THE EFFECT OF FRONT OF PACKAGE LABELING ON POUR ACCURACY OF A STANDARD DRINK FOR ALCOHOLIC BEVERAGES POURED BY COLLEGE STUDENTS

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ABSTRACT

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In the United States, few laws govern the labeling requirements for alcoholic beverages. Research shows that overconsumption of alcoholic beverages can be the source of many health-related issues, undergraduate students often engage in dangerous levels of alcohol consumption, and front of package (FOP) labels garner attention and are easily understood when used with food products. This study investigates undergraduate student ability to accurately pour a standard drink and the effect a front of package label identifying the number of standard drinks per container has on their ability to do so. Participants were asked to complete an alcohol behavior survey, with results indicating that undergraduate students consumed alcoholic beverages across alcohol categories and have minimal knowledge regarding alcohol related information (alcohol content, warnings, etc.). In a pouring task, participants were instructed to pour a standard drink of a mock alcoholic beverage presented to them, including beer, wine, and liquor, of high and low alcohol content for each category. In the pouring task, the FOP label was found to have a significant and more accurate effect across alcohol categories and content levels in comparison to traditional alcohol by volume labeling ($\propto$=0.05). When pour error is converted to a percentage of a standard drink, the FOP benefit for beer was found to have a significantly greater effect when compared to wine or liquor ($\propto$=0.05). This study presents an opportunity to implement FOP standard drink labeling as a way of increasing standard drink pour accuracy.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 - INTRODUCTION

Alcohol, a chemical compound produced through the fermentation of grains, fruits, and other substances, has been around for thousands of years. Over the course of time, alcoholic beverages have served a variety of purposes, including: a source for needed nutrients, medicinal and antiseptic purposes, thirst quenchers, and enjoyment of various life activities.

Risks Associated with Alcohol

Alcohol consumption is known to be associated with a variety of risks, including being a leading risk factor for birth defects (if consumed during pregnancy) and major diseases. Other risks include alcoholism, binge drinking, alcohol poisoning, and mortality. (See Table 1 for a summation of drinking behaviors) (1)

Table 1: Drinking Behaviors as Defined by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) (1)

Drinking Behavior	**Definition**	**For Men**	**For Women**
Moderate Drinking	Standard drinking behavior	2 standard drinks per day	1 standard drink per day
Binge Drinking	Pattern of drinking that brings blood alcohol concentration (BAC) levels to 0.08 g/dL	5 standard drinks in 2 hours	4 standard drinks in 2 hours
Heavy/Excessive Alcohol Use	Pattern of excessive binge drinking	Binge drinking 5+ times per month	Binge drinking 5+ times per month

Furthermore, excessive drinking behaviors can be associated with morbidity. The Alcohol-Related Disease Impact Report (ARDI) estimates that excessive alcohol use accounts for an average of 88,000 deaths per year in the United States alone, with more than half of these attributable to binge drinking (2)[1]. In 2014, alcohol impaired driving fatalities accounted for 9,967 deaths, nearly 1/3 (31%) of all driving fatalities (3). Excessive drinking was estimated to cost the US $249 billion in 2010, with three quarters of the total cost attributable to binge drinking (4).

While excessive alcohol consumption has been associated with health issues and higher rates of mortality, moderate consumption has been associated with a few health benefits. These benefits include reduced risk of developing and dying from heart disease, reduced risk of ischemic stroke, and potential reductions in the risk for developing diabetes (5,6,7). In light of the potential for varied outcomes associated with consumption behaviors, policies which encourage appropriate consumption behaviors have important ramifications for not only health, but also the economy.

Current Alcohol Regulations

In the United States, alcohol is regulated by the Alcohol, Tobacco, Tax and Trade Bureau (TTB). Currently, a minimal number of statutes dictate mandates regarding products categorized as alcohol. Among these are the National Minimum Drinking Age Act, which required all states to increase their required drinking age to 21 or sacrifice funding (8). That said, many States have exemptions to the age requirements for consumption. These include religious purposes, medicinal purposes, and medical amnesty, where a minor will not be charged with underage

[1] Based on data collected from 2006-2010

alcohol consumption if they are contacting emergency services for another person who has consumed too much alcohol.

The Alcoholic Beverages Act of 1988 required that all alcoholic beverage containers have a “Beverage Health Warning Statement,” which was intended to inform consumers about risks associated with alcohol consumption, including the increased likelihood of birth defects and impaired ability to drive or operate machinery (9). Although these statements are now present on alcoholic beverages, research suggested that knowledge of the message increased slowly and was largely incomplete after the regulations it authorized were implemented. In fact, nearly four years after the introduction of this warning, awareness of the message had only risen to 80% in the population (10).

While alcohol is largely legislated at the national level, it is also governed by the states themselves. The 21st amendment, which repealed national prohibition, gave states the right to decide whether to allow the sale of alcohol, determine allowable hours for daily sales and distribution practices throughout the state, and whether or not alcohol can be sold in grocery stores (11). The grocery store decision is based on the classification of alcohol into beer, wine, or distilled spirits, which is primarily determined by the alcohol by volume (ABV) in the product. The U.S. Code of Federal Regulations (CFR) specifically defines terms for beer, malt beverage, wine, and distilled spirits (12,13,14). These definitions, alongside a calculated standard drink sizes and alcohol content, can be found in Table 2.

Table 2: Definitions of Beer, Malt Beverage, Wine, and Distilled Spirits

(12,13,14) (See Alcohol Content for standard drink calculation)

Type	Definition	Standard Alcohol by Volume	Standard Drink Size
Beer	Beer, ale, porter, stout, and other similar fermented beverages (including sake or similar products) of any name or description containing one-half of 1 percent or more of alcohol by volume, brewed or produced from malt, wholly or in part, or from any substitute therefor	5%	12 oz
Malt Beverage	A beverage made by the alcoholic fermentation of an infusion or decoction, or combination of both, in potable brewing water, of malted barley with hops, or their parts, or their products, and with or without other malted cereals, and with or without the addition of unmalted or prepared cereals, other carbohydrates or products prepared therefrom, and with or without the addition of carbon dioxide, and with or without other wholesome products suitable for human food consumption	7%	8-9 oz
Wine	Every kind (class and type) of product produced on bonded wine premises from grapes, other fruit (including berries), or other suitable agricultural products. Still wine, including vermouth or other aperitif wine, artificial or imitation wines or compounds sold as still wines, champagne or sparkling wine, and artificially carbonated wine, and flavored or sweetened fortified or unfortified wines, by whatever name sold or offered for sale, containing not over 24 percent alcohol by volume.	12%	5 oz
Distilled Spirits	Ethyl alcohol, ethanol, or spirits of wine, and all mixtures or dilutions thereof, from whatever source or by whatever process produced, including alcohol, whisky, brandy, gin, rum, and vodka, but not including wine	40%	1.5 oz

As previously mentioned, the TTB regulates the manufacture and sale of alcohol in the United States. The Federal Alcohol Administration Act (15) gives broad authority to the TTB to define regulations with respect to the label requirements for malt beverages, beer, wine, and distilled spirits. Each alcohol classification is subjected to similar labeling requirements under the TTB. A summary of these requirements can be found in Table 3.

Table 3: Label Requirements Summary

Mandatory label Information	**Malt Beverages & Beer**	**Wine**	**Distilled Spirits**
Brand Name	X	X	X
Class & Type Designation	X	X	X
Alcohol Content	X	X	X
Name & Address	X	X	X
Country of Origin	X	X	X
Net Contents	X	X	X
Presence of Coloring Materials			X
Treatment with Wood			X*
FD&C Yellow #5 Disclosure	X	X	X
Saccharin Disclosure	X	X	X
Aspartame Disclosure	X	X	
Sulfite Declaration	X	X	X
Commodity Statement			X*
Statement of Age			X*
State of Distillation			X*
Health Warning Statement**	X	X	X

* = Only applicable to certain class and type designations. Specific guidelines for each requirement can be found here: https://www.ttb.gov/labeling/labeling-resources.shtml
** = **GOVERNMENT WARNING**: (1) According to the Surgeon General, women should not drink alcoholic beverages during pregnancy because of the risk of birth defects. (2) Consumption of alcoholic beverages impairs your ability to drive a car or operate machinery and may cause health problems.

It is important to note that while beer and malted beverages are classified under the same general labeling requirements in this situation, the definition of beer and malt beverage differ (as shown in Table 2) and can lead to different labeling requirements under a special circumstance where a brewed product meets the definition of beer (12), but does not meet the definition of a malt beverage under the Federal Alcohol Administration Act (FAA) (13). To clarify this situation, the TTB released a ruling describing the classification of brewed products as beer and malt beverages (16). This ruling states that the definition of beer does not require that it be brewed from malted barley; instead, it may be brewed from a partial portion of malted barley or any substitute therefor. Additionally, the production of beer does not require the use of hops and must contain one half of one percent or more of alcohol by volume. There is no minimum alcohol content for malt beverages. In some instances, a brewed beverage may fall under the definition of beer, but not malted beverage as defined by the FAA Act. In this case, the brewed product falls outside the scope of the FAA Act and is, therefore, exempt from traditional labeling requirements for beer and malted beverages under the TTB as noted in Table 2. These products will instead be subjected to the food labeling requirements of the US Food and Drug Administration (FDA) as well as labeling of alcohol content and presence of the government warning statement. *For purposes of this study, the primary targets will be beer, wine, and distilled spirits (liquor).*

Currently, there are no distinct/explicit nutrition labeling requirements on the majority of alcohol products sold in the US. While there are some exceptions, including gluten free beer and hard ciders (16), these beverages fail to meet the definition of a "malt beverage" as mentioned prior, and therefore fall under the authority of the US Food and Drug Administration (FDA). In addition, cooking wines are considered a non-beverage wine through the addition of food additives, therefore falling under the labeling requirements of the FDA (17).

While the labeling of most alcoholic beverages falls to the TTB, a majority of the requirements for food labeling are authored by the FDA which, empowered by Congress under the Nutritional Labeling Education Act of 1990 and the Federal Allergen and Consumer Protection Act of 2004, which amended the Federal Food Drug and Cosmetic Act, has promulgated regulations (18). These regulations mandate the content and formatting of information, including nutrition in the form of the Nutrition Facts Panels (NFP) (18), content requirements (20), and allergen requirements (21). The separate regulatory authorities, whom have very different missions, have historically resulted in alcoholic beverages typically requiring much less information regarding ingredients and nutrition compared to food products.

There is some indication that this might change in the future. Over the past decade, the TTB has explored the idea of a "Serving Facts Panel" (SFP), issuing a guidance document for this concept in 2013 (22). The SFP, modeled closely after the NFP, is intended to present key pieces of nutritional information; however, the TTB has not introduced or endorsed a specific format for the SFP after years of deliberation. In the recent past, some alcoholic beverage manufacturers have begun to include nutrition and ingredient information on secondary packaging as a way to increase transparency between the manufacturer and the consumer (23). It is important to note that while this may appear beneficial to the consumer, the application of these labels is largely unregulated by the TTB. For example, Bud Light has recently released a series of commercials identifying the use of a serving facts panel on secondary packaging (the package containing bottles/cans) of Bud Light. In these commercials, Bud Light touts a new level of transparency with the consumer regarding the nutrition and ingredients of their beer; however, these inclusions are entirely voluntary and unregulated. The notion that an alcoholic beverage manufacturer is free to include such information without regulation, as opposed to regulations prescribed by the FDA for food products, allows a flexibility for the manufacturer and the potential to present information without uniformity across products. This new adaption is still in its early form with potential to spread to many other large alcoholic beverages manufactures.

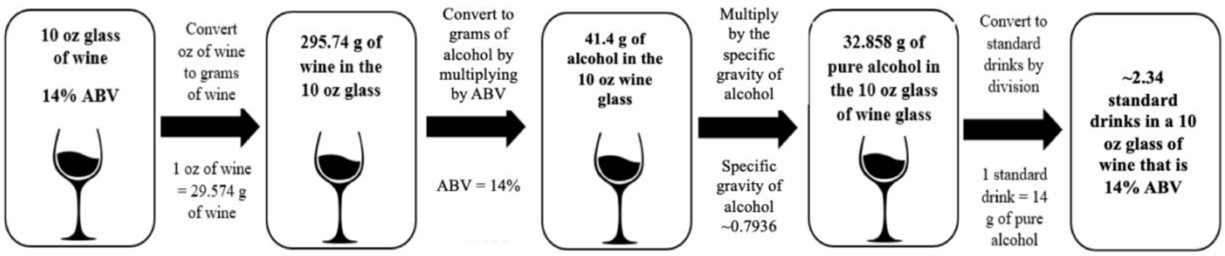
While the TTB has explored the SFP concept, the FDA has begun exploring the use Front of Package Labels (FOP) for application in products regulated by the FDA, namely, food. FOPs generally present a few pieces of critical nutrition information on the front panel of a package. While there are no current US regulations for FOPs on food products, interest has grown and official bodies have begun to urge research on the topic. These bodies include the White House's Task Force on Childhood Obesity, convened under the Obama Administration, which explicitly recommended the development and implementation of standardized FOP labels based on scientific research (24); the US FDA, who identified investigation of FOP designs as a key initiative in its 2012-2016 Strategic Plan (25) and the Institute of Medicine (now the National Academy of Medicine) who called for objective evaluation of the efficacy of FOPs, including recommendations regarding design requirements (26). A review of the literature regarding the efficacy of FOPs for food labels, presented in the literature review, suggests there is a growing body of evidence regarding the efficacy of FOP labeling, begging the question of whether or not a similar system of front of package labeling could be adopted/adapted for alcoholic beverages and their respective alcohol contents.

Alcohol Content

There are a variety of different ways in which alcohol content can be conveyed. These include alcohol content by volume (ABV), proof, the number of standard drinks in a standard serving, the number of standard drinks in a container, the amount of pure alcohol in a standard serving, or the amount of pure alcohol in a drink container. Currently, the TTB favors presentation of ABV, maintaining a rationale that consumers are used to seeing alcohol content presented in this fashion and may be confused by presentation in an alternate way (22). While consumers may be used to seeing alcohol content presented this way, there is reason to believe this presentation may not be the best way to convey information on alcohol content.

For example, the mental math required to calculate the number of standard drinks consumed from a container is challenging. It requires knowing what constitutes a standard drink; the US Centers for Disease Control and Prevention (CDC) considers a standard drink as containing 14 grams of pure alcohol, or 0.6 fl oz of pure alcohol. With that information, consider a bottle of wine with 14% alcohol by volume (ABV) printed on its label. When pouring a 10 oz glass of wine, ounces need to be converted to grams by multiplying 10 oz wine by 29.574 g/oz wine, which shows that the glass will contain 295.74 grams of wine. After which point, the grams of wine are multiplied by the alcohol be volume (14%), resulting in in 41.40 grams of alcohol in that 10 oz glass. This amount must be multiplied by the specific gravity of alcohol (~0.7936), which would be 32.858 grams. The last step requires dividing that number by 14 grams of per alcohol/standard drink, (the reference standard according the CDC) (14), to find that the one 10 oz glass of this particular wine is equivalent to 2.34 standard drinks (Figure 1). This calculation demonstrates that reasoning the number of standard drinks based on alcohol by volume is neither easy nor intuitive.

Figure 1: Converting to Standard Drinks



While the CDC maintains recommendations for standards drinks of wine, beer, malt beverages, and distilled spirits (see Table 1 for reference), it is important to note that there can be wide variation in the ABV of a single type of alcohol, especially for beers or distilled spirits. For example, the recommendation is valid for a can (container) of Budweiser (5% ABV), but the consumption of a 12 oz can of New Holland Dragon's Milk (11% ABV) exceeds 2 standard drinks. In this case, if using the aforementioned heuristic that a 12 oz can of beer is equal to one standard drink and consuming the Dragon's Milk, there is a potential for significant over-consumption.

Overall, this information demonstrates that presenting alcohol content using alcohol by volume ABV may not be the most effective way. This raises the question of whether another form of presentation would better convey information to consumers regarding alcohol content, such as the number of standard drinks in a standard serving, the number of standard drinks in a container, or the amount of pure alcohol in a standard serving.

CHAPTER 2 - LITERATURE REVIEW

Alcohol Behaviors

In young adults, drinking can be particularly problematic as this cohort is increasingly susceptible to binge drinking (27) and resultant problems. In the United States, binge drinking has become a serious problem, especially among those aged 18 to 25 (28); one study found that a large portion of college student's drink at peak levels well beyond the binge threshold (see table 1) (29). To help combat this issue, intervention initiatives are becoming increasingly common. This is a primary reason for why proposed work focuses on undergraduate college students and their ability to identify and pour standard drinks based on alcohol content.

Studies investigating the efficacy of warning labels as an approach for informing consumers about the dangers of overconsumption have demonstrated that consumer awareness of warning labels tends to remain constant or diminish as consumers habituate the presence of the warning on alcohol labels (30). Moreover, research suggests that current alcohol warning labels in the US do not have the preventative effects that they intend regarding consumption behaviors (31). In one study, the effectiveness of alcohol warning labels was investigated to determine if the presence of these labels would have an effect on drinking behavior. In particular, results showed that warning labels formatted as questions were able to increase negative alcohol-related outcome expectancies (addiction, headaches, feeling depressed, etc.) individuals reported as opposed to warning labels formatted as statements; however, potential changes in drinking behavior were not promising as reported drinking intentions did not change (32). This knowledge is useful in demonstrating that alarmist warning labels are not successful in changing overt behavior, thus begging the question of whether or not a fact-based front of package label may have different outcomes.

Psychological Reactance Theory

According to the theory of psychological reactance, when people feel their behavioral freedoms are being threatened, they experience a state of reactance that motivates them to further engage in that behavior to protect their behavioral freedom (33). It is important to note that this theory has potentially played a role in collegiate drinking behaviors (e.g. binge drinking, excessive drinking, etc. – See Table 1), as the current warning label enacted tends to come from a fear motivated place of persuasion.

A study conducted shortly after increasing the legal drinking age to 21 in the United States indicated that an increase in underage drinking may have been due to arousal of reactance motivation with regard to the new law and the restrictions it imposed (34). Furthermore, in a study examining the effects of persuasive health messages, it was found that these messages can either facilitate or buffer reactance effects depending on the severity of the threat communicated (35). Only original messages comprised of low threats were capable of being buffered (35), implying that one must be careful to not over-impose threats in order to avoid reactance mechanisms. Lastly, another study monitored the effects of students receiving high and low threat messages regarding alcohol consumption and found that the high threat messages were perceived more negatively and resulted in higher drinking intentions (36). This study continued with a "perception study" where students were instructed to taste and rate beers; males who received high threat messages drank significantly more beer compared to controls (36). Together, these studies support the idea that participants experienced reactance due to a perceived threat toward their behavioral freedom regarding alcohol consumption.

Herein, messaging is analytical, not fear motivated, having the goal of empowering consumers to make knowledgeable pouring decisions using a fact-based appeal that employs the use of a front of package (FOP) labeling system containing the number of standard drinks in a given alcoholic beverage container. The hypothesis is that by avoiding labeling that suggests a threat to personal freedoms, reactance motivation is avoided. Results from this work can potentially be continued into a study of behavior to monitor any potential reactance as a result of the label-based appeal.

Alcohol Content & Standard Drink Comprehension

As a specific objective of this study is to evaluate college student's understanding of alcohol content and how a front of package labeling system can potentially assist in information processing and pouring behaviors, it is important to review the literature that exists. Currently, standard drink labeling requires that alcohol content be displayed in the form of alcohol by volume (%ABV), but, as previously discussed, conversion to standard drink sizes requires arduous math and knowledge of alcohol content standards. When looking at standard drink sizes, one study required U.S college students to complete an alcohol survey and pour a variety of alcoholic beverages to a volume they deemed to be a standard drink. The study found that the students did not know how to define standard drinks accurately and overestimated volume when pouring drinks (37). Several other studies of young-adult drinkers and colleges students have also determined that they are generally unaware of alcohol content in beverages, and national recommendations regarding drinking behaviors (38,39).

Another study of college students and bartenders in the U.S. established that both tended to over-pour distilled spirits into short-wide, empty shot glasses (40). Furthermore, one study examined alcohol content in college party mixed drinks and found that while sampled mixed drinks typically approximated to one standard drink, there was high variability in the strength of mixed drinks which would inhibit a student's ability to keep track of standard drinks they consumed (41).

A limited number of studies explore the addition of standard drink information on labels for alcoholic beverages. A two-part Australian study found that participants using ABV information on alcoholic beverage containers tended to underestimate the total number of standard drinks in the beverage and over-poured standard drinks when compared to participants using alcoholic beverage containers with standard drink labels (42). In this study, after a brief educational session on standard drinks, participants were asked to pour standard drinks of mock beer or wine using traditional ABV labeling and a new label that defined the number of standard drinks per container. The rectangular standard drink labels used 3.5 mm black text on a white background; However, the location of these labels on the beverage was not specified. The second study found 63% of participants preferred the standard drink label (43), and Australia has since adopted a standard drink labeling practice for alcoholic beverages.

Reviewed studies suggest that college students are largely unaware of alcohol content and standard drink sizes (37,38,39), and that it is important to explore strategies of varied types that would increase alcohol content comprehension. Herein, we propose to leverage the front of package strategy, proven effective for food products (49-58), to present standard drinks per container, which has evidence of efficacy with Australian drinkers (42,43).

Front of Package Labels

A majority of the research regarding front of pack labeling studies its efficacy with nutrition information. While there are no specific regulations or requirements for including any form of nutritional information on alcoholic beverages, we believe that the front of pack strategy offers potential benefit for informing consumers about how to more accurately pour a standard drink. Given the complexities illuminated elsewhere in this document, this represents an important opportunity.

Researchers have examined how the effect of the presence of standard nutrition labels alongside alcoholic beverages impact perceptions and behaviors. One such study investigated how the presence of nutrition labels impacted plans for drinking. The results demonstrated no positive or negative effect for the presence of a nutrition label; however, 86.1% to 87% of participants indicated a preference for having the information present on the package (44). The study targeted underaged college students, as they are generally at high risk for high levels of alcohol consumption and binge drinking (45) and are often unaware of nutrition information specific to alcohol (46). Researchers indicated that results pointed to the idea that students planned their alcohol consumption, and the presence of nutrition labels did not differentially affect these plans (44). Furthermore, results suggest the existence of a demand for labeling concerning nutrition and health issues related to wine, although consumers did report difficulty in understanding this information (47).

Research indicates that the positioning and design of nutrition labels on food products has been shown to affect many behaviors. This has led to interest in how shortened nutrition labels that appear on the front of the package (FOP) may impact a variety of behaviors (e.g. attention, comprehension and, ultimately, food consumption) (48). As previously mentioned, this push includes many official bodies urging the exploration of FOP labeling as a viable solution. Generally, an FOP presents key pieces of nutritional information on the principle display panel (PDP) of a package. The PDP is the panel that consumers see on grocery store shelves, which can capture attention and enable on-shelf cross product comparisons (49). Research from around the world documents various aspects of the FOP approach for nutrition labeling.

In Australia, research determined that adult consumers were able to make healthier food choices through the use of various FOP label formats (50) and found strong support for the inclusion of total fat, saturated fat, sugar, and sodium nutrient information on front of package labels (51). In France, studies found that the purpose of FOPs was generally understood and accepted by adults (52), consumers preferred FOP labels with complete, simplified information (52), and FOP labels assisted in making healthier food choices (53). Lastly, in Mexico research demonstrated that FOP labels were easy to understand, highly accepted, and useful for making decisions by Hispanic consumers (54).

In the United States, research has found that FOP labels are attended to more often, and earlier, than the currently regulated nutrition facts panel on both novel and commercial brands (55), and that the use of color increased attention to FOP labels over monochromatic designs (55). Further work using eye tracking indicated that colored FOP labels enhanced the probability of attention to nutrition information, including faster detection and longer viewing of the provided information (56). Benefits were not limited to attention; work suggests that the presence of FOP labels can improve consumer accuracy of judgements about the nutritional quality of food and beverage products (57). Lastly, research focused on parental food purchasing decisions for their children demonstrated that presentation of favorable health and nutrient content on the front of a package was effective in positively impacting parent's choices for healthier food options (58). Based on this information, there is a timely opportunity to explore whether or not front of pack labels can share these same effects when applied to alcoholic beverages for alcohol content in order to more clearly communicate information about standard drinks.

CHAPTER 3 - HYPOTHESIS & STUDY OBJECTIVES

Since alcohol sold in the United States is controlled by the TTB, an agency which emphasizes labeling through regulations that are driven by a mission that is quite different than that of the US FDA, only small amounts of information are required to be present on the package. For instance, alcohol content is only required to be presented in the form of alcohol by volume (ABV). At the same time, a large, and growing, body of evidence suggests multiple benefits of using Front of Pack (FOP) labeling strategies for food products. With this in mind, we propose objectively exploring consumer understanding of current alcoholic beverage labels and assessing the performance of a novel FOP labeling system for alcoholic beverage labels. More specifically, could an FOP convey information about a container's number of standard drinks to college students in a way that increases the accuracy of pouring (i.e. induces participants to accurately pour a standard drink). This research consists of a primary hypothesis and 2 objectives:

Hypothesis - A front of pack (FOP) labeling strategy, found to be effective at: garnering attention, enhancing understanding and inducing healthier selection when incorporated into nutrition labeling, will aid college-aged participants' ability to correctly identify, comprehend and pour a standard drink.

Objective 1

1) Gather information about college student's current understanding of alcoholic beverage labels and their drinking behaviors
    - Evaluate student's knowledge of standard drink sizes and alcohol content
    - Evaluate student perception of labeling on beer, wine, and liquor
    - Evaluate student's drinking behaviors relating to beer, wine, and liquor

Objective 2

2) Evaluate the impact that a novel FOP labeling system which conveys standard drinks per container has on the ability to accurately comprehend and pour a standard drink

   - Determine the effect that the FOP has on pour accuracy

   - Examine these effects in light of how pouring behavior could potentially impact consumption, and ultimately, health

CHAPTER 4 - MATERIALS & METHODS

To study how a novel front of package label designed by the research team impacted undergraduate participants' ability to pour (identify) a standard drink, we conducted a pour study where accuracy of pour was the dependent variable. Treatments were comprised of mock alcoholic beverages from three product categories (beer, wine and liquor) each at two levels of alcohol content per category (high and low). All participants were between 18 and 25 years old and were recruited using the paid SONA system available through the College of Communication Arts and Sciences (CAS) at Michigan State University.

Internal Review Board (IRB) Approval

The IRB application (STUDY 0000083) was approved with exempt status with all subjects providing informed, written consent to participate. The IRB approved documents, including the approval letter, consent form, recruitment flyer, and questionnaire relating to knowledge of alcohol and consumption behaviors, are included in Appendix 1.

Participant Recruitment

Eighty-four participants were recruited through the online paid research pool SONA system, which is maintained by the College of Communication Arts and Sciences at Michigan State University. The SONA system allowed participants who qualified for the study (see screening criteria below) to sign up for a 1-hour time-slot during the Summer and Fall semesters of 2018. This sign-up included information on the experiment, the testing location, and information relating to compensation for participation. In exchange for their participation, a $20 cash incentive was provided. This incentive and required materials were funded using funds that remained from a College of Agriculture and Natural Resources Undergraduate Research stipend provided to Eric Brunk in the Fall of 2015 and Spring of 2016, and funding from the Healthcare, Universal design, and Biomechanics (HUB) Laboratory funds. As they underwent the informed consent process, participants were instructed that they were free to withdraw from the study at any point and still receive compensation. Every participant received a reminder email 24 hours before the study time-slot.

For reasons thoroughly discussed in the literature review portion of this document, undergraduate students were the target population for this study. It is imperative that this vulnerable population have an understanding of alcohol content and the variations in content that exists within and between different product categories (beer, wine, and liquor), as variations in alcohol content have the potential to lead to significant differences in the number of standard drinks per container.

To be eligible for the study, participants were required to be undergraduate students 18 years of age or older. The paid SONA system requires prospective participants to set up a research profile, which includes a pre-screening questionnaire. Students that did not self-identify as Undergraduates during the prescreening material were not forwarded to the study. In addition, participation required subjects to provide their own transportation to and from the School of Packaging at Michigan State University, be willing to have their experiment data stored anonymously, not be legally blind, and provide an email address to be contacted with a study reminder prior to their scheduled time slot.

Stimulus Design

As previously stated, this study uses a 3 x 2 x 2 experimental design, with 3 alcohol categories (beer, wine and liquor), 2 label types (traditional and an FOP presenting standard drinks/container), and 2 alcohol content levels (high and low in each of the respective categories). This results in a total of 12 different combinations (3 category x 2 label x 2 levels of alcohol). For each alcohol category (beer, wine, and liquor), one original brand was created and used for both label types (traditional and FOP) and alcohol content levels (high and low). Each label was designed in Adobe Illustrator and printed on Primera 101.6 x 76.2 mm Extreme White Matte BOPP labels using a Primera LX900 label printer. For beer, the label was printed and cut to 76.2 x 76.2 mm in order to fit the bottle appropriately. In accordance with common practice, each label design had the alcohol content placed in the lower right corner of the label and the bottle capacity in the lower left; However, laws regulating the labeling of alcoholic beverages (27 CFR Parts 4-7) (9) only require this information to be placed on the front, back, or side of the package. In accordance with current legal requirements, net content was displayed in fluid ounces (fl oz) for beer in bottles less than 1 pint, in milliliters (mL) for wine in bottles less than 1 liter (L), and in milliliters (mL) for liquor in bottles less than 1 liter (L). For each design, the alcohol category was identified. A summary of the information used to design stimuli is found in Table 1. Labels are presented in Table 5 and to scale in Appendix B. An example stimulus representing each of the two label styles is found in Figure 2 (category, beer; high alcohol content and standard labeling) and Figure 3 (category, beer, high alcohol content and FOP labeling treatment).

Using the standard drink calculator available at "Rethink Drinking" published by the NIAA, the standard drinks per container were calculated (59). The calculator enables the user to input the bottle size and alcohol content, and the calculator will output the standard drink size and number of standard drinks per container. For each beverage type, a low and high alcohol content level was selected representing a product at the low and high end of alcohol content for its respective category. Information at each level (low content and high content) was used to create both label formats (standard and front of package).

Table 4: Summary of Stimulus Design

Type	Container	Container Size*	Receptacle	Receptacle Size*	Brand	Alcohol Level	Standard Label (Alc. By Vol.)	FOP Label Standard Drinks per container	Standard Drink Size*
Beer	Bottle	12 fl oz 355 mL	Solo cup	16 oz 473 mL	"High Seas Brewing Co."	Low	5% (A)	1 (B)	12 fl oz 355 mL
						High	10% (C)	2 (D)	6 fl oz 177 mL
Wine	Bottle	25.4 fl oz 750 mL	Stemless wine glass	14 oz 414 mL	"Simply Divine Fine Wines"	Low	10% (E)	4.2 (F)	6 fl oz 177 mL
						High	15% (G)	6.3 (H)	4 fl oz 118 mL
Liquor	Bottle	25.4 fl oz 750 mL	Bar shot glass	9 oz 266 mL	"Caribbean Dreams"	Low	20% (I)	8.4 (J)	3 fl oz 89 mL
						High	40% (K)	16.9 (L)	1.5 fl oz 44 mL

Red font indicates the 12 different label variations used in the study. The standard and FOP labels indicate the same amount of alcohol per container in low and high formats. Each letter corresponds to the stimulus labels located in Table 2.
**Volume provided in fl oz and mL due to differences in labeling requirements among alcoholic beverage categories (beer, wine, liquor) as stated previously*

Figure 2: Example Stimulus Design: Beer, Standard Label, High Alcohol Content

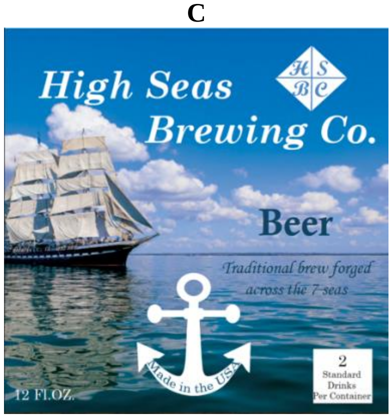
Figure 3: Example Stimulus Design: Beer, FOP Label, High Alcohol Content

Table 5: Stimulus Label Design

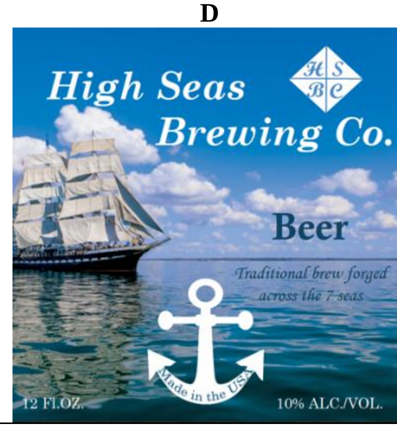
<table>
<tr><th></th><th>Front of Package Label</th><th>Standard Label</th></tr>
<tr><td>Beer
Low Alcohol
Content</td><td>A

</td><td>B

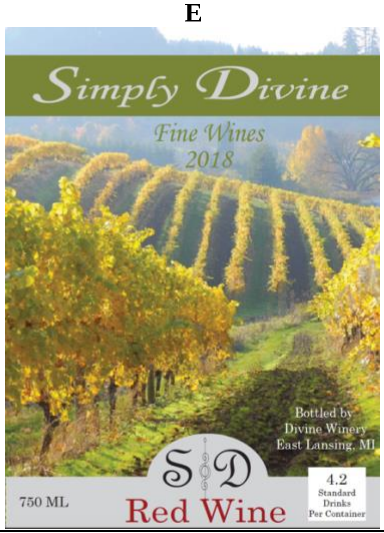
</td></tr>
<tr><td>Beer
High Alcohol
Content</td><td>C



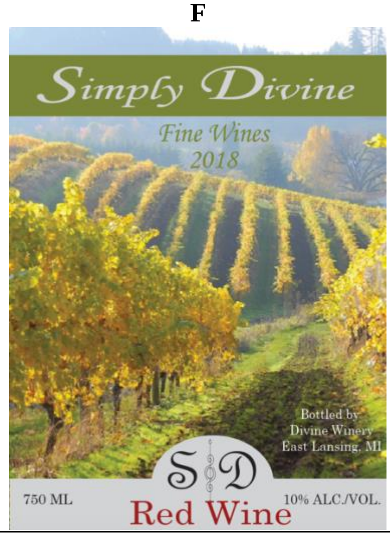
</td><td>D



</td></tr>
<tr><td>Wine
Low Alcohol
Content</td><td>E

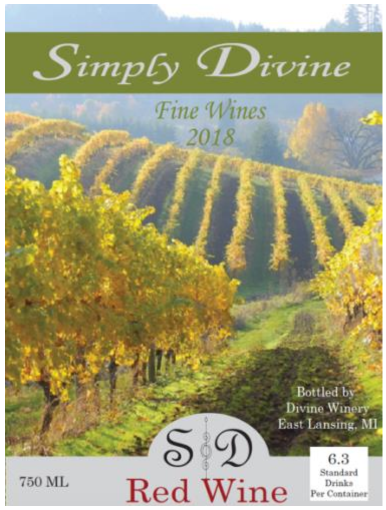
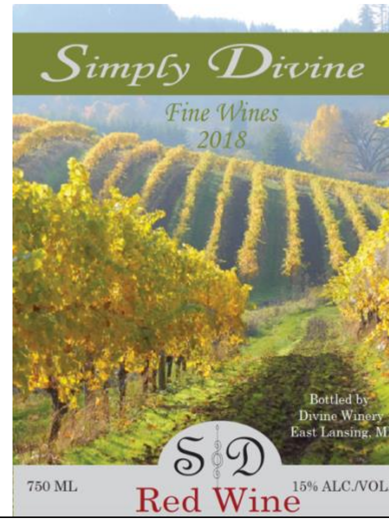
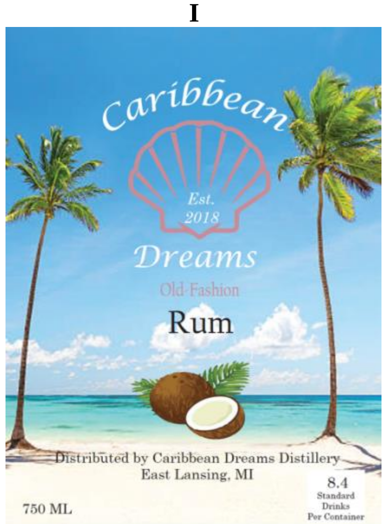
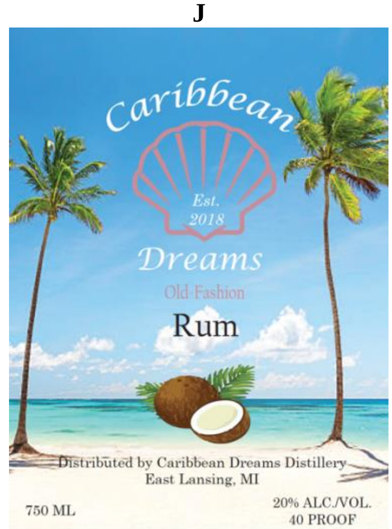
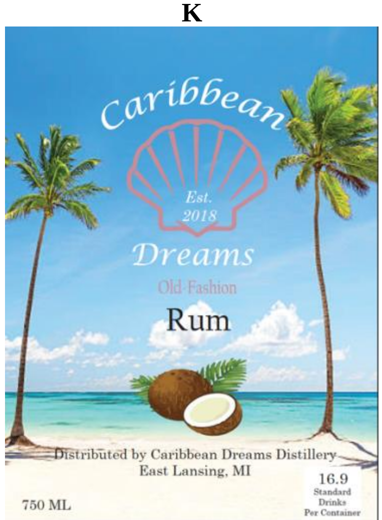
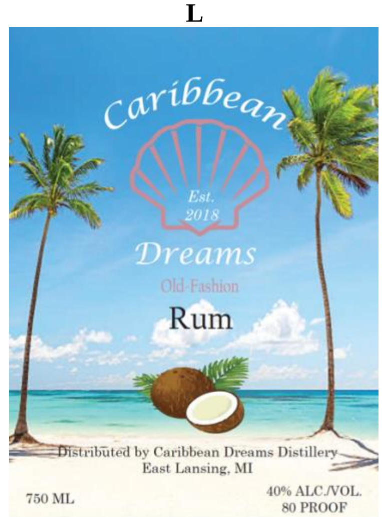


</td><td>F



</td></tr>
</table>

Table 5 (cont'd): Stimulus Label Design

	G	**H**
Wine High Alcohol Content		
	I	**J**
Liquor Low Alcohol Content		
	K	**L**
Liquor High Alcohol Content		

Each label was vertically centered on the body of the bottles purchased specifically for each product category. Specifically, for beer, a 12 fl oz amber beer bottle (Leinenkugel Summer Shandy Glass Beer Bottle (label removed), Amber, 12 fl oz, USA) was used. For treatments from the beer category, participants were asked to pour a standard drink into a 16 oz solo cup (Solo, Red, 16 oz, USA). For wine, a 750 mL green glass Bordeaux wine bottle (North Mountain Supply Glass Bordeaux Wine Bottle, Transition Green, 750 mL, USA) was used in conjunction with a 14 oz glass stemless wine glass. For the liquor category, a 750 mL clear glass claret bottle (Midwest Homebrewing Glass Claret Bottle, Clear, 750 mL, USA) was used in conjunction with a 9 oz bar-style shot glass for pouring.

Once all labels were applied, filtered water was measured using a 500 mL graduated cylinder with 5 mL graduation (EISCO, 500 mL) to accurately fill each bottle to its label claim capacity (355 mL for the beer category, 750 mL for wine, and 750 mL for liquor). Food coloring was used to make the mock beverage appear more realistic. Brown food coloring (Americolor, Chocolate Brown, 0.75 oz, USA) was added for mock beer and red food coloring (McCormick, Red, 1 oz, USA) was added for mock wine. The mock liquor was clear. An example of this set up can be found in Figure 4.

Figure 4: Experimental Set Up

Laboratory Set Up

The experiment took place in the Healthcare, Universal Design, and Biomechanics (HUB) laboratory, located in room 159 of the School of Packaging at Michigan State University. The laboratory was set up to allow for 2 participants to partake in the study during a 1-hour time slot. In preparation, two participant workstations were set up, complete with a rolling chair, height-adjustable desk, pen, paper towel, and subject number. An opaque divider wall was placed between the two participant workstations to disable participants from seeing each other's pouring behaviors. Prior to each participant, the bottles were refilled to their respective full levels. Each participant completed a total of 24 pours, which were accomplished in two blocks of 12 pours. Each block contained all 12 different label treatments (3 alcohol categories, x 2 levels of alcohol content x 2 label treatments) developed for this study, so after the first block, the participant will have been exposed to all different label combinations (category x label x alcohol level). The first block (12 pours) presented to the participant was randomized using the RAND() function in Microsoft Excel to assign a random number to each of the 12 different treatments. These random numbers were sorted from smallest to largest to achieve a randomized order for all 12 label treatments. The second block (12 pours) was an exact replicate of the randomized order created for the first block (i.e. participants completed the same 12 pours in the same order as the first block). Prior to participant arrival, the 12 treatment bottles were placed in the randomized order on a table behind the participant with labels facing the wall. The respective pouring receptacle was placed alongside each treatment.

A separate station was set up for the purpose of accessing each participant's pour accuracy by treatment. This station was equipped with one 500 mL graduate cylinder (EISCO, 500 mL), one 250 mL graduated cylinder (EISCO, 250 mL), three liquid pitchers, and a waste bucket. Protective mats were placed on all tables in case of spills. Cleaning supplies and materials to dispose properly of broken glass were available to handle unexpected breakage of treatments.

Two researchers from the HUB laboratory were present in the lab for the majority of participants in the study. The primary researcher, Eric Brunk, was present for all participants. Eric Brunk's role for each participant included an introduction, providing the consent form, and measuring all participant pours at the measuring station in order to keep consistency among measurement of the dependent variable. Other roles fulfilled by HUB laboratory researchers present for the study include general experimental set up, providing participants with each treatment during the pouring task, refilling samples during intermission and after completion of the study, and providing the participant with the cash incentive.

Full Material List:

- North Mountain Supply Glass Bordeaux Wine Bottle, Transition Green, 750 mL, USA
- Midwest Homebrewing Glass Claret/Bordeaux Bottle, Clear, 750 mL, USA
- Leinenkugel Summer Shandy Glass Beer Bottle (label removed), Amber, 12 oz, USA
- Michley Drinking Glasses (Bar shot glasses), 9 oz, USA
- Solo plastic Party Cups, 16 oz, USA
- Standard Wine Glass, 14 oz, USA
- Primera 4.0” x 3.0” Extreme White Matte BOPP Label Stock
- Primera LX900 Label Printer
- EISCO Polypropylene Graduated Cylinder, 500 mL, 5 mL graduation
- EISCO Polypropylene Graduated Cylinder, 250 mL, 2 mL graduation
- McCormick Food Color, Red, 1 oz, USA
- Americolor Soft Gel Paste Food Color, Chocolate Brown, 0.75 oz, USA
- Wide-mouth Funnels
- Liquid Pitchers
- Paper Towels
- Glass Cleanup Supplies

Participant Process

As a participant arrived at the HUB laboratory, the first step in the procedure was to assign a subject number in order to de-identify all data associated with this study. Each participant then received two copies of the consent form. The first copy (white) was given to the participant and they were instructed to read it over, ask questions if needed, and sign, indicating a willingness to participate. The second copy (blue) was provided to the participant to take home; both included contact information should any questions occur after they had completed their participation in the study. Once the participant indicated they had no further questions and signed the consent form, the study commenced.

To begin, each participant was provided with a laptop to answer a brief questionnaire aimed at assessing their knowledge of alcohol and behavior regarding the same; this was completed prior to the pouring task. Each participant entered their assigned subject number and completed the questionnaire. The purpose of this questionnaire was to gather basic demographic information and engage students in thinking about their drinking behaviors in preparation for the pouring task. The full questionnaire can be found in appendix A.

Once the questionnaire was complete, the laptop was removed from the participant's workspace in order to prepare for the pouring task. Each participant was read the same prompt prior to beginning the pouring task. The prompt read as follows,

> "In this experiment you will be pouring standard drinks of a mock alcoholic beverage for multiple trials. We will provide you with a bottle of a mock alcoholic beverage as well as a vessel in which to pour the drink in to. Once you believe you have accurately poured a standard drink, we will collect the sample to be measured and provide you with the next for a total of 24 trials with a brief intermission after the first 12. You may use any information presented on the bottle to help determine what the standard drink size of the given beverage may be. Do you have any questions before we begin?"

Once the participant indicated they had no further questions, they were provided with the first trial. As stated, each trial consisted of a mock alcoholic beverage comprised of one of the twelve different treatments and its respective receptacle for pouring a standard drink (Figure 3). As stated, the order for the first block of 12 pours was randomized for each participant and replicated in the same order for a second block of 12 pours. The participant poured a standard drink, and the receptacle was removed to measure how much liquid (in mL) of the mock beverage had been poured into the receptacle. The poured volume was recorded in order to calculate the accuracy of the participant's pour for a given treatment. Pour accuracy by treatment was compared. Once the mock alcoholic beverage and receptacle (i.e. solo cup, stemless wine glass or bar shot glass) were removed from the desk, the next trial would be provided to the participant. After the first block of 12 pours, the participant would receive a five-minute intermission. During this time, researchers replaced and re-filled the twelve stimuli in preparation for the second block of pouring. Once all stimuli were prepared, the participant was asked to begin the second block.

After a total of 24 pours had been completed, each participant's desk was fully cleared, and a $20 cash incentive was provided to the participant in exchange for their signature to verify receipt of the incentive. All participants were thanked for their participation in the study.

CHAPTER 5 - RESULTS & DISCUSSION

Participant Summary

Eighty-four participants ranging in age from 18-25 years old were recruited using methods described previously; the median and mean participant age was 21 years old (SD 1.35 years). Basic demographic information of the participant population is summarized in Table 6. The complete survey can be found in Appendix A.

Table 6: Participant Demographic – Gender, Ethnicity, & Year in School

	Total	%
Sample Size	84	100%
Gender		
Male	22	26%
Female	61	73%
Non-binary or Other	1	1%
Total	84	
Ethnicity		
Black or African American	12	14%
Asian	8	10%
White	56	67%
Hispanic, Latinx	2	2%
Two or more races	4	5%
Other	2	2%
Total	84	
Year in School		
Freshman	2	2%
Sophomore	8	10%

Table 6 (cont'd): Participant Demographic – Gender, Ethnicity, & Year in School

Junior	16	19%
Senior	58	69%
Total	84	

Survey

To further characterize participants in support of Objective 1, students were asked various questions about their drinking behaviors, including frequency of drinking by beverage category and other questions which were intended to gauge their knowledge of alcohol content among different categories of alcoholic beverages and different beverages. Portions of this survey were adapted from the Student Alcohol Questionnaire (SAQ) and used with permission for research purposes (60). Results pertaining to the responses related to drinking frequency are summarized in Figures 5 (frequency by product category) and 6 (level of alcoholic beverage consumption on an average occasion).

Figure 5: Survey Responses for Undergraduate Drinking Behavior – Frequency of Consumption

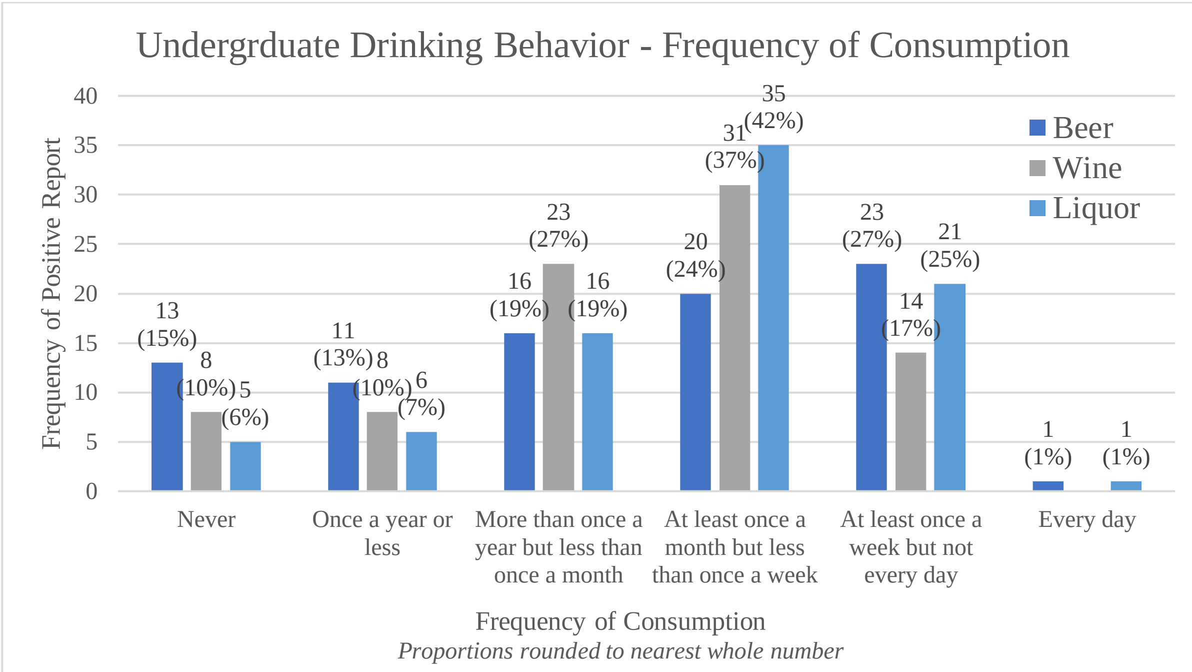
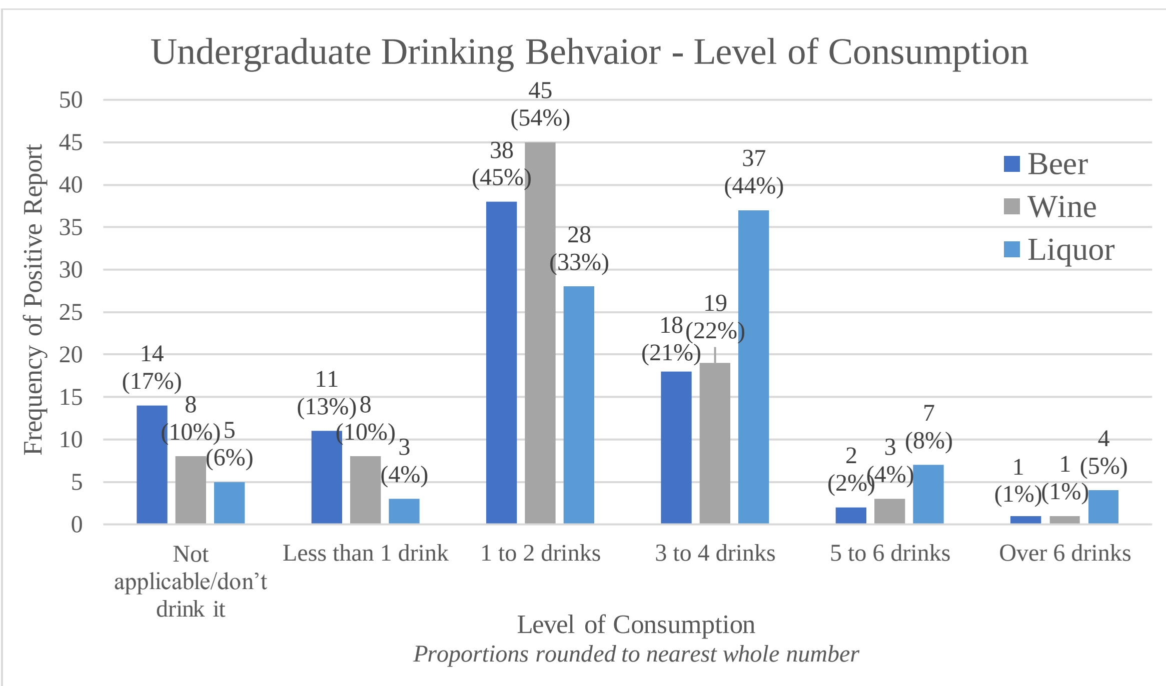


Figure 6: Survey Responses for Undergraduate Drinking Behavior – Level of Consumption Per Occasion



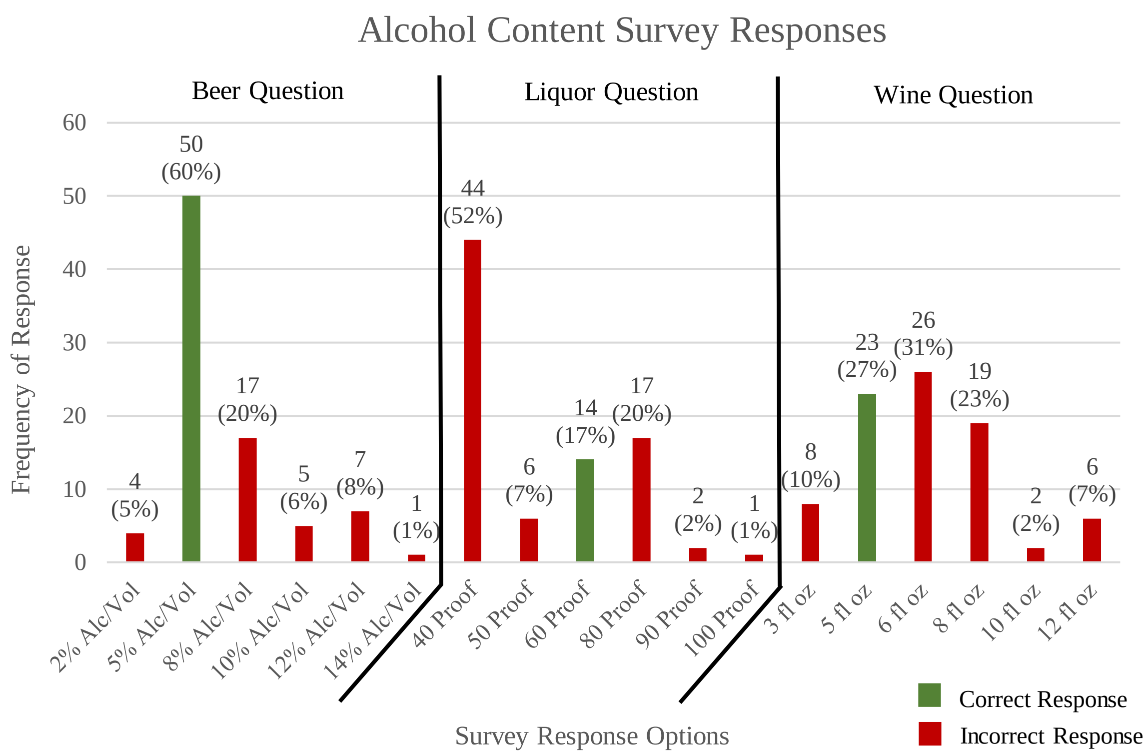
In order gauge participants' understanding of the meaning of the term "standard drink," participants were asked to answer three different, multiple choice questions. For each question, the participants were expected to use information provided in the question about alcohol content in a specific drink (referenced within the question) to formulate the question's answer. Participants were asked a single question for each alcohol category (beer, wine, and liquor). For example,

> "How many ounces of a wine with 12% alcohol by volume do you think would be considered a standard drink?"
> 1) 10 fl oz
> 2) 8 fl oz
> 3) 5 fl oz
> 4) 3 fl oz
> 5) 12 fl oz
> 6) 6 fl oz"

The correct response is 5 fl oz.[2] For this question specifically, 23 participants, or 27% of the total participants (84) selected the correct response. Only 14 participants, or 17% of participants answered the question associated with liquor correctly, and 50 participants (60% of participants) answered the question associated with beer alcohol content correctly. These results, in support of Objective 1, provide evidence for a lack of knowledge among undergraduate students regarding the conversion between alcohol content, proof, and standard drink sizes. A summary figure for these three questions by alcohol category can be found in Figure 7, with the questions included.

[2] Standard drink calculation of wine with 12% alcohol by volume (see Figure 1 for reference):
= (5 oz x 29.574 g x 0.7936 x 0.12) / 14 g = 1.0 standard drinks

Figure 7: Alcohol Content Survey Responses



Beer Question: If a standard drink of a certain beer is 12 fluid ounces, what do you think the alcohol by volume is? (Correct Answer: 5% Alc/Vol)

Liquor Question: If a standard drink of a distilled spirit is 2 fluid ounces, what do you think the proof would be? (Correct Answer: 60 Proof)

Wine Question: How many ounces of a wine with 12% alcohol by volume do you think would be considered a standard drink? (Correct Answer: 5 fl oz)

Proportions rounded to nearest whole number

In addition, participants were asked a yes/no question about whether or not they knew how many grams of pure alcohol define a standard drink; if a student responded yes, they were asked to record a number. From this question, 81 participants, or 96% of participants, responded "No." Of the 3 participants that responded "Yes," not a single participant provided the correct response, 14 grams. As demonstrated in the introduction section, the conversion between alcohol by volume (or proof) to standard drinks is not an easy one, and previous results suggest that participants don't have even the most basic information (grams of alcohol/standard drink) required to estimate the appropriate quantity of product to pour and consume (i.e. volume of liquid comprising a single, standard drink). This is important as it suggests that even those motivated to drink appropriately might not have information providing them with the ability to do so.

Participants self-reported their use of scientific information present on products by alcohol category; specifically, we asked how often participants used scientific information specific to alcohol (alcohol type, the alcohol content, or the alcohol by volume) when consuming these products. These results are summarized in Figures 8 and 9. Results suggest a lack of engagement with the information that is required that could help inform pour accuracy; only 8% of participants reported always using this information, with nearly half of participants reporting never using the information for beer (36), 32% never using it for wine (27) and 30% (25) never for liquor.

Figure 8: Survey Responses for Frequency of Use of Scientific Information Specific to Alcohol (Type, Alcohol Content, Alcohol by Volume) Sorted by Frequency

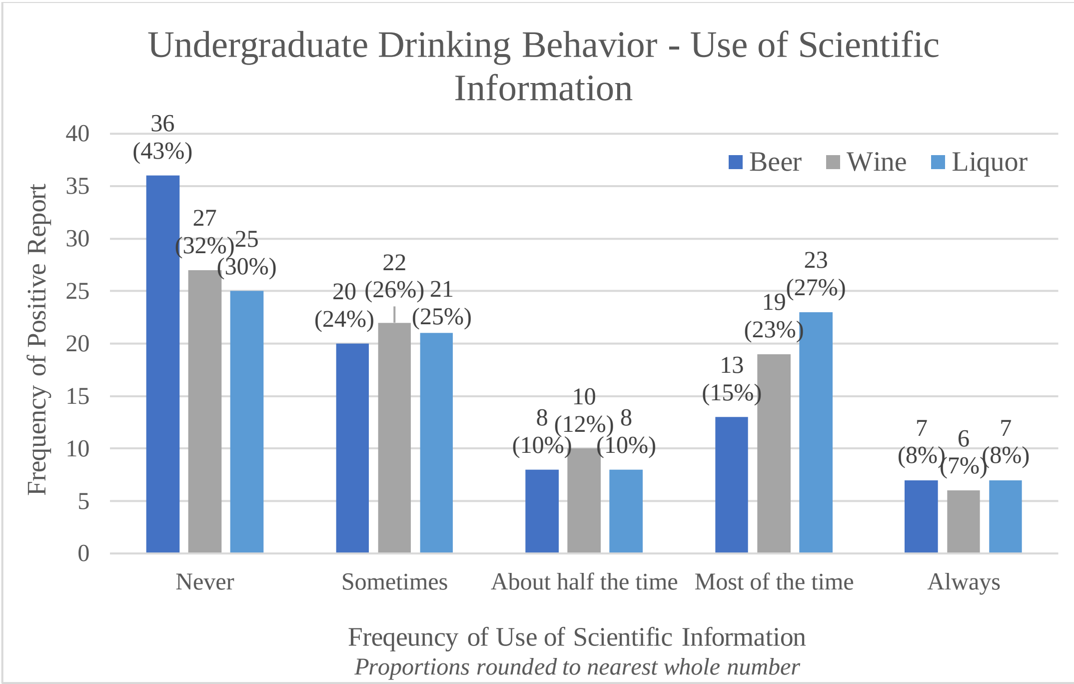
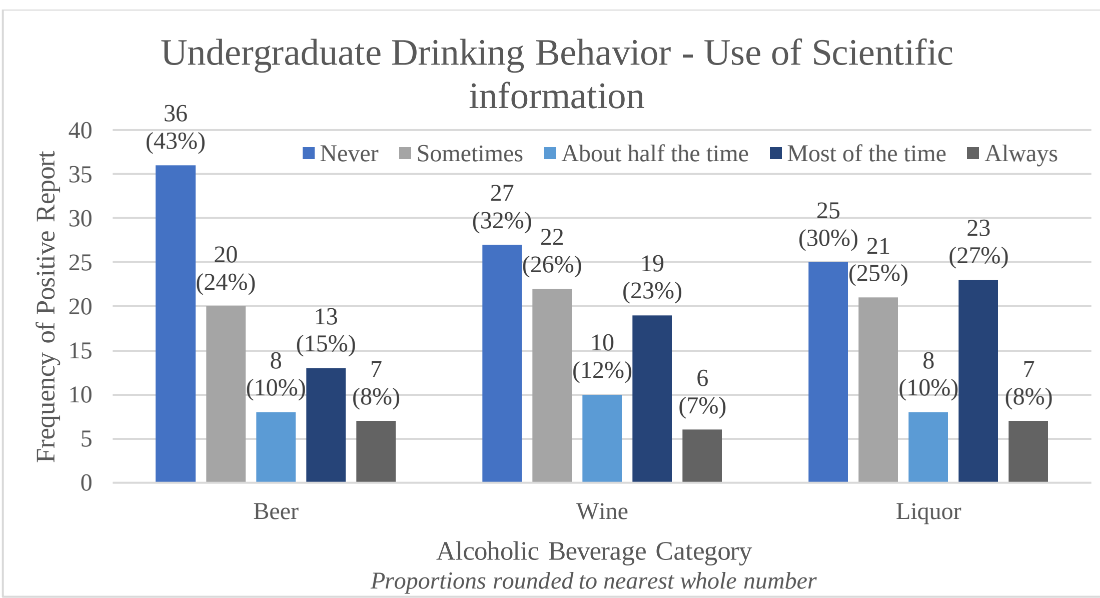


Figure 9: Survey Responses for Frequency of Use of Scientific Information Specific to Alcohol (Type, Alcohol Content, Alcohol by Volume) Sorted by Category



To further characterize the knowledge of the participant population, students were questioned about their awareness of the number of standards drinks per day (as defined by the NIAAA) considered to be "moderate drinking" for both men (2 standard drinks) and women (1 standard drink). The majority of participants responded no for both men and women; 70 participants (83%) responded no for awareness of moderate drinking for men, and 72 (86%) responded no for awareness of moderate drinking for women. Survey results collected in support of Objective 1 suggest a lack of knowledge among undergraduate students regarding alcohol content and standard drink sizes.

Survey Conclusions

Survey results support the idea that even if student wished to engage in informed drinking behaviors (e.g. accurately pouring a standard drink and drinking an amount defined as moderate), a lack of understanding regarding the definition of moderate, and the inability to calculate the amount of alcohol consumed per drink may preclude their ability to do so.

These findings implore us to explore different means of conveying information to enhance the ability of people so that they can more accurately pour appropriate standard drinks; thus, our evaluation of FOP labels containing standard drink information.

Pouring Behaviors

Objective 2 focused on evaluating the impact that a novel FOP intended to convey standard drinks per container had on students' ability to accurately identify, comprehend and pour a standard drink. A summary of the variables used are presented in Table 7 for reader ease.

Table 7: Analysis Variable Definitions

Variable	Explanation
Observed Pour	Participant pour recorded during experiment as measured using a graduated cylinder with a capacity of 250 mL or 500 mL, and a sensitivity of 2 mL and 5 mL, respectively
Mean Observed Pour	Average of all Observed Pours per alcohol category, label type, and content level (mL)
Accurate Pour based on the NIAAA's definition of a Standard Drink	A uniquely calculated value for each combination of high and low by alcohol category (a total of six unique values) which utilized the concentration of alcohol in a given treatment to calculate the volume of product which comprised a "standard drink" (see Figure 1)
Pour Error	The difference between an observed pour and the accurate pour/standard drink (Observed - Accurate) for every trial (mL); Each participant had a total of 24 pour errors (12 treatments x 2 pours each)
Mean Pour Error	Average of all Pour Errors among all participants within treatment (Alcohol category x label type x alcohol content level) (mL). In other words, a unique average pour error value for each of the 12 treatments used in this experiment.
Absolute Pour Error	Absolute value of Pour Error (mL)
Mean Absolute Pour Error	Average of all Absolute Pour Errors per alcohol category, label type, and content level (mL)
Mean Absolute Pour Error Alcohol category by Label treatment	Average of the Absolute Pour Error for each Alcohol Category by Label Type (ACLT) data set (mL)
Absolute Effect	Difference between the mean absolute pour error ACLT for the FOP label and standard label (mL)

Analysis of Pours using mL as the Dependent Variable

To begin, the mean observed pour for each participant for each treatment (comprised of the 3 alcohol categories: beer, wine and liquor x 2 alcohol contents: high and low x 2 label types: standard, FOP) was calculated across the two replicates for each participant. Each replicate (pour 1 and pour 2) was included in the mean observed pour volume. Recall that participants provided 24 trials (3 x 2 x 2 x 2 replicates); the average of the replicates of the pour volume were average such that each participant had a total of 12 average observed pour volumes, one for each treatment. Six subjects (20, 21, 50, 51, 54, 59) produced pours that were more than three standard deviations from the mean for at least one trial. Data from these participants were eliminated from further analysis. As such, analysis included complete data sets from a total of 78 subjects.

Mean pour volumes (presented with standard errors) for each treatment (alcohol category x label type x alcohol content level) are presented in Figure 10. Dark blue bars representing calculated mean observed pour volume for the FOP label in a given alcohol category and alcohol content level are contrasted with the light blue bar representing the mean observed pour for the standard labels. For the sake of comparison and in support of Objective 2, the standard drink amounts for each alcohol category at the high and low level are presented in grey.[3]

[3] Standard drinks are defined as the pour volume which would be required to deliver the 14 g of pure alcohol present in a single standard drink (as defined by NIAAA guidelines).

Figure 10: Mean Pour Volume by Alcohol Category, Label Type, and Alcohol Content Level, and Accurate Pour/Standard Drink Size

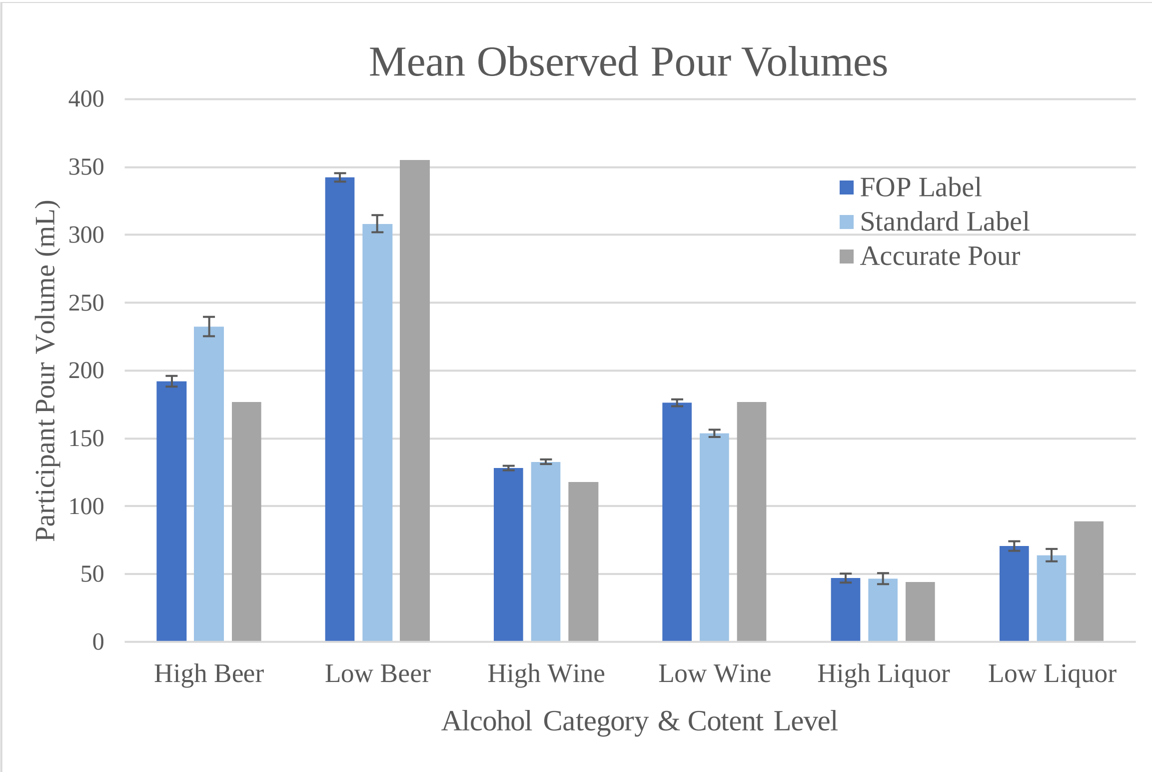


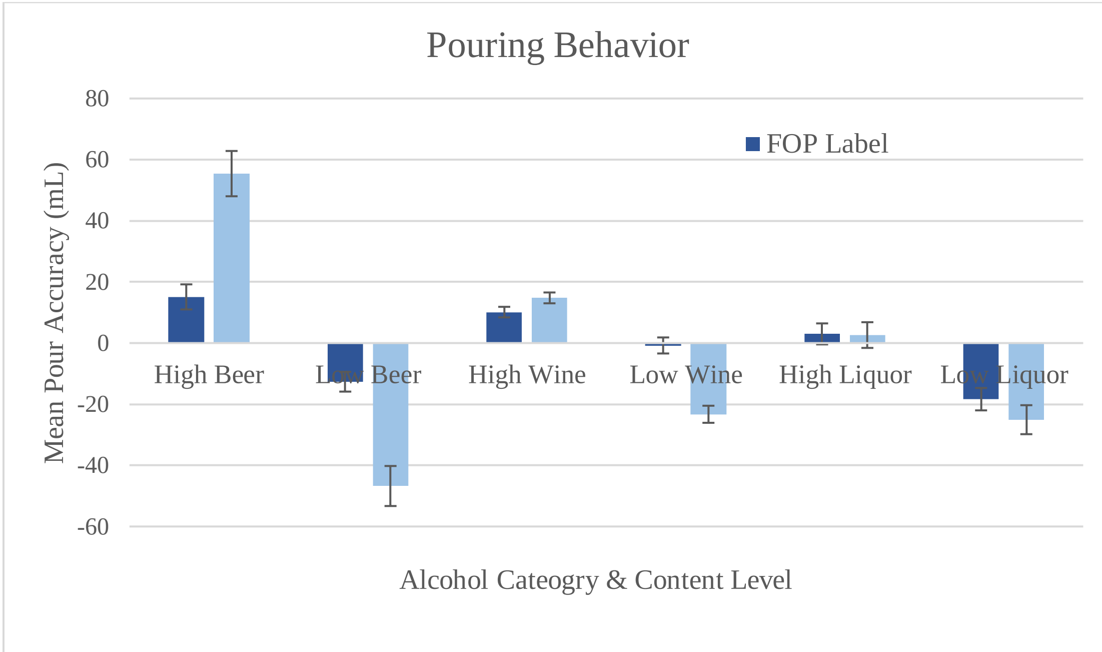
Figure 10 indicates that for all of the high alcohol content treatments, participants poured more than a standard drink; this held true across all product categories and both label treatments. Treatments comprising the low alcohol content category demonstrated the opposite, with all treatments having an under pour. Furthermore, Figure 10 indicates that the difference in mean observed pour volumes between the FOP and standard label for beer in both alcohol content levels is greater than those of liquor or wine. This is likely because of the differing volumes of a "standard drink" across categories, a difference that will be considered in later sections of this document.

Next, for every participant trial for each of the 12 treatments, we calculated the pour error of each replicate by subtracting the accurate pour/standard drink from the observed pour. Table 8 represents an example of this calculation, performed for every trial in the experiment (24/participant). The closer the pour error value is to zero, the greater the accuracy of a participant's pour; in other words, the closer they were to pouring a standard drink of alcohol (defined as the volume of a product that will give 14 grams of alcohol) in a given trial. Thus, a positive value for pour error represents an overpour, and a negative value represents an underpour. After pour errors were calculated for all trials, the mean pour error was calculated for each of the 12 treatments (3 (alcohol category: beer, wine and liquor) x 2 (alcohol content: high and low) x 2 (label type: standard, FOP)) used in this experiment. Figure 11 presents the mean pour error across conditions accounting for both over and under pours, as both negative and positive values for pour error were included. The pattern that was first observed with the average pour volumes (Figure 10) begins to become clearer, suggesting a tendency to over-pour high alcohol content treatments, and underpour treatments comprised of low alcohol content level. That said, this approach still doesn't consider the concentration of the alcohol within the volume that is being under or over poured. Further analysis is still needed.

Table 8: Example Pour Error Calculation

Example Stimulus	**Observed Pour**	**Accurate Pour/Standard Drink**	**Observed – Accurate/Standard (Pour Error)**
Wine FOP High Alcohol Content Pour 1	150 mL	118 mL	[150 – 118] = 32 mL

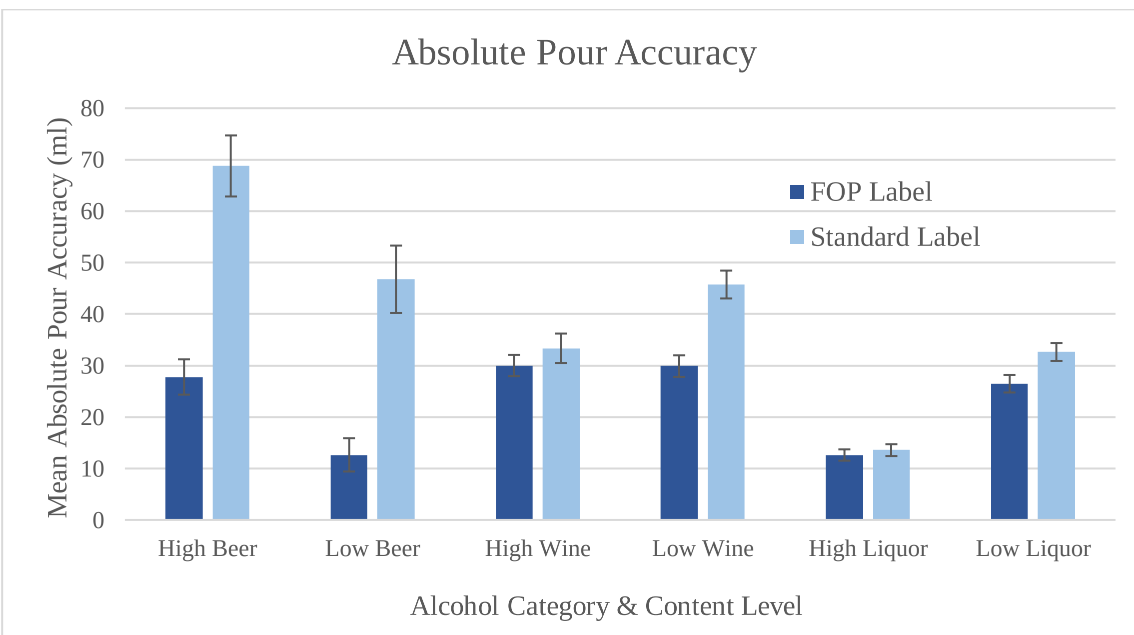
Figure 11: Pouring Behavior by Alcohol Category, Label Type, and Alcohol Content Level



Before performing inferential analysis, we ran tests of normality on the pour errors for each of the 12 treatments. In all cases, the data was found to fail to meet normality assumptions. Log transformation was applied to the data as a technique to assist with normality problems; however, the transformation did not satisfy assumptions for all treatments. We note that, while it is an assumption of the test, ANOVA tests are very robust to violations of the assumption of normalcy (61). Given this robustness, we performed ANOVA omnibus tests, but in follow-up analyses we verified paired differences using Wilcoxon Signed Rank Tests, a non-parametric analysis that does not have an assumption of normality. Result show parity, providing us confidence in our ability to draw conclusions.

To examine whether or not the presence of an FOP aided participants ability to be more accurate in pouring a standard drink, the absolute value of every pour error was calculated (observed pour - standard pour = |absolute value pour error|) for each of the 24 pours provided by each participant. Next, the mean of the two replicates for each treatment was calculated, resulting in one mean value for absolute pour error for each of the 12 treatments per participant. Figure 12 presents the mean absolute pour error for the FOP label (dark blue) and standard label (light blue) for each alcohol category and alcohol content level. The figure supports that idea that the presence of an FOP label providing the number of standard drinks per container assists consumers in pouring a standard drink across all conditions. Standard error bars are included for comparative purposes.

Figure 12: Mean Absolute Pour Error by Alcohol Category, Label Type, and Alcohol Content Level



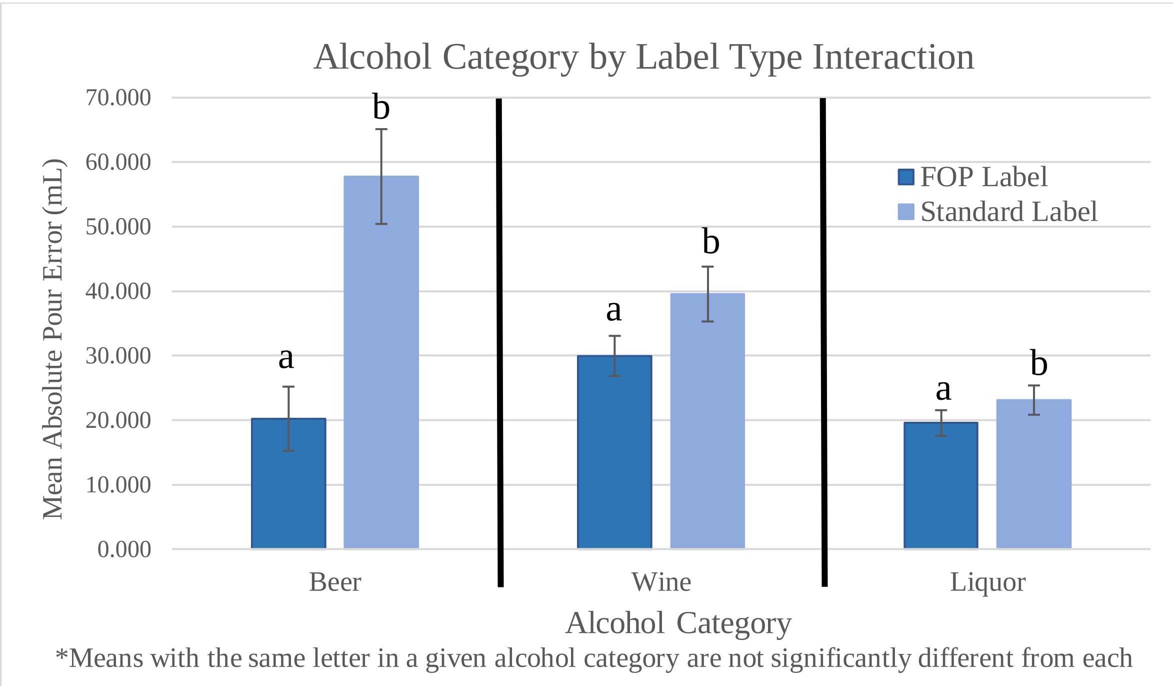
To examine the potential effects statistically, a 3 (alcohol category) x 2 (label type) x 2 (alcohol content level) repeated measure ANOVA was run on the absolute pour error values ($\propto$ = 0.05). Results are presented in Table 9.

Table 9: Results of Repeated Measure Test of Within Subject Effects ($\propto$ = 0.05)

Source	Num. DF	Den. DF	F Value	Significance
Alcohol Category	**2**	**154**	**34.650**	**0.000**
Alcohol Content Level	1	77	420.010	0.568
Label Type	**1**	**77**	**102.465**	**0.000**
Alcohol Category by Alcohol Content Level	**2**	**154**	**22.700**	**0.000**
Alcohol Category by Label Type	**2**	**154**	**42.259**	**0.000**
Alcohol Content Level by Label Type	1	77	0.835	0.364
Alcohol Category by Label Type by Alcohol Content Level	2	154	2.439	0.091

Findings yield evidence of significant interaction effects for alcohol category (beer, wine and liquor) by label type (FOP and standard), and alcohol category (beer, wine, and liquor) by alcohol content level (high and low). Of primary interest to this study (in support of Objective 2) is the interaction effect between alcohol category and label type. To further explore this interaction, pairwise comparisons were conducted on the mean absolute pour errors as a function of alcohol category and label type (Figure 13). The FOP label for each alcohol category is represented by a blue bar, and the standard label for each alcohol category is represented by a light blue bar. A paired samples t-test was run for this interaction to demonstrate an absolute pour error performance benefit of the FOP label (Table 10).

Figure 13: Effect of Alcohol Category by Label Type (∝ = 0.05)



The results of this paired samples t-test show significant difference in mean absolute pour error within each alcohol category when the mean absolute errors generated by FOP label and those generated by the standard label are compared at α=0.05. That said, the magnitude of these differences varied by alcohol category; for example, absolute mean errors for beer were larger when treatments that employed a standard label are examined relative to the other two alcohol categories. That said, results suggest pour accuracy is enhanced in treatments that include an FOP as compared to those with standard labels for each alcohol category, implying that the FOP label enhanced accuracy (when the goal was to pour a standard drink accurately).

Table 10: Paired Samples t-test for Alcohol Category by Label Type Interaction (∝ = 0.05)

Pair	Mean of Differences	Std. Error of Mean	Difference		t	df	Significance (2 tail) (∝ = 0.05)
			Lower	Upper			
Beer FOP – Beer Standard	-37.554	4.136	-45.791	-29.318	-9.079	77	**0.000**
Liquor FOP – Liquor Standard	-3.558	1.134	-5.812	-1.280	-3.137	77	**0.002**
Wine FOP – Wine Standard	-9.599	2.354	-14.286	-4.912	-4.078	77	**0.000**

These results are further substantiated by results obtained using a Wilcox Signed Rank Test, a non-parametric alternative to the t-test used to compare the means of two related samples (Table 11). Given the failure to meet normality assumptions required in the ANOVA testing, we ran the Wilcox Signed Rank test in support of the robustness of the ANOVA and paired t-tests (presented above). Like the paired samples t-test, the Wilcoxon Signed Rank test yielded the same conclusions (∝ = 0.05).

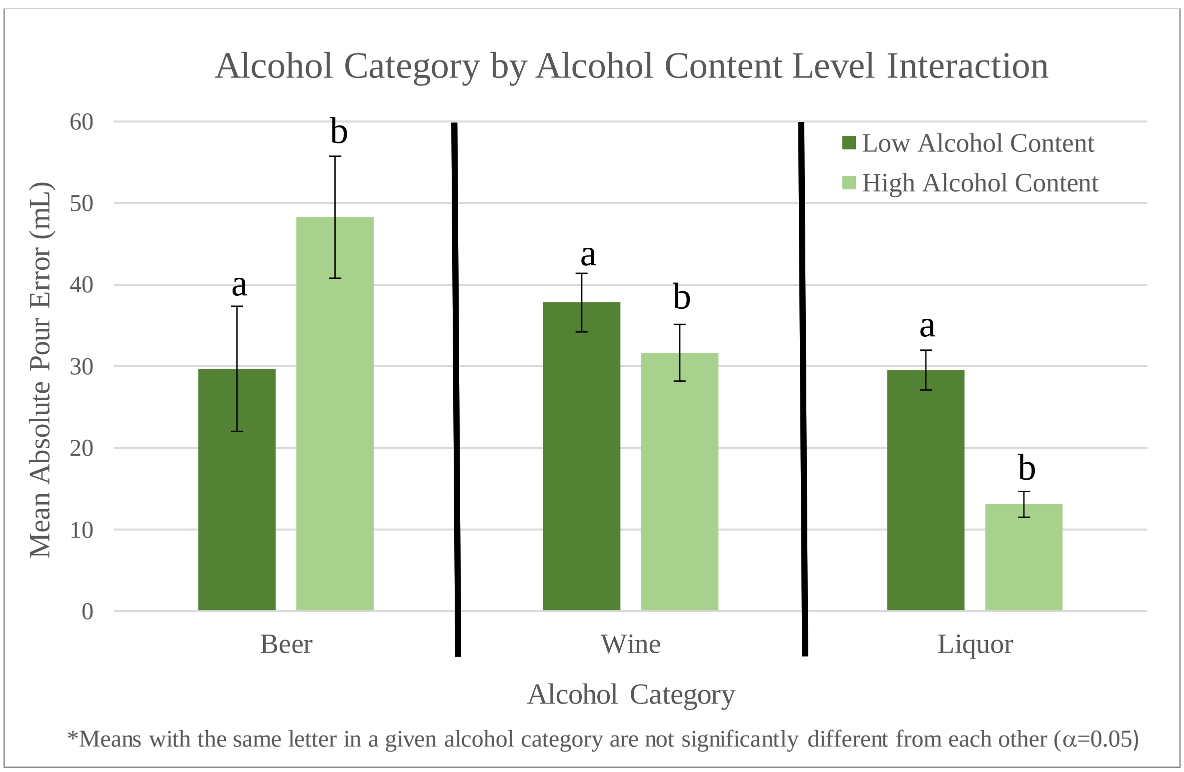
Table 11: Wilcoxon Signed Rank Test for Alcohol Category by Label Type Interaction (∝ = 0.05)

Null Hypothesis	Significance	Decision
The median differences between Mean Absolute Pour Error of Beer FOP and Beer Standard equals 0	**0.000**	Reject Null
The median differences between Mean Absolute Pour Error of Liquor FOP and Liquor Standard equals 0	**0.012**	Reject Null
The median differences between Mean Absolute Pour Error of Wine FOP and Wine Standard equals 0	**0.000**	Reject Null

Of primary interest to our Objective 2 (FOPs aid pour accuracy), findings suggest that FOP label presence was of benefit in terms of accuracy of pour. Specifically, that the mean absolute error was less in the presence of an FOP (within alcohol category) than when standard labels were present. Both paired samples t-test and non-parametric results were consistent in this finding.

ANOVA results also yielded evidence of an interaction between alcohol category (beer, wine, and liquor) and alcohol content level (high and low) impacting the mean absolute error (mL). To further explore this interaction, pairwise comparisons were conducted on the mean absolute pour errors as a function of alcohol category and alcohol content level (Figure 14). The low alcohol content for each alcohol category is represented by a dark green bar, and the high alcohol content for each alcohol category is represented by a light green bar. A paired samples t-test was run to examine differences in mean absolute pour error when low and high alcohol content levels within alcohol categories are compared (Table 12).

Figure 14: : Effect of Alcohol Category by Alcohol Content (∝=0.05)



The results of this paired samples t-test suggest significant differences in mean absolute pour error within each alcohol category when the mean absolute errors generated by low alcohol content level and those generated by the high alcohol content level are compared at α=0.05. Specifically, for beer, the error in pouring was greater for the high concentration than the low; this is likely because of a "ceiling effect" with the low. In other words, the entire bottle of the low concentration represented a standard drink. As such, participants could not overpour for that treatment; the only error that they could make was to not pour the entire bottle. This was not the case for the wine or liquor, which had a different result as compared with the beer; For these categories, the high alcohol content level resulted in a significantly smaller mean absolute pour error (or pours that are closer to zero pour error, i.e. an accurate pour) than pours from the low concentration treatment within each alcohol category.

Table 12: Paired Samples t-test for Alcohol Category by Alcohol Content Level Interaction (α = 0.05)

Pair	**Mean of Differences**	**Std. Error of Mean**	**Difference**		**t**	**df**	**Significance (2 tail) ($\propto$ = 0.05)**
			Lower	**Upper**			
Beer Low – Beer High	-3.078	6.035	-30.590	-6.557	-3.078	77	**0.002**
Wine Low – Wine High	6.138	2.383	1.393	10.883	2.576	77	**0.012**
Liquor Low – Liquor High	16.455	1.692	13.086	19.824	9.726	77	**0.000**

As with the previous interaction term (label type x alcohol category), the data used in the ANOVA failed to meet normality assumptions. To bolster our confidence in our ability to draw inferences regarding the results, we repeated the analysis using a Wilcoxon Signed Rank Test (Table 13). Like the paired samples t-test, the Wilcoxon Signed Rank test yielded the same conclusions ($\propto$ = 0.05).

Table 13: Wilcoxon Signed Rank Test for Alcohol Category by Alcohol Content Level Interaction (∝ = 0.05)

Null Hypothesis	Significance	Decision
The median differences between Mean Absolute Pour Error of Beer Low Alcohol Content and Beer High Alcohol Content equals 0	**0.004**	Reject Null
The median differences between Mean Absolute Pour Error of Wine Low Alcohol Content and Wine High Alcohol Content equals 0	**0.013**	Reject Null
The median differences between Mean Absolute Pour Error of Liquor Low Alcohol Content and Liquor High Alcohol Content equals 0	**0.000**	Reject Null

In conclusion, this analysis presents the interaction between alcohol category and alcohol content level. Results suggest that alcohol content level results in significantly different performance within alcohol categories across label types. Specifically, people more accurately pour a standard drink for high alcohol content when pouring liquor and wine (than the low concentrations) and are more accurate pouring a single standard drink of beer when it is in low alcohol content (as compared to beer that is higher in alcohol content). Both paired samples t-test and non-parametric results were consistent in this finding.

Magnitude of the FOP Benefit

As presented in the previous section, there is a significant interaction between alcohol category and label type (Table 9). Figure 13 suggests that the benefit of the FOP label is of greater magnitude for beer than liquor or wine (when the absolute error related to pour accuracy in mL is the dependent variable). To further examine how the presence of an FOP impacted behaviors across the categories (in terms of pour accuracy), we collapsed results across high and low treatments within category and averaged the absolute pour error (absolute value applied to each individual replicate) by participant (see Table 14 for an example calculation). The result is the mean absolute pour error across the high and low treatments by label type within alcohol category, ACLT (alcohol category label type).

Table 14: Example Calculation for Mean Absolute Pour Error ACLT

	Low Alcohol Content		**High Alcohol Content**		**Mean Absolute Pour Error ACLT**
	Pour 1 Pour Error	**Pour 2 (replicate) Pour Error**	**Pour 1 Pour Error**	**Pour 2 (replicate) Pour Error**	
Beer FOP Label	-22 mL	0 mL	32 mL	18 mL	(11+25)/2 **= 18 mL**
	(|-22| + |0|)/2 = 11 mL		(|32|+|18|)/2 = 25 mL		
Beer Standard Label	-70 mL	-40 mL	56 mL	44 mL	(55+50)/2 = **52.5 mL**
	(|-70|+|-40|)/2 = 55 mL		(|56|+|44|)/2 = 50 mL		

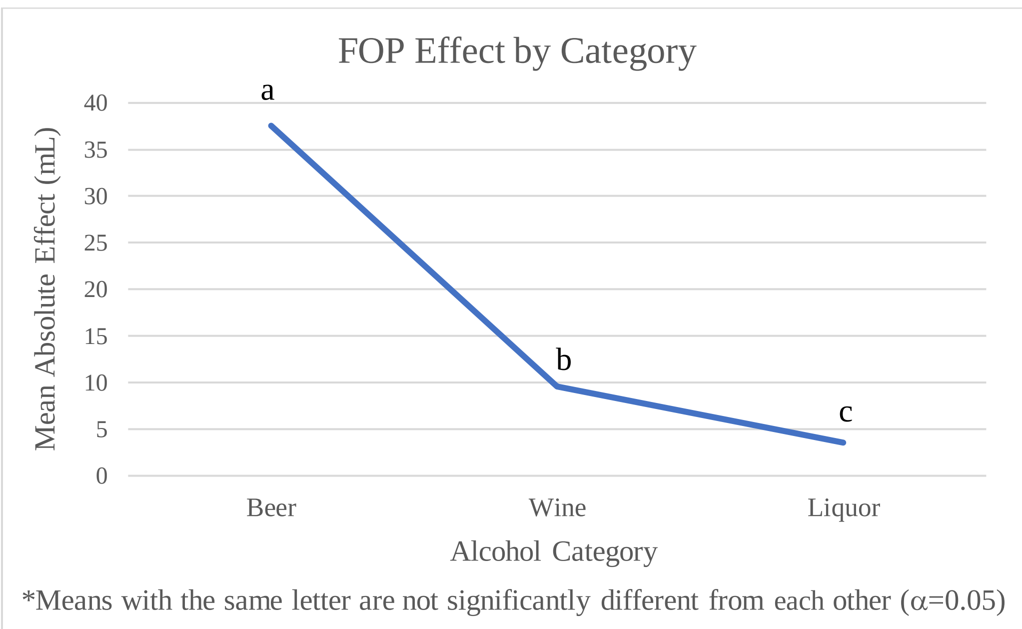
In order to compare how the labels informed (or failed to inform) pour accuracy, the average of the absolute pour errors (within a category across high and low treatments- ACLT) for the FOP label was subtracted from the mean absolute pour error ACLT for the standard label in a given alcohol category (standard label – FOP label) for each participant, resulting in the difference in the pouring effects between treatments (see Table 15 for an example of this calculation). This is conducted in an attempt to investigate the magnitude of the benefit the presence of an FOP, which based on previous analysis, was suggested to be beneficial to accuracy of pour when the directionality of the error was disregarded.

Table 15: Example Calculation for Mean Absolute Effect Per Participant

Mean Absolute Pour Error ACLT Beer FOP	**Mean Absolute Pour Error ACLT Beer Standard Label**	**Absolute Effect**
18 mL	52.5 mL	(52.5-18) = **34.5 mL**

Since the mean absolute pour error (ACLT) for FOP was subtracted from the mean absolute pour error ACLT for the standard label, a calculation which results in a positive value represents the fact that the mean absolute pour error (ACLT) for the FOP label in an alcohol category is smaller than that of the standard label counterpart. All calculations conducted on this data set resulted in positive values, that is, the absolute pour errors (when averaged across high and low alcohol content - ACLT) were less for FOPs than standard labels, supporting the idea that these labels enhance pour accuracy, and further bolster the notion that the benefit varies by alcohol category when the pour volume in mL is the unit of the dependent variable (see Figure 15).

Figure 15: Absolute Effect by Category (∝=0.05)



To more comprehensively investigate the phenomenon, a paired samples t-test was run to compare the absolute effect. Specially, three t-tests (Beer-Liquor, Beer-Wine, and Liquor-Wine) were performed to analyze data for statistical differences between alcohol categories. The results of these tests are found in Table 16. Based on this test, it is clear that each alcohol category is significantly different from one another in terms of the overall effect of FOP on pour error when it is measured in ML.

Table 16: T-test of Mean Absolute Effect by Alcohol Category (∝=0.05)

Pairing	**Mean of Differences**	**Std. Error Mean**	**Difference**		**t**	**df**	**Significance (2 tail) (∝ = 0.05)**
			Lower	Upper			
Beer - Liquor	33.997	4.333	25.370	42.624	7.847	77	**0.000**
Beer - Wine	27.955	4.666	18.665	37.246	5.992	77	**0.000**
Liquor - Wine	-6.041	2.484	2.484	-10.987	-2.433	77	**0.017**

As with other results presented, the results of these t-tests were further reinforced using the non-parametric Wilcoxon Signed Rank test because of the concerns related to deviations from normality. Results obtained by the Wilcoxon Signed Rank tests are summarized in Table 17. As with the previous analysis, results obtained using the Wilcoxon Signed Rank parallel those obtained using the t-test, with the magnitude of the FOP effect being different for each alcohol category, but nonetheless beneficial.

Table 17: Wilcoxon Signed Rank Test for Alcohol Category (∝=0.05)

Null Hypothesis	**Significance**	**Decision**
Median differences between Absolute Effect for Beer and Liquor equals 0	**0.000**	Reject Null
Median differences between Absolute Effect for Beer and Wine equals 0	**0.025**	Reject Null
Median differences between Absolute Effect for Liquor and Wine equals 0	**0.000**	Reject Null

These analyses support the idea that the presence of an FOP is beneficial in terms of more accurate pouring but failed to consider the directionality of errors (whether the pour was over, or under) and the concentration of the products involved, and, therefore, its presence in the error (i.e. impact on the amount of alcohol consumed). In other words, how the pour inaccuracies relate to standard drinks, or the amount of alcohol consumed; specifically, to this point, we have examined the accuracy of the beverages poured in milliliters.

Analysis of Pour - Considering Concentration of Alcohol

Next, we consider the data in light of "Weber's Law of Just Noticeable Difference" (62). This law is used to help estimate the minimal amount of change required for a noticeable difference in sensation. From a more practical perspective, considering the data in this way examines the difference in the amount of alcohol (related to the volume of the error considering the concentration of alcohol in the product) that would be consumed as a result of the pouring error. For instance, a 25 mL inaccuracy in pour may be minimally noticeable in the beer category, but the same error amount for liquor could result in a dramatic difference in the amount of alcohol consumed. As such, this concept is not only of theoretical interest, but also practical in terms of the relationship that the consumption has on an individual, and relevant ramifications to the public discussed previously (e.g. disorderly conduct, damage to property, health of the population, etc.).

In the following sections we convert the pour errors (previously presented in terms of mL) to standard drinks; in doing so, we more accurately consider how errors have the potential to impact consumption of alcohol.

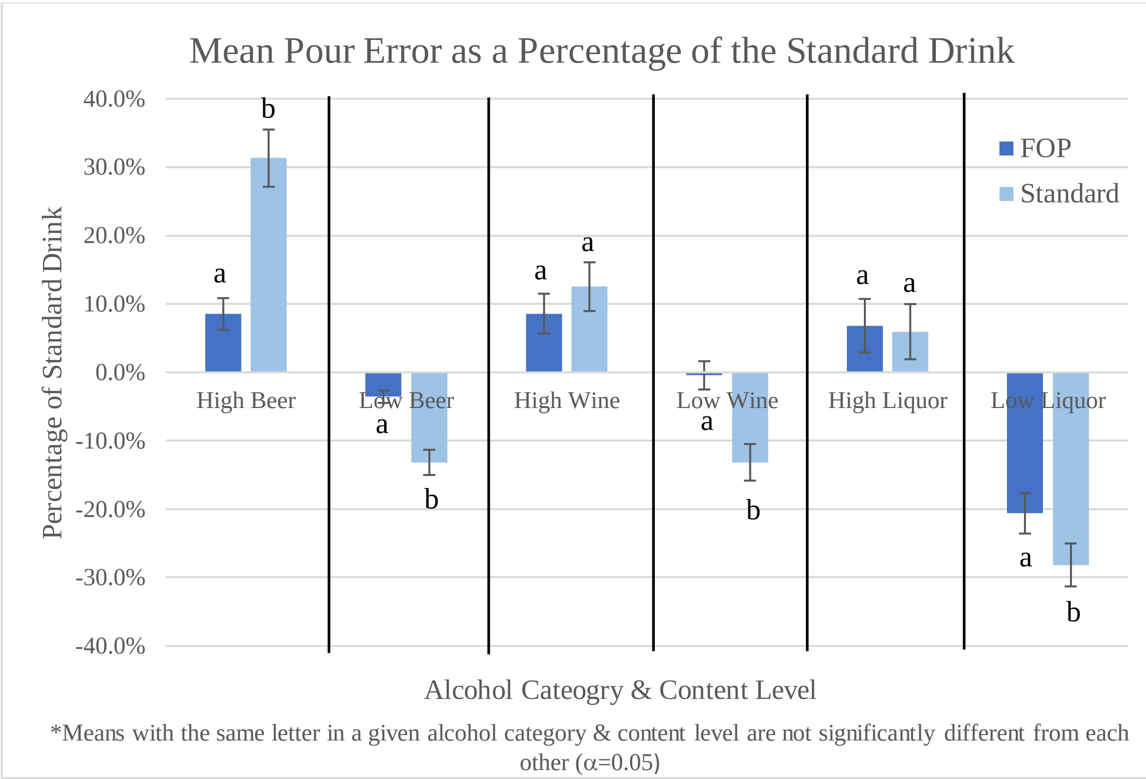
FOP Effect Conversion

To begin this analysis, the pour error for every trial was converted to a percentage of the standard drink. This was accomplished by dividing the pour error (in mL) by the standard drink volume (mL) for that specific treatment's alcohol category and alcohol content level (see Table 18 for an example calculation). This enabled calculation of a mean pour error as a percentage of the standard drink for each alcohol category, label type, and alcohol content level (see Figure 16). Recall findings presented in Figure 11 (directionality of the pouring behaviors), which indicate participants exhibited a tendency to overpour treatments of high alcohol content (positive percentage of a standard drink), and under-pour treatments of low alcohol content (when error was considered in mL). As expected, this tendency remains, but the newly calculated results account for the differences in concentration of alcohol in each of the product categories and concentrations. Nonetheless, the addition of the FOP remains beneficial to most treatments, and even when controlling for different concentrations of the categories, the benefit is still largest for the beer.

Table 18: Conversion of Pour Error (mL) to a Percentage of Standard Drink

Wine FOP Low Alcohol Replicate 1 Pour Error	**Wine FOP Low Alcohol Standard Drink Size**	**Percentage of Standard Drink**
-50 mL	177 mL	(-50/177)x100% = -28.2%

Figure 16: Mean Pour Error as a Percentage of Standard Drink by Alcohol Category, Label Type, and Alcohol Content Level (∝=0.05)



As demonstrated in Figure 16, paired samples t-tests were run within alcohol category and alcohol content level to determine whether or not the FOP label demonstrated a significant difference in pour error as a percentage of the standard drink. This calculation allows the directionality of the pour error as a percentage of a standard drink to remain intact. The results of these tests can be found in Table 19.

Table 19: T-test of Pour Error as a Percentage of Standard Drink by Alcohol Category, Label Type, and Alcohol Content Level (∝=0.05)

Pair	Mean of Differences	Std. Error of Mean	Difference		t	df	Significance (2 tail) (∝ = 0.05)
			Lower	Upper			
Beer High FOP – Standard	-0.228	0.045	-0.317	-0.138	-5.072	77	**0.000**
Beer Low FOP – Standard	0.096	0.018	0.060	0.132	5.328	77	**0.000**
Wine High FOP – Standard	-0.39	0.036	-0.111	-0.032	-1.095	77	0.277
Wine Low FOP – Standard	0.127	0.028	0.072	0.183	4.563	77	**0.000**
Liquor High FOP – Standard	0.009	0.034	-0.058	0.076	0.260	77	0.796
Liquor Low FOP – Standard	0.075	0.027	0.022	0.129	2.819	77	**0.006**

The results of this paired samples t-test show significant difference in pour error when presented as a percentage of standard drink within each alcohol category and content level for most alcohol categories and content levels, with the exception of wine and liquor of high alcohol content, when the percentage of standard drinks over/under poured in FOP label treatments and for the standard label treatments are compared at $\alpha=0.05$. These results suggest pour accuracy is positively impacted for when an FOP treatment is applied in each alcohol category except for wine and liquor of high alcohol content; however, when considering directionality, the more accurate pour with the FOP label may result in more alcohol being poured. When considering a public health perspective, the FOP application in its current form may be most beneficial when applied strictly to beer as there are no significant effects for high alcohol content wine and liquor, and the FOP label results in increased pour across low alcohol content variants.

Furthermore, the Wilcoxon Signed Rank Test performed on the pour error as a percentage of standard drink (Table 20) substantiated results of the t-test (Table 19).

Table 20: Wilcoxon Signed Rank Test of Pour Error as a Percentage of Standard Drink by Alcohol Category, Label Type, and Alcohol Content Level (∝=0.05)

Null Hypothesis	**Significance**	**Decision**
The median differences between Pour Error as a Percentage of Standard Drink of Beer High FOP and Standard equals 0	**0.000**	Reject Null
The median differences between Pour Error as a Percentage of Standard Drink of Beer Low FOP and Standard equals 0	**0.000**	Reject Null
The median differences between Pour Error as a Percentage of Standard Drink of Wine High FOP and Standard equals 0	0.189	Fail to Reject Null
The median differences between Pour Error as a Percentage of Standard Drink of Wine Low FOP and Standard equals 0	**0.000**	Reject Null
The median differences between Pour Error as a Percentage of Standard Drink of Liquor High FOP and Standard equals 0	0.932	Fail to Reject Null
The median differences between Pour Error as a Percentage of Standard Drink of Liquor Low FOP and Standard equals 0	**0.004**	Reject Null

To consider the overall impact on accuracy that an FOP label has, regardless of the directionality of the error (over or underpouring), the absolute pour error for every trial was converted to a percentage of the standard drink. This was accomplished by dividing the absolute pour error by the standard drink volume. Figure 17 represents a comparison of the mean absolute pour error as a percentage of standard drink by alcohol category, label type, and alcohol content level.

Figure 17: Mean Absolute Pour Error as a Percentage of Standard Drink by Alcohol Category, Label Type, and Alcohol Content Level

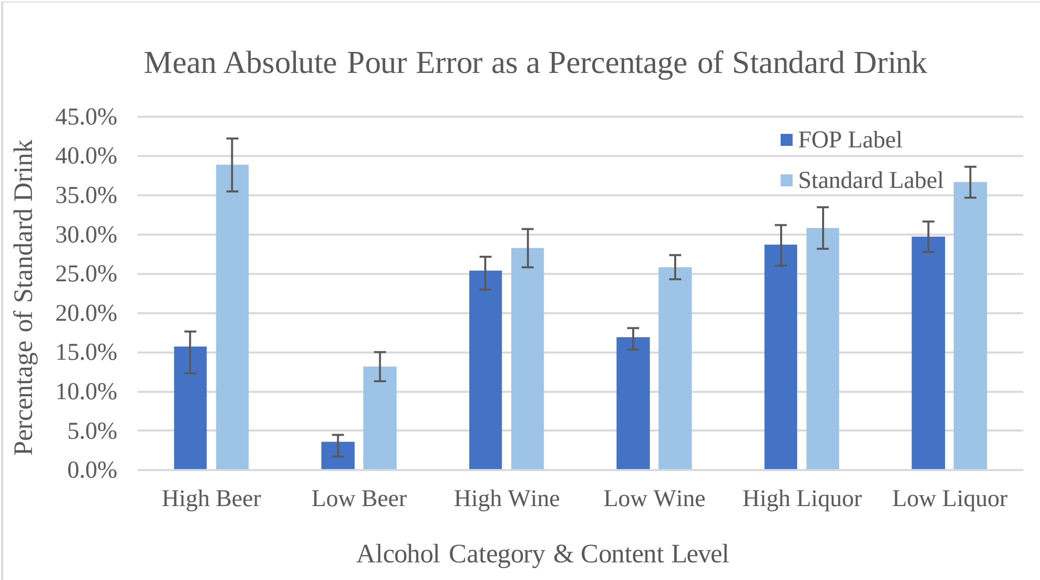
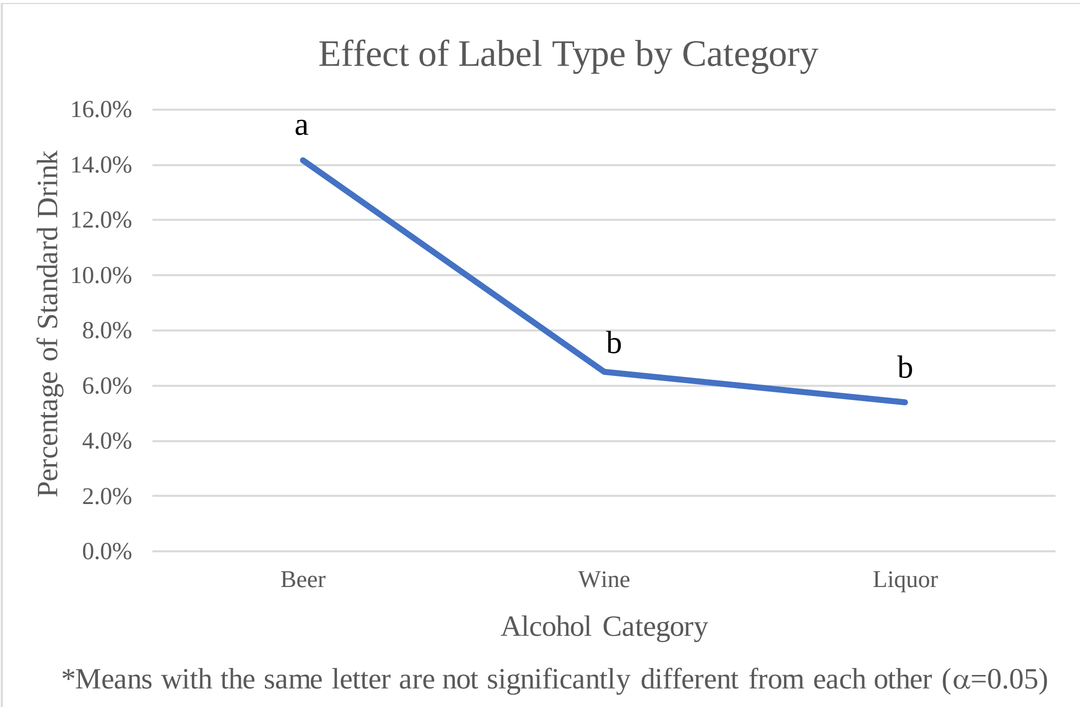


Figure 17 demonstrates the same pattern of an FOP benefit across all alcohol categories and alcohol content levels. Even when controlling for the concentration of the alcohol within the product by converting errors to the percentage of standard drinks over/under poured, the high concentration of beer continues to show the most benefit in accuracy when pour errors in FOP treatments are compared to those resulting in standard trials, though there is evidence of benefit for all categories.

Finally, we can look at the absolute effect as a percentage of standard drink. To calculate this, the mean absolute effect (Table 15), or difference in performance between the FOP and standard label, in each alcohol category is divided by the average standard drink size in milliliters for that alcohol category. This calculation provides all positive values, meaning that the mean absolute pour errors (when averaged across high and low alcohol content) as a percentage of a standard drink were less for FOPs than standard labels. This is demonstrated in Figure 18.

Figure 18: Absolute Effect as a Percentage of Standard Drink by Category (∝=0.05)



While the pattern of FOP performance is similar to that in Figure 15, another paired samples t-test can be run between categories on the absolute effect as a percentage of standard drink. Specially, three t-tests (Beer-Liquor, Beer-Wine, and Liquor-Wine) were replicated on absolute effect as a percentage of standard drink to analyze differences in effect between alcohol categories. The results of these tests are found in Table 21. Based on this test, it is clear that beer is significantly different from wine and liquor; however, the absolute effect as a percentage of standard drink of wine and liquor are not significantly different. These results contrast the first t-test on the absolute effect in milliliters which found significant difference among all three alcohol categories. This new finding implies that while the actual pours in milliliters are different among beer, wine, and liquor, the overall percentage of the standard drink those pours represent are not significantly different for liquor and wine.

Table 21: T-test of Mean Absolute Effect as Percentage of Standard Drink by Alcohol Category (∝ = 0.05)

Pairing	**Mean**	**Std. Error Mean**	**Difference**		**t**	**df**	**Significance (2 tail) (∝ = 0.05)**
			Lower	Upper			
Beer - Liquor	0.087	0.024	0.040	0.134	3.693	77	**0.000**
Beer - Wine	0.076	0.022	0.033	0.119	3.496	77	**0.001**
Liquor - Wine	-0.011	0.022	-0.055	0.033	-0.509	77	0.612

The results of this t-test are reinforced using the non-parametric Wilcoxon Signed Rank test, summarized in Table 22. As with the previous analysis, results obtained using the Wilcoxon Signed Rank test parallel those obtained using the t-test, with the magnitude of the FOP effect being significantly different for beer, but not liquor and wine.

Table 22: Wilcoxon Signed Rank Test for Absolute Effect as Percentage of Standard Drink by Alcohol Category (∝=0.05)

Null Hypothesis	**Significance**	**Decision**
Median differences between Absolute Effect as Percentage of Standard Drink for Beer and Liquor equals 0	**0.00**	Reject Null
Median differences between Absolute Effect Absolute Effect as Percentage of Standard Drink for Beer and Wine equals 0	**0.001**	Reject Null
Median differences between Absolute Effect Absolute Effect as Percentage of Standard Drink for Liquor and Wine equals 0	0.638	Reject Null

CHAPTER 6 - CONCLUSIONS

To conclude, the results of this experiment demonstrate that for undergraduate participants at Michigan State University, an FOP label containing the number of standard drinks per container led to more accurate pouring of a standard drink than those poured from containers with standard labeling. While the FOP labels were found to enhance the undergraduate's ability to pour an accurate standard drink of a given beverage, the application of the labels needs to be considered, particularly as the effect on beer is much different than on wine or liquor. For beer specifically, these results offer potentially wide-reaching benefits, particularly as survey results demonstrated that these undergraduates do consume alcohol across different alcohol categories, do not have a decent understanding of standard drinks, and often do not use scientific information on labels related to alcohol content. For wine and liquor, it is recommended that further research be performed on alternative labeling mechanisms to increase pour accuracy.

The benefit, even when the concentration of the alcohol in the errors was accounted for, was greatest for beer with a high concentration of alcohol. Though it should be noted, the directionality of pours is an important consideration. For low concentrations of product, increasing the accuracy meant pouring a larger drink, as participants had a tendency to underpour the low categories across all products.

To understand this effect from a public health aspect, we can perform some calculations to translate how the FOP label can demonstrate difference in the amount of alcohol one might consume using information participants reported about their drinking behaviors in correlation with NIAAA definitions for drinking behaviors. Moderate drinking is defined by the NIAAA as

1 standard drink per day for women, and 2 for men. In this experiment, 59 participants (70%) reported drinking 1 or more beers on a given occasion, 68 participant (81%) reported drinking 1 or more glasses of wine on a given occasion, and 76 participants (90%) reported 1 or more drinks of liquor on a given occasion. While these reports are not tied to frequency of occurrence, using 1 drink as a heuristic for moderate drinking, a large portion of participants fall into moderate drinking. When looking at the results of this experiment, the FOP label enabled more accurate pouring of a standard drink; however, the directionality of these pours is important when considering public health. Using this moderate drinking (1 drink) heuristic in conjunction with Figure 16, the use of an FOP suggests a positive benefit from a public health perspective of the FOP label for beer and wine of high alcohol content as the mean pour error as a percentage of a standard drink is reduced from 0.31 (31%) (standard label) to 0.09 (9%) (FOP) for beer of high alcohol content, and from 0.13 (13%) (standard label) to 0.08 (8%) (FOP) for wine of high alcohol content. In combination with the moderate drinking heuristic, participants would be reducing their alcohol intake from 1.31 standard drinks of high alcohol content beer to 1.09 standard drinks, and 1.13 standard drinks of high alcohol content wine to 1.08 standard drinks. This reduction enables one to more closely align their drinking behavior with the moderate drinking heuristic, resulting in less overall alcohol consumption. For beer, wine, and liquor of low alcohol content, the FOP label enables more accurate pouring of a standard drink than the standard label; however, it is important to note that as the mean pour errors are negative, the inaccuracy is associated with underpouring. In fact, the standard labels for low alcohol content beer, liquor, and wine resulted in a larger underpour as a percentage of standard drink than the FOP labels. While the FOP label enabled more accurate pours, it also meant more alcohol being poured than the standard label. This begs the question of whether or not this is a positive benefit

to public health as one may be consuming more alcohol than previous while using the moderate drinking heuristic in combination with an FOP label. A summary of the change in total number of standard drinks consumed when using the moderate drinking heuristic can be found in Table 24. Positive changes in standard drink consumption represent an increase of total alcohol poured by the FOP when compared to the standard label, and negative changes in standard drink consumption represent a decrease in total alcohol poured by the FOP when compared to the standard label.

Table 23: Standard Drink Comparison

	Percentage of Standard Drink - Standard	**Percentage of Standard Drink - FOP**	**Standard Drink Consumption - Standard Label**	**Standard Drink Consumption - FOP Label**	**Change in Standard Drinks**
Beer High Alcohol	31%	9%	1.31	1.09	-0.22
Beer Low Alcohol	-13%	-4%	0.87	0.96	+0.09
Wine High Alcohol	13%	9%	1.13	1.09	-0.04
Wine Low Alcohol	-13%	0%	0.87	1.00	+0.13
Liquor High Alcohol	6%	7%	1.06	1.07	+0.01
Liquor Low Alcohol	-28%	-21%	0.72	0.79	+0.07

While the change in overall consumption of standard drinks may seem small for moderate drinking, the effect is amplified by binge drinking, which the NIAAA defines as consuming 4 or more standard drinks for women and 5 or more for men. Consider the portion of our participant population that reported drinking 5 or more drinks on a given occasion for each alcohol category: 3 participants (4%) for beer, 4 participants wine (5%), and 11 participants (13%) for liquor. For the standard label (when pouring the high concentration labels), this would calculate to 6.56 standard drinks for beer and 5.63 standard drinks for wine. When the FOP label is applied, this could reduce alcohol consumption to 5.43 standard drinks for high alcohol content beer, and 5.43 standard drinks for high alcohol content wine. With regard to public health, this represents a reduction in amount of alcohol consumed. For low alcohol content varieties, beer consumption would increase from 4.35 standard drinks (standard label) to 4.8 standard drinks (FOP), liquor consumption would increase from 3.6 standard drinks (standard label) to 3.95 standard drinks (FOP), and wine consumption would increase from 4.32 standard drinks (standard label) to 5.0 standard drinks (FOP). While these pours are more accurate, it may not necessarily be a favorable outcome from a public health perspective.

Labels designed to more accurately and efficiently convey the information regarding the amount of alcohol that people are consuming in “a drink” are needed. Herein, we demonstrate that the use of a novel FOP label presents an opportunity to display an alcoholic beverage’s alcohol content in an alternative format that may be more beneficial to consumers when pouring standard drinks. The ability to pour and gain a better understanding of a standard drink could be largely beneficial to consumers in helping keep track of drinking and understanding one’s drinking habits. As demonstrated in this study, the FOP label improved pour accuracy for undergraduate students, opening the door for use among other demographics outside of undergraduate students. Furthermore, these results present additional opportunity to explore front of package labeling as a viable option for alcoholic beverages and serve as a new resource for consumers to gather important information about a product. Overall, this study demonstrates a benefit of an FOP application in increasing pour accuracy on alcoholic beverages across different alcohol categories and alcohol content levels; However, application must be considered from a public health perspective.

CHAPTER 7 - LIMITATIONS & RECOMMENDATIONS FOR FUTURE WORK

The primary limitations for this experiment lie within the participant demographic and experimental design. As demonstrated in Table 6, the sample was largely female (73%). Additionally, the sample was primarily of senior class status (69%) and had a mean and median age of 21 years old (the legal drinking age). This information presents the question of whether or not the demographic sample for this experiment is wholly representative of the undergraduate student population at Michigan State University. These different demographic factors were not controlled for as undergraduate recruitment had been completed through the paid SONA system at Michigan State University with the intention of recruiting a diverse demographic of undergraduate students.

The second limitation of this experiment was the pouring task being completed in a laboratory setting with manual pour measurement. The laboratory setting may be responsible for differences in pouring behavior among undergraduate students, and this was not controlled for. A participant's standard pour in the laboratory setting may be entirely different in a bar or party setting. Additionally, all pour measurements were completed by Eric Brunk using two graduated cylinders. While person-to-person measurement error was minimized by only one person completing all measurements, this manual method is subject to error due to any residual liquid in the pour receptacle and human error in reading and recording the pour level from the graduated cylinder. The larger 500 mL graduated cylinder used 5 mL graduations, and the smaller 250 mL graduated cylinder used 2 mL graduations.

While this study attempted to evaluate how a front of package label containing the number of standard drinks per container may influence an undergraduate's ability to pour an accurate standard drink when compared to traditional alcohol by volume labeling, there are a few unanswered questions. As stated, the laboratory setting could be a possible source of error. A primary recommendation for future work would be to conduct a study of similar nature in an alternative setting, such as a college bar, and evaluate pour accuracy in that setting. Other recommendations include studying the effect of different alcohol packaging formats, such as cans and pints, using eye tracking to better understand the information consumers attend to on an alcoholic beverage label, and applying similar techniques for studying front of package labels containing standard drink information to subject samples with ages beyond those of undergraduate students. Furthermore, as results of this experiment demonstrated the FOP application is best suited for beer, researching alternative labeling formats for alcohol content or standard drinks is of importance, particularly for wine and liquor.

APPENDICES

APPENDIX A

Approved Forms

Research Participant Information and Consent Form

You are being asked to participate in a research study. Researchers are required to provide a consent form to inform you about the research study, to convey that participation is voluntary, to explain risks and benefits of participation, and to empower you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Study Title: Evaluation of a Front of Package Label for Alcoholic Beverages

1. PURPOSE OF RESEARCH

The purpose of this research study is to evaluate the effect front of package labels can have when used on alcoholic beverage packages. More specifically, can front of package labels assist in more accurate pouring of standard drinks of a given alcoholic beverage.

2. WHAT YOU WILL DO

This study involves a <u>one-hour lab session.</u> At the lab session, you will complete a brief demographic survey which also will assess your drinking behaviors, use of alcohol labeling and understanding of alcohol content. Following this, you will engage in a pouring task in which you will be asked to pour standard drinks of mock alcoholic beverages across three categories of alcoholic beverage: beer, wine, and liquor, into different containers.

3. POTENTIAL BENEFITS

You will not benefit personally from being in this study. However, we hope that, in the future, other people might benefit from this study because of the knowledge that may be gained on use of front of package labels on a student's ability to recognize and pour standard drinks of common alcoholic beverages.

4. POTENTIAL RISKS

There are no more than minimal psychological, emotional, physical, legal, financial, or privacy risks associated with this study.

5. PRIVACY AND CONFIDENTIALITY

Your privacy will be protected to the maximum extent allowable by law. No personally identifying information will be available, not even the research team will be able to tie your responses to your identity. Aggregate results may be provided to publications on an as needed basis, but these will contain no tie to your identity. All records will be securely kept for at least three years after the project closes.

6. YOUR RIGHTS TO PARTICIPATE, SAY NO, OR WITHDRAW

You have the right to say no to participate in the research, or any portion of the research that you do not wish to complete. You can stop at any time after it has already started. There will be no consequences if you stop and you will not be criticized. You will not lose any benefits that you normally receive.

7. COSTS AND COMPENSATION FOR BEING IN THE STUDY

There are no costs to participate in this study. Participants who consent to take part in this study will be compensated with $20.

8. CONTACT INFORMATION

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researcher (Laura Bix, email: bixlaura@anr.msu.edu) or the study coordinator (Eric Brunk, email: brunkeri@msu.edu, phone: (586) 246-9649).

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

9. DOCUMENTATION OF INFORMED CONSENT.

Your signature below means that you voluntarily agree to participate in this research study.

____ ______________________________

Signature Date

You will be given a copy of this form to keep.

A signature is a required element of consent – if not included, a waiver of documentation must be applied for.

Michigan State University

Alcohol Packaging Research Study

Participants are needed for a research study on functionality of alcohol packaging conducted by Michigan State University.

If you choose to participate, you will come to the Packaging Building at MSU and perform a pouring task. In this task, you will be instructed to pour various mock alcoholic beverages into different containers. No alcohol will be consumed and what is being poured contains no alcohol.

In exchange for your participation, you will receive $20. The study will take no longer than 45 minutes. To participate in this study, you must:

- Be 18 years of age or older
- Be enrolled in a college degree-granting program
- Have transportation to the Packaging Building at Michigan State University
- Be willing to have your data stored (anonymously)
- Be willing to provide a contact phone number or email so that researchers can contact you to remind you of your appointment

If you are interested in participating in this study opportunity, please contact Eric Brunk at brunkeri@msu.edu to make an appointment.

If you have questions or comments regarding this study, please contact Dr. Laura Bix, Professor of Packaging at Michigan State University at 517-355-4556 or bixlaura@anr.msu.edu.

Study Instruments[4]

Online Questionnaire

Demographic information:

Age: ________

Gender:
- Male
- Female
- Non-binary or Other
- Prefer not to say

Ethnic/Racial Background:
- American Indian or Alaska Native
- Native Hawaiian or Other Pacific Islander
- Black or African American
- Asian
- White
- Hispanic, Latino
- Two or more races
- Other

Year in school: ______

Member of a PanHellenic organization?
- Yes
- No

Drinking Behaviors

Information in [] not included in final survey

[Student Alcohol Questionnaire – SAQ; (RC Engs, 1975); permission granted for school and research purposes at http://www.indiana.edu/~engs/quest/saq.html]

1) Let's take **beer** first. How often, on the average, do you usually have a beer? (If you do not drink beer at all go to question 3)

    1. every day
    2. at least once a week but not every day
    3. at least once a month but less than once a week
    4. more than once a year but less than once a month

[4] All measures and response options are example items, with the understanding that any modifications will not change the amount of risk associated with them

5. once a year or less

2) When you drink **beer**, how much, on the average, do you usually drink at any one time?

1. more than one six pack (6 or more cans or tavern glasses)
2. 5 or 6 cans of beer or tavern glasses
3. 3 or 4 cans of beer or tavern glasses
4. 1 or 2 cans of beer or tavern glasses
5. less than 1 can of beer or tavern glass

3) Now let's look at table **wine**. How often do you usually have wine? (if you do not drink wine at all, go to question 5)

1. every day
2. at least once a week but not every day
3. at least once a month but less than once a week
4. more than once a year but less than once a month
5. once a year or less

4) When you drink **wine**, how much, on the average, do you usually drink at any one time?

1. over 6 wine glasses
2. 5 or 6 wine glasses
3. 3 or 4 wine glasses
4. 1 or 2 wine glasses
5. less than 1 glass of wine

5) Next we would like to ask you about **liquors and spirits** (whiskey, gin, vodka, mixed drinks, etc.). How often do you usually have a drink of liquor? (If you do not drink liquor at all, skip questions 5 and 6)

1. every day
2. at least once a week but not every day
3. at least once a month but less than once a week
4. more than once a year but less than once a month
5. once a year or less

6) When you drink **liquor**, how many drinks, on the average, do you usually drink at any one time?

1. over 6 drinks
2. 5 or 6 drinks
3. 3 or 4 drinks
4. 1 or 2 drinks

5. less than 1 drink

The following are common results that other students have reported. If you have never had a drink at all, go to question 33. If you currently drink or have ever drunk in the past, put the number corresponding to the frequency of the occurrences in the box beside it.

1. at least once in the past two months and at least one additional time during the past year.
2. at least once within the past two months but not during the rest of this past year.
3. not during the past two months but at least once during the past year.
4. has happened at least once in my life but not during the past year.
5. has not happened to me.

7) had a hangover

8) gotten nauseated and vomited from drinking

9) driven a car after having several drinks

10) driven a car when you knew you had too much to drink

11) driven a car while drinking

12) come to class after having several drinks

13) "cut a class" after having several drinks

14) missed a class because of a hangover

15) arrested for DWI (Driving While Intoxicated)

16) been criticized by someone you were dating because of your drinking

17) had trouble with the law because of drinking

18) lost a job because of drinking

19) got a lower grade because of drinking

20) gotten in trouble with school administration because of behavior resulting from drinking too much

21) gotten into a fight after drinking

22) thought you might have a problem

23) damaged property, pulled a false fire alarm, or other such behavior after drinking.

24) participated in a drinking game

Current Interactions with Labeling for Alcohol

1) Do you read the scientific information specific to alcohol currently printed on labels of malted beverage (beer) products (i.e. type, alcohol content, alcohol by volume)?
    a. Always
    b. Very often
    c. Sometimes
    d. Rarely
    e. Never

2) Do you read the scientific information specific to alcohol currently printed on labels of wine products (i.e. type, alcohol content, alcohol by volume)?
    a. Always
    b. Very often
    c. Sometimes
    d. Rarely
    e. Never

3) Do you read the scientific information specific to alcohol currently printed on labels of distilled (liquor) products (i.e. type, alcohol content, alcohol by volume)?
    a. Always
    b. Very often
    c. Sometimes
    d. Rarely
    e. Never

4) Are you aware of government warnings presented on alcoholic beverage labels?
    a. Yes
    b. No

If the participant answers yes, a secondary question will open up

4A) If yes, list all the warnings on alcohol beverage labels that you can recall.

5) Do you use information about alcohol content when making decisions about what malted beverage (beer) to consume?
    a. Always
    b. Very often
    c. Sometimes
    d. Rarely
    e. Never

6) Do you use information about alcohol content when making decisions about what wine to consume?
    a. Always
    b. Very often
    c. Sometimes
    d. Rarely
    e. Never

7) Do you use information about alcohol content when making decisions about what distilled beverage (liquor) to consume?
    a. Always
    b. Very often
    c. Sometimes
    d. Rarely
    e. Never

8) Are you aware of how many grams of pure alcohol is considered a standard drink in the United States?
    a. Yes
    b. No

    If the participant answers yes, a secondary question will open.
    16A) If yes, how many grams of pure alcohol are considered a standard drink?

9) Are you aware of the number of standard drinks per day that is defined by Dietary Guidelines for Americans as moderate drinking for men?
    a. Yes
    b. No

    If the participant answers yes, a secondary question will open.
    17A) If yes, how many standard drinks per day is defined as moderate drinking for men?

10) Are you aware of the number of standard drinks per day that is defined by Dietary Guidelines for Americans as moderate drinking for women?

a. Yes
b. No

If the participant answers yes, a secondary question will open
18A) If yes, how many standard drinks per day for women is defined as moderate drinking?

11) If a standard drink of a certain beer is 12 ounces, what do you think the alcohol by volume content of the beer would be?
    a. 12%
    b. 2%
    c. 14%
    d. 5%
    e. 10%

12) If a standard drink of a distilled spirit is 1.5 ounces, what do you think the proof would be?
    a. 80
    b. 90
    c. 70
    d. 100
    e. 60

13) How many ounces of a wine with 12% alcohol by volume do you think would be considered a standard drink?
    a. 10 oz
    b. 5 oz
    c. 8 oz
    d. 3 oz
    e. 12 oz

MICHIGAN STATE
UNIVERSITY

EXEMPT DETERMINATION

June 15, 2018

To: Laura Lee Bix

Re: **MSU Study ID:** STUDY00000833
Principal Investigator: Laura Lee Bix
Category: Exempt 98
Exempt Determination Date: 6/15/2018

Title: Evaluation of a front of package label for alcoholic beverages

This project has been determined to be exempt under 45 CFR 46.101(b) 98.

Principal Investigator Responsibilities: The Principal Investigator assumes the responsibilities for the protection of human subjects in this project as outlined in Human Research Protection Program (HRPP) Manual Section 8-1, Exemptions.

Continuing Review: Exempt projects do not need to be renewed.

Modifications: In general, investigators are not required to submit changes to the Michigan State University (MSU) Institutional Review Board (IRB) once a research study is designated as exempt as long as those changes do not affect the exempt category or criteria for exempt determination (changing from exempt status to expedited or full review, changing exempt category) or that may substantially change the focus of the research study such as a change in hypothesis or study design. See HRPP Manual Section 8-1, Exemptions, for examples. If the project is modified to add additional sites for the research, please note that you may not begin the research at those sites until you receive the appropriate approvals/permissions from the sites.

Change in Funding: If new external funding is obtained for an active human research project that had been determined exempt, a new initial IRB submission will be required, with limited exceptions.

Reportable Events: If issues should arise during the conduct of the research, such as unanticipated problems that may involve risks to subjects or others, or any problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants that may change the level of review from exempt to expedited or full review must be reported to the IRB. Please report new information through the project's workspace and contact the IRB office with any urgent events. Please visit the Human Research Protection Program (HRPP) website to obtain more information, including reporting timelines.

Office of Regulatory Affairs
Human Research Protection Program

4000 Collins Road
Suite 136
Lansing, MI 48910

517-355-2180
Fax: 517-432-4503
Email: irb@msu.edu
www.hrpp.msu.edu

Personnel Changes: After determination of the exempt status, the PI is responsible for maintaining records of personnel changes and appropriate training. The PI is not required to notify the IRB of personnel changes on exempt research. However, he or she may wish to submit personnel changes to the IRB for recordkeeping purposes (e.g. communication with the Graduate School) and may submit such requests by submitting a Modification request. If there is a change in PI, the new PI must confirm acceptance of the PI Assurance form and the previous PI must submit the Supplemental Form to Change the Principal Investigator with the Modification request (http://hrpp.msu.edu/forms).

Closure: Investigators are not required to notify the IRB when the research study is complete. However, the PI can choose to notify the IRB when the project is complete and is especially recommended when the PI leaves the university.

For More Information: See HRPP Manual, including Section 8-1, Exemptions (available at https://hrpp.msu.edu/msu-hrpp-manual-table-contents-expanded).

Contact Information: If we can be of further assistance or if you have questions, please contact us at 517-355-2180 or via email at IRB@ora.msu.edu. Please visit hrpp.msu.edu to access the HRPP Manual, templates, etc.

Exemption Category. This project has qualified for Exempt Category(ies) 98. Please see the appropriate research category below from 45 CFR 46.101(b) for the full regulatory text. [123]

Exempt 1. Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Exempt 2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Exempt 3. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

Exempt 4. Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Exempt 5. Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) Public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

Exempt 6. Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

[1]Exempt categories (1), (2), (3), (4), and (5) cannot be applied to activities that are FDA-regulated.
[2] Exemptions do not apply to research involving prisoners.
[3] Exempt 2 for research involving survey or interview procedures or observation of public behavior does not apply to research with children, except for research involving observations of public behavior when the investigator(s) do not participate in the activities being observed.

APPENDIX B

Stimulus Design

Beer Labels

(76.2 mm x 76.2 mm)

Figure 19: Beer FOP Low Alcohol Content (A)

Figure 20: Beer Standard Low Alcohol Content (B)

Figure 21: Beer FOP High Alcohol Content (C)

Figure 22: Beer Standard High Alcohol Content (D)

Wine Labels

(101.6 mm x 76.2 mm)

Figure 23: Wine FOP Low Alcohol Content (E)

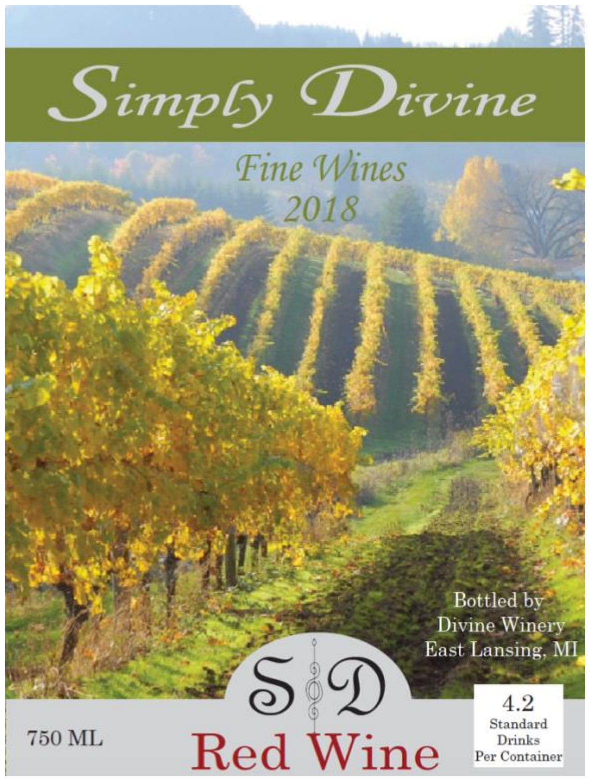


Figure 24: Wine Standard Low Alcohol Content (F)

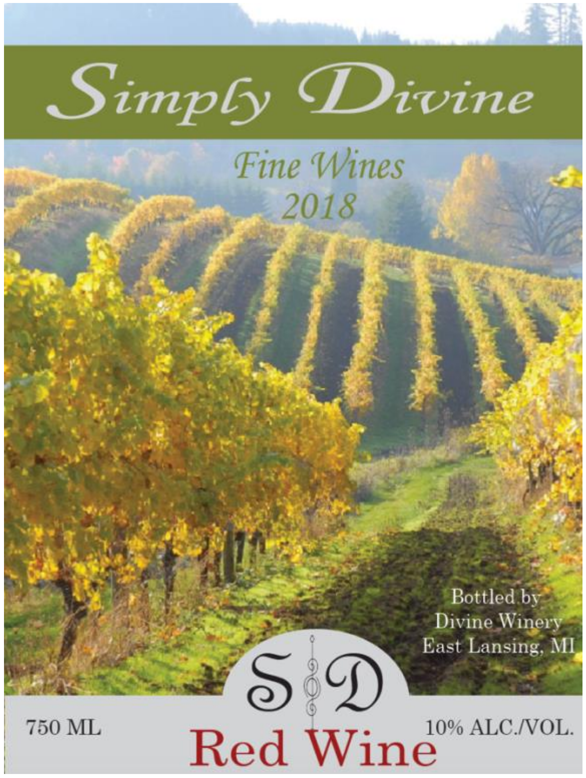


Figure 25; Wine FOP High Alcohol Content (G)

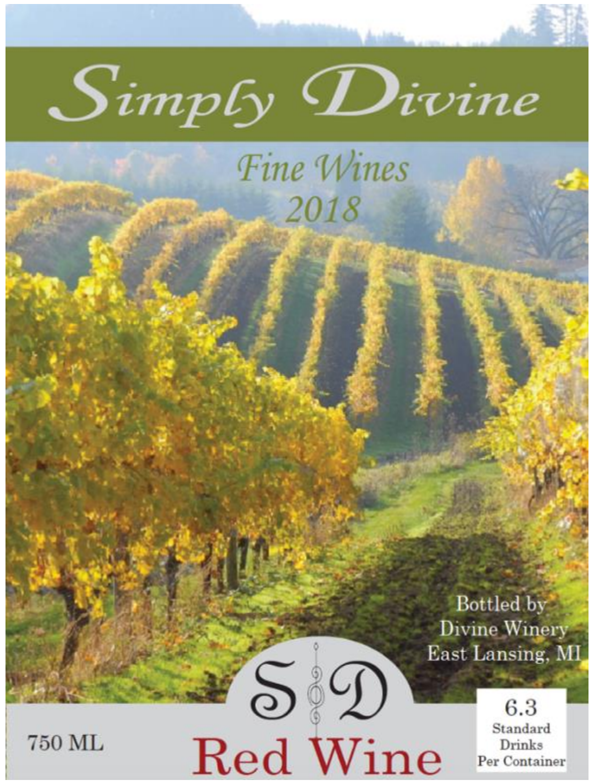
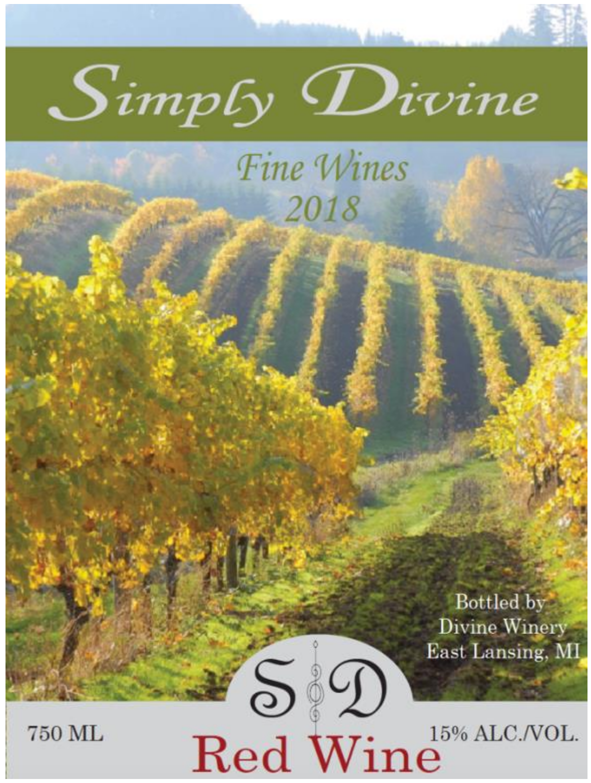


Figure 26: Wine Standard High Alcohol Content (H)



Liquor Labels

(101.6 mm x 76.2 mm)

Figure 27: Liquor FOP Low Alcohol Content (I)

Figure 28: Liquor Standard Low Alcohol Content (J)

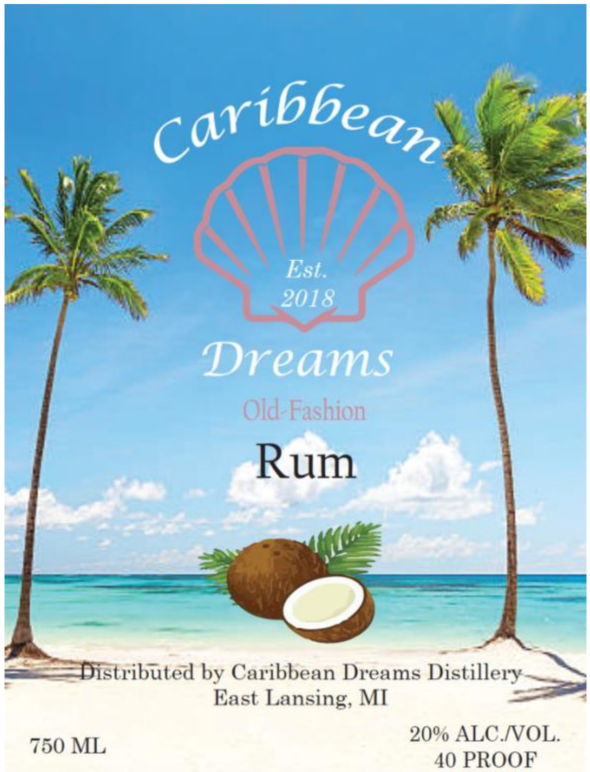
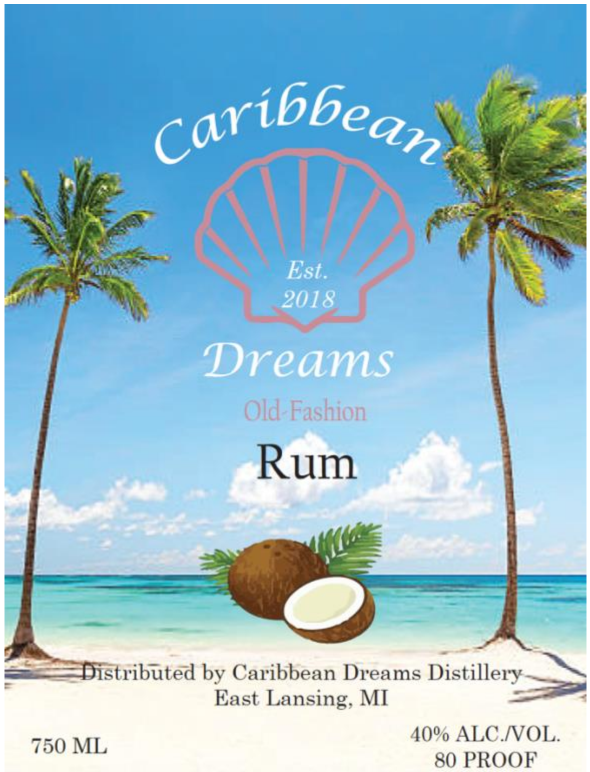


Figure 29: Liquor FOP High Alcohol Content (K)

Figure 30: Liquor Standard High Alcohol Content (L)



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