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Effects of Specific Alcohol Control Policy Measures on Alcohol-Related Mortality in Russia from 1998 to 2013†

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Abstract

Aims: To elucidate the possible effects of alcohol control policy measures on alcohol-related mortality in Russia between 1998 and 2013.

Methods: Trends in mortality, alcohol production and sales were analyzed in conjunction with alcohol control legislative measures. Correlation analysis of health and alcohol market indicators was performed.

Results: Ethyl alcohol production was the strongest correlate of alcohol-related mortality, which is probably due to the fact that ethyl alcohol is used for both recorded and unrecorded alcohol production. Measures producing greatest mortality reduction effect included provisions which reduced ethyl alcohol production (introduction of minimum authorized capital for ethyl alcohol and liquor producers in 2006 and the requirement for distillery dreg processing), as well as measures to tax and denaturize ethanol-containing liquids in 2006. Liquor tax decrease in real terms was associated with rising mortality in 1998–1999, while excise tax increase was associated with mortality reduction in 2004 and since 2012. Conventional alcohol control measures may also have played a moderately positive role.

Conclusions: Countries with high alcohol-related mortality should aim for a reduction in spirits consumption as a major health policy. Alcohol market centralization and reduction of the number of producers can have immediate strong effects on mortality. These measures should be combined with an increase in alcohol taxes and prices, as well as other established alcohol policy measures. In 2015 in Russia, this is not being implemented. In Russia, legislation enforcement including excise tax collection remains the major challenge. Another challenge will be the integration into the Eurasian Economic Union.

INTRODUCTION

Alcohol-related mortality has been high in Russia, both in the Soviet period and the post-Soviet period (Nemtsov, 1995, 2001, 2003a,b, 2009, 2011; Leon *et al.*, 1997, 2007, 2009; Shkolnikov and Chervyakov, 2000; McKee *et al.*, 2001; Shkolnikov *et al.*, 2001, 2004a,b, 2008, 2013; Men *et al.*, 2003; Brainerd and Cutler, 2005; Korotayev and Khaltourina, 2005, 2006; Khaltourina and Korotayev, 2006a,b,c,d, 2008a,b,c; Rehm *et al.*, 2007; Yuriev *et al.*, 2007; Demin *et al.*, 2009; Zaridze *et al.*, 2009,

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2014; Korotayev *et al.*, 2010, 2012, 2014; Neufeld and Rehm, 2013; Pridemore *et al.*, 2013a,b, 2014; Grigoriev *et al.*, 2014).

This was shown by time series analysis, by the study of gender, age and occupational distribution of mortality in Russia (Murphey *et al.*, 2006; Shkolnikov and Chervyakov, 2000; Khaltourina and Korotayev, 2008a,b,c; Zaridze *et al.*, 2009, 2014), and, most importantly, this was demonstrated by data on blood and urine alcohol concentrations from autopsies (Shkolnikov and Chervyakov, 2000; Zaridze *et al.*, 2009, 2014). Alcohol-related mortality was estimated as high as 700,000 for some years (Nemtsov, 2001) including recorded alcohol-related mortality as well as the rates of those dying with elevated blood alcohol content (Shkolnikov and Chervyakov, 2000; Khaltourina and Korotayev, 2008b; Zaridze *et al.*, 2009). This puts Russia (and the countries with similar patterns of alcohol abuse) as outliers having alcohol-related mortality even higher than tobacco-related mortality (with mortality attributable to tobacco also being very high) (Nemtsov, 2002; Demin *et al.*, 2009; Leon *et al.*, 2009; Rehm *et al.*, 2012, 2013; Zaridze *et al.*, 2009; Razvodovsky, 2012b).

Excessive mortality in Russia is argued to be related to high levels of consumption of distilled spirits (mostly in the form of vodka), since a number of beer- and wine-drinking countries with similar alcohol consumption levels (14 liters of ethanol per adult per year or more) do not seem to have such a high alcohol-related mortality (Khaltourina and Korotayev, 2005; Zaridze *et al.*, 2014). This is probably explained by the high per-event intake of ethanol by liquor drinkers (Andrienko and Nemtsov, 2005): alcohol intoxication is a risk factor for fatal alcohol poisonings, accidents, murders, cardiac failures and hemorrhagic strokes.

Overall, it is believed that the extraordinarily high levels of distilled spirits consumed in Russia are the main cause of excessive deaths in Russia, the danger of spirits consumption being poorly understood by drinkers (Bobak *et al.*, 1999; Gmel *et al.*, 2001; Simpura and Karlsson, 2001; Leifman *et al.*, 2002; Rehm *et al.*, 2003, 2012; Khaltourina and Korotayev, 2005, 2006a,b, 2008a,b,c; Kharchenko *et al.*, 2005; Korotayev *et al.*, 2005; Korotayev, 2006; Khaltourina, 2007; Klimova 2007; Popova *et al.*, 2007; Korotayev and Khaltourina, 2008; Zaridze *et al.*, 2009; Kiselev *et al.*, 2010; Shield *et al.*, 2011; Ilyk *et al.*, 2012; Tomkins *et al.*, 2012; Neufeld and Rehm, 2013; Pridemore *et al.*, 2014).

Leon *et al.* (2007) identified another cause of excessive alcohol-related mortality in Russia to be ethanol consumption in the form of 70–90% strong liquids not intended for drinking (non-beverage alcohol in the form of tinctures, sanitizers and perfumes). Chemical analysis of these liquids did not identify toxic admixtures in addition to alcohol (McKee *et al.*, 2005), so one may conclude that the main risk factor of such drinks is the very high content of the ethanol.

Additionally, Nuzhnyi (2004) and Nuzhnyi and Savchuk (2008) performed chemical and toxicity analyses of illegal spirits in Russia (illegally produced vodka, samogon (moonshine) and industrial and synthetic ethyl alcohol bought from illegal sellers). They found that these illegal liquors were no more dangerous or toxic than legal spirits and ethyl alcohol intended for consumption as beverages (for similar results see also Rehm and Gmel, 2007; Solodun *et al.*, 2011).

Finally, Harchenko *et al.* (2005) provide data on beverages consumed by the victims of fatal alcohol poisoning in Moscow in the period 2000–2003. They found that ethanol was the main killer, while methanol was found in <1% of cases.

All these studies lead to the conclusion that the main cause of the excessive mortality in Russia has been high consumption of strong (40% and higher share of ethanol) alcoholic beverages, with super-strong (70–90%) non-beverage alcohol having greater negative impact per quantity consumed. There is no evidence that toxic admixtures to the non-beverage or illegal alcohol played substantial roles, however, there is still a possibility that this factor has an effect which has been overlooked (McKee *et al.*, 2005). (A possible candidate for increased toxicity of non-beverage alcohol is diethyl phthalate, which served as an (ineffective) denaturizer until 2006.)

Alcohol-related mortality has been declining steeply since 2003, especially since early 2006. The strongest decline has been observed in deaths from alcoholic poisoning, followed by external causes of mortality. A milder decline has been observed in cardio-vascular mortality, but this still accounts for the greatest number of preventable deaths. The same pattern and range of mortality decline were observed by researchers in the USSR in the mid-1980s. This was shown to be caused by the anti-alcoholic campaign (Shkolnikov and Nemtsov, 1997; Khaltourina, 2006, 2007; Khaltourina and Korotayev, 2006a,b, 2008a,b,c; Klimova, 2007; Nemtsov, 2009, 2011; Neufeld and Rehm, 2013; Pridemore *et al.*, 2013a,b, 2014; Shkolnikov *et al.*, 2013; Grigoriev *et al.*, 2014).

Russia adopted a set of amendments to alcohol control legislation in early 2006, followed by additional regulations and amendments later on (Khaltourina, 2006; Levintova, 2007; Khaltourina and Korotayev, 2008b; Putiy and Ayala, 2010; Tael *et al.*, 2011; Neufeld and Rehm, 2013). The role of alcohol policy reform has been acknowledged in a number of recent high profile studies (Neufeld and Rehm, 2013; Shkolnikov *et al.*, 2013; Pridemore *et al.*, 2014). However, the scope and the mechanisms of the effect of legislation change on mortality remain under discussion. Levintova (2007), Neufeld and Rehm (2013), Shkolnikov *et al.* (2013) and Pridemore *et al.* (2014) performed detailed analyses of the alcohol policy reforms and consumption changes in order to elucidate the possible effects of the Russian alcohol control policies on alcohol consumption and mortality for the period 2000–2010. Thus, Neufeld and Rehm (2013) found that 'the regulations introduced since 2006 seem to have positive effects on both drinking behavior and health outcomes'. Our goal is to identify specific regulatory mechanisms leading to specific changes in market performance, consumption, and ultimately morbidity and mortality.

METHODS

The main methodology was a narrative review, coupled with descriptive and simple analytical statistical analyses (correlation analysis). Most decisive policy change events were identified using analysis of dynamics of mortality, morbidity and market indicators, and by indicator correlation analysis in combination with an analysis of Russian law, and the research and analytical literature (Leon *et al.*, 2007; Levintova, 2007; Shkolnikov *et al.*, 2013).

We used three alcohol supply indicators: spirits production (usually vodka or other types of beverages of about 35–45% of ethanol), ethyl alcohol production (95.57% water solution of ethanol) (according to the State Standard No. 18300-72.), and retail sale of spirits.

Production of vodka and liquor data, as well as data on production of ethyl alcohol have been obtained from the declarations submitted by producers to Rosstat (Russian State Statistical Agency).

Data on retail sales of vodka and liquor have been obtained from the Rosstat figures based on the declarations submitted to Rosstat by retail sellers. Federal Service for Alcohol Market Regulation (FSAMR) provides statistical books with data on alcohol production market since 2011 collecting data from other agencies including Rosstat. Therefore, the data provided by the Federal Service for Alcohol Market Regulation must be comparable with the earlier data of Rosstat,

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however, FSAMR might have become more demanding to the Rosstat data quality, once it started being in charge of the data publishing.

So, the Rosstat data on production and sales in 2012–2013 are taken from the official publication of the FSAMR (2014). The alternative data on alcohol production based on the Centralized State Automated Information System for Ethyl Alcohol, Alcohol and Ethanol-Containing Products Recording (CSAIS/EGAIS) were obtained from personal correspondence with government agencies. CSAIS/EGAIS data provided significantly higher figures of vodka and ethyl alcohol production than the Rosstat data. However, these data are not publicly available, so we could only obtain it for the year 2011, and we used it for the general unrecorded consumption share assessment.

Given the high levels of unrecorded alcohol consumption in Russia (Andrienko and Nemtsov, 2005; Levintova, 2007; Leon *et al*, 2007; Gil *et al*., 2009) all indicators should be assessed critically (see Discussion).

Data on deaths from all causes and from alcohol poisoning were obtained from Rosstat and the Ministry of Health of the Russian Federation.

The source of the data on adult male mortality rate is the Russian Fertility and Mortality Database (RusFMD). Data on alcohol taxation were obtained by analyzing editions of the Tax Code of the Russian Federation. We choose the following indicators of alcohol-related mortality in Russia: the number of deaths from alcohol poisoning, the number of deaths in general and the working age male mortality rate. We found the adult male mortality rate to be an indicator of alcohol-related mortality in Russia (which is mainly specific for males), superior to others. Alcohol poisoning mortality has been a good indicator of Russia's alcohol-related problems (Nemtsov, 1995, 1998, 2000, 2001, 2011; Neufeld and Rehm, 2013), but it could have become less relevant with the recent alcohol-related mortality decrease and changes of the pattern of alcohol consumption.

Table 1 contains the sources for the indicators used for the quantitative analysis.

RESULTS

The data on the variables under consideration are presented in Table 2 and Figs. 1 and 2:

First of all, we see the poor quality of the reporting of vodka and liquor sales and production, as the figures on production are significantly lower than those of sales (while the amount of export and import was insignificant in the years in question). Meanwhile, the amount of vodka which was actually taxed was even lower. It is clear that the amount of spirits consumed was higher. At the same time, we hypothesize that the dynamics of the official data on production and sales must reflect the consumption.

Production of vodka and liquor (as reported by the producers to Rosstat) rose steeply from 1997 to 1999, remained high (with certain fluctuations) until 2007 (with the exception of 2006, when the alcohol tracking system was implemented), and then declined starting from 2008.

Treisman (2010) provided a convincing explanation for the rise of alcohol consumption and alcohol-related mortality in Russia since 1998. Russia experienced severe economic crisis in 1998 resulting in an 84% inflation rate in 1998 and 36% in 1999. However, the high inflation rates in 1998 and 1999 were not compensated with a sufficient increase in excise tax on spirits. Thus, vodka excises and prices declined in real terms, which made it significantly more affordable in comparison to other products. It looks like this particular decision triggered the entire mortality crisis after 1998 against the background of economic growth and improvement in life satisfaction (Brainerd and Cutler, 2005).

The production of ethyl alcohol from crops (based on producers' reporting) continued to increase from 1998 up until 2004. It was significantly higher than the recorded vodka and liquor production (in liters of ethanol). It started declining from 2005 with a particular steep decrease in 2006—by 30%. After this, the amount of recorded ethyl alcohol production became close to that of the recorded vodka and liquor production.

Recorded sales of vodka and liquor peaked in 2003 and declined gradually since then.

The adult male mortality rate, as well as the number of deaths, started to decline only in 2006, with the weakest rates of decline in 2008 and 2010. The number of deaths has continued to decline since 2011 despite population aging.

Mortality from alcohol poisoning has declined dramatically (more than four times) since 2003, with the highest rates of decline in 2006 and 2007.

The correlation analysis (We had to avoid using multiple regression analysis because there were strong multicollinearity effects;

Table 1. Sources for the indicators of alcohol market and alcohol-related mortality

Indicator	Source
Production of vodka and liquor, millions of decaliters	The Rosstat data, which was published at the Rosstat website until 2010, and at the FAMRS website since 2011 (FAMRS 2014)
Production of ethyl alcohol from crops, millions of decaliters	The Rosstat data, which was published at the Rosstat website until 2010, and at the FAMRS website since 2011
Retail sales of vodka and liquor, millions of decaliters	The Rosstat data, including the United Inter-Agency Information-Statistical Database (UIAISD, 2015)
Number of deaths, thousands	The Rosstat data
Number of deaths from alcohol poisoning, thousands	The Rosstat data
Adult male mortality rate	The Russian Fertility and Mortality database (RusFMD) (http://demogr.nes.ru/en/demogr_indicat/data) and The Human Mortality Database (http://www.mortality.org/) are the sources for World Bank's (http://data.worldbank.org/indicator/SP.DYN.AMRT.MA) and for our (for the years 2011 and 2012) calculations of the adult male mortality rate.
Excise taxes on spirits, in 1997 rubles per a liter of pure ethanol	Retrospective excise tax rates have been obtained from the previous editions of the Tax Code of the Russian Federation at the website of 'Konsultant Plus' (http://www.consultant.ru), while the Rosstat data were used as the source for the inflation rates.

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Table 2. Alcohol production, sales and mortality in Russia, 1997–2010

	Production of vodka and liquor, millions of decaliters[a]	Production of ethyl alcohol from crops, millions of decaliters[b]	Retail sales of vodka and liquor, millions of decaliters[a]	Number of deaths, thousands	Number of deaths from alcohol poisoning, thousands	Adult male mortality rate	Excise taxes on spirits, in 1997 rubles[c]
1997	86.6	53	214.7	2016	27.9	391.617	45.00
1998	86.4	47.9	217.5	1989	26.1	383.463	27.11
1999	134.6	62.5	223.5	2144	29.9	416.557	23.84
2000	123	62.4	214.6	2225	37.2	442.954	23.14
2001	131	65.9	209.1	2255	41.1	451.477	24.58
2002	138.7	72.8	211.3	2405	44.7	462.232	23.92
2003	134.9	74.5	216.4	2440	42.7	471.894	24.65
2004	136.6	80.3	208.6	2303	37.9	465.095	26.13
2005	132.4	71.6	203.5	2304	35.9	466.788	25.48
2006	104	55	197.2	2167	28.4	429.445	25.46
2007	131	55.9	184.6	2084	20.8	402.562	23.18
2008	122	45.20	177.2	2081	19.2	396.388	21.91
2009	113	46.4	166.1	2011	16.3	371.747	22.17
2010	106	42.4	157.8	2031	14.4	367.067	22.41

[a]In Russia the average contents of ethanol in vodka and liquor is 39%.
[b]96% water solution of ethanol.
[c]Per a liter of pure ethanol.

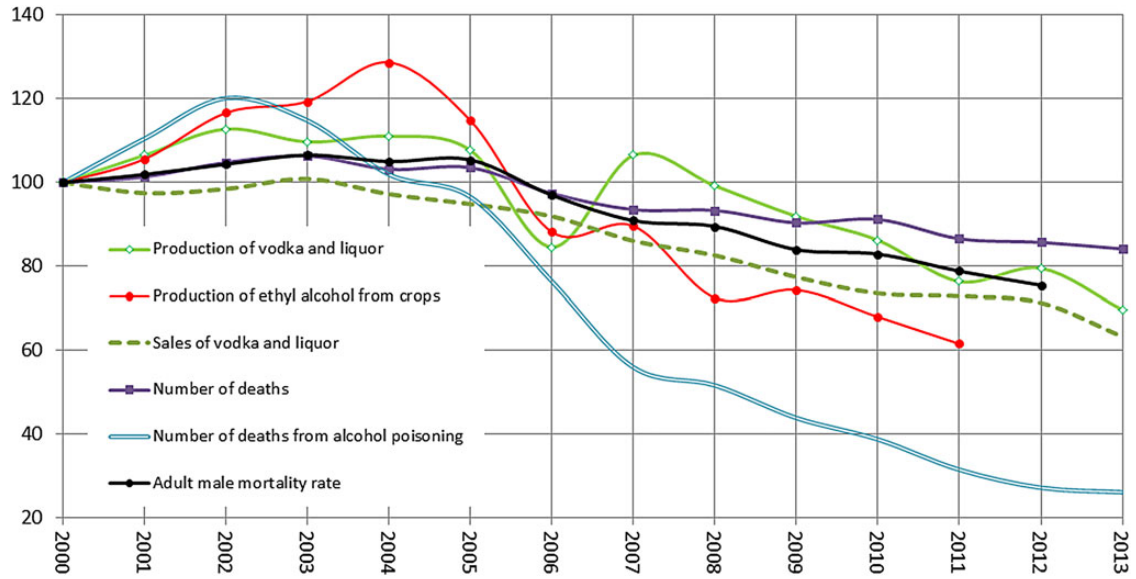

Fig. 1. Alcohol production, sales and mortality in Russia, 2000–2013 (100 = the level in 2000), version 1 (with number of deaths from alcohol poisoning). Sources: Rosstat and Federal Service for Alcohol Control Market (http://www.fsrar.ru/industry) are the sources of data for vodka and liquor production and sales, as well as for ethyl alcohol production, Rosstat is the source for the number of deaths, number of deaths from alcohol poisonings; Russian Statistical Service (Rosstat). The Russian Fertility and Mortality database (RusFMD) (http://demogr.nes.ru/en/demogr_indicat/data) and The Human Mortality Database (http://www.mortality.org/) are the sources for World Bank's (http://data.worldbank.org/indicator/SP.DYN.AMRT.MA) and for our (for the years 2011 and 2012) calculations of the adult male mortality rate.

hence, Table 3 displays straightforward bivariate correlation coefficients) that we perform (see Table 3 and Fig. 2) identifies ethyl alcohol production as the strongest predictor of adult male mortality, number of deaths from all causes, and the number of deaths from alcohol poisoning.

The Pearson's coefficient *r* for adult male mortality rate is 0.94 for production of ethyl alcohol from crops, 0.70 for the production of vodka and liquor, 0.57 for the sales of vodka and liquor, and just -0.12 for the excise tax on spirits (inflation adjusted). Interestingly, the correlations between GDP per capita (inflation adjusted) and the mortality indicators are insignificant. The number of deaths shows similar correlation patterns.

Alcohol poisoning mortality rate correlates with the strength of 0.89 (Pearson's coefficient) with ethyl alcohol production, while the correlation coefficient is lower for alcohol sales (0.77), and even lower for vodka and liquor production (0.52).

To understand alcohol market and alcohol mortality indicator dynamics, we should take a close look at the measures affecting alcohol production, consumption and sales. We modified the list of the most effective measures that reduced alcohol use in Russia (both

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registered and unregistered) composed by Levintova (2007) and Neufeld and Rehm (2013) by adding new measures which produced a strong effect (according to our policy analysis) and excluding measures whose effect has not been established.

1998–1999—Excise taxes on alcohol were not adjusted to hyperinflation which led to a 47% decrease of liquor excise tax in 2 years in real terms.
January 2004—Excise tax on spirits increased by 6% above inflation.
New excise stamps for alcohol were introduced, and the old ones were banned. The stamps included information on exact package volume.
January 2006—Amendments to the 171 Federal Law 'On State Regulation of Production and Turnover of Ethyl alcohol, Alcohol and Ethanol-Containing Production' from 22 November 1995 were enacted, providing for new regulations of alcohol production, sales, and transportation.
Authorized capital was introduced for producers of ethyl alcohol and spirits. Regions were empowered to establish authorized capital for retail sellers.
Centralized State Automated Information System for Ethyl Alcohol, Alcohol and Ethanol-Containing Products Recording (CSAIS/EGAIS), including the use of raw materials and leftovers, started to be implemented.
New effective mandatory denaturizers were adopted (petrol, kerosene, denatonium benzoate, crotonaldehyde), and the old ineffective one—diethyl phthalate—was canceled.
Regional authorities were granted the rights to introduce time limits on retail alcohol sale for alcoholic beverages with ethanol content of >15%, and to establish authorized capital for retail sellers.
Ethanol-containing liquids started to be taxed at the rates similar to vodka (with the exception of medicines, antiseptics and perfumes) according the changes to Article 181 of the Tax Code of the Russian Federation.
July 2006—New excise stamps were adopted and it became forbidden to use the old ones.
January 2007—Excise taxes on spirits were increased negligibly which resulted in their actual decrease by 6% in real terms.
July 2007—Sales of perfumes without proper denaturizers were banned.
January 2010—Introduction of minimal prices on vodka, other spirits and ethyl alcohol.
April 2010—The requirement to process distillery dregs was introduced.
January 2011—Ethyl alcohol producers not having expensive equipment to process distillery dregs were not able to renew their licenses.
July 2011—A new set of amendments to federal alcohol control law No. 171 was introduced.
January 2012—Alcohol tax increase in real terms by 22%.
- A national ban on sales of all types of alcoholic beverages from 11 PM to 8 AM was introduced to complement regional bans;
- Authorized capital for spirits producers was increased by 40%;
- A ban on ethyl alcohol retail sales that were formerly allowed in northern areas;
- The list of places where alcohol sale was banned, was expanded and now included educational, sport and culture facilities; however the fines for violation remained very small.
- The ban on alcohol sale in kiosks was extended to all types of alcohol, while earlier (since 1995) it was only for spirits;
- The mandate of the regions to limit alcohol retail sales was expanded to include places and conditions of the sales.

July 2012—Ethyl alcohol transportation became licensed.
January 2013—Excise tax on spirits was increased by 27% in real terms.

We provide the following interpretations of the massive changes in the dynamics of the alcohol-related and general mortality in Russia since the late 1990s.

The rapid increase in alcohol-related mortality after 1998 is likely to have been caused by the fact that the excise taxes on liquor declined 47% in real terms in 1998–1999, despite being nominally increased (see Table 1). This made taxed vodka much more affordable in comparison to other products, which probably affected the prices of untaxed spirits as the competing alcohol categories. The situation was worsened by the impressive growth in population income in the forthcoming years and the poor tax collection system (Treisman, 2010).

It is unclear if alcohol-related mortality decreased in 2003. Mortality from alcohol poisoning decreased 4.5%. However, the number of deaths and the adult male mortality rate increased in 2003. Alcohol poisoning mortality seems to be superlinearly related to hard liquor consumption, and it could be prone to fluctuation at such extreme levels as it was in Russia in the early 2000s. Alcohol dependence prevalence, which declined after 2000, also seems to be a poor indicator of alcohol abuse, as it did not reflect significant alcohol mortality decline in 1995–1998. Its decline might instead reflect the decrease in financing the state narcological service after the financial crisis of 1998 or previous dynamics due to time lag in alcoholism development. Therefore, it is doubtful that there was a significant decline in alcohol-related mortality in 2003.

The year 2004, in contrast, shows some decrease in all mortality indicators under consideration, including an 11% decrease in deaths from alcohol poisoning, a 5.6% decrease in the number of deaths, but only a 2% decrease in the adult male mortality rate. In fact, the mortality decrease in 2004 was higher among women than among men, and it was lower among younger men than among older men and children (Vishnevskiy 2007, pp. 151–153). This suggests that the mortality decline in 2004 was partly due to the economic growth.

Some of the decline in alcohol-related mortality in 2004 may have been caused by the 6% increase of excise taxes on spirits in real terms, and by the introduction of new excise stamps. These new excise stamps were volume specific and had identification numbers unlike the previous ones. This system was clearly imperfect but it made vodka production more complicated in 2004, which may have resulted in a 3.6% decline in recorded vodka and liquor sales. The production of ethyl alcohol and spirits increased in 2004, so the decline in sales must have occurred due to the decline of vodka and liquor from producers who did not report alcohol production (unrecorded production).

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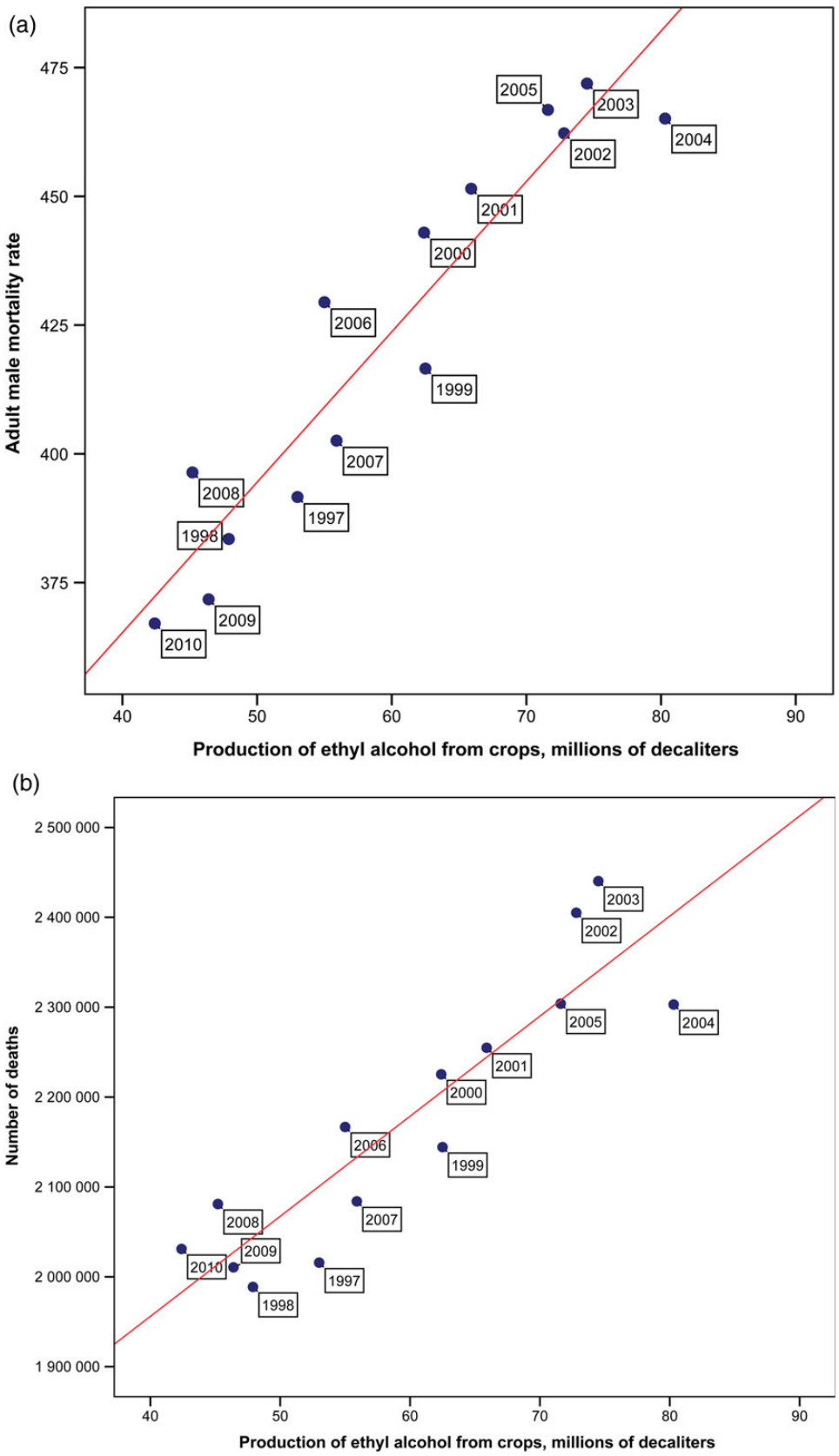

Fig. 2. Correlation between the production of ethyl alcohol from crops and mortality indicators in Russia, scatterplots with fitted regression lines, 1997–2010: (**a**) with the adult male mortality rate; (**b**) with the total number of deaths per year; (**c**) number of deaths from alcohol poisonings.

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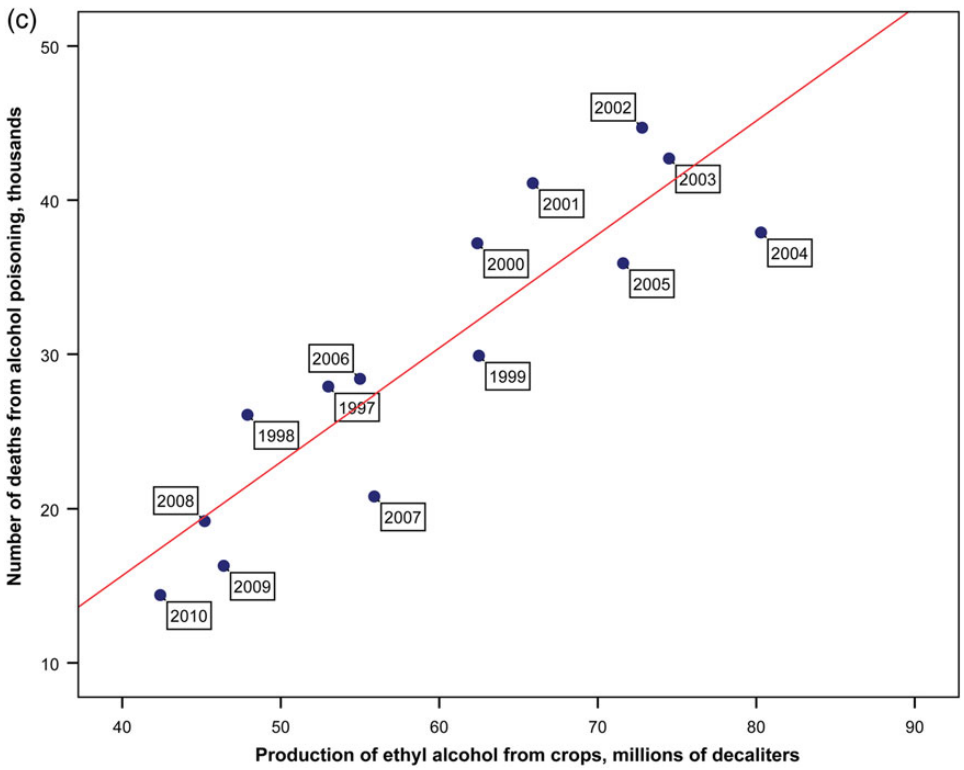

Fig. 2. Continued

The year 2005 shows complex dynamics with declining alcohol production and sales, and declining mortality from alcohol poisoning, but with minor increases in the number of deaths and adult male mortality rate. This can be interpreted as a moderate increase in unrecorded alcohol consumption against the background of a decrease in recorded alcohol consumption. Also, unrecorded ethyl alcohol and alcohol producers could have been preparing for the forthcoming tightening of the alcohol market regulation in 2006.

The greatest decline in alcohol-related mortality happened in 2006, when the number of deaths from alcohol poisoning decreased by 21%, adult male mortality rate decreased by 8%, and general number of deaths decreased by 6% (or by 137.2 thousand deaths).

At the same time, recorded vodka and liquor production decreased by 21% and recorded ethyl alcohol production decreased by 23%, while recorded vodka and liquor sales decreased only by 3.1%. These dynamics imply that (a) the decrease was strongest in unrecorded production of ethyl alcohol and spirits, which resulted in significant mortality decrease, but in modest decrease in sales (Demin *et al.*, 2009; Neufeld and Rehm, 2013); (b) real production and consumption figures were significantly greater than recorded sales and (c) the dynamics of recorded ethyl alcohol and spirits production reflect the real dynamics but at lower levels. Additionally, a part of the difference between vodka production and sales dynamics can be explained with overproduction which is likely to have taken place before the enactment of alcohol control measures in 2006. In this case the extra vodka produced in 2005 was sold through 2006.

One of the strongest measures which led to the reduction of ethyl alcohol and spirits production in 2006 was the introduction of minimum authorized capital for ethyl alcohol and spirits producers. Authorized capital is the initial investment by the founders of a company according to the Russian law. Minimum authorized capital refers to the required minimum threshold for the such authorized capital. Such a measure forced a significant number of smaller producers to close down.

Other key measures which facilitated the strong decrease in unrecorded alcohol consumption and some decrease in recorded alcohol consumption in 2006 included the introduction of the excise taxes on ethanol-containing liquids equal to the excise tax on spirits, as well as new effective denaturizers. This removed the entire segment of very strong non-beverage alcohol masked as technical liquids for cleaning, fire igniting, bathing, etc. Only medicines, sanitizers and perfumes were excluded from taxation by Article 189 of the Tax Code of the Russian Federation, which still caused their consumption and a large number of unnecessary deaths (Leon *et al.*, 2007, 2009; Demin *et al.*, 2009).

The introduction of the Centralized State Automated Information System for Ethyl Alcohol, Alcohol and Ethanol-Containing Products Recording (CSAIS/EGAIS) through 2006 as well as new excise stamps significantly disturbed vodka and ethyl alcohol production which may have resulted in lower production and sale numbers. In fact, the introduction of CSAIS/EGAIS was gradual, and it started working only since 2009, improving its functioning over time. It probably had a lasting profound effect on alcohol market reducing the amount of unrecorded alcohol. Unfortunately, CSAIS/EGAIS controls only producers and not wholesalers or retailers according to the law, which limits significantly its effectiveness.

Since 2006 the regions were allowed to introduce regional laws and decrees that would limit time of liquor retail sales. According to Kolosnitsyna *et al.* (2014) 72 of the 83 Russian regions introduced an alcohol sale ban at night, which resulted in an average decrease in alcohol consumption by 3.7% in those regions. Finally, the regions were also allowed to introduce authorized capital for retail sellers, and some regions used this right, resulting in the reduction of the number of retail outlets, which in turn, is one of the most effective measures to reduce alcohol consumption (Österberg, 2004; Demin *et al.*, 2009).

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Table 3. Correlation matrix (for 1997–2010)

		Adult male mortality rate	No. of deaths	No. of deaths from alcohol poisoning	Production of ethyl alcohol from crops, millions of decaliters	Production of vodka and liquor, millions of decaliters	Sales of vodka and liquor, millions of decaliters	Excise taxes on spirits, in 1997 rubles	Per capita GDP, PPP
Adult male mortality rate	Pearson's *r*		0.953	0.922	**0.944**	0.696	0.596	−0.117	−0.269
	Sig.		**<0.001**	**<0.001**	**<0.001**	0.006	0.025	0.690	0.353
Number of deaths	Pearson's *r*			0.883	**0.903**	0.749	0.469	−0.224	−0.176
	Sig.			**<0.001**	**<0.001**	0.002	0.090	0.441	0.548
Number of deaths from alcohol poisoning	Pearson's *r*				**0.894**	0.524	0.774	0.067	−0.577
	Sig.				**<0.001**	0.054	0.001	0.821	.031
Production of ethyl alcohol from crops, millions of decaliters	Pearson's *r*				1	0.715	0.628	−0.031	−0.346
	Sig.					0.004	0.016	0.916	0.226
Production of vodka and liquor, millions of decaliters	Pearson's *r*					1	0.146	−0.550	0.130
	Sig.						0.618	0.041	0.658
Sales of vodka and liquor, millions of decaliters	Pearson's *r*						1	0.365	−0.880
	Sig.							0.199	0.000
Excise taxes on spirits, in constant rubles of 1997	Pearson's *r*							1	−0.470
	Sig.								0.090
Per capita GDP, PPP, 2005 international dollars	Pearson's *r*								1
	Sig.								

Note: $N = 14$ for all the cells.
Bold values indicate $P < 0.001$.

The effect of the policy measures introduced in 2006 lasted through the following years. Some measures were introduced gradually, including CSAIS/EGAIS. The lower rate of alcohol-related mortality decrease in 2008 can be explained with lowering excise tax on spirits in real terms.

Minimum price on vodka, other spirits and ethyl alcohol was introduced in 2010 (Neufeld and Rehm, 2013; Shkolnikov *et al.*, 2013). This measure reduced the demand for untaxed vodka (a large part of which was registered by official statistics), as the price became the same both for the production of honest producers, and those who avoided excise (and probably other) taxation. Minimum vodka prices did create very high margins for tax evading vodka producers, but the demand on their production decreased, which must have had a sustainable beneficial effect on reducing alcohol-related deaths.

The requirement to process distillery dregs (Distillery dregs are leftovers from the ethyl alcohol production. It is a light brown liquid (suspension) with 6% of hard matter. Thirteen liters of distillery dregs are produced per each 1 l of distilled ethyl alcohol) was introduced in April 2010. This required quite expensive equipment, and the number of ethyl alcohol producing factories was reduced from 67 in 2010 to 28 in 2011 according to Rosstat, as many factories, especially small ones, were not able to renew their licenses. As a result, vodka and liquor production decreased by 11% in 2011, while ethyl alcohol production decreased by 9%. The number of deaths from alcohol poisoning decreased by 11% in 2011, the number of deaths in general decreased by a remarkable 5%, and the adult male mortality rate decreased by 4.9%. At the same time, the recorded sales of vodka and liquor decreased only by 1%, which implies that the reduction of alcohol-related mortality in 2011 was due to decreased ethyl alcohol production by small factories, which was used for unrecorded alcohol consumption.

A new set of amendments to the 171 Federal Law was adopted in July 2011, and enacted through 2012–2013. The key measures were the introduction of licensing for alcohol transportation, a national alcohol sales ban at night, a ban of all sorts of alcohol beverage retail sales in kiosks, a ban of ethyl alcohol retail sales (which was earlier allowed in certain northern areas, which in fact included large territories).

Excise taxes on spirits (as well as on other alcoholic beverages and ethanol-containing liquids) were significantly increased in 2012 and 2013 (and later in 2014). The alcohol reform amendments of 2011 together with significant tax increases resulted in a 3% decrease in vodka and liquor retail sales in 2012, and an 11.3% decrease in 2013. The adult male mortality rate decreased by 4.2% in 2012 (there is no data available for 2013), the number of deaths from alcohol poisoning decreased by 14% in 2012 and by 4% in 2013, and the number of deaths in general decreased by 1% in 2012, and by 1.8% in 2013.

These relationships are graphically presented at Fig. 3.

DISCUSSION

Towards interpreting associations between different alcohol and mortality indicators

The poor quality of data due to the high (and changing) share of unrecorded alcohol consumption hinders causal relationship analysis.

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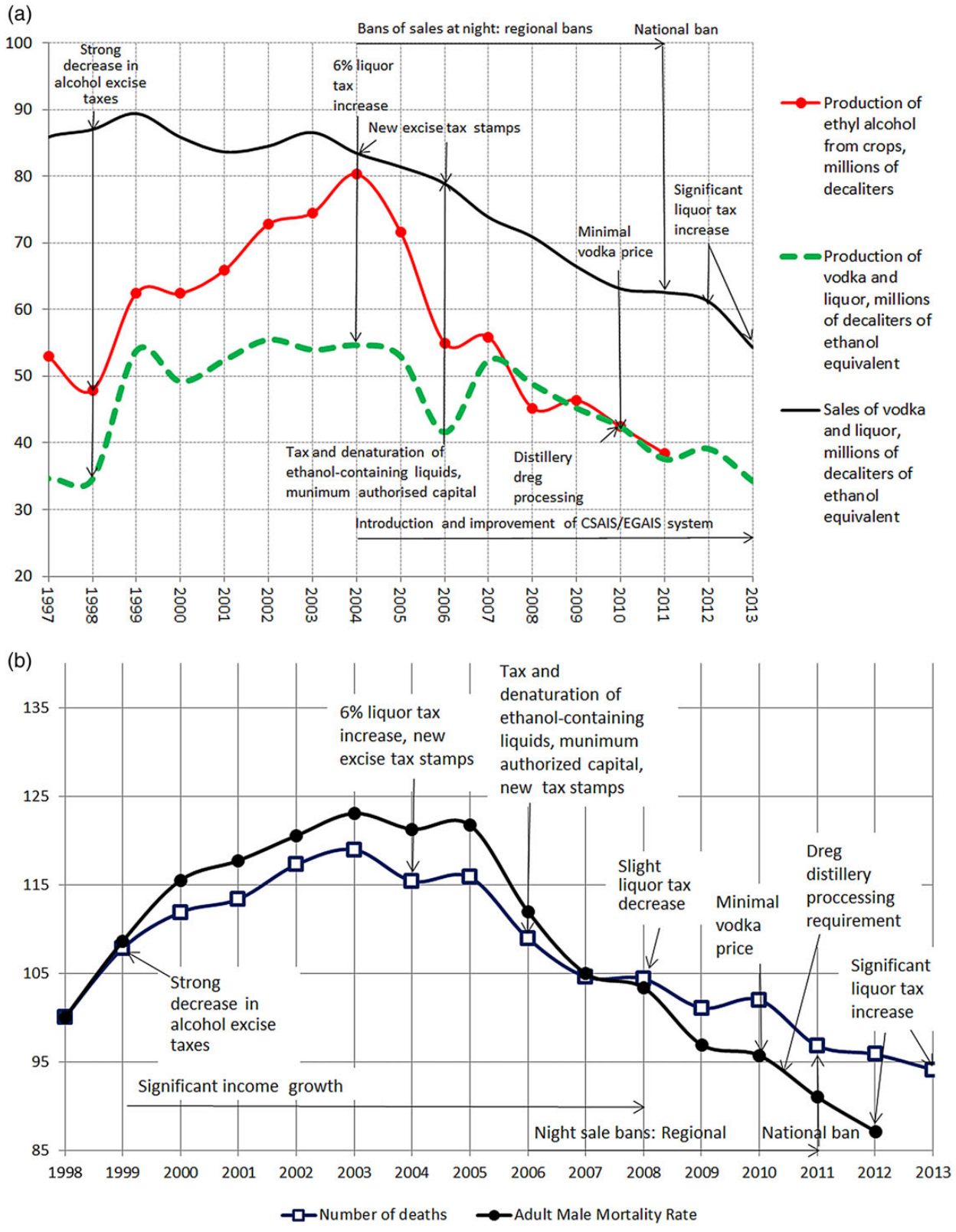

Fig. 3. Dynamics of alcohol production, sales and mortality indicators in Russia in the context of alcohol control legislation in Russia in 1998–2013: (**a**) retail sales of vodka and liquor, production of vodka, liquor and ethyl alcohol; (**b**) number of deaths and adult male mortality rate (1998 level = 100); (**c**) number of deaths from alcohol poisoning, thousands.

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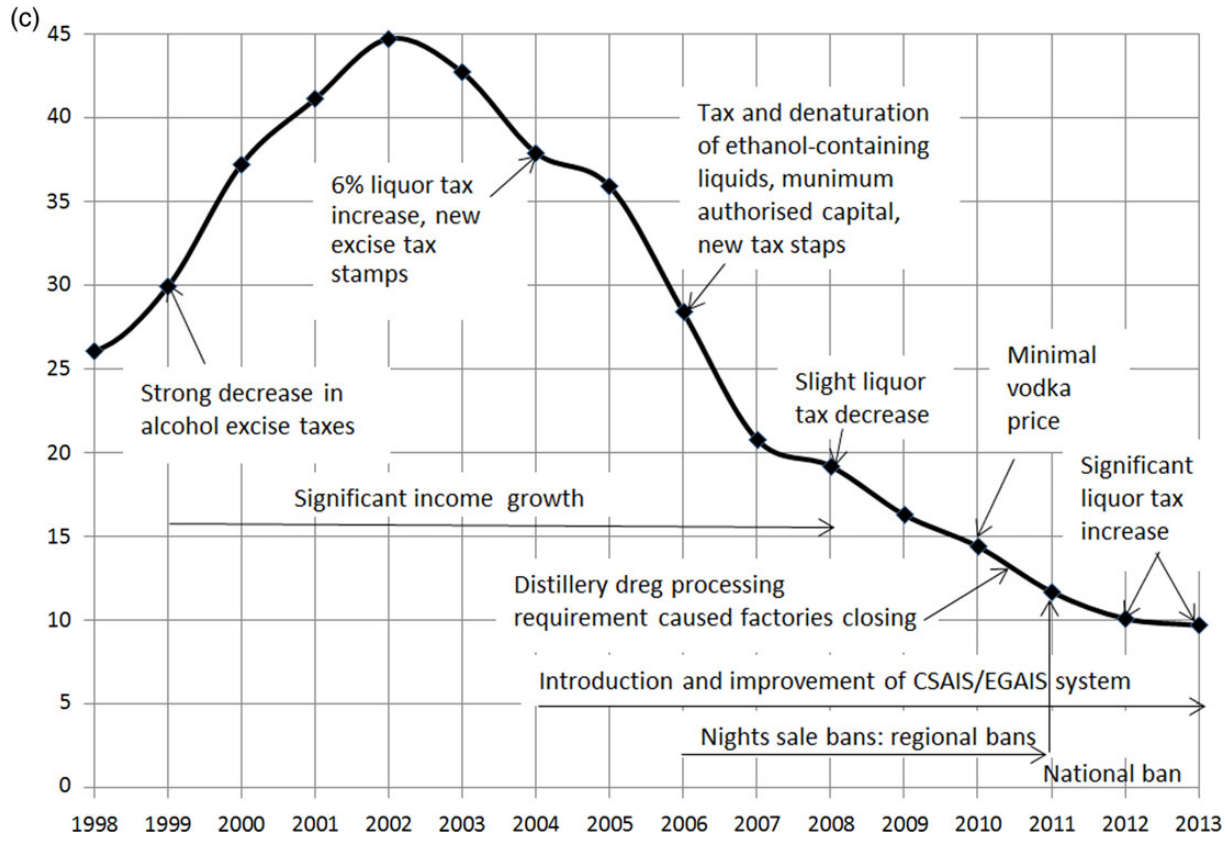

Fig. 3. Continued

There are different gradations of unrecorded alcohol. The data on alcohol retail sales (based on the retail sellers' reports to Rosstat) provide figures higher than both Rosstat (based on the producers' report) and CSAIS/EGAIS data on liquor production. Recorded ethyl alcohol production data do not correspond well to recorded liquor production figures. The amount of taxed vodka and liquor is even lower. This indicator has not been analyzed in this paper but it is worth mentioning to illustrate the problems of alcohol market regulation in Russia.

The data on alcohol retail sales (based on the retail sellers' reports to Rosstat) provide figures higher than both Rosstat (based on the producers' report) and CSAIS/EGAIS data on liquor production. At the same time, we could not use data on retail spirits sale as the main alcohol consumption indicator. We see that data on alcohol and liquor sales increased in 2011 while alcohol-related mortality clearly decreased in the same period. This indicates that the data on alcohol retail sales (which are often quoted as recorded alcohol consumption in Russia (see e.g.: Neufeld and Rehm, 2013)) are an imperfect predictor of alcohol-related mortality. This can be explained by the fact that the data on recorded sales reflect both alcohol consumption and market transparency.

However, some conclusions can still be made as most vodka and liquor consumed by the population is purchased in the official retail stores, especially in the urban areas, and illegal alcohol producers and sellers often try to mimic legal production and sales to avoid problems with controlling agencies and to keep customers. Only a substantial number of rural residents (Andrienko and Nemtsov, 2005) and some share of urban alcoholics (Leon *et al.*, 2007) consume clearly illegal alcohol, and there is no evidence that they dominated in defining mortality dynamics, as in accordance with the log-normal distribution of alcohol consumption (as shown by Lederman, 1956), moderate drinkers consume the largest share of alcohol in a society. Statistical analysis shows that alcohol-related mortality indicators correlate more strongly with the figures on ethyl alcohol production than with the figures on alcohol sales and vodka and liquor production.

This pattern can be explained by the fact that ethyl alcohol is used for the production of all major types of ethanol-containing liquids consumed, including recorded vodka and liquor, unrecorded spirits, as well as non-beverage ethanol-containing liquids. The Russian case indicates that a high level of consumption of distilled spirits with high ethanol content has a much stronger effect on mortality than the same levels of low content alcohol beverages like beer and wine (see e.g. Khaltourina and Korotayev, 2005; Zaridze *et al.*, 2014).

Identifying the effect of the alcohol control measures

The dynamics of alcohol market and mortality indicators implies that measures to reduce the amount of ethyl alcohol available to consumption in the form of non-beverage liquids for technical purposes or in other forms have had a strong effect on mortality decrease in Russia. Such measures included taxation and effective denaturation of the ethanol-containing liquids in 2006.

Measures to reduce the number of ethyl alcohol and spirits producers led to mortality decrease in Russia, as they resulted in the reduction of ethyl alcohol and spirits available for consumption at least in the short term. That included the introduction of minimum authorized capital in 2006 for liquor and ethyl alcohol producers, its further increase for vodka producers in 2011, and the requirement to process

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distillery dregs in 2011 (which required expensive equipment). Such measures forced small producers to close their businesses reducing the amount of ethyl alcohol and liquor available for consumption at least in the short term. These measures were followed by significant alcohol-related mortality decrease in 2006 and in 2011.

Ban of liquor sales at night seems to have been effective in reducing at least registered liquor sales, and most likely alcohol consumption in general. However, the only study available (Kolosnitsyna *et al.*, 2014) covers the period from 2006 to 2011, when only liquor sales at night were banned. The effect of the total off-premise alcohol sale ban at night has not been examined yet, but it coincides with the decrease in alcohol mortality, production and sales.

The introduction of the new liquor excise stamps disturbed incidentally liquor market functioning life in 2004 and 2006, which seems to have had a certain positive effect on alcohol-related mortality indicators in Russia.

The effect of introducing CSAIS/EGAIS alcohol tracing and tracking system is unclear. Generally, its introduction in 2009 was followed by the decrease in the sale and production volumes, as well as in mortality indicators (with the exception of the number of deaths in 2010, which grew against the background of the decrease in adult male mortality rates as well as mortality from alcohol poisoning). The system could have allowed alcohol-related mortality decrease against the background of the significant liquor tax increase in 2012 and especially in 2013.

Minimal vodka price is also hard to connect to mortality, production and sale dynamics, while it is clear that it must have reduced untaxed cheap alcohol consumption, reducing the consumption as a whole.

According to studies, the most effective measures to reduce alcohol consumption include increasing excise taxes, limiting the time of alcohol sales, and reducing the number of alcohol retail sale outlets, with tax and price measures being the most effective (Österberg, 2004; WHO 2004; Demin *et al.*, 2009).

The tax collection ratio in Russia is quite low, so excise tax dynamics were not a major factor of alcohol-related mortality between 2000 and 2011. Treisman (2010) shows that the reduction in real terms of alcohol taxes and prices in 1998 and 1999 was the key factor of the subsequent mortality growth, especially against the background of significant population income growth. It is plausible that tax increases on spirits in real terms may have played a role in 2003 and 2004, and especially between 2012 and 2014, while the liquor tax decrease in real terms may explain the smaller decrease of mortality rates in 2008 than in the years before and after. At the same time, it is clear that the dramatic reduction of alcohol-related mortality between 2003 and 2011 is not related to alcohol taxation (see Table 1).

The effect of alcohol taxation measures is likely to be significant and moderately positive. However, its significance was outperformed with much stronger effects of the measures to reduce availability of ethyl alcohol and non-beverage alcohol with very high alcohol content. At the same time, strong inflation adjusted decrease of the liquor excise tax is likely to have caused a steep rise in mortality in Russia between 1998 and 2003 against the background of a rather fast average income growth. Some liquor tax increase could have caused decrease in alcohol-related mortality in 2004. Additionally, the significant drop in excise tax rate in 2008 might have caused slower speed of mortality decrease in 2008. Finally, strong increase of liquor excise tax appears to have been a key factor of mortality decrease between 2012 and 2014. Introducing the excise tax on ethanol-containing liquids in 2006 can well be regarded as an unconventional tax measure which produced a major change in the level of alcohol-related mortality, reducing the amount of extremely cheap unrecorded alcohol in the form of illegal vodka and ethanol-containing non-beverage liquids (Khaltourina and Korotayev, 2008b; Neufeld and Rehm, 2013; Shkolnikov *et al.*, 2013).

The introduction of effective mandatory denaturizers for ethanol-containing technical liquids together with their taxation (with the exception of medical liquids and perfumes for both measures) killed the entire and massive segment of very cheap and extremely strong alcohol-containing liquids resulting in a massive reduction of mortality (Khaltourina, 2006; Levintova, 2007; Neufeld and Rehm, 2013; Shkolnikov *et al.*, 2013).

All these measures greatly reduced the amount of ethyl alcohol available for consumption in the short term and resulted in more centralized and transparent ethyl alcohol and alcohol markets in the long term. In fact, alcohol market centralization in the form of removal of small ethyl alcohol and vodka producers from the market did have a major positive public health effect by reducing ethyl alcohol and vodka production (especially various types of unrecorded alcohol), resulting in a very significant mortality reduction.

Many regulations that caused market disturbances, such as the introduction of the alcohol tracing and tracking system and changes in the excise stamp format, caused a reduction of alcohol-related mortality, so they should not be viewed only negatively. Altogether measures that reduced ethyl alcohol and spirits production did affect average alcohol prices and its affordability for the population, so they did act as indirect price measures, especially in regard to ethanol-containing liquids.

Other conventional alcohol control measures have also had significant effects. The efforts to bring down teenage drinking by improving enforcement and increasing sanctions seem to have had some positive effect, as alcohol consumption among teenagers has decreased (Curries *et al.*, 2012). It is likely that the reduction of the number of retail outlets (kiosk sale ban) has contributed to lower alcohol sales and consumption.

Implications of the Russia's alcohol policy experience for Russia and other countries

Countries with a high share of unrecorded alcohol consumption and significant alcohol-related harm should combine measures to reduce ethyl alcohol and alcohol production with conventional alcohol control policy measures. Centralization of ethyl alcohol and liquor markets is beneficial for alcohol-related morbidity and mortality reduction in these cases. Specific measures to reduce unrecorded alcohol consumption like introducing alcohol tracing and tracking systems or effective denaturation and taxation of ethanol-containing liquids can produce direct positive effects.

Unfortunately, the Russian government facing the 2014–2015 financial crisis seems to be repeating the mistakes of 1991 and 1998. Alcohol taxes were not increased nominally (in rubles) for 2015, and the plan is not to increase excise tax on spirits and alcohol-containing liquids in 2016. This means a decrease of excise taxation in real terms due to the inflation. Moreover, Federal Service for Alcohol Market Regulation issued the decree no. 409 which reduced minimal vodka prices by 16% from 1 February 2015. This will lead to increased vodka financial availability as well as to greater tax avoidance. Additionally, the Ministry of Industry and Trade is proposing to allow alcohol sales in kiosks, while the government is going to legalize distance alcohol retail sales online. The data analyzed above suggests that all this will lead to rather significant increases in various mortality indicators in Russia and could have tragic demographic consequences (see Arkhangelsky *et al.*, 2015 for more detail).

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As for Russia, it can be advised to ensure law enforcement, especially in the areas of tax collection and prevention of untaxed illegal and non-beverage alcohol sales. At present, the Centralized State Automated Information System for Ethyl Alcohol, Alcohol and Ethanol-Containing Products Recording (CSAIS/EGAIS) is not connected to the tax collection system, and its marking is different from excise stamp marking. It would make sense to integrate alcohol production tracking with excise tax collection.

The sanctions for unmarked alcohol sales should be extended for lower-scale offenses, as the Note to Article 169 of the Criminal Code of the Russian Federation currently states that Article 171.1 'Production, purchase, storage, transportation and sale of unmarked goods and products' can only be applied if the damage is above 1.5 million rubles, which is far beyond a reasonable threshold to prevent illicit alcohol retail sales. Similarly, the threshold for sanctions for tax evasion, as defined in Article 199 of the Criminal Code 'Tax Payment Evasion' should be set at a much lower level for liquor excise taxes than the current 2 million rubles or 10% of taxes in the past 3 years. The 3-year waiting period to start criminal prosecution seems to be inappropriate for alcohol excise collection. Also, the loophole of Article 189 of the Tax Code of the Russian Federation which provides exceptions for excise taxation of ethanol-containing medical tinctures (sanitizers registered as medicines) and perfumes, should be removed at least for the brands most often consumed as non-beverage alcohol or altogether.

Finally, Russia should struggle to preserve its past achievements in alcohol control legislation as it enters the Eurasian Economic Community (a union of mainly northern Eurasian countries).

The 'Treaty on Eurasian Economic Community' (TEEC) approved on 29 May 2014 has neither a provision on public health as a priority in decision making, nor a statement of preference of national sovereignty over legislation in public health and specifically alcohol control, unlike the Treaty of Functioning of the European Union. This makes the Eurasian Economic Commission extremely vulnerable to industrial lobbyism. In fact, the Eurasian Economic Commission is already pushing the draft 'Agreement on Regulation of Activities of Alcohol Market Stakeholders in the Territories of the States Parties to the Custom Union and United Economic Space' according to the Decision for the Eurasian Economic Commission No. 310 from the 25 December 2013. The only exception made is for alcohol price (but not tax) regulation according to Article 85 of the TEEC. Actually, Article 71 of the TEEC provisions ('harmonization of excise taxes on sensitive goods') is used by the Eurasian Economic Commission as the basis for pushing the draft 'Agreement about Principles of Tax Policy in the Sphere of Alcohol and Tobacco Products of the States-Parties to the Eurasian Economic Union'. In fact this could result in reducing alcohol taxes in Russia for tax harmonization purposes. Therefore, it is not clear whether Russia will be able to retain and expand its significant achievements in reducing alcohol-related mortality.

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CONFLICT OF INTEREST STATEMENT

None declared.

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