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A time-series analysis of the impact of heavy drinking on homicide and suicide mortality in Russia, 1956–2002*

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Abstract

Aim—Assess the impact of heavy drinking on homicide and suicide mortality in Russia between 1956 and 2002.

Measures and design—Alcohol-related mortality was used as a proxy for heavy drinking. We used autoregressive integrated moving average techniques to model total and sex-specific alcohol—homicide and alcohol—suicide relationships at the population level.

Findings—We found a positive and significant contemporaneous association between alcohol and homicide and between alcohol and suicide. We found no evidence of lagged relationships. These results held for overall and sex-specific associations.

Conclusion—Our results lend convergent validity to the alcohol—suicide link in Russia found by Nemtsov and to the alcohol—homicide associations found in cross-sectional analyses of Russia. Levels of alcohol consumption, homicide and suicide in Russia are among the highest in the world, and the mounting evidence of the damaging effects of consumption on the social fabric of the country reveals the need for intervention at multiple levels.

Keywords

Alcohol; heavy drinking; homicide; Russia; suicide

INTRODUCTION

The level of alcohol consumption in Russia is among the highest in the world. While valid measures are difficult to acquire in the country for several reasons, Nemtsov [1,2] has estimated current annual consumption of about 12–14 litres of ethanol per person. More importantly, vodka and illegally produced distilled spirits (*samogon* in Russian) comprise 70–80% of the alcohol consumed in the country (see, for example, p. 18 of Andrienko & Nemtsov [3]), and about one-third of Russian males admit to binge drinking at least once per month [4]. This toxic mixture of consumption level, beverage choice and drinking pattern has been linked theoretically and empirically to several negative health outcomes in Russia, including overall mortality, cardiovascular disease [5,6], the mortality crisis of the 1990s [7,8] and lethal violence [9–11].

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Russian homicide and suicide mortality rates are also among the highest in the world. For example, age-adjusted homicide and suicide mortality rates in Russia in 2002 (the final year employed in this study) were 31 and 38 per 100 000, respectively. The Russian homicide rate is about five times higher than in the United States, usually considered the most violent industrialized nation in the world, and about 15–20 times higher than in most European countries. The Russian suicide rate is about two to three times higher than in the United States and Europe. Although both homicide and suicide rates increased dramatically following the break-up of the Soviet Union they were already high before that momentous event, even given the declines experienced during the anti-alcohol campaign in the mid-1980s. As with alcohol, violent mortality was also an important component of the Russian mortality crisis, especially for males [12,13].

Alcohol, homicide and suicide

During the last 10–15 years a number of studies have examined the alcohol—suicide link at the aggregate level. Most of these studies were of European countries and employed time-series designs. Norström [14] found a positive and significant association over time between alcohol and suicide in Norway (see also Rossow [15]) and Sweden, and Skog [16] and Skog *et al*. [17] found a similar relationship in Denmark and Portugal, respectively. Norström [18] and Ramstedt [19] also found an alcohol—suicide association in several European countries, although their results suggested that the strength of this relationship is conditioned by a nation's wet/dry drinking culture (i.e. it may be weaker or non-existent in wet drinking cultures). Studies of eastern European nations have also found support for an aggregate-level association between alcohol and suicide [20]. Skog & Elekes [21], for example, used Hungarian time-series data and found a positive association. Wasserman, Värnik & Eklund [22,23] used Soviet-era data and found evidence of a positive association in several Soviet countries. Two aggregate-level time-series studies in the United States also found a positive association [24,25]. Given subnational variation in levels of consumption and suicide rates, cross-sectional analysis can also be informative when examining the alcohol—suicide link at the aggregate level, and a few such studies [16,26,27] have provided evidence of an association, although effect sizes varied and there were sometimes differential effects for males and females.

Substantially fewer studies have examined the population-level association between alcohol and homicide. However, scholars such as Pernanen [28] and Parker [29] have presented sophisticated explanations of the mechanisms through which consumption may operate to influence levels of interpersonal violence, and a handful of time-series and cross-sectional analyses have provided evidence for a positive association between the two [29–32].

Russia

Due to former Soviet secrecy and data falsification—especially relative to ideologically sensitive social issues such as alcohol, homicide and suicide—it was almost impossible to undertake research on these topics in Russia until the dissolution of the Soviet Union. Further, while several scholars have suggested a causal connection between alcohol and lethal violence in Russia, only a small number of studies have tested this hypothesis formally. Those that have, however, have found evidence of an association. Nemtsov [1,33], for example, examined the impact of the anti-alcohol campaign and the political—economic reforms on alcohol-related mortality in Russia, including homicide and suicide. Most germane to our current study, Nemtsov [9] also found a positive association between alcohol and suicide rates in Russia between 1965 and 1999, and Razvodovsky [34,35] found an association between the two in his time-series analyses of neighboring Belarus. In a cross-sectional analysis of Russian regions (i.e. provinces), Pridemore [10] also found an association between a proxy for heavy drinking and suicide rates, as did an unpublished study by Andreeva [36].

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Another set of studies has shown consistent evidence of a link between alcohol and homicide at the aggregate level in Russia. In his cross-sectional panel analysis of Russian regions, Andrienko [37] found alcohol to be associated with increases in regional homicide rates. Andreeva [36] and Pridemore [11] also found a strong positive association between heavy drinking and homicide in cross-sectional studies of Russian regions. Further, in a series of subsequent studies of social structure and homicide carried out by the latter, this association remained significant when controlling for a number of structural covariates of homicide (e.g. poverty, single-parent households, regional geographic location and socio-economic and political change). Next, in a study of death records from the Udmurt region, Pridemore [38] found a significant association between the daily distribution of fatal alcohol poisonings and homicide deaths. Finally, Razvodovsky [34] found a significant and positive association between consumption of distilled spirits and homicide rates in a time-series analysis of Belarussian data.

Overall, there appears to be (1) consistent support for an aggregate-level alcohol—suicide link, although evidence suggests the strength of this relationship is conditioned by drinking culture; (2) some support for an alcohol—homicide association at the aggregate-level, although there is less evidence for this than for suicide; and (3) evidence that alcohol is associated with lethal violence in Russia. The findings from Russia, however, are based mainly on cross-sectional designs and only one longitudinal analysis, and the estimates of consumption in the latter were different from those employed here and necessarily limited to only 35 years because of data availability.

DATA AND METHOD

Data

The data on alcohol, homicide and suicide used in this study were all taken from the Russian vital statistics registration system. Mortality data such as these were inaccessible until recently due to former Soviet secrecy. Between 1965 and 1987, for example, homicides and suicides were among a group of causes of death that were extracted systematically from the original statistical tables and placed into a classified table, labelled ‘5B’ [39]. There seemed to be no pressure to falsify the actual cause of death (see, for example, Wasserman & Värnik [40]), however, and thus the death records and underlying data still contained valid estimates of homicide and suicide deaths. This secrecy ended in the late 1980s and today homicide and suicide data are released annually in various publications available from the Russian State Committee for Statistics (Goskomstat) and the Russian Ministry of Health [41]. Further, a research group was given access to the previously unpublished historical data and was able to extract the homicide and suicide (and other) deaths from the 5B table and to reclassify them appropriately [42,43]. All data used for the current study were prepared for us by Russian colleagues based upon this project. The 1965–2002 data are publicly available from Goskomstat and we obtained the 1956–64 data, which are currently unpublished, from Dr Meslé and Dr Shkolnikov. All data were for Russia proper, not the Soviet Union as a whole.

The dependent variables were the annual overall and sex-specific homicide and suicide mortality rates per 100 000 people between 1956 and 2002. We note that Russia used the Soviet coding system to classify cause of death until 1999. Items 173 (suicide) and 174 (homicide) in this system had the same case definitions as the World Health Organization’s (WHO) *International Classification of Diseases* (ICD) codes E950—E959 and E960—E978, respectively [39]. Since 1999 the Russian vital statistics registration system has employed the new ICD-10 codes.

The independent variable was a proxy for aggregate annual heavy drinking. Obtaining reliable estimates of consumption at the national level is difficult in any country, and especially so in

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Russia. Measures often used elsewhere—such as production, retail sales and tax receipts—are notoriously unreliable in Russia [44]. For instance, production data are an invalid measure of consumption as illegally produced alcohol (*samogon*) accounts for a substantial amount of total consumption in the country, as does consumption of alcohol substitutes such as aftershaves and industrial alcohols [45]. More importantly for this time-series analysis, consumption of *samogon* and alcohol substitutes as a proportion of overall consumption varied substantially during the period under study [2]. Sales and tax receipts are also suspect because (1) sales of *samogon* and alcohol substitutes and (2) reliable figures are unavailable from the Soviet era.

Another approach in aggregate-level studies is to use the death rate from liver cirrhosis as a proxy for consumption. Russian registration habits, however, often classify deaths caused by the long-term effects of drinking in the alcohol poisoning category [13], which annually makes up about 80% of all deaths directly related to alcohol in Russia [44,46,47]. Nevertheless, the combination of binge drinking vodka and the consumption of alcohol substitutes and of illegally produced alcohol of unregulated quality results in an abnormally high rate of deaths due to true poisoning. Given these recording peculiarities, we used all deaths due directly to alcohol as our proxy for heavy drinking (specifically, the annual overall and sex-specific death rate per 100 000 residents). There are four categories of deaths due directly to alcohol consumption in this classification scheme: chronic alcoholism, alcohol psychosis (including encephalopathy and dementia), alcoholic cirrhosis and alcohol poisonings. This measure, unlike others mentioned above, also has the benefit of being available for the entire period under study. Yet another advantage of the mortality data is that they are gender-specific, whereas a measure such as per capita alcohol consumption is not. We note that post-mortem diagnosis of chronic alcoholism is rare, and so has little influence on this measure. A potentially more important issue, however, is that alcoholic cirrhosis deaths are probably lagged relative to other alcohol-related causes. The alcohol poisonings category may thus be a better proxy of heavy drinking than the combination of these four categories. Nevertheless, we wish to point out that (1) the reason we used all alcohol-related deaths in this analysis was because previous analyses using only alcohol poisonings were criticized for not using all alcohol-related deaths and (2) analyses of the alcohol—homicide and alcohol—suicide associations in Russia that employed only the alcohol poisonings category led to the same results presented here.

It is important to point out that the sharp increases in recorded deaths due to alcohol, homicide and suicide following the collapse of the Soviet Union represented true changes and are not artifacts of new measurement systems [5]. For example, the changes in these death rates follow similar patterns in other, completely unrelated, causes of death. Further, as noted above, Russia did not change its death classification system when the Soviet Union collapsed. The country did begin a transition to WHO classifications in 1993, but it was not until 1999 that it actually began reporting deaths using ICD-10 codes.

Model estimation procedures

We used autoregressive integrated moving average (ARIMA) techniques to model the reciprocal relationships between the age-adjusted total and sex-specific alcohol-related homicide and suicide cause of death series for Russia. These data are annual, spanning the years 1956–2002 ($n = 47$). A number of detailed statements concerning the manner in which ARIMA models are used to assess the bivariate relationship between two time-series appear in the social science literature (see, for example, Chamlin [48], Langworthy [49] and Loftin & McDowall [50]). Hence, we offer here only a brief description of the procedures involved in using this technique (for a detailed discussion of ARIMA model building see McCleary & Hay [51]).

The identification and specification of univariate and bivariate models involves three basic steps. Granger & Newbold [52] demonstrate that bivariate correlations between two raw time-

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series are almost invariably spurious, due to common sources of trend, drift and autocorrelation. Therefore, the first step in ARIMA causal modeling entails transforming each raw series into a new set of observations that are distributed independently and normally with a mean of zero and a constant variance (i.e. a white noise process). In the language of ARIMA modeling the process of removing this systematic (i.e. confounding) variation within each time-series prior to the examination of any potential causal relationships is referred to as 'pre-whitening'. The second step entails the calculation and inspection of the cross-correlation function (CCF), a measure of association between two pre-whitened time-series. Based on one's interpretation of the CCF, a preliminary bivariate transfer function is specified and estimated (assuming, of course, that the CCF indicates that a significant bivariate relationship may exist). The last step involves subjecting the final model to a number of diagnostic checks. If it is found to be inadequate, a new model is estimated. This iterative procedure continues until a statistically adequate model is constructed.

RESULTS

Univariate analyses

Figures 1, 2 and 3 show overall and male- and female-specific age-adjusted alcohol-related homicide and suicide mortality rates per 100 000 residents in Russia between 1956 and 2002. The patterns for men and women are very similar, although (1) rates are much higher for men on all three causes of death and (2) the decreases in homicide and suicide mortality in the mid-1980s and the subsequent increases in the early 1990s were proportionally greater for men than for women. While a detailed discussion of these trends is beyond the scope of the current paper, we mention briefly that the sharp decreases in these time-series in the mid-1980s corresponded with and are generally accepted to be partially the result of Gorbachev's anti-alcohol campaign. The smaller increases in the late 1980s were probably the result of (1) a regression to the mean following the halt of this campaign in 1988, together with worsening social conditions and (2) the waning enforcement of the anti-alcohol campaign before its official demise. The much more dramatic increases in the early 1990s correspond with the collapse of the Soviet Union and the concomitant anomic conditions accompanying the swift economic, social, political and ideological changes.

Table 1 presents the final univariate ARIMA models for the age-adjusted total and sex-specific cause of death time-series. The table contains information about the functional form and statistical adequacy of these models. As alluded to above, the residuals of a statistically adequate time-series are uncorrelated (i.e. distributed as a white noise process). The *Q* statistic, which has a χ^2 distribution, tests whether or not the model residuals differ as a whole from a white noise process. All the final univariate models meet this diagnostic criterion (i.e. none of the autocorrelation functions are significant at the 0.05 level).

In brief, the general form of the univariate ARIMA model is (p,q,d) (P,D,Q); where p =the order of the autoregressive process, d = the degree of differencing, q = the order of the moving average process, P = the order of the seasonal autoregressive process, D = the degree of seasonal differencing and Q = the order of the seasonal moving average process. Inspection of Table 1 reveals that only relatively simple nonseasonal models were needed to reduce each series to a white noise process. Only five series required a log transformation of the observations to induce variance stationarity, while much of the systematic variation within most of the series was well accounted for by the application of first-order differencing and the specification of a first-order moving average parameter.

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Bivavariate analyses

Once we remove the spurious effects of systematic error that accumulate over time (i.e. autocorrelation) we can estimate the cross-correlation function to identify the presence or absence of a reciprocal relationship between two time-series. In brief, the CCF can be thought of as a Pearson product–moment coefficient (approximately) between two time-series separated by ±k observations. Thus, the CCF can be divided into two halves, where the positive half reveals the lagged effects of the first series on the second and the negative half reveals the lagged effects of the second series on the first. Lagged values that are at least twice their standard errors are suggestive of a significant bivariate relationship between two series.

Table 2 presents the cross-correlation functions between the total and sex-specific age-adjusted cause of death series. Panel (a) contains the CCFs for the total age-adjusted death rate series, while panels (b) and (c) contain those for the female and male age-adjusted death rates series, respectively. For each bivariate relationship we report the correlations and the associated standard errors for the first two lags of the CCF. Because it is possible that a particular cross-correlation might appear to indicate the presence of a statistically significant association, when in fact this correlation merely reflects chance variation, we also estimated the Box—Ljung test statistics (distributed as χ^2), which evaluate the null hypotheses of no association between the first series on the second (the positive lags), the second series on the first (the negative lags), and the entire set of CCFs (see Table 2).

Two patterns emerge from these analyses. First, and most importantly, we find virtually no reason to believe that there is a lagged, causal relationship between any of the age-adjusted cause of death time-series. Only one of the 24 lagged cross-correlation coefficients is at least twice its standard error, the lagged (1 year) positive effect of female alcohol-related deaths on female suicides (r = 0.32, SE = 0.149). However, the Box—Ljung statistic associated with the lagged effects of female alcohol-related deaths on female suicides was non-significant ($Q_{-2\text{ to }-1}$ = 5.24, P = 0.10). Consequently, we suspect that the discovery of a single, statistically significant lagged is simply an artifact of the data (a consequence of calculating a large number of coefficients) and not a substantively meaningful finding.

Secondly, the size of the instantaneous bivariate associations between alcohol and homicide (r = 0.65, SE = 0.147) and between alcohol and suicide (r = 0.62, SE = 0.147) are positive and substantially greater than their respective standard errors. Further, this finding holds for men (homicide: r = 0.64, SE = 0.147; suicide: r = 0.66, SE = 0.147) and women (homicide: r = 0.79, SE = 0.147; suicide: r = 0.46, SE = 0.147). Given our expectations about the relationships among these variables, we interpret these findings to mean that annual levels of alcohol consumption in Russia are associated with annual homicide and suicide mortality rates.

DISCUSSION

Russia has a long history of alcohol-related social problems, and alcohol (especially vodka) has long been incorporated into daily Russian culture in many ways, including anecdotes, jokes and folk remedies [53,54]. The negative effects of heavy drinking were generally acknowledged and even led sometimes to occasional public health campaigns in the country [55,56]. During the Soviet era, however, ideological sensitivity to the negative social, economic and health outcomes of alcohol, together with Soviet secrecy related to various data related to these spheres, curtailed the ability of Russian scholars to undertake formal analyses of these issues, or kept them from publishing their results if they did carry out such analyses. The importance of the negative effects of heavy drinking, however, is reflected in the increasing number of studies being published in the post-Soviet era, not to mention the often dire tone of the conclusions drawn from these studies. There is now growing evidence that alcohol is linked to such outcomes as the Russian mortality crisis of the 1990s, crime, cardiovascular deaths,

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work absenteeism and violence. In short, the pattern of alcohol consumption in Russia represents a serious threat to public health in the country.

We believe the results of our present study are important because—despite the growing number of studies of alcohol in Russia—there has been only one previous time-series analysis of alcohol and suicide in the country and none of alcohol and homicide. This represents a gap in the growing literature as (1) mortality rates from suicide and homicide in Russia are both among the highest in the world, (2) homicide and suicide have played an important role in increased mortality and decreased life expectancy in the post-Soviet years, especially among men and (3) there is evidence of such associations from analyses undertaken in other nations.

The positive and significant contemporaneous association between heavy drinking and suicide in our analysis replicates the findings of Nemtsov [9] in the only previous study of this type in Russia (although see Razvodovsky [10] for a time-series study in neighboring Belarus and Pridemore [35] for similar results from a cross-sectional analysis in Russia). As with Nemtsov, we also found that this association was larger for males than for females ($r = 0.66$ and $r = 0.46$, respectively). We believe that our replication of his results is important in two respects. First, our analysis more than doubled the number of cases/years employed by Nemtsov (47 versus 23). We were able to do this because of newly available data on homicide and suicide back to 1956 (provided to us by France Meslé and Vladimir Shkolnikov) and because we employed an alternative measure of alcohol consumption relative to Nemtsov's analysis, which in fact is the second reason we believe our replication of Nemtov's alcohol—suicide results to be important. Measuring alcohol consumption at the population level in Russia is notoriously difficult for the reasons stated earlier. Further, Nemtsov's measure is not easily replicable because it comes from different sources using different estimation procedures for different years (p. 162 in Nemtsov [9]). Both his and our measures have their limitations, however, and our argument is not that ours is better. Further, it could be argued that our proxy is more indicative of heavy or hazardous drinking (see Norström [57] for a similar argument) relative to Nemtsov's measure, which was an estimate of more general alcohol consumption. At any rate, that we found essentially the same results with two very different measures of the independent variable represents, we believe, convergent validity of the strength and importance and the alcohol—suicide link in Russia.

Finally, while ours is the first alcohol—homicide time-series analysis in Russia (see Razvodovsky [34] for a similar study in Belarus), our findings of a positive and significant association between the two are consistent with previous studies employing cross-sectional and pooled cross-sectional designs by Andrienko [37] and Pridemore. [11] In fact, in a series of studies by the latter author examining several various causes of the dramatic increase the Russian homicide rate following the dissolution of the Soviet Union, the control for alcohol consumption continued to be among the strongest predictor of homicide rates.

Drinking patterns and drinking culture

The recent theoretical and empirical literature on alcohol-related health outcomes (including violent morbidity and mortality) has focused not simply on consumption in general, but on drinking patterns and drinking culture [58]. In a comparative study, for example, Norström [18] found a stronger effect of alcohol on suicide rates in Sweden relative to France. He concluded that the sensitivity of suicide rates to alcohol consumption may be greater in dry relative to wet drinking cultures because heavy drinkers in the former may be at a greater risk for weakened family and community bonds, as their behavior is viewed as less acceptable in such cultures. A study of 14 European nations by Ramstedt [19] showed similar results for wet/dry drinking cultures and provided further support for Norström's hypothesis. On the other hand, Russia is a wet drinking culture with suicide rates that appear to be associated strongly with levels of alcohol consumption, which Nemtsov [9] and Pridemore [10] have noted to be

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at odds with the Norström hypothesis. Whether an alternative theory is necessary to explain these results or Russia is simply an anomaly in this respect remains to be seen.

Two further important issues relevant to the population-level alcohol—suicide and alcohol—homicide links in Russia are beverage preference and drinking pattern. Distilled spirits (especially vodka), which can result in a quicker and deeper intoxication, are the beverage of choice in Russia. Similarly important are the acute and toxic effects of alcohol substitutes consumed in Russia [45], which comprise an unusually high proportion of all alcohol consumed in the country. Further, surveys [4] show that nearly one-third of Russian males binge drink at least once per month (and the real proportion is probably higher, see Laatikainen *et al*. [59]), and Koposov *et al*. [60] found that young Russian male problem drinkers often use alcohol as a form of stress control. The volatile mixture of binge drinking distilled spirits may be one reason for the strong association between alcohol consumption and violent outcomes (directed at the self or at others) in Russia. This situation may be especially lethal when combined with a drinking population with an increased likelihood of stress, given the current social, economic and political conditions in Russia. Although we are unable to draw specific conclusions concerning these issues from our study (given our general proxy for heavy drinking), results from population-level studies of other nations appear to support the stronger association of violence with distilled spirits relative to beer or wine [25,34,61].

Limitations

There is one main limitation associated with our interpretation of the relationship between these variables and a few measurement-related limitations that must be considered when interpreting our results. First, the ARIMA analyses showed that alcohol and homicide and alcohol and suicide covary at lag 0. This contemporaneous association may be interpreted in two ways. One interpretation is that alcohol, homicide and suicide are all being influenced by an antecedent variable: in other words, a spurious relationship. This is not implausible, given that these three behaviors may respond similarly to other social forces. If reliable data on potential social or economic confounders from the Soviet era become available in the future, it would be worthwhile to examine their impact on these three time-series. The other interpretation, of course, is that one of the variables is influencing the other. We believe that our interpretation of alcohol consumption influencing rates of homicide and suicide is appropriate in this case for two main reasons. It is difficult to think of a way in which homicide or suicide rates would have an instantaneous effect on levels of heavy drinking (especially as our proxy for the latter was alcohol-related mortality). Further, both the theoretical and empirical literatures at different levels of analysis are increasingly providing evidence for the influence of alcohol (especially via heavy drinking and consumption of distilled spirits) on violence directed at the self and at others. Thus, while we do not discount the possibility of a spurious relationship in our findings, our interpretations and conclusions are consistent with the growing literature in this area (including other time-series analyses that have found alcohol and violence to covary at lag 0).

Turning to measurement issues, the difficulties associated with measuring alcohol consumption at the population level in Russia have already been discussed, as has our justification for the proxy we employed here. Further, our proxy for heavy drinking provides an alternative to Nemtsov’s [9] estimates of alcohol consumption that is replicated more easily and internally consistent over the time period under study. That our results, using an alternative measure, are similar to Nemtsov’s increases our confidence in the alcohol—suicide link despite the problems associated with measuring alcohol consumption and hazardous drinking in Russia.

Next, the measures of our dependent variables include all homicides and suicides, not only those that are alcohol-related, and thus our population-level results are based only on the ‘marginals’. In other words, we have no way of knowing the actual number of alcohol-related

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homicides and suicides in a given year and thus we cannot know how they vary by annual levels of consumption. Such data are simply not readily available for Russia as a whole, although it is important to note that Nemtsov [9] showed a strong correlation between level of consumption and blood alcohol content-positive suicides in his analysis of eight Russian regions. Further, using multiple individual- and event-level data sources (including qualitative descriptive narratives of the event) to examine homicides in one Russian region (the Udmurt Republic), Chervyakov *et al*.'s [62] results suggested that involvement of alcohol in homicides actually decreased during the 1990s. If this is so for Russia as a whole, then our inclusion of these years in our analysis would actually make ours a conservative test of the alcohol—homicide association.

The final measurement-related limitation concerns the deterioration of mortality data in post-Soviet era [63]. During the 1990s there was a disproportionate increase in the number of deaths recorded as 'violent, cause unknown', which was item 175 in the Soviet codes and corresponds to E980–E989 in the ICD-9 codes [63,64]. By definition, many of these are homicides and suicides, but are not coded as such. Both the cause and effect of this phenomenon represent serious issues and have important implications. Nevertheless, the end result is that the true number of annual homicides and suicides were undercounted precisely at a time when our proxy for consumption increased. This means that any alcohol—homicide or alcohol—suicide association would be attenuated, again making our test for relationships conservative.

CONCLUSION

Ours is the first time-series analysis of alcohol and homicide in Russia in the western literature and only the second time-series study of alcohol and suicide in the country. Our analysis more than doubled the data points (i.e. Russian-years) of the previous suicide study and employed an alternative proxy for heavy drinking. That our results closely replicate those from the previous study provides convergent validity to the hypothesis of an alcohol—suicide link. Similarly, our result for the alcohol—homicide association is consistent with the findings from prior cross-sectional analyses of Russia, which have shown population levels of alcohol consumption to be among the strongest and most consistent predictors of homicide rates in the country even after controlling for a host of other social, economic and political characteristics.

The level of alcohol consumption in Russia is among the highest in the world. The results of this study contribute to the increasing evidence implicating alcohol as an important factor in Russian homicide and suicide rates, which are both also among the highest in the world. This adds to the other widespread negative health and social outcomes of high rates of consumption in the country shown by recent studies, including its contribution to Russia's mortality crisis [12], cardiovascular deaths [65] and family instability [66]. Recent literature suggests that consumption alone is not the probable source of these social problems in Russia, but that the pattern of binge drinking [4] and a preference for distilled spirits/vodka [2] are probable culprits. The years following the dissolution of the Soviet Union were chaotic and left local and federal governments in disarray. The last several years have been relatively stable compared to the earlier period, however, and it is time for the current administration and other officials to take this matter seriously.

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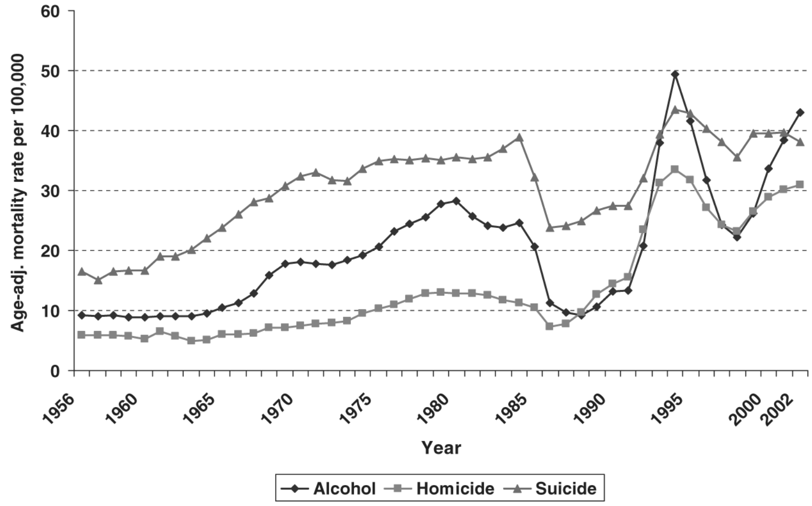

Figure 1.
Overall age-adjusted alcohol-related, homicide and suicide mortality per 100 000 residents in Russia, 1956–2002

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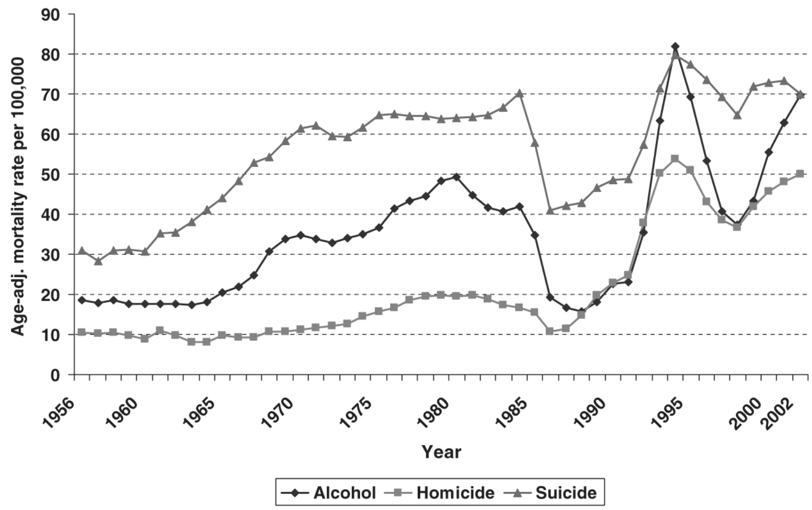

Figure 2.
Male age-adjusted alcohol-related, homicide and suicide mortality per 100 000 residents in Russia, 1956–2002

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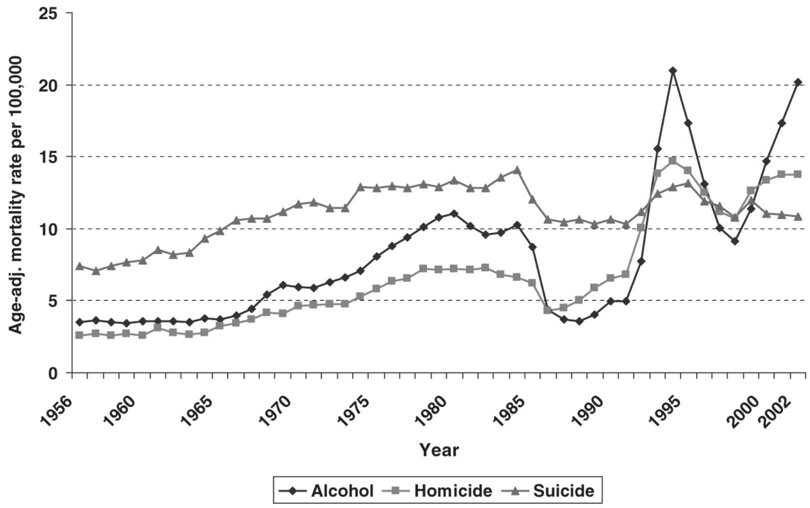

Figure 3.

Female age-adjusted alcohol-related, homicide and suicide mortality per 100 000 residents in Russia, 1956–2002

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Table 1

Final univariate models for age-adjusted death rates: total and sex-specific series.

Series	*Series*	*Q-statistic*
(a) Alcohol-related death rates		
Total	Ln(0,1,1)*	*Q* = 12.2, df = 11, *P* = 0.35
Female	Ln(0,1,1)	*Q* = 10.2, df = 11, *P* = 0.5
Male	Ln(0,1,1)	*Q* = 12.6, df = 11, *P* = 0.32
(b) Homicide rates		
Total	Ln(0,1,1)	*Q* = 7.9, df = 11, *P* = 0.73
Female	(0,1,1)	*Q* = 6.9 df = 11, *P* = 0.81
Male	Ln(0,1,1)	*Q* = 7.8, df = 11, *P* = 0.7
(c) Suicide death rates		
Total	(0,1,1)	*Q* = 7.3, df = 11, *P* = 0.78
Female	(0,1,0)	*Q* = 11.9, df = 11, *P* = 0.52
Male	(0,1,1)	*Q* = 8.3, df = 11, *P* = 0.69

* The general form of the nonseasonal ARIMA model is (p,d,q): where p = the order of the autoregressive parameter, d = the order of differencing, and q = the order of the moving average parameter. *Q* = Box-Jenkins test statistic for the null hypothesis that the model residuals are distributed as white noise.

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Table 2

Cross-correlation functions and Box-Ljung tests for the null hypothesis of zero joint association between two prewhitened series: total and sex-specific, age-adjusted cause of death rates.

Lag	*r*	*SE*
(a) Cross-correlation functions: total death rates		
(1) Homicide and alcohol-related deaths		
-2	0.19	0.151
-1	0.19	0.149
0	0.65	0.147*
1	0.15	0.149
2	-0.17	0.151
$Q_{1 \text{ to } 2} = 2.48$, $P = 0.29$		
$Q_{-2 \text{ to } -1} = 3.6$, $P = 0.17$		
$Q_{-2 \text{ to } 2} = 26.76$, $P < 0.001$		
(2) Alcohol-related and suicide deaths		
-2	-0.05	0.151
-1	0.19	0.149
0	0.62	0.147*
1	0.28	0.149
2	-0.12	0.151
$Q_{1 \text{ to } 2} = 4.54$, $P = 0.11$		
$Q_{-2 \text{ to } -1} = 1.89$, $P = 0.39$		
$Q_{-2 \text{ to } 2} = 25.08$, $P < 0.001$		
(b) Cross-correlation functions: female death rates		
(1) Homicide and alcohol-related deaths		
-2	0.07	0.151
-1	0.22	0.149
0	0.79	0.147*
1	0.10	0.149
2	-0.04	0.151
$Q_{1 \text{ to } 2} = 0.54$, $P = 0.77$		
$Q_{-2 \text{ to } -1} = 2.68$, $P = 0.27$		
$Q_{-2 \text{ to } 2} = 33.42$, $P < 0.001$		
(2) Alcohol-related and suicide deaths		
-2	-0.04	0.151
-1	0.32	0.149*
0	0.46	0.147*
1	0.20	0.149
2	-0.18	0.151
$Q_{1 \text{ to } 2} = 3.46$, $P = 0.18$		
$Q_{-2 \text{ to } -1} = 5.24$, $P = 0.10$		
$Q_{-2 \text{ to } 2} = 18.66$, $P < 0.01$		
(c) Cross-correlation functions: male death rates		
(1) Homicide and alcohol-related deaths		
-2	-0.22	0.151
-1	0.17	0.149
0	0.64	0.147*
1	0.10	0.149
2	-0.18	0.151
$Q_{1 \text{ to } 2} = 2.15$, $P = 0.35$		
$Q_{-2 \text{ to } -1} = 3.85$, $P = 0.15$		
$Q_{-2 \text{ to } 2} = 25.66$, $P < 0.001$		
(2) Alcohol-related and suicide deaths		
-2	-0.01	0.151
-1	0.13	0.149
0	0.66	0.147*
1	0.24	0.149
2	-0.07	0.151
$Q_{1 \text{ to } 2} = 3.16$, $P = 0.21$		
$Q_{-2 \text{ to } -1} = 0.85$, $P = 0.65$		
$Q_{-2 \text{ to } 2} = 24.69$, $P < 0.001$		

Lag = the lag of the cross-correlation function. Negative values report the CCF for the first series on the second at lag k. Positive values report the CCF for the second series on the first at lag k; r = the cross-correlation function; SE = standard error of the cross-correlation function.

* The cross-correlation coefficient is at least twice its standard error. $Q_{1 \text{ to } 2}$ = Box—Ljung test statistic for the null hypothesis that the set of positive values for the cross-correlations is jointly independent. $Q_{-2 \text{ to } -1}$ = Box-Ljung test statistic for the null hypothesis that the set of negative values of the

cross-correlations is jointly independent. $Q_{-2 \text{ to } 2}$ = Box-Ljung test statistic for the null hypothesis that the entire set of values for the cross-correlations is jointly independent.

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