EPIDEMIOLOGY

Recent Heavy Alcohol Consumption at Death Certified as Ischaemic Heart Disease: Correcting Mortality Data from Kaunas (Lithuania)

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Abstract — Aims: To assess the proportion of deaths assigned to ischaemic heart disease (IHD) which in fact were caused by the toxic effects of alcohol, and how this may affect the official statistics of mortality from IHD in Lithuania. Methods: Using the IHD register in Kaunas, Lithuania, and verifying underlying causes of death using standard international methodology, 3061 cases were found in Kaunas city who had died from IHD at age 25–64 during 1993–2007. Out-of-hospital sudden deaths accounted for 2467 cases (81%), including 1498 where forensic autopsy was conducted and post-mortem concentration of alcohol in blood and urine was available. Results: In total, 78.4% of all initial IHD diagnoses were verified, while in 8.7% of deaths the underlying cause of death was corrected into an alcohol-related cause and in 12.9% to other diseases. Alcohol was found in about half (50.3%) of out-of-hospital death cases subjected to autopsy. In 18.0% of cases, the alcohol concentration was 3.5% or higher. Alcohol was more likely to be present in winter months and at weekends. Conclusion: A significant number of alcohol-attributable deaths in Lithuania were misclassified as coronary deaths, accounting for almost one-tenth of officially registered deaths from IHD in ages 25–64. A high prevalence of positive post-mortem blood or urine alcohol tests suggests that the proportion of alcohol-related deaths among out-of-hospital IHD deaths may be actually even higher. A similar situation may be present in some other countries where high levels of alcohol consumption and binge drinking patterns are observed.

INTRODUCTION

Ischaemic heart diseases (IHD), especially chronic IHD, is the most frequently stated cause of death in Lithuania, as in many other countries, particularly in the countries of Central and Eastern Europe and the Commonwealth of Independent States (CEE&CIS). It is the case not only among the elderly, but also among the middle-aged, working population. The standardized mortality rate from IHD in men aged 25–64 years in Lithuania is one of the highest compared with other European countries. In 2008, it was almost four times the average of the 27 European Union (EU) countries according to the World Health Organization (WHO) data (www.euro.who.int/en/what-we-do/data-and-evidence/databases). The proportion of chronic IHD in the structure of overall IHD mortality in the 25–64 age group in Lithuania is the largest among European countries for which sufficiently detailed mortality data are available in the WHO databases. Chronic IHD accounts for 77% of the overall IHD mortality in Lithuania, while the EU average is around 39%.

Although IHD morbidity and mortality are high in Lithuania, explained by unhealthy lifestyles and other natural causes, the exceptionally high mortality from chronic IHD suggests that there may be certain inaccuracies or biases in death certification, i.e. some of these IHD deaths actually might be caused by other factors. Indeed, there are a number of studies suggesting that a certain proportion of IHD deaths in reality occur because of other causes, in particular due to the toxic effect of alcohol (Stalioraitaite et al., 2004; Zarižde et al., 2009). Naturally, these inaccuracies in defining the cause of death have an impact on official national mortality statistics. The impact of alcohol consumption on morbidity and mortality is particularly expressed in CEE&CIS countries because of high alcohol consumption and binge drinking patterns in these regions (Rehm et al., 2006, 2007; Grabauskas et al., 2009). It is likely that certain alcohol-related death certification practices causing misclassification of alcohol-related deaths are also more prevalent in these regions.

Using the data from the Kaunas IHD register, the aim of this study was to estimate the proportion of deaths attributed to IHD which have actually occurred because of other causes, in particular of the toxic effect of alcohol, and to assess the possible impact of these inaccuracies in death certification on national IHD mortality statistics.

METHODS

The data from the Kaunas IHD register, covering the period from 1993 to 2007, have been used for this study. The average total population of Kaunas city for the above period was about 380,000. The register has been functioning since the beginning of 1970s when it was started in the framework of the WHO international collaborative study ‘Myocardial infarction community registers’ (WHO Regional Office for Europe, 1976). It uses internationally standardized methodology for defining new myocardial infarction (MI) cases and IHD deaths.

The study material consisted of 3061 cases of death in the age group 25–64 years with IHD as the underlying cause of death mentioned in the death certificate. Men and women accounted, respectively, for 81.3 and 18.7% of cases. Out-of-hospital sudden deaths, i.e. those that occurred before reaching the hospital, accounted for 2467 cases (81%), including 1498 cases subjected to forensic autopsy and
post-mortem blood alcohol test. In 1119 autopsies, the alcohol concentration was also measured in the urine. Alcohol levels in the blood or the urine were measured by gas chromatography.

Forensic autopsies generally were not done for persons who died at home and when family doctors or other medical professionals had sufficient information from documented medical history of the deceased to issue a death certificate. Autopsy was not done by request of relatives of the deceased if there were no legal requirements to do it.

Two sets of criteria for assessing the potential impact of alcohol consumption on the risk of IHD death were used:

(a) The complete set of IHD register criteria for verification of cause of death using post-mortem blood alcohol level, other autopsy findings (when available) and medical documentation of the deceased person. The initial diagnosis of IHD was changed to the appropriate alcohol-related cause of death if the blood alcohol concentration was 3.5% or higher and the stenosis of coronary arteries was <50%, there was no scar of previous MI found and no medical history of previous MI recorded. Mental and behavioural disorders due to use of alcohol (ICD-9 code 303 and ICD-10 code F10) or accidental poisoning by and exposure to alcohol (ICD-9 code E980 and ICD-10 code X45) were mostly used in such cases as the correct diagnosis. These criteria have been applied to all 3061 death cases.

(b) Taking into account only post-mortem blood or urine alcohol level, whichever was higher, alcohol concentration was categorized using thresholds of 0.4% (being used in Lithuania to define ‘drunkenness’) and 3.5% (used by IHD register to define potentially lethal alcohol poisoning). Combined blood and urine alcohol levels allowed a more accurate assessment of alcohol consumption prior to death. Only 1498 out-of-hospital deaths with available post-mortem blood alcohol levels were analysed in this way.

Student’s $t$-test was used for between-group comparisons for continuous variables and $\chi^2$ test for categorical variables. The difference was considered to be statistically significant when $P < 0.05$.

**RESULTS**

Using standard IHD diagnosis verification criteria, the initial IHD diagnosis among out-of-hospital deaths was confirmed only in 75.6% of cases (Table 1). The remaining deaths were recategorized to other causes of death, including deaths due to alcohol, which accounted for 10.5%. Among the deaths that occurred in a hospital, the initial diagnosis of IHD was confirmed in 89.9% cases. Thus, the proportion of the total of confirmed initial IHD diagnoses was 78.4%. Missclassified alcohol-attributable deaths accounted for 8.7% of all IHD deaths in the Kaunas population aged 25–64 during 1993–2007.

Most (65%) of out-of-hospital deaths were initially assigned to the subcategory of unspecified chronic IHD. In the case of in-hospital deaths, this proportion was much lower (27%).

About half (48.5%) of out-of-hospital deaths that were subject to autopsy had alcohol present in blood. Depending on the time elapsed since the last episode of alcohol consumption and death, a certain proportion of alcohol is usually already removed by the kidneys from blood to urine. Using the blood or urine alcohol level, whichever is higher, one can get a more informative indicator than taking into account the blood test only. In this case, the number of out-of-hospital deaths with alcohol present in blood or urine increased to 50.3% and with alcohol concentration ≥3.5% from 14 to 18%, compared with percentages based on blood alcohol levels only (Table 2).

Naturally, the alcohol levels in blood and urine were highly correlated (Fig. 1) with a correlation coefficient of 0.95.

The blood alcohol concentration was measured more frequently for men than women (respectively, 62.5 and 51.9%), but there were no significant differences in the distribution of alcohol levels between genders ($P = 0.10$). Alcohol tests were also performed more frequently in younger age groups, 75.7 and 59.4% in the 25–34 and 55–64 years age groups, respectively. The distribution of alcohol levels differs significantly between younger and older age groups ($P = 0.02$). High alcohol levels (≥3.5%) were more frequent in the age group of 25–44, while lower alcohol levels (0.01–3.49%) in older ages (Table 3).
The possible impact of alcohol on the variation of IHD mortality with respect to the day of the week and between seasons was examined. Comparisons between Friday–Sunday and the remaining days of the week for out-of-hospital IHD deaths are presented in Table 4. The initial IHD diagnoses were changed to alcohol-related causes ~1.5 times more frequently for deaths that occurred during the weekend compared with other days of the week. Significantly higher post-mortem blood or urine alcohol levels were observed during the weekends as well. The average blood alcohol concentration was highest on Sundays (1.50%) and varying during other days from 0.91% (Tuesday) to 1.24% (Friday).

The seasonality was visible only among out-of-hospital IHD deaths (Fig. 2). The average number of IHD deaths during the winter months (December–February) was higher by approximately one-third when compared with the summer months. The number of cases where the IHD diagnosis was changed into alcohol related was nearly double. The average blood alcohol level in December was twice as high as that in August (1.48 and 0.7%, respectively), and the proportions of cases with blood or urine alcohol exceeding 0.4% were 51.6 and 31.4%, respectively. Comparisons between winter-spring and summer-autumn seasons are presented in Table 5. The obtained results suggest that alcohol may play an important role in the seasonality of IHD mortality.

Trends in blood alcohol levels >0.4% and ≥3.5% for 1993–2007 are presented in Fig. 3. As can be seen from the data, drunkenness frequency among those who died from IHD persons tended to decline until 2000, while it doubled in 2001 and subsequently continued fluctuating at the 37–49% level.

### DISCUSSION

Applying the complete set of standard IHD register criteria for verification of IHD diagnoses, in 21.6% of death cases the initial IHD diagnosis had to be changed to other causes. This included 8.7% alcohol-related causes, such as accidental alcohol poisoning or alcohol dependence syndrome, accounting for 40.3% of all incorrect initial diagnoses.

The IHD diagnosis verification criteria used by the register were designed primarily to identify deaths that occurred clearly due to acute alcohol poisoning. For example, even in cases with blood alcohol ≥3.5%, the initial IHD diagnosis was still confirmed if coronary artery stenosis was ≥50%. In such cases, alcohol had most likely acted as a trigger provoking an acute episode of IHD, leading to the sudden death. Alcohol levels below 3.5%, especially after prolonged alcohol consumption, may also cause cardiovascular reactions, for example, cardiac ventricular fibrillation or cardiac arrest due to blockade, culminating in sudden death (Templeton et al., 2009; Leon et al., 2010; Zivković et al., 2010). In addition, the blood alcohol levels at autopsy do not

### Table 3. Alcohol levels in blood and urine in out-of-hospital deaths by age

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Alcohol concentration in blood or urine, n (%)</th>
<th>0‰</th>
<th>0.01–0.4‰</th>
<th>0.41–3.49‰</th>
<th>≥3.5‰</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>25–44</td>
<td></td>
<td>85</td>
<td>10 (6.4)</td>
<td>24 (15.4)</td>
<td>37 (23.7)</td>
<td>156 (100)</td>
</tr>
<tr>
<td>45–64</td>
<td></td>
<td>659</td>
<td>105 (7.8)</td>
<td>345 (25.7)</td>
<td>233 (17.4)</td>
<td>1342 (100)</td>
</tr>
</tbody>
</table>

### Table 4. Differences in out-of-hospital IHD deaths and post-mortem alcohol levels between the weekend and other days of the week

<table>
<thead>
<tr>
<th>Daily average number of out-of-hospital deaths with initial IHD diagnosis</th>
<th>Friday–Sunday</th>
<th>Monday–Thursday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial IHD diagnoses corrected into alcohol-related causes, daily average (% of initial IHD diagnoses)</td>
<td>48 (13.2%)*</td>
<td>29 (8.4%)</td>
</tr>
<tr>
<td>Daily average of deaths with blood or urine alcohol level ≥3.5‰ (% of cases with available alcohol test)</td>
<td>46.7 (20.5%)*</td>
<td>32.5 (16.0%)</td>
</tr>
<tr>
<td>Daily average of deaths with blood or urine alcohol level &gt;0.4‰ (% of cases with available alcohol test)</td>
<td>106.3 (46.7%)*</td>
<td>80 (39.3%)</td>
</tr>
<tr>
<td>Average blood alcohol level</td>
<td>1.30‰*</td>
<td>1.03‰*</td>
</tr>
</tbody>
</table>

*P < 0.05, statistically significant difference between Friday–Sunday and Monday–Thursday.

Fig. 1. Correlation between post-mortem alcohol levels in blood and urine in out-of-hospital IHD deaths.
necessarily reflect the highest levels reached during the last episode of alcohol consumption before the death, as alcohol may have already been partially metabolized or removed. Therefore, significant proportion of IHD deaths with alcohol below 3.5% may also be alcohol related.

Taking into account post-mortem blood or urine alcohol concentrations only, 18% of out-of-hospital deaths with extremely high alcohol levels (≥3.5%) can be considered as clearly alcohol related (Table 2). It should be pointed out that this percentage is based only on death cases with available alcohol tests (60.7% of all out-of-hospital deaths). Regarding deaths where no alcohol test was performed, we made two assumptions: one, that there was zero alcohol level and another one, which is much more likely, that the frequency and distribution of alcohol levels were about the same as in cases where the alcohol tests were done. Using the first, most cautious assumption, the percentage of cases with alcohol ≥3.5% among all out-of-hospital deaths would be 10.9%.

Moderate to high alcohol levels (0.4–3.5%) were observed in 15.0–24.6% of deaths (depending on the above-mentioned assumptions) meaning that alcohol might be responsible in one way or another for a certain proportion of these deaths. Taking into account all alcohol levels, alcohol was present in 30.6–50.3% of out-of-hospital IHD deaths.

The above estimates of the possible alcohol effect on IHD mortality look surprisingly high particularly taking into account numerous prospective studies demonstrating even some protective role of light or moderate drinking (Murray et al., 2005; Arriola et al., 2010; Klatsky, 2010). Having in mind that the cited sources represent long-term alcohol consumption effect on morbidity and mortality, our study demonstrates the acute effect of alcohol on the risk of death. The fact that 30–50% of people who died suddenly before reaching the hospital had alcohol present in blood, suggests that in a majority of these cases alcohol consumption acted as a trigger or a catalyst for events leading to death. It is difficult to find another explanation. To get 30–50% positive post-mortem alcohol tests under the assumption of no association between alcohol and IHD death risk, one would also need to accept the assumption that the entire population aged 25–64 years 30–50% of the time is constantly more or less drunk.

High proportions of autopsies showing the presence of alcohol among sudden out-of-hospital cardiovascular deaths have been reported by other studies (Perola et al., 1994; Benošis and Jasulaitis, 2004; Zavidze et al., 2009). These data are not commonly known or taken into account when assessing the effect of alcohol consumption on IHD mortality. On the other hand, a similarly high percentage of positive post-mortem blood alcohol tests among deaths from external causes are accepted as an evidence of the effect of alcohol on the risk of death from causes like traffic accidents, drowning, falls etc.

Considering that IHD is responsible for a high proportion of adult mortality and that out-of-hospital deaths are accounting for ~80% of all IHD deaths, the number of alcohol-related IHD deaths may be quite high and even comparable with major fully alcohol-attributable categories, like the accidental poisoning by alcohol. For example, assuming that about half of deaths with moderate to high alcohol levels (0.4–3.5%) are alcohol-related, the total proportion of alcohol-related out-of-hospital deaths would be at least ~18.4% (10.8% + 0.5 × 15.0%). This estimate corresponds to the above-mentioned assumption of zero alcohol level in death cases when an alcohol test was not done. After adjustment for in-hospital deaths, the estimated proportion of alcohol-related deaths among all IHD deaths would be ~14.9%. Applying this proportion to the number of officially registered 2268 IHD deaths in Lithuania (in 2007, ages 25–64), about 338 cases might be alcohol related. This number is close to the registered 430 cases of death due to accidental poisoning by alcohol in the same year and age group. The weakest point in this rough estimate is the assumption that half of the death cases with an alcohol level between 0.4 and 3.5% are alcohol-related. However, even using an estimate based on alcohol levels ≥3.5% only and complete IHD register criteria (8.7%), the estimated number of alcohol-related

### Table 5. Differences in out-of-hospital IHD deaths and post-mortem alcohol levels between winter-spring and summer-autumn seasons

<table>
<thead>
<tr>
<th></th>
<th>November–April</th>
<th>May–October</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of out-of-hospital deaths with initial IHD diagnosis during 6 months of the season</td>
<td>1365*</td>
<td>1102</td>
</tr>
<tr>
<td>Initial IHD diagnoses corrected into alcohol-related causes (% of initial IHD diagnoses)</td>
<td>155 (11.4%)*</td>
<td>105 (9.5%)*</td>
</tr>
<tr>
<td>Cases with blood or urine alcohol level ≥3.5‰ (% of cases with available alcohol test)</td>
<td>160 (19.7%)</td>
<td>110 (16.1%)</td>
</tr>
<tr>
<td>Cases with blood or urine alcohol level &gt;0.4‰ (% of cases with available alcohol test)</td>
<td>373 (45.8%)*</td>
<td>266 (38.9%)*</td>
</tr>
<tr>
<td>Average blood alcohol level</td>
<td>1.25‰*</td>
<td>1.03‰</td>
</tr>
</tbody>
</table>

*P < 0.05, statistically significant difference between November–April and May–October periods.
IHD deaths still would be sufficiently high (197), thus making a strong impact if it were taken into account when calculating the total alcohol-related mortality.

Alcohol-related deaths, ‘hidden’ as IHD deaths, may be divided into two types: misclassified accidental alcohol poisonings and various alcohol-related cardiac disorders caused by chronic and acute alcohol consumption. A similar situation is likely in some other countries, especially CEE&CIS, where high levels of alcohol consumption, particularly of spirits and prevailing binge drinking patterns are observed (Rehm et al., 2007; Zaridze et al., 2009; Leon et al., 2010).

Indirect evidence of an alcohol impact on IHD mortality can be seen by examining differences between days of the week and seasons. An increase in total mortality and particularly in mortality from external causes and IHD at weekends in Lithuania and some other countries were reported in several studies (Chenet et al., 1998, 2001). The assumption explaining this phenomenon is that of an increase in alcohol consumption during holidays. Our data fully confirm this hypothesis. The daily average number of IHD deaths during weekends (Friday–Sunday) exceeded the average for other days of the week by 17 cases (Table 4). At the same time, the difference in the average number of deaths re-classified into alcohol-related causes was 19. This means that even when using strict IHD register criteria, the increase in IHD mortality rate during weekends is fully explained by an increase in the number of alcohol-related deaths, initially incorrectly assigned to IHD.

IHD also is one of the leading causes of death contributing to the seasonality of total mortality, expressed by higher mortality rates during winter and spring months (Van Rossum et al., 2001; Healy, 2003). Our data suggest that alcohol plays a role in the seasonality of IHD mortality, although the mechanism of this association is not clear. During November–April, there were 263 more deaths than in May–October. The difference in the number of deaths reclassified into alcohol-related causes was 50, explaining ~1/5 (19%) of the seasonality in IHD mortality. Taking into account only very high levels of alcohol in blood or urine (≥3.5%), this could explain 35% of seasonality and in case of ‘soft’ criteria (≥0.4%)—75%.

Most likely there are several reasons for misclassification of alcohol-related deaths. One of them is the delay in receiving results of alcohol tests after an autopsy. Blood and urine alcohol tests were performed at forensic laboratories, and results were usually sent back in a week. Meanwhile, the official death certificates have been already handed to relatives of the deceased persons with a provisional autopsy diagnosis without mentioning the possible impact of alcohol. When alcohol test results are received from the laboratory, forensic experts correct provisional diagnoses in internal autopsy protocols, if needed. Usually, no correction is made to the original death certificates which by that time were already registered at the local Civil Registry office and included in the national mortality database used for the production of official mortality statistics.

There is also an ethical aspect of the problem. Often relatives of the deceased person ask forensic experts to avoid mentioning in the death certificate diagnoses related to acute or long-term effects of alcohol.

On the other hand, we should keep in mind the somewhat different criteria used in clinical practice and epidemiological studies of IHD. Physicians taking care of patients are guided by clinical algorithms. There are also some differences in the evaluation of the damage of myocardium and coronary arteries during the autopsy, which may have an impact on the verification of IHD diagnoses.

Comparison of local and national mortality data suggests that the Kaunas population is representative of the whole Lithuanian population with respect to alcohol consumption and IHD mortality. The average standardized mortality rate for 2003–2007 from fully alcohol-attributable causes (alcoholic liver disease, accidental alcohol poisoning, alcohol dependence syndrome and other) in the city of Kaunas and in Lithuania are almost identical (respectively, 38.3 and 38.5 per 100,000 population). IHD mortality rates were also
similar, although mortality in Kaunas was slightly lower, respectively, 306 and 344 per 100,000 population. There is also no reason to assume that the death certification practices among Kaunas medical practitioners significantly differ from the national average. Trends in post-mortem blood alcohol levels during 1993–2007 (Fig. 3), particularly the sharp increase in 2001, are also well associated with national alcohol consumption and total mortality trends (Grabauskas et al., 2009). Therefore, the Kaunas population-based estimates of inaccuracies in IHD death certification and of associations between alcohol consumption and IHD mortality, might be applied at the national level.

CONCLUSIONS

Our results suggest that there is a significant acute effect of alcohol consumption on the risk of sudden deaths that are registered as due to IHD, especially in countries where high levels of alcohol consumption and prevailing binge drinking patterns are present. These alcohol-related IHD deaths usually are not taken into account when estimating the total alcohol-related mortality. In the case of Lithuania, it is likely that a significant proportion of alcohol-attributable deaths have been misclassified as coronary deaths, accounting for almost one-tenth (~8.7%) of officially registered deaths from IHD in ages 25–64. The high prevalence of positive post-mortem blood or urine alcohol tests suggests that the number of alcohol-related deaths among out-of-hospital IHD deaths may be actually even higher. It means that in reality the IHD mortality in Lithuania in ages below 65 is at least ~10% lower than what official statistics show and the alcohol-related mortality is correspondingly higher.

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