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Consumption of Alcoholic Beverages Associated With Physical Health Status in Adults: Secondary Analysis of the Health Information National Trends Survey Data

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Abstract

Introduction: Alcohol consumption constitutes one of the main modifiable risk factors that contribute to the increase in the global burden of non-communicable diseases (NCDs). The objective of this study was to determine the effects of the consumption of alcoholic beverages on the state of physical health and its equivalence according to gender. **Methods:** Cross-sectional data from the Health Information National Trends Survey (HINTS) of the National Cancer Institute (NCI) (n = 3865), collected during 2020 were used. Structural equation modeling was applied to assess the fit of the model, which included the prediction of measures of alcohol consumption in physical health and the equivalence of measurements of the proposed structural model in men and women. **Results:** The proposed structural model reported adequate goodness-of-fit indices (SBχ^2/gl = 3.817, CFI = 0.984, TLI = 0.968, RMSEA [90% CI] = 0.027 [0.016-0.039]; SRMR = 0.016). Frequent alcohol consumption had a negative effect on physical health ($b = -0.13$, $P < .01$). Similarly, occasional alcohol consumption negatively predicted elevated BMI and chronic conditions such as, diabetes, hypertension, CVD, and cancer ($b = -0.09$, $P < .01$). In addition, drinking patterns of alcoholic beverages affect physical health in equal ways for men and women. **Conclusion:** The findings highlight that frequent and occasional alcohol consumption significantly affected physical health in a negative way. Future interventions could address ways to encourage the adoption of a healthy lifestyle to reduce the risks of chronic conditions derived from excessive alcohol consumption.

Keywords

alcoholic beverages, health behavior, healthy lifestyle, noncommunicable diseases, risk factors

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Introduction

NCDs represent one of the main public health problems not only in high-income countries but also in low-income countries.[1] According to a report published by the World Health Organization (WHO), NCDs cause approximately 41 million deaths each year. The main causes of mortality from NCDs are cardiovascular diseases (CVD), different types of cancer, chronic respiratory diseases, and diabetes.[2] In the USA, NCDs have overtaken infectious diseases and become the leading cause of death in the country, accounting for 89% of all deaths, the highest mortality rate for all NCDs compared to the global average.[3] In 2018, previous research has indicated that just over a quarter (27.2%) of American adults had various chronic diseases.[4] The prevalence of these chronic diseases was higher in women, Hispanic white adults, older adults, as well as adults living in rural areas.[4] Compared with adults who do not have these chronic conditions, those with various chronic diseases have a poorer health-related quality of life. In addition, they

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experience an increase in health-care costs and are at greater risk of death.[5]

Alcohol consumption, together with inappropriate eating habits, sedentary behaviors, and smoking are the main modifiable risk factors that contribute to the increase in the global burden of non-communicable diseases.[2,6] The consumption of alcohol causes approximately 3.3 million deaths globally each year, which is equivalent to 5.9% of all deaths in the world. Furthermore, 5.1% of the global burden of disease is attributed to the harmful use of alcohol.[7] It is a causal factor of various diseases such as different types of cancer, ischemic heart disease, obesity, ischemic stroke, and liver cirrhosis.[8,9] In the countries of the Organization for Economic Co-operation and Development, alcohol consumption is roughly twice the world average.[10] Sales of alcoholic beverages increased significantly in the U.S., possibly due to stay-at-home policies and the relaxation of consumption restrictions because of the COVID-19 pandemic.[11] From 2019 to 2020, retail sales increased 14%.[12] Also, the 4 months after February, 2020 represent the 4 largest year-to-year increases recorded since 1993.[12] Excessive alcohol consumption should be one of the main focuses of preventive actions and strategies to control NCDs.

Alcohol consumption continues to increase in the U.S. population. On the other hand, non-communicable diseases have spread at a dizzying rate.[7] Therefore, an understanding of the relationship between alcohol use and chronic conditions is imperative for policy implementation and intervention strategies, health promotion, and disease prevention. The objective of this study was to evaluate the effects of alcohol consumption on physical health in American adults and their equivalence in men and women.

Materials and Methods

Study Design and Participants

The Health Information National Trends Survey (HINTS) is a cross-sectional and representative survey conducted nationwide in non-institutionalized civilian adults in the United States and is sponsored by the NCI. The HINTS contains a series of questions that seek to obtain information on the prevalence of cancer, health status, and health-related behaviors. Data from HINTS 5, cycle 4, collected between January and June 2020, were used in this study. A self-administered questionnaire was applied by mail in a single way, using the next birthday method for the selection of respondents. A 2-stage sampling strategy was applied: in the first, a stratified sample of addresses was selected from a file of residential addresses; in the second, one adult was selected from each sampled household.[13] Patients who provided information on the consumption of alcoholic beverages and the presence of chronic conditions were included. Finally, we obtained a sample size of 3865 participants.

Study Variables

Consumption of alcoholic beverages. The consumption of alcoholic beverages was considered as the independent variable. The current state of alcohol consumption was evaluated through 3 items, which were: (1) "During the past 30 days, on how many days per week did you have at least one drink of any alcoholic beverage?" (2) "During the past 30 days, on the days when you drank alcohol, about how many drinks did you have on average?" (3) For men, "in the past 30 days, how many times did you have 5 or more alcoholic beverages on a single occasion?" For women, "in the past 30 days, how many times have you had 4 or more alcoholic beverages on a single occasion?" They were provided with a list of drinks that was composed as follows: 12 fluid ounces of regular beer, 8 to 9 fluid ounces of malt liquor, 5 fluid ounces of table wine, and 1.5 fluid ounce shot of 80 proof distilled spirits (gin, rum, tequila, vodka, whiskey, among others).

Physical health status. The physical health index validated by Yanuar et al[14] was used for a structural equation model, which was measured based on 3 measures used in another previous study that included data from the HINTS.[15] The following variables were considered: body mass index (BMI) and chronic conditions such as diabetes, hypertension, CVD, and cancer.

BMI. Participants' BMI was measured using self-reported height and weight. They were asked, "How tall are you without shoes?" and "How much do you weigh, in pounds, without shoes?" Both variables (weight and height) were measured in feet, inches, and pounds, respectively. Subsequently, they were converted into kilograms and meters to calculate the BMI. The Quetelet formula was used where the BMI is calculated by dividing the weight (measured in kilos) by the square of the height (measured in meters). The use of self-reported height and weight-based BMI was validated in previous studies.[16,17] However, the self-reported BMI is biased compared to the measured BMI.[18]

Diabetes, hypertension, CVD, and cancer. To determine the presence of diabetes, hypertension, CVD, and cancer, the following questions were asked: "Has a doctor or other health professional ever told you that you had diabetes or high blood sugar?"; "Has a doctor or other healthcare professional ever told you that you had hypertension or high blood pressure?"; "Has a doctor or other healthcare professional ever told you that you had a heart condition such as a heart attack, angina, or congestive heart failure?"; "Have you ever been diagnosed as having cancer? All questions had binary answers (Yes or No)."

Co-variables. The sex of the participants was classified as male = 0 and female = 1. Marital status was recorded with

Table 1. Number and Percentages of Participants According to Their Socio-demographic Characteristics.

Characteristics	Mean ± SD/n (%)		χ^2	P-value
	Women	Men		
Age (years)	55.73(18.43)	54.34(20.94)		.001
Marital status			94.27	.001
Live as a couple	1028 (46.6)	950 (57.2)		
Previously married	744 (33.8)	354 (21.3)		
Single	432 (19.6)	357 (21.5)		
Education			13.18	.040
Basic	658 (29.9)	463 (27.9)		
Incomplete university	600 (27.2)	481 (29)		
Complete university	560 (25.4)	419 (25.2)		
Postgraduate	386 (17.5)	298 (17.9)		
Currently employed			0.98	.321
Yes	1062 (56.2)	1142 (57.8)		
No	828 (43)	833 (42.2)		
Income ranges			38.36	.001
$0-$19 999	649 (29.4)	392 (23.6)		
$20 000-$49 999	548 (24.9)	363 (21.9)		
$50 000-$99 999	539 (24.5)	456 (27.5)		
$100 000 or more	468 (21.4)	450 (27.1)		

1 = lives as a couple, 2 = previously married, and 3 = single. Academic achievement was converted on a 4-point scale, with 1 = basic, 2 = incomplete university, 3 = complete university, and 4 = postgraduate. Similarly, occupational status was re-coded to "currently employed," with 1 = "Yes" and 0 = "No." Annual Household Income was originally measured based on the categorical income used in HINTS 2020. A recode into quartiles was considered: "$0-$ 19 999," "$20 000-$49 999," "$50 000-$99 999," and "$100 000 or more."[19]

Statistical analysis. Structural equation modeling was used to evaluate the fit of the model, which included the prediction of alcohol consumption measures in physical health (BMI and chronic conditions). The most frequent goodness-of-fit indices were considered such as the comparative fit index (CFI), expecting a value >0.95, the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), <0.05,[20] the chi-square index with Satorra-Bentler correction,[21] the ratio between the Satorra-Bentler chi-square and the degrees of freedom (S-Bχ^2/gl), considering an adequate fit with estimated values that are ≤4.[22] In addition, the invariance of the structural model was evaluated according to sex to determine that the results obtained were equivalent in men and women.[23]

Results

Table 1 shows the socio-demographic characteristics of the participants. The mean age was 55.73 ± 18.43 in women and 54.34 ± 20.94 in men. Male participants tended to be married or living as a couple (57.2%). Almost 30% of the women had a basic education. Regarding the income level, 29.4% of the women declared an annual family income of less than $19 999.

The proposed structural model reported adequate goodness of-fit-indices (SBχ^2/gl = 3.817, CFI = 0.984, TLI = 0.968, RMSEA [IC 90%] = 0.027 [0.016-0.039]; SRMR = 0.016) where frequent and occasional alcohol consumption had a negative effect on physical health ($b = -0.13$, $P < .01$, and $b = -0.09$, $P < .01$, respectively). According to the measurement equivalence analysis, the models were continuously evaluated according to sex for the invariance analysis (Table 2).[23] The configural invariance (M1) was the basis for generating the rest of the models with restrictions obtaining acceptable values. Then, we proceeded to the analysis of the metric invariance model (M2), evidencing adequate adjustment indices: ΔCFI = 0.001 and ΔRMSEA = 0.002, presenting values similar to M1, due to the fact that they present minimal differences within the parameters (ΔCFI ≤ 0.01 and ΔRMSEA ≤ 0.015).[24,25] For this reason, it is possible to conclude the equivalence of the factorial loads allow for comparing the variances. The invariant analysis was followed which evaluated the strong invariance (M3) (ΔRMSEA < 0.015 and ΔCFI < 0.01). Similarly, the invariance of the intercepts was accepted, meeting the equivalence standard. Likewise, the analysis of residual invariance (M4) was continued, which showed that the differences between the models where the factor loadings, intercepts, and residuals remain equivalent in both

Table 2. Measurement Invariance of the Structural Equation Model.

	Invariance	$\Delta\chi^2$	*P*	Δgl	CFI	RMSEA	ΔCFI	ΔRMSEA
Sex	M1	27.084	**		0.987	0.026		
	M2	29.532	**	14	0.986	0.024	0.001	0.002
	M3	29.532	*	16	0.988	0.021	0.002	0.003
	M4	33.506	*	19	0.987	0.020	0.001	0.001

Abbreviations: $\Delta\chi^2$, delta Chi square; Δgl, delta degrees of freedom; CFI, comparative fit index; RMSEA, root mean square error of approximation; ΔCFI, delta comparative fit index; ΔRMSEA, delta root mean square error of approximation; **$P \leq .01$; *$P \leq .05$; M1, configural; M2, metrics; M3, intercepts; M4, residual.

groups (ΔRMSEA = 0.001, ΔCFI = 0.001), which, in turn, provides empirical support for the strict invariance.[24,25]

Discussion

Alcohol use affects more than 2 billion people around the world and it is an important risk factor for mortality and morbidity at the global level[7]. It is a drink that is commonly consumed in excess, whose consumption can cause more than 200 diseases and injuries.[26] In this nationwide study of the U.S. population, frequent and occasional alcohol consumption was found to have a significantly negative effect on the physical health of the participants; in addition, it significantly predicted an elevated BMI and chronic conditions such as type 2 diabetes mellitus, hypertension, CVD, and cancer.

Elevated BMI

Overweight and obesity are public health problems and are an important factor that contributes to the development of the metabolic syndrome,[27] which, in turn, is associated with a higher incidence of CVD, various types of cancer, type 2 diabetes mellitus and other chronic conditions that add to the global burden of disability.[28] Among the main causes of obesity are excessive intake of high-calorie foods and beverages. In addition, high alcohol consumption can contribute to obesity.[29] Energy consumed through alcohol intake contributes to energy from other sources, resulting in excessive short-term energy consumption by stimulating appetite.[30] Energy intake after alcohol consumption, even moderate intake, correlates with BMI and is a contributing factor to weight gain.[31] Several studies[27,29,31] have shown the association between alcohol consumption and the onset of overweight and obesity. Recently, it has been found that excessive daily alcohol consumption was independently associated with an increase in BMI. Furthermore, those who consumed had a significantly higher prevalence of obesity compared to those who did not.[27] Several mechanisms have been proposed to explain the possible relationship between alcohol intake and body weight. For example, it is likely that, during or after a period of alcohol consumption, consumers themselves will make unhealthy food choices[32]; this, in turn, could be due, at least partially, to the fact that alcohol, as a psychoactive substance, has a disinhibitory effect, which can alter habitual behavior[33]; or also due to the appetite-enhancing effect of alcohol.[33] Some studies found that alcohol intake was positively associated with BMI in both sexes.[34] However, other studies report that the association of alcohol consumption with weight varies between women and men, possibly due to differences in alcohol metabolism that reflect differences in body fat between men and women.[31,35]

Diabetes

Diabetes is a chronic disease that constitutes one of the main causes of mortality and morbidity. This is due to the presence of associated diseases such as cardiovascular, kidney, ophthalmic, and neurological.[36] Alcohol consumption is a major risk factor for non-communicable diseases including type 2 diabetes mellitus.[37] Previous studies have found that alcohol consumption is directly or indirectly associated with an increased risk of type 2 diabetes mellitus. For example, a study conducted in a Chinese population found that excessive alcohol intake appeared to be causally associated with an increased risk of diabetes.[38] On the other hand, experimental studies carried out in animals found that prolonged alcohol consumption is associated with pancreatic damage and the development of diabetes.[39] This could be due to pancreatic β-cell dysfunction and apoptosis.[39,40] Although the excessive and chronic consumption of alcohol is considered a potential risk factor and harmful to people's health, there is evidence that low-moderate alcohol intake can have certain beneficial effects, especially regarding insulin resistance and the appearance of type 2 diabetes mellitus.[37,41,42] These beneficial effects may be due to the fact that it could increase glucose-stimulated insulin secretion and insulin sensitivity.[42] However, there are some discrepancies. For example, some studies suggest that the reduction in diabetes risk among moderate drinkers may be limited to women and race and may have been overestimated.[37,43] Furthermore, in many of the studies conducted, cross-sectional data was used. That is, alcohol

consumption was measured at a single point of time, assuming that consumption is stable over time. However, alcohol intake is dynamic, particularly for longer periods. Consequently, measurement at a particular point in time could confuse the results.[37]

Hypertension

Hypertension is one of the main causes of morbidity and mortality and represents a major public health problem.[44] There have always been studies that have shown a link between alcohol consumption and blood pressure.[45] In fact, alcohol consumption and hypertension are one of the top 5 risk factors responsible for increasing global burden of NCDs[46] and they occupy a key place within WHO's goals in the fight to reduce NCD mortality by 25% by 2025.[47] Excessive alcohol consumption is one of the most common causes of high blood pressure. Results of a study conducted by Tasnim et al[48] showed that consuming large doses of alcohol caused a drop in blood pressure within 6 h and that the effect lasted up to 12 h after consumption. However, after this time they noticed an increase in blood pressure. Heart rate increased significantly after alcohol consumption and remained elevated each time it was measured. Similarly, findings from other studies have observed through meta-analysis that there is a linear relationship between the amount of alcohol consumed and the degree of hypertension.[49,50] The molecular pathways by which alcohol consumption increases blood pressure are unclear. However, it is suggested that acute consumption may affect the renin-angiotensin-aldosterone system by increasing plasma renin activity. This, in turn, increases the production of angiotensin I (AI), which is converted to angiotensin II (AII) by angiotensin-converting enzyme (ACE). AII hormone is a potent vasoconstrictor capable of stimulating the secretion of aldosterone and vasopressin from the adrenal gland, which promotes sodium and water retention.[51] Consequently, peripheral resistance and blood volume increase, leading to an increase in arterial blood. Furthermore, alcohol consumption stimulates the sympathetic nervous system and increases the production of norepinephrine, which increases heart rate and blood pressure by stimulating adrenergic receptors located in the heart muscles.[48] Therefore, it is essential to implement effective interventions in both men and women who consume more than 2 drinks per day, with the aim of reducing the risk of hypertension and the morbidity and mortality burden derived from alcohol consumption. Nevertheless, in some studies,[52-54] mild and moderate alcohol consumption did not show a strong correlation with hypertension, and in fact may favor a decrease in the rates of arterial and coronary heart disease, due to the reduction of atherosclerosis, blood coagulation and platelet aggregation. While consuming medium doses of alcohol can lower blood pressure, it can increase heart rate within 6 h after consumption. Alcohol can steadily increase heart rate at any time within 24 h of consumption.[48]

CVD

The findings found in our study were also aligned with the results of a study in which a causal association between excessive alcohol consumption and an increased risk of cardiovascular disease has been shown.[55] These findings are supported by another study[56] where a harmful association has been observed between alcohol consumption and having a higher risk of CVD in men. However, this same study,[56] found that among women, there is an apparent protective association between mild and moderate alcohol consumption and CVD risk. Also, other research has reported a lower risk of CVD among men who consume alcohol moderately.[57] It is worth mentioning that, since always there have been some controversies about the beneficial effects of alcohol consumption on cardiovascular health.[58] While some studies have shown that low and moderate consumption can be beneficial and cardio-protective in the prevention of cardiovascular disease,[52] other research has shown that excessive alcohol consumption increases the risk of CVD.[55] Although moderate alcohol intake may have long-term CVD benefits, even low consumption can have some risk. In fact, some authors consider that these benefits have several limitations and that, perhaps, they could have been overestimated.[55]

Cancer

Cancer is the second leading cause of death globally and has become one of the major public health problems. Cancer constitutes a disease burden that could be prevented by choosing healthy lifestyles, including limited alcohol consumption.[59] Alcohol, as a globally consumed beverage, has been shown to be associated with many types of cancer.[60] Alcohol consumption is causally associated with cancer of the upper aero-digestive tract, which includes areas such as the oral cavity, pharynx, larynx, and esophagus. There is also evidence of association with cancers of the colon, rectum, liver, and female breast.[61] For example, results from a case-control and cohort meta-analysis study suggested that the risk of bladder cancer was significantly increased with excessive consumption of alcoholic beverages in men and the Japanese population without significant statistical heterogeneity.[62] Possible reasons that could explain this puzzling relationship could be supported by the hypothesis that acetaldehyde derived from alcohol consumption plays an important role in the development of bladder cancer.[63] Similarly, the consumption of alcoholic beverages is a common risk factor for colorectal cancer. In a large prospective study, researchers found that higher alcohol consumption was associated with an elevated risk of colon cancer.

However, the association was significant only for the highest intake category of ≥30 g/day, without a significant linear trend.[64] Several mechanisms have been suggested to explain the association between alcohol consumption and the risk of cancer mortality, including the effects of alcohol on tumor growth through insulin signaling, poor diet, the carcinogenic effect of nitrosamines, and increased folate breakdown.[65,66] Alcoholic beverages are composed of many carcinogens, but most of the risk relationship between alcohol consumption and the development of cancer is due to ethanol.[67] Not only does alcohol have toxic and harmful elements like carcinogenic metabolites, but alcoholics generally lean on a diet low in folate and fiber, which could further increase alcohol-induced carcinogenesis, particularly in the case of colon cancer.[68]

Limitations

There are several limitations to this study. First, the temporality and causal inference of the association is unknown due to the cross-sectional nature of the survey. Therefore, they highlight the importance of conducting longitudinal or experimental research to explore the associations between alcohol consumption. Additionally, responses come from self-reported data, which are often subjective, meaning that they may be susceptible to recall biases or other inaccuracies in recording. Despite these limitations, we consider that this study has one strength. Namely, the use of a large and nationally representative sample.

Conclusion

The effects of daily and occasional alcohol consumption were significantly negative on physical health. In fact, these findings suggest that it is a predictor of elevated BMI and chronic conditions such as, diabetes, hypertension, CVD, and presence of cancer. In addition, drinking patterns affect physical health equally for men and women. Longitudinal studies are suggested to confirm these results and implement population-level causal mechanisms to further explain how drinking alcoholic beverages affects physical health. It is important to develop effective interventions in both men and women to encourage the adoption of a healthy lifestyle, including a gradual decrease in alcohol consumption to help reduce the risk of chronic conditions resulting from excessive alcohol consumption.

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Supplemental Material

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