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Light wine consumption is associated with a lower odd for cardiovascular disease in chronic kidney disease

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Abstract

Aims: To examine the association between wine consumption and the prevalence of chronic kidney disease (CKD) and cardiovascular disease (CVD).

Data synthesis: We performed a cross-sectional logistic regression analysis of National Health and Nutrition Examination Survey (NHANES) in participants 21 years of age or older from 2003–2006 in a large representative study of the U.S. population. Wine consumption was categorized as none (0 glass per day), light (< 1 glass per day), or moderate (1–2 glasses per day). Prevalent CKD was defined as a urine albumin/creatinine ratio (UACR) ≥ 30 mg/g or estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73m². CVD was defined as history of CVD including angina, myocardial infarction, or stroke.

Only 27(0.5%) individuals reported moderate wine consumption, whereas 57.5% and 42% reported abstinence and light wine consumption, respectively. Light wine consumption was associated with a lower prevalence of CKD as opposed to abstinence in unadjusted analysis. After adjusting for demographics and CVD risk factors light wine consumption was associated with lower prevalence of CKD defined as UACR ≥ 30 mg/g but not with low eGFR. Furthermore, light wine consumption was associated with significantly lower rates of CVD in the general population and in subjects with CKD. The adjusted odd of CVD for those with light wine consumption was 0.72 (CI 0.52–0.99, p=0.046) for the subjects with CKD.

Conclusion: These data suggest that light wine consumption (compared to abstinence) is associated with lower prevalence of CKD and a lower odd of CVD in those with CKD in the U.S. population.

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Author contributions

All authors read, revised and approved the draft of the manuscript.

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Conflicts of interest

The authors declare that there are no conflicts of interest

Keywords

wine consumption; CKD; CVD

INTRODUCTION

The prevalence of chronic kidney disease (CKD) in the United States (U.S.) is high (estimated at approximately 11.5%).[1] While dialysis or transplantation may result from CKD, the majority of CKD patients will die prematurely from cardiovascular disease (CVD) prior to reaching this end-point.[2-4] Importantly, CKD is associated with increased cardiovascular mortality partially due to increased prevalence of traditional risk factors such as age, diabetes mellitus, hypertension, and hyperlipidemia in patients with CKD.[5, 6] However, CKD is also associated with an increased prevalence of nontraditional risk factors unique to this patient population such retention of uremic toxins, anemia, abnormalities in bone mineral metabolism, and increased inflammatory states which likely contribute to the higher risk of CVD in CKD.[7-10]

It has been speculated that variations in diet and lifestyle may contribute to an individual's risk for CVD, and that light and moderate wine consumption may potentially alleviate such deleterious cardiovascular effects. Indeed, Renaud et al.'s seminal studies in the 1990s on the French paradox, found a relatively low incidence of cardiovascular disease in middle-aged French men, despite a relatively high dietary intake of saturated fats, potentially attributable to the consumption of red wine.[11] Subsequent observational studies, including in the U.S. and other populations, have demonstrated similar positive biological and clinical associations of light-to-moderate wine consumption on CVD and mortality.[12-14] Collectively, the available evidence suggest that light-to-moderate wine consumption may confer some degree of protection from CVD risk. Considering the strong link between CVD and CKD, we hypothesized that wine consumption would be associated with a lower odd of CKD and with a lower odd of CVD in patients with CKD. Therefore, the present study evaluated the prevalence of CKD according to wine consumption, and the odds of CVD in subjects with and without CKD using the National Health and Nutrition Examination Survey (NHANES), a large representative study of the U.S. population.

METHODS

We performed a cross-sectional analysis of adult NHANES participants between the years 2003 to 2006 with the primary aim of evaluating the association between wine consumption and the prevalence of CKD. A secondary goal of the analysis was to evaluate the association between wine intake and cardiovascular disease in subjects with and without CKD. As shown in the flow chart in Figure 1, NHANES identified 12,761 persons for the sample in 2003-2004 and 10,248 for the sample in 2005-2006. Of those, 9,643 persons had completed the interview and physical examination and were eligible for inclusion in the analysis. [15, 16] In order to meet inclusion criteria for the analysis, subjects were required: 1) to be 21 years of age or older, 2) to have responded to the food frequency questionnaire, and 3) to have data available to be labeled for sex, race, age, education, household income, waist

circumference, hypertension, HDL cholesterol, triglycerides, and kidney disease. Of the original sample, 5,852 subjects fulfilled these inclusion criteria. Diabetes mellitus was defined as diagnosed by a physician or the use of diabetic medications. CVD was defined as a positive response to the questions regarding history of CVD including angina, myocardial infarction, and stroke. Prevalent CKD was defined as urinary albumin/creatinine ratio (UACR) of ≥ 30 mg/g or eGFR of <60 mL/min/1.73m² calculated using the Modification of Diet in Renal Disease study formula. [1] Hypertension was defined as taking blood pressure medications or as an average systolic blood pressure of >140 mmHg or average diastolic blood pressure of >90 mmHg. Wine intake was extracted from the NHANES food frequency questionnaire data and included wine and wine coolers. For purposes of this investigation, wine consumption was categorized as none (0 glass/day), light (< 1 glass per day), or moderate (≥ 1 glasses per day). [17]

To account for the complex sample strategy of NHANES, appropriate 4 year weights and strata were applied. Statistical analysis software 9.3 PROC SURVEYREG and SURVEYFREQ was used to obtain descriptive statistics for the population. All statistical tests were two-tailed ($\alpha = 0.05$). Characteristics of the population were compared among wine consumption categories using the Rao-Scott Chi Square for survey-adjusted categorical variables and ANOVA for continuous variables. Parametric analysis was utilized as the data is normally distributed. We performed logistical regression analysis to determine if light wine consumption was associated with prevalent CKD and CVD. Due to the small number of subjects with moderate wine consumption ($n=27$), this group was not included in the regression analysis. If the overall test was significant for variables with more than 2 levels, p-values for comparisons between groups are presented as odds ratios with 95% confidence intervals.

RESULTS

General characteristics according to wine consumption:

A total of 5,852 participants met inclusion criteria for the study. The majority ($n=3,370$; 57.5%) reported no wine intake, whereas 2,455 (42%) participants reported light wine intake. Compared to individuals who did not drink wine, light wine drinkers were significantly younger, had lower prevalence of diabetes, hypertension, and CVD, had a higher mean waist circumference, and lower HDL-cholesterol (Table 1).

The prevalence of CKD based on wine consumption categories:

1,031 (18%) participants had CKD. The prevalence of CKD was significantly lower in subjects who reported light wine consumption compared to non-drinkers (13% vs 20%, $p < 0.0001$). Light wine drinkers in CKD were also less likely to have UACR ≥ 30 mg/g or eGFR <60 mL/min/1.73m² (Figure 2). In the unadjusted analysis, the odds ratio (OR) of having CKD was 0.63 lower for those with light wine consumption compared to those who did not drink any wine (CI 0.54-0.74, $p < 0.0001$). This association remained significant after adjusting for demographics (OR 0.67, CI 0.55-0.81, $p = 0.0001$) and CV risk factors (OR 0.75, 0.62-0.91, $p = 0.02$). Other variables that were associated with CKD in the multivariate model are shown in Supplemental Table 1 and include: sex (females), age, diabetes, and

hypertension. As shown in Table 2, when analyzing the components used to diagnose CKD separately, participants who reported wine consumption were significantly less likely to have UACR <30 mg/g independently of demographics and other CV risk factors (OR 0.62, CI 0.44-0.87, $p = 0.006$). Although light wine consumption was associated with lower odds of eGFR < 60 mL/min/1.73m² in unadjusted analysis, this association was attenuated and no longer significant after adjusting for demographics or CV risk factors.

Odds of CVD with wine consumption:

Of those with CKD, 666 (11%) participants reported a history of CVD. As shown in Figure 3, the prevalence of CVD was lower in those individuals who drank light wine compared to non-drinkers (5.8% vs 10.7%, $p < 0.0001$). In the unadjusted analysis, those who reported light wine consumption had approximately half the odds of CVD compared to those who did not drink wine (CI 0.42-0.64, $p < 0.0001$) as shown in Table 3. This association remained significant after adjusting for demographics and CV risk factors as shown in Table 3. In the final multivariate model (data not shown), male gender, older age, diabetes, and hypertension were significantly associated with self-reported CVD.

Odds of CVD with wine consumption based on CKD status:

Results after stratifying subjects by CKD status are presented in Table 3. Findings for those without CKD were similar to the overall group where light wine consumption was associated with lower odds of CVD compared to reported abstinence even after adjusting for demographics and CV risk factors (OR 0.60, CI 0.45-0.81, $p = 0.001$). For subjects with CKD, light wine consumption was similarly associated with lower odds of CVD after adjusting for demographics and CV risk factors. Other variables that were associated with increased odds of self-reported CVD in the multivariate model included: age, diabetes, and hypertension. Female sex was associated with significantly lower odds of CVD in those with CKD in the multivariate model. These data are shown in Supplemental Table 2. Of note, in subjects with CKD, the odds of CVD with light wine consumption remained significantly lower than in those who did not drink any wine after adjusting for level of education and household income (OR 0.78, $p = 0.04$).

DISCUSSION

In this analysis, we evaluated self-reported intake of wine in NHANES, a large representative sample of the U.S. population. We found that the majority of the U.S. population reported either no or light intake of wine (defined as < 1 glass per day). Our analysis, furthermore, indicated that light wine consumption is associated with lower odds of CKD. Lastly, and most notably, in subjects with CKD, light wine consumption was associated with significantly lower odds of CVD independent of demographics, CVD risk factors and socio-economic factors. Collectively, these findings are important considering the high risk of CVD in patients with CKD, as they highlight that light wine consumption (i.e. < 1 glass per day) may reduce CVD in CKD. [2-4]

Previous data have indicated moderate wine consumption associates a lower risk of CVD. [11-14, 18] These epidemiological observations have often been attributed to the

cardiovascular benefit of red wine; specifically the polyphenol content of red wine.[19-21] Polyphenol compounds may decrease oxidative stress, enhance cholesterol efflux from vessel walls (mainly by increasing levels of HDL), and inhibit lipoproteins oxidation, macrophage cholesterol accumulation, and foam-cell formation.[22] They may also increase nitric oxide bioavailability, thereby antagonizing the development of endothelial dysfunction. [23] However, it is important to note that most of the published epidemiological studies did not distinguish between red and white wine intake.[11, 13, 18] In addition, studies that did examine red and white wine intake reported similar risk reduction for white and red wines, suggesting that other factors than red wine components may be at play.[14, 24] Furthermore, although phenolic compounds exist in white wine in smaller amounts, there is data to suggest that the quantity/volume of ingested polyphenols may be less important than the biological activity.[25, 26] Our results appear to raise an intriguing question; that is, does light (<1 glass/day) wine consumption elicit a greater cardiovascular benefit and reduced all-cause mortality compared to the widely accepted, and highly investigated, moderate (1 glass/day) wine consumption? Future studies will be needed to fully elucidate this running hypothesis.

With regards to the association between light wine intake and CKD, we are unaware of other studies that have explored this potential association. Earlier analyses from NHANES (1976-1980) reported no association between alcohol consumption and CKD.[27] However, the earlier study did not evaluate wine consumption specifically, as we have done, which may explain our discrepant findings. Much like the link between wine intake and CVD, some data suggest that the polyphenol content of the wine may modify the disease process in the kidney itself. Resveratrol, for example, has been shown to reduce fibrosis in animal models of CKD.[28-30] Additionally, in animal models of diabetic kidney disease, resveratrol has been shown to reduce hyperglycemia-mediated oxidative stress and inflammation leading to slower kidney disease progression in these models.[31-34] Of interest, in human subjects with stage 3 and 4 CKD, there is data to suggest white wine compounds may reduce markers of inflammation including C-reactive protein and interleukin-6. [35] Unfortunately, we were unable to evaluate the potential association between wine consumption and markers of inflammation in this analysis. In addition, due to the cross sectional nature of the study, we are unable to evaluate CKD progression. Rather, we found an independent association between wine intake and albuminuria. Considering that albuminuria is a marker of endothelial dysfunction, it is likely that our findings reflect the potential benefit of wine intake on the vasculature rather than on the kidney. Consistent with that, the observed lower odds of CVD with light wine consumption was observed in both groups with and without CKD, suggesting that this effect may be independent of CKD. Alternatively, wine compounds have been shown to inhibit common mediators of both CVD and CKD such as platelet activating factor [36, 37]. As such, it is possible that the effects of wine compounds include both CVD and CKD by targeting common pathways between both conditions.

Our study has some limitations, including its cross-sectional design from which we cannot derive causation. In addition, because we relied on participants' reports, recall and reporting bias have the potential to introduce spurious associations.[27] Moreover, we used three categories of wine consumption, but we could not account for the exact amount of wine

consumption due to the limitations of the questionnaire nor were we able to compare light with moderate wine consumption due to the small number of subjects in the latter group. Finally, we did not account for other forms of alcohol intake, as some studies have suggested alcohol intake in general (not just wine) may associate with cardiovascular benefits. [38] However, recent data indicate no net benefit from alcohol intake itself, rather such data are likely attributable to inappropriate selection of “abstainers” who had a higher burden of disease in general.[38, 39] Notwithstanding these limitations, strengths of the present study include a large population consisting of light wine drinkers, generalizability to the overall population, and the ability to define CKD and adjust for socioeconomic factors. Lastly, we should acknowledge that, while we found light drinkers to have lower odds of CKD and CVD than non-drinkers, the results should be interpreted with caution, as it may be unwise for non-drinkers to take up drinking wine as a means of lowering their risk. Data on the renal effects of light to moderate alcohol consumption in general are scarce, however, heavier alcohol use is associated with negative outcomes including hypertension and end stage renal disease.[40, 41]

In conclusion, our data demonstrate that light wine consumption (compared to abstinence) is associated with lower prevalence of CKD and a lower odd of CVD in those with CKD within the U.S. population. Additionally, we have found that light wine consumption associates with lower odds of albuminuria. Collectively, these findings suggest that the potential cardiovascular benefits of light wine consumption may extend to those with CKD. Future prospective cohort studies will be needed to better understand the potential mechanisms that may underlie these findings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Analysis of the National Health and Nutrition Examination Survey, a large representative sample of the U.S. population
- Evaluation of the association between light wine consumption and CVD and CKD
- Light wine consumption is associated with a lower prevalence of CKD
- Light wine consumption is associated with a lower odd of CVD in those with CKD

Study Flow Chart

Figure 1: Study flow chart.

Of the 9,643 persons eligible for the inclusion in the analysis, 5,852 met inclusion criteria, which included an age ≥ 21 years, completion of the food frequency questionnaire and data on all anthropometric and socioeconomic characteristics

Figure 2: Light wine intake is associated with a lower prevalence of CKD relative to non-wine drinkers.

CKD = chronic kidney disease, UACR = urine albumin/creatinine ratio (≥ 30 mg/g), eGFR = estimated glomerular filtration rate (<60 mL/min/1.73m²). Variables are shown as a survey weighted %. None is defined as 0 glass/day, light wine consumption is defined as <1 glass/day and moderate wine consumption is defined as ≥ 1 glass/day. Overall-effect p value < 0.0001 . Values are mean $\pm$ SD.

Figure 3: Light wine intake is associated with a lower prevalence of CVD in CKD relative to non-wine drinkers.

Variables are shown as a survey weighted %. None is defined as 0 glass/day, light wine consumption is defined as <1 glass/day and moderate wine consumption is defined as 1 glass/day. Overall-effect p value < 0.0001. Values are mean $\pm$ SD.

Table 1.

Characteristics of participants according to wine consumption

	None (n = 3,370)	Light (n = 2,455)	Moderate (n = 27)	p-value *
Age, mean (years)	49 ± 0.5	48 ± 0.5	48 ± 2.7	0.02
Male gender (%)	50 ± 1.0	44 ± 0.6	50 ± 11.7	0.0009
Non-Hispanic white (%)	73 ± 2.6	79 ± 1.8	91 ± 4.7	<0.0001
Diabetes (%)	11 ± 0.7	6 ± 0.6	3 ± 3.0	<0.0001
Hypertension (%)	43 ± 1.7	35 ± 1.2	40 ± 11.3	<0.0001
Waist circumference (cm)	52 ± 0.4	57 ± 0.4	65 ± 5.4	<0.0001
HDL (mg/dL)	100 ± 0.4	96 ± 0.5	95 ± 2.2	<0.0001

HLD = high-density lipoprotein, CVD = cardiovascular disease

Categorical variables are reported as survey weighted %. Continuous variables are reported as mean ± SD. None, defined as 0 glass/day; light wine consumption, defined as <1 glass/day; moderate wine consumption, defined as 1 glass/day

*
p-values presented test for overall differences across wine-consumption categories

Table 2.

Association between light wine consumption and CKD

	UACR ≥ 30		eGFR <60		CKD [*]	
	Odds ratio (CI)	p-value	Odds ratio (CI)	p-value	Odds ratio (CI)	p-value
Unadjusted	0.51 (0.38-0.68)	<0.0001	0.75 (0.61-0.92)	0.006	0.63 (0.54-0.74)	<0.0001
Adjusted for demographics ^{**}	0.56 (0.40-0.77)	0.0004	0.83 (0.65-1.07)	0.35 [†]	0.67 (0.55-0.81)	<0.0001
Adjusted for demographics and CV risk factors [‡]	0.62 (0.44-0.87)	0.006	0.94 (0.72-1.22)	0.87 [†]	0.75 (0.62-0.91)	0.004

Light wine consumption defined as <1 glass per day; reference defined as no wine consumption

UACR = urine albumin/creatinine ratio, eGFR = estimated glomerular filtration rate

^{*} CKD, defined as either UACR ≥ 30 or eGFR <60

^{**} Demographics: age, gender, race

[‡] CV risk factors: waist size, HDL, triglycerides, diabetes, hypertension

Table 3.

Association between light wine consumption and CVD

	All participants OR (CI, p value)	CKD absent OR (CI, p value)	CKD present OR (CI, p value)
Unadjusted	0.51 (0.42-0.64, p <0.0001)	0.50 (0.37-0.6, p <0.0001)	0.72 (0.52-0.99, p = 0.046)
Adjusted for demographics **	0.55 (0.44-0.69, p <0.0001)	0.52 (0.39-0.71, p <0.0001)	0.65 (0.48-0.89, p = 0.008)
Adjusted for demographics and CV risk factors †	0.63 (0.61-0.79, p <0.0001)	0.60 (0.45-0.81, p = 0.001)	0.71 (0.53-0.95, p = 0.02)

Light wine consumption defined as <1 glass per day; reference defined as no wine consumption

CKD, defined as either UACR ≥30 or eGFR <60

** Demographics: age, gender, race

† CV risk factors: waist size, HDL, triglycerides, diabetes, hypertension