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Are you an alcoholic?
Check out Your Ethnic Makeup to Understand the Health Risk

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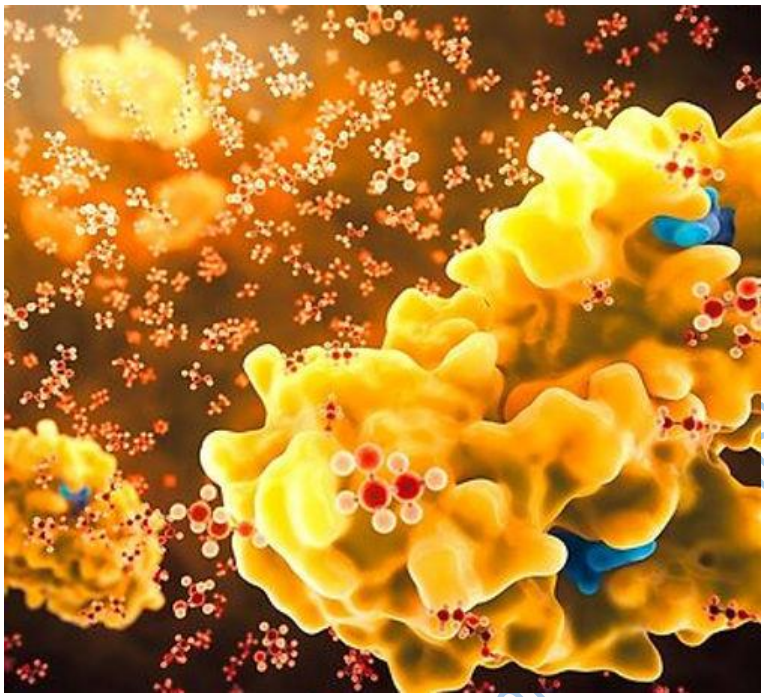
Abstract

Alcohol consumption is fast becoming a global social practice despite its well established adverse health effects. The extent of adverse effects primarily depends on ethnicity and genetic makeup. The adverse effect is mainly due to two important enzymes, namely alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH), which are responsible for metabolism of alcohol and acetaldehyde respectively to harless acetic acid. The extent of these two enzymes decide how different populations process alcohol. Variations in the genes encoding ADH enzymes are known to differ across ethnic groups, leading to diverse physiological responses to alcohol consumption and varying risks of alcohol-related diseases. This article brings forth the change in cultural landscape in today's society, the relationship between ADH genetic polymorphisms and ethnicity, and the implications for alcohol metabolism and health outcomes.

1. Introduction

Alcohol has been consumed by humans for centuries, often embedded within cultural and social rituals of many societies. Despite its societal prevalence, alcohol is a psychoactive substance with dependence potential and significant adverse effects on health. The unabashed fancy of consuming alcohol is fast becoming a societal malice in recent times. Road accidents because of driving under

the influence of excessive alcohol, alcoholic fatty liver, diabetes are getting routine in today's society. Road accidents, drownings, falls, and accidental alcohol poisonings are often associated with alcohol consumption. Acute alcohol intoxication impairs cognitive and motor functions, increasing the risk of accidents, injuries, and fatalities. Ethanol and its metabolite acetaldehyde



can cause cancer by damaging DNA, interfere with folate metabolism, and increase estrogen levels (in breast cancer). It can also alter neurotransmitter levels, affects brain structure and function, and can exacerbate pre-existing mental health conditions. The World Health Organization (WHO) reports that alcohol consumption contributes to over 3 million deaths annually, representing 5.3% of all deaths globally [1]. In this article, following issues will be discussed: (a) Socio-Economic Implications (b) Health risk of excessive alcohol consumption (c) Role of enzymes in alcohol metabolism, and (d) Relationship of alcohol consumption ability to ethnicity

2. Discussion

2.1 Socio-Economic Implications: The adverse effects of alcohol consumption extend beyond individual health, impacting society economically and socially. Healthcare costs for treating alcohol-related conditions, loss of productivity, and social issues such as family disruption, crime, and accidents impose a significant burden [2]. In India, alcohol abuse is fast becoming a style statement as a result of which youths are getting diabetic and diseases due to liver damage can be seen in every ten households.

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2.2 Health risk of excessive alcohol consumption: The adverse effects of alcohol consumption on physical and mental health is known to all. It is one of the main reasons for dysfunctional family structure in today's society. Not only does it affect an individual, it acts as a catalyst to socio-economic implications of alcohol-related health issues. Excessive alcohol consumption affects the central nervous system (CNS), reducing reaction time, coordination, and judgment. Numerous instances of potentially fatal conditions characterized by confusion, vomiting, seizures, slow breathing, and hypothermia are observed due to alcohol poisoning. High blood alcohol concentrations depress CNS functions leading to respiratory failure and compromised vital functions. Chronic alcohol consumption also damages the liver causing liver diseases such as fatty liver, hepatitis, fibrosis, and cirrhosis. Generally, the alcohol-related liver disease (ALD) evolves through these stages, ultimately leading to liver failure and death. While low to moderate alcohol consumption has some protective cardiovascular effects, excessive drinking increases the risk of hypertension, cardiomyopathy, arrhythmias, and stroke. Excessive alcohol consumption also invites several cancers, including those of the mouth, pharynx, larynx, esophagus, liver, breast, and colon [3]. Nevertheless, drinking of alcohol is linked to various mental health issues, such as depression, anxiety, and alcohol use disorder (AUD) [4]. It may also lead to cognitive impairments and dementia.

2.3 Role of enzymes in alcohol metabolism: We get energy from food due to biochemical reactions. These biochemical reactions convert carbohydrate, fat, proteins, etc., in food to smaller molecules and release energy in those processes. Most of the carbohydrates get converted to glucose and fructose in the presence of enzymes, and finally generate ethanol, the alcohol that is part of beer and wine. The enzymes are catalysts that catalyze biochemical reactions for conversion of carbohydrates to ethanol. It may be noted that a catalyst is like a mediator that brings two parties closer to achieve an outcome. Two chemicals that are ordinarily unreactive may react in the presence of a catalyst to give a product. Question automatically arises, why should we be worried if our body itself generates ethanol from food? For this, we will have to understand that the liver is the primary site of most metabolic reactions due to the presence of many enzymes in the liver. The alcohol produced from our food is also generated in the liver. To avoid any damage from alcohol, the liver converts the alcohol to acetaldehyde with the help of an enzyme called alcohol

dehydrogenase (ADH). The acetaldehyde which is also toxic to the liver is converted to less harmful acetic acid by another enzyme called aldehyde dehydrogenase (ALDH). The concentration of ADH and ALDH in the liver is limited which is sufficient to oxidize the alcohol generated from food. Insufficient amount of ADH and ALDH leads to accumulation of toxic alcohol in the liver [5]. Excess alcohol in the liver interrupts the metabolism of fats. Normally, the liver processes fats and synthesizes lipoproteins that transport fat throughout the body [6]. As a result, fat accumulates in the liver due to poor export of fat as lipoprotein. Excess alcohol in the liver also increases the delivery of fatty acids to the liver from adipose tissue due to increase of certain hormones and enzymes that mobilize fat from body stores. Additionally, alcohol in the liver inhibits the oxidation of fatty acids that are broken down to produce energy, resulting in further fat accumulation in the liver. Since excess alcohol potentially generates high levels of acetate which can also inhibit the normal metabolic pathways of fats, contributing further to fat accumulation in the liver. Nonetheless, chronic alcohol consumption can lead to uncontrolled blood sugar levels and fat metabolism, a phenomenon known as insulin resistance. Overall, excess alcohol can paralyze normal metabolic functions of the liver and leads to liver diseases such as fatty liver, liver cell damage, inflammation, fibrosis, and cirrhosis.

2.4 Relationship of alcohol consumption ability to ethnicity: As discussed above, alcohol dehydrogenase (ADH) is the most critical enzyme in the metabolism of alcohol, and its concentration in the liver can significantly influence how different populations process alcohol. Interestingly, variations in the genes encoding ADH enzymes are known to differ across ethnic groups, leading to assorted physiological responses to alcohol consumption and varying risks of

alcohol-related diseases [7-10]. The relationship between ADH genetic polymorphisms and ethnicity dictate the extent of alcohol metabolism in the liver and consequent health outcomes. Among the ADH family of enzymes, one namely ADH1B*2 (rs1229984) shows the fastest conversion of ethanol to acetaldehyde. ADH1B*2 is highly prevalent in East Asian populations (e.g., Chinese, Japanese, Korean). Therefore, people with east asian origin can take more alcohols due to rapid conversion of ethanol to acetaldehyde [11-14]. That may explain the culture of drinking alcohol by the Assamese people of mongolian origin such as Misings, Ahom, Kachari, etc. Interestingly, individuals with these variants often experience "alcohol flush reaction," characterized by facial flushing, nausea, and tachycardia due to elevated acetaldehyde levels. In the hindsight, this unpleasant response can deter excessive drinking leading to lower rates of alcoholism but higher risks of alcohol-related cancers due to prolonged acetaldehyde exposure. On the other hand, caucasian people has higher concentration of another enzyme called ADH1B*1 which converts alcohol to acetaldehyde rather slowly [15]. Higher alcohol tolerance is observed among caucasians that may lead to liver disorders. But the slower production of acetaldehyde may reduce the immediate adverse effects seen in East Asians. African populations exhibit a wide range of ADH polymorphisms, including the ADH1B*3 allele which is associated with moderate enzyme activity. Because of the presence of varying ADH alleles, alcohol consumption among African populations leads to diverse metabolic responses affecting susceptibility to alcohol dependence and related health issues. As the Indian population is the mixture of all the three ethnic groups, the extent of alcohol metabolism varies. Therefore, understanding ethnic variations in ADH polymorphisms can inform targeted public health interventions [16]. Education about the risks of alcohol consumption may be tailored to populations based on their genetic predispositions to adverse effects, promoting healthier drinking habits and reducing alcohol-related morbidity.

3. Conclusion

The adverse effects of alcohol consumption are multifaceted, affecting various organ systems and contributing to numerous health conditions. Proper understanding of the science behind these is crucial for public health policies and interventions aimed at reducing alcohol-related harm. The relationship between the alcohol degrading enzymes, i..e. alcohol dehydrogenases and ethnicity

underscores the importance of genetic factors in alcohol metabolism and its health consequences. Genetic lineage often dictates the extent of ADH variants leading to diverse physiological responses to alcohol, influencing drinking behaviors and susceptibility to alcohol-related diseases. Recognizing these genetic differences is critical for developing effective public health strategies and personalized medical interventions to mitigate the unwarranted risks associated with alcohol consumption. Ironically, huge genetic diversity among the Indian population makes it more difficult to develop targeted public health interventions and personalized medical treatments. Therefore, preventive measures, including education, regulation, and support for individuals with alcohol dependence, are essential to mitigate these adverse effects. Generation of social awareness can be the prime driver to save our livers from alcohol abuse and prevent the malaise of many alcohol borne diseases such as fatty liver, diabetes, liver cirrhosis, and cancer.

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