

*Full Length Research Paper*

# Prevalence of alcohol in autopsied medico-legal cases at the National Institute of Forensic Medicine, Jordan

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It is well established that drinking alcohol increases the risk of fatal injuries. The presence of blood alcohol in autopsied deaths is regularly encountered in medico-legal practices. The aim of this study is to investigate the prevalence and concentration of alcohol in 1731 medico-legal autopsies that were conducted in the National Institute of Forensic Medicine (NIFM), Jordan from January 2007 to December 2007, and to report acute alcohol influence on these deaths. A total of 63 cases were identified according to the concentration of alcohol. These cases were analyzed for possibilities of acute alcohol influence as either the underlying or contributory causes of death. Furthermore, the cases were pertained according to age, sex, manner of death, and specific cause of death. Blood alcohol concentration (BAC) ranged from (10 to 541 mg/dl). BAC of more than or equal to 50 mg/dl was found in (65%, n=41). It was concluded that post-mortem BAC more than or equal to 50 mg/dl should be regarded as possible contributory factor in all medico-legal cases, that were autopsied.

**Key words:** Alcohol, medico-legal cases, Jordan.

## INTRODUCTION

Alcohol is in the top list of toxic substances encountered in forensic toxicology for a simple reason that heavy drinking and drunkenness are incriminated in many fatal accidents, trauma deaths, suicides, crimes of violence and antisocial behavior in general (Kugelberg et al., 2007). Adverse effects of alcohol have been demonstrated through many disorders, including liver cirrhosis, mental illness, several types of cancer, pancreatitis, and damage to the fetus among pregnant women (WHO, 2000).

Reports from accident and emergency service departments worldwide provide ample evidence to support the negative impact of alcohol abuse and alcoholism in societies. The impairment caused by over-consumption of alcoholic beverages explains many accidents at home, in the workplace and on the roads (Jones, 2000). Accordingly, measuring and interpreting the concentrations of alcohol in blood and other biological specimens are routine procedures in forensic medicine

and toxicology (Martinis et al., 2006). The existence of threshold limits of blood-alcohol concentration (BAC) for driving a motor vehicle, such as 80 mg/dl in united Kingdom UK and 50 mg/dl in most of the other European nations, means that the results of forensic alcohol analysis have important social and medico-legal ramifications (Jones, 2000).

Qualitative and Quantitative analysis of alcohol in postmortem specimens is a relatively simple analytical procedure along with gas chromatographic methods; accurate, precise, and specific results are possible (Kugelberg et al., 2007). This determination allows a proper interpretation of the degree of mood alteration result from alcohol. More importantly, it allows a means of assessing the degree of impairment in the ability to operate complex machines such as, motor vehicles (Hodgson, 2000). In general, interpretation of BAC typically focuses more often on a discussion of its impairing effect on human performance and behavioral toxicity than on its overt physiological toxicity (Levine and Kunsman, 2000).

Information regarding alcohol in the Eastern Mediterranean Region is inadequate and far from clear.

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While in Europe alcohol-related problems rank fourth and in the Americas they rank second. The global burden of disease study for the year 2000 recorded that alcohol is not considered among the first 15 causes of disability-adjusted life years (DALYs) lost in the Eastern Mediterranean region. Furthermore, World Health Organization (WHO) global status report on alcohol in 2004 recorded that information was available from only 12 countries in the region (WHO, 2006). Accordingly there is a lack of information about alcohol consumption in the region.

An important study of fatal poisoning due to alcohol and drugs was carried out in the greater Amman County during the period (from 1978 to 1996). Total of 60 deaths with alcohol and drugs represented 0.98% (n=6109) of all postmortem, 30 deaths (50%) were due to alcohol (Abu-Ragheb and Hadidi, 1999).

However, there is a need to conduct an updated study to investigate the prevalence and concentration of alcohol in medico legal autopsies in the NIFM-Jordan, and to report the acute alcohol influence among those deaths in recent times. The aim of the study is to investigate the prevalence and concentration of alcohol in medico legal autopsies in the NIFM during one year, starting from January 2007 to December 2007.

## EXPERIMENTALS

### Postmortem cases and specimens sampling

Amman is the capital city of Jordan; the greater Amman County has an estimated population of (2220500) according to 2007 census (department of statistics). From January 2007 to December 2007, (1731) Postmortem cases have been performed at the NIFM. All their death certificates files have been manually searched, then all autopsies in which alcohol tests have been performed, are documented and considered in this study. Information included in autopsy reports have been classified in a set of variables with pre-defined values, along with a short summary related to the manner of death and the cause of death.

Manner of death distinguishes natural from non-natural deaths. Natural death cases are defined as those without external injuries and/or deaths without medical assistance (Martinis et al., 2006). Non-natural deaths, depending on the jurisdiction, can be divided in to several categories such as homicide, suicide, various accidents and undetermined. Cause of death is the physiologic agent or event necessary for death to occur (Goldfrank et al., 2002). The underlying cause of death and other causes of death must be mentioned, acute alcohol influence must be mentioned as one of these causes of death in order to be registered (Nordrum et al., 2000).

This data has been analyzed according to the following variables: age, sex, manner of death, specific cause of

death, concentration of alcohol analyses in all cases, and acute alcohol influence as either the underlying or contributory causes. All blood samples have been obtained in tubes with 1% sodium fluoride as preservative and transferred to the laboratory on the same day and stored at (4°C) until analyzed. This study has been carried out at the NIFM at AL-Basher hospital, Ministry of Health.

## MATERIALS AND METHODS

Ethanol, methanol and 1-propanol have been used throughout the study were high performance liquid chromatography (HPLC) grade from scharlau chemie, Barcelona Spain and laboratory analysis was done at the Toxicology Laboratory in the NIFM.

### Determination of alcohol

Alcohol analyses have been carried out by gas chromatography (GC-2010 SHIMADZU; Japan, equipped with flame ionization detector and a meta wax column (30 m × 0.25 mm I.D, film thickness 0.25µm), serial no.M2054315 and headspace injections have been performed using an automatic sampler cycle compose PAL1-(AOC-5000 auto injector). The obtained results of alcohol concentration in biological samples have been calculated in mg/dl. Instrumental procedures for alcohol analysis have been suggested by the standard operation preparation system in the toxicology laboratory at the NIFM.

200 µl of specimen was placed into a 10 ml head space vial with 2 ml of internal standard (1- propanol). The specimen were incubated at 70°C for 3 min prior to injection. Pre-incubation agitator speed has been set at 500 rpm. The syringe fill speed has been set to (100 µl/s), and the injection speed is (500 µl /s). The prepared injection was split at (170°C) the column temperature was set for (50°C) to max temp (320°C). The temperature of detector has been set for 250°C, Helium (He) was used as carrier gas with a linear velocity of 20.4cm/s. Statistical processing of the data was performed using Statistical Package for the Social Sciences (SPSS) version 11.0 software for windows.

## RESULTS

Two hundred and sixty-six out of 1731 autopsies have been subjected to alcohol test. The study was performed at NIFM during January 2007 to December 2007. Accordingly, a total of (63) out of (266) Positive cases for alcohol test have been found which represents (23.7%, n=266), and represents (3.6%, n=1731). Out of the 63 positive cases, 56 were males represents (88.9 %, n=63). Seven cases were females (11.1 %, n=63). The age distribution was presented in Table 1. Their mean age group (34, n=63), the range was (10-77) years, the age group of (30-39) represents the highest percentage of fatalities (22, 35%, n=63). The majority of fatal intoxication (16%, n=10) occurred in December. It was interesting to notice that both January and July had equal number of fatalities (seven cases each month).The majority of the victims were Jordanians 52, (82.5%, n=63) and 11, (17.5%, n=63) were of other nationalities.

**Table 1.** Age distribution of alcohol victims.

Age (year's )	Number of cases	% of alcohol
10 to 19	7	11
20 to 29	17	27
30 to 39	22	35
40 to 49	9	14.3
≥50	8	12.7
Total	63	100

**Table 2.** Cases with alcohol analysis by manner of death.

Manner of death	Number	%
Violent death		
Homicide	7	11.1
Suicide	0.0	0.0
Road traffic accidents	17	27.0
Accidental poisoning	6	9.5
Falling	8	12.7
Immersion	1	1.6
Undetermined	2	3.2
Fire deaths	2	3.2
Natural death	20	31.7
Total	63	100.0

Death circumstances were as follow: (61) victims (96.8%, n=63) were found dead or died on arrival to the hospital, the remaining victims (2) (3.2%, n=63) died in the hospital. (59) death cases occurred in Amman area, this represents (93.7%, n=63), and four cases occurred outside Amman, representing (6.3%, n=63). In the cases where death occurred inside hospital, it occurred in less than 24 h arrival to the hospital. 54 deaths occurred at night, representing (85.7%, n=63), while 9 (14.3%, n=63) fatalities occurred in morning period.

The manner of death has been classified as natural and violent deaths. Violent deaths have been classified into suicide, homicide, and various accidents and undetermined. It has been found that (43) (68.3%, n=63), and (20) (31.7%, n=63) of the fatalities are violent and natural deaths respectively. According to the autopsies of the violent deaths, it has been found that (36) (57%, n=63) and (7) (11.1%, n=63) of the fatalities were various accidents and homicide respectively. Surprisingly, no death certificate of suicide by alcohol was noticed in the (63) postmortem cases, but there are two cases with undetermined manner of death. It was observed that three of alcohol deaths were among alcoholics, representing (4.8%, n=63). But a higher number (60) (95.2%, n=63) had unknown social history of alcohol drinking.

BAC is presented in Table 2 and Figure 1. The average

blood alcohol concentration was (118) SD± (109.4) mg/dl, n=63 cases. The lowest concentration is (12 mg/dl), and the highest concentration is (541 mg/dl). For these cases there are seven decomposed samples with blood alcohol concentration range from (15 to 65 mg/dl). Most deaths (25.4%) have been observed at blood alcohol concentrations between (150 to 299 mg/dl).

Under reporting of acute alcohol influence relevant to the cause of death among violent deaths is (9.5%, n=6) out of the total number (63). It has been considered that among these cases as a major contributing cause of death.

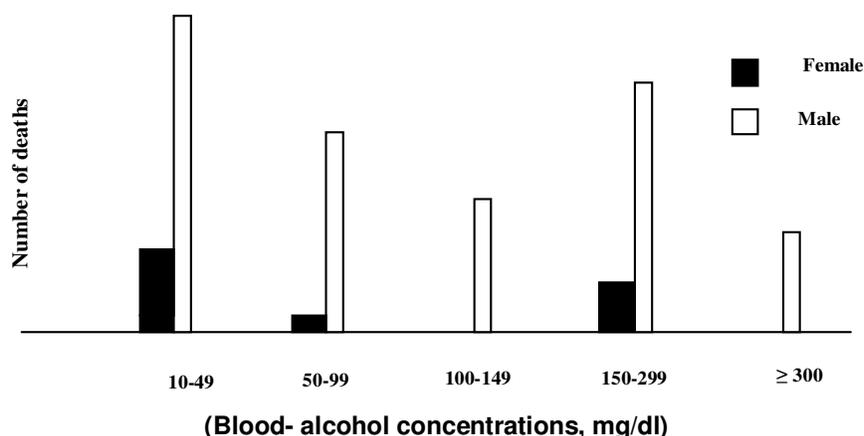
Table 3 shows the cases of road traffic accidents (RTA) by dividing motor vehicles traffic accidents into drivers and non-drivers. The non-drivers cases are four, two of them are pedestrians and two cases are passengers.

As revealed in Table 4, acute alcohol influence has been considered as a contributory cause of death in all drivers and non-drivers cases because of multiple injuries and bleeding. The major cause of death has been considered as a result of attack with a solid body. However, the concentration of alcohol in four cases is high (320, 303, 284 and 234 mg/dl) respectively. This might be considered as an evidence of acute alcohol influence causing death.

Table 4 shows the reporting of acute alcohol-influenced natural deaths. Twenty cases out of sixty-three have

**Table 3.** Blood alcohol concentration.

BAC (mg/dl)	Number of cases	%
10 to 49	22	35
50 to 99	13	20.6
100 to 149	7	11
150 to 299	16	25.4
≥300	5	8
Total	63	100



**Figure 1.** Distribution of sex and BAC in deaths attributed to acute alcohol poisoning.

**Table 4.** Blood alcohol concentration in drivers and non-drivers in traffic accidents.

Non-drivers (mg/dl)	Drivers (mg/dl)
303	320
182	284
166	234
118	166
	129
	118
	83
	61
	60
	37
	36
	24
	18

been identified as alcohol-influenced natural deaths, representing (31.7%). In the autopsied natural deaths, the acute alcohol influence has been classified as contributory cause of death. The underlying cause of death in two cases was brain hemorrhage and the underlying cause of death in another case was sunstroke, respiratory failure, due to different pulmonary diseases

such as lung emphysema, lung fibrosis and Chronic obstructive pulmonary disease (COPD). There was one case in which the cause of death is hepatic failure, and one case had bone cancer. There are many types of heart diseases which have been identified as the underlying cause of death in seven cases, three of them but in eight cases the cause of death results from are

**Table 5.** Blood alcohol concentration by manner of death.

Manner of death	BAC (mg/dl)						
	Number	%	10 to 49	50 to 99	100 to 149	150 to 299	≥300
Violent death							
Homicide	7	11.1	1	3	1	2	
Suicide	0.0	0.0					
Road traffic accidents	17	27.0	4	3	3	5	2
Accidental poisoning	6	9.5				3	3
Falling	8	12.7	3	1	1	3	
Immersion	1	1.6		1			
undetermined	2	3.2	1			1	
Fire deaths	2	3.2	2				
Natural death	20	31.7	11	5	2	2	
Total	63	100	22	13	7	16	5

related to the presence of coronary heart diseases, and one of them have had ischemic heart disease, but in another case the underlying cause of death is hemorrhage due to aortic aneurysm, and one case died as a result of cardiomyopathy. Finally, one case died as a result of cardiac arrest related to the presence of severe fibrosis in the heart.

Table 5 shows all the cases of BAC. They have been classified according to the manner of death. For example, 22 cases of deaths have a BAC from (10 to 49) mg/dl. It was interesting to notice that among these cases for instance, natural death comprises 11 cases out of 22 cases, while falling comprises three cases. Another illustrative example was death with BAC (from 50 to 99) mg/dl. For the total of 13 cases belonging to this BAC, similar numbers of all manner of death have been documented. Twenty eight death cases with BAC from 100 mg/dl or above and five cases with BAC $\geq$ 300 mg/dl have been reported in Table 5.

### Postmortem alcohol formation (putrefaction)

There are seven samples with known BAC in decomposed bodies; the range of BAC for these samples was (15 to 65 mg/dl). Postmortem alcohol formation can occur in the body between death and specimen collection, or can occur after the specimens are collected but prior to analysis (Levine and Kunsman, 2000). The time between death and autopsy and from autopsy to the performing of the laboratory analysis for the decomposed samples ranged from (one day to eleven days).

In our study, blood alcohol concentration of four decomposed bodies is above 50 mg/dl (53 to 65mg/dl), while the other three cases are from (15 to 47 mg/dl). Within 24 h of death, little alcohol was formed even at room temperature. Alcohol metabolism by microorganism varies from zero under frozen condition to 0.29 mg/dl/day at 22°C and 43 mg/dl/day at 62°C (Ellenhorn and

Barceloux, 1988). The concentration of alcohol <30 mg/dl is more likely to be formed in postmortem than high concentration. In addition to the presence of extensive trauma to a body likewise increases the potential for spread of bacteria and heightens the risk of alcohol production after death (Kugelberg et al., 2007).

Comparing the concentration of alcohol in vitreous humor (VH) with the blood alcohol concentration allows a check on whether postmortem synthesis of alcohol in the blood sample needs to be considered or not (Jones, 2000). In this study there are two cases which have vitreous humor; the concentration of (Right V.H) for the first case is (201.58 mg/dl) and (Left VH) is (215.091 mg/dl). For the same victim, the blood alcohol concentration equals to (206.37 mg/dl). The concentration of alcohol in VH should exceed that of the femoral venous blood as there is roughly 10 to 20% more water in the eye fluid (206.37 mg/dl) is in femoral venous blood compared to left (VH) = 215.091 mg/dl.

The VH/BAC ratio depends to some extent on the time after drinking when death ensued, that is, on the stage of absorption and distribution of alcohol in the body (Jones, 2000). In this case V.H/BAC=1.04 (Left V.H) and for (Right V.H) equal to 0.98. When the VH/BAC ratio of alcohol is less than or close to unity, one might expect that death occurred during or shortly after the end of drinking. This illustrates this case where VH/BAC= 1.04, 0.98, this means that the person had recent alcohol drinking shortly before death. But the VH/BAC ratio should be about (1.2:1) in the post absorptive stage of alcohol pharmacokinetics, when equilibration of alcohol in all body fluids is complete (Jones, 2000).

The second case for analysis VH with blood for alcohol concentration has been used in decomposed body, the BAC= 57 mg/dl while in (V.H=0.0 mg/dl). In this case, BAC was positive and the vitreous humor concentration was negative. This was a strong indication that the alcohol concentration in the blood was the result of decomposition (Levine and Kunsman, 2000).

## DISCUSSION

This study investigated the prevalence of alcohol in medico legal autopsies and presents the degree of the effect of acute alcohol influence relevant to the cause of death. However, the research data may have a selection bias in autopsy request practice; this might be due to several possible reasons, for example as of result of an assumption that alcohol was being involved in the events leading to the death (Nordrum et al., 2000).

The present study showed a significant gender difference in alcohol cases (88.9% males, n=56) while (11.1% females, n=7). This finding can be explained that males in Jordan travel abroad frequently and work abroad for years, which makes them more exposed to foreign habits like alcohol drinking. This is revealed by the habitual consumption of alcohol by males more than females. But according to a previous study in Jordan of fatal poisoning due to alcohol and drugs, there are (30) deaths, (50%) were among adult males due to alcohol, and no cases related to females (Abu-ragheb and Hadidi, 1999). The presence of females in this current study though few cases showed that alcohol consumption is no more limited to males only. There are studies which suggest that women are less likely to be identified and diagnosed with harmful and hazardous drinking, while other reports suggest that alcoholism has been the third leading cause of morbidity and mortality among women (Zaidan et al., 2007; Svikis and Reid-Quinones, 2003).

The place of death were mainly in Amman area (93.7%, n=59), and only (6.3%, n=4) outside Amman. This high percentage of death in Amman is due to the fact that not all the victims from outside Amman are transferred to the NIFM, except the cases that have unclear reason about the specific cause of death, and also due to the presence of forensic medicine centers in most big cities in Jordan.

Deaths mostly occur between (30 to 39) years old; this result was similar to a previous study in Jordan (Abu-ragheb and Hadidi, 1999). They reported that the highest age group among alcoholic group was (30 to 49) years, so this showed high prevalence of alcohol consumption among middle-aged males.

Alcohol exerts a series of effects on the central nervous system. These effects comprise general influence and intoxication affecting, for instance, judgments, and leading to impairment of various skills. All such effects were generally more pronounced as the higher the BAC was. It was necessary to define what BAC was, though this was debatable. Nevertheless, it was vital for determining if acute alcohol influence should be regarded as a contributory cause of death. Acute alcohol influence should be classified as a contributory cause of death if the possibility exists that this influence contributed to death (Nordrum et al., 2000). In this study 68.3 and 31.7% of the tested violent and natural deaths, respectively, had BAC of 13 mg/dl or above. Violent deaths with a BAC of 13 mg/dl and above occurred as

well, except for accidental poisoning characterized by BAC from (206 to 541 mg/dl). Deaths due to accidental poisoning were defined as a poisoning with alcohol alone or combined with other chemicals or drugs. The findings generally support the fact that a moderate to severe influence of alcohol was a risk factor of violent death (Nordrum et al., 2000). In this study, no death certificate of suicide by alcohol was noticed in the 63 post-mortem cases. The percentage of acute alcohol influence among homicide was evident only in 7 cases (11.1%).

Generally, there are cases where there is uncertainty if the acute alcohol influence is relevant to death or not. This uncertainty is probably due to a random absence of adequately stated contributory cause of death in the autopsy reports. This uncertainty decline somewhat when a higher [BAC $\geq$ 100 mg/dl] is used to define acute alcohol influence as a contributory cause, which also could be expected. In this study, 28 cases have been reported for alcohol concentration with more than or equal 100 mg/dl. In general, higher BAC is probably more seriously considered as a contributory cause than lower ones (Nordrum et al., 2000).

The identification of the characteristics related to violent and natural deaths in a population was based on the official cause of death records, which were available in the NIFM. This study emphasized the significance of alcohol presence, despite the normal manner of death. Twenty cases of natural death were recorded with BAC from 12 to 245 mg/dl.

## Conclusion

- (1) Fatal poisoning due to alcohol has a minor contribution to the total deaths among Jordanian in comparison to other societies.
- (2) The risk of alcohol related deaths is noticed among males in higher number than females.

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