6-2021

Alcohol And Its Long-Term Effects On Hearing Loss: A Systematic Review

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A capstone paper submitted to the Graduate Faculty in audiology in partial fulfillment of the requirements for the degree of Doctor of Audiology, The City University of New York.

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This manuscript has been read and accepted for the Graduate Faculty in Audiology in satisfaction of the capstone project requirement for the degree of Au.D.

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Abstract

ALCOHOL AND ITS LONG-TERM EFFECTS ON HEARING LOSS: A SYSTEMATIC REVIEW

By

Talia Sowalsky

Advisor: Dr. Barbara Weinstein

Objective: To review the literature on potential permanent effects of long-term alcohol consumption on hearing status in adults 40 years of age and older.

Study Design: Systematic review of prospective and retrospective studies; meta-analysis of case-controlled studies.

Methods: One researcher independently reviewed MEDLINE (January 1, 2000-May 1, 2019), CINAHL (January 1, 2000-May 1, 2019), PubMed (January 1, 2000-May 1, 2019), and Web of Science (January 1, 2000-May 1, 2019). A manual reference search was additionally conducted. Randomized controlled trials, prospective cohort studies, consecutive/non-consecutive case series, and retrospective reviews in which a clear definition of hearing loss was stated were included in the study.

Results: Seven articles met the inclusion criteria. There were disparate findings among the literature. Several articles found no association with alcohol and hearing loss while others found a protective effect, with differing quantities of consumption. What is evident is that there is limited data assessing the effect of alcohol on hearing loss, rendering it difficult to make conclusions.

Conclusions: There is evidence demonstrating an association between heavy alcohol consumption and worsened hearing thresholds. However, there are disparate findings on less quantities of consumption of alcohol on one's hearing. Additionally, the differences among the studies make it difficult to draw definitive conclusions. Furthermore, although several studies have found independent discoveries of cultural, racial, and gender-based differences, there is insufficient data to confidently state a difference between the aforementioned categorical variables. It is evident that more research needs to be conducted in order to better understand the correlation between alcohol consumption and its effects on one's hearing.

Keywords: Hearing loss, high-frequency hearing loss, low-frequency hearing loss, conductive hearing loss, sensorineural hearing loss, mixed hearing loss, permanent hearing loss, alcohol, spirits, port, liquor, wine, beer, male, female, race, ethnicity, culture.

ACKNOWLEDGMENTS

I cannot express enough thanks to my capstone advisor, Dr. Weinstein for providing me with invaluable guidance throughout this journey. She has truly been a mentor, not only with my research but with my education as well. It was a privilege to work and study under her leadership.

I would also like to thank my parents for their love and support. I am immensely appreciative for their consistent encouragement preparing me for my future.

Finally, I am so grateful to my loving, and supporting husband, Joseph. His care and comfort during my four-year doctorate program have been incredible. I am so thankful for everything.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Alcohol, once thought to be a costly commodity, is consumed daily by the majority of Americans. According to the 2015 National Survey on Drug Use and Health (NSDUH) of people ages 18 or older, 86.4 percent reported drinking alcohol at some point in their lifetime, 70.1 percent reported drinking in the past year, and 56.0 percent reported drinking in the past month. The amount of alcohol consumed on a monthly, weekly, or daily basis dramatically differs from person to person. At one end of the spectrum, we have teetotalers who prefer to abstain from alcohol, and on the other end, we have alcoholics who cannot control their consumption of alcohol despite its negative implications (NIAAA.nih.gov, 2020). There are approximately 15 million alcoholics in the United States (Tallbotcampus.com, 2020). The chances of developing diseases including heart disease, diabetes, and liver disease increase with alcohol abuse. The longer the list of negative consequences, the stronger the motivation of individuals to abstain from alcohol. As alcohol is ingested by the majority of Americans and 12.7% of American adults meet the definition of an alcoholic (Gibbs, 2017), it is crucial to know the side effects of alcohol consumption. Common effects of alcohol on one's body have been studied extensively; however, a paucity of literature exists focusing on the lesser-known side effects, such as the effect on hearing status (Villa, 2018).

Alcohol quenches one's thirst, and it also increases the pleasures of life (Mackenzie, 2018). However, alcohol is also a depressant and has calming effects, thought to be favorable to many (Godman & Levine, 2019). Alcohol consumption is believed to date back thousands of years (Recovery.org, 2019). Beer jugs have been found dating back to the stone age, approximately 10,000 B.C., and wine made an appearance in Egyptian pictographs around 4000 B.C (Marc, 2017). Alcohol also plays a key role in religion. The god of wine, Osiris, was worshipped by the Egyptian people. The Babylonians similarly worshipped the wine goddess and other deities in

2,700 B.C. and would offer wine and beer to their gods. The Chinese also used alcohol as a spiritual food during memorial ceremonies such as weddings, births, reunions, deaths, departures, and prior to going to war (Curry, 2017). In Greece, alcohol was used as medicine and a symbol of hospitality and was commonly consumed with meals. Even today, many other people value alcohol and use it in their rituals, one example being Judaism (Gately, 2008). The Jewish people fill a cup of wine every Friday night and Saturday afternoon and say a blessing over the wine prior to eating. Additionally, the Romans were known to have abused alcohol in the mid-first century. Wine was practically free at the time, which led to many imbibed emperors and citizens. Some rituals even encouraged excessive drinking, including drinking on an empty stomach and vomiting for the purpose of consuming more (alcoholproblemsandsolutions.org). The consumption of alcohol is certainly not a new phenomenon, however technological and research advances have made it possible to better analyze and understand the actual effects on the human body.

The positive and negative effects of alcohol consumption are well-known and well-established. Short term negative effects of alcohol consumption include flushing of the skin, vomiting, passing out, difficulty concentrating, mood swings, raised blood pressure, and dulled vision, to name a few. Long-term side effects of alcohol consumption include cirrhosis of the liver, hypertension, memory loss, trouble learning, and increased risk of cancer, stroke, and cardiovascular disease (Monico, 2020). As a depressant, alcohol slows down brain activity, along with many more downstream effects (Gowin, 2010). Consuming enough alcohol to bring one's blood alcohol concentration level to 0.08g/dL or above is considered poisonous to one's body, with signs of alcohol poisoning including pale skin, slowed breathing, and seizures (Monico, 2020).

Liver disease is a common side effect of alcohol abuse. Over time, the liver becomes inflamed with the consumption of alcohol and can develop scarring. The digestive system, including the stomach lining, can be worn down and lead to ulcers. Additionally, pancreatitis is a known side effect of alcohol consumption. Cardiovascular disease including high blood pressure, irregular heartbeat, blood clots, and heart attacks are known side effects of alcohol abuse. Additionally, alcohol consumption can lead to calcium imbalance through the disruption of vitamin D absorption, which is in turn needed for calcium absorption, affecting bone health. There are also psychological effects of alcohol such as alcohol-induced psychiatric syndromes and mental illnesses (Monico, 2020).

While much of the medical literature has focused on alcohol consumption, liver disease, cardiovascular disease, and hypertension, few studies have focused on other areas of one's body that might be affected by long-term alcohol consumption. To explain, upon consumption, 33 percent of alcohol is absorbed into the blood, through the stomach lining, and 67 percent is slowly absorbed into the blood through the small intestine (Schimmel, 2012). Once alcohol has made its way into the bloodstream, it flows through to practically every part of the human body (Schimmel, 2012). The alcohol will go into the bloodstream and remain there until the liver filters the blood. The liver can filter approximately one standard drink (14 grams) per hour. Approximately 90% of alcohol is broken down into water, carbon dioxide, and other substances that are used for energy. High levels of alcohol consumption will result in alcohol remaining in the blood for a longer period of time (Arnarson, 2018). As a result, the blood, which is circulating throughout the body, is delivering alcohol-infused blood to many organ systems, including the inner ear (Clason, 2019).

For the cochlea to function optimally, it is dependent on an adequate vascular supply. The human ear has a blood supply that is essential in maintaining proper function, namely: fluid

homeostasis, ionic balance, and metabolic supply. The external carotid artery supplies vasculature to the external ear through its branches, called the posterior auricular artery, the superficial temporal artery, the occipital artery, and the maxillary artery (Jones, 2018). The internal auditory artery supplies blood to the inner ear and to the facial and vestibulocochlear nerves (Barral and Croibier, 2009). Disruption of the cochlear blood flow, even a brief cessation, can lead to extreme changes including, but not limited to, high susceptibility to noise-induced hearing loss, presbycusis, sudden hearing loss, vestibular neuritis, Meniere's disease, and autoimmune disorders (Mei et al., 2018). High concentration of alcohol in the bloodstream can also cause damage to the hair cells of the inner ear as a result of the ototoxicity of alcohol. (Clason, 2019). Ultimately, when an ototoxic substance enters the ear it destroys the hair cells that lie within the inner ear. Despite many continued attempts by researchers, hair cells do not rejuvenate. Therefore, ototoxic damage to the inner ear is permanent and results in permanent hearing loss (Clason, 2019). The permanence of hearing loss due to damaged hair cells has been proven over and over. As a result, it is reasonable to speculate that a lack of oxygen delivered to the inner ear as a result of excessive alcohol in the blood stream can ultimately cause permanent damage to the hair cells and thus negatively affect hearing.

Many researchers prior to the year 2000 assessed the correlation between alcohol consumption and hearing status. Squires et al. (1985), Lukomski et al. (1999), Koff et al. (1973), Beam et al. (1978), wheeler et al. (1980), Spitzer and Ventry (1980), Ylikoski et al. (1981), Spitzer (1981), Shen (1983), Zuev (1984), Golabek and Niedzielska (1984), and Jozefowicz-Korzynska et al. (1994) have reported that alcohol use, in different quantity, is correlated with sensorineural hearing loss. Similarly, Rosenhall et al. (1993) and Popelka et al. (1998) found that chronic alcohol consumption was associated with increased hearing thresholds. Similarly, Alpert and Borgorad

(1975) found a significant correlation between hearing loss and duration of alcohol consumption. There is substantial evidence commenting on the association of the two variables, leading one to believe that alcohol in the blood stream may in fact contribute to a disruption of blood flow to the inner ear, and thus causing hearing loss. Additionally, Spitzer and Ventry (1980) and Spitzer (1981) discussed impacts on central auditory function and found tinnitus to be correlated with alcohol abuse. In contrast, there are some researchers, including Brant et al. (1996), who did not find a significant association between alcohol consumption and hearing thresholds.

This systematic review aimed to discuss recent literature from journals from January 1, 2000 to May 1, 2019 and to synthesize the effects of alcohol and permanent hearing loss in adults ages 40 or older. Further, we sought to identify a potential difference among drinking habits and type of alcohol consumed. Similarly, we aimed to evaluate disparity among gender, age, education, socioeconomic status, race, ethnicity, and culture as well as the types of hearing loss associated and configuration of the hearing loss. With regard to permanent effects on hearing status, a disparity among type of hearing loss, i.e., sensorineural, conductive, and/or mixed hearing loss, was considered as well as interaction with configuration of hearing loss (`e.g., high-frequency versus low-frequency, flat, etc.). If hearing loss is a true side effect of alcohol consumption, exposing this fact might be another impetus for individuals not to abuse alcohol. That being said, a systematic review on the literature can also cultivate designs for future research and further an attempt at preservation of hearing.

The hypothesis of this systematic review is that alcohol has slow-acting detrimental effects on hearing loss and that the volume of consumption is inversely related to hearing thresholds (i.e. the more alcohol one consumes, the worse one's hearing thresholds become). The research questions are as follows:

(1) What are the negative and positive effects of alcohol consumption on hearing?
(2) Does alcohol use differentially affect the parts of the ear (outer, middle and inner ear) leading to different types of hearing loss (sensorineural, conductive, and mixed)?
(3) Does the type of alcohol consumed have a differential effect on hearing status?
(4) Does the quantity of alcohol consumed differentially affect hearing thresholds?
(5) Does the effect of alcohol consumption on hearing differ based on gender, age, education, socioeconomic status, race, ethnicity, and/or culture affect?
(6) Does alcohol consumption differentially affect pure tone test frequencies?

METHODS AND ANALYSIS

In order to fulfill eligibility criteria only articles written in English were considered. Study design was not limited in determining eligibility. Research articles had to have been published to be included in the initial search. Systematic reviews and meta-analyses were not included. The inclusion criteria included (1) participants aged 40 years and older; (2) articles written in English; and (3) articles focusing on permanent hearing loss. Exclusion criteria included animal subjects, articles not written in English, alcoholic subjects, and those published prior to January 1st, 2000. The list of articles from the research from CINAHL, MEDLINE, PubMed, and Web of Science were printed and kept as a reference to cross-analyze and review.

One independent reviewer scanned CINAHL, MEDLINE, PubMed, and Web of Science for the data. The search terms were “alcohol,” “hearing loss,” “spirits,” “liquor,” “wine,” “port,” “beer,” “high frequency hearing loss,” “low frequency hearing loss,” “male,” “female,” “gender,” “race,” “ethnicity,” “culture,” “sensorineural,” “flat,” “mixed,” and “conductive”. The degree of hearing loss, such as flat, sloping, cookie bite, and rising, were taken into consideration but were

not used as a search term. Studies were also identified by reviewing references of articles identified during research.

Once articles meeting the inclusion and exclusion criteria were identified, they were further scanned by searching the terms “alcohol” and “hearing loss” throughout. If an article did not have both of these terms, it was not included for additional analysis. Once all articles included both words, the definition of hearing loss was defined as an objective measure of hearing using pure tone audiometry with a three-or-four-frequency pure tone average (PTA). The pure tone average was required to include at least three of the four octave frequencies 500, 1000, 2000, and 4000 Hz, and must have been greater than 25 dB HL to be considered “hearing loss”. If the definition of hearing loss was defined using a method other than pure tones, such as word recognition scores or auditory brainstem response testing, the articles were excluded. Additionally, the included articles must have defined alcohol consumption in terms of some measure that could then be converted into grams. If a quantity of alcohol was not given for the purpose of quantifying alcohol consumption, the article was not included in this review. The use of the terms “mild,” “moderate,” or “heavy” consumption, for example, to define the quantity of alcohol consumption, was insufficient given the subjectivity of the words. A discrete quantity was essential in order to cross analyze articles and deduce conclusions.

Once the final articles were chosen, the main prioritization was determining the effect of alcohol on hearing loss. Once this outcome was assessed, if there was an effect of alcohol on hearing loss, correlation of gender differences, socioeconomic status, ethnicity, age group, configuration of hearing loss, degree of hearing loss, types of alcohol consumed, intensity of

alcohol consumed, number of years spent consuming alcohol, and educational advancement were reviewed and noted.

Data from each article were extracted based on the questions posited. The data was clustered into sections so that comparisons could be made. However, comparisons were difficult due to the disparity among articles including, but not limited to, the majority gender of individuals, the types of alcohol included, the age of individuals, and the quantity of alcohol consumed. Following the discussion, the result section brings forth articles that did not meet inclusion criteria, but had pertinent information to the systematic review. Finally, limitations and strengths of each study are noted as well as clinical implications.

No publication biases were present in this study. The author had no prior association with any databases or authors. Selective reporting was used since several articles discussed other influences on hearing loss, however they were independent of alcohol consumption and were not warranted in this systematic review.

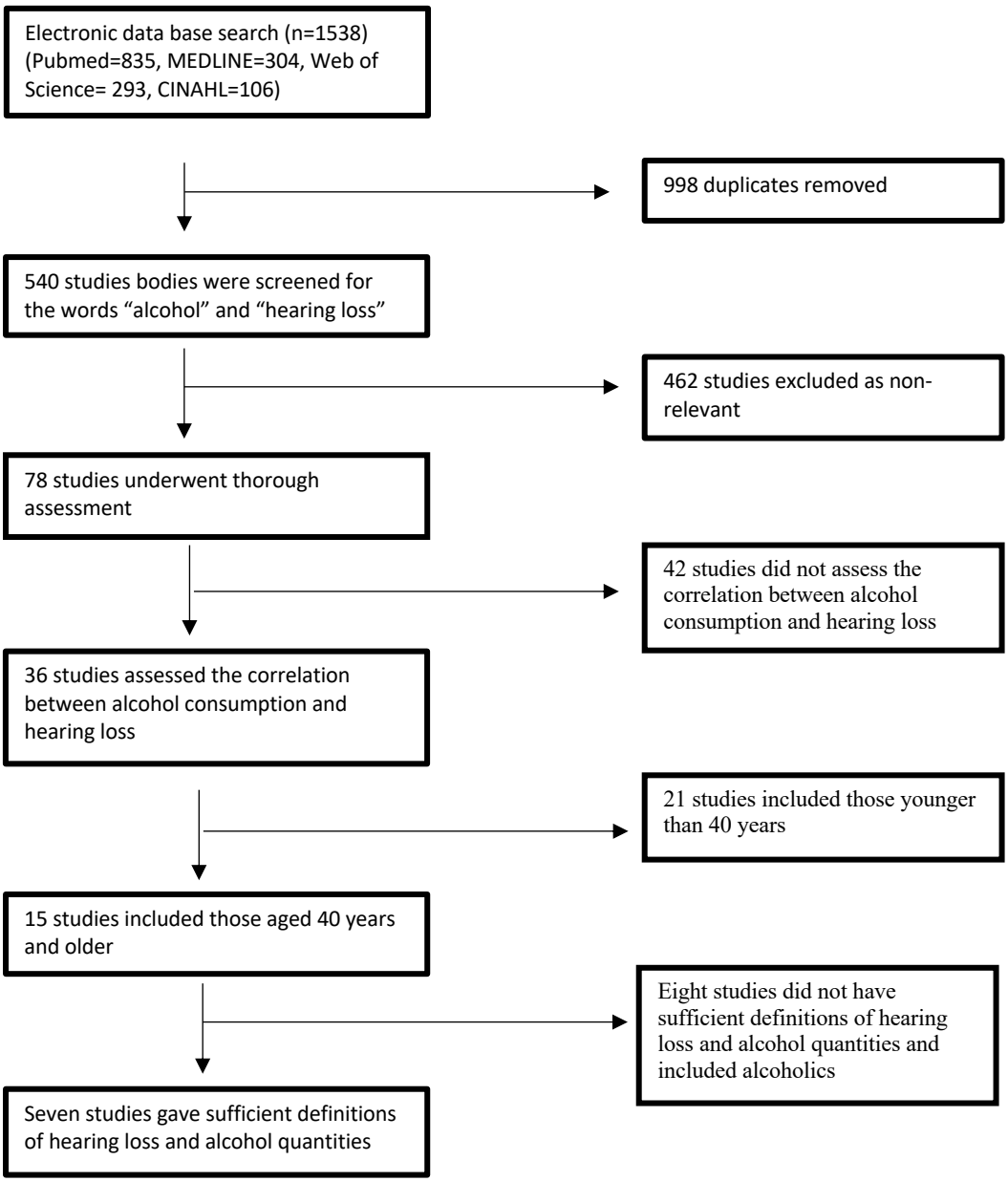

FIGURE I. Information Synthesis

The initial search yielded 1,538 articles from all four databases. Specifically, 835 articles were yielded from PubMed, 304 articles from MEDLINE, 293 articles from Web of Science, and

106 articles from CINAHL. Upon removal of 998 duplicates, 540 articles remained. All articles' complete texts were screened to assess eligibility for inclusion according to the aforementioned criteria of "alcohol" and "hearing loss". 78 articles remained that included the word "alcohol" and the term "hearing loss." Upon retrieval of these 78 articles, the full texts were assessed to see if the association of alcohol and hearing loss was indeed discussed. Full text assessment revealed 36 articles that sufficiently discussed alcohol and its effect on hearing loss. Upon further removal of articles focusing on individuals less than 40 years and those that included alcoholics, 15 articles remained. The 15 remaining articles were then analyzed to see the definition of hearing loss and the definition of alcohol consumption. Of the 15 articles, seven gave a sufficient description of alcohol consumption and quantities as well as an appropriate definition of hearing loss and did not include alcoholics.

Seven final articles were included in this systematic review based on inclusion criteria. Classification of hearing loss and mode of attainment (i.e.: PTA) were pre-determined and specified prior to analyzing the literature. Articles were only included if they had a complete definition of hearing loss and defined alcohol consumption in units, drinks, or grams.

For each included article, data was collected on the authors, the year of publication, the design, the location, the sample size, the age range, and the major findings. Of the seven articles, three studies assessed the correlation with gender, none assessed the correlation with socioeconomic status, one study assessed the correlation with ethnicity/race, one study compared results between different age groups, three studies assessed the difference between high-and-low frequencies, and none assessed the correlation with educational advancement.

For the purpose of cross analyzing the data, all quantities of alcohol were converted into grams per day of consumption. One drink was considered 14 grams of alcohol (niaaa.ig.gov) and one unit was considered 8 grams of alcohol (nhs.uk).

TABLE 1. Characteristics of Studies Included in Review

Study	Age range	Sample Composition	Levels of alcohol consumption	Design	Major Findings
Kim (2015)	60 and older	2,353 Male, 3,094 Female	1-15 g/day and >30g/day	Cross-sectional	No association between alcohol consumption and hearing loss
Popelka et al. (2000)	43-84	1,539 Male, 2,032 Female	None, ≤2g/day, 2.14-10.57g/day, 10.71-20g/day, >20g/day, >46g/day	Cross-sectional	Alcohol has a protective effect, except for consuming more than 20 grams/day, which has a negative effect on low and high frequencies and consuming more than 56 grams which negatively affects the high frequencies
Rigters et al. (2018)	55 and older	347 Male, 375 Female	None, Woman: 8g/day, >8g/day Men: 8-16g/day, >16g/day	Longitudinal	No association between alcohol consumption and hearing loss
Fransen et al. (2008)	53-67	1967 Male, 2,116 Female	≥1.14g/day	Cross-sectional	Protective effect
Gopinath et al. (2010)	49 and older	1,218 Male, 1,597 Female	Wine and Beer: none, ≤10g/day, >10g/day-19.9g/day, >20g/day Port: none, ≤10g/day, >10g/day	Cross-sectional	Protective effect

			Spirits: ≤10g/day, >20g/day		
Cruicks hanks et al. (2015)	43-84	637 Male, 1,288 Female,	None, 0.1-1.9g/day, 2.14-10.57g/day, 10.71-20 g/day, >20.14g/day, >40g/day, >56g/day	Longitud inal	No association between alcohol consumption and hearing loss
Helzner et al. (2005)	73-84	970 Male, 1,082 Female	≥8g/day	Cross-sectional and Longitud inal	Protective effect

RESULTS

The data from the seven studies meeting the eligibility criteria were used to answer each of the research questions.

In the section to follow, a synthesis of each study is given with regard to the initial questions of the systematic review, including type of hearing loss (sensorineural, conductive, and/or mixed hearing loss), configuration of the hearing loss (high frequency, low frequency, or flat hearing loss), type of alcohol (spirit, wine, beer, liquor, port), duration of alcohol consumption in years, as well as gender, age, race, ethnicity, socioeconomic status, education level, and cultural differences. Most of the articles included in the systematic review contained different quantities of alcohol consumption, making it difficult to draw direct conclusions and comparisons between the studies. However, only the articles that specified the quantity of alcohol consumption in grams, units, or drink were used. All quantities of alcohol were then converted to grams of ethanol.

<u>Research Questions #1, #5, and #6:</u> What are the negative and positive effects of alcohol consumption on hearing? Does the effect of alcohol consumption on hearing differ based on gender, age, education, socioeconomic status, race, ethnicity, and/or culture affect? And does alcohol consumption affect certain frequencies and not others?

The findings were mixed in response to these questions. Let us first discuss the articles that found no association between alcohol consumption and hearing loss. The multivariate analysis by Kim (2015) found alcohol consumption patterns to not be associated with hearing loss. The data of Rigters and colleagues (2018) confirmed the findings of Kim (2015); alcohol consumption was not associated with risk of hearing loss. Similarly, Cruickshanks et al. (2015) demonstrated no association between alcohol consumption and hearing loss and found similar results for both men and women.

In contrast, Popelka et al. (2000), Fransen et al. (2008), Helzner et al. (2005) and Gopinath et al. (2010) found significant and non-significant protective trends across all test frequencies. Popelka et al. (2000) looked at age and gender as well as high-frequency (4000-8000Hz) and low frequency (500-2000Hz) effects of alcohol consumption on hearing loss. Popelka and colleagues found that consuming more than 0 grams per day, but less than 20 grams per day, was associated with better hearing; however, these results were not statistically significant. This was true for those with pure tone averages greater than 25 dB HL and greater than 40dB HL, and there was no difference when looking at age groups 48-69 years and 70-92 years. Similarly, there were no differences between men and women. Additionally, Popelka et al. (2000) did find that consuming more than 20 grams per day had a statistically significant negative effect on hearing. The authors also found that consuming more than 56 grams of alcohol per day was not significantly associated

with elevated low frequencies, however there was a statistically significant association with the high frequency thresholds being elevated. Lastly, when looking at the data itself, Popelka and colleagues found an indubitable U-shaped, or quadratic, trend; teetotalers and those that consumed more than 20 grams per day had worse hearing thresholds than those who consumed more than 0 grams per day, but less than 20 grams per day.

Gopinath et al. (2010) found comparable results. When analyzing white and red wine, beer, port, and spirits, the authors found a statistically significant protective effect when consuming more than 10 grams of alcohol per day on hearing, compared to teetotalers. When looking at those with hearing loss greater than 40dB HL, the majority of those individuals drank less than 10 grams per day. When looking at the categories of those who consumed more than 10 grams per day, but less than 20 grams per day, and those that consumed more than 20 grams per day, the number of individuals with hearing loss greater than 40 dB HL significantly decreased. That being said, consuming more than 20 grams per day was significantly associated with having less chances of developing hearing loss greater than 40 dB HL. Gopinath and colleagues looked at the low-frequency (500-2000Hz) and high-frequency (4000-8000Hz) differences as well. The authors found that the association between consuming red and white wine with better low-frequency thresholds to be statistically significant; however, the same was not true for high-frequency thresholds.

Fransen et al. (2008) demonstrated that alcohol consumption of more than 1.14 grams per day had significant protective effects on participants, in all frequencies, in three out of the nine locations, and that two additional locations found a protective trend that did not reach significance in the high frequencies. There were no statistically significant gender effects. Lastly, Helzner et al. (2005) found that black females were 83% less likely to have hearing loss when consuming the

equivalent or more than 8 grams of alcohol per day. However, a greater probability of hearing loss in teetotalers was not observed.

<u>Research Question #2:</u> Does alcohol use differentially affect the parts of the ear (outer, middle, and inner ear) leading to different types of hearing loss (sensorineural, conductive, and mixed)?

All articles included in the study defined hearing loss using a three-frequency pure tone average (PTA) of specific air conduction thresholds, and there were was rarely a mention of bone conduction thresholds being assessed. Therefore, information on type of hearing loss was rarely available

<u>Research Question #3:</u> Does the type of alcohol consumed have a differential effect on hearing status?

Popelka et al. (2000) included light beer, regular beer, wine, and liquor in their analysis, and they found a protective trend when consuming less than 20 grams per day. Additionally, those who consumed less than 20 grams per day, but more than 0 grams per day, had better thresholds than teetotalers and those who consumed 56 grams or more of alcohol per day had worsened high-frequency thresholds. Data from Fransen and colleagues (2008) included beer, wine, and spirits, and found similar protective effects in three of their locations and two non-significant trends toward protection. Similarly, Gopinath et al. (2010) included beer, red and white wine, port, and spirits and found a significantly lower chance of developing hearing loss greater than 40 dB HL with any type of alcohol consumption greater than 20 grams per day. The authors also found a significant protective effect of red and white wine on low-frequency (500-2000Hz) hearing loss.

On the other end of the spectrum, Cruickshanks et al. (2015), included beer, wine, and spirits, and found no association between alcohol consumption and hearing loss. However, the authors noted that most of the alcohol consumed was beer, which may have influenced the results. The common factor of beer and wine can be seen in the three articles that demonstrated a protective effect. However, no conclusions can be determined based on this information, seeing as not all of the articles mentioned the types of alcohol consumed and the limited data in general.

<u>Research Question # 4:</u> Does the quantity of alcohol consumed differentially affect hearing thresholds?

Popelka and colleagues (2000) found that consuming less than 20 grams of alcohol per day had a protective effect on thresholds. However, consuming more than 20 grams per day had a significant negative effect on hearing. Furthermore, the authors found increased high-frequency thresholds in those that consumed more than 56 grams of alcohol per day with statistical significance. Similarly, Gopinath et al. (2010) found that drinking more than 10 grams per day, but less than or equal to 20 grams per day, was significantly associated with better hearing when compared to teetotalers, and that the average consumption of more than 20 grams per day was significantly associated with a lower probability of developing a hearing loss greater than 40 dB HL.

DISCUSSION

Questions #1 and #4

The findings from the various studies were mixed. Kim (2015), Rigters et al. (2018) and Cruickshanks et al. (2015) found no form of association between alcohol consumption and hearing

loss. Studies by Fischer et al. (2014), Ohgami et al. (2011) and Vasconcelos and colleagues (2012) found similar conclusions. Similarly, Marieke and colleagues (2013), who measured hearing levels using speech recognition thresholds (SRT), found no association with alcohol consumption.

In contrast, Popelka et al. (2000), Fransen et al. (2008), and Gopinath et al. (2010) found significant, as well as non-significant, protective trends across all frequencies as well as across specific frequencies. Popelka and colleagues (2000) and Gopinath et al. (2010) found a protective effect of consuming more than 20 grams per day. Similarly, Engdahl et al. (2015) found a non-significant protective effect of alcohol consumption. Sogebi (2013) found that "occasional or light consumption" had protective effects on hearing thresholds. Dawes et al. (2014) found that, compared to teetotalers, those who consumed 0.14 to 28.11 grams per day had a 40% less chance of developing hearing loss. Lee JS et al. (2015) also observed that those who consumed alcohol less than once a month and that those who consumed alcohol more than two-to-four times a month had better high-frequency thresholds than teetotalers and those who consumed alcohol four times per week.

Several studies worth mentioning did not define hearing loss and/or alcohol consumption, and for the most part, the results revealed negative effects of alcohol consumption on air conduction thresholds. These articles have their limitations as we can either not ascertain the veracity of the hearing thresholds or we cannot quantify alcohol consumption. However, these articles are still important to consider. Nakamura et al. (2001) found that those who consumed more than 54 grams of alcohol per day were more than twice as likely to have a flat hearing loss and were five times as likely to have profound hearing loss than teetotalers. Lao et al. (2013) similarly found that "daily" consumption resulted in an increased risk of hearing loss and Pecorari

et al. (2019) found that those who consumed more than 10 grams of alcohol per day had a higher risk of hearing loss.

Along those lines, Popelka et al. (2000) demonstrated a trend of increased hearing loss in teetotalers and those who consumed less than or equal to 20 grams per day. Verma et al. (2006) similarly found increased thresholds (more than 30 dB) in the high frequencies of those who were alcohol dependent, compared to teetotalers. Belle et al. (2007) found that alcoholics and "long term" alcohol consumers had higher risk for hearing loss. Contrawise, Itoh et al. (2001) and Dawes et al. (2014) did not find an increased risk of developing hearing loss when consuming more than 30 grams per day, which according to the Royal College of Psychiatrists (2011), is considered hazardous to one's health.

Question #2

All studies defined hearing loss according to the three-or-four-frequency PTA, and most studies did not detail the type of hearing loss as sensorineural, conductive, or mixed. Therefore, the type of hearing loss that can potentially arise due to alcohol consumption cannot be confirmed.

Question #3

Of the articles that specified the type of alcohol consumed, three-out-of-four found significant protective effects. The alcoholic beverages considered in those studies were beer, wine, spirits, ports and liquor. The article by Cruickshanks et al. (2015), did not reveal an association between alcohol consumption and hearing loss, admitted that the majority of their subjects drank beer, which could be a reason for their results. The beverages in common among all articles are wine and beer.

Question #5

Gopinath et al. (2010) adjusted for age and gender. Rigters et al. (2018) and Kim (2015), did not analyze the effects of gender with respect to alcohol consumption. Cruickshanks et al. (2015) Fransen et al. (2008), and Popelka et al. (2000) found no differences between genders. Helzner et al. (2005) on the other hand found that black women who consumed more than 8 grams per day were 83% less likely to develop hearing loss than teetotalers. All other variables analyzed in this systematic review were mentioned in disparate articles; however, they were not analyzed with respect to both alcohol consumption and hearing loss but were mentioned in relation to hearing loss only. Similar to Helzner et al. (2005), Park and Suh (2019) found a difference between men and women. The authors found that more than 42 grams of consumption for men and less than or equal to 14 grams for women reduced their risks for hearing loss, but the results were not statistically significant.

Lin and colleagues (2017) assessed the effects of moderate alcohol consumption (MAC) on hearing thresholds among men and women. The definition of MAC was classified as 8 grams per day for women and 8-to-16 grams per day for men. Lin et al. (2017) found that only female drinkers with MAC tended to have better high-and-low frequency thresholds when compared to teetotalers.

As a result of the work of Lin et al. (2017) and Helzner et al. (2005), it appears that there may be a greater chance for women to develop hearing loss more readily than men as a result of alcohol consumption. The article by Park and Suh (2019) further support this idea.

Question #6

Fransen et al. (2018) reported that three-out-of-nine locations revealed a statistically significant association between alcohol consumption and hearing loss in both the high and the low frequencies. Additionally, two more subsamples had a similar trend in the high frequencies. Gopinath et al. (2010) found a protective association between red and white wine and low-frequency hearing status that was statistically significant. With respect to high frequencies, there were no statistically significant associations observed. Moreover, Popelka et al. (2000) found that all levels of alcohol consumption, except consuming greater than 20 grams per day, had a protective effect on hearing loss, which was similar in both high and low frequencies. No association was found in the low frequencies when consuming more than 56 grams per day; however, a significant association was found in the high frequencies, suggesting an increased risk for hearing loss in the high frequencies with greater consumption. Rigters and colleagues (2016) conducted a cross-sectional study to assess the low-and-high frequency hearing loss in both men and women. The authors found that the consumption of at least 8 grams of alcohol per day is significantly associated with better low-frequency thresholds in both men and women when compared to teetotalers. Contrarily, Upile et al. (2007) found that "mild to moderate" consumption of alcohol resulted in increased low-frequency thresholds.

LIMITATIONS OF SYSTEMATIC REVIEW

All studies arrived at conclusions which were pertinent; however, comparisons across studies were not possible. The researcher wanted to analyze similarities between studies where a particular effect was found; however, both the underlying quantitative and qualitative data produced within each study could not be grouped or combined into mutually exclusive intervals, which constrained the ability to extrapolate any further. For example, there were limited studies

with similar intervals for the quantity of alcohol consumed, such as 0-20 grams per day and 20-40 grams per day. Therefore, although individual study conclusions were made, inter-study comparisons and aggregate analysis were not possible.

Another limitation of this systematic review, which further impeded the ability to cross-analyze, was the actual quantity of alcohol consumption. Almost all of the articles had a lower bound on the drinking criteria, but no upper bound. Additionally, some of the authors skipped complete intervals of consumption. For example, Kim (2015) included those who consumed 1-15 grams of alcohol per day and those who consumed more than 30 grams per day, but completely disregarded those who consumed 15-to-30 grams per day. The data on the association of hearing loss with alcohol consumption are limited, thereby constraining further conclusions. Many articles' studies, which were not included in this systematic review, did focus on the topic at hand, however they lacked substantial information. Several authors failed to define the levels of alcohol consumption and the degree of hearing loss. Without a proper definition of these key terms, it is impossible to use any data from these articles in a meaningful way. Future research should be clearer with their definitions and should be as specific as possible. If alcohol is being assessed, the types of alcohol should be stratified, and if hearing is being assessed, the degree and type of hearing loss should be noted. The more specific the information, the better.

It is quite evident from the breakdown of the database search that there was insufficient research with adequate definitions. Many articles were excluded due to a lack of proper descriptions of alcohol quantities consumed and objective hearing loss measures. Of the 15 articles that contained alcohol and hearing loss in those aged 40 years and older, only eight articles

provided definitions for both these terms, one of which included alcoholics and was therefore excluded.

Furthermore, race/ethnicity, gender, socioeconomic status, and education level are all important factors that should be analyzed; however, most articles do not analyze these nominal and ordinal variables with respect to alcohol and its effect on hearing loss; rather, they simply analyze them in terms of hearing loss alone. It would be interesting to first analyze the effects of alcohol on hearing loss and then stratify based on these variables.

CLINICAL IMPLICATIONS

Heavy alcohol consumption significantly affects many bodily functions including blood pressure and cardiovascular function (CDC.gov). As the list of negative side effects increases, the risk for heavy alcohol consumption will hopefully decrease. While some authors have debunked the fact that heavy alcohol affects hearing thresholds, many authors have concluded just that. This finding adds to the list of detrimental effects of heavy alcohol consumption and can potentially deter individuals from consuming a hazardous amount of alcohol.

It is important for individuals to understand the consequences and implications of the comestibles they consume. As is well known, alcohol has many detrimental effects on one's body when consumed in a large quantity. While there is clearly a paucity of well conducted studies on the effects of alcohol consumption on one's hearing, there seems to be a negative effect of consuming a significantly large amount of alcohol; however, the quantity of alcohol needed to reach significance is difficult to quantify. As a result, clinicians can conclude from the correlation

analyses that it is important to counsel individuals to be careful when it comes to consuming alcohol seeing as, when taken in excess, the effects can be unhealthy.

In summary, most of the studies revealed that consuming less than 20 grams of alcohol per day either had no effect or had a positive effect on one's hearing. Therefore, one may potentially conclude that there is no negative effect of consuming these quantities of alcohol. Moreover, of the studies that found a positive effect of consuming alcohol on one's hearing, those who consumed alcohol tended to have better hearing thresholds than teetotalers.

Correlation is not cause and effect. As a result of the limited data and similarities among studies, no cause and effect can be noted. Therefore, correlations are the only conclusions that can be made.

TABLE 2: Tips For Counseling Patients

Consuming less than 20 grams of alcohol per day either has a positive effect or no effect on hearing.
Consuming a large amount of alcohol (unspecified quantity) is correlated with elevated thresholds.
Those who consume less than 20 grams of alcohol every day tend to have better thresholds then teetotalers (Popelka et al., 2000)
Red and white wine tend to be correlated with better low frequency thresholds (Gopinath et al., 2010)
Those who consume more than 20 grams of alcohol per day have less chance of having hearing loss greater than 40 dBHL (Gopinath et al., 2010)
Black females are 83% less likely to have hearing loss when consuming the equivalent or more than 8 grams of alcohol in one day (Helzner et al., 2005)

Consuming the equivalent or more than 1.14 grams of alcohol every day has a significant protective effect on hearing (Fransen et al., 2008)
Consuming more than 56 grams of alcohol per day is significantly associated with high frequency hearing loss (Popelka et al., 2000)

CONCLUSIONS

This systematic review sought to determine a connection between alcohol consumption and hearing loss. The hypothesis of the study was that alcohol would be detrimental to hearing and that the volume of consumption is inversely related to hearing thresholds. Based on the seven included studies, it is evident that there is a positive correlation between alcohol consumption and hearing loss. The different levels of alcohol consumption defined by the various articles make it difficult to develop deeper conclusions, but the relationship is indubitable. Furthermore, there is certainly a negative relationship between heavy alcohol consumption (albeit by an unspecified amount) and hearing. Upon summarizing the seven articles, it is apparent that more research must be conducted in order to construct stronger conclusions. There are copious relevant articles dating to the years prior to 2000, however this data needs to be updated and conducted in a way that clearly defines hearing loss and alcohol consumption, as well as modifies by age, gender, socioeconomic system, educational level, degree of hearing loss, type of hearing loss, race, ethnicity, and culture. By amalgamating this information and by separating the different types of alcohol, it will be possible to make conclusions regarding the true relationship between alcohol and hearing.

REFERENCES

Alcohol and hearing loss - Can drinking alcohol cause ear problems. (n.d.). Retrieved January 17, 2021, from https://www.hear-it.org/Alcohol-can-cause-hearing-loss

Alcohol's Effects on the Body. (n.d.). Retrieved January 17, 2021, from https://www.niaaa.nih.gov/alcohols-effects-health/alcohols-effects-body

Alcohol Units. (n.d.). https://www.nhs.uk/live-well/alcohol-support/calculating-alcohol-units/#:~:text=Units%20are%20a%20simple%20way,can%20process%20in%20an%20hour.

Alpert M, Bogorad DD. (1975). Reduction of sensory sharpening processes associated with chronic alcoholism. *Adv Exp Med Biol*, 59, 605-613.

Arnarson, A. (2018). Alcohol and Health: The Good, the Bad, and the Ugly. Retrieved from https://www.healthline.com/nutrition/alcohol-good-or-bad

Barral, J., & Croibier, A. (2009). Vestibulocochlear nerve. In *Manual therapy for the cranial nerves* (1st ed., pp. 167-180). Edimburgh: Churchill Livingstone.

Beam, S. L., Gant, R. W., & Mecham, M. J. (1978). Communication deviations in alcoholics: a pilot study. New Brunswick, NJ: Rutgers Center of Alcohol Studies, Publications Division.

Bellé M, Sartori Sdo A, Rossi AG. Alcoholism: effects on the cochleo-vestibular apparatus. *Braz J Otorhinolaryngol*. 2007 Jan-Feb;73(1):110-6. doi: 10.1016/s1808-8694(15)31132-0. PMID: 17505609.

Brant, L. J. (1996). Risk factors related to age associated hearing loss in the speech frequencies. *Journal of the American Academy of Audiology*, 152–160.

Burke, D. (2017, July 17). Age-Related hearing loss: Causes, diagnosis, and treatment. *Healthline*.

Clason, D. (2020, November 10). Age-related hearing loss - Why do people lose hearing in old age? Retrieved January 17, 2021, from https://www.healthyhearing.com/report/52510-Presbycusis-understanding-age-related-hearing-loss

Clason, D. (2019, November 15). Drinking and hearing loss: Know the risks. Retrieved January 17, 2021, from https://www.healthyhearing.com/report/52762-Drinking-and-hearing-loss

Cohen, J. M., Blustein, J., Weinstein, B. E., Dischinger, H., Sherman, S., Grudzen, C., & Chodosh, J. (2017). Studies of physician-patient communication with older patients: How often is hearing loss considered? A systematic literature review. *Journal of the American Geriatrics Society, 65*(8), 1642-1649. doi:10.1111/jgs.14860

Curry, A. (2017, February 1). Our 9,000-year love affair with booze. *National Geographic*.

Dawes P, Cruickshanks KJ, Moore DR, Edmondson-Jones M, McCormack A, Fortnum H, Munro KJ. Cigarette smoking, passive smoking, alcohol consumption, and hearing loss. J Assoc Res Otolaryngol. 2014 Aug;15(4):663-74. doi: 10.1007/s10162-014-0461-0. Epub 2014 May 28. PMID: 24899378; PMCID: PMC4141428.

Drinking too much alcohol can harm your health. Learn the facts. (2021, January 14). Retrieved January 17, 2021, from https://www.cdc.gov/alcohol/fact-sheets/alcohol-use.htm

Editorial Staff, Wagener, D., M.A, & Thomas, S., M.D. (2019). The History of Alcohol Throughout The World. *American Addition Centers*.

Stein, S., MSN, & Monico, N. (2021). Effects of Alcohol on the Body & Mind. *American Addiction Centers*.

Engdahl B, Aarhus L, Lie A, Tambs K. Cardiovascular risk factors and hearing loss: The HUNT study. Int J Audiol. 2015;54(12):958-66. doi: 10.3109/14992027.2015.1090631. Epub 2015 Oct 8. PMID: 26642893.

Fischer, M. E., Schubert, C. R., Nondahl, D. M., Dalton, D. S., Huang, G., Keating, B. J., . . . Cruickshanks, K. J. (2015). Subclinical atherosclerosis and increased risk of hearing impairment. *Atherosclerosis, 238*(2), 344-349. doi:10.1016/j.atherosclerosis.2014.12.031

Fransen, E., Topsakal, V., Hendrickx, J. J., Laer, L. V., Huyghe, J., Eycken, E. V., … Van Camp, G. (2008). Occupational noise, smoking, and a high body mass index are risk factors for age-related hearing impairment and moderate alcohol consumption is protective: A European population-based multicenter study. *Journal of the Association for Researchin Otolayngology,* 9(3), 264–276.

Gately, I. (2009). *Drink: A Cultural History of Alcohol*. New York: *Gotham Books.*

Gibb, C. (2017, August 11). One in eight American adults is an alcoholic: study. *NY Daily News.*

Gołabek W, Niedzielska G. (1984). Audiological investigation of chronic alcoholics. *Clin Otolaryngol Allied Sci*, 9(5), 257-261.

Gopinath, B., Flood, V. M., Mcmahon, C. M., Burlutsky, G., Smith, W., & Mitchell, P. (2010). The effects of smoking and alcohol consumption on age-related hearing loss: The Blue Mountains hearing study. *Ear and Hearing,* 31(2), 277–282.

Gowin, J. Ph.D. and Hagan, E. (2010, June 18). Your Brain on Alcohol: is the conventional wisdom wrong about booze? *Psychology Today.*

Helzner EP, Cauley JA, Pratt SR, Wisniewski SR, Zmuda JM, Talbott EO, de Rekeneire N, Harris TB, Rubin SM, Simonsick EM, Tylavsky FA, Newman AB. Race and sex differences in age-related hearing loss: the Health, Aging and Body Composition Study. J Am Geriatr Soc. 2005 Dec;53(12):2119-27. doi: 10.1111/j.1532-5415.2005.00525.x. PMID: 16398896.

Itoh A, Nakashima T, Arao H, Wakai K, Tamakoshi A, Kawamura T, Ohno Y. Smoking and drinking habits as risk factors for hearing loss in the elderly: epidemiological study of subjects undergoing routine health checks in Aichi, Japan. Public Health. 2001 May;115(3):192-6. doi: 10.1038/sj.ph.1900765. PMID: 11429714.

Jones, O. (2018, September 23). The External Ear. Retrieved from https://teachmeanatomy.info/ head/organs/ear/external-ear/

Józefowicz-Korczynska M, Lukomski M, Kurnatowski P. (1994). Vestibular system in alcohol and drug addicts. *Mater Med Pol,* 26(4), 123-126.

Kahkonen, S., Rossi, E. M., & Yamashita, H. (2004). Alcohol impairs auditory processing of frequency changes and novel sounds: a combined MEG and EEG study. *Psychopharmacology*, 177(4), 366–372.

Kim, K. S., & Kwon, O. J. (2012). Prevalence and Risk Factors of Hearing Loss Using the Korean Working Conditions Survey. *Korean Journal of Audiology*,16(2), 54.

Koff R, S, Oliai A, Sparks R, W. (1973). Sensori-Neural Hearing Loss in Alcoholic Cirrhosis. Digestion 8, 248-253.

Lao, X. Q., Yu, I. T. S., Au, D. K. K., Chiu, Y. L., Wong, C. C. Y., & Wong, T. W. (2013). Noise exposure and hearing impairment among Chinese restaurant workers and entertainment employees in Hong Kong. Public Library of Science, 8(8).

Lee JS, Choi HG, Jang JH, Sim S, Hong SK, Lee HJ, Park B, Kim HJ. Analysis of Predisposing Factors for Hearing Loss in Adults. *J Korean Med Sci*. 2015 Aug;30(8):1175-82. doi: 10.3346/jkms.2015.30.8.1175. Epub 2015 Jul 15. PMID: 26240497; PMCID: PMC4520950.

Li, Y., Healy, E. W., Drane, J. W., & Zhang, J. (2006). Comorbidity between and risk factors for severe hearing and memory impairment in older Americans. *Preventive Medicine*,43(5), 416-421.

Lin, YY., Chen, HC., Lai, WS. *et al.* Gender Differences in the Association between Moderate Alcohol Consumption and Hearing Threshold Shifts. *Sci Rep* **7,** 2201 (2017). https://doi.org/10.1038/s41598-017-02426-4

Lukomski M, Kurnatowski P, Józefowicz-Korczyńska M. (1999). Charakter upośledzeń słuchu u narkomanów i osób spozywajacych alkohole niekonsumpcyjne. Types of hearing disorders in drug addicts and individuals drinking non-consumable alcohols. *Med Pr*, 50(1), 37-42.

Mackenzie, M. (2018, November 29). Confirmed: A Cinco de Mayo Marg *Will* Make You Happier.

Mark, J. (2020, August 29). Beer in Ancient Egypt. Retrieved from https://www.ancient.eu/article/1033/beer-in-ancient-egypt/

Mei, X., Atturo, F., Wadin, K., Larsson, S., Agrawal, S., Ladak, H. M., … Rask-Andersen, H. (2018). Human inner ear blood supply revisited: the Uppsala collection of temporal bone—an international resource of education and collaboration. *Upsala Journal of Medical Sciences*, 123(3), 131–142.

Nakamura M, Aoki N, Nakashima T, Hoshino T, Yokoyama T, Morioka S, Kawamura T, Tanaka H, Hashimoto T, Ohno Y, Whitlock G. Smoking, alcohol, sleep and risk of idiopathic sudden deafness: a case-control study using pooled controls. J Epidemiol. 2001 Mar;11(2):81-6. doi: 10.2188/jea.11.81. PMID: 11388497.

Ohgami N, Kondo T, Kato M. (2011). Effects of light smoking on extra-high-frequency auditory thresholds in young adults. *Toxicol Ind Health*. 2011 Mar;27(2):143-7. doi: 10.1177/0748233710382539. Epub 2010 Sep 21. PMID: 20858647.

Park JA, Suh MJ. (YEAR). Hazardous Alcohol Consumption and the Risk of Hearing Impairment in Adults Based on the Korean National Health and Nutrition Survey: A Retrospective Study. *J Audiol Otol*. 2019 Apr;23(2):63-68. doi: 10.7874/jao.2018.00241. Epub 2019 Feb 8. PMID: 30727720; PMCID: PMC6468280.

Pecorari G, Riva G, Naqe N, Bruno G, Nardo M, Albera R. (YEAR) Long-term Audiometric Outcomes in Unilateral Sudden Sensorineural Hearing Loss without Recurrence. J Int Adv Otol. 2019 Apr;15(1):56-61. doi: 10.5152/iao.2019.6670. PMID: 31058596; PMCID: PMC6483438.

Popelka, M. M., Cruickshanks, K. J., Wiley, T. L., Tweed, T. S., Klein, B. E., Klein, R., & Nondahl, D. M. (2000). Moderate Alcohol Consumption and Hearing Loss: A Protective Effect. Journal of the American Geriatrics Society,48(10), 1273-1278.

Richards, P. (2020, April 09). Alcoholism Statistics You Need to Know. Retrieved January 17, 2021, from https://talbottcampus.com/alcoholism-statistics/

Rigters, S. C., Metselaar, M., Wieringa, M. H., Jong, R. J., Hofman, A., & Goedegebure, A. (2016). Contributing Determinants to Hearing Loss in Elderly Men and Women: Results from the Population-Based Rotterdam Study. *Audiology and Neurotology, 21*(Suppl. 1), 10-15. doi:10.1159/000448348

Rigters, S., Van Der Schroeff, M., Papageorgiou, G., Baatenburg De Jong, R., & Goedegebure, A. (2018). Progression of Hearing Loss in the Aging Population: Repeated Auditory Measurements in the Rotterdam Study. *Audiology and Neurotology*. 23(5), 290-297.

Rosenhall, U., Sixt, E., Sundh, V., & Svanborg, A. (1993). Correlations between Presbyacusis and Extrinsic Noxious Factors. *International Journal of Audiology*, 32(4), 234–243.

Sampson, H. W. (1998). Alcohol's Harmful Effects on Bone. Alcohol Health and Research World, 22(3), 190–194.

Schimmel, D. (2019). The Truth about What Alcohol Does to Your Body.

Schuckit, M. A. (2005). Alcohol-related disorders. In B. J. Sadock & V. A. Sadock (Eds.), Kaplan and Sadock's Comprehensive Textbook of Psychiatry (7th ed.). Philadephia: Lippincott Williams & Wilkins.

Shen WW. (1983). Alcoholic neuropathy associated with the eighth cranial nerve. Psychosomatics, 24(4),407-408.

Sogebi, O. (2013). Assessment of the risk factors for hearing loss in adult Nigerian population. *Nigerian Medical Journal, 54*(4), 244. doi:10.4103/0300-1652.119648

Spitzer JB. (1981). Auditory effects of chronic alcoholism. *Drug Alcohol Depend*, 8(4),317-335.

Spitzer JB, Ventry IM. (1980). Central auditory dysfunction among chronic alcoholics. *Arch Otolaryngol*, 106(4), 224-229.

Squires S, Chichester C, Cirelli D, Divadio L, Hulcher S. (1985). Sensory alterations in alcohol abuse. *Topics in Clinical Nursing*, 6(4), 51-63.

Upile T, Sipaul F, Jerjes W, Singh S, Nouraei SA, El Maaytah M, Andrews P, Graham J, Hopper C, Wright A. The acute effects of alcohol on auditory thresholds. BMC Ear Nose Throat Disord. 2007 Sep 18;7:4. doi: 10.1186/1472-6815-7-4. PMID: 17877829; PMCID: PMC2031886.

Vasconcelos KA, Lima MA, Frota S, Ruffino Netto A, Kritski AL. Audiometric evaluation of patients treated for pulmonary tuberculosis. J Bras Pneumol. 2012 Jan-Feb;38(1):81-7. English, Portuguese. doi: 10.1590/s1806-37132012000100012. PMID: 22407044.

Verma RK, Panda NK, Basu D, Raghunathan M. Audiovestibular dysfunction in alcohol dependence. Are we worried? Am J Otolaryngol. 2006 Jul-Aug;27(4):225-8. doi: 10.1016/j.amjoto.2005.09.005. PMID: 16798396.

What happens when you drink alcohol? (n.d.). Retrieved from https://www.alcohol.org.nz/alcohol-its-effects/about-alcohol/what-happens-when-you-drink-alcohol

What is a standard drink? (n.d.). https://www.niaaa.nih.gov/alcohols-effects-health/overview-alcohol-consumption/what-standarddrink#:~:text=In%20the%20United%20States%2 C%20one,which%20is%20about%2040%25%20alcohol

Wheeler DC, Dewolfe AS, Rausch MA. (1980). Audiometric configuration in patients being treated for alcoholism. *Drug Alcohol Depend*, 5(1), 63-68.

Yildirim, N. (2012). Hearing Impairment in Vascular Disorders . Van Tıp Dergisi, 149–157.

Ylikoski JS, House JW, Hernandez I. (1981). Eighth nerve alcoholic neuropathy: a case report with light and electron microscopic findings. *J Laryngol Otol*, 95(6), 631-642.

Zuev VA. Kokhleovestibuliarnye narusheniia u bol'nykh khronicheskim alkogolizmom. (1984). Cochleovestibular disorders in chronic alcoholics. Zh Nevropatol Psikhiatr Im S S Korsakova, 84(2), 238-240.