ALCOHOL
Alcohol: a drug, not a food

Drugs used by most people:
  #1 caffeine
  #2 alcohol

Alcohol dates back: 2100 BC

Egyptian docs: recommend beers & wine- medical treatment
Not everyone drinks alcohol
NIH survey: 43,000 US adults

<table>
<thead>
<tr>
<th>Percent of U.S. adults with this pattern</th>
<th>Drinking pattern</th>
<th>Risk level</th>
</tr>
</thead>
<tbody>
<tr>
<td>9%</td>
<td>Drink more than both the single-day limits and the weekly limits</td>
<td>Highest risk</td>
</tr>
<tr>
<td>19%</td>
<td>Drink more than either the single-day limits or the weekly limits</td>
<td>Increased risk</td>
</tr>
<tr>
<td>37%</td>
<td>Always drink within low-risk limits</td>
<td>Low risk</td>
</tr>
<tr>
<td>35%</td>
<td>Never drink alcohol</td>
<td></td>
</tr>
</tbody>
</table>
Drink definition: 1 drink =

12 ounces beer
or
5 ounces wine
or
1.5 ounces distilled spirits
Some drinks: 1.3-1.5 X standard drink
What’s in beer, wine, distilled liquor?

- Beverage alcohol = **ethanol**
  - 7 calories/gram
- Additional **calories**: mixers/ingredients
- H₂O
- Sugars: **4 calories/gram**
- Negligible: protein, vitamins, minerals
- “Empty calories”
Beverage Alcohol = Ethanol

**FIGURE F1.1** Ethanol is a small water-soluble molecule. It is the type of alcohol present in all alcoholic beverages. (Andy Washnik)

![Ethanol molecule](image)

Ethanol
<table>
<thead>
<tr>
<th>Drink</th>
<th>Calories</th>
<th>Carbs</th>
<th>Ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gin/tonic</td>
<td>114</td>
<td>10.5</td>
<td>10.7</td>
</tr>
<tr>
<td>Wine</td>
<td>170</td>
<td>20.2</td>
<td>13.2</td>
</tr>
<tr>
<td>Cooler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Beer</strong></td>
<td>146</td>
<td>13.2</td>
<td>12.8</td>
</tr>
<tr>
<td>Light Beer</td>
<td>100</td>
<td>4.6</td>
<td>11.3</td>
</tr>
<tr>
<td>Beer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drink</td>
<td>Calories</td>
<td>Carbs (g)</td>
<td>Ethanol (g)</td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>White</td>
<td>100</td>
<td>1.2</td>
<td>13.7</td>
</tr>
<tr>
<td>Wine</td>
<td>106</td>
<td>2.5</td>
<td>13.7</td>
</tr>
<tr>
<td>Red Wine</td>
<td>96</td>
<td>0</td>
<td>13.9</td>
</tr>
<tr>
<td>Bourbon</td>
<td>96</td>
<td>0</td>
<td>13.9</td>
</tr>
<tr>
<td>Whiskey</td>
<td>96</td>
<td>0</td>
<td>13.9</td>
</tr>
<tr>
<td>Vodka</td>
<td>96</td>
<td>0</td>
<td>13.9</td>
</tr>
</tbody>
</table>
Alcohol absorption: rapid into blood

- Some directly - stomach (1\textsuperscript{st} pass) - few seconds after sips beer
- Most - small intestine
- Empty stomach - faster absorption
- Food - stomach: dilutes alcohol, slows stomach emptying - slower absorption (3X, especially fat)
a. Some alcohol is metabolized in the stomach by the enzyme alcohol dehydrogenase.

b. Some alcohol is absorbed through the stomach. Food in the stomach slows the absorption of alcohol.

c. Most alcohol is absorbed in the small intestine.

d. Most alcohol is metabolized in the liver.

e. Alcohol that is not metabolized will return to the blood and circulate throughout the body, including the brain.
Alcohol: water soluble

• Rapidly distributed - all body compartments
• Affects - every organ in body
• Blood alcohol level (BAL) - good estimate - alcohol in entire body
Blood alcohol reflects:

- **Absorption**
  - Phase (↑ level)

- **Elimination**
  - Phase (↓ level)
Peak Blood Alcohol: \( \sim 1 \text{ hour} \) after ingestion

- Non-alcoholic- liver breaks down alcohol constant rate:
  
  1 drink/1-1.5 hours

- \( > 1 \) drink/hour: liver can’t keep up

- Excess alcohol \( \rightarrow \) blood
Black coffee: doesn’t speed up alcohol breakdown
Moderate drinking: sipping/not gulping
1 drink over 1.5 hours- gives time:
liver metabolize alcohol
Factors affecting: blood alcohol level

#1 Weight: ↑ weight
  ↑ body water - dilutes alcohol in blood
  ↓ BAL
Factors affecting: blood alcohol level

#2 Sex

Men $\uparrow$ body water (dilutes alcohol)

$\uparrow$ stomach enzyme - metabolize alcohol

$\downarrow$ BAL vs. woman same size
Women and Alcohol

- Higher proportion body fat/less H₂O: alcohol more concentrated in blood
- 20-30% less stomach ethanol enzyme
- Intoxication: faster
- Alcohol metabolism: slowest just before menstrual period: ↑ intoxication
1 Alcohol drink man = 1.5 woman
Women and Alcohol

- **Female sex hormones** affect alcohol metabolism
- **Birth control pills**: ↓ rate of elimination of alcohol from body
Factors affecting: blood alcohol level

#3 Food

**Slows** alcohol absorption

↑ Food before drinking

↓ BAL
Factors affecting: blood alcohol level

#4 Drinking rate

Body metabolizes alcohol slowly

↑ # of drinks ↑ BAL
Factors affecting: blood alcohol level

# 5 Type of drink

carbonated mixes (tonic H₂O, club soda)

↑ alcohol absorption

↑ BAL
Blood alcohol level: biological variability

0.10% = 100 milligrams/100 milliliters of blood

AMA - evidence intoxication

All states: DWI: 0.08%

But DWI evident - crashes at 0.05%
Children and alcohol

Child: **2.5 drinks** = **death**

Small body size, **small blood volume**

Children/adolescence drinking:

Brain developing/changing:

permanent ↓ learning & memory
Metabolism of Alcohol

• Some by stomach enzyme: “1st pass metabolism”: protective barrier at low dose; overcome at high dose

• > 90 % liver (enzyme)
Metabolism of Alcohol

- ~5% excreted: urine or eliminated - lungs
- Alcohol - diuretic: kidneys - dehydration
- Lungs predictable levels basis: breathalyzer

A Breathalyzer is used to measure a person's blood alcohol concentration (BAC).
Metabolism of Alcohol

• Blood alcohol > Urine alcohol: **Absorption** phase

• Urine alcohol > Blood alcohol **Elimination** phase
New York: new proposed law: Convicted 1\textsuperscript{st} time drunk drivers

Required: \textbf{Interlock Device} - detects high alcohol in person’s breath: prevents \textbf{ignition} from starting

• 47 states use interlocks
• Inside car cameras sometimes used
• Newer techniques: steering wheel sensors- detect alcohol in skin or inside air of car
Liver - primary enzyme: alcohol metabolism

Alcohol

↓

Acetaldehyde (toxic)

↓

Acetyl CoA

*Disulfiram-drug

*Treatment alcoholic: acetaldehyde ↑ blood: flushing, rapid heart beat, nausea, hyperventilation
With excessive alcohol intake:

- Acetyl CoA
- Krebs cycle \((\text{CO}_2 + \text{H}_2\text{O})\)

**Fatty acid synthesis**

- Liver triglyceride

**Blood triglyceride**

**Lipoproteins**
Liver: major organ detoxification- chemicals

- **Secondary enzyme**- smooth endoplasmic reticulum- liver cells
- Also metabolizes alcohol
- **Active**↑ alcohol consumption
Smooth ER: where drugs are metabolized
Secondary enzyme - alcohol metabolism

↑ Capacity to drink more

“Alcohol tolerance”

“Drink you under the table”

0.1% BAL: no signs of intoxication
Chronic drinker

- High level alcohol intake
- Brain cell membranes: ↑ cholesterol, saturated fat: rigid
- Alcohol ↔ brain cell membranes
- “Brain tolerance”
“Drug tolerance”

- ER room: Docs give anesthetics/sedatives to sober alcoholic: difficult to sedate
- Secondary enzyme: rapid breakdown- sedatives- no effect
Cancer problems

• Environmental **carcinogens**: activated by smooth endoplasmic reticulum enzymes

• Result: liver cancer
Alcohol + drugs: _same time_

- Compete for _same_ smooth endoplasmic reticulum enzymes
- **Prolongs** drug action in body
- Over the counter drugs: antihistamines (allergy) + alcohol: very drowsy (sedative effect)
Large doses- painkillers: acetaminophen (Tylenol) + alcohol = liver damage

You should not drink alcohol while taking antihistamines or medications with acetaminophen.
Alcohol: adverse effects

- Alcohol intoxication → alcohol poisoning → death
- Alcohol and nervous system: 
  
  depressant: slows rate- nerve signals
- Anesthetic effects
- Hour before sleep: disrupts sleep cycle
Hangovers

- Alcohol- diuretic: lose water & electrolytes in urine
- Acid stomach ↑ pancreas/intestine secretions
- Stomach pain/nausea/vomiting
- Drinks: congeners (added or during fermentation): produce hangovers
- Alcohol interference: insulin/glucagon ↓ blood glucose: fatigue, weakness, irritability
More you drink, more parts brain affected

High ethanol: brain stem - controls breathing/heart rate → death
<table>
<thead>
<tr>
<th># Drinks/hr</th>
<th>BAL*</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.05%</td>
<td>Impaired judgment, altered mood, relaxed inhibitions</td>
</tr>
</tbody>
</table>

*150 pound person; variable: food, gender, body weight
<table>
<thead>
<tr>
<th>Drinks/hr</th>
<th>BAL*</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.10</td>
<td>Impaired coordination, delayed reaction time, ↓ peripheral vision</td>
</tr>
<tr>
<td>Drinks/hr</td>
<td>BAL*</td>
<td>Effect</td>
</tr>
<tr>
<td>----------</td>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>6</td>
<td>0.15</td>
<td>Unrestrained behavior, slurred speech, blurred vision, staggered walk</td>
</tr>
<tr>
<td>8</td>
<td>0.20</td>
<td>Double vision, can’t walk</td>
</tr>
</tbody>
</table>
# Drinks/hr | BAL* | Effect
---|---|---
12 | 0.30 | Stupor, confusion, coma
≥ 14 | 0.35-0.60 | unconscious, heart rate, brain breathing centers (respiratory arrest), shock, coma, death
Binge Drinking
Binge Drinking

- 5 or more drinks at one time
- May cause: 50% deaths on college campuses
- Person may lose consciousness before alcohol poisoning & death
- Problem: vomiting- choking to death
Binge Drinking

• Don’t let friends “sleep it off”
• Look for vomiting, cold clammy, bluish skin, irregular breathing
• Blackouts: ethanol still absorbed- continued ↑ BAL
• Get emergency help: ASAP
Binge Drinking Effects

- Hypertension
- Vasospasm
- Hemorrhagic stroke
- Cardiomyopathy
- Arrhythmias ("holiday heart")
- Sudden Death
Samantha Spady: 19 died Sept. 5, 2004

- Sophomore at Colorado State University
- At Frat party
- **BAL**: .436 %
- Drank equivalent: 30-40 beers + shots
- **Alcohol poisoning**
Alcoholism: alcohol addiction

- Genetic predisposition & environment
- ↑ Risk addiction - people start to drink young age
Alcoholism: 4 symptoms

#1 **Craving** - strong urge to drink

#2 **Loss of control** - not being able to stop drinking

#3 **Physical dependence** - withdrawal symptoms when drinking stopped: nausea, sweating, shakiness, anxiety

#4 **Tolerance**: the need to drink great amounts of alcohol → “high”
Alcohol affects all body organs

1. Brain
   Impairs brain functioning and damages brain

2. Esophagus
   Increases risk of cancer of the esophagus

3. Skin
   Causes flushing of skin and heat loss

4. Heart
   Damages heart muscle, resulting in enlargement of the heart and heart failure

5. Stomach
   Irritates stomach lining and increases risk of stomach cancer

6. Liver
   Causes liver cells to fill with fat, eventually resulting in liver cirrhosis and failure

7. Pancreas
   Impairs pancreatic function, can cause inflammation of the pancreas and increases risk of pancreatic cancer

8. Small intestine
   Interferes with nutrient absorption

9. Abdomen
   Increases fat deposits in abdominal region

10. Colon and rectum
    Increases risk of colon and rectal cancer
Adverse health effects: chronic alcohol use

#1 Birth defects: alcohol = teratogen (substance: causes birth defects)

Pregnant woman:
Alcohol $\rightarrow$ placenta $\rightarrow$ fetal blood
Fetal liver immature: Alcohol

Fetal Alcohol Syndrome
Fetal Alcohol Syndrome

- **Malformations**: face, arms, legs, heart, damage to nervous system
- **Mortality** likely
- **Children**: facial abnormalities
Breast feeding and alcohol

Alcohol $\rightarrow$ Mom $\rightarrow$ Breast Milk $\rightarrow$ Baby

Mom’s BAL = Baby’s BAL

↓ Mother’s milk production

Baby sleepy - depressed nervous system

Slow motor development
Adverse health effects: chronic alcohol use

#2 GI Damage: stomach, small intestine lining, pancreatitis

#3 Liver disease: result of acetaldehyde toxic effects: production of free radicals oxidation lipids/membrane damage
Liver disease: 12,000 deaths/year

- Fatty liver → reversible
- Alcoholic hepatitis (inflammation) → Cirrhosis (scar tissue)
  - irreversible

Death → Cirrhosis (scar tissue)

Liver: unable to filter toxins/wastes
Normal liver

Fatty liver
A fatty liver can occur after just a few days of overconsumption.

Cirrhosis
By the cirrhosis stage, permanent damage is done and scar tissue has developed.
Adverse health effects: chronic alcohol use

#4 Malnutrition: ↓ nutrient absorption/storage vitamin/mineral deficiencies

Poor diet: alcohol replaces nutrient-dense food
Adverse health effects: chronic alcohol use

#5 Nervous system: ↓ memory, dementia, nerve damage

#6 Cardiovascular system: hypertension, arrhythmias, stroke

#7 Blood: anemia, infections

#8 ↓ Immune system function

↑ risk infection, pneumonia, tuberculosis
Adverse health effects: chronic alcohol use

#9 Cancer ↑ risk: esophagus, mouth, throat, larynx, liver, pancreas, breast, colon
Adverse health effects: chronic alcohol use

#10 Sexual dysfunction

Premature menopause, menstrual irregularities, ↓ sexual responsiveness
#10 Sexual dysfunction

Impotence, sterility, feminization

↓ sperm count, testicular atrophy

↓ testosterone (↓ libido)

testosterone → estrogen

“chemical feminization”

breast enlargement
Adverse health effects: chronic alcohol use

#11 Psychological disturbances
Depression, anxiety, insomnia, ↑ risk- suicide

#12 Body weight
Excess alcohol calories deposited “apple pattern” abdominal fat
#12 Body weight: overweight/obesity

alcohol ▶️ satiety response

People don’t **compensate** for extra alcohol calories by eating less food

Low alcohol intake: 1 drink/day (3-7 days): ↓ BMI

High alcohol, binging  ↑ BMI
Adverse health effects: chronic alcohol use

#13 Mortality: 75,000 deaths/year alcohol related- U.S.

6000 Americans under 21 die/year

Alcohol related: falls, drowning, accidents, homicides, suicides

Alcohol consumption: leading cause death: people under 21
#14 Heavy drinking & the heart

- **Alcoholic cardiomyopathy** - weakened heart muscle
- **Hypertension**
- **Hemorrhage stroke**
- **Arrhythmias: Atrial Fibrillation** (Holiday Heart)
  - Women >2 drinks, men >3 drinks
- **High blood triglycerides/cholesterol**
- **Sudden death**
Who should not drink

People:

- Who can’t limit alcohol intake
- Taking medications affected by alcohol
- Driving cars
- Operating machinery
- With liver disease
Who should **not** drink

- **Children**: permanent learning/memory during brain development
- **Women**: who may become/are pregnant
- **Breastfeeding mothers**
Beneficial effects: moderate alcohol consumption (limits)

- **Women:** 1 drink/day
- **Men:** 2 drinks/day

Light-moderate drinking

- Heart disease, stroke, platelet aggregation, blood clotting
- HDL
- Alzheimer’s risk, cognitive decline-aging
Mortality risk: “J” shaped curve

But: high alcohol ↑ heart disease
Wine consumption: may explain heart disease

Mediterranean Diet

French Paradox
Red wine: beneficial components

1. Alcohol

2. Phytochemicals (antioxidants)

3. Resveratrol (also grape juice, grapes) anti-aging effects
Resveratrol: seeds and skin of grapes
Used to make red wine, little in white wine (but white wine contains heart healthy polyphenols)
Resveratrol

- “Middle-aged” mice fed high fat diet = coconut cream pie every meal + resveratrol
- Grew fat but less likely develop diabetes
- Live as long as mice - standard diet
- Translation: humans to get equivalent resveratrol: 150 lb person: need to drink 750 bottles red wine/day
Normal vs. Cirrhotic Liver