Original Article

Journal of Forensic Chemistry and Toxicology
Volume 6 Number 2, July–December 2020
DOI: http://dx.doi.org/10.21088/jfct.2454.9363.6220.13

Survey of Youth Awareness Regarding Toxic Alcohol (Methanol) and HOOCH Tragedies

Vivekanshu Verma

Author Affiliation: Associate Consultant, Emergency and Trauma Care, Medanta: The Medicity, Gurugram 122413, Haryana, India.

Corresponding Author: Vivekanshu Verma, Associate Consultant, Emergency and Trauma Care, Medanta: The Medicity, Gurugram 122413, Haryana, India.

E-mail: vivekanshu@yahoo.co.in

Abstract

The term Toxic alcohol include as a proper name Methanol, and is applied both to the absolute substance further specified by chemists as methyl alcohol, and to its mixtures with smaller proportions of water and slight proportions of other substances. In chemistry, the word alcohol is used as a common or generic name to designate several series of substances containing Ethanol in different percentages.

Alcohol consumption has existed in India for many centuries. The quantity of toxicity problem has undergone substantial changes over the past twenty years. In India many deaths are related to intake of toxic alcohol. These are liquors made in India under government license and the maximum Ethanol content allowed is 42.8%. Besides licensed distilleries, a number of small production units operate clandestinely. The toxic alcohol is industrial methylated sprits which regularly cause mass toxicity to humans, who lose their lives or suffer irreversible eye damage and overdose of methanol is death results in this research survey showed that maximum youth are not aware about the toxic alcohols. There is an urgent need to make people aware about methanol toxicity.

Keywords: Toxic Alcohol; Toxicity; Methanol; HOOCH; Snowfield blindness; etc.

How to cite this article:
Vivekanshu Verma. Survey of Youth Awareness Regarding Toxic Alcohol (Methanol) and HOOCH Tragedies. J Forensic Chemistry Toxicol 2020;6(2):111–125.

Introduction

Methyl alcohol (methanol) is a toxic and inexpensive substance among illicit drinks.[1] There is a slight level of methanol in commercially available alcoholic drinks while these drinks contain sufficient amounts of ethanol. In contrast, illicit alcoholic drinks contain high levels of methanol, which can lead to poisoning. Most of the patients survive, but some cases result in death, which cannot be even prevented using intensive care, dialysis, and treatment with antidotes.[2] Poisoning by counterfeit alcoholic drinks is one of the most hazardous poisonings that sometimes leads to death.[3–5] Since the sale, production, and consumption of alcoholic beverages are legally prohibited in some states of our country, thereis a high possibility of profiteering and fraud in their illicit production. There is not any detailed report available on the prevalence of methyl alcohol consumption in our country, but the increase in alcohol poisoning and even death indicates that substandard and counterfeit alcoholic beverages have targeted the young population's health.[5] Alcoholic beverages are among the preparations that have taken the lives of many people to date and sometimes lead to their intoxication. One of the hazardous alcohol is wood alcohol or methanol.[8,9] Due to reported

cases of mass epidemics of methanol poisoning, familiarity with the principles of diagnosis and treatment of them are of paramount importance in some cities of the country.[8,10,11] World Health Organization (WHO) reports that 7.5% of people in a attempt alcohol abuse on average[12] Although statistics in our country is much lower than this amount.[13] The remarkable thing is that most cases of alcohol abuse and its related complications are reported in the country side in peripheries, among migrated youngsters.[14]

Material and Method

This research data is used for the purpose of study of Youth Awareness Regarding Toxic Alcohol (Methanol). The data was collected as per the Google form of during 2019 year. Youth were being surveyed all over Delhi NCR region of our country, which was carefully chosen to ensure submission with respect to google form survey. The selected 17 above 29 years age group of youth 101 (male and female) answered the entire question and then statically graph shows result.

Result and Discussion

After doing Analysis of data of we found that 54.5% students of age group 17–29 yrs belonged to metropolitans (Fig. 1), and both males and females in survey almost equally participated proportionately (Fig. 2), but maximum participants were below 20 yrs age (Fig. 3). The estimates show the connection between Youngsters toxic alcohol awareness and consequent HOOCH tragedy consequences. This data was being analysed and we have used percentage analysis for this data to describe/Predict the outcomes.

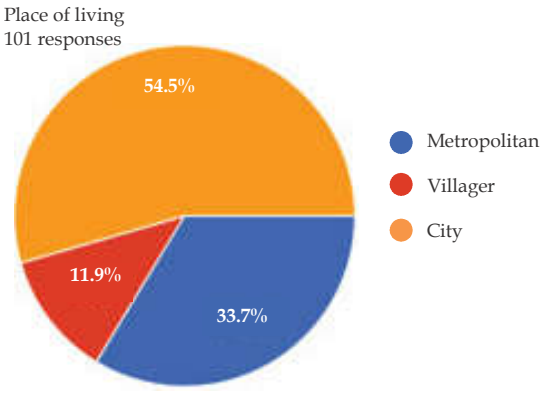


Fig. 1: Place of living among the surveyed participants.

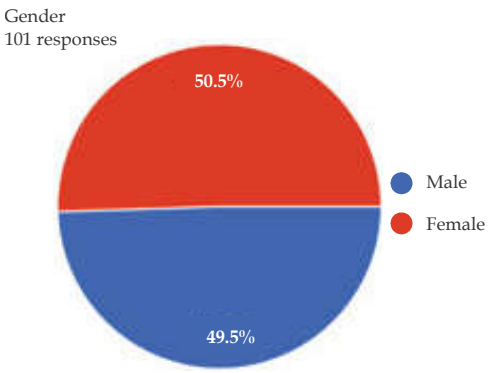


Fig. 2: Gender of participants in our survey.

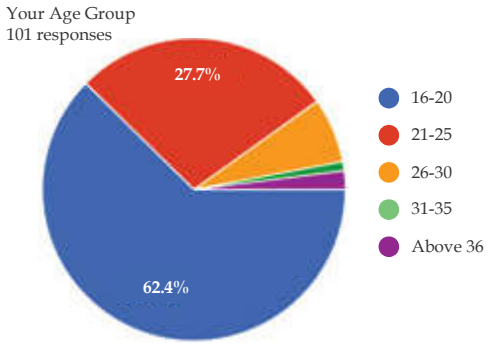


Fig. 3: Age of participants in our survey.

Indian youth suffer frequent casualties after Methyl Alcohol poisoning from consuming Wines, Beer, Arrack, Country liquor, Indian made foreign liquor and different other branded alcoholic beverages Counterfeited for quick money illegally. The alcohol produced illegally is called illicit alcohol. They do not follow any set standards and thus have no quality control. The alcohol produced from these units is usually adulterated and may contain a highly fatal substance called methylated spirit or methanol. This added methylated spirit can lead to death or blindness. Illicit alcohol also evades all national and state-level taxes and duties, thus making it very cheap and affordable. Illicit alcohol is produced under unregulated circumstances and

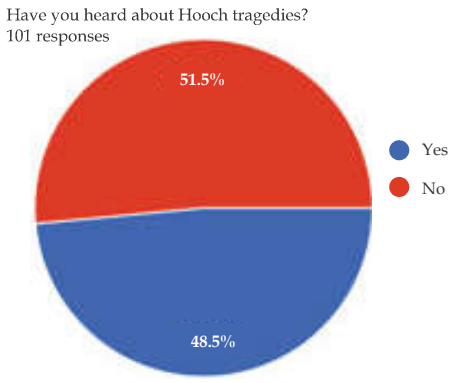


Fig. 4: Awareness about Hooch tragedy.

is often adulterated with chemicals like methanol, to save costs. This adulteration makes it absolutely unfit for human consumption and could lead to blindness or even be fatal to the consumer. In spite that, our survey found that 51.5% are unaware about Hooch tragedy (Fig. 4) and internet was the main source of information for 42.6% (Fig. 5).

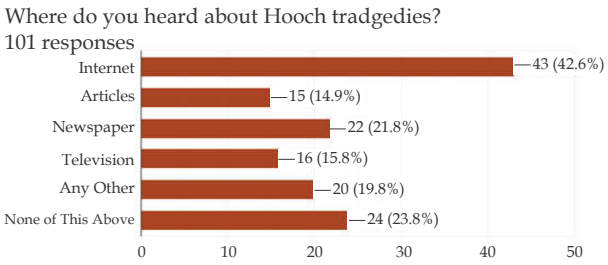


Fig. 5: Source of information about Hooch tragedy.

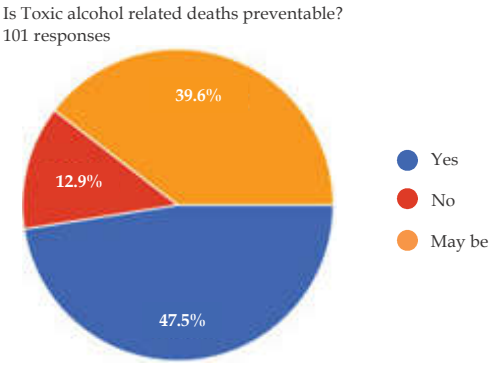


Fig. 6: Alcohol related Poisonings are Avoidable.

Alcohol related Poisonings are Avoidable, and 47.5% of our participants agreed to it (Fig. 6). So, if we educate the public on its harms and can "Prevent the Repent" of Fatal Predictable Epidemics.

Alcohol is the most commonly used intoxicating substance in India. It is a legal product but there is a minimum legal drinking age limit that varies from state to state (from 18–25 years).

Alcohol prohibition is one of the Directive Principles of the Constitution of India (Article 47) (15), but taxation on sales of alcohol is a major revenue-earner for most states.

As alcohol is a state subject, the production, distribution, and sale of alcohol is a state responsibility. Different state ministries and departments regulate different aspects of alcohol. For example, the Ministry of Social Justice and Empowerment (MoSJE) looks after alcohol use prevention programs, developing networks and capacity building for alcohol prevention and control, and monitoring. The Ministry of Health and Family Welfare (MoHFW) runs de-addiction centres.

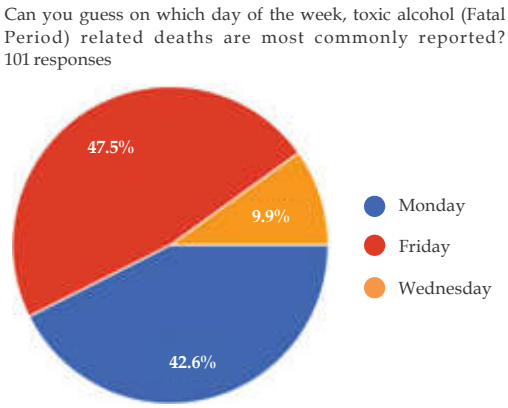


Fig. 7: Which day of the week, toxic alcohol related deaths are reported

As methanol is consumed in adulterated alcohol unknowingly, and maximum alcohol consumption occurs on weekends (Friday), but the methanol itself is not toxic, but its metabolite formic acid becomes toxic to the consumer, which takes 24–36 hrs for its conversion inside victim's liver. Thus the victims of methanol poisoning lands up in emergency on Mondays, mostly, if they have abused alcohol on weekends. This observation is verified from the past incidence of HOOCH tragedies, which was reported on week's onset, enabling the contradiction, to what the maximum youngsters (47.5%) in our study were surveyed (Fig. 7).

Incidence of fatal outcome of these HOOCH Tragedies by Methanol has some unique features: Uniquely in Males, Mostly on Weekends, as Adult Males have tendency to party with alcoholic beverages like beer, whisky, brandy, rum and arrack on weekends. HOOCH word is formed by rearranging by shifting C in the chemical formula of toxic metabolite formic acid (HCOOH) due to metabolism of methyl alcohol by liver causing toxicity by- formic acid chemical formula is CH_2O_2- which can also be written as HOOCH. HCOOH is Formic acid derived from ants and toxic in nature in body, methyl alcohol turns into formaldehyde, that causes blindness, and then to Formic acid, all are toxic to humans. Victims often only seek medical care after a significant delay, mainly because there is a latent period between ingestion and toxic effects. Awareness regarding Latent period of Methyl alcohol was surveyed, and revealed that maximum think its within 24 hrs (Fig. 8), but actually it takes 24–36 hrs to manifest toxic symptoms of snow field blindness. Late medical care contributes to the high level of morbidity and mortality seen in many methanol poisoning outbreak. Because patients with methanol poisoning often need intensive medical care, outbreaks of methanol poisoning can rapidly overwhelm medical facilities.

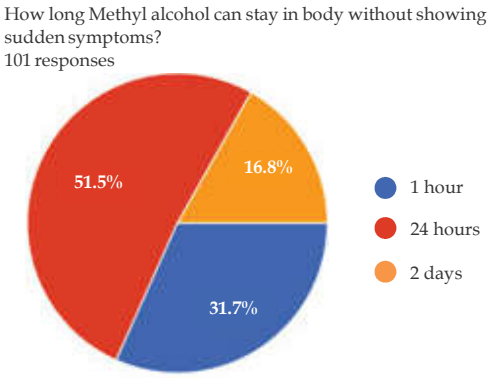


Fig. 8: Latent period of Methyl alcohol.

Fatal period of Methanol

1. If Methanol is consumed in non-fatal doses, it may not show any signs and symptoms, till its chronic accumulation occurs to toxic levels over weeks or months. In acute consumption of fatal doses of methanol, there may be a variable latent period between methanol ingestion and the development of symptoms, even though very short intervals have been reported following ingestion of very large quantities. The latency represents the time needed for sufficient amounts of formic acid to accumulate. Since ethanol inhibits methanol metabolism, concomitant ethanol intake may considerably lengthen the latent period.[16]
2. The phenomenon of continual methanol build up has been heavily investigated, as methanol metabolism is inhibited by ADH when ethanol levels are above approximately 0.2 g/kg. This is regularly seen in alcoholics allowing methanol concentrations to build up to potentially toxic levels, well above the endogenous levels of 0.86 ± 0.76 mg/kg that are found to be in the blood of non-alcoholic drinkers. For this reason, measurement of blood methanol has been shown to be useful as a diagnostic tool to distinguish acute from chronic Alcoholism.[17]

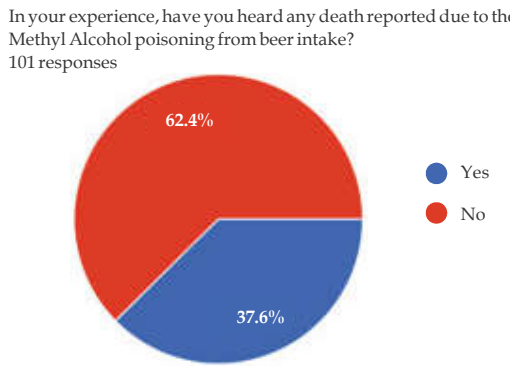


Fig. 9: Deaths from Methyl alcohol.

Deaths from Methyl alcohol

Methanol related deaths are frequently reported in newspapers at depressing regular intervals from all parts of the world every year due to the Methyl Alcohol related fatal poisonings, in western countries it is mostly due to consumption of automobile AC coolants – anti freeze containing methyl alcohol, and Indian population suffer frequent casualties after Methyl Alcohol poisoning from consuming Wines, Beer, Arrack, Country liquor, Indian made foreign liquor and different other branded alcoholic beverages Counterfeited for quick money illegally. But our survey revealed that 62.4% are unaware of the fatal toxicity and Deaths from Methyl alcohol (Fig. 9).

1. The Indian liquor industry comprises the Indian Made Foreign Liquor (IMFL), country liquor, foreign Liquor Bottled in Origin (BIO), illicit alcohol, beer and wine segments. Beer has become a popular beverage in the country only over the last two decades and it's growing at a rate of about 17 per cent per year. The highest levels of beer consumption in India are observed in the southern states. South India dominates the alcohol market in India, with that region accounting for about 60 per cent of total IMFL sales and 45 per cent of total beer sales. The alcohol produced illegally is called illicit alcohol. They do not follow any set standards and thus have no quality control. The illicit industry is also a local industry and is run by local criminals directly or sometimes indirectly when they provide protection to the owners of the illicit distilleries. The alcohol produced from these units is usually adulterated and may contain a highly fatal substance called methylated spirit or methanol. This added methylated spirit can lead to death or blindness. Illicit alcohol also evades all national and state-level taxes and duties, thus making it very cheap and affordable. Country liquor produced in local licensed distilleries and is made of cheap raw material, primarily rectified spirits of grains or molasses. The production cost for country liquor is low; the excise duties are also lower than they are for other liquor. Imported liquor forms a very small part of alcohol consumption in India and growing at the rate of 25 per cent annually.[18]
2. Incidence of fatal outcome of these Hooch Tragedies by Methanol: Uniquely in Males, Mostly on Weekends, as Adult Males have tendency to party with alcoholic beverages like beer, whisky, brandy, rum and arrack on weekends.

3. March 03, 2019: In Assam, which faced its worst liquor tragedy in which 160 people died and more than 500 were affected, many of those who survived have lost their eyesight and are dealing with major health complications.[19]
4. Feb 11, 2019: UP hooch tragedy: At least 116 died in Saharanpur, Kushinagar, Meerut and Haridwar.[20]
5. The preponderance of methanol poisonings have resulted from the consumption of adulterated alcoholic beverages, e.g., "moonshine", or "bootleg whiskey", wood alcohol and spirits mixed with whiskey. Bennett et al. (1953) described a case that occurred in Atlanta, Georgia, USA, in 1951, when within a 5-day period, 323 people consumed bootlegged whiskey contaminated with 35–40% methanol and 41 of them died. Before 1978, many alcoholics in Sweden were reported to supplement their intake of alcohol with readily available cleansing solutions containing up to 80% methanol. Since 1978, the methanol content of such solutions has been limited to 5%. However, consumption of these solutions by alcoholics is still widely seen, exposures of 1–2 weeks being associated with blood methanol concentrations ranging from 1000 to 2000 mg/litre (31–62 mmol/litre) (Heath, 1983).[21]
6. In medicolegal study by Fedakar, R. et al (2008), 73.7% of the alcohol poisonings were observed in years 2000–2002, and of the methyl alcohol poisoning, 35.9% and 29.7% were seen in years 2001 and 2002, respectively.[22]

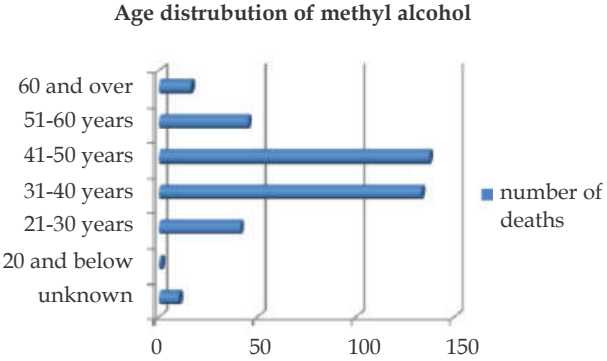
Table 1: Liquor tragedies timeline in 21st Century.[23]

Liquor Tragedies in 21st Century India - The Terrible Timeline

Date	Location	Deaths
Jan 2015	Uttar Pradesh	32
Oct 2013	Uttar Pradesh	40
Feb 2012	Odisha	35
Dec 2011	West Bengal	170
Oct 2010	Punjab	12
March 2010	Uttar Pradesh	35
Feb 2010	Uttar Pradesh	13
Jan 2010	Andhra Pradesh	14
Sept 2009	Uttar Pradesh	29
July 2009	Gujarat	136
May 2009	West Bengal	20
March 2009	Delhi	12
Jan 2009	West Bengal	27
May 2008	Karnataka	180
March 2006	Odisha	22
Dec 2004	Maharashtra	87
Oct 2001	Uttar Pradesh	18

7. In 2012, Total 63 males were admittedto V.S. Hospital (Ahmedabad) between 18 to 60 years, due to methyl alcohol poisoning after commercial alcohol consumption. 17 patients were terminally ill with hypotension, could not be subjected for hemodialysis and expired. Of remaining 46 patients, 20 responded to conservative management whereas 26 underwent hemodialysis of which only 3 died.[24]

Graph 1: Age Distribution of methyl alcohol death by Kurtas, U. et al. 2017[25].



8. Nand, L. et al (2014) reported a case of methyl alcohol poisoning after commercial alcohol consumption, manifestation of typical toxicity and outcome which revealed severe metabolic acidosis with high anion gap, blindness complicating bilateral optic atrophy and putaminal hemorrhagic necrosis. The patient improved with aggressive treatment including oral ethyl alcohol, but the occurrence of permanent blindness could not be prevented probably due to late presentation.[26]
9. The fatal dose varies greatly but is usually between 100 and 200mL in adults, although ingestion of 30mL can sometimes be lethal; permanent blindness has been caused by as little as 10mL. Toxic effects are usually associated with blood concentrations >100mg/L and blood concentrations >200mg/L are indicative of severe poisoning and may be lethal. The maximum permissible atmospheric concentration is 200 ppm.[27]
10. Serious Methanol (CH_3OH) toxicity is most commonly associated with ingestion. Following ingestion, the parent alcohol can cause CNS depression, ataxia, difficult breathing, acute gastritis or pancreatitis, anorexia, intense abdominal pain, vomiting, and diarrhea (Tephly, 1991). Left untreated, acute CH_3OH poisoning in humans is characterized by an asymptomatic latent period of 12 to 24 hours followed by formic acidemia, ocular toxicity, coma, and in extreme cases death (Lanigan, 2001). These

effects are caused by its metabolites. Respiratory failure or sudden respiratory arrest is the most common cause of death in methanol poisoning. Visual disturbances generally develop between 18 and 48 hours after ingestion and range from mild photophobia and misty or blurred vision to markedly reduced visual acuity and complete blindness (Eells et al., 1996). Although there is considerable variability among individuals in susceptibility to CH_3OH, a frequently cited lethal oral dosage is 1 mL/kg. Blindness and death have been reported with dosages as low as 0.1 mL/kg (ATSDR, 1993).[28]

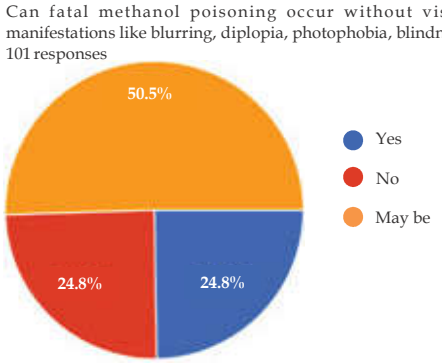


Fig. 10: Optic toxicity with Methanol.

Snow field Vision

As Methanol's selective toxicity of the optic nerve is well-known manifestation of methanol poisoning. Visual disturbances, like photophobia, blurred or misty vision (snowfield vision), central or peripheral scotoma, decreased light perception, concentric diminution of visual fields causing temporary or complete blindness due to optic neuritis and atrophy from accumulation of formic acid within the optic nerve. Retinal edema and hyperemia may be seen. Our survey showed that only 24.8% youth in our survey were aware regarding optic toxicity (Fig. 10).

Classic symptoms includes: Vertigo, Vomiting and Vision Loss; typical onset 24–36 hrs after consumption of country made liquor.[29] Awareness regarding classical symptoms of methanol toxicity revealed that 35.6% youths think that kidney damage occurs. (Fig. 11).

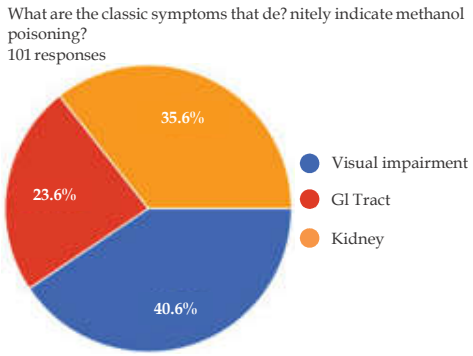


Fig. 11: Awareness regarding classical symptoms of methanol toxicity.

Methanol is cheap and readily accessible; therefore, it is one of the most common adulterants found in commercially available alcoholic beverages, especially in developing countries.

1. *Beer:* It is an un-distilled alcoholic beverage made from any malted grain, but commonly from barley malt, with hops or products obtained from hops to impart a bitter flavor and sometimes added with adjuncts like wheat, maize, corn rice and sugar. Methanol, a potent toxicant in humans, occurs naturally at low levels in most alcoholic beverages. Illicit alcohol is produced under unregulated circumstances and is often adulterated with chemicals like methanol, organophosphorus compounds, together with ethanol to save costs. This adulteration makes it unfit for human consumption and could lead to blindness or even be fatal to the consumer in the long or short run.[30]

Table 2: Top five Beer Producers of alcohol in the world by Sowmyashree et al 2016.[31]

Sl. No.	Brewer	Headquarters	Market share (%)	Rank
1.	Anheuser-busch InBev	Belgium	20.00	1
2.	SAB miller plc	UK	12.90	2
3.	Heineken NV	Netherlands	8.30	3
4.	Carlsberg breweries A/S	Denmark	6.50	4
5.	China Resources Enterprises Ltd.	China	5.30	5

Source: www.iaz.org.uk

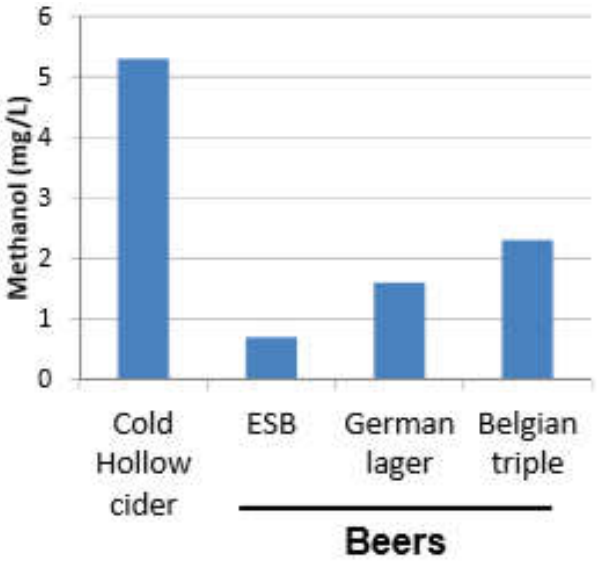
Beer commonly contains approximately 800 congeners (Methanol, butanol, isopropanol), wine: 600 and spirits: 800 at generally very low concentrations (~ 1:1000) compared with the corresponding ethanol content.

Table 3: Methanol content in foods and beverages.[32]

Methanol Levels in Foods and Beverages

Sample	Methanol Level
Fresh and canned fruit juices (orange and grapefruit juices)	1-43 mg/l 11-80 mg/l 12-640 mg/l *(average of 140 mg/l)*
Beer	6-27 mg/l
Wines	96-329 mg/l
Beans	1.5-7.9 mg/kg
Lentils	4.4 mg/kg
Carbonated beverages	~56 mg/l

2. Tolerable ("safe") daily dose of methanol in an adult is 2 g and a toxic dose is 8 g. The simultaneous ingestion of ethanol has no appreciable effect on the proposed "safe" and "toxic" doses when considering exposure over several hours. Thus, assuming that an adult consumes 4 x 25-ml standard measures of a drink containing 40% alcohol by volume over a period of 2 h, the maximum tolerable concentration (MTC) of methanol in such a drink would be 2% (v/v) by volume. However, this value only allows a safety factor of 4 to cover variation in the volume consumed and for the effects of malnutrition (i.e., folate deficiency), ill health and other personal factors (i.e., ethnicity). In contrast, the current EU general limit for naturally occurring methanol of 10 g methanol/L ethanol [which equates to 0.4% (v/v) methanol at 40% alcohol] provides a greater margin of safety.[33]



Graph 2: Bar diagram of Methanol in different liquors by Buglass, AJ. et al. 2011.[34]

3. Since most of the commercial brands of Beer have methanol contamination at different levels, establishment of a definitive relationship between the methanol content and toxicological effects can be vital. EDI of methanol for Iranian people through consumption of Beer was determined 0.023mg/kg bw/day.[35]
4. Illicit liquor becomes fatal when mixed with chemicals and repacked in new bottles. Adulteration of liquor is a major concern as it can lead to fatalities. At times the bootleggers are mixing methanol with liquor to increase the quantity which is a worrying sign for us as that could result in a huge tragedy.[36]

Table 4: FSSAI(Food Safety and Standards Act 2006) standards for Canned Beer.[37]

Table - 3 Requirement for Beer (canned/bottled)					
Sr. No.	Characteristic	Beer			
		Light	Standard	Strong	Super strong
1.	Ethyl alcohol content at 20 degree C percent by volume (Range)	0.5-4.0	4.1-5.0	5.1-6.0	6.1-8.0
2.	pH (Range)	3.8-4.5	3.8-4.5	3.8-4.5	3.8-4.5
3.	Carbon dioxide, v/v (not less than)	2.5	2.5	2.5	2.5
4.	Methyl alcohol mg/l max.	50.0	50.0	50.0	50.0
5.	Copper (mg/l), Max.	1.0	1.0	1.0	1.0
6.	Iron (as Fe) mg/l, Max.	5.0	5.0	5.0	5.0
7.	Lead (mg/l), Max.	0.2	0.2	0.2	0.2
8.	Arsenic (mg/l), Max.	0.25	0.25	0.25	0.25
9.	Cadmium (mg/l), Max.	0.1	0.1	0.1	0.1
10.	Total plate count, cfu per ml, max	2.0	2.0	2.0	2.0
11.	Coliform count, cfu per ml	Absent	Absent	Absent	Absent
12.	Yeast & Mould, cfu per ml	Absent	Absent	Absent	Absent

Table 5: FSSAI (Food Safety and Standards Act 2006) standards for Draught Beer.[37]

Table – 4: Requirements for Draught Beer					
Sr. No.	Characteristic	Beer			
		Light	Standard	strong	Super strong
1.	Ethyl alcohol content at 20 degree C percent by volume(Range)	0.5-4.0	4.1-5.0	5.1-6.0	6.1-8.0
2.	pH (Range)	3.8-4.5	3.8-4.5	3.8-4.5	3.8-4.5
3.	Carbon dioxide, v/v (not less than)	2.5	2.5	2.5	2.5
4.	Methyl alcohol mg/l max.	50.0	50.0	50.0	50.0
5.	Copper (mg/l), Max.	1.0	1.0	1.0	1.0
6.	Iron (as Fe) mg/l, Max.	5.0	5.0	5.0	5.0
7.	Lead (mg/l), Max.	0.2	0.2	0.2	0.2
8.	Arsenic (mg/l), Max.	0.25	0.25	0.25	0.25
9.	Cadmium (mg/l), Max.	0.1	0.1	0.1	0.1
10.	Total plate count, cfu per ml, max	50	50	50	50
11.	Coliform count, cfu per ml	Absent	Absent	Absent	Absent
12.	Yeast & Mould, cfu/ml, max	40	40	40	40

: Alcohol companies and their major brands in India

Sr. No.	Company	Whisky	Rum	Vodka	Brandy	Beer	Gin
1.	Empee Distilleries		Old Secret, Victoria,Sixer		Napoleon		
2.	Globus Spirits	County club	Hannibal Rum		Le' Mans		White Lace
3.	Imperial Spirits	Glen Special, Gold Coast Malt	Black Magic, Hatrick	Black Magic, Imperial Iceberg Premium	Imperial, Imperial Exclusive VSOP		Seagull London Dry
4.	Mohan Meakins	Summer Hall, Colonel's special, Golden Eagle	Old Monk		Triple Crown, Doctor's Reserve No.1		Big Ben London
5.	Radico Khaitan	After Dark, 8PM	Contessa	Magic Moments	Old Admiral, Morpheus		
6.	Som Distilleries		Black Fort			Hunter,Wood pecker	
7.	Tilaknagar Inds.	Mansion House, Senate Royale	Madira XXX Rum	Castle Club	Mansion House		Savoy Club
8.	United Breweries					Kingfisher, Zingaro, London Pilsner Heineken, Sandpiper. Black label,	
9.	United Spirits	McDowell N0.1, RC, Bagpiper, Black Dog, Whyte and Mackay, Vat 69, Officer's Choice, Royal Stag.	McDowell Celebrations, Old Cask	Red Romanov, White Mischief	McDowell No.1, Honey Bee		Blue Riband

Table 6: Alcohol Companies and their major brands in India.Sowmyashree, KL, et al (2016). [31]

5. The producer of branded beer, which is among three brands of alcohol blamed for causing the deaths of 21 people in Malaysia in September 2018. The liquor company has yet to explain why methanol is found in their product despite deaths occurring after drinking it, pointing out that it was the number one selling brand in India and sold in 52 countries worldwide.[38] Branded beers contain Methanol or not, was discussed in a panel discussion too.[39]
6. Howland, J. et al. (2008) described effects of heavy drinking of Beer on next day performance. A total of 172 participants received alcoholic beverage. In studies 1 and 2 the beverage alcohol was beer (7.3% alcohol by weight).[40]

S.No. (1)	Characteristics (2)	Requirements (3)
1.	Ethyl alcohol content at 20 degree C, per cent by volume	0.5 to 8.0
2.	Residue on evaporation, per cent. (g/liter), Max.	25.0
3.	Total acids as tartaric acid, per cent. (m/v), Max.	1.0
4.	Methyl alcohol (expressed in terms of g/100 l of absolute alcohol), Max.	25.0
5.	Sugar, per cent. (w/v), Max.	20.0
6.	pH	2.0 to 5.0
7.	Copper (mg/l), Max.	1.0
8.	Iron (as Fe) mg/l, Max.	5.0
9.	Lead (mg/l), Max.	0.2
10.	Arsenic (mg/l), Max.	0.25
11.	Cadmium (mg/l), Max.	0.1 "

Table 7: New guidelines for Lowered Methanol levels to 25 mg/dl in alcoholic beverages by FSSAI in 2019.[41]

7. Characterization of Indian beers. The study by Pai, TP. et al (2015) describes the variations in phenolic content and antioxidant activities of commercial beers among several commercial brands of beer sold in India. DPPH radical scavenging activity and ABTS radical cation scavenging activity were positively correlated to each other and the phenolic content of the beer. The phenolic compounds are responsible for beer antioxidant activity.[42]
8. Beer's Methanol determination done by Tomassetti, M. et al. (2016) in which the cell was used to check methanol content in several commercial wine and beer samples.[43]
9. Loguercio, C. et al. (2009) did Human Study on Beer effects on gastric function and harmful impacts on Gastric epithelial cell viability due to oxidative stress-induced damage.[44]

Blood in vomiting after alcohol toxicity can have multiple causes

1. Liver cirrhosis is a serious form of alcoholic liver disease and is irreversible. Complications such as liver cirrhosis can develop after 5 to 10 years. About 10–20 percent of heavy drinkers usually develop cirrhosis around 10 or more years. Generally, drinking 80 grams of ethanol daily for 10–20 years is required to develop cirrhosis which corresponds to approximately one liter of wine, eight standard sized beers, or one half pint of hard liquor each day. (Fig. 12).

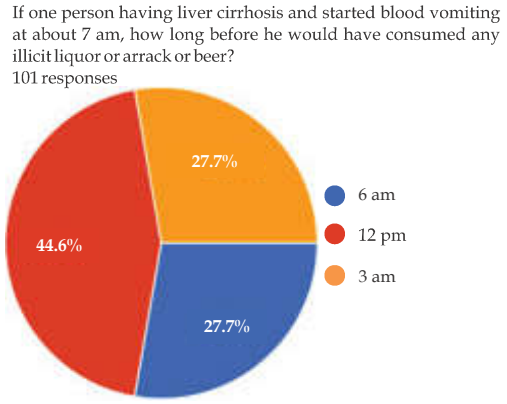


Fig. 12: Liver cirrhosis and started blood vomiting.

2. Apart from symptoms similar to alcoholic hepatitis, one can develop other serious complications such as accumulation of fluid in the abdomen (ascites), bleeding from esophageal or stomach veins, kidney failure, liver cancer or significant liver failure, signs of acute changes in mental status and possibly coma within 4–5 yrs of chronic alcohol abuse.
3. Esophagitis and gastroesophageal reflux: Stomach acid that returns, or "refluxes" back into the esophagus from the stomach can cause irritation and inflammation of the esophagus (esophagitis) that may lead to bleeding within few hours after alcohol consumption.
4. *Varices:* These are abnormally enlarged veins usually located at the lower end of the esophagus or the upper stomach. They may break open and bleed. Cirrhosis of the liver is the most common cause of esophagealvarices. It takes a few years to develop on regular alcohol consumption.

5. *Mallory-Weiss tears:* These are tears in the lining of the esophagus. It is usually caused by severe vomiting, immediately or within few hours after excessive intake of alcohol.
6. *Gastritis:* Inflammation of the stomach. Alcohol and some pain medicines can cause it.
7 *Ulcers:* If they are present in the stomach, they may enlarge and erode through a blood vessel, causing bleeding.[45]
8. According to Karnataka Excise Rules (1997), the ethanol content of whisky, rum and gin (IMFL) are mandated at 42.8% volume by volume (75° proof) and of country liquor or "arrack" at 33.3% volume by volume (65° proof) at 15/15°C. The Karnataka Excise Act specifies that for the manufacture of IMFL and arrack, the basic material is Rectified spirit (95% Ethanol and 5% Methanol) [manufactured by distillation of molasses].[46]
9. *Arrack:* It is a distilled alcoholic beverage typically produced from either the fermented sap of coconut flowers, palm, sugarcane, grain or fruit. The clear distillate may be blended, aged in wooden barrels, or repeatedly distilled and filtered depending upon the taste and colour objectives of the manufacturer. This beverage contains about 36–50 percent of alcohol.

   Arak or Araq: It is a clear, colourless, unsweetened anise-flavored distilled alcoholic beverage.[47]
10. Blood methanol concentrations during experimentally induced ethanol intoxication in alcoholics during a 10–15 day period of chronic alcohol intake showed that blood methanol levels increased progressively from 2–27 mg/litre from the first to the 11th day of drinking, when blood ethanol concentrations ranged between 1500 and 4500 mg/litre. Blood methanol levels decreased at the rate of 2.9 ± 0.4 mg/litre per h only after blood ethanol levels decreased to 700 to 200 mg/litre. Blood methanol disappearance lagged behind the linear disappearance of ethanol by approximately 6–8 h and complete clearance of methanol required several days. Methanol probably accumulates in the blood as a result of the competitive inhibition of alcohol dehydrogenase by ethanol and the presence of endogenously formed methanol, Oral doses of 71–84 mg methanol/kg in humans resulted in blood levels of 47–76 mg/litre blood 2–3 h later. The urinary concentrations of methanol rapidly reached a peak capacity in 1 h and declined exponentially, reaching control values in 13–16 h. The urine/blood concentration ratio was found to be relatively constant at 0.30.[48]

Hemodialysis

1. Yes, Hemodialysis can help in the removal of toxic alcohols accumulated in circulating blood. Hemodialysis removes both methanol (half life reduced to 3–6 hours) and formate.[49] (Fig. 13).

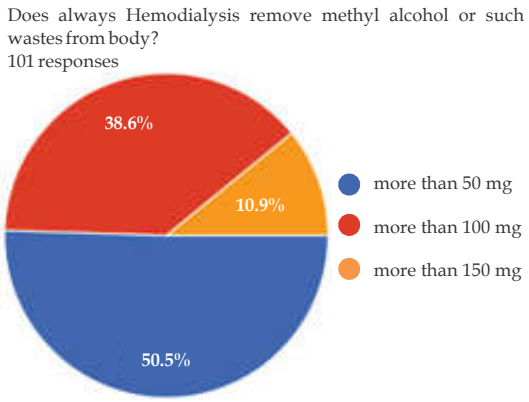


Fig. 13: Hemodialysis remove methyl alcohol or such wastes from body.

2. Hemodialysis is effective in removing methanol and formate and in correcting severe metabolic acidosis.[50]
3. The management of methanol intoxication by haemodialysis is a well-known and clinically effective treatment.[51]
4. The definitive therapy for symptomatic for clinically ill patients poisoned by toxic alcohols is hemodialysis. Hemodialysis clears both the alcohols and their toxic metabolites from the blood and corrects the acid–base disorder.[52]

Accumulation of Methanol in chronic alcohol abuser

It can be due to multiple reasons mentioned below:-

1. Patients presenting late after ingestion may already have metabolized all parent compound to toxic metabolites and thus may have low or no measurable toxic alcohol concentrations.[52]
2. Trace amounts of methanol are found naturally in fruit juices - this is non-toxic. Methanol is also a product of fermentation and is found in both alcoholic and non-alcoholic fermented drinks. Concentrations of 6–27 mg/L have been measured in beer and 10–220 mg/L in spirit. In these concentrations methanol is not harmful. Problems arise when higher concentrations are formed during incorrectly managed distillation processes, but more particularly when methanol is deliberately added to fortify informally-

produced spirits and illicit alcoholic drinks. Some illicitly-produced drinks are made to appear legitimate through bottle design and labelling and consumers can be misled into believing they are buying a genuine brand of alcohol.[53] (Fig. 14).

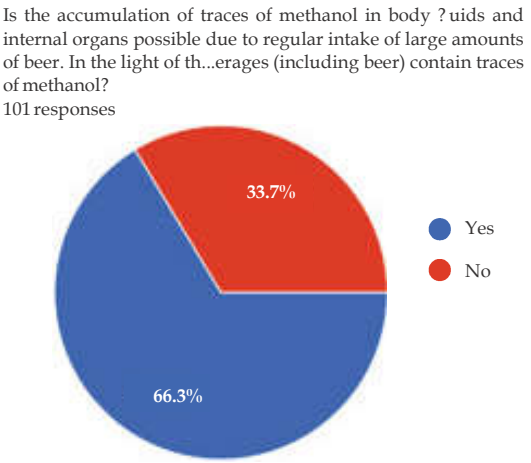
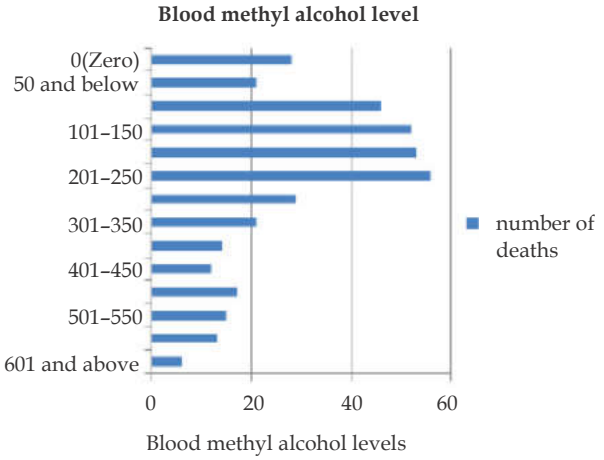


Fig. 14: Accumulation of Traces of Methanol in Body Fluids and Internal Organs.

3. Small amounts of methanol are present as congeners in some fermented alcoholic beverages. Heavy drinking of alcohol (ethanol) blocks the oxidation of endogenous methanol because alcohol dehydrogenase is engaged with ethanol metabolism, resulting in accumulation of methanol - both endogenous and exogenous - from beverage-related congeners. Endogenous blood-methanol concentrations are about 1.5 mg/L, and urinary formic acid concentrations are about 12–17 mg/L.[54]
4. Frequent exposure to methanol and its toxic products of metabolism, formaldehyde and formic acid, might constitute an additional health risk associated with heavy drinking in predisposed individuals.[55]
5. Since Methanol is volatile Alcohol at room temperature, and it evaporates quickly. It is possible to find Different levels of methanol in antemortem samples at different timings during treatment and hemodialysis of the patient, and can be found different levels of methanol in postmortem samples due to endogenous production of methanol causing false high/low levels. Was it the same extent of serum alcohol levels, or some amount of volatile alcohol is lost due to evaporation from the time of collection to the time of testing the sample at different laboratories during transport, lessening the quantitative levels.[56]
6. Ethanol and other alcohols including methanol can be produced during putrefaction by fermentation of the carbohydrates and proteins of the body, which may be as high as 0.2%.[57]
7. The routine Laboratory sample collection method practiced in Hospitalised patients for any blood sampling is first disinfecting the site of pricking needle by using methylated spirit, which contains 95% by volume of Ethanol and 5% Methanol, which can give false positive results for high methanol and ethanol concentration.[58]
8. Range of dose levels of methanol that are toxic, 120 ml (4 fluid ounces) of Columbian spirits, or 95 g of methanol (Columbian spirits is basically pure methanol), was lethal in 40% of the poisoning cases. For a 70-kg person, this dose is equivalent to about 1.4 g methanol/kg body weight. This figure is consistent with currently accepted values for lethality, and 0.3 to 1 g/kg is considered the range of a minimum lethal dose for untreated cases of methanol poisoning.[59]



Graph 3: Evaluation of deaths due to methyl alcohol intoxication. Kurtas, U. et al 2017.[25]

9. Methanol has been identified as a volatile component of dried legumes with reported levels of 1.5–7.9 mg/kg in beans, 3.6 mg/kg in split peas and 4.4 mg/kg in lentils. Methanol has also been reported (no levels stated) in roasted filberts and baked potatoes. It has been detected in low-boiling volatile fractions of cooked foods, including Brussels sprouts, carrots, celery, corn, onion, parsnip, peas and potatoes. Humans can also ingest varying amounts of methanol in foods and or drugs isolated or recrystallized from methanol, e.g., methanol is used as an extraction solvent for spice oleoresins and hops. Additionally, certain foods and drugs, consumed or administered as their methyl ester, can release methanol during their metabolism and excretion. For example, 10% of the sweetening agent aspartame (L-aspartyl-L-phenylalanine

methyl ester) hydrolyzes in the gastrointestinal tract to become free methanol. Carbonated beverages contain about 555 mg aspartame/litre, equivalent to approximately 56 mg methanol per litre. The amount of methanol present in an average serving of beverage sweetened by aspartame alone is considerably less than in the same volume of many fruit and vegetable juices. For instance, tomato juice will result in 6 times the amount of methanol exposure than consumption of an equivalent volume of aspartame sweetened beverage.[60] (Fig. 15).

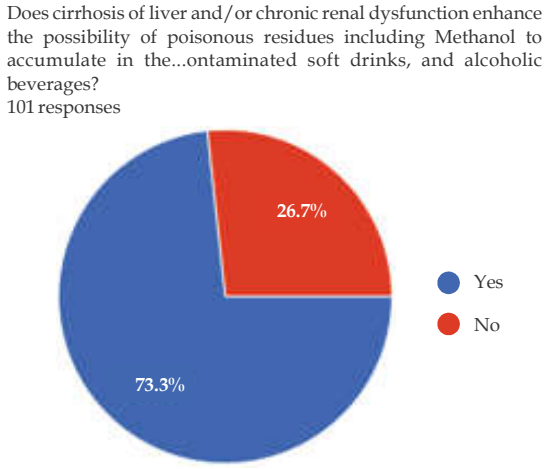


Fig. 15: Cirrhosis of Liver and/or Chronic Renal Dysfunction Enhance.

Fatal concentrations of methanol

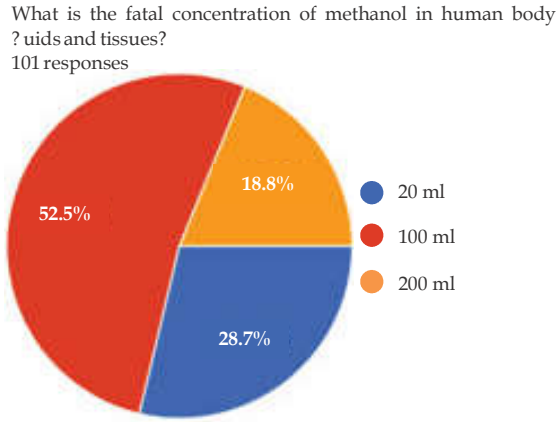


Fig. 16: What is the Fatal Concentration of Methanol in Human Body Fluids and Tissues 101 Responses.

Different Toxicology books have different values of fatal concentrations of methanol mentioned in different units, as per the author's research and reported cases in their Hospitals observed by them, (Fig. 16) as mentioned below:-

1. Fatal dose of methanol is 15–30 ml of 40 percent methanol have produced deaths.[61]
2. Blood Methanol Levels of 200 mg % can be fatal.[62]
3. Blood Methanol Levels of 50 mg/100ml indicates serious poisoning.[63]
4. > 50 mg/dL-Methanol level- Severe toxicity.

>30 ml of methyl alcohol ingestion- causes optic N toxicity-potentially lethal dose-– indication of dialysis. (Fig. 17).

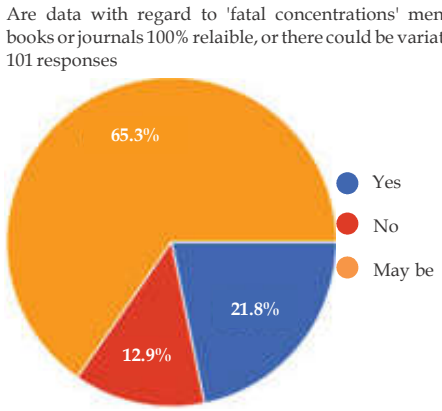


Fig. 17: 'Fatal Concentrations' Mentioned.

Conclusion

Understanding the type of alcohol toxicity problems that precede future possible HOOCH tragedies is critical for developing effective intervention programs which are targeted at youth who suffer from these emergencies. These Research outcomes, provides strong sustenance for a progressive alcohol intake and possibility of methanol poisoning in chronic abusers. Our Research result shows that male and female are both unaware regarding harmful effects of alcohol, which indicates the risk of methanol toxicity and high vulnerability.

Visual disturbances, dyspnoea, and gastrointestinal symptoms are among the variable symptoms, while severe metabolic acidosis, coma, and increased pCO_2 are associated with inappropriate and poor treatment outcomes. Due to this increment they are being involved in mass tragedies of intoxication, and various morbidities and resulting mortality rate, thus we must create awareness among society to restrain from consuming alcohol casually in the Youth population and provide them supportive environment for alcohol deaddiction.

Author's Contributions: All authors have read, reviewed and contributed to the final manuscript.

Conflict Of Interest: Nil.

References

1. Kute VB, Godara SM, Shah PR, Gumber MR, Goplani KR, Vanikar AV, et al. Hemodialysis for methyl alcohol poisoning: A single-center experience. Saudi Journal of Kidney Diseases and Transplantation.2012;23(1):37.
2. Andresen H, Schmoldt H, Matschke J, Flachskampf F, Turk E. Fatal methanol intoxication with different survival times—morphological findings and postmortemmethanol distribution. Forensic science international.2008;179(2):206–10.
3. Oberts DM, Yates C, Megarbane B, Winchester JF, Maclaren R, Gosselin S, et al. Recommendations for the role of extracorporeal treatments in the management of acute methanol poisoning: a systematic review and consensus statement. Critical care medicine.2015;43(2):461–72.
4. Rostrup M, Edwards JK, Abukalish M, Ezzabi M, Some D, Ritter H, et al. The Methanol Poisoning Outbreaks in Libya 2013 and Kenya 2014. PloS one.2016;11(3):e0152676.
5. Massoumi G, Saberi K, Eizadi-Mood N, Shamsi M, Alavi M, Morteza A. Methanol poisoning in Iran, from 2000 to 2009. Drug and chemical toxicology.2012;35(3):330–3.
6. Oberts DM, Yates C, Megarbane B, Winchester JF, Maclaren R, Gosselin S, et al. Recommendations for the role of extracorporeal treatments in the management of acute methanol poisoning: a systematic review and consensus statement. Critical care medicine. 2015;43(2):461–72.
7. Rostrup M, Edwards JK, Abukalish M, Ezzabi M, Some D, Ritter H, et al. The Methanol Poisoning Outbreaks in Libya 2013 and Kenya 2014. PloS one. 2016;11(3):e0152676.
8. Massoumi G, Saberi K, Eizadi-Mood N, Shamsi M, Alavi M, Morteza A. Methanol poisoning in Iran, from 2000 to 2009. Drug and chemical toxicology. 2012;35(3):330–3.
9. Zakharov S, Pelclova D, Navratil T, Belacek J, Komarc M, Eddleston M, et al. Fomepizole versus ethanol in the treatment of acute methanol poisoning: Comparison of clinical effectiveness in a mass poisoning outbreak. Clinical Toxicology. 2015;53(8):797–806.
10. Rafzadeh A, Shariati S, Pourmohammad L, Fooladmehr S. Application a colorimetric method for qualitative analysis of methanol. IJFM. 2010;16(2):89–94.
11. Hassanian-Moghaddam H, Nikfarjam A, Mirafzal A, Saberinia A, Nasehi AA, Asl HM, et al. Methanol mass poisoning in Iran: role of case finding in outbreak management. Journal of public health. 2015;37(2):354–9.
12. Organization WHO. Global status report on alcohol and health, 2014.
13. Poznyak V, Fleischmann A, Rekve D, Rylett M, Rehm J, Gmel G. The World Health Organization's global monitoring system on alcohol and health. Alcohol res. 2013;35:244–9.
14. Mostafazadeh B, Eghbali H. An Epidemiologic Study on Methyl Alcohol Poisoning in Tehran, Iran. Asia Pacific Journal of Medical Toxicology. 2014;3:8.
15. Article 47 in the Constitution of India 1949.47. Duty of the State to raise the level of nutrition and the standard of living and to improve public health. The State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties and, in particular, the State shall endeavour to bring about prohibition of the consumption except for medicinal purposes of intoxicating drinks and of drugs which are injurious to health. https://indiankanoon.org/doc/1551554/
16. Human Toxicology - J. Descotes (Elsevier, 1996) WW. Chapter 24 — Alcohols and glycols. P632–35.
17. Roine, RP, CJ Eriksson, R Ylikahri, A Penttilä, and M. Salaspuro, Methanol as a marker of alcohol abuse. Alcohol ClinExp Res, 1989. 13(2): p. 172–175.
18. Sowmyashree, KL Et al. An overview of Indian alcohol industry. Volume 9 | Issue 1 | April, 2016| 80–86. International Journal of Commerce and Business Management. DOI:10.15740/HAS/IJCBM/9.1/80–86. Link: http://www.researchjournal.co.in/online/IJCBM/IJCBM%209(1)/9_80–86_A.pdf)
19. Chaudhary, R. Assam Liquor Tragedy Exposes Isolation, Neglect Of Tea Garden Workers. https://www.ndtv.com/india-news/assam-hooch-tragedy-assam-liquor-tragedy-exposes-isolation-neglect-of-tea-garden-workers-2001917
20. UP hooch tragedy: 116 died in Saharanpur, Kushinagar, Meerut and Haridwar. Link: https://www.financialexpress.com/india-news/hooch-tragedy-saharanpur-live-toll-deaths-uttar-pradesh-uttarakhand-haridwar-yogi-adityanath-up/1483734/
21. Fishbein, L Methanol. World Health Organization, Geneva, 1997.International Programme on Chemical Safety (IPCS) http://www.inchem.org/documents/ehc/ehc/ehc196.htm#SectionNumber:1.2
22. Fedakar, R et al. Fatal Poisonings In The South Marmara Region Of Turkey, 1996–2003. European Journal of General Medicine (ISSN: 1304–3897) Vol 5 Num 1. May 2018. DOI: 10.29333/ejgm/82566 Link: https://www.researchgate.net/publication/27794746_Fatal_Poisonings_In_The_South_Marmara_Region_Of_Turkey_1996–2003)
23. Pillay, VV. Textbook of Forensic Medicine and Toxicology. 19th Ed. 2019. Chapter 33. Alcohols and Sedatives. Terrible Toxic Tragedies on Timeline of India. p 639.

24. Shah,S. et al. Study of 63 cases of methyl alcohol poisoning (hooch tragedy in Ahmedabad). May 2012. The Journal of the Association of Physicians of India 60(5):34–6. https://www.researchgate.net/publication/231816032_Study_of_63_cases_of_methyl_alcohol_poisoning_hooch_tragedy_in_Ahmedabad)
25. Kurtas, U. et al. The evaluation of deaths due to methyl alcohol intoxication. Biomedical Research (2017) Volume 28, Issue 8. Link: http://www.alliedacademies.org/articles/the-evaluation-of-deaths-due-tomethyl-alcohol-intoxication.html)
26. N and, L. et al. Methyl alcohol poisoning: A manifestation of typical toxicity and outcome. August 2014. The Journal of the Association of Physicians of India 62(8):756–9 link: https://www.researchgate.net/publication/274724605_Methyl_alcohol_poisoning_A_manifestation_of_typical_toxicity_and_outcome)
27. Clarke's Analysis of Poisons. 4th Ed. 2011. Methanol. p1652–53.
28. Casarett and Doull's Toxicology: Basic Science of Poisons, 9th edition. McGraw Hills 2019. Chapter 24. Toxic Effects of Solvents and Vapors. p1207.
29. Modi, JP. Medical Jurisprudence and Toxicology. 26th Edition. Lexis Nexis. 2018 p 244.
30. Alcohol Marketing and Regulatory Policy Environment in India. A Report. 2013: https://iogt.org/wp-content/uploads/2013/12/PHFI-Alcohol-Industry-Report.pdf)
31. Sowmyashree, KL. Et al. An overview of Indian alcohol industry. Volume 9 | Issue 1 | April, 2016 | 80– 86. International Journal of Commerce and Business Management.
32. Methanol Safe Handling Manual 1st Ed. Methanol Institute. 2008. http://www.southernchemical.com/wp/wpcontent/uploads/2009/12/Methanol-Safe-Handling-Manual-Oct-20081.pdf
33. Paine A, Davan AD. Defining a tolerable concentration of methanol in alcoholic drinks. Hum Exp Toxicol. 2001 Nov;20(11):563–8)
34. Buglass, AJ. Handbook of Alcoholic Beverages. Technical, Analytical and Nutritional Aspects. Volume I. Wiley Publication. 2011).
35. Shirani K, Bostan HB, Baroti A, et al. Ethanol and Methanol Concentration in Commonly Used Brands of Ma-al-shaeer in Iran: Estimation of Dietary Intakes and Risk Assessment. J Pharmacopuncture 2018; 21(3): 168–176.
36. Nigam, Chayyanika. Delhi authorities worry over adulteration of liquor, smuggling from Haryana. India Today. New Delhi. June 1, 2018 https://www.indiatoday.in/mail-today/story/delhi-authorities-worry-over-adulteration-of-liquor-smuggling-from-haryana-1247522–2018–06–01)
37. FSSAI (Food Safety and Standards Act 2006) standards for Alcoholic beverages. https://old.fssai.gov.in/Portals/0/Pdf/Notice_Comments__WTO_TBT_Alcoholic_Beverages.pdf
38. Looi, S. What's in Kingfisher beer? Perak exco demands answers after alcohol poisoning deaths. Reported in Malaymail. September 2018. https://www.malaymail.com/news/malaysia/2018/09/21/whats-in-kingfisher-beer-perak-exco-demands-answers-after-alcohol-poisoning/1675074)
39. Kingfisher beers contain Methanol or not?(Ref:https://www.nst.com.my/news/nation/2018/09/415522/kingfishermanufacturer-denies-viral-message-saying-beer-cause-methanol)
40. Howland, J et al. The incidence and severity of hangover the morning after moderate alcohol intoxication. Addiction. Volume 103, Issue 5. May 2008. p758–765. Link: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1360–0443.2008.02181.x)
41. New guidelines for Lowered Methanol levels to 25mg/dl in alcoholic beverages by FSSAI (Food Safety and Standards Direction_Alcoholic_Beverages_29_03_2019.
42. Pai, TP. Characterization of Indian beers: chemical composition. J Food Sci Technol. 2015 Mar; 52(3): 1414–1423. doi: 10.1007/s13197–013–1152–2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4348278/)
43. Tomassetti, M. et al.Catalytic fuel cell used as an analytical tool for methanol and ethanol determination. Application to ethanol determination in alcoholic beverages. ElectrochimicaActa 191 (2016) xxx–xxx. Link: https://iris.uniroma1.it/retrieve/handle/11573/856583/201712/Tomassetti_Catalytic-fuel_post-print_2016.pdf
44. Loguercio, C. Alcoholic beverages and Gastric epithelial cell viability. Journal of Physiology And Pharmacology 2009, 60, Suppl 7, 87–92 Link: https://pdfs.semanticscholar.org/636b/bcfc5efd088f318b982b19193fce4d43b91b.pdf
45. Burt AD, MacSwee R. (1999) Pathology of Alcoholic Liver Disease. In: Bircher J, Benhamou JP, McIntyre N, Rizzetto M, Rodes J (eds). Oxford Textbook of Clinical Hepatology. Oxford University Press, Oxford, pp1179–84).
46. Ref: Pandey, RK., Sankhla MS, Kumar, R. Determination of adulterants in suspected liquor samples using chemical tests MOJ Toxicol.2018;4(4):309□314. Link: https://medcraveonline.com/MOJT/MOJT–04–00118.pdf
47. FSSAI (Food Safety and Standards Act 2006) Definitions for Alcoholic beverages. 2.2.5 https://old.fssai.gov.in/Portals/0/Pdf/Notice_Comments__WTO_TBT_Alcoholic_Beverages.pdf
48. Fishbein, L. Methanol. World Health Organization, Geneva, 1997.International Programme on Chemical Safety (IPCS) http://www.inchem.org/documents/ehc/ehc/ehc196.htm#SectionNumber:1.2)

49. Olson KR. Poisoning and Drug Overdose 7th Ed. 2018. McGraw-Hill Education. p314–16.
50. Roberts DM, Yates C, Megarbane B, et al. Recommendations for the role of extracorporeal treatments in the management of acute methanol poisoning: a systematic review and consensus statement. Crit Care Med 2015; 43(2): 461–472.)
51. Kraut Jeffrey A, Kurtz Ira. Toxic alcohol ingestions: clinical features, diagnosis, and management. Clin J Am SocNephrol 2008; 3: 208–25.
52. Goldfrank, L. Goldfrank's Textbook of Toxicological Emergencies. 10th Ed. McGraw Hills. 2015. Toxic Alcohols. Ch 109.
53. World Health Organisation- environmental health emergencies-methanol poisoning information note. July 2014. p1–2. https://www.who.int/environmental_health_emergencies/poisoning/methanol_information.pdf)
54. Knight, Bernard. Forensic Pathology. 4th edition. CRC Press 2016. p586.
55. (Jones AW, Lowinger H. Relationship between the concentration of ethanol and methanol in blood samples from Swedish drinking drivers. Forensic SciInt 1988; 37(4): 277–85.
56. Biswas, G. Recent Advances in Forensic Medicine and Toxicology. Volume 2. Jaypee Publishers. 2018. Section 5: Forensic Science. Chapter 23: Controversies in Forensic Tests, Investigations and Expertise. p642.
57. Reddy, KSN. Medicolegal Manual. 5th Ed. ALT publications. 2014 p239.
58. Dikshit, PC. Textbook of Forensic Medicine and Toxicology. 2nd Edition. 2014. Chapter 41. CNS Depressants- Methanol. p546.
59. Röe, 1955; Erlanson et al., 1965; Gonda et al., 1978.(Ref: Fishbein, L. Methanol. World Health Organization, Geneva, 1997. International Programme on Chemical Safety (IPCS) http://www.inchem.org/documents/ehc/ehc/ehc196.htm#SectionNumber:1.2)
60. Cruz-Pamplona M, Margaix-Muñoz M, Gracia Sarrión-Pérez MG. Dental considerations in patients with liver disease. J ClinExp Dent 2011; 3(2): e127–34.
61. Agarwal, Praveen. Diagnosis and management of Common poisoning. Oxford 1st ed. OUP. 1998. Chapter: Methanol p133.)
62. Agarwal, Anil. Textbook of Forensic Medicine and Toxicology. 1st Ed. Avichal publishers. 2015. Chapter: Toxic Alcohols.
63. Pillay, VV. Comprehensive Medical Toxicology. 3rd ed. Paras Publishers. 2018. Chapter 8: Alcohols p276.