GAGNAM STYLE:
ALCOHOL AND THE CARDIOVASCULAR SYSTEM
(COMPARING US AND SOUTH KOREA)

By
JEEEUN OH

A Thesis Submitted to The Honors College
In Partial Fulfillment of the Bachelors degree
With Honors in
Physiology

THE UNIVERSITY OF ARIZONA
MAY 2015

Approved by:
Dr. Zoe Cohen
Department of Physiology
# Table of Contents

Abstract .................................................................................................................. 3

Introduction to the Cardiovascular System ............................................................. 4
- Heart .................................................................................................................... 6
- Blood Vessels ....................................................................................................... 8
- Blood .................................................................................................................. 10
- Red Blood Cell ................................................................................................... 11

History of Alcohol ................................................................................................ 12

Cultural Differences between America and Korea ................................................. 24

Alcohol and the Cardiovascular System ............................................................... 40

Conclusion ........................................................................................................... 47

List of Figures ...................................................................................................... 49

References .......................................................................................................... 52

Appendix ............................................................................................................. 58
Abstract

The relationship between alcohol and the cardiovascular system (CVS) can have serious effects on the whole system. Excessive consumption causes damage while moderate consumption (1 drink/day for women; 2 drinks/day for men) can be protective. Moderate alcohol intake has been proven to show health benefits by increasing levels of high-density lipoprotein cholesterol and preventing clot formation which reduces the risk of coronary heart disease, stroke, and diabetes. However, excessive alcohol intake can lead to development of chronic diseases. By comparing alcohol consumption between the US and South Korea, it was discovered that factors such as location, culture, as well as, occupation, play a role in both the type and amount of alcohol consumed. In both nations, alcohol consumption has been increasing each year. A study showed that 16,749 deaths were due to alcoholic liver disease in 2011 in the United States. In Korea, the percentage of cases of chronic liver diseases as incidences of acute pancreatitis have increased. Lastly, although many studies show the affect of alcohol on arteries and arterioles, not much work has been done on capillaries and veins.
Introduction to Cardiovascular System

The human cardiovascular system (CVS) is an organ system that is comprised of the heart, blood vessels, and blood. One of the key functions of the CVS is to carry oxygenated blood and nutrients, such as amino acids and hormones, to all tissues in the body, while removing carbon dioxide and waste products. “Every organ and organ system in the body is nourished and kept alive through the use of the circulatory system” (Dunbar 4).

Figure 1. A double circuit of the heart supplying the organ system with blood

The heart is a dual pump with the left heart and the right heart functioning as separate pumps that keeps blood moving through the body (Cohen). The right heart pumps deoxygenated
blood from the systemic circulation to the lungs while the left side pumps oxygenated blood from the pulmonary circulation to the rest of the body as shown in figure 1. In the systemic circulation, blood leaves the left ventricle to the aorta after which it separates into smaller vessels. Major arteries originating from the aortic arch supply oxygenated blood to other tissues in the body. The blood moves through the arterioles, capillaries and then finally through the veins to the inferior and superior vena cava where deoxygenated blood re-enters the heart at the right atrium. In the pulmonary circulation, the deoxygenated blood leaves the right ventricle through the pulmonary artery. The pulmonary arteries carry blood to the lungs where there is an exchange between oxygen and carbon dioxide. The oxygenated blood passes through the capillaries then through the pulmonary vein back to the left atrium of the heart.
Heart:

The heart is a hollow muscular organ with an apex and a base and is about the size of a fist. The apex of the heart is lowest superficial part that is responsible for ventricular contraction as shown in figure 2. The base is a flat top where the great vessels enter and leave the heart. The heart is divided into four chambers: upper right and left atria and lower right and left ventricles. Four unidirectional valves separate the atria from the ventricles and the ventricles from the major arteries. The atrioventricular (AV) valves are found between the atria and the ventricles and are known as tricuspid valve on the right and bicuspid, or mitral valve on the left. The semilunar
valves which include pulmonary and aortic valves prevent backflow of blood into the ventricles. The pulmonary valve is positioned between the right ventricle and the pulmonary artery and the aortic valve is between the left ventricle and the aorta. The heart is located within the mediastinum, the thoracic cavity medial to the lungs and posterior to the sternum.

Figure 3. Layers of the heart

It is enclosed within a double membranous sac called the pericardium. The pericardium has a superficial fibrous pericardium and the inner serous pericardium. The fluid containing pericardial space between the parietal and the visceral pericardia (epicardium) allows the heart to contract and relax without any friction and the pericardial sac protects and anchors the heart. The thickest layer of the heart wall is the myocardium which is composed of cardiac muscle cells. The contraction of the myocardium allows the circulation of blood through the heart and into the major arteries. The most inner layer called the endocardium consists of endothelial tissue and connective tissue. This smooth layer is responsible for keeping blood from sticking to the inside of the heart and is continues along the inner lining of blood vessels.
Blood Vessels:

There are four main types of blood vessels: arteries, arterioles, capillaries, and veins. Arteries are thick walled vessels that carry blood away from the heart. Because of their elasticity and the ability to be compliant, they act as a pressure reservoir moving the blood at high pressures. The thick elastic middle layer in the arteries (tunica media) in figure 4 allows the vessel to withstand the high pressure by stretching and accommodating to the pressure to the heart. During ventricular systole (contraction), arteries distend with blood as the elastic layer in their walls stretch. During cardiac diastole (relaxation), the walls are able to rebound right back pushing blood along. Arterial pressure is the driving force for blood flow to all the organ systems (Cohen). Major arteries, including the aorta, divide into arterioles which carry respiratory gases, nutrients, wastes within the blood to other parts of the body. Arterioles have a large amount of smooth muscle allowing them to serve as the major determinant of blood pressure and blood flow to the individual organs. In figure 5, the comparison of the diameter between arteries and arterioles is illustrated. This smaller diameter increases the resistance significantly to the blood flow creating a pressure gradient in the circulatory system. Then the arterioles branch into thin-walled capillaries where exchange of fluids, gasses, nutrients and wastes between the blood and tissues take place. Due to the large surface area, capillaries have a low resistance as a class of vessels. The deoxygenated blood flows in to the veins after giving its oxygen and nutrients to tissue cells. Veins are highly distensible and are storage vessels holding 60% of the entire blood volume at rest. Due to their large radii compared to arteries in figure 5, there is a decrease in resistance to flow at low pressures—one tenth of that in the arteries. Unidirectional valves in the veins allow the blood to flow back to the heart increasing blood volume returning to the heart. When venular valves open, the blood flows against gravity back up to the heart. The increase in
blood pressure in the vein causes the upstream valve (furthest from the heart) to close and the downstream valve (closest to the heart) to open allowing a unidirectional flow. Since large veins lie within skeletal muscles, when the muscles contract, they compress the veins forcing blood back to the heart ("Function: The Blood Circulation").

Figure 4. Cross-section of vessels showing different layers
Blood:

Blood is a bodily fluid that transports necessary nutrients and oxygen to the tissue cells and removes carbon dioxide and waste products from those same cells to the lungs. “The heart keeps approximately ten pints (4.73 liters) of blood constantly circulating through seventy-five-thousand miles of blood vessels” (Dunbar 2). Blood is made up of acellular and cellular components. Acellular components of blood are made up of plasma and plasma proteins and cellular components of blood are red blood cells (RBCs), white blood cells (WBCs), and platelets. Plasma is comprised of many organic (plasma proteins) as well as inorganic substances (carbon dioxide, bicarbonate). Albumin, the most abundant plasma protein, contributes to colloidal osmotic pressure establishing an osmotic gradient between the blood and interstitial fluid.
Red Blood Cell:

Because of its flat, disc shape with an indent in the middle, it allows the red blood cell to have a larger surface area and to be flexible to fit through smaller vessels as shown in figure 6. Each erythrocyte contains about 250 million hemoglobin molecules, an iron containing protein with four heme groups. Hemoglobin facilitates transportation of oxygen by carrying four oxygen molecules. Because the spectrum of light absorbed by hemoglobin differs between the oxygenated and deoxygenated states, the blood exhibits different colors due to its association with oxygen binding. When oxygen binds to hemoglobin, the color of the blood transmits as bright red. Deoxygenated blood is a darker shade of red in the veins. Each milliliter of blood contains about five billion erythrocytes (Cohen). In the whole body, there are approximately 25-30 trillion erythrocytes. Blood is constantly recycled through the system. Since erythrocytes only have a life span of 120 days; two to three million red blood cells die every second and must be
created at the same rate. Blood also has immunological function and detects foreign materials by antibodies with the help of white blood cells, or leukocytes. Platelets, on the other hand, are produced from megakaryocytes in the bone marrow and aid in clotting of blood. Without the coagulation process, hemorrhage can occur which can lead to death.

History of Alcohol

Alcohol, produced by fermentation of yeast, sugars, and starches, is a neurological depressant containing ethanol which is the intoxicating ingredient in beer, wine, and liquor (“Alcohol Use”). Nowadays, many people around the globe drink alcohol as a means of social interaction, but alcohol had many other purposes of usage when it was first discovered. It is believed that alcohol production started as early as the Neolithic period (circa 10,000 B.C.) with the discovery of late Stone Age beer jugs and studies suggest that beer was seen as a staple rather than bread (Hanson “World”). Alcohol consumption is common in many cultures; however, many beverages display cultural characteristics. Its use is diverse; it can be used for medicinal purposes, religious practices, a social lubricant, and it plays a pivotal role in enhancing enjoyment and quality of life. Alcohol has displayed many benefits throughout history but it has also shown signs of misuse leading to alcoholism.

The first use of alcohol is not known but it is likely that fermentation in fallen fruit was noticed by early farmers (“Alcohol History”). While berries and honey were used to make the earliest alcoholic beverages, wild grapes were used in winemaking in the regions of the Middle East. It was discovered that alcoholic beverages were made from grape and hawthorn fruits, honey mead and rice beer as far back as 7000-5600 B.C, according to a chemical analysis of the fermented drinks. Grapevines were cultivated between the Black Sea and the Caspian Sea
located near Turkey and Armenia and the success of wine making activity spread throughout Asia. The world’s oldest winery was located in a cave in Armenia dating to about 4100 B.C. (Owen).

In the early civilization of Egypt, the Egyptians honored and worshiped Osiris, the god of wine, and believed that he also invented beer (Hanson “World”). Because beer was considered one of the necessities of life, brewing became a lifestyle in the homes of many. The ancient Egyptians produced at least 17 variations of beer and 24 styles of wine which held both sacred values and were offered to gods. Around 3000 B.C., overflowing production of wine in Egypt provided great economic wealth, becoming an important part of Mediterranean commerce ("History of Alcohol Use"). The alcoholic beverages in ancient Egypt were used for nutrition, medicine, pleasure, salary, and burials. Even though the Egyptians did not believe that habitual drunkenness was a problem, they stressed the importance of moderation in regards to secular and religious norms. Alcohol was an important part of their culture and their way to socialize but it was generally kept in moderation.

Mead was the first alcoholic beverage to acquire extensive popularity in Greece. It was a fermented drink made from honey and water, and appeared between 2900-2000 B.C. (“A Brief History of Alcohol- Drug-Free World”). Despite its adoration from Greeks, the availability of the beverage was limited due to a low supply of honey. In Greece, they were mostly temperate drinkers despite having multiple banquets and festivals with alcohol. They diluted wine with water to avoid excess intake of alcohol and praised temperance with an exception of few cults and ethnic groups in Greece (Hanson “World”). Generally, inebriety was viewed as a threat to spiritual salvation and societal well being. Winemaking became common by 1700 B.C. and was
served for the same purpose as found in other countries: religious rituals, medicinal purposes, and at daily meals.

Drinking wine was prevalent in the early Christian period and has been recorded in the New Testament. It is written in the Bible that Jesus drank wine with his disciples but he harshly condemned alcohol abuse for wine was a symbol of God’s blessing. Cir. 1200 B.C., the Hebrews were introduced to wine during their imprisonment in Egypt (Hanson “Timeline”). After their freedom from Egypt and exile in Babylon, the Hebrews found Judaism and incorporated wine into their culture. It became a common beverage for a wide range of ages and social classes and thus became a necessary commodity for the Hebrews. The spread of Christianity in Western Europe gradually influenced drinking attitudes and behaviors. In the New Testament, references to alcohol pointing out the importance of moderate consumption and its use for medicinal purposes changed the behaviors. However, the clash between traditional Jewish culture and the new teachings of Christianity concerning the use of wine enforced new Talmudic rules (Hanson “World”). The rules limited the amount of wine intake on the Sabbath, the way to drink wine, and the responsibility of an intoxicated person. Purim is a Jewish holiday which celebrates the deliverance of the Jewish people in ancient Persia where a plot had been devised to destroy them. The Talmud states that “one is to drink to the point of not knowing the difference between ‘cursed is Haman’ and “blessed is Mordechai’” in reference to Purim which resulted in an unpleasant incident between two Jewish Rabbis (Spitzer). Before this incident, where one of the intoxicated rabbi murdered the other, some scholars underestimated the serious problems of drunkenness and reflected a lighthearted attitude towards it. The Talmudic rules state that if a person prays in a state of drunkenness, his prayer is an abomination (“Drunkenness”). A person
under the influence of alcohol is legally responsible for his actions unless the person has a
reached a state of unconsciousness.

Around 1500 B.C. during the Middle Ages, mead, rustic beers—showing farmy, earthy,
leathery notes, and wild fruit wines were favored among Celts, Anglo-Saxons, Germans, and
Scandinavians (Hanson “Timeline”). With rustic beers continually being brewed in homes,
monks mastered the art of brewing and guarded their knowledge necessary to enhance their skills.
Starting from the thirteenth century, hops, female flowers of the hop plant, were used commonly
in northern Europe to produce flavor and to preserve beers ("History of Alcohol Use"). After the
discovery of distillation of grain alcohol, Europe also maintained viticulture. Throughout the
Middle Ages, the best vinyards were kept at monasteries and were tended to by monks to
produce large amounts for their celebration of the mass. One of the most important discoveries
was the process of distillation, first described by Albertus Magnus (Hanson “World”). This
allowed monks, physicians, and alchemists to manufacture distilled spirits as a cure for diseases.
During the Middle Ages, it was called aqua vitae, meaning “water for life,” but it was later
termed as brandy. Flavored distilled spirits with juniper berries were originally known as jenever,
which the English modified to geneva and then to gin. The Black Death (mid-14th century) left
people in panic and with no understanding of the plague and thus they relied on alcohol. Alcohol
made the victims of the plague feel more robust compared to any other medicine to alleviate pain.
Some believed that increased consumption of alcohol would protect them from the plague virus.
In Bavaria, Germany, beer consumption increased to about 300 liters per capital per year and
wine consumption in Florence, Italy was about ten barrels per year during the Black Death
(Hanson “World”). Around the early 1500’s, excessive use of distilled spirits spread to England,
France and Scotland. Rather than consuming distilled spirits as a medication, it became a regular beverage by the end of the Middle Ages.

In the 16th century, the consumption of alcohol continued to increase and it reached 100 liters per person a year in Spain and a gallon of beer in Denmark (Hanson “Timeline”). Alcohol production peaked in the colonial world with the beginning of European expansion. In 1516, the German Beer Purity Law, “Rheinheitsgebot,” was passed which made it illegal to produce beer from anything other than hops, barley, yeast, and water and it was in Germany where beer was first sold in a glass bottle (“History of Alcohol Use”). Soon after, sparkling wine was produced due to an accidental occurrence when wine from the Champagne, region of France, was stored over winter, undergoing a secondary fermentation. Even in the 17th century, colonists continued with the traditional beliefs of benefits of moderate alcohol consumptions but the successful production of gin increased alcohol intake drastically in the 18th century. The European government encouraged the use of grains for gin production allowing the emergence of Gin Epidemic (Hanson “World”). Because of the rise of cheap spirits in markets, people of London sought out comfort from harsh realities of urban life. After its dramatic peak in consumption, the Parliament tried to discourage drinking of gin by lowering the prices of high quality beers, banning distillation for a limited time, and increasing coffee and tea consumption with criticism of drunkenness. By the 19th century, there was a change in attitudes as a result of increase in industrialization and the need for professionalism in the work force. Drunkenness was viewed as a threat to industrial growth and efficiency.

Alcoholic beverages have been consumed in the United States since the days of Christopher Columbus when he brought sherry on his voyage to the New World (Hanson “Alcohol”). The Puritans loaded more beer and wine more than water on the ships carrying
settlers to the New World. In colonial times, there were a limited amount of supply of water and milk available and were prone to contamination or spoilage, and tea and coffee were expensive. Due to the scarce amount of beverages, the Pilgrims turned to cider and beer, and less frequently, whiskey, rum, and gin. The early colonialists learned to make alcohol from ingredients such as carrots, tomatoes, onions, beets, celery, and dandelions. Ironically, at the first Thanksgiving, instead of eating cranberry sauce, mashed potatoes, or pumpkin pie, the Pilgrims consumed beer, brandy, gin, and wine (Hanson “Alcohol”).

Alcohol was viewed positively and alcohol moderation was practiced due to strong community social restrictions. The colonialists believed that alcohol had the ability to cure the sick, enliven the aged, and strengthen the weak. Rum-soaked cherries helped with cold, hot brandy punch was consumed for cholera, and whiskey for colic and laryngitis (Crews). Furthermore, pregnant women and women in labor received a dose of alcohol to ease their discomfort. Often, social events such as christenings, weddings, funerals, and Election Day involved alcohol where the candidates would tempt the voters with free drinks (Crews). Workers drank at work and out in the fields, and similar to today, college students, then, enjoyed malted beverages. Due to the popularity of alcohol among students, one of the Harvard’s first construction projects was a brewery for a steady supply of beer to be served in the student dining halls (Ammerman 32). Although the majority of the colonists drank regularly, the community emphasized the necessity to restore harmony and stability within the community which curbed any tendency toward immoderation. Increase Mather, a Puritan minister in the early history of Massachusetts Bay Colony, praised alcohol saying, “Drink is in itself a creature of God, and to be received with thankfulness”. With this belief, even toddlers enjoyed drinking beer, wine, and cider with their parents and regular alcohol use was thought to have health benefits (32).
However, the abuse was alcohol was viewed harshly and condemned with a clear consensus that although alcohol was a gift from God, its abuse was from the Devil. Excess alcohol consumption was blamed as a sin of gluttony and a lack of will.

The Founding Fathers, like students and workers, took pleasure in drinking. Every signer of the American Declaration of Independence drank alcoholic beverages and some were involved in alcohol businesses. In fact, the first draft of the Declaration of Independence was written in a tavern in Philadelphia by Thomas Jefferson. John Hancock, the first signer of the document, was accused of smuggling wine. John Adams, the second president of the United States, begin his days with hard cider to soothe his stomach ("History of Hard Cider"). Because of their praise of alcohol, they created dozens of words to describe drunkenness including Benjamin Franklin who collected 200 such terms: buzzey, busky, cracked, cherubimical, and "halfway to Concord" (Crews). The national anthem of the United States, "The Star-Spangled Banner," was set to the tune of a popular British drinking song written by John Stafford Smith. The first Europeans thought that the New World would provide an ideal location to start viticulture; however, European grapevines were not able to withstand American pests and diseases. Jefferson, a passionate wine advocate and connoisseur, took interest in wines during his diplomatic service in France during the 1780s. This started his collection of wine and purchased over 20,000 bottles of European imports as President (Crews).
With time, distilled spirits gained popularity and became widely available. The requirement of skill component, costly equipment, and the use of raw materials, such as grapes, apples, blackberries, and cherries, was necessary to produce distilled spirits. As a result of the high concentration of alcohol, they were aged longer than cider and beer and were thus more potent. This made better economic sense for the producers since the intoxicant per ounce was higher and took less space than beer or cider, allowing for easier transportation. Due to these attributes, rum gained huge success in America before the Revolutionary War. Rum, made from molasses, produced about 4.8 million gallons annually by 1770 (Crews). Whiskey, on the other hand, gained popularity during and after the Revolution. It was only available to farmers who had surplus grain but that began to change when molasses imports became expensive and irregular which made Americans to turn away from rum and towards domestic whiskey. Bourbon
whiskey was an all-American drink made by American grain and is the official spirit of the United States, by act of Congress (Hanson “Alcohol”). In 1793, the Whiskey Rebellion occurred when Congress imposed an excise tax on farmers who produced liquors. This protest began with a sense of outrage with tax placed on a product, for most part, for their own consumption (“An Alcohol History Timeline”). In 1790, the government presented annual per capita numbers of alcohol consumption for everyone over the age of fifteen. It showed that 34 gallons of beer and cider, 5 gallons of spirits, and one gallon of wine were consumed. In the 1830’s, the Americans drank an average of nine and a half gallon of distilled spirits, half a gallon of wine and 27 gallons of beer with average consumption of 7.1, about 3 times the current consumption as shown in figure 8 (Hanson “Alcohol”).

### Apparent Mean Consumption of Absolute Alcohol in U.S. Gallons per Capita of the Drinking-Age Population

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Consumption</th>
<th>Year</th>
<th>Mean Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1710</td>
<td>5.1</td>
<td>1890</td>
<td>2.1</td>
</tr>
<tr>
<td>1770</td>
<td>6.6</td>
<td>1885</td>
<td>2.1</td>
</tr>
<tr>
<td>1785</td>
<td>6.1</td>
<td>1900</td>
<td>2.1</td>
</tr>
<tr>
<td>1790</td>
<td>5.8</td>
<td>1905</td>
<td>2.3</td>
</tr>
<tr>
<td>1795</td>
<td>6.2</td>
<td>1910</td>
<td>2.6</td>
</tr>
<tr>
<td>1800</td>
<td>6.6</td>
<td>1915</td>
<td>2.4</td>
</tr>
<tr>
<td>1805</td>
<td>6.8</td>
<td>1920</td>
<td>0.9</td>
</tr>
<tr>
<td>1810</td>
<td>7.1</td>
<td>1925</td>
<td>0.9</td>
</tr>
<tr>
<td>1815</td>
<td>6.8</td>
<td>1930</td>
<td>0.9</td>
</tr>
<tr>
<td>1820</td>
<td>6.8</td>
<td>1935</td>
<td>1.5</td>
</tr>
<tr>
<td>1825</td>
<td>7.0</td>
<td>1940</td>
<td>1.6</td>
</tr>
<tr>
<td>1830</td>
<td>7.1</td>
<td>1945</td>
<td>2.0</td>
</tr>
<tr>
<td>1835</td>
<td>5.0</td>
<td>1950</td>
<td>2.0</td>
</tr>
<tr>
<td>1840</td>
<td>3.1</td>
<td>1955</td>
<td>1.9</td>
</tr>
<tr>
<td>1845</td>
<td>1.8</td>
<td>1960</td>
<td>2.0</td>
</tr>
<tr>
<td>1850</td>
<td>1.8</td>
<td>1965</td>
<td>2.2</td>
</tr>
<tr>
<td>1855</td>
<td>2.0</td>
<td>1970</td>
<td>2.5</td>
</tr>
<tr>
<td>1860</td>
<td>2.1</td>
<td>1975</td>
<td>2.7</td>
</tr>
<tr>
<td>1865</td>
<td>2.0</td>
<td>1980</td>
<td>2.8</td>
</tr>
<tr>
<td>1870</td>
<td>1.9</td>
<td>1985</td>
<td>2.6</td>
</tr>
<tr>
<td>1875</td>
<td>1.8</td>
<td>1990</td>
<td>2.5</td>
</tr>
<tr>
<td>1880</td>
<td>1.9</td>
<td>1992</td>
<td>2.4</td>
</tr>
<tr>
<td>1885</td>
<td>2.0</td>
<td>2000</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Adapted from Williams, Clem, and Dufour, 1994; Rorabaugh, 1979.

Figure 8. Mean Consumption of Alcohol per Capita
After the American Revolution, drinking was on the rise due to the low cost of whiskey and its easy accessibility (Theobald). Also, around this time, a wave of religious revivalism swept across the country increasing demand for temperance. As a result, a number of groups were organized as a part of a new Temperance movement in attempt to prevent intoxication of a person. The Temperance movement blamed alcohol for society misfortunes, especially murder and crime. Saloons, a social haven for drinkers, were viewed poorly by many, especially women, as a place of corruption and debauchery. Benjamin Rush, a Philadelphia physician and signer of the Declaration of Independence, believed more in moderation than prohibition. He argued in his treatise, “The Inquiry into the Effects of Ardent Spirits upon the Human Body and Mind” (1784), that excessive alcohol was harmful to physical and psychological health addressing drunkenness as a disease (Crews). In 1838, Massachusetts passed a temperance law banning the sale of distilled spirits in less than 15 gallon quantities which set foot in proceeding of the legislation of prohibition. Even though the prohibition law was repealed in 1856, Maine was the first state to pass the law prohibiting the sale of all alcoholic beverages except for medicinal or manufacturing purposes in 1846 (“Prohibition” PBS). Soon after, twelve other states joined Maine by 1855, together called the “dry” states.
Figure 9. Illustration for Hawaiian Gazette newspaper illustrating ASL and WCTU campaign against sellers of beer

The Woman’s Christian Temperance Union (WCTU), founded in 1873, advocated prohibition of alcohol to prevent abuse from alcoholic husbands, to improve public education, and to secure women’s rights (“Roots of Prohibition”). They started taking direct action against saloons and the liquor traffic with prayer vigils, petition campaigns, and hymn singing. However, it wasn’t until the emergence of a new organization, the Anti-Saloon League, for WCTU’s ultimate objective, a prohibition amendment to the constitution, to enter the realm of possibilities. The Anti-Saloon League (ASL), founded in 1893, became the most successful national organization by forming alliances with any organizations that had the same foundation: a desire for a constitutional amendment that would ban the manufacture, sale, and transportation of alcohol (“Roots of Prohibition”). They had branches that worked with churches to mobilize the prohibition fight and also united with Democrats and Republicans, the Ku Klux Klan, as well as
influential industrialists including Henry Ford, John D. Rockefeller, and Andrew Carnegie. As the strong anti-German fervor started to rise, ASL propaganda effectively connected beer with Germans to taint the public mind shown in figure 10. Mobilization provided ASL with a boost to persuade Americans to support prohibition capitalizing on the patriotic emotions surrounding the war effort “Anti-Saloon League”). In 1917, the 18th amendment, which prohibited the sale and manufacture of alcohol, was added to the Constitution of the United States due to immense power and support of ASL. The Prohibitionists rejoiced and hoped America would stay permanently dry but soon later, the Americans were about to discover that enforcing the law would be a more difficult task.

Figure 10. WWI Poster "Will You Back Me or Back Booze"

In the early Prohibition time, there were signs of success including a 30 percent drop in alcohol consumption and a decline in drunkenness arrests ("Prohibition” History). However, its effect lasted only a short while and those who could not stop drinking found more inventive ways to drink. “Bootlegging”, the illegal manufacturing and sale of liquor, as well as “speakeasies,” stores or nightclubs selling alcohol, and “moonshine,” informal production of liquor in private homes, went on for a decade. These led to massive production of unregulated and untaxed alcohol, increased violence, and political corruption (Ammerman 38).
criminal activity was associated with bootlegging in the Prohibition era. Many alcohol stills used lead coils giving off acetate of lead, a dangerous poison. Some bootleg alcohol included iodine, or embalming fluid, and regarding a more serious problem, highly toxic wood alcohols like methanol was found in the liquor. The outcome of consuming bootleg liquor in large quantities was paralysis, blindness, and death. In 1927, almost twelve thousand deaths were due to alcohol poisonings (39). Prohibition drinkers consumed large amount of distilled spirits secretly. People, simply, walked over to speakeasies, and paid “high prices for very poor quality alcohol” to get drunk (39). Removing alcohol from the norms of every society increased drinking problems making Prohibition counterproductive. As these problems continued on, the society strongly turned against Prohibition. Franklin D. Roosevelt ran for president in 1932 pledging to end Prohibition and easily gained majority of the votes against President Herbert Hoover. In February 1933, the Congress adopted the 21st amendment to the Constitution to repeal the 18th (“Prohibition” History).

Cultural differences between America and Korea

There are many misperceptions about alcohol in America. Many people believe “alcohol is an integral part of American life” and “most Americans enjoy drinking on a regular basis.” These widely held perceptions, partly due to alcohol advertising and pop culture, have affected the attitudes of many toward alcohol and policies regarding sales and consumption by adults as well as youth. In fact, alcohol consumption has decreased over time from 2.75 gallons per person in 1980 to 2.31 in 2007, reported by the National Institute on Alcohol Abuse and Alcoholism (Hanson “Alcoholic Beverage”).
In the United States, a beverage is considered alcoholic if it contains 0.6 ounces of pure alcohol. On average, the percentage of pure alcohol in the following beverages are:

- 12-ounces of beer (5% alcohol content).
- 8-ounces of malt liquor (7% alcohol content).
- 5-ounces of wine (12% alcohol content).
- 1.5-ounces of distilled spirits or liquor such as gin, rum, vodka, whiskey (40% alcohol content) ("Fact Sheets").

Some factors that contribute to alcohol consumption are gender, age, location, and social status. Abstention in the U.S. is inversely related with social status and proportional to education. There was high abstention in lower social class, while the amount of consumption rose with higher education (Hanson Alcoholic Beverage”).

A study was conducted by Gallup Consumption Habits from July 2002- July 2004, with 3,013 U.S. national subjects, aged 18 and older, to describe the amount of drinking as well as to provide insight into which Americans drink (Blizzard). According to the collected data, 63% of Americans disclosed that they drink alcoholic beverages such as beer, wine, or hard liquor, while 37% abstain. From figure 11, it can be observed that men are more likely to drink than women and those under the age of 50 are more likely than adults over 50 years.

Drinking habits held constant between the years 2011-2012 ranging in the mid 60% with an average of just over 4 drinks per week as shown in figure 12 (Saad). With no surprise, beer was preferred amongst 39% of Americans followed by wine (35%) then liquor with only 22%. In 2010, capita beverage consumption in U.S. was reported by Beverage Marketing Corporation. Carbonated soft drinks were the most consumed beverage in the U.S with 45 gallons per person in 2005, and beer came in third as the most consumed alcoholic beverage. Average Americans
drank 21 gallons of beer in 2010 and wine and liquor at 2.3 and 1.5 gallons, respectively (Zmuda). However, the study reported that a slight majority of males, 55%, most often drank beer, followed by liquor and wine. Compared to males, female drinkers showed a strong preference for wine, with 52%, compared to beer and liquor. Additionally, the preference of the type of alcohol also depended on the geographical location. Drinkers on the East Coast showed higher preference for wine, while those in the Midwest chose beer their as preferred alcoholic beverage (presented in figure 13).

![Figure 11. Alcohol Consumption based on gender and age](image)

Figure 11. Alcohol Consumption based on gender and age
**Gallup Alcohol Consumption Measures – Recent Trend**

<table>
<thead>
<tr>
<th>Have occasion to drink alcohol</th>
<th>Jul 7-10, 2011</th>
<th>Jul 9-12, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>64%</td>
<td>66%</td>
</tr>
<tr>
<td>No</td>
<td>32%</td>
<td>34%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of alcoholic beverages consumed in past seven days</th>
<th>Jul 7-10, 2011</th>
<th>Jul 9-12, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 or more</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>1 to 7</td>
<td>54%</td>
<td>52%</td>
</tr>
<tr>
<td>Zero</td>
<td>33%</td>
<td>34%</td>
</tr>
<tr>
<td>Average number</td>
<td>4.1 drinks</td>
<td>4.2 drinks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alcoholic beverage drunk most often*</th>
<th>Jul 7-10, 2011</th>
<th>Jul 9-12, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beer</td>
<td>36%</td>
<td>39%</td>
</tr>
<tr>
<td>Wine</td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td>Liquor</td>
<td>23%</td>
<td>22%</td>
</tr>
</tbody>
</table>

* Number of drinks consumed and alcoholic beverage drunk most often are based on drinkers

GALLUP

**Figure 12. Measure of Alcohol Consumption during July 2011- July 2012**

**Alcoholic Beverage Consumed Most Often by U.S. Adult Drinkers**

By gender, age, and region

<table>
<thead>
<tr>
<th></th>
<th>Beer</th>
<th>Wine</th>
<th>Liquor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>55%</td>
<td>20%</td>
<td>21%</td>
</tr>
<tr>
<td>Women</td>
<td>23%</td>
<td>52%</td>
<td>22%</td>
</tr>
<tr>
<td>18 to 24 years</td>
<td>45%</td>
<td>30%</td>
<td>22%</td>
</tr>
<tr>
<td>25 to 64 years</td>
<td>45%</td>
<td>31%</td>
<td>21%</td>
</tr>
<tr>
<td>65 and older</td>
<td>28%</td>
<td>45%</td>
<td>22%</td>
</tr>
<tr>
<td>Men 18 to 49</td>
<td>62%</td>
<td>15%</td>
<td>21%</td>
</tr>
<tr>
<td>Men 50+</td>
<td>43%</td>
<td>28%</td>
<td>20%</td>
</tr>
<tr>
<td>Women 18 to 49</td>
<td>27%</td>
<td>45%</td>
<td>23%</td>
</tr>
<tr>
<td>Women 50+</td>
<td>17%</td>
<td>59%</td>
<td>21%</td>
</tr>
<tr>
<td>East</td>
<td>37%</td>
<td>44%</td>
<td>12%</td>
</tr>
<tr>
<td>Midwest</td>
<td>47%</td>
<td>29%</td>
<td>20%</td>
</tr>
<tr>
<td>South</td>
<td>35%</td>
<td>35%</td>
<td>28%</td>
</tr>
<tr>
<td>West</td>
<td>39%</td>
<td>34%</td>
<td>25%</td>
</tr>
</tbody>
</table>

GALLUP

**Figure 13. Alcoholic Beverage Consumed by U.S. Drinker by gender, age, and region**
Not only do adults drink, but youth from ages 12-17 misuse alcohol even when the age limit has not been met. In 2012, approximately 9.3 million people ranging between ages 12-20 reported drinking alcohol from the National Survey on Drug Use and Health (NSDUH) ("Alcohol Facts and Statistics"). It was documented that 24.7% of males and 24% of females drank in the survey. Also, about 5.9 million people in the same age group were binge drinkers (16.5% males and 14% females). National Institute on Alcohol Abuse and Alcoholism (NIAAA) defined binge drinking as a “pattern of drinking that brings blood alcohol concentration (BAC) levels to 0.08 g/dL” ("Drinking Levels Defined"). The BAC levels typically rise after four drinks for women and five drinks for men within two hours.

Moderate alcohol consumption, up to 1 drink per day for women and up to 2 drinks for men, has shown to have beneficial effects on health. Results from epidemiological studies regarding chronic diseases such as coronary heart disease (CHD), stroke, and diabetes consistently display that alcohol reduces mortality, especially among older age groups. This positive cardioprotective effects on CHD, diabetes and ischemic stroke are due to increased levels of high-density lipoprotein cholesterol, decreased levels of low-density lipoprotein cholesterol, preventing clot formation, and reduction in platelet aggregation ("Alcohol Facts and Statistics").

However, excessive drinking can have negative effects on health. Substance Abuse and Mental Health Services Administration (SAMHSA) defined heavy drinking as “8 or more drinks per week for females and 15 or more per week for males.” Alcohol abuse led to 88,000 deaths and 2.5 million years of potential life lost each year, resulting in an average of 30 years lost per alcohol-attributable deaths from 2006-2010 in the United States according to a journal article published by physicians (Stahre et al., 2014). Additionally, 1 in 10 deaths among adults between
the ages of 20-64 occurred due to excessive drinking ("Fact Sheets"). Excessive alcohol use can immediately increase risks of harmful conditions. Some of the common short-term health risks results of binge and heavy drinking include alcohol poisoning, miscarriage and stillbirth, violence, and sexual assault. Excessive alcohol consumption can lead to development of chronic diseases and other serious problems including cancer of many organs, mental health problems such as depression and anxiety, dementia, and heart and liver disease. In 2011, there were 16,749 deaths due to alcoholic liver disease and 1 in 3 liver transplants was due to alcohol-related liver disease in 2009 ("Alcohol Use").

Figure 13. A Map of World Alcohol Consumption of ages 15 and up

Figure 13 displays liters of alcohol consumed per year around the globe indicating that 7.5-10 liters of pure alcohol is consumed in the United States. According to World Health Organization, the world drank about 6.1 liters of pure alcohol per person in the year 2005.
(Economist Online). Alcohol is most largely consumed in Europe and in the former Soviet States. With 10 to 15.56 liters of alcohol consumption in many nations of Europe and Asia, Americans drank much lower per year. South Korea, averaging between 10-12.50 liters, drank average of 13.7 shots of liquor per week ranking number one in the world shown in figure 14 (Ferdman). The Russians came in second with 6.3 shots per week according to the analysis conducted by Euromonitor International, a global marketing research firm. America, drinking around 2.5 shots per week, placed in 11th place out of 53 countries around the world (Kiersz). Liquor consumption in Korea is almost entirely due to fermented rice spirit called Soju which holds 97% of the country’s sales (Lijas).

**The average amount of liquor consumed by a person of drinking age**

*Shots per week of any spirit*

![Graph showing the average amount of liquor consumed per week across various countries](image-url)

Figure 14. Average amount of alcohol consumed per week
Figure 15. Amount of liquor sold in each country per capita, per week in 2013

Due to major crop production of rice, Korean traditional alcoholic beverages are often made from rice, and others use fruits, herbs, and flowers. The six main types of Korean beverages are yakju (ዓᴶ)—refined alcohol, takju (õ Twig)—unrefined alcohol, soju (õ Twig)—distilled liquors, and fruit, flower, and medicinal wines differing in filtration and distillation processes (“Liquors”). Korean alcoholic beverages are called ju (Twig) influenced by Sino-Korean that combined both words from Chinese and Korean.

The fermentation process and the ingredients of yakju and takju are the same except they are extracted during different stages. The rice-base alcohol separates into a clear top part and a grainier bottom part when processed. The clear liquid is extracted first which is called yakju and the remaining bottom substance is filtered with water called takju. The more common name for takju is makgeolli ( vé Twig ) and this fermented rice drink gives off a milky, opaque color due to residues settled at the bottom and mixture of both sweet and sour taste. This oldest alcohol beverage in Korea is considered a healthy drink containing ten essential amino acids, dietary
fiber, vitamin B and C and lactic acids ("Liquors"). The taste of makgeolli varies according to types of rice used and manufacturing methods and some are customized to fit the desired taste by adding various ingredients such as herbs, pine nuts, and black beans. It is popular among women for its beneficial effects on the skin and low calorie count (46kcal per 100ml) with 6-8% of alcohol by volume (ABV). Recently, makgeolli has been served as a fruit cocktail targeting younger age groups by adding in strawberries, kiwis, peaches, or grapes.

Soju, the most commonly consumed Korean liquor, is made from grains (rice, wheat, or barley) or even with other starches like sweet potatoes or tapioca. It is a clear and colorless liquid with the taste resembling sweet, watered-down vodka. Soju has a higher alcohol content of 40 proof (20% ABV), however, by using freeze distillation, the city of Andong is able to use traditional methods to achieve 90-100 proof. The freeze distillation allows for enrichment of the alcohol by partially freezing the content then removing the frozen material then freezing it again until the alcohol no longer freezes. This alcoholic beverage is consumed by many on a regular basis due to its inexpensive prices and high exposure to markets. A typical 375mL bottle costs 1,000 to 3,000 won, roughly around $1 to $3 in USD (Jung). Somaek (Soju), named by merging
soju and beer—maekju (enties), is assembled by mixing a small glass of soju into a mug of beer. It is also known as bomb drink because of its high alcohol content to knock the person out. The texture of the drink is comparatively less carbonated than beer and smoother than soju.

Figure 18. Bokbunjaju made from Korean blackberries

Korea also has numerous traditional wines made from fruits, flowers, and medicinal herbs and roots. Some of the most popular fruit wines are maesilju (高职) made from Korean green plums, maesil, or also known as Japanese apricot, ume. Bokbunjaju (高职) is made from Korean blackberry exhibiting an oxblood color and has been traditionally associated with male virility. Recently, in 2008, it was confirmed by a group of scientists that testosterone levels as well as sperm counts in mice increased due to the berry (Jung). Traditional flower wines are made from acacia flowers, maesil blossoms, peach blossoms, honeysuckle, and wild roses. A flower wine called baekhawju (高职) is known to be made from a hundred different varieties of flowers. Some medicinal alcohols, yagyongju (高职), made with ginseng known as
Insamju ( Ginseng ), bekseju ( 100-year liquor ), and bemju ( snake wine ). Insamju is made by fermenting ginseng and the whole roots are kept inside the bottle for presentation as well as to prolong its fermentation process. It is particularly popular among elders for its benefits. Bekseju literally translates to “100-year liquor” because of the belief that bekseju will help prolong life to 100 years (“Jung”). This herbaceous yellow wine is made from rice and multiple roots and herbs. Bemju, or snake wine, is an alcoholic beverage produced by placing a snake in a jar of rice wine or distilled liquor. Snake wine is believed to possess medicinal qualities such as improving health and virility. Also, people were convinced that the more venomous the snake was, stronger and more powerful the medicinal quality.

South Korea’s drinking culture is reflected on its social structure, lifestyle and traditions. Drinking patterns and manners have been altered in recent years, but generally, the same rules are still followed. Ever since the Koryo Dynasty (936-943), Korea has kept a long tradition of consuming alcohol to celebrate holidays, such as Korean New Years, Korean Thanksgiving (Chuseok— ), and seasonal events. Farming and harvest season was often correlated with drinking alcohol during downtime, usually consumed a bowl of rice wine, takju with a snack.
called saecham. The traditional trait of drinking alcoholic beverages was mostly accompanied with nutritional side dishes and meals. Korean ancestors drank seju, meaning spring, on New Year believing that it would protect them from harmful diseases. In modern Korea, drinking culture has changed in such way that alcoholic beverages are consumed regardless of places and events. Street stalls or small tented restaurants called pojangmacha invite customers to enjoy soju and street food to relieve their daily stress ("Liquors"). Furthermore, tables and chairs are set outside convenience stores for customers to quickly have a drink and snacks. However, manners in drinking alcohol and showing respect to elders or at workplace have been strictly kept. The tradition dictates that alcohol is offered to the oldest person or the person with the highest position in a workplace poured with both hands in courteous manner. The alcohol bottle should be held with the right hand while the left hand is placed under the right arm for support. In contrast, when the drink is offered to the lower status person, the person usually kneels and takes the glass with both hands. When the drink is poured, the person receiving would turn away from the person who offered the drink, to show respect, and drink it quickly ("Drinking Customs"). Due to a strong hierarchy system in the workplace, stress can build up for new employers. Drinking allows for a chance to relieve some stress and to bond with their coworkers/peers. Because drinking is such a critical part in social context, many Koreans consume alcohol more than the average amount.
According to the World Health Organization, South Korea ranked 13\textsuperscript{th} in world for alcohol consumption overall, but stood in first in hard liquor consumption (Choe). Because of the permissive public attitudes of drinking in modern Korean culture, more than 70\% of adult males over 18 years of age drink occasionally and half of those males are regular drinkers (Lee). The number of drinkers have increased remarkably to 86\% of the population were regular drinkers in 2001 from a data presented by National Health and Nutrition Survey (“Republic of Korea”). Studies have shown that demographics correlate with alcoholism depending on gender, age, education, and occupation. The rate of heavy drinking increases with age. The World Health Organization reported 66.3\% of males and 57.8\% of females are heavy drinkers among drinkers. Recently, an epidemiological study announced that there was a 20- to 30-fold higher lifetime prevalence rate of alcoholism in male population than the female population. A study of 2124
students (1092 boys and 1032 girls) attending junior high and high schools (age group 12 to 16 years old) in Seoul recorded that 28% of used alcohol weekly (“Republic of Korea”). Comparing locations, consumers who live in the countryside are more prone to be heavy drinkers than the ones that reside in the city. Alcohol is most consumed by workers in agriculture or at fisheries followed by self-employed business owners, sales people, and the unemployed.

**Figure 22.** Liters of pure alcohol per capita consumption

**Figure 23.** Data from the Household Health interview survey of heavy drinkers
South Korea’s alarming alcohol consumption has led to outbreaks of drunken violence and alcohol related diseases which in turn forced the Ministry of Health and Welfare to launch a marketing campaign in 2011 to restrain people from drinking. The ministry has been running public advertisement advising the audience to “Don’t mix two or more kinds of liquor. Don’t go bar-hopping, and go home by 9 p.m.” (Nakano). Major companies such as Samsung and Asiana Airlines have started a campaign prohibiting employees from drinking during the day and by limiting the amount of business dinners. It became very common for drunken men and women to be locked up in almost every police station in Seoul, verbally and physically abusing the officers (Choe). In 2011, 77% of intoxicated adults were charged with obstruction of justice by abusing public servants but they are only charged with a small fine. According to a government report, South Koreans have spent a total of 1.28 trillion won ($1.1 billion) in medications to treat diseases associated with drinking such as liver disease since the year 2007 (Nakano). Another report stated that businesses lose an estimate of 20 trillion won per year due to decrease in work productivity and destruction of property caused by excessive drinking.
**Chronic mortality**

![Chronic mortality time-series graph](image)

Note: Chronic mortality time-series measured on two axes, ischaemic heart disease on right axis and the other causes on the left.

**Figure 24. Chronic mortality time-series**

**Acute mortality**

![Acute mortality time-series graph](image)

Source: WHO Mortality Database

Note: Caution should be exercised when interpreting the results as death registration level is incomplete.

**Figure 25. Acute mortality time-series**
Due to the increase in alcohol consumption, acute and chronic mortalities have risen as well. As shown in figure 23, cases involving alcoholic liver diseases of chronic liver diseases have shown a dramatic increase from 1.5% in 1980 to 24% in 1993. 84% of males patients of hepatocellular cariconma patients in South Korea are indicated to be heavy drinkers compared to the female patients who are not habitual drinkers (“Republic of Korea”). Alcohol consumption being the main contributing factor to acute pancreatitis, the annual incidence per 100,000 people has increased from 15.6 in 1995 to 19.4 in 2000. Parallel with the growth of industrialization and urbanization, alcohol consumption increased along with alcohol-related deaths. The number of traffic mortality has increased approximately 12.7% annually and the ratio of alcohol-related total deaths have risen from 3.1% in 1990 to 6.7% in 1995. Compared to other developed countries, Korea has about a 10-fold higher rate of car accidents caused by drunk driving. Behavioral problems resulting from alcohol are well tolerated in Korean society as well as a tendency to dismiss transgressions that occurred in a drunken state.

Alcohol and the Cardiovascular System

Drinking in moderation, one to two glasses per day for men and one glass for women, appears to decrease cardiovascular issues. A drink amounts to 12 ounces of beer, 4 ounces of wine, 1.5 ounces of 80-proof liquor or 1 ounce of 100-proof spirits (“Alcohol and Heart Health”). Some of the health benefits of moderate alcohol use are that it may reduce the risk of ischemic stroke where the arteries to the brain become narrowed or blocked, reducing blood flow, lowering low-density lipoprotein (LDL) or bad cholesterol, and increasing high-density lipoproteins (HDL) or good cholesterol, as well as lowering systemic blood pressure (“Alcohol and Heart Disease”). In contrast, excessive drinking may cause more harm than good.
Research acknowledges the effects of heavy, long-term drinking on the heart. Alcohol may weaken the heart muscle, causing a condition known as dilated cardiomyopathy (“Alcohol and Nutrition”). The weakening of the muscle impairs pumping blood efficiently throughout the body which can cause premature death through heart failure. The symptoms of dilated cardiomyopathy include shortness of breath, fatigue, irregular heartbeat, and swollen limbs (edema) (“Interactive Body Content”). The heart depends on an internal pacemaker system, starting at the SA node, to pump blood at the correct rate but alcohol can disrupt this system causing irregularity to the beat called arrhythmias. Atrial fibrillation, the most common type of cardiac arrhythmia, can trigger a stroke because the upper chambers of the heart twitch chaotically, creating blood clots which can go on to block a cerebral blood vessel. Drinking excessively can also increase the risk of high blood pressure which is one of the main factors of a heart attack or a stroke by increasing blood pressure, triggering cardiac arrhythmias, and causing weight gain. Other conditions associated with alcohol are an increase in triglycerides, higher calorie intake leading to obesity and diabetes, and cardiac death ("Alcohol and Heart Health").
Figure 26. Atherosclerosis in coronary artery

Heavy alcohol consumption results in structural changes in the heart as well as arteries and other vessels, termed “remodeling.” Multiple researchers have shown a correlation between alcohol consumption and coronary morbidity and mortality (Vliegenthart et al, 2000). Coronary artery disease (CAD) is the leading cause of death in the United States in both genders making it the most common type of heart disease (“Heart Disease Facts”). CAD may cause myocardial ischemia by depriving the heart muscle of oxygen and nutrients due to the formation of atherosclerotic plaques in the coronary circulation (Cohen “Coronary Artery Disease”). Arteries become hardened and narrowed. Atherosclerosis is the buildup of cholesterol and other substances traveling through the blood stream that form plaques on the inner walls. The failure to deliver oxygen to the tissue can lead to angina (chest pain) or a heart attack (“What is”). In a study conducted by a research professor at the University of Rochester Medical Center, it was found that levels of LDL rose 20 percent in mice that drank approximately ethanol equivalent to
seven drinks for two days of the week and declined 40 percent in the daily-moderate drinking mice that were fed 2 drinks. With every 10 percent increase in LDL, there is a 20 percent increase in risk of atherosclerosis according to past studies (“Study Links”). In addition, another study measured the heart muscle and evaluated the stiffness of the arteries as well as the blood pressure inside the aorta. The researchers found that subjects who were heavy drinkers had high blood pressure along with stiffening of the heart muscle and arteries (Steenhuysen).

Similar to arteries, arteriolosclerosis can occur in the inner and middle linings of arterioles with long duration heavy alcohol consumption. The arteriolar muscle walls become hard and thick due to calcification, elevating blood pressure. The buildup of fat, cholesterol and other substances restrict blood flow, depriving the organs of its oxygen. The kidney is often affected by this disorder, ultimately leading to kidney failure (Lam). In the brain, a study conducted by researchers reported the impairment of dilation of cerebral (pial) arterioles in response to nitric oxide, a vasodilator, during exposure to high concentrations of alcohol (Sun and Mayhan H992). Also, it has been found that alcohol can stimulate lipid peroxidation, which is the oxidative degradation of lipids. A free radical, an ion that has unpaired electrons, takes electrons from the lipids in cell membrane causing cell damage. The increase in free radicals leads to oxidative stress in organ system directly damaging the endothelium, in response, affecting the synthesis of nitric oxide to alter vascular tone (H992). In another study, they determined the effects of different concentrations of ethanol on responses of cerebral resistance arterioles by measuring the diameter of pial arterioles before and after the application of ethanol (Mayhan and Didion 2097). The diameter altered in response to agonists that stimulate the release of nitric oxide from the endothelium (ADP [adenosine diphosphbate], acetylcholine, and histamine) or neurons (N-methyl-D-aspartate [NMDA]). The open bars, in figure 27, represent
dose-related dilation of cerebral arterioles produced in response to the agonists before the application of 20 mmol/L ethanol. After the superfusion, a technique of pouring liquid over the surface of tissue, of 20 mmol/L ethanol, it did not change the responses of the arterioles. The same result occurred up until 60 mmol/L ethanol where it had no affect on the pial arterioles. However, higher concentrations of ethanol (80 and 100 mmol/L) caused impairment of dilation to agonists. Although previous studies have shown that ethanol produces vasoconstriction, this particular study did not find significant effect in the diameter suggesting that it may be due to differences in methods, vessel size, and type (2099).

Figure 27 Response of pial arterioles to ADP, acetylcholine, histamine, NMDA under control conditions (open bars) and after topical application of 20 mmol/L ethanol for 1 hour

Figure 28. Response of pial arterioles to ADP, acetylcholine, histamine, NMDA under control conditions (open bars) and after topical application of 60 mmol/L ethanol for 1 hour
Although not much work has been done regarding the association between alcohol and capillaries, there are some suspected outcomes from alcohol abuse. Long-term excessive alcohol consumption can increase arteriolar and venous pressure leading to increase in blood pressure. This causes veins to stretch and repeated stress of capillaries cause rupture, showing up as broken vessels on face or other parts of the body (“Broken Blood”). Furthermore, a study done in 2009 concluded that excessive alcohol can induce the development of acute respiratory distress syndrome by affecting normal permeability of the alveolar-capillary barrier (Burnham et al., 2008). Acute respiratory distress syndrome (ARDS) is a life-threatening condition where the fluid build-up in the alveoli in the lungs leads to a decrease in the oxygen level that is needed to function (“ARDS”). The alveolar-capillary membrane in the lung serves as a barrier to facilitate efficient gas exchange but restrains large solutes from entering to prevent accumulation of fluid in the air sacs. The subjects were introduced to an isotope, $^{99m}$Tc-DTPA, to measure their lung permeability and demonstrated that individuals with a history of alcohol abuse absorbed the isotope much faster suggesting incase in permeability of the membrane. The researchers
compared the rate at which the isotope was cleared from the lungs between subjects with a history of alcohol and control group. The volume of extravascular lung fluid was almost twice as much in subjects that abused alcohol compared to the other subjects who did not. This shows that excessive alcohol consumption affects the permeability in the alveolar-capillary membrane as well as other organ systems that contributes to ARDS.

As mentioned previously, alcohol can cause veins to stretch because there is an increase in blood flow due to faster heart rate. In a healthy leg, blood is pumped back to the heart helped by unidirectional valves which prevent pressure build up, causing swelling in the legs. However, when blood volume is increased due to alcohol consumption, veins have to work harder in order to circulate blood back up to the heart resulting in weakened valves. The damaged valves caused by alcohol can lead to varicose veins along with other contributing factors such as obesity, age, gender, and activity level. Lastly, a condition called liver cirrhosis, where scar tissue is formed limiting its function by blocking blood flow through the liver, can

![Figure 30. Measured half-life of $^{90m}$Tc-DTPA in lungs of subjects with alcohol abuse and controls of non-smokers](image)
lead to varicose veins (“Cirrhosis of the Liver”). The liver is unable to filter toxins and wastes in the blood causing blood to become more viscous. The thickened blood puts more stress on the valves to propel the blood allowing the blood to pool at the feet and leading to varicose veins (“The Relationship Between”).

![Figure 31. Stages of Liver Damage](image)

**Conclusion**

While there are many studies showing the benefits of moderate drinking, alcohol can lead to many complications to the cardiovascular system as well as other organs, if taken in excessive quantities. These include increased risk of coronary artery disease and hypertension. Alcohol consumption in the US as well as in S. Korea is rising per year and it is important to know the risks in order to make necessary changes to protect the heart.

Dating back as early as 10,000 B.C., alcohol has been around for many generations and developed its characteristics to each culture and each type of alcohol. It was used for medicinal purposes, in religious practices, and the most common use, as of today, alcohol as a social lubricant. One of the reasons why the drinking rate in South Korea is so high is because of the
social structure. It is a tradition for alcohol to be present during holidays, harvest seasons, and to fulfill the enjoyment of life. Also, drinking with coworkers is highly suggested to show respect and to bond even outside of work. In the U.S., it was found that sobriety is proportional to levels of education but inversely related to social class. Gender, age, and location are also factors that contribute to alcohol consumption which showed that males generally consume more alcoholic beverages compared to females and the preference of the type of alcohol differed as well. Due to increase in alcohol abuse in both countries, prevalence of chronic diseases and mortalities increased as the result. Approximately 90,000 deaths were due to alcohol abuse each year and around 17,000 deaths were due to alcoholic liver disease in 2011. In Korea as well, there was a little more than 20% increase in cases regarding alcoholic liver diseases only in 10 years in the 1990s and the citizens have spent over a billion dollars to treat the diseases.

Not only can alcohol harm the liver, but it can damage the cardiovascular system by impairing the heart and the blood vessels. Alcohol can cause dilated cardiomyopathy, weakening the heart muscle preventing efficient blood flow throughout the body. It can also lead to atrial fibrillation which can trigger a stroke by creating blood clots. Increase in alcohol intake, raises triglycerides and low density lipoproteins causing buildup in arteries and arterioles. Coronary artery disease is the leading cause of death in the U.S. which is a disease due to plaque buildup reducing oxygen delivery to tissues.

Recommended drinks per day for men and women have shown beneficial effects of alcohol on the cardiovascular system but heavier consumption is related to many health problems. It is important to take these facts into consideration and take precautions to improve heart health.
List of Figures


References


Burnham, Ellen L., Raghuveer Halkar, Marsha Burks, and Marc Moss. "The Effects of Alcohol Abuse on Pulmonary Alveolar-Capillary Barrier Function in Humans." Alcohol and


Appendix A

Gangnam Style:
Alcohol and the Cardiovascular System
(Comparing US and South Korea)

Jennifer Oh and Zee Cohen, Ph.D.
Department of Physiology,
University of Arizona

Abstract
The relationship between alcohol and the cardiovascular system (CVS) affects the system. Excessive consumption causes damage while moderate consumption (1 drink/day for women, 2 drinks/day for men) can be protective.

We then compared alcohol consumption between the US and South Korea and discovered that factors such as location, culture, and occupation play a role in both the type and amount of alcohol consumed.

Cardiovascular System
The cardiovascular system (CVS) is an organ system that is comprised of the heart, blood vessels, and blood. The heart is a dual pump that imparts pressure on blood moving through the body. The four main types of blood vessels are arteries (pressure), arterioles (resistance), capillaries (exchange), and veins (volume). Blood is a bodily fluid that transports necessary nutrients and oxygen to the tissue cells and removes waste products.

Alcohol and the Cardiovascular System
Drinking in moderation can be beneficial to the cardiovascular system by reducing low density lipoprotein (LDLs), lowering blood pressure, as well as decreasing the risk of ischemic diseases.

However, excessive drinking can have the opposite effect. It can lead to dilated cardiomyopathy, coronary artery disease (CAD), dyslipidemia, increased risk of stroke, and kidney failure (liver centesis).

Alcohol Consumption: S. Korea
South Koreans drink an average of 10-12.5 liters of alcohol (13.7 weeks of liquid) per year. Liquid consumption in Korea is almost entirely due to a fermented rice drink called soju (주). In 2001, the number of regular drinkers increased to 98% of the population.

Conclusion
Alcohol can lead to many complications to the cardiovascular system as well as other organs. It takes its excessive quantities. These include increased risk of coronary artery disease and hypertension.

Alcohol consumption in the US as well as in S. Korea are rising per year and it is important to know the risks in order to make necessary changes to protect the heart.

References
[Details of references provided]

Which States Drink the Most?

Which States Drink the Most?

[Map showing states with the highest alcohol consumption]