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The Metabolism of Alcohol: Risk and Protective Factors

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Background

In 2013, it was reported by the National Institutes of Health that 59.4% of college aged students (18-22) drank alcohol in the past month of being asked, as compared to 50.6% of those not in college. They also found that 20% of college students met the criteria for at least one alcohol use disorder (AUDs). Many genes have been linked to an increased risk for AUDs and how individuals process and respond to alcohol. Genes that metabolize alcohol are obvious candidate genes for alcohol-related phenotypes. The purpose of this presentation is to synthesize information about the key genes involved in alcohol metabolism, as documented in the literature.

Gene Pathways

Alcohol metabolism genes affect how individuals process and respond to alcohol.

- ADH1B: *1 risk allele, prevalent in Caucasians and American Indians*¹
- ADH1C: *1 protective allele, prevalent in Asians (especially Eastern) and somewhat in Russians*²
- ALDH2: *protective allele, almost exclusive to African Americans*³

Other important genes:

- CYP2E1: metabolizes ethanol to acetaldehyde and generates ROS⁸
- CAT: pathway= metabolizes ethanol to acetate in non-liver tissues⁸

Results

- Alcohol metabolism genes affect how individuals process and respond to alcohol.
- Main genes: alcohol and aldehyde dehydrogenase
  - ADH1B and ADH1C: first metabolize ethanol (alcohol) into the by-product acetaldehyde
  - ALDH2: acetaldehyde is then metabolized into the waste product acetate
- Many of the adverse effects associated with alcohol consumption are due to the build up of acetaldehyde
  - Some of these effects include facial flushing, nausea, headaches, and other similar alcohol sensitivity symptoms
- Acetaldehyde builds up after alcohol consumption at different rates depending on the type of enzymes they produce
  - super-active alcohol dehydrogenase isoenzyme and slow aldehyde dehydrogenase enzyme- less likely to develop AUDs due to the negative effects from excess acetaldehyde in the body
  - Others are more likely to endorse increased drinking behaviors and AUDs since they don’t experience the same ill effects

Spit for Science: the VCU Student Survey is currently investigating these genes and their association with alcohol consumption and alcohol use disorder symptoms. Due to the diverse nature of the sample, the researchers are able to explore ethnic differences in these alcohol metabolism genes and their effects.

Implications

In general, the more public knowledge about these genes and research findings, the more at-risk populations better understand metabolism, alcoholism, and affected populations better, especially in college students where drinking is highly prevalent.

Methods

The information about each gene was found through a literature search using databases including PubMed, Google Scholar, and cited references from relevant papers. For database searches, the names of the genes were used as well as terms such as AUDs, alcohol metabolism, and alcohol and aldehyde dehydrogenase. The focus of the presentation is relevant to college-aged students, but relies on research done in college and adult populations due to a lack of sufficient college-aged gene-based studies in this area.

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References


Figure 1: example of one adverse affect caused by a build-up of acetaldehyde commonly known as "Asian flush"

Figure 2: example of one adverse affect caused by a build-up of acetaldehyde commonly known as "Asian flush"