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>
</tr>
</thead>
<tbody>
<tr>
<td>9%</td>
<td>Drink more than both the single-day limits and the weekly limits</td>
</tr>
<tr>
<td>19%</td>
<td>Drink more than either the single-day limits or the weekly limits</td>
</tr>
<tr>
<td>37%</td>
<td>Always drink within low-risk limits</td>
</tr>
<tr>
<td>35%</td>
<td>Never drink alcohol</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)

H-H
H-C-G-OH
H-H

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>
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<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 Wine</td>
<td>100</td>
<td>1.2</td>
<td>13.7</td>
</tr>
<tr>
<td>Red Wine</td>
<td>106</td>
<td>2.5</td>
<td>13.7</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 (1st 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)
Some alcohol is metabolized in the stomach by the enzyme alcohol dehydrogenase.

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

Most alcohol is absorbed in the small intestine.

Most alcohol is metabolized in the liver.

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: \(~1\ hour\ after\ ingestion\)

- 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 - metabolizes alcohol

\(\downarrow\) BAL vs. woman same size
Women and Alcohol

• Higher proportion body fat/less water: alcohol more concentrated in blood

• 20-30% less stomach ethanol enzyme

• Intoxication- faster

• Alcohol metabolism: slowest just before menstrual period: ↑ intoxication
Alcohol drink man = 1.5 woman
<table>
<thead>
<tr>
<th>Male 170 lbs.</th>
<th>Blood Alcohol Concentration (percentage)</th>
<th>Female 137 lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Legal limit</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.06</td>
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<td></td>
<td>.05</td>
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<td>.04</td>
<td></td>
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<td>.03</td>
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<td>.02</td>
<td></td>
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<tr>
<td></td>
<td>.01</td>
<td></td>
</tr>
</tbody>
</table>
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

Get drunk faster on empty stomach

↑ 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

• \( \sim 5\% \) excreted: 
  - urine or eliminated - lungs

• Alcohol - diuretic: kidneys - dehydration

• Lungs 
  - predictable levels 
  - basis: breathalyzer
Metabolism of Alcohol

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

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

Required: **Interlock Device**- detects high alcohol in person’s breath: prevents **ignition** from starting

- 47 states *(MA)* use interlocks
- Inside car cameras sometimes used
- Newer techniques: steering wheel sensors- detect alcohol in skin or inside air of car
Other Alcohol Monitoring Systems
LA Court Ordered **Ankle Bracelet**

**Lindsay Lohan**

- Monitors alcohol in **Perspiration** every 30 min.
- Same method as breathalyzer
- Data → modem → monitoring company
- Queens NY- 94% success rate people wearing bracelets
Liver - primary enzyme: alcohol metabolism

Alcohol

↓

Acetaldehyde (toxic)

↓

*Disulfiram-drug

Acetyl CoA

*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
- Lipoproteins

Blood triglyceride
Liver: major organ *detoxification* - chemicals

- **Secondary enzyme** - smooth endoplasmic reticulum - liver cells
- Also metabolizes alcohol
- **Active**↑ alcohol consumption
Smooth ER: where drugs- 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
Alcohol: adverse effects

- Alcohol intoxication $\rightarrow$ alcohol poisoning $\rightarrow$ 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>
<tr>
<td># Drinks/hr</td>
<td>BAL*</td>
<td>Effect</td>
</tr>
<tr>
<td>------------</td>
<td>--------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>12</td>
<td>0.30</td>
<td>Stupor, confusion, coma</td>
</tr>
<tr>
<td>≥ 14</td>
<td>0.35-0.60</td>
<td>unconscious, heart rate, brain breathing centers (respiratory arrest), shock, coma, death</td>
</tr>
</tbody>
</table>
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
- Sudden Death
Samantha Spady: 19 died Sept. 5, 2004

- Sophomore at Colorado State University
- At Frat party
- **BAL**: 0.436%
- Drank equivalent: 30-40 beers + shots
- **Alcohol poisoning**
Jason Reinhardt

- Frat House
- Minnesota State Univ.
- Celebrated 21st birthday
- Drank 16 shots
- Went back to bed
- ↓ Breathing, Heart Beat Irregular, Comatose, Organs Shut Down

- BAL: 0.361  Died: Alcohol Poisoning
Four Loko

- Combo 12% Alcohol plus Caffeine (1 cup coffee)
- Sweet flavors: watermelon, blue raspberry, lemon/lime
- Problem: binge drinking - feeling alert, keep drinking, alcohol poisoning, emergency room → DEATH
- 2010 FDA bans caffeine in alcoholic drinks
Alcoholism: alcohol addiction

- Genetic predisposition & environment
- ↑ Risk addiction - people start to drink young age
Genetics and Alcohol
2010 University North Carolina
Study people without Alcohol problem but with One alcoholic parent

- Gave 3 drinks - ask to describe effects
- Compare results to chromosome analysis
- People with specific gene on chromosome #10: more sensitive to alcohol’s effect on brain alcohol metabolism
Prefrontal Cortex: abstract thinking, sophisticated cognition

Human vs. chimp brain: human more complex wiring, more space and connections between neurons
Genetics and Alcohol

Frontal Lobes - Brain

- Direct civilized behavior
- Important: goal directed behavior
- Have restraining influence on more emotional, impulsive parts of brain
2010 Harvard Medical Study

- Teens who did **not** start to drink but with family history - alcoholism
- Given word/visualization test
- Measure O2 use: MRI scan
- Found less mature frontal lobe system and neuron response
- ? Related to how they might manage real-life situations (alcohol, drug use)
Drinking Spreads → Social Networks

Dr. Christakis - Harvard

- Examined Framingham Heart Study Data
- **↑ Heavy drinking** if friend or relative also drank **heavily**
- People’s Lives and Health connected through **Social Networks**
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
Hangovers

Blurred vision

Brain damage, addiction, and stroke

Slurred speech

Heart disease, irregular heart beat

Breathing may stop

Liver disease, liver failure

Malnutrition, overnutrition

Infertility (in women), impotence (in men)

Osteoporosis
Adverse health effects: chronic alcohol use

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

Pregnant woman:
Alcohol → placenta → 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
Fetal Alcohol Syndrome

• Emotional, behavioral, social, learning problems, low IQ
• Leading cause: mental retardation/birth defects
• 6,000 babies born/year
• Bottom line: pregnancy- no safe alcohol intake level
Breast feeding and alcohol

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

Mom’s BAL = Baby’s BAL

$\downarrow$ 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
#3 Liver disease: 12,000 deaths/year

Fatty liver → Alcoholic hepatitis (inflammation)
reversible

Death ← Cirrhosis
scar tissue
irreversible

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

- Seattle Study 2010: women who have 1 drink/day

- ↑ Risk Hormone (estrogen/progesterone) Positive Breast Cancer
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
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 of 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
- **Breast feeding 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