Secular Trends in Alcohol Consumption over 50 Years: The Framingham Study

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ABSTRACT

BACKGROUND: Population trends in patterns of alcohol use are important data for policymakers but are generally based on repeated cross-sectional surveys.

METHODS: We used self-reported alcohol consumption data collected repeatedly over 50 years (1948-2003) among 8600 Framingham Heart Study participants to determine patterns of alcohol use and disorders according to sex, age, and birth cohorts.

RESULTS: Among drinkers, there was a decrease across succeeding birth cohorts in average alcohol intake: among individuals between ages 30 and 59 years, age-adjusted mean intake was 30.6, 25.5, and 21.0 g/day for those born in 1900-1919, 1920-1939, and 1940-1959, respectively, in men (P < .001), and 14.2, 12.3, and 10.4 g/day, respectively, in women (P < .001). In all birth cohorts, proportion of abstinence increased and average consumption among drinkers decreased with age. Furthermore, proportion of moderate use was higher but heavy use was lower in the younger birth cohorts than in the older cohorts. The proportion of alcohol from beer decreased and that from wine increased with age for all cohorts. Among the 2 earlier birth cohorts, the cumulative incidence of an alcohol use disorder from age 40 to 79 years was much higher in men (12.8%) than in women (3.8%); it tended to be slightly higher among subjects born after 1920 than among those born 1900-1919.

CONCLUSIONS: We found a decrease in average intake and more wine consumption over the more than 50 years of follow-up. The cumulative incidence of alcohol use disorders, however, did not show a decrease.

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The adverse effects on health and on society of excessive alcohol use have been well described. On the other hand, numerous studies have shown that “moderate” alcohol consumption without heavy drinking episodes is associated with a reduced risk of most cardiovascular diseases and many other diseases associated with ageing, and with improved morbidity and mortality among the elderly. Furthermore, there is appreciation of the importance of the pattern of alcohol consumption in determining the net effects of alcohol consumption, with the greatest health benefits and fewest adverse effects being associated with regular moderate consumption without binge drinking. A number of studies have described trends in alcohol use, drinking patterns, and frequency of unhealthy use in the United States. Studies have generally used data collected from sequential cross-sectional surveys, hospital discharge records, or sales and traffic data. The results suggest that the total amount of alcohol consumed in the United States has decreased slightly over recent decades, and that certain indicators of unhealthy use, such as death from driving while intoxicated or alcohol-related cirrhosis, have generally decreased since the middle of the 20th century.
CLINICAL SIGNIFICANCE

- Over 50 years of follow-up, there was a decrease across succeeding birth cohorts in average alcohol intake, with more moderate and less heavy consumption.

- The proportion of alcohol from beer decreased and that from wine increased in succeeding cohorts and with age.

- Despite more favorable secular patterns of drinking, risk of alcohol dependence did not show a decrease, warranting continued efforts at its prevention and treatment.

METHODS

The Framingham Heart Study began in 1948 in Framingham, Massachusetts.\(^2\) The original cohort, hereafter referred to as the “Original Cohort,” included 5209 subjects, aged 28-62 years at the first examination. Starting with the second examination, surviving participants have been examined biannually. At each examination, participants received a medical history interview, a physical examination, and a series of laboratory tests. In 1971-1974, examinations were offered for the children of the Original Cohort and their spouses, and a total of 5124 subjects were examined as part of the Framingham Offspring Study. The second examination in the Offspring Cohort occurred approximately 8 years after the baseline examination; subjects have been followed in 4-year cycles since then, with evaluations similar to those of the Original Cohort.

Assessment of Alcohol Consumption

Average Alcohol Consumption. Information on amount of alcohol consumption has been collected repeatedly from both the Original Cohort and the Offspring Cohort. At early examinations (up to the 7th examination) of the Original Cohort, subjects were asked how many 2-oz cocktails, 8-oz glasses of beer, and 4-oz glasses of wine they consumed in a month. At subsequent examinations (the 12th-15th, the 17th-23rd, and the 26th-27th examinations) of the Original Cohort and at all examinations (the 1st-7th examinations) of the Offspring Cohort, subjects were asked about the number of 1.5-oz cocktails, 12-oz glasses (or cans) of beer, and 4-oz glasses of wine they consumed in a week. Total alcohol consumption (grams per day) has been computed by multiplying the average amounts of alcohol in beer, wine, and mixed drinks times the amount drunk. We adjusted for secular changes that occurred in the late 1960s in the alcohol content of liquor commonly consumed (from 100% to 80% proof) and the type of wine generally consumed (from fortified to table wine), as well as a change in the average serving sizes of drinks to calculate the total ethanol content according to when the data were collected.

Heavy Episodic Drinking. In the later examinations of the Original Cohort (the 15th and 17th-23rd examinations) and starting at the 2nd examination of the Offspring Cohort, subjects were asked by trained interviewers prompted by an examination form to specify, “On average, what is your limit for number of drinks at one period of time?” Using this information, subjects reporting more than 4 drinks per occasion for men and more than 3 drinks per occasion for women were identified as having heavy episodic drinking.

Alcohol Use Disorders. Trained research assistants reviewed all available medical records, including Framingham Study questionnaires, hospital records, letters from private doctors, and other original source documents, for each study participant. An ICD-9 (International Classification of Diseases, 9th Revision) code was assigned for every disease or condition that could be coded. For the current analysis, alcohol use disorders included ICD-9 codes of 305.0 (alcohol abuse), 303.9 (alcohol dependence), and other diagnoses considered to be due exclusively to alcohol (“100% attributable”), such as alcohol withdrawal symptoms (291.81), delirium tremens (291.0), alcoholic myopathy (425.5), alcoholic cirrhosis (571.2), and alcohol detoxification therapy (94.62).

We also identified an additional group that did not meet criteria for ICD-9 coding for an alcohol use disorder, but review of their medical records identified words/phrases indicating a “possible” alcohol use disorder. The record
review leading to this designation included a search for key words such as “lost job because of drinking,” “attends AA,” “arrested for drunk driving,” “advised to decrease my drinking,” “physically injured because of drinking,” and many others. To check the quality of record review, we randomly selected 450 records from the Original Cohort and 450 records from the Offspring Cohort and had them re-reviewed independently by both the project manager (ES) and the principal investigator (RCE). The proportion of agreement on key words indicating a possible disorder was 99% for both the Offspring Cohort and the Original Cohort.

**Statistical Analysis**

Subjects were grouped into 4 birth cohorts: born before 1900, and born in 1900-1919, 1920-1939, and 1940-1959. Because data on alcohol consumption were collected biannually in the Original Cohort and every 4 years in the Offspring Cohort, we divided age into 2-year age categories, with the first age category being 18-21 years and the last being ≥86 years of age. Data included in these analyses were those collected from 1948 through November 19, 2003 (end of the 27th examination) for the Original Cohort and from 1971 through October 26, 2001 (end of the 7th examination) for the Offspring Cohort.

We calculated the average amount of alcohol consumption among the drinkers and plotted it against age for each birth cohort for men and women separately. For comparison of birth cohorts that had overlapping data, we calculated age-adjusted average amount of alcohol consumption between ages 30 and 59 years for the 3 younger birth cohorts and between ages 60 and 79 years for the 3 older birth cohorts. We assessed the effect of age and birth cohorts on average total alcohol consumption using generalized estimating equations.21

We estimated the proportion of the total amount of alcohol consumed from beer, wine, and liquor by dividing the amount of beer, wine, and liquor consumed by subjects in a particular age group of the specific birth cohort by the total amount of alcohol consumed at the time by the same subjects.

We defined a participant as a nondrinker (abstainer) at a particular examination if he/she did not report any alcohol beverage intake at that examination. Among drinkers, we defined an individual as a “moderate” drinker if the subject’s average amount of alcohol met current guidelines of the United States Department of Agriculture/Health and Human Services (an average of ≤24 g of alcohol per day for men and ≤12 g of alcohol per day for women) and no heavy episodic drinking (defined as ≥4 standard drinks per occasion for men and ≥3 drinks per occasion for women). Because data on maximum drinking on an occasion were collected only in more recent examinations of the Original Cohort, the analysis evaluating secular trends of “moderate” and “heavy” alcohol consumption among alcohol consumers was limited to the 3 younger birth cohorts. For each birth cohort, we obtained the age- and sex-specific prevalence of abstainers and the proportion of consumers deemed “moderate” and “heavy” drinkers, and examined their association with age and birth cohort using generalized estimating equations.

Finally, we estimated the cumulative incidence of an alcohol use disorder from age 40 to 79 years for the older cohorts (those with data extending to age 80 years). Because it is likely that very few subjects would become newly dependent after age 80 years, this is the closest we could come to giving the “lifetime risk” of an alcohol disorder for adults at age 40 years or older. Because some members of the Framingham Study were not recruited into the study until they were older than 40 years, our analyses could not include everyone in the current study who may have developed an alcohol use disorder at an earlier age. For the present analyses, we excluded any individual who was identified as having such a disorder before age 40 years. We also calculated the cumulative incidence by age 80 years of an alcohol use disorder when defined as having either an ICD-9 code for such a disorder or a key word indicating a possible alcohol use disorder.

**RESULTS**

The characteristics of the subjects at the time of their baseline examination (1948-1953 for the Original Cohort or 1971-1975 for the Offspring Cohort) are shown in Table 1. About one half of subjects were 40 years or younger at the time of their baseline examinations and over 40% were born before 1920. Approximately one quarter of participants did not graduate from high school. Prevalence of smoking was much higher in men than in women.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Characteristics of Participants at Their Baseline Examination in The Framingham Heart Study, Framingham, MA, 1948-1975</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristics at Baseline</strong></td>
<td><strong>Men</strong> (n = 4097)</td>
</tr>
<tr>
<td>Age, years (%)</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>18.7</td>
</tr>
<tr>
<td>31-40</td>
<td>32.7</td>
</tr>
<tr>
<td>41-50</td>
<td>30.3</td>
</tr>
<tr>
<td>&gt;50</td>
<td>18.4</td>
</tr>
<tr>
<td>Birth cohort (%)</td>
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<tr>
<td>&lt;1900</td>
<td>12.2</td>
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<tr>
<td>1900-1919</td>
<td>30.1</td>
</tr>
<tr>
<td>1920-1939</td>
<td>34.5</td>
</tr>
<tr>
<td>1940-1959</td>
<td>23.2</td>
</tr>
<tr>
<td>Education (%)</td>
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<tr>
<td>&lt;High school</td>
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<tr>
<td>High school graduate</td>
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<tr>
<td>Some college</td>
<td>16.0</td>
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<tr>
<td>College graduate</td>
<td>29.0</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td></td>
</tr>
<tr>
<td>Never smoker</td>
<td>23.5</td>
</tr>
<tr>
<td>Past smoker not now</td>
<td>18.1</td>
</tr>
<tr>
<td>Current smoker</td>
<td>58.4</td>
</tr>
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</table>
The average amount of alcohol intake, in grams of alcohol per day, for individuals reporting any drinking is presented in Figure 1. In both men (Figure 1A) and women (Figure 1B), average consumption was lower among those in the younger birth cohorts compared with the older ones. Among men between ages 30 and 59 years, the age-adjusted mean alcohol consumption was 30.6, 25.5, and 21.0 g/day for those born in 1900-19, 1920-39, and 1940-59, respectively (P < .001). Corresponding figures for women were 14.2, 12.3, and 10.4 g/day, respectively (P < .001). Among subjects for whom data between ages 60 and 79 years were available, that is, those born before 1900, from 1900-1919, and 1920-1939, a similar pattern also was observed. Among these older men, age-adjusted mean alcohol consumption was 27.9 g/day for those born before 1900, 24.0 g/day for those born in 1900-1919, and 19.3 g/day for those born in 1920-1939 (P < .001). The corresponding amount of alcohol consumption for these older women changed less over time (11.6, 12.0, and 11.0 g/day, respectively, P = .36).

Among men reporting any alcohol intake at an examination, the proportion derived from beer showed a striking decrease with age for all birth cohorts, being 50% or more of their total alcohol for subjects until they reached their mid-30s and decreasing to approximately 25% by their mid-70s. For the youngest birth cohort (born 1940-1959), the proportion of their alcohol use from beer was higher than among men in earlier cohorts. Over the same time period, the proportion of alcohol from wine showed a gradual increase with age for all birth cohorts. There was <15% of alcohol from wine for men before age 40 years, but it increased to more than 25% in later years. Between ages 40 and 60 years, men in the youngest birth cohort consumed a higher proportion of their alcohol from wine than did the earlier birth cohorts. There was less of an effect of age on the proportion of alcohol from liquor for all cohorts. However, the proportion of alcohol from liquor was lower at most ages for individuals born in the younger birth cohorts.

For women, the percentage of alcohol derived from beer was much lower than it was for men, but a similar decrease with age was seen for all birth cohorts. Women consumed a higher percentage of alcohol from wine and, as in men, the percentage increased with age for all birth cohorts. The highest percentage from wine was seen for the youngest birth cohort. For liquor, the pattern with age was similar for women as for men, without substantial effects for the older birth cohorts. Women in the youngest birth cohort, however, consumed less of their alcohol from liquor, and showed a steady decrease with age.

For both men and women, there was a steady increase in abstinence with age for all birth cohorts. By age 80 years, more than 40% of men and 60% of women reported no alcohol consumption. For the earliest birth cohort (born before 1900), women in their 50s and 60s were more likely to be abstainers than were women in later cohorts. In the 3 younger birth cohorts, the prevalence ratios (PR) of abstinence among men were 0.75 and 0.73, respectively, for participants born from 1900-1919 and 1920-1939 in comparison with those born in 1940-1959. In women, in the later cohorts, the corresponding figures were 0.80 and 1.01, respectively.

For the birth cohorts with available data, among individuals reporting any alcohol intake, the proportion reporting “moderate” amounts of alcohol increased with age in men (Figure 2A), but somewhat less so in women (Figure 2B). Further, where the ages overlapped, for both men and women, the younger birth cohort tended to show a higher prevalence of such a drinking pattern than the older one. For example, for men between ages 40 and 55 years, the age-adjusted PR of “moderate” drinking among alcohol consumers in the youngest cohort was 1.21 (95% confidence interval [CI], 1.12-1.32) in comparison with subjects born from 1920-1939; for women in these cohorts, the PR was 1.18 (95% CI, 1.10-1.27). Between ages 60 and 75 years, for men and women combined, the age-adjusted PR of “moderate” alcohol drinking was 1.17 (95% CI, 1.07-1.28) when comparing individuals born from 1920-1939 with those born from 1900-1919 (P < .013).

In contrast, the prevalence of “heavy” drinking for the 3 more recent birth cohorts was lower in the younger cohorts
than in the older cohorts for both men (Figure 3A) and women (Figure 3B). For men, the proportion with “heavy” drinking tended to decrease with age, although the pattern was less clear among women.

As shown in Table 2, the cumulative incidence of evidence of an alcohol use disorder between ages 40 and 79 years showed a slight increase from the cohort born between 1900 and 1919 to the later birth cohort; the overall cumulative incidence for the combined cohorts was 12.8% for men and 3.8% for women. When the analysis included individuals with either a code for an alcohol use disorder or a keyword indicating a possible disorder, the cumulative incidence increased very little: 13.8% for men and 4.4% for women.

**DISCUSSION**

Using repeatedly collected data on alcohol use and consequences over 50 years in the Framingham Heart Study, we found that the average amount of alcohol consumed by drinkers decreased across birth cohorts. The proportion of individuals reporting “moderate” consumption increased and the proportion reporting “heavy” intake decreased. Further, the percentage of the alcohol intake from beer decreased and the percentage from wine increased across birth cohorts.

The effects of age were similar for most cohorts. The average amount of alcohol was highest between ages 30 and 50 years, then decreased with age. The percentage of alcohol derived from beer decreased and that derived from wine increased with age; the proportion from liquor showed little change with age. Proportion of abstinence increased markedly with age. Among participants in the older cohorts where data were available, the cumulative incidence of identifying an alcohol use disorder between ages 40 and 79 years was about 3 times higher for men than for women, but showed little change across cohorts.

Several characteristics of this study are noteworthy. First, unlike cross-sectional surveys that have described patterns of alcohol consumption, in this study, data on alcohol were collected repeatedly in the same subjects fol-
However, there are some limitations to consider. First, the estimates of alcohol intake were all based on self-report, and sought data on the subject’s usual intake over time, which may be less accurate than estimates based on records kept of alcohol consumption. Because ethanol content and serving size changed during the study period, we developed a conversion formula to account for such changes; however, when we repeated our analyses excluding data collected at the earlier examinations, we found no appreciable differences. Secondly, an important measure of alcohol intake is the drinking pattern, and such information was not systematically recorded for some of the earlier examinations. When such data were collected, we used a commonly used definition for “heavy episodic drinking” based on the reported limit for number of drinks at one period of time. Also, our data are from mainly middle-aged and older white adults; we have limited data on younger individuals and none on minorities. Because many participants did not enter the Framingham Study until they were in their 50s, we are unable to calculate the lifetime risk of developing an alcohol use disorder. Our estimates of risk of developing such a disorder are limited to those not showing such alcohol problems in medical records before age 40 years. However, because most alcohol use disorders develop before age 40 years, it is likely that the disorders first recognized in these records as incident represent disorders that had their initial symptoms in young adulthood.

The Framingham Study did not have specific questions to solicit the evidence of an alcohol use disorder; thus, our estimate on the occurrence of such a disorder was based on the appearance of a relevant diagnosis in the medical records. It is quite possible that we may have underestimated the prevalence of these disorders, even after adding those with possible disorders from key words within the text of records, because many such consequences do not come to medical attention.

Grant et al.15 showed that “alcohol abuse” increased between cross-sectional surveys in 1991-1992 and 2001-2002, whereas “alcohol dependence” showed a decrease. Of note, the prevalence of current alcohol use disorder in their sample (12% for men, 5% for women) was similar to the proportions identified in our study. However, it is difficult to compare the cumulative rates of alcohol use disorders among the same subjects over the very long period of time that we report with the prevalence from cross-sectional surveys among different individuals.15,16

**CONCLUSION**

These analyses provide data that may be useful for groups making recommendations about drinking and setting alcohol policy. Research continues to support potentially beneficial effects of moderate drinking on cardiovascular disease.
and other diseases of aging, as well as adverse health and social effects of heavy alcohol use. The findings in this study may be considered encouraging in many ways: the average amount of alcohol has decreased in more recently born cohorts, the percentage of the population exhibiting “moderate” alcohol intake has been increasing steadily, and the percentage reporting “heavy” drinking has decreased over time. Further, with greatly increasing numbers of elderly people, the trends for less “heavy” drinking with advancing age for all birth cohorts also is encouraging. While these data suggest the development of more favorable patterns of alcohol consumption over the latter part of the 20th century, they also show that, at the same time, the cumulative incidence of alcohol use disorders has not shown a decrease, and continuing efforts at preventing them are warranted.

References