers comparing to wine and beer consumers was suggested in ecological studies in Denmark (Grønbæk *et al.*, 2000), USA (Kerr and Ye, 2011), Kazakhstan (Davletov *et al.*, 2015), the UK (Beard *et al.*, 2017), French overseas territories (Mété, 2017) etc. Also, the much disputed J-shaped relationship between alcohol consumption and cardiovascular events is only found for wine (Tverdal *et al.*, 2017) and sometimes beer, but seems to be absent for spirits (Costanzo *et al.*, 2011). Also, distilled spirits do not contain plant-derived phenols, which might slightly compensate the toxicity of ethanol (Arranz *et al.*, 2012).

The differences in life expectancy in the Northern Caucasus also point to alcohol as the major male mortality risk factor. Gender gap in deeply Islamized (and low in alcohol consumption) neighboring regions like Ingushetia, Chechnya or Dagestan was about 5 years in 2016, while in vodka-drinking (and vodka-producing) Northern Ossetia it was over 10 years, just as in the rest of Russia (Rosstat, 2018).

In fact, our results are very congruent with the ones obtained earlier by Rehm *et al.* (2006) who demonstrated that alcohol exposure in the European countries differs markedly in the main dimensions of alcohol consumption, i.e. overall level of consumption, beverage preference and drinking pattern. This is why within Europe, there are countries with similar volumes of alcohol consumption that, however, differ markedly in drinking patterns and rates of adult male mortality. In relation to this, the European countries were divided by Rehm *et al.* (2006) to reflect the variations in all dimensions of alcohol consumption, whereas this division demonstrated that the European countries with the highest adult mortality rates are characterized by very high levels of alcohol consumption in the form of spirits and associated drinking patterns (like binge drinking). This research supports their findings, demonstrating that they stand even after the introduction of a significant number of relevant controls.

We fully realize that our analysis is based on ecological data, which typically has limited potential of hypothesis confirmation. Yet, the outstanding harm of distilled spirits consumption has already been shown in microdata-based observational studies in Russia (Denisova, 2010; Zaridze *et al.*, 2014). This study simply suggests the magnitude of this harm.

Shield and Rehm (2015) produce a Russia-specific estimated alcohol-attributable burden of disease, noting on the detrimental drinking patterns. Our findings amplify the evidence that spirits consumption could be a major missing factor which should be integrated into the global mortality and disability risk factor models like Global Burden of Disease (Lim *et al.*, 2012).

More importantly, current research literature implies that governments and intergovernmental organizations like the World Health Organization should promote policies aimed specifically against high consumption of distilled spirits using all range of effective alcohol control policies.

Finally, significant public health harm and lack of evidence for the benefits of low doses of distilled spirits (Arranz *et al.*, 2012) dictates the need to change the approaches to the liquor industry. It implies that liquor industry should be treated just like tobacco industry and not as potential partner in public health policies, which has already been proposed based on alcohol industry corporate social responsibility policy analysis (Casswell, 2013; Knai *et al.*, 2015).

These changes should be incorporated into global public health policies as soon as possible, given the fact that distilled spirits consumption is not only highly prevalent in the Eastern Europe but is also becoming a significant issue in some other regions of the world, including China (Yang *et al.*, 2012) and India (Benegal, 2005).

CONFLICT OF INTEREST STATEMENT

None Declared

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APPENDIX

Table A1. Descriptive statistics for 2005 and 2010 datasets

	N	Minimum	Maximum	Mean	Standard error	Standard deviation	Dispersion
Descriptive statistics for 2005 dataset							
Consumption of vegetables and fruit (kg) per capita per year	39	89.46	427.00	204.385	10.33	64.52	4162.43
Opiates (Percentage of population age 15–64 years consuming)	37	0.10	2.10	0.524	0.0716	0.4357	0.190
Alcohol, recorded per capita (15+) consumption (in litres of pure alcohol)	40	1.75	15.52	10.180	0.4419	2.79494	7.812
Beer, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	38	0.85	8.39	4.024	0.2813	1.73396	3.007
Wine, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	38	0.62	12.15	3.758	0.41360	2.54963	6.501
Spirits, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	38	1.67	11.59	4.272	0.41945	2.58566	6.686
Alcohol, total (recorded and unrecorded) per capita (15+ years) consumption (in litres of pure alcohol)	40	4.65	20.78	12.505	0.50477	3.19245	10.192
Alcohol, unrecorded per capita (15+) consumption (in litres of pure alcohol)	40	0.40	10.00	2.325	0.303	1.91910	3.683
Beer, recorded per capita consumption (in litres of pure alcohol per adult per year)	40	0.85	7.39	3.977	0.254	1.60868	2.588
Wine, recorded per capita consumption (in litres of pure alcohol per adult per year)	40	0.36	7.99	3.104	0.301	1.90512	3.629
Spirits, recorded per capita consumption (in litres of pure alcohol per adult per year)	40	0.55	6.89	2.737	0.250	1.58288	2.506
Mortality rate, adult, male (per 1000 male adults)	40	68.86	464.86	170.253	15.755	99.64031	9928.192
Unemployment, male (% of male labor force) (modeled ILO estimate)	40	0.74	36.53	8.960	0.998	6.31037	39.821
Smoking prevalence, males (% of adults)	38	26.50	64.00	40.766	1.69480	10.44743	109.149
latitude	45	35.17	64.14	48.29	1.02534	6.87816	47.309
Total per capita health expenditure, $	40	302.77	7040.71	2424.70	262.082	1657.555	2747489
Descriptive statistics for 2010 dataset							
Consumption of vegetables and fruit (kg) per capita per year	40	107.51	396.58	207.541	10.331	65.34084	4269.425
Smoking prevalence, males (% of adults)	38	21.10	61.20	37.3842	1.704	10.50649	110.386
People Who Inject Drugs (Prevalence (%) among population aged 15–64)	38	0.008	2.290	0.4397	0.070	0.431633	0.186
Alcohol, recorded per capita (15+) consumption (in litres of pure alcohol)	41	1.47	14.97	9.811	0.4052	2.59465	6.732
Beer, recorded per capita consumption (in litres of pure alcohol per adult per year)	41	0.73	6.97	3.832	0.2314	01.48172	2.195
Wine, recorded per capita consumption (in litres of pure alcohol per adult per year)	41	0.33	7.49	3.0217	0.27089	1.73453	3.009
Spirits, recorded per capita consumption (in litres of pure alcohol per adult per year)	41	0.39	6.73	2.598	0.24069	1.54120	2.375
Alcohol, unrecorded per capita (15+) consumption (in litres of pure alcohol)	41	0.20	10.50	1.8585	0.28072	1.79749	3.231
Beer, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	41	0.73	7.57	3.851	0.23793	1.52350	2.321
Wine, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	41	0.75	10.59	3.661	0.33734	2.16002	4.666
Spirits, total (recorded and unrecorded) per capita consumption (in litres of pure alcohol per adult per year)	41	0.94	9.93	3.778	0.34936	2.23701	5.004
Alcohol, total (recorded and unrecorded) per capita (15+ years) consumption (in litres of pure alcohol)	41	4.27	18.75	11.669	0.440	2.81573	7.928
Mortality rate, adult, male (per 1000 male adults)	40	70.52	365.66	148.314	12.636	79.91571	6386.521
Opiates (Percentage of population age 15–64 years consuming)	32	0.05	1.40	0.379	0.0524	0.29619	0.088
Unemployment, male (% of male labor force) (modeled ILO estimate)	40	0.72	31.87	11.011	1.041	6.58196	43.322
Total per capita health expenditure, $	40	472.50	7046.70	2692.2113	268.897	1700.65	2892211