
Alcohol Consumption in Older Adults and Medicare Costs

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We determined the relationship of alcohol consumption and Medicare costs among 4,392 participants in the Cardiovascular Health Study (CHS), a longitudinal, population-based cohort study of adults age 65 or over in four U.S. communities. We assessed 5-year Parts A and B costs and self-reported intake of beer, wine, and liquor at baseline. Among both sexes, total costs were approximately \$2,000 lower among consumers of >1-6 drinks per week than abstainers. The lower costs associated with moderate drinking were most apparent among participants with cardiovascular disease (CVD) and for hospitalization costs for CVD among healthy participants. Former drinkers had the highest costs.

INTRODUCTION

Alcohol consumption has effects on a myriad of physiological systems, particularly at high levels of consumption. The effects of heavy alcohol consumption on the central and peripheral nervous systems, gastrointestinal organs, liver, pancreas, and immune system are well described (U.S. Department of Health and Human

Services, 2000). At the same time, moderate alcohol consumption (typically up to 14 drinks per week) is associated with apparent health benefits, including lower total mortality and lower rates of coronary heart disease than abstention or very light drinking among middle-aged and older adults (Colditz et al., 1985; Scherr et al., 1992).

The economic effects of alcohol consumption, and particularly heavy alcohol consumption, have been modeled in several different ways (Harwood, 2000; Rice, 1990). Most commonly, these studies have focused on the specific health effects of alcohol abuse using a cost-of-illness approach, summing the opportunity costs attributable to health care expenditures (directly due to alcohol abuse and its associated health consequences and indirectly due to lengthened hospital stays for unrelated conditions), lost productivity, and other societal losses (such as property damage in motor vehicle crashes). For example, using a cost-of-illness approach, Harwood (2000) estimated that alcohol abuse was responsible for over \$184 billion in costs in the U.S. in 1998. Over \$26 billion of this expense was attributable to health care and related expenditures with lost earnings due to illness accounting for over \$87 billion.

Few studies have assessed the potential economic consequences of moderate alcohol consumption. Given the apparent association of moderate alcohol use with lower risk of CVD (the major cause of death in the U.S.), moderate alcohol drinkers might be expected to have lower health care expenditures. However, this hypothesis

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has not been formally tested. We know of no population-based study that has prospectively examined the actual health care charges of older adults according to their self-reported alcohol intake.

To address these questions, we assessed the association between alcohol consumption and Medicare Parts A and B costs in the CHS, a longitudinal, population-based cohort study of older Americans. Because Medicare is the primary payer for health care expenditures in this age group, relatively reliable information on both inpatient and outpatient expenditures is available.

METHODS

Study Population and Design

The CHS is a longitudinal study of 5,888 males and females age 65 or over who were recruited from a random sample of Medicare eligibility lists in four communities: Forsyth County, North Carolina; Sacramento County, California; Washington County, Maryland; and Allegheny County, Pennsylvania. Participants were not institutionalized or wheelchair-dependent in the house, did not require a proxy for consent, were not under treatment for cancer at the time of enrollment, and were expected to remain in their respective regions for at least 3 years. In 1989 and 1990, 5,201 consenting participants were recruited and examined (the original cohort); in 1992 and 1993, an additional 687 Black participants were recruited and examined (the new cohort). The institutional review board at each participating center approved the study, and each participant provided informed consent.

The CHS study design and objectives have been published previously (Fried et al., 1991). The baseline examination included standardized medical history ques-

tionnaires, physical examination, resting electrocardiography, spirometry, carotid ultrasonography, echocardiography, and laboratory examination. A full list of participating investigators and institutions can be found at <http://www.chs-nhlbi.org>.

Alcohol Consumption

At the baseline visit, participants individually reported their usual consumption of 12-ounce cans or bottles of beer, 6-ounce glasses of wine, and shots of liquor. These values were summed to determine total alcohol consumption. Participants also reported (in yes/no format) whether they changed their pattern of consumption during the past 5 years and whether they ever regularly consumed five or more drinks daily. Participants who reported current abstinence but responded yes to either of these questions were classified as former drinkers; those who responded no to both questions were considered long-term abstainers. In a validation analysis, the age-, sex-, and race-adjusted correlation of baseline alcohol intake with high-density lipoprotein cholesterol levels among the 5,802 CHS participants with available data was 0.23 ($p < 0.001$) (Mukamal et al., 2003) essentially identical to the correlation found in other cohorts (Linn et al., 1993). The full text of the CHS nutritional questionnaire is publicly available (Cardiovascular Health Study, 1989). No specific questions regarding problem drinking or current alcohol dependence were included.

We categorized participants into categories according to weekly ethanol consumption as follows: none, former, ≤ 1 drink weekly, >1 -6 drinks weekly, >6 -13 drinks weekly, and >13 drinks weekly, to ensure consistency with previous CHS analyses (Mukamal et al., 2003).

Determination of Medicare Payments

As part of the Sedentary Lifestyle Project (Luepker et al., 2002), CMS provided Medicare Parts A and B information on hospitalizations, outpatient visits, visits to physicians and other providers, and denominator files for CHS participants for 1991-1998, based on claim account number and sex information provided by the CHS Coordinating Center. Only hospitalization information was available for 1989-1990. For each of the three types of claims (hospitalization, hospital outpatient, and physician and other providers), one record per participant per year was created using the appropriate utilization and denominator files.

For hospitalization claims, each record contained total payment, number of hospitalizations, number of hospital episodes, total length of stay, number of months alive, and number of months not enrolled in managed care for a given participant in each year. We also subdivided hospitalization claims into those for cardiovascular or non-cardiovascular causes, based on diagnosis-related group (DRG) categories.¹ For Part B physician and outpatient claims, records included total payment, number of days that a service was provided, and the number of months alive and enrolled in Part B.

Medicare payment information was available only for participants in the Medicare fee-for-service system. We included only participants with less than 6 months of enrollment in fixed premium health maintenance organizations during the entire followup period, leaving 4,392 eligible participants. By the end of the study period, 59 percent of participants in California, 17 percent in Pennsylvania, 9 percent in Maryland, and 8 percent in North Carolina were enrolled in managed care.

The followup period for these analyses ran from recruitment in 1989-1990 to 1995, at which point the proportion of participants in fixed premium health maintenance organizations limited further analysis. For each participant, we determined total medical costs and costs attributable to CVD by summing the costs from individual years across the entire followup period.

Definitions of Other Covariates in Multivariable Models

As in previous Sedentary Lifestyle Project analyses (Luepker et al., 2002) we defined three groups of participants—healthy, impaired, and CVD—using standardized CHS criteria for health status (Siscovick et al., 1997). Healthy participants had no history of CVD and reported no physical limitations on their ability to exercise or perform activities of daily living. The remaining participants were divided into those with a confirmed or probable history of CVD at baseline (the CVD group) and those without it (the impaired group).

We categorized dietary patterns into five groups, based on a previous cluster analysis (Diehr and Beresford, 2003). We rated social support as the sum of responses (on a four-point scale) to a six-item version of the Interpersonal Support Evaluation List and assessed social networks using the Lubben Social Network Scale (Newsom and Schulz, 1996). We assessed depression using the Center for Epidemiological Studies Depression (CES-D) scale (Radloff, 1977). Higher levels on these scales indicate greater social support, more extensive social networks, and greater levels of depressive symptoms, respectively. At baseline, participants self-reported their income, educational attainment, and whether they lived alone.

¹ Available from author on request.

Statistical Methods

We used mean aggregate costs as the primary outcome variable. Although these costs are not normally distributed, we used linear regression to estimate mean differences, based on the large sample size of CHS and the smaller number of assumptions required for this method. This method also appears to predict future costs well (Diehr et al., 1999), is relatively easily interpreted, and allows for inferences about the effects of patient characteristics that are relatively similar across various model specifications (Buntin and Zaslavsky, 2004). We did not adjust for differential survival according to alcohol use, as such an adjustment would obscure true differences in total costs accrued by Medicare by minimizing the costs associated with interventions that reduce mortality; our approach mirrors that of cost-effectiveness analysis, in which costs are estimated in parallel with, but not adjusted for, effects on survival (Weinstein et al., 1996). Of note, alcohol use is inversely associated with unadjusted but not adjusted 5-year mortality in CHS (Fried et al., 1998).

In linear regression models, we adjusted for factors that could confound the relationship between alcohol consumption and Medicare costs, using long-term abstainers as the reference category and indicator variables for each of the other drinking categories. These factors were age (in three categories), race, sex, cohort (original versus new), clinic site, dietary pattern, depression score, social support score, social network score, pack-years of smoking, living alone, and body-mass index. Where large degrees of confounding appeared to occur, we explored models with smaller numbers of covariates to estimate which were the strongest confounders. We present differences in costs with their stan-

dard errors from regression models, along with p -values for individual comparisons where appropriate. We derived p -values for homogeneity across all drinking categories using F -tests with 5 degrees of freedom from generalized linear models.

To explore possible effect modification, we repeated adjusted analyses in males and females and among participants in the healthy, impaired, and CVD groups. These groups were chosen to reflect sex-related differences in metabolism of alcohol (Baraona et al., 2001) and differences among sexes and across levels of health status in likelihood of hospitalization, which itself has been previously associated with alcohol intake (Armstrong and Klatsky, 1989).

In sensitivity analyses, we additionally controlled for years of education and income using natural splines with three degrees of freedom (Greenland, 1995). We assigned missing indicators to the 312 participants (7 percent of the total) with missing information on education or income in these analyses. We also performed analyses with and without adjustment for education and income limited to participants without missing information on these variables; these analyses suggested similar results for education and income as those with missing indicators and are not shown here. We also repeated analyses with and without adjustment for dietary pattern (which included alcohol consumption as one element of diet); this did not affect our results.

In beverage type analyses, we grouped consumption of beer, wine, and liquor into four categories each (none, ≤ 1 , $>1-6$, and >6 drinks per week), because the intake of any given beverage was smaller, and then assessed average costs in each category, controlling for consumption of other beverages.

Table 1
Characteristics of 4,392 Cardiovascular Health Study Participants, According to Usual Baseline Alcohol Consumption

Characteristic	Weekly Number of Drinks					
	None	Former	≤1	>1-6	>6-13	>13
Number	1,764	347	1,115	575	252	339
Age (Years)	73.3 ±5.7	72.5 ±5.5	72.8 ±5.5	72.2 ±5.1	73.4 ±5.7	72.3 ±4.9
Male (Percent)	31	63	39	56	60	60
Black Population (Percent)	6	10	10	9	5	8
Pack-Years of Smoking	12 ±22	30 ±33	18 ±26	22 ±27	23 ±29	32 ±32
Body-Mass Index (kg/m ²)	26.8 ±4.9	26.6 ±5.0	26.5 ±4.6	26.4 ±4.1	25.3 ±3.5	25.4 ±3.6
Health Group						
Healthy (Percent)	46	36	48	51	48	53
Impaired CVD (Percent)	30	30	28	24	31	27
CVD (Percent)	24	33	24	25	22	20
Social Support Score	8.2 ±2.6	8.7 ±2.9	8.2 ±2.5	8.3 ±2.5	8.2 ±2.6	8.2 ±2.5
Social Network Score	33.8 ±6.2	33.5 ±6.3	34.1 ±6.2	34.1 ±6.5	34.1 ±6.1	33.6 ±6.4
Depression Score	4.9 ±4.8	5.2 ±4.8	4.7 ±4.4	4.2 ±4.2	3.7 ±3.4	4.0 ±4.2
5-Year Medicare Costs (\$1,000)						
All Participants	14.1 ±20.2	20.9 ±25.6	15.4 ±22.9	13.9 ±17.0	15.3 ±22.8	14.3 ±19.1
Males	17.6 ±23.1	21.6 ±26.2	19.9 ±24.9	16.0 ±18.6	18.3 ±26.7	15.5 ±21.0
Females	12.5 ±18.6	19.9 ±24.6	12.4 ±21.0	11.3 ±14.3	10.8 ±14.2	12.4 ±15.7
Healthy	11.0 ±17.4	15.3 ±21.0	11.4 ±16.4	10.9 ±15.5	13.8 ±23.9	11.2 ±15.5
Impaired, No CVD	14.9 ±21.3	20.5 ±28.4	15.8 ±20.8	14.5 ±17.4	15.2 ±22.7	15.1 ±18.7
CVD	22.1 ±26.5	29.2 ±27.1	23.5 ±32.6	19.8 ±19.4	22.1 ±24.0	21.7 ±23.7

NOTES: Mean values and standard deviations are shown for continuous variables. CVD is cardiovascular disease.

SOURCE: Kenneth J. Mukamal, M.D., M.P.H., Beth Israel Deaconess Medical Center, Boston, Massachusetts, 2006.

RESULTS

Table 1 shows the unadjusted sociodemographic and clinical characteristics of the 4,392 eligible CHS participants, according to usual baseline alcohol consumption. Alcohol consumption tended to be associated with the male sex and with cigarette smoking; differences in other variables across drinking categories were less prominent. Medicare costs were lowest among healthy participants, intermediate among the impaired group, and highest among participants with CVD. Former drinkers had greater levels of depression and were less likely to be in the healthy group than were abstainers or current drinkers.

Total Medicare Costs in All Participants

Table 2 demonstrates the association of alcohol consumption with subsequent Medicare costs among CHS participants,

controlling for demographic and lifestyle characteristics. In both the full sample and in subgroups, former drinkers generally had higher costs than did long-term abstainers, although these differences were not always statistically significant.

In the complete cohort, adjusted total costs were similar among very light drinkers (up to one drink per week) and abstainers and generally lower among participants who consumed more than one drink per week. Differences with abstainers were greatest for consumers of >1-6 drinks per week ($p=0.05$) and >13 drinks per week ($p=0.06$).

The adjusted relations of total costs to alcohol use stratified by sex are shown in Table 2. In both sexes, consumers of >1-6 drinks per week had average costs that were about \$2,000 lower than abstainers. However, males who consumed more than 13 drinks per week had significantly lower costs than abstainers ($p=0.05$), while females who consumed this amount had average costs equal to abstainers.

Table 2

Mean Differences in Total Medicare Costs (in \$1,000) Among 4,392 Cardiovascular Health Study (CHS) Participants Relative to Abstainers, According to Usual Baseline Alcohol Consumption

Participant	Weekly Number of Drinks						P-Value ¹
	None	Former	≤1	>1-6	>6-13	>13	
All (N)	1,764	347	1,115	575	252	339	
Unadjusted	Ref	6.8 ±1.2	1.3 ±0.8	-0.2 ±1.0	1.2 ±1.4	0.2 ±1.3	<0.001
Adjusted ²	Ref	3.8 ±1.3	-0.0 ±0.9	-2.1 ±1.1	-1.3 ±1.5	-2.6 ±1.4	0.001
With SES ³	Ref	3.9 ±1.3	0.3 ±0.9	-1.6 ±1.1	-0.6 ±1.5	-1.9 ±1.4	0.006
All Males (N)	545	219	440	323	151	205	
Unadjusted	Ref	4.0 ±1.9	2.3 ±1.5	-1.6 ±1.6	0.7 ±2.1	-2.1 ±1.9	0.02
Adjusted ²	Ref	2.8 ±2.0	1.2 ±1.6	-2.2 ±1.8	-0.8 ±2.3	-4.1 ±2.1	0.04
With SES ³	Ref	3.0 ±2.0	1.5 ±1.6	-1.7 ±1.8	0.3 ±2.3	-3.5 ±2.2	0.08
All Females (N)	1,219	128	675	252	101	134	
Unadjusted	Ref	7.3 ±1.8	-0.1 ±0.9	-1.2 ±1.3	-1.7 ±2.0	-0.1 ±1.7	<0.001
Adjusted ²	Ref	6.2 ±1.9	-0.9 ±0.9	-1.9 ±1.4	-2.4 ±1.9	-0.0 ±1.8	0.004
With SES ³	Ref	6.2 ±1.9	-0.7 ±1.0	-1.4 ±1.4	-2.0 ±2.0	0.6 ±1.8	0.01
Healthy Group (N)	1,023	197	702	383	174	245	
Unadjusted	Ref	4.2 ±1.5	1.7 ±0.9	1.3 ±1.1	2.7 ±1.5	1.7 ±1.3	0.04
Adjusted ²	Ref	2.4 ±1.7	0.8 ±0.9	-0.9 ±1.2	0.7 ±1.6	-0.4 ±1.4	0.46
With SES ³	Ref	2.5 ±1.7	1.0 ±1.0	-0.5 ±1.2	1.2 ±1.7	0.1 ±1.5	0.52
Impaired Group (N)	523	105	315	140	77	92	
Unadjusted	Ref	5.6 ±2.3	0.9 ±1.5	-0.4 ±2.0	0.3 ±2.6	0.2 ±2.4	0.25
Adjusted ²	Ref	0.4 ±2.7	-0.2 ±1.8	-0.3 ±2.4	-1.8 ±2.9	-3.6 ±2.9	0.85
With SES ³	Ref	0.6 ±2.7	0.3 ±1.8	0.1 ±2.5	-1.5 ±3.0	-3.0 ±3.0	0.89
CVD Group (N)	424	116	267	143	55	67	
Unadjusted	Ref	7.2 ±2.8	1.4 ±2.1	-2.2 ±2.6	0.1 ±3.9	-0.4 ±3.6	0.12
Adjusted ²	Ref	7.1 ±3.0	-2.1 ±2.2	-5.8 ±2.8	-3.3 ±3.9	-3.4 ±3.7	0.008
With SES ³	Ref	7.7 ±3.0	-1.9 ±2.2	-5.7 ±2.8	-2.6 ±4.0	-3.0 ±3.8	0.009

¹ P-values derive from analysis of variance and assess the homogeneity of costs across all categories.

² Adjusted models include age, sex, race, cohort, clinic site, pack-years of smoking, body-mass index, depression score, social support score, social network score, living alone, and dietary pattern.

³ These models additionally controlled for years of education and income; 312 participants with missing information were included and assigned indicator variables.

NOTES: Arithmetic mean values and standard errors are shown. Negative values indicate costs are lower than abstainers in that category. SES is socioeconomic status. CVD is cardiovascular disease. Ref is reference category.

SOURCE: Kenneth J. Mukamal, M.D., M.P.H., Beth Israel Deaconess Medical Center, Boston, Massachusetts, 2006.

Total Medicare Costs in Groups

We did not find meaningful differences in total Medicare costs across drinking categories in the healthy group of CHS participants (Table 2). In the impaired group, total costs were inversely associated with alcohol use in stepwise fashion, but the numbers of participants in these comparisons was smaller than in the healthy group and no comparisons were statistically significant.

Among participants with CVD, consumption of >1-6 drinks per week was associated with lower costs after adjustment for potentially confounding factors. The null association before adjustment was confounded

chiefly by sex and clinic site. The pattern of lower costs among consumers of >1-6 drinks per week was similar among both men and women with CVD.²

Sensitivity analyses that included education and income as covariates showed modest attenuation in the lower costs among moderate and heavier drinkers (Table 2).

Cardiovascular and Non-Cardiovascular Medicare Costs

We separately assessed costs paid by Medicare Part A (hospitalizations) and Part B (outpatient and physician claims)

² Available from author on request.

Table 3
Mean Differences in Adjusted Medicare Parts A and B Costs (in \$1,000) among 4,392 Cardiovascular Health Study (CHS) Participants Relative to Abstainers, According to Usual Baseline Alcohol Consumption

Participant	Weekly Number of Drinks						P-Value ¹
	None	Former	≤1	>1-6	>6-13	>13	
Part A²							
All	Ref	2.5 ±0.9	-0.5 ±0.6	-1.6 ±0.8	-0.7 ±1.0	-1.7 ±0.9	0.002
Males	Ref	1.5 ±1.5	0.2 ±1.2	-1.8 ±1.3	-0.2 ±1.6	-2.3 ±1.5	0.21
Females	Ref	4.6 ±1.2	-1.1 ±0.6	-1.4 ±0.9	-1.7 ±1.2	-0.7 ±1.2	<0.001
Healthy Group	Ref	1.6 ±1.2	0.8 ±0.7	-0.8 ±0.8	0.8 ±1.2	-0.3 ±1.0	0.31
Impaired Group	Ref	0.5 ±1.9	-0.7 ±1.3	-1.1 ±1.7	-1.4 ±2.1	-2.5 ±2.1	0.82
CVD Group	Ref	4.5 ±2.0	-3.2 ±1.5	-3.2 ±1.9	-2.1 ±2.6	-2.6 ±2.5	0.004
Part A CVD²							
All	Ref	0.1 ±0.4	-0.6 ±0.3	-0.8 ±0.3	-0.9 ±0.4	-1.1 ±0.4	0.006
Males	Ref	-0.0 ±0.7	-0.5 ±0.5	-1.1 ±0.6	-1.0 ±0.7	-1.6 ±0.7	0.14
Females	Ref	0.2 ±0.5	-0.7 ±0.2	-0.4 ±0.3	-0.8 ±0.5	-0.4 ±0.4	0.05
Healthy Group	Ref	-0.2 ±0.4	-0.1 ±0.2	-0.7 ±0.3	-0.7 ±0.4	-0.7 ±0.4	0.12
Impaired Group	Ref	-0.3 ±0.6	-0.1 ±0.4	0.2 ±0.6	0.0 ±0.7	-0.4 ±0.7	0.97
CVD Group	Ref	0.5 ±1.1	-2.3 ±0.8	-2.1 ±1.0	-2.5 ±1.4	-2.1 ±1.4	0.02
Part A Non-CVD²							
All	Ref	2.4 ±0.8	0.1 ±0.5	-0.8 ±0.7	0.2 ±0.9	-0.6 ±0.8	0.02
Males	Ref	1.5 ±1.3	0.7 ±1.0	-0.7 ±1.1	0.8 ±1.4	-0.7 ±1.3	0.53
Females	Ref	4.4 ±1.1	-0.4 ±0.5	-1.0 ±0.8	-0.9 ±1.1	-0.4 ±1.0	<0.001
Healthy Group	Ref	1.9 ±1.1	0.9 ±0.6	-0.1 ±0.8	1.5 ±1.1	0.4 ±0.9	0.29
Impaired Group	Ref	0.8 ±1.8	-0.6 ±1.2	-1.3 ±1.6	-1.4 ±1.9	-2.1 ±1.9	0.79
CVD Group	Ref	4.0 ±1.6	-1.0 ±1.1	-1.1 ±1.4	0.4 ±2.0	-0.5 ±1.9	0.05
Part B²							
All	Ref	0.1 ±0.3	0.1 ±0.2	-0.1 ±0.2	0.0 ±0.3	-0.3 ±0.3	0.75
Males	Ref	-0.2 ±0.4	0.4 ±0.3	-0.1 ±0.4	0.0 ±0.5	-0.7 ±0.4	0.19
Females	Ref	0.8 ±0.4	-0.2 ±0.2	-0.2 ±0.3	-0.1 ±0.4	0.3 ±0.4	0.25
Healthy Group	Ref	0.1 ±0.4	0.2 ±0.2	-0.1 ±0.3	0.2 ±0.4	-0.1 ±0.3	0.85
Impaired Group	Ref	-0.2 ±0.6	-0.1 ±0.4	0.2 ±0.5	0.0 ±0.6	-0.3 ±0.6	0.97
CVD Group	Ref	0.4 ±0.6	-0.1 ±0.4	-0.5 ±0.5	-0.0 ±0.7	-0.2 ±0.7	0.83

¹ P-values derive from analysis of variance and assess the homogeneity of costs across all categories.

² Adjusted models include age, sex, race, cohort, clinic site, pack-years of smoking, body-mass index, depression score, social support score, social network score, living alone, and dietary pattern.

NOTES: CVD is cardiovascular disease. Ref is reference category.

SOURCE: Kenneth J. Mukamal, M.D., M.P.H., Beth Israel Deaconess Medical Center, Boston, Massachusetts, 2006.

and further stratified Part A costs by the primary DRG code for each hospitalization (Table 3). The relationships of alcohol use with Part A costs were similar to the corresponding relationships with total costs, as expected. In individual comparisons with abstainers, Part A costs were significantly lower among consumers of >1-6 drinks per week ($p=0.03$) and nearly so among consumers of 13 or more drinks per week ($p=0.07$), with the largest differences occurring in the subgroup of participants with known CVD.

In analyses of Part A costs attributable to CVD, we found a graded inverse relation between alcohol use and such costs, with

the lowest costs among those who consumed >13 drinks per week. This graded inverse relation was most notable in the healthy group, where consumers of >1-6 and 13 or more drinks per week differed significantly from abstainers ($p=0.01$ and 0.05) and consumers of >6-13 drinks per week nearly so ($p=0.09$). In the CVD group, all drinking categories had substantially lower costs than abstainers.

In analyses of Part B and non-CVD Part A costs, former drinkers had consistently higher non-CVD Part A costs than abstainers or current drinkers in every subgroup examined but particularly among females.

Table 4

Mean Differences in Adjusted Medicare Costs (in \$1,000) Among 4,392 CHS Participants Relative to Abstainers, According to Usual Baseline Consumption of Individual Alcoholic Beverages

Beverage	Weekly Number of Drinks				P-Value ¹
	None	≤1	>1-6	>6	
Wine	Ref	-0.0 ±1.1	-0.3 ±2.2	-2.0 ±1.9	0.20
Beer	Ref	0.2 ±1.0	-1.8 ±2.2	-2.5 ±1.8	0.19
Liquor	Ref	-0.9 ±1.0	-0.8 ±1.7	-1.2 ±1.4	0.49

¹ P-values derive from analysis of variance and assess the homogeneity of costs across all categories.

NOTES: CHS is Cardiovascular Health Study. All estimates adjusted for age, sex, race, cohort, clinic site, pack-years of smoking, body-mass index, depression score, social support score, social network score, living alone, dietary pattern, and consumption of the other beverage types. Ref is reference category.

SOURCE: Kenneth J. Mukamal, M.D., M.P.H., Beth Israel Deaconess Medical Center, Boston, Massachusetts, 2006.

There were no other significant differences across drinking categories in non-CVD Part A or Part B costs.

As sensitivity analyses, we performed post-hoc tests of linear trend to explore the relationship of alcohol use and Medicare costs among long-term abstainers and current drinkers. These tests were consistent with a significant inverse linear relationship between alcohol intake and Part A CVD costs among all participants ($p=0.007$), males ($p=0.04$), healthy participants ($p=0.02$), and those with known CVD ($p=0.04$), and suggested a similar trend for females ($p=0.11$). We did not find significant linear trends in the associations with total or non-CVD Part A costs.

Total Medicare Costs According to Beverage Type

Table 4 shows average Medicare costs according to consumption of individual alcoholic beverages. The three beverage types assessed appeared to have similar inverse relations with Medicare costs, although none of these relations was statistically significant individually.

DISCUSSION

In this longitudinal analysis of a population-based study of older adults, we found generally lower Medicare costs among CHS participants who consumed more than

one drink per week, particularly for CVD-related costs and among those with prevalent CVD. Former drinkers consistently had higher such costs (and especially costs for hospitalizations for non-cardiovascular causes) than long-term abstainers, reinforcing the importance of distinguishing these groups.

The relationship of alcohol consumption to health care expenditures in older adults poses some interesting issues. In contrast to younger adults, health conditions common among older adults tend to be shifted toward those that might benefit from alcohol use—cardiovascular disease accounts for an increasingly large proportion of mortality, while traumatic conditions and direct intoxication account for a lower proportion of deaths. Also, because older adults have generally left the active workforce, the proportion of cost-of-illness estimates attributable to health care expenditures is higher in older adults than in adults in middle age, making accurate assessment of health care expenditures particularly important for older adults. Finally, because alcohol use tends to decline over time and because of differential mortality through middle age, heavy and binge drinkers comprise a smaller portion of the population at older ages, tending to minimize their contribution to overall health care expenditures and emphasizing the importance of studying abstainers, light-to-moderate drinkers, and heavier drinkers.

Few previous studies in older adults have sought to examine the relation of alcohol use across a range of intake with subsequent health care costs. Leigh and Fries (1992) found that intake of more than two drinks per day was associated with greater number of hospital days, physician visits, and days spent in bed over 1 year, but estimated costs were used, only heavy drinking was studied, and the sample was limited to 1,558 bank retirees. Hunkeler and colleagues (2001) studied the cross-sectional association of alcohol use and 1995 health care costs among 10,175 patients in the Kaiser Permanente Medicare Care Program in Northern California, of whom about one-quarter were age 60 or over. The authors found a modest inverse relation that was not statistically significant. Using a similar design, Polen and colleagues (2001) studied 8,034 members of Kaiser Permanente in northwest Oregon and southwest Washington. They found that estimated health care costs in the preceding 1 year and ensuing 2 years were approximately \$350 lower among consumers of 15-29 drinks per month than among abstainers, a difference that was not statistically significant ($p < 0.10$). Other cross-sectional studies have also found inverse associations of alcohol use with use of health care services (Rodriguez Artalejo et al., 2000).

An important deficiency in the use of Medicare payments in the time period studied is the absence of data on prescription drug costs, a growing proportion of total health care costs. Interestingly, in a 6-month analysis of 685 females employed by a health maintenance organization, moderate alcohol intake was associated with approximately \$40 lower pharmacy costs (with no change in other costs), with particularly lower costs for anxiolytic agents (McMillan and Lapham, 2004). We also

cannot estimate the indirect costs of illness, such as lost productivity and income among participants and their caregivers.

Our results do not mitigate the heavy public health and economic burden imposed by problematic alcohol use, particularly among young and middle-aged adults. The National Centers for Disease Control and Prevention estimate that alcohol consumption was responsible for 85,000 deaths in the U.S. in 2000, nearly as many as firearms, illicit drug use, and motor vehicles combined (Mokdad et al., 2004). Although it is not known whether the incidence of alcohol abuse is increasing among older adults (Johnson, 2000) the sheer number of older adults with alcohol problems is likely to grow as this age group comprises an increasingly large portion of the U.S. population. However, in part because the prevalence of alcohol abuse among older adults remains relatively low, our results may suggest that CMS is unlikely to gain substantial savings in Medicare costs from large-scale efforts to restrict alcohol use among older adults to recommended limits of no more than one drink per day (Clinical Practice Committee, 1997). Heavy alcohol use and its consequences can be reduced by population-wide approaches, such as increasing taxes on alcohol, but it is uncertain whether such approaches can be targeted to decreasing heavy, but not light or moderate, use (Chaloupka, Grossman, and Saffer, 2002). As a result, it remains crucial for individual physicians to identify and counsel older adults at risk for problem drinking, especially in light of the medical care savings that treatment of established alcoholism offers (Holder et al., 2000). CMS might benefit from population-based programs to prevent heavy drinking in middle-aged adults if they led to lower costs among the subset of older former drinkers who previously were heavy drinkers.

We found some suggestion that light-to-moderate alcohol use among older adults could lead to lower Medicare costs in some instances, such as among patients with established CVD and perhaps for CVD-related costs in general. This observation is consistent with results from cohort studies of older adults that have found lower rates of coronary heart disease among moderate drinkers (Colditz et al., 1985; Scherr et al., 1992), including similar results from CHS regarding wine intake (Burke et al., 2001). Cohort studies have also found lower rates of morbidity among patients with established CVD who drink moderately (de Lorgeril et al., 2002). Although data on the association of alcohol consumption and CVD remains only observational to date, the association is consistent with effects of alcohol on high-density lipoprotein cholesterol, fibrinogen, and other cardiovascular risk factors documented in randomized trials (Rimm et al., 1999).

Study Strengths and Limitations

The CHS cohort represents an attractive population in which to study the economic effects of alcohol use in older adults. First, as noted, relatively complete information on health care expenditures is potentially available for individuals of this age group, with little loss to followup. Second, alcohol consumption has been assessed carefully in this cohort, including two questions regarding previous alcohol use at the baseline examination. Such information is not readily available in administrative databases that include older adults. Third, because the CHS is a large population-based study, the results of analyses have broader applicability than analyses from more restricted cohorts. Fourth, important information on potentially confounding factors is available for CHS participants, including measures of diet, social integration, and depression.

The CHS has important limitations to consider. CHS participants represent a relatively healthy group of older adults, given the CHS eligibility criteria and selective participation in CHS. Thus, our results are most readily generalized to older adults in similar health and not to other populations, including institutionalized older adults who may disproportionately include former problem drinkers. Moreover, our results do not reflect the association of alcohol use and costs in managed care settings, although this was unlikely to have produced substantial bias because managed care enrollment by CHS participants was related primarily to state of residence and not to lifestyle features.

As with any observational study, unevenly distributed characteristics could lead us to over- or underestimate the true effect of alcohol consumption, although the range of covariates available in CHS is more robust than in administrative databases or in many cohort studies. We also took the conservative approach of separating former heavy drinkers from long-term abstainers but not from other drinking categories, to minimize the effect of those who cease alcohol use because of chronic illness or recommendations from their physicians, although participants who quit more than 5 years earlier may have been misclassified and we cannot assess the exact duration of abstention among former drinkers. Among participants with CVD, we also did not have detailed clinical information with which to assess severity.

While controlling for possible confounding, we may have overadjusted for some covariates that are actually intermediates in the causal pathway between alcohol consumption and health care costs. For example, if alcohol consumption has direct psychological benefits (Baum-Baicker, 1985) which in turn lead to better social supports, then controlling for social support and social

networks may have caused us to underestimate the actual cost reduction associated with moderate alcohol consumption.

The interrelationships between alcohol use, measures of socioeconomic status (SES), and health care costs are complex, and our data did not allow us to explore these interrelations definitively. Interestingly, while SES is associated with lower morbidity among older adults (Seeman et al., 2004) previous work suggests that it may simultaneously be associated with greater need-adjusted expenditures in this age group (Chen and Escarce, 2004). Future studies that incorporate complete and updated assessments of both alcohol use and multiple SES measures over time may be able to address these interrelations further.

We relied on self-reported alcohol consumption assessed by a standardized questionnaire, a technique that has been validated in other settings (Giovannucci et al., 1991). Errors in assessment of alcohol use in the elderly appear to be no worse than those in surveys of the general population (Herzog, 1998). We have found the expected graded relation of alcohol use and HDL levels in CHS, with a correlation coefficient virtually identical to that found in other representative studies (Linn et al., 1993).

We did not have detailed information on drinking patterns in this study. Our use of a measure of average alcohol use may have obscured differences between regular and episodic alcohol intake, although binge-drinking rates decline with age among adults in the U.S. (Naimi et al., 2003). As with other studies of older adults, the range of alcohol use among the participants who consumed the most alcohol was limited, and we could not study the effects of very heavy intake in this study.

CONCLUSIONS

In conclusion, in this study of older adults, we found generally lower Medicare costs among older adults who consumed alcohol at least weekly. This was most notable among the subgroup of participants with CVD, in whom consumption of >1-6 drinks per week was particularly associated with lower costs than abstinence, both among men and women. Similar studies to define the costs of alcohol use in representative populations of younger or less healthy adults are still needed to help clarify the economic costs of alcohol consumption (particularly at moderate levels of intake) with greater certainty.

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