Trends in Alcohol Use Among Women With and Without Myocardial Infarction in the United States: 1997–2008*

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ABSTRACT. Objective: This study examined the frequency and temporal trends of alcohol use among women with and without myocardial infarction (MI) in the United States. **Method:** We pooled yearly surveys from the nationally representative Behavioral Risk Factor Surveillance System between 1997 and 2008. Subjects for this study were 1,186,951 women, of whom 50,055 had a previous MI. Yearly weighted prevalence rates and frequencies of drinking behaviors were calculated for alcohol use in women with and without previous MI. **Results:** Fewer post-MI women consumed alcohol than other women (24% vs. 46%), but the prevalence of drinking increased over time in both groups. Nearly one third of post-MI women and half of all women consumed more than one drink per day. Heavy episodic drinking (four or more drinks per

day) increased over time in both groups. After multivariable adjustment, post-MI women were less likely to report any drinking or consuming more than one drink per day, but the prevalence of heavy episodic drinking and the increasing trends over time were similar in both groups. **Conclusions:** Heavy alcohol use and heavy episodic drinking among women in the United States increased over the past decade, regardless of MI history. Although this may have reflected the influence of national guidelines on alcohol consumption, the increase in heavy episodic drinking suggests that better efforts to educate clinicians and women about the harms from excessive alcohol are required. (*J. Stud. Alcohol Drugs*, 72, 885–891, 2011)

CORONARY HEART DISEASE (CHD) is the leading cause of death for women in the United States. In 2007, 421,918 women died from CHD, accounting for nearly one third of female mortality (Roger et al., 2011), and many more women live with chronic CHD. In 2008, the overall prevalence of women with prior CHD was 6.1% (Roger et al., 2011). Not only has the quality of life for these women diminished, but they are also at greater risk for future CHD events (Agency for Health Research and Quality, 2010).

A major focus in CHD prevention is behavioral and life-style factors, including alcohol consumption. Epidemiological studies have consistently found an association between moderate alcohol consumption and decreased risk of CHD. Although much of this research has been conducted in men, the association of modest alcohol intake with lower risk of CHD has also been established in women. Meta-analysis of 26 studies (Corrao et al., 2000) found that women's risk declined with intake of up to 10 g of alcohol per day (relative risk = 0.85, 95% CI [0.80, 0.90]).

Concerns exist that guidelines on alcohol consumption may be interpreted as “official encouragement of drinking for health reasons” (Center for Science in the Public Interest,

2000). This is of particular concern regarding women with heart disease, for whom data on alcohol consumption and prognosis are less certain. Observational studies reported associations between light-to-moderate alcohol consumption and decreased risk in CHD and all-cause mortality (Costanzo et al., 2010) among CHD patients. Unfortunately, none of the studies comprised women only, and sex-specific risks were not reported. Moreover, heavy episodic drinking among individuals with heart disease may eliminate benefits obtained from moderate drinking (Mukamal et al., 2005).

Despite the growing numbers of women with established myocardial infarction (MI), there is scant information on the frequency and temporal trends of alcohol consumption in this vulnerable population. The aim of this article is to describe the prevalence and trends in drinking behaviors in women with MI over the last decade and compare these findings with those from other women in the U.S. population.

Method

Survey description

The Behavioral Risk Factor Surveillance System (BRFSS) is an ongoing annual survey conducted by the Centers for Disease Control and Prevention (CDC) since 1994 to measure risk factors in the adult population (age 18 years or older) living in households in the 50 states, District of Columbia, Puerto Rico, Guam, and the Virgin Islands. For the present analysis, the study population was all women who answered the survey questions on drinking behavior and

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cardiac history. Survey years that did not include data on MI and/or drinking behavior data were excluded. As a result, we included survey years 1997 and 1999–2008 and 1,186,951 women—50,055 with prior MI and 1,136,896 without.

The BRFSS incorporates probability sampling and post-stratification weights to account for the disproportionate stratified sample design and to ensure representativeness of the sample used to the target population.

Risk factors assessed by the BRFSS include demographics, alcohol and tobacco use, health behaviors and outcomes, physical activity, and women's health issues. Data are collected from a random sample of adults (one per household) through a telephone survey conducted by state health personnel or contractors. The questionnaire has three parts: (a) the core component, (b) optional modules, and (c) state-added questions, and it is administered in both English and Spanish. Most states use audio-monitoring for quality assurance. BRFSS core and module questionnaires are publicly accessible at www.cdc.gov/brfss/questionnaires/questionnaires.htm.

The survey had a median Council of American Survey and Research Organizations (CASRO) response rate (a conservative calculation that incorporates sampling efficiency and cooperation rate) from 1997 to 2008 that ranged from 48.9% to 62.1%. Sample sizes increased steadily from 135,582 in 1997 to 430,912 in 2007.

The BRFSS informs all respondents at the outset that the survey is anonymous and confidential, that it collects no personally identifying information, and that answering any or all questions is entirely voluntary; consent is presumed on the basis of willingness to participate. Our study was approved by the Institutional Review Board of the Beth Israel Deaconess Medical Center Committee on Clinical Investigations, which provided an exemption from continuing review.

Assessment of myocardial infarction

MI and its risk factors were ascertained in each survey. Respondents in each survey reported whether a health professional had told them that they had a "heart attack or myocardial infarction." Women who responded "don't know/not sure" or refused to answer were classified as missing.

Assessment of alcohol consumption

The survey included several key questions regarding alcohol consumption. In 1997, 1999, 2001, and beyond, the core questionnaire asked the following three questions: (1) Any drinking: "During the past 30 days, how many days per week or per month did you have at least one drink of any alcoholic beverage?" (2) Average amount of drinking: "On the days when you drank, about how many drinks did you drink on average?" (3) Heavy episodic drinking: "Considering all types of alcoholic beverages, how many times during

the past 30 days did you have four or more drinks on an occasion?" Women who responded "don't know/not sure" or refused to answer were classified as missing.

Other behavioral characteristics

We used body mass index (BMI) as a continuous variable but marked the values as missing for individuals with extreme values of BMI (<10 and >50). Race/ethnicity was categorized into four groups (White, African American, Asian/Native Hawaiian or other Pacific Islander, and American Indian or Alaskan Native/multiracial/other). A separate question ascertained Hispanic heritage. Educational attainment was determined in six categories from no formal schooling to college graduate. Smoking was categorized as never, former (e.g., no current smoking but smoked at least 100 cigarettes in lifetime), and current (e.g., occasional or daily smoking reported). Marital status was assessed as married, divorced, widowed, separated, never married, and member of an unmarried couple. Response categories for employment were employed for wages, self-employed, out of work for more than 1 year, out of work for less than 1 year, homemaker, student, retired, and unable to work. Income was determined in eight income groupings ranging from less than \$10,000 to more than \$75,000. Exercise was reported as participation in physical activities or exercises specifically for exercise in the past month. Mental health was reported as the number of days in the past 30 that the respondents described their mental health as not good.

Age standardization

In our study population, there was an average age difference of 20 years between women with and without heart disease. Thus, age standardization was used in the models. First, the study population was assessed to determine the age distribution in the women with and without prior MI separately. Weights were determined based on the age distribution in the post-MI women by the formula (number of women with MI in each age category / total number of women with MI). These weights were applied to 15 age categories to create the age standardization for the entire population. Thus, age standardization was used to determine appropriately weighted prevalence rates with control for confounding by age (Rothman et al., 2008).

Statistical analyses

Initial data management, including recoding the data and combining years of the survey, was done using SAS Version 9.1 and 9.2 (SAS Institute Inc., Cary, NC). The complex survey design required analysis using survey weights. In combining different years of the survey, we divided the survey weights by the number of years used. To account for

TABLE 1. Age-standardized weighted prevalence of selected characteristics, mean age, and BMI in post-MI women and other women in 1997, 2002, and 2007

Characteristics	1997		2002		2007	
	Post-MI women (<i>n</i> = 453) % (<i>SE</i>)	Other women (<i>n</i> = 11,500) % (<i>SE</i>)	Post-MI women (<i>n</i> = 675) % (<i>SE</i>)	Other women (<i>n</i> = 17,167) % (<i>SE</i>)	Post-MI women (<i>n</i> = 11,775) % (<i>SE</i>)	Other women (<i>n</i> = 257,151) % (<i>SE</i>)
White	75 (4.7)	83 (0.6)	89 (2.0)	82 (0.5)	73 (2.3)	82 (0.2)
African American	18 (3.7)	10 (0.4)	9 (1.8)	14 (0.4)	19 (2.4)	11 (0.1)
Never smoker	53 (5.2)	62 (0.7)	37 (2.6)	58 (0.6)	46 (2.3)	62 (0.2)
Former smoker	19 (2.6)	17 (0.6)	30 (2.2)	19 (0.4)	23 (1.6)	21 (0.2)
Current smoker	28 (5.0)	21 (0.6)	33 (3.0)	23 (0.5)	30 (2.2)	17 (0.2)
Married	58 (4.1)	59 (0.7)	50 (3.1)	58 (0.5)	44 (2.1)	58 (0.2)
College graduate	9 (2.1)	24 (0.6)	12 (2.7)	27 (0.5)	16 (1.3)	32 (0.2)
Employed for wages	40 (4.6)	51 (0.6)	17 (2.5)	52 (0.5)	31 (2.3)	48 (0.2)
Retired	18 (1.1)	17 (0.3)	15 (0.8)	15 (0.3)	14 (0.3)	15 (0.1)
Income < \$10,000	28 (5.0)	10 (0.4)	22 (2.5)	6 (0.3)	16 (2.1)	6 (0.1)
	<i>M</i> (<i>SE</i>)	<i>M</i> (<i>SE</i>)	<i>M</i> (<i>SE</i>)	<i>M</i> (<i>SE</i>)	<i>M</i> (<i>SE</i>)	<i>M</i> (<i>SE</i>)
Age in years	46.5 (1.3)	45.4 (0.2)	46.8 (1.0)	45.4 (1.6)	45.7 (7.3)	45.4 (0.6)
BMI	27.6 (6.1)	25.2 (0.8)	27.2 (3.6)	26.5 (6.8)	29.0 (3.8)	26.8 (2.7)

Notes: BMI = body mass index; MI = myocardial infarction.

the weighting scheme, the SVY commands in STATA Version 11.1 (StataCorp LP, College Station, TX) were used. Prevalence of drinking behaviors was compared between post-MI women and women without MI using both unadjusted and age-standardized methods. Logistic and linear models were used to compare the unadjusted, age-adjusted, and multivariable-adjusted trends across the study period. Prevalence odds ratios and their 95% confidence intervals (CIs) accounting for survey weights were estimated in the logistic models. The multivariable models adjusted for age, BMI, race, smoking, marital status, education, employment, income, exercise, and mental health.

Results

The study population ranged from 11,953 women (453 with prior MI) in 1997 to 257,593 (11,800 with prior MI) in 2008, and the total number of women in the study across all years was 1,186,951, of whom 50,055 reported a prior MI. To illustrate differences across years, Table 1 shows the age-standardized weighted prevalence of selected characteristics, mean age, and BMI from 3 representative years (1997, 2002, and 2007) of BRFSS samples. More than 70% of the study population was White, and roughly 11% was African American. After age standardization, post-MI women were less likely to be never smokers, college graduates, and employed for wages. Post-MI women were more likely to be current smokers, have an income less than \$10,000, and have a higher BMI.

The overall unadjusted prevalence of alcohol consumption is 23.7% (95% CI [22.9%, 24.5%]) in post-MI women and 45.6% (95% CI [45.4%, 45.8%]) in all other women. Figure 1 shows the unadjusted and age-standardized trends

in prevalence and frequency of drinking in the overall population over time comparing post-MI women and all other women. Although fewer post-MI women were drinkers than other women, both groups had an increasing trend over time, and the gap in prevalence narrowed with age standardization. Although post-MI women reported more frequent alcohol consumption than other women, this observation reversed after age standardization, with more frequent use among women who did not report previous MI.

Figure 2 shows the unadjusted and age-standardized trends in risky drinking behaviors comparing post-MI women and all other women. The proportion of women drinking more than the recommended amount of one alcoholic beverage per occasion was approximately one third, with no clear trend over time and no significant differences between the groups. Although the proportion of post-MI women who reported heavy episodic drinking was lower than that among other women before adjustment, the disparity in heavy episodic drinking between post-MI women and other women was attenuated after age standardization. However, an increasing trend over time remained in both groups.

Table 2 compares the prevalence odds of drinking behaviors between post-MI women and other women, with multivariable adjustment. In fully adjusted models, post-MI women were less likely to report any drinking, drank fewer drinks per month, and were significantly less likely to drink more than one alcoholic beverage per occasion than were other women. However, there was no statistically significant difference in heavy episodic drinking between the two groups.

Table 3 compares the trends of drinking behaviors between post-MI women and other women. In both the age-adjusted and fully adjusted models, there was no evidence

FIGURE 1. Unadjusted and age-standardized prevalence and trends of drinking behaviors from 1997 to 2008. Trends in drinking behaviors over time stratified by prior myocardial infarction (MI) and all other women, including both unadjusted and age-standardized prevalence.

FIGURE 2. Unadjusted and age-standardized prevalence and trends of risky drinking behaviors from 1997 to 2008. Trends in risky drinking behaviors (drinking more than the recommended amounts and heavy episodic drinking) over time stratified by prior myocardial infarction (MI) and all other women, including both unadjusted and age-standardized prevalence.

TABLE 2. Prevalence of drinking behaviors in post-MI women (with other women as the reference group)

Variable	Age adjusted		Fully adjusted ^a	
	Prev. OR	[95% CI]	Prev. OR	[95% CI]
Any drinking	0.47	[0.45, 0.50]	0.66	[0.62, 0.69]
>1 drink per occasion	1.09	[1.00, 1.20]	0.89	[0.80, 0.97]
Heavy episodic drinking ^b	1.21	[1.06, 1.39]	0.95	[0.80, 1.13]
	β	[95% CI]	β	[95% CI]
Drinks per month	-1.04	[-1.39, -0.69]	-0.8	[-1.20, -0.40]

Notes: MI = myocardial infarction; prev. = prevalence; OR = odds ratio; CI = confidence interval. ^aAdjusted for body mass index, race/ethnicity, Hispanic ethnicity, educational attainment, smoking status, marital status, employment, income, exercise in last 30 days, and mental health status in last 30 days; ^bheavy episodic drinking means any woman consuming more than four drinks on any one occasion.

of effect modification by prior heart disease, with similar temporal trends in drinking behaviors over time in both groups.

A sensitivity analysis that excluded survey year 2000, which did not ask the drinking behavior questions in all states, found consistent and similar results.

Discussion

Our findings indicate an increasing trend in alcohol consumption over time for all women. Although post-MI women drank less frequently than other women, they still demonstrated an increasing trend in alcohol consumption over the years of the study. These results show that the societal trends over the last decade are largely the same in post-MI women as in all other women.

Most women report a level of alcohol consumption that is within the guidelines of a healthy lifestyle. However, our results indicate increasing prevalence of heavy episodic drinking, a common behavior among both men and women (Naimi et al., 2003). The negative impact of heavy episodic drinking on health is incontrovertible and is associated with significant increases in the risk of many detrimental health

effects beyond MI, including cirrhosis, pancreatitis, various cancers, hypertension, and neurologic diseases (CDC, 2010; Roerecke and Rehm, 2010). Thus, health professionals should emphasize that women who drink should do so in moderation. This is particularly important for women with a prior MI who are at high risk for adverse events. Clinicians caring for women following MI should not make assumptions about drinking behaviors and should screen universally (Bradley et al., 1998).

Although alcohol consumption had been declining over time worldwide (World Health Organization, 2004), the present results suggest that this period of decline may be over in the United States (Greenfield et al., 2000). The results presented here raise the possibility—but certainly do not prove—that statements indicating that moderate alcohol use may be protective against MI may have prompted increasing alcohol use (Costanzo et al., 2010). In fact, the U.S. Department of Agriculture and the U.S. Department of Health and Human Services released the updated *Dietary Guidelines for Americans* in 2000 (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2000) that contained more restrictive wording about modest drinking because of these concerns. Clearly, there are both risks and

TABLE 3. Trends over time in post-MI women (with other women as the reference group)

Variable	Age adjusted		Fully adjusted ^a	
	Prev. OR	[95% CI]	Prev. OR	[95% CI]
Any drinking	1.00	[0.99, 1.02]	1.00	[0.98, 1.03]
>1 drink per occasion	0.99	[0.95, 1.03]	0.99	[0.94, 1.04]
Heavy episodic drinking ^b	1.04	[0.99, 1.11]	0.97	[0.90, 1.05]
	β	[95% CI]	β	[95% CI]
Drinks per month	-0.03	[-0.18, 0.13]	-0.04	[-0.26, 0.18]

Notes: MI = myocardial infarction; prev. = prevalence; OR = odds ratio; CI = confidence interval. ^aAdjusted for body mass index, race/ethnicity, Hispanic ethnicity, educational attainment, smoking status, marital status, employment, income, exercise in last 30 days, and mental health status in last 30 days; ^bheavy episodic drinking means any woman consuming more than four drinks on any one occasion.

benefits to making alcohol intake recommendations to an entire population. Clinical and public health professionals must recognize high-risk populations to whom these recommendations should be given with caution.

A major strength of this study is that the BRFSS is a nationally representative sample of U.S. adults who provide information on many important behavioral risk factors that are not assessed in other surveys. The large sample size in each year and the repetitive nature of the BRFSS allowed us to combine findings from more than a decade of surveys for a final sample of more than 1 million women, which is larger than any comparable study. The BRFSS is considered the gold standard survey for behavioral risk factors in the United States, and the conservative CASRO response rate remained relatively high and constant between 48.9% and 58.3% each year. The BRFSS asks detailed questions covering diverse areas potentially related to alcohol consumption.

Several important limitations should be mentioned. By design, the BRFSS is limited to self-reported information. However, this was necessitated by the size and scope of this large epidemiological study. Nevertheless, this survey appears to have collected reliable information on alcohol consumption, based on previous data (Link and Mokdad, 2005). Still, the possibility exists that underreporting of alcohol intake may have resulted in both random and systematic misclassification.

Another potential limitation is that of missing data, including missing survey years and changes to the questions between surveys. Although there was a large sample size in the study, years 1994, 1995, 1996, and 1998 were omitted from all statistical analyses because surveys in these years either did not ask questions on alcohol consumption or MI or were lacking any post-MI women. Another limitation was that the wording of some of the questions changed over different years. An example of such a change is from number of alcoholic beverages in the last month to number of alcoholic beverages in the last 30 days. Although these changes were generally minor, the lack of consistency in questions has been an important limitation in the field of alcohol consumption research more generally (Del Boca and Darkes, 2003).

Last, because the BRFSS is a cross-sectional survey, neither directionality nor causality can be inferred from these results. Longitudinal studies that measure both alcohol consumption and risk factors such as those included here, with endpoints of MI, would be a helpful next step in describing these relationships.

In conclusion, there appear to be no consistent differences in the drinking behaviors that women with and without prior heart disease manifest over time. However, alcohol intake—and particularly heavy episodic drinking—has been increasing over recent years, which may have serious adverse public health implications. This study heralds the need for measures to assure that all women, and particularly post-MI women, are better educated regarding potential harms of

drinking more than the currently recommended limits—specifically, avoiding heavy episodic drinking and consuming more than one serving per day—to minimize their risk of the many harms related to excessive alcohol consumption (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2010).

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