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What Are the Health Implications of Alcohol Consumption?

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The harmful effects of alcohol are far better known than its beneficial effects. This is scarcely surprising: it requires no training in epidemiology to recognize the devastating harm that often comes with both drunkenness and chronic alcohol abuse. However, findings that have emerged in recent years have uncovered several surprising associations between moderate alcohol intake and enhanced health and well being.

In this chapter, the American definition of a drink, namely 12.5–13.0 g of alcohol, is used. This quantity of alcohol is approximately the amount contained in 12 oz (356 g) of regular beer, 4–5 oz (118–148 g) of wine, or 1.5 oz (42 g) of spirits. We also use the US Department of Agriculture (USDA) dietary guidelines' definition of moderate alcohol consumption as up to two drinks a day for men and one drink a day for women.

1. HARMFUL EFFECTS OF ALCOHOL

1.1. Accidents, Violence, and Suicide

It is well established that abuse of alcohol is associated with accidents, violence, and suicide. The most dramatic evidence of this has come from Russia. Between 1984 and 1994, there was serious economic decline and great political turmoil. During this period, life expectancy fell by 4 yr in men and by 2 yr in women. A major factor contributing to this decline was widespread alcohol abuse, particularly binge drinking, which led to large increases in deaths from accidents, homicide, and suicide, as well as cardiovascular disease (1,2).

In 1999 in the United States, there were approx 15,800 alcohol-related traffic accidents, approx 38% of all traffic fatalities. This is a decrease of 30% when compared with 1989 (3). Stricter enforcement of existing legal codes and the passage of new laws have been suggested as promoting these beneficial changes.

1.2. Chronic Alcohol Abuse

For many people, years of alcohol abuse eventually lead to chronic health and nutritional problems. Alcohol is rich in calories and typically devoid in nutrients, especially alcohol-rich and sugar-rich hard liquors. The body often compensates for the high caloric intake by decreasing the stimulus to eat regular nutrient-rich foods. As a result, there is

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a high probability of malnutrition, especially of folate and thiamin. The thiamin deficiency associated with alcohol abuse is known as Wernicke-Korsakoff syndrome. Liver disease is also a likely result, with a downward spiral from fatty liver to alcoholic hepatitis and, eventually, to cirrhosis.

1.3. Fetal Alcohol Syndrome

Pregnancy is another situation in which alcohol misuse can have tragic consequences. This induces fetal alcohol syndrome (FAS). FAS encompasses several symptoms, including prenatal and postnatal growth retardation, abnormal facial features, and an increased frequency of major birth defects. Children born with FAS never recover.

A subclinical form of FAS is known as fetal alcohol effects (FAE). Children with FAE may be short or have only minor facial abnormalities or develop learning disabilities, behavioral problems, or motor impairments.

FAS occurs at a level of alcohol intake that in a nonpregnant woman would not be considered alcohol abuse. Approximately four drinks per day pose a real threat of FAS, whereas one or two drinks per day may still retard growth, although the epidemiological data are weaker and somewhat inconsistent at these lower consumption levels. Although women who have an occasional drink during pregnancy should not fear they are doing irreparable harm to their fetuses, it is now generally accepted that any woman who is or may become pregnant should abstain from alcohol.

1.4. Cancer

Alcohol increases the risk of cancer of the mouth, throat, and esophagus (4,5). It also acts as a cocarcinogen with cigarette smoke (6). It is likely that among heavy alcohol consumers, the alcohol or one of its metabolites, acetaldehyde, is toxic to mucosal epithelial cells. Alcohol also increases the risk of cancer of the liver, ovary, and breast (4,5). The risk ratio (RR) with an alcohol intake of four drinks per day is estimated to be 2.3 for cancer of the mouth, throat, and esophagus; 1.7 for breast cancer; and 1.15–1.35 for cancer of the stomach, colon-rectum, liver, and ovary (5). For all cancer combined, a significant risk is seen starting at an alcohol intake of two drinks per day, with a RR of 1.22 at four drinks per day (5). For breast cancer, it is less likely that ethanol is toxic, because the increase has been seen at relatively low levels. It is more likely that alcohol influences circulating estrogen levels, which may affect disease occurrence (7,8).

Emerging evidence also indicates that alcohol, even in moderation, may suppress circulating folate levels, which could affect DNA synthesis and gene expression. Several recent large prospective studies of breast cancer (9,10) show that an adequate folate intake ameliorated the carcinogenic action of alcohol (*see* Fig. 1). As with breast cancer, the effect of alcohol on colon cancer may be muted or eliminated completely if the diet has sufficient folate or methionine (both methyl donors) (11).

1.5. Obesity

Alcohol, of course, is a source of calories (7 kcal/g). It is important to remember that alcoholic beverages also contain carbohydrates that add additional calories. A half liter of wine contains approx 350 kcal, whereas three cans of beer supply approx 250–450 kcal, clearly enough to tip the energy balance well into positive territory. These numbers explain the popularity of low-calorie “light beers.” It is predictable, therefore, that alcohol con-

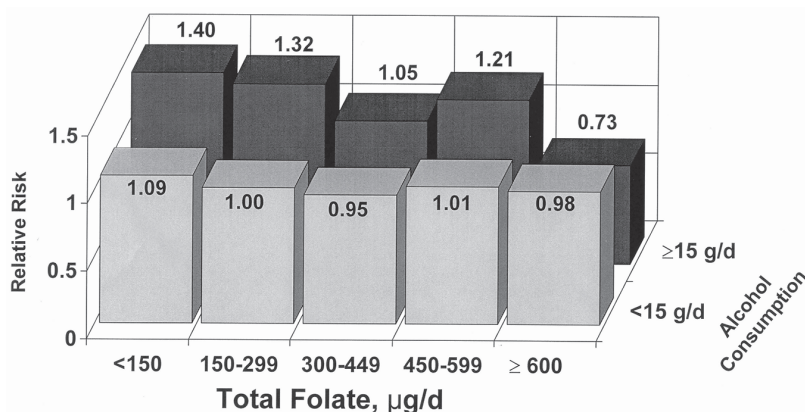


Fig. 1. Multivariate relative risk of breast cancer by total folate intake and alcohol consumption. The reference group for all comparisons was women who consumed 150–299 µg/d of total folate and fewer than 15 g/d alcohol.

sumption should be associated with excess weight gain. But, as so often happens in nutrition, predictions collapse in the face of reality. A solid body of evidence from mostly cross-sectional studies has demonstrated that alcohol intake actually has an inverse association with body mass index (an index of weight relative to height) (12–14). However, when diet, physical activity, and other lifestyle factors are not examined prospectively, it can be difficult to interpret whether the association is causal. Thus, more longitudinal studies of alcohol and weight gain are needed. Intervention studies are inconclusive, although Cordain et al. (15) reported that supplementation with 35 g of alcohol per day (a little less than three glasses of wine) to the daily energy requirements for a period of 6 wk did not affect body weight and/or energy metabolism. It is feasible that the increase in basal metabolic rate caused by moderate alcohol consumption may offset the additional calories from consuming alcohol-containing beverages (16).

2. PROTECTIVE EFFECTS OF ALCOHOL

2.1. Coronary Heart Disease

A convincing body of evidence suggests that the risk of coronary heart disease (CHD) is reduced by 10–40% in persons who consume alcohol in moderation (17). In some populations, this association can be skewed if individuals at higher risk for CHD reduce or eliminate alcohol consumption due to a diagnosis of a related chronic disease (e.g., hypertension or diabetes). This is frequently described as the “sick quitter” syndrome and can create a spurious artificial inverse association between alcohol and CHD (18). Because conditions like hypertension and diabetes increase the risk of CHD by twofold to threefold, a study that does not consider these conditions may find that moderate drinkers have as much as 50–70% less heart disease. However, even in large cohort studies where sick quitters are removed or moderate drinkers are compared to lifelong abstainers, alcohol has had strong cardiovascular benefits (19).

There has been much speculation that wine may be more potent than beer or spirits in preventing CHD. This is largely based on findings from ecological studies (i.e., countries

like France that have a high intake of wine have relatively low CHD rates) (17). It has been repeatedly shown that such associations can easily be spurious. This is indicated by the findings from case-control and cohort studies: these show no clear trend for one type of alcohol to be more consistently associated with protection from CHD (17). Where one type of alcohol does manifest a stronger association than other types, this is likely due to confounding by such factors as smoking and drinking pattern or to differences in other lifestyle factors, such as eating patterns or physical activity.

Short-term experimental studies have helped to explain the mechanisms by which alcohol prevents CHD (20). First and foremost, alcohol causes an increased level of high-density lipoprotein (HDL) cholesterol. This explains approximately half of the association between alcohol and CHD. Another protective mechanism is that alcohol exerts an antithrombotic action by reducing hepatic production of fibrinogen and other clotting proteins. There is also some evidence indicating that alcohol may lower low-density lipoprotein (LDL) cholesterol levels (21), but findings are not consistent.

Alcohol has been reported to elevate the blood homocysteine level, a relatively new CHD predictor. This was seen with 6 wk of consumption of a moderate level of alcohol (30 g/d) (22). Red wine and beer had a greater effect than spirits. This action of alcohol is predicted to partly counter its protective benefit on CHD.

As with cancer, there is a suggestion of an alcohol-folate interaction: the beneficial effects of alcohol on CHD may be strongest among those with folate-sufficient diets (23,24). Because alcohol may suppress folate levels leading to a subsequent increase in homocysteine, individuals with high folate intakes may benefit the most from a moderate alcohol intake because they will have low levels of homocysteine from the extra folate yet still reap the beneficial effects of alcohol on lipids, coagulation factors, and insulin sensitivity.

Recent findings from the Physicians' Health Study reveal a genetic component to the relationship between alcohol intake and risk of CHD (25). The enzyme alcohol dehydrogenase is crucial to the metabolism of alcohol. Approximately 15% of the population is homozygous (or has two copies of the gene) for the form of the gene that induces a slow rate of alcohol metabolism. Slow metabolizers have higher plasma HDL cholesterol levels than fast metabolizers, and, among those in the Physicians' Health Study who drink moderately there is a dramatically low risk of CHD. This is one of the first diet-gene interactions to be reported in the literature and provides strong evidence that the ethanol component of alcohol-containing beverages is responsible for the benefit rather than other components in wine, beer, or spirits.

2.2. Blood Pressure and Stroke

A relatively high alcohol intake (>4 drinks/d) is associated with elevated blood pressure (26,27) and an increased risk of stroke. Recent evidence from cohort studies suggest that the association between alcohol and hypertension may be J-shaped, such that light and moderate drinkers have a modestly reduced risk of developing hypertension, although the exact mechanism for this effect is unknown (28). Studies on the association between moderate alcohol consumption and stroke have been mixed. Several case-control and cohort studies have seen a reduced risk of stroke among moderate drinkers. Yet others find little benefit in the moderate range. In studies that find benefit, the reduction is usually limited to ischemic rather than hemorrhagic stroke (4,29–31).

Clearly, the data support no increase in ischemic risk at moderate levels, but more work is needed to determine if drinking patterns influence risk of stroke (i.e., frequent consumption of small amounts of alcohol vs binge drinking).

2.3. Impotence

The relationship between excessive alcohol intake and poor erectile function is well known. As Shakespeare wrote: “It provokes the desire, but takes away from the performance” (Macbeth). However, as in the case of alcohol and blood pressure, recent findings have revealed an apparently beneficial effect, or at least no ill effects, of moderate alcohol consumption. Preliminary data from the Health Professionals’ Follow-up Study, a prospective cohort study of more than 50,000 US male health professionals, show a modest U-shaped relationship between alcohol intake and erectile dysfunction. Like CHD, the strongest risk reduction was among those who consumed one to two drinks per day (32). Although erectile dysfunction was originally believed to be purely psychogenic in nature, 80–90% of the dysfunction is likely the result of biological factors that may share a similar profile to atherosclerosis.

2.4. Gallstones

Most studies that have examined this question have reported a protective association between alcohol and risk of gallstones. For instance, Leitzmann et al. (33) observed that men who consume alcohol frequently (5–7 d/wk) have a reduced risk of gallstones but not those who consume alcohol less frequently (1–2 d/wk). These findings indicate that frequency of alcohol consumption rather than quantity is the critical factor.

2.5. Bone Health

Although findings are not consistent, several studies have reported an inverse association between moderate alcohol intake and bone mineral density, especially in women who are postmenopausal (34,35). This suggests that alcohol may help prevent osteoporosis. However, as osteoporosis is so dependent on lifetime diet, physical activity, obesity, and other factors, it is probable that alcohol does not play an important role in osteoporosis. In contrast to the situation with osteoporosis, high levels of drinking cause loss of balance and falls, leading to an increased risk of hip or wrist fracture.

2.6. Hearing Loss

A cross-sectional study of subjects aged 50–91 years reported that moderate alcohol intake was associated with better hearing (36). Again, like bone health, many other environmental and genetic effects play a more important role in the etiology of hearing loss.

2.7. Cognitive Function

Findings from the Framingham study, conducted among older adults, suggested that alcohol is associated with enhanced cognitive ability, especially in women (37). This was seen at an intake of two to four drinks per day in women and four to eight drinks per day in men, an intake above what is usually considered moderate. An earlier study observed that this benefit was seen only in women (38). It is well known that higher intakes have a damaging effect on brain function. Once again, therefore, alcohol manifests a U-shaped or J-shaped relationship. An even more revealing study that had detailed measures of

cognitive function and dementia also reported benefits of alcohol consumption. In a 6-yr follow-up of 8000 middle-aged and older men and women in the Netherlands, Ruitenberg et al. (39) found that men and women consuming 1–3 drinks per day had a 42% lower risk than abstainers of developing dementia (mainly Alzheimer's disease).

2.8. Benign Prostatic Hyperplasia

A cohort study reported that moderate alcohol intake (2.5–4 drinks/d) was associated with a reduced risk of benign prostatic hyperplasia (RR of 0.59) (40). The mechanisms for this action are speculative but may include the effects of alcohol on steroid hormone levels.

2.9. Diabetes

Cohort studies have suggested that alcohol may be protective against type 2 diabetes. A British (41) and an American (42) cohort study indicated that moderate alcohol consumption reduces risk of the condition by approx 40% in men but less so among American women (43). Interestingly, there have been several recent studies suggesting that moderate alcohol consumption among men and women with type 2 diabetes is also associated with a much reduced risk of subsequent CHD, the leading killer of people with diabetes (44–47).

2.10. Lung Disease

Alcohol may also be protective against chronic obstructive pulmonary disease (COPD). A cohort study of middle-aged men in Finland, the Netherlands, and Italy revealed a protective association between alcohol intake and risk of death from COPD (48). The lowest risk was seen at an intake of up to approximately three drinks per day. Alcohol intake has also been observed to manifest a protective association with emphysema in smokers (49).

3. EFFECT OF ALCOHOL ON TOTAL MORTALITY

When alcohol intake is moderate, the beneficial health effects on the cardiovascular system outweigh most detrimental effects. As a result, the net effect of alcohol on total mortality is a J-shaped curve, with minimum mortality associated with a moderate alcohol intake but with a rising curve as consumption increases. A major study by the American Cancer Society reported that in each gender, persons consuming one drink daily had a risk of death from all causes approx 20% below those of nondrinkers (4). To put this in perspective, among American men and women aged 35–69 yr, a moderate consumption of alcohol prevents approximately one death for every six deaths caused by smoking (4).

The alcohol intake corresponding to the nadir for mortality is still unclear but in people aged 50–80 is approx 0.7–1.2 drinks per day in men and 0.3 drinks per day in women (50). However, because this is based on self-reported intake, which represents a substantial underestimation, the true nadir is almost certainly higher (50).

The benefits of alcohol are most apparent in the middle-aged and elderly. This is because alcohol reduces risk of CHD and stroke, the first and third leading causes of death, respectively, in that age group. By contrast, the leading cause of death in Americans under age 40 yr is accidents, with homicide and suicide also being major causes,

especially in men. These are all associated with alcohol. This age effect is illustrated by a report from the Nurses' Health Study. A moderate alcohol intake has a protective relationship with total mortality in women aged over 50 yr (RR is 0.80–0.88) but is associated with a doubling of the risk of death in those aged 34–39 yr (51). Similar findings were reported from England and Wales. A net favorable mortality outcome was seen only in men over age 55 and women over 65 yr (52).

4. DRINKING PATTERNS

More recently, research has focused on the importance of drinking pattern on risk of health outcomes. Not surprisingly, alcohol is most protective when consumed in small regular amounts rather than binge or episodic drinking. This was demonstrated in a cohort study in the United States (53). People who engaged in occasional heavy drinking had a higher risk of death than persons with the same alcohol intake but who did not engage in binge drinking. Similar observations were made on cardiovascular disease in Canada. The data from that study revealed that although alcohol consumption has a protective association with both CHD and hypertension, binge drinking increases the risk of both, especially in men (54). In a recent study of US male health professionals, frequency of consumption (d/wk) was more important than quantity consumed. Men who consumed alcohol at least 4 d/wk had the lowest risk of type 2 diabetes, regardless of the total amount consumed (55). These findings are hardly surprising: many dietary components cause no harm in small frequent doses but are toxic when a large dose is taken.

5. CONCLUSIONS

Clearly, alcohol can do much good but also much harm. It is important to remember that the harmful effects of alcohol frequently occur at a much younger age than the benefits. Consequently, if the effects of alcohol are measured in terms of quality years of life (lost or gained), then the harm done to one (usually younger) person by alcohol may be far greater than the benefit gained by another (usually older) person.

The majority of the harmful effects of alcohol can be avoided by sensible drinking, by not smoking, by drinking in moderation, and by avoiding alcohol when driving. For the person who can drink sensibly and can avoid alcohol's negative side effects, alcohol can be of considerable benefit. Like so much else in life, it's a matter of balance. Although alcohol should perhaps not be prescribed (56), neither should it be proscribed.

Australian researchers estimated that for people aged over 60 yr, the cost per life year gained by moderate consumption of alcohol was A\$5700 (US \$2900) in men and A\$19,000 (US \$9600) in women (57). On this basis, alcohol can be considered a cost-effective medication. For instance, it is many times more cost-effective than medication with statins for treatment of hypercholesterolemia (58).

The findings discussed in this chapter have implications for public health policy. But what are these implications? One possible policy is the following: all adults aged over 40 yr should be encouraged to consume moderate amounts of alcohol daily, unless there is a specific reason to the contrary, such as religion, medication use, or a history of alcohol abuse. The problem with such a policy is the risk of causing a rise in the prevalence of alcohol abuse. Typically, approx 5–10% of people in any society where alcohol is available become abusers of the beverage. The actual proportion is related to the mean

alcohol intake: the higher the mean alcohol intake, the higher the proportion of alcohol abusers (59). Thus, a policy that encourages greater alcohol use will likely also lead to more problems associated with abuse.

Arguably, the most prudent policy is one that explains that alcohol in moderation will likely have several health benefits for people who are middle age and older, while also stressing the hazards of abuse.

6. MAIN POINTS FOR PRIMARY AND CLINICAL REVIEW

1. An alcoholic drink is generally considered to contain 12.5–13 g of alcohol (ethanol); this amount is found in a 12-oz (356 g) beer, 4–5-oz (118–148 g) wine, or 1.5-oz (42 g) of distilled spirits.
2. The US Department of Agriculture defines moderate alcohol consumption as 2 drinks/day for men or 1 drink/day for women.
3. Alcohol creates many social problems, such as violence and accidents, as well as negative health effects, most notably those related to cancer and fetal alcohol syndrome.
4. Although persons with alcoholism should perhaps never drink, moderate alcohol consumption is associated with significant protective effects with respect to cardiovascular disease, several other diseases, and overall mortality.
5. The alcohol intake associated with the lowest overall mortality is 0.7–1.3 drinks/day in men and approx 0.3 drinks/day in women, but this is probably an underestimate.

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