Alcohol and Health in Canada:

A Summary of Evidence and Guidelines for Low-Risk Drinking

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Completed November 3, 2010 and published November 25, 2011

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Printed in Canada
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Suggested Citation: Butt, P., Beirness, D., Gliksman, L., Paradis, C., & Stockwell, T. (2011). *Alcohol and health in Canada: A summary of evidence and guidelines for low risk drinking.* Ottawa, ON: Canadian Centre on Substance Abuse.

This report was commissioned by the National Alcohol Strategy Advisory Committee (of Canada).

Ce document est également disponible en français sous le titre : *L'alcool et la santé au Canada: résumé des données probantes et directives de consommation à faible risque*

ISBN 978-1-926705-79-8

Acknowledgements

The authors are indebted to the following organizations and individual for the valuable feedback received in response to an earlier consultation draft of this document:

Alberta Health and Wellness
Brewers Association of Canada
British Columbia Ministry of Healthy Living and Sport
Canadian Association of Chiefs of Police
Canadian Association of Liquor Jurisdictions
Canadian Centre on Substance Abuse
Canadian Vintners Association
Centre for Addiction and Mental Health
Centre for Addictions Research of British Columbia
Dr. Louise Nadeau
Éduc'alcool
Health Canada
MADD Canada
National Native Addiction Partnership Foundation
Nova Scotia Department of Health Promotion and Protection
Public Health Agency of Canada
Spirits Canada – Association of Canadian Distillers
The Student Life Education Company
Yukon Liquor Corporation

The authors also wish to thank the Canadian Centre on Substance Abuse (CCSA) for providing travel costs, expenses, a venue and a first-class secretariat to support our work. Carolyn Franklin hosted the meetings on behalf of CCSA and single-handedly coordinated, facilitated and provided a secretariat to enable the work to take place over a period of several months. The authors owe her a huge debt of gratitude for making the process enjoyable, congenial and constructive. We thank our three expert peer reviewers, each drawn from different continents of the world and each sharing unique perspectives and special expertise in alcohol epidemiology, prevention and policy. The Working Group also acknowledges with thanks the help of Matilda Stockwell in the preparation and presentation of some of the tables in the report.

Alcohol and Health in Canada: A Summary of Evidence and Guidelines for Low-Risk Drinking

Executive Summary

This document is intended for health professionals, policymakers, communication experts and members of the public who may wish to be informed about low-risk use of alcohol, whether for themselves or to advise others. The summary of evidence provided here and the proposed Canadian Guidelines for Low-Risk Drinking have both been developed by an independent expert working group with members drawn from Canadian addiction research agencies. The document has also been significantly strengthened by a process of international peer review conducted by three invited experts on alcohol epidemiology and feedback from concerned individuals and organizations.

These Guidelines have been developed against a backdrop of:

- a 14 percent increase in per capita alcohol consumption in Canada since 1996;
- different advice provided by authorities in different Canadian provinces;
- a rapidly growing scientific literature that identifies both significant risks and some possible benefits from low levels of alcohol consumption; and
- a national strategy document, *Reducing Alcohol-related Harm in Canada: Towards a Culture of Moderation - Recommendations for a National Alcohol Strategy"* (National Alcohol Strategy Working Group, 2007).

The Guidelines are intended to provide a basis upon which to advise all Canadians on how to minimize risks from their own and others' drinking in this complex environment. The Guidelines also acknowledge and support personal choices made by many Canadians to not drink alcohol at all, whether for cultural, spiritual, health-related and/or other personal reasons. They are not intended to encourage individuals or communities who choose to abstain to take up drinking. High-risk groups and situations are also discussed in which either abstinence or extreme caution with alcohol intake is advised, including alcohol use during pregnancy, by youth, in association with high-risk activities (such as driving) and in combination with medication and/or other drugs. No separate guideline is provided for older Canadians, given that the major risk factors for this group (being physically unwell, using medication and reduced tolerance) are highlighted under

other guidelines. While the Guidelines are intended for all Canadians, we recommend the need for consultation with Aboriginal groups for a more nuanced community- and population-specific approach in order to more fully address their sometimes diverse and complex circumstances.

The Guidelines identify three distinct types of risk from drinking:

- situations and individual circumstances that are particularly hazardous (e.g., women who are pregnant or planning to become pregnant, teenagers, persons on medication) and for which abstinence or only occasional light intake is advised;
- increased *long-term* risk of serious diseases caused by the consumption of alcohol over a number of years (e.g., liver disease, some cancers); and
- increased *short-term* risk of injury or acute illness due to the overconsumption of alcohol on a single occasion.

There are different ways to establish recommended low-risk drinking guidelines for those who choose to drink. A complication with assessing a low-risk level of alcohol consumption for the ***long-term*** risk of serious diseases is that there is also evidence of health benefits in relation to diabetes and some cardiac diseases. The approach employed here was to identify a level of average daily consumption where overall *net risk* of premature death is the same as that of a lifetime abstainer because potential health risks and benefits from drinking exactly cancel each other out. While there are non-fatal health and social problems associated with drinking, the level of consumption for the risk of these has been less well quantified and so only studies on risk of death from all causes presently provide a means of balancing costs versus benefits for individual drinkers. Relative rather than absolute risks of adverse outcomes were assessed (i.e., the focus was on whether risk increased for individuals because of their drinking rather than whether they were already at high or low risk before drinking due to other characteristics).

In relation to ***short-term*** harms that can happen during or after a particular drinking occasion, an emphasis is placed on reducing risk by using good judgement about settings and associated activities that are consistent with low-risk drinking, as well as restricting the amount consumed per occasion.

Average long-term consumption levels as low as one or two drinks per day have been causally linked with significant increases in the risk of at least eight types of cancer (mouth, pharynx, larynx, esophagus, liver, breast, colon and rectum) and numerous other serious medical conditions (e.g. epilepsy, pancreatitis, low birthweight, hemorrhagic stroke, dysrythmias, liver cirrhosis and hypertension). Risk of these individual medical conditions increases with every increase in average daily alcohol consumption over the long term. In addition, there are a number of serious medical conditions caused entirely by hazardous alcohol use, including alcohol dependence syndrome, alcoholic psychosis, nervous system degeneration, alcoholic polyneuropathy, alcoholic myopathy, alcoholic cardiomyopathy, alcoholic gastritis, alcoholic liver diseases and hepatitis, alcohol induced pancreatitis, fetal alcohol syndrome, and alcohol toxicity and poisoning.

Low levels of consumption have also been associated with health benefits resulting in lower risks of illness and premature death, notably from ischemic heart disease, ischemic stroke and diabetes. Systematic reviews and meta-analyses that estimated risk of death from all causes were identified to help define a 'balance point' of average daily consumption where the likelihood of harms and benefits exactly cancel each other out. A review by Di Castelnuovo et al (2006) indicated that maximum health benefits from drinking could be obtained with an average daily consumption of between a half and one standard drink per day. This meta-analysis was singled out as having made significant efforts to define the comparison group as comprising lifetime abstainers. The zero-net-risk point compared with lifetime abstainers at which the risks and benefits balanced each other out was two drinks on average per day for women and three for men.

Reviews of emergency room studies that quantified the relative risk of injury as a result of consumption within the previous six hours were also examined. However, there are some methodological problems with these studies. It was evident that risk of injury was significant at low levels of consumption when the context of drinking was not controlled (i.e., the place, company and activity). Because drinking context adds a great deal to the risk of injury on a given drinking occasion, it was considered that most of these studies did not provide accurate estimates of the risk from alcohol consumption.

Recommended Guidelines for Low-Risk Drinking

Note: These Guidelines are not intended to encourage people who choose to abstain for cultural, spiritual or other reasons to drink, nor are they intended to encourage people to commence drinking to achieve health benefits. People of low bodyweight or who are not accustomed to alcohol are advised to consume below these maximum limits.

<table>
<tr><td>Guideline 1
Do not drink in these situations:</td><td colspan="2">When operating any kind of vehicle, tools or machinery; using medications or other drugs that interact with alcohol; engaging in sports or other potentially dangerous physical activities; working; making important decisions; if pregnant or planning to be pregnant; before breastfeeding; while responsible for the care or supervision of others; if suffering from serious physical illness, mental illness or alcohol dependence.</td></tr>
<tr><td rowspan="3">Guideline 2
If you drink, reduce long-term health risks by staying within these average levels:</td><td>Women</td><td>Men</td></tr>
<tr><td>0–2 standard drinks* per day
No more than 10 standard drinks per week</td><td>0–3 standard drinks* per day
No more than 15 standard drinks per week</td></tr>
<tr><td colspan="2">Always have some non-drinking days per week to minimize tolerance and habit formation. Do not increase drinking to the upper limits as health benefits are greatest at up to one drink per day. Do not exceed the daily limits specified in Guideline 3.</td></tr>
<tr><td>Guideline 3
If you drink, reduce short-term risks by choosing safe situations and restricting your alcohol intake:</td><td colspan="2">Risk of injury increases with each additional drink in many situations. For both health and safety reasons, it is important not to drink more than:
Three standard drinks* in one day for a woman
Four standard drinks* in one day for a man
Drinking at these upper levels should only happen occasionally and always be consistent with the weekly limits specified in Guideline 2. It is especially important on these occasions to drink with meals and not on an empty stomach; to have no more than two standard drinks in any three-hour period; to alternate with caffeine-free, non-alcoholic drinks; and to avoid risky situations and activities. Individuals with reduced tolerance, whether due to low bodyweight, being under the age of 25 or over 65 years old, are advised to never exceed Guideline 2 upper levels.</td></tr>
<tr><td>Guideline 4
When pregnant or planning to be pregnant:</td><td colspan="2">The safest option during pregnancy or when planning to become pregnant is to not drink alcohol at all. Alcohol in the mother's bloodstream can harm the developing fetus. While the risk from light consumption during pregnancy appears very low, there is no threshold of alcohol use in pregnancy that has been definitively proven to be safe.</td></tr>
<tr><td>Guideline 5
Alcohol and young people:</td><td colspan="2">Alcohol can harm healthy physical and mental development of children and adolescents. Uptake of drinking by youth should be delayed at least until the late teens and be consistent with local legal drinking age laws. Once a decision to start drinking is made, drinking should occur in a safe environment, under parental guidance and at low levels (i.e., one or two standard drinks* once or twice per week). From legal drinking age to 24 years, it is recommended women never exceed two drinks per day and men never exceed three drinks in one day.</td></tr>
</table>

** A "standard drink" is equal to a 341 ml (12 oz.) bottle of 5% strength beer, cider or cooler; a 142 ml (5 oz.) glass of 12% strength wine; or a 43 ml (1.5 oz.) shot of 40% strength spirits (NB: 1 Canadian standard drink = 17.05 ml or 13.45 g of ethanol)*

A summary of the Canadian Guidelines for Low Risk Drinking recommended by the expert working group is provided above. Recommendations are also made for improving the knowledge base from which drinking guidelines can be developed. A comprehensive set of communications strategies is suggested to promote low-risk drinking in Canada, including the use of interactive Internet technology, brief interventions by health professionals and consideration of the introduction of standard drink labels on alcohol containers.

Were all Canadian drinkers to consume within the proposed Guidelines, it is estimated that alcohol-related deaths would be reduced by approximately 4,600 per year. A substantial proportion of all alcohol consumed in Canada (i.e., at least half) is presently consumed in excess of low-risk drinking guidelines similar to those recommended in this document (Stockwell et al, 2009). It is unrealistic to expect that the provision of drinking guidelines alone will have any significant effect if implemented in isolation. Low-risk alcohol guidelines can, however, support the implementation of other evidence-based regulatory and preventative interventions (Loxley et al, 2004; Babor et al, 2010).

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Introduction

Every week new research is published and discussed in the media that reports either positive or negative health consequences from drinking alcohol. In order to support Canadians who wish to make healthy choices about their own drinking and who might wish to give sound advice to others, the Canadian Guidelines for Low-Risk Drinking attempt to make sense of this new research and give balanced advice.

The Guidelines have been developed by an independent expert working group with members drawn from addiction research agencies from across Canada (see Appendix 1 for list of members). The establishment and support for the expert working group was provided by the Canadian Centre on Substance Abuse (CCSA) as part of a core recommendation of the National Alcohol Strategy Working Group Report (2007), a policy framework developed under the joint leadership of CCSA, Health Canada and the Alberta Drug and Alcohol Abuse Commission. The Guidelines were informed by work commissioned by CCSA and undertaken by Dr. Jürgen Rehm, Senior Scientist, and colleagues at the Centre for Addiction and Mental Health and University of Toronto. Members of the expert committee also contributed independent systematic reviews and analyses on selected topics.

It is hoped that health professionals, policymakers, educators, communications experts and concerned members of the public will use this document to inform a variety of clinical and health promotion activities intended to reduce alcohol-related harm.

Underlying Philosophy and Purpose of the Guidelines

Examples of guidelines for the low-risk use of alcohol can be found across millennia representing different perspectives and concerns. The Greek philosopher Eubulus provided one of the more colourful examples in 375 BC (cited by Ball et al, 2007):

> *Three cups do I mix for the temperate; one to health, which they empty first, the second to love and pleasure, the third to sleep. When this bowl is drunk up, wise guests go home. The fourth bowl is ours no longer, but belongs to violence; the fifth to uproar, the sixth to drunken revel, the seventh to black eyes, the eighth is the policeman's, the ninth belongs to biliousness, and the tenth to insanity and the hurling of furniture.*

In the sixth century AD, Saint Benedict (as cited by Verheyen, 1949) recommended that members of his order restrict themselves to "one hemina" of wine per day (about half a litre of wine with a lower alcohol content than is usual today). In modern times, guidelines for low-risk drinking have been published by different authorities in a number of countries and make a variety of recommendations. There is some evidence of a trend towards lower recommended limits over time (National Health and Medical Research Council, 2008). In Canada, there has also been diversity in the levels recommended between provinces, perhaps reflecting different cultural attitudes towards alcohol. Appendix 2 provides a summary of guidelines that have been adopted in Ontario, British Columbia, Québec and the Atlantic provinces in recent years. It is hoped that the guidelines established in this document will be adopted by all Canadian jurisdictions and that they will be reviewed periodically as new evidence emerges.

Dr. Jürgen Rehm and his colleagues at the Centre for Addiction and Mental Health and the University of Toronto have developed a comprehensive database of studies published worldwide. This database provides quantified estimates of the risk of suffering a variety of illnesses and injuries with a known causal connection to alcohol consumption. Employing alcoholic drink sizes applicable to Canada (13.45 g of pure alcohol in a standard drink, see next section), this database was used to prepare estimates of daily levels of average alcohol intake for the risk of one of these outcomes in comparison to that of a lifetime abstainer. In order to assess the overall risk of experiencing increased risk of premature death as a consequence of alcohol consumption, recent published papers were identified that report comprehensive reviews or meta-analyses summarizing risk of death from all causes, again in comparison with lifetime abstainers.

The quality of science in this area is as yet far from perfect and hence there are several issues that come down to judgement and interpretation. In addition to presenting the latest and most relevant evidence to support recommendations on low-risk drinking, areas of potential bias both upward and downward in the data will be discussed. It is important that the reasons for the recommendations given here are made as transparent as possible.

Definitions of Key Terms Used in the Guidelines

Definitions of risk

Relative risk is the likelihood that an event will happen to a particular person in a particular situation in comparison with someone else. For example, the risk of premature death from a hemorrhagic stroke for a woman who regularly has four drinks per day is two times higher than for a woman who is a lifetime abstainer.

Absolute risk is the actual likelihood that an event will happen in a particular situation over a particular time. For example, the absolute risk of death from ischemic heart disease for the average Canadian up to the age of 70 years is a 1-in-13 likelihood.

The first aim of this document is to provide concise summaries of the evidence on how different levels of drinking are likely to impact on different aspects of health and safety. To evaluate the extent of risk posed by alcohol use, comprehensive reviews of published studies were examined that looked at how the risk of some health or social outcome changed at different levels of consumption. The risk of a particular outcome was compared wherever possible against the risk experienced by people who have never consumed alcohol in their lives. We refer to this as the ***relative risk*** of death, injury, illness or social harm. This is a different approach than was used in guidelines prepared for Australian audiences (National Health and Medical Research Council, 2008; Taylor et al, 2008), in which the ***absolute risk*** of such outcomes was considered and daily drinking levels were estimated that would increase lifetime risk of premature death, injury or illness by more than one percent. In the future, a consensus might be possible about what constitutes an acceptable level of absolute risk for a personal behaviour such as consuming alcohol (for a critique of the absolute risk approach, see Dawson, 2009). A main criterion used to develop the Canadian Guidelines was the level of average daily consumption that does not increase overall risk of premature mortality from *any cause* over a lifetime compared with a person who completely abstains from alcohol.

Definitions of a Canadian standard drink

These Guidelines refer to "standard drinks" of beer, wine, spirits and coolers that contain 17.05 ml or 13.45 g of pure alcohol. The following are roughly equal to one standard drink:

- 341 mL (12 oz.) bottle of 5% beer, cider or cooler
- 142 mL (5 oz.) glass of 12% wine
- 43 mL (1.5 oz.) shot of 40% spirits

Level of alcohol consumption is described in this document in terms of the number of Canadian ***standard drinks*** consumed in a day. These refer to quantities of different alcoholic beverages that all contain roughly the same amount of alcohol—about 13.45 g or 17.05 millilitres of pure alcohol (see below). In practice, there is much variation in the amount of alcohol that is served in different situations, both at home (Kerr et al, 2009) and on licensed premises (Kerr et al, 2008) because of both variations in serving size and alcoholic strength. As will be discussed later, this also partly contributes to underreporting of alcohol consumption when assessed by survey (Stockwell et al, 2008).

Definitions of health outcomes

Short-term or "acute" effects from drinking are associated with the 'dose' taken on one occasion and the degree of impairment.

Long-term or "chronic effects" from drinking are associated with the volume of alcohol consumed in the longer term and result from its effects mainly on the central nervous and digestive systems.

Mortality refers to fatal outcomes that may be caused by drinking.

Morbidity refers to non-fatal illnesses and injuries that may be caused by drinking.

All-cause mortality refers to death from all causes (i.e., not necessarily those with a proven causal association with drinking).

Lifetime abstainer is a person who has never had even one drink of alcohol.

Most of the scientific studies concerning risk from different drinking levels assess this against different kinds of health outcomes (i.e., different types of disease and injury). These can be broadly divided into studies that look at the link between drinking and different causes of death (***mortality*** studies) or the link between drinking and different causes of non-fatal injury or illness (***morbidity*** studies). In each case, mortality and morbidity outcomes can be further divided broadly into those that can be considered ***short-term or acute*** effects of drinking associated with intoxication (e.g., injuries, overdoses, acute illnesses) and ***long-term or chronic*** effects of drinking over many years (e.g., liver disease, certain cancers). A small number of studies have also tried to quantify the level of consumption at which social consequences of drinking are more likely to occur (e.g., relationship, work and legal problems). These also will be considered, though it is harder to quantify precise levels of drinking that increase risk of

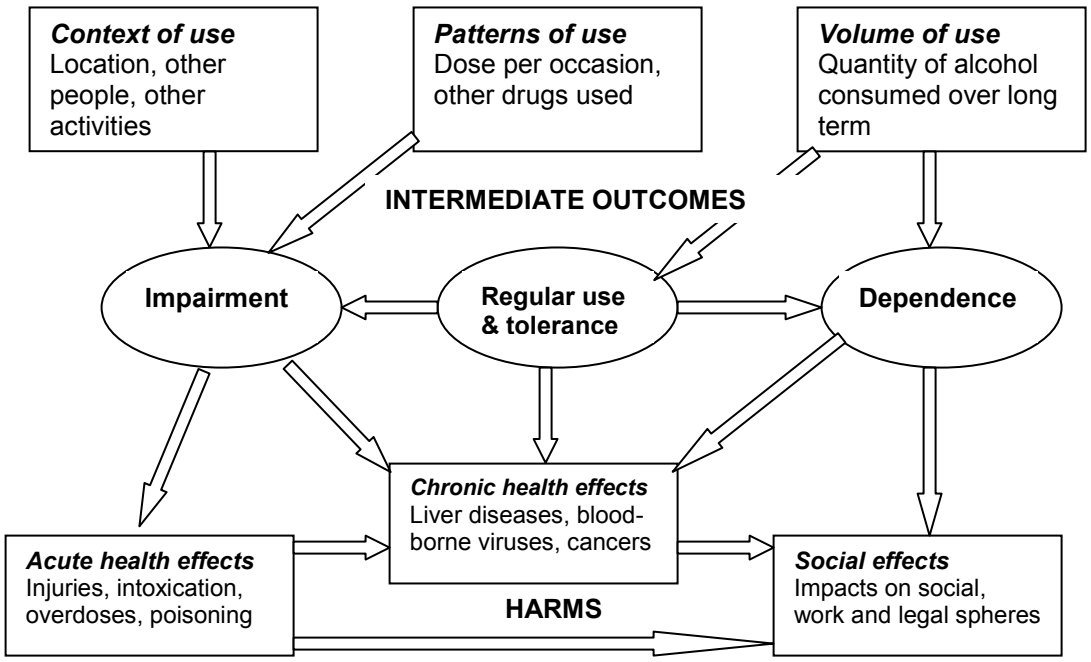
these outcomes because of the many other factors that bear upon the social consequences of drinking.

A key concept used in these Guidelines is that of ***all-cause mortality*** (i.e., death from all causes). Because the same level of drinking has been associated with both health benefits and harms for middle-aged and older adults, one way of assessing the balance between these is to assess risk of dying from any cause at each level of alcohol consumption. Most (but not all) studies of all-cause mortality find a 'J-shape' risk curve such that light and moderate drinkers have a lower risk of death than both lifetime abstainers and heavy drinkers, the latter being at the highest relative risk of death. These Guidelines will attempt to identify levels of alcohol consumption associated with the same risk of premature death as that of lifetime abstainers.

Drinking Patterns

The per capita consumption of alcohol in Canada has risen by 14 percent since 1996 and more quickly in some provinces than others (Statistics Canada, 2001, 2005 & 2009). Hidden behind these national statistics, however, are a wide variety of different individual patterns of drinking, each of which have different implications for the drinker's health and well being—both in the short- and long-term. Different people drink different amounts in different frequencies, with varying consequences for their health and safety. The amount drunk (or 'dose' consumed) on one drinking occasion will determine their subjective experience, physical reactions and how they behave, in accordance with blood alcohol concentration (BAC) achieved and individual tolerance to alcohol effects. For example, low doses may induce pleasant mood states while higher doses may sometimes result in drowsiness and depressed mood. Having many drinks on one occasion and getting 'drunk' can result in serious health problems such as gastrointestinal bleeding, abnormal heart functioning (arrhythmia), stroke (i.e., cerebrovascular accident) and respiratory depression, possibly leading to death. Furthermore, intoxication contributes to a host of social problems, including those affecting family well being, friendships and work. These relationships between different patterns and intensities of drinking and different health and social outcomes are illustrated in Figure 1 below.

Figure 1. Dimensions of alcohol use and related harms.



Moderate alcohol consumption appears to provide some protection against certain illnesses, including heart disease and diabetes, while also increasing risk of other serious diseases (Bagnardi et al, 2008; Di Castelnouvo et al, 2006; Djousse and Gaziano, 2008; Rehm et al, 2009; Standridge et al, 2004). As the amount of alcohol usually consumed in a day increases, so does the risk of a wide range of physical and mental illnesses, including a number of cancers, liver disease and depression (Rehm et al, in press). Sustained heavy drinking can also result in drinkers developing a degree of dependence on alcohol characterized by tolerance, withdrawal symptoms on waking and an impaired ability to control their drinking. Some harmful consequences from alcohol consumption are a product of both long-term and short-term drinking patterns. For example, the long-term consumption of alcohol is known to increase risk of depression (Rehm et al, in press), while intoxication from alcohol appears to increase the likelihood a depressed person will act on suicidal impulses (Sher, 2006).

A number of national surveys have been used to describe Canadian drinking patterns. Two particularly comprehensive surveys were carried out in 2004–2005: the Canadian Addiction Survey (CAS; Adlaf et al, 2005) and the GENACIS-Canada study, both of which included about 14,000 respondents (Paradis et al, 2010). More recently, the

Canadian Alcohol and Drug Use Monitoring Survey (CADUMS) was launched in 2008 to provide a continuous tracking of national consumption patterns (Health Canada, 2009). Such population surveys are valuable in comparing consumption patterns between different population groups, although reported levels of alcohol consumption tend to be underestimated. For example, analysis of the 2004 CAS found that respondents said they drank, on average, only a third of what would be expected from official alcohol sales data (Stockwell et al, 2009). Ideally, both sales and survey data need to be available to understand and interpret trends in overall levels and patterns of drinking. Despite this underreporting, 73.4 percent of the alcohol that was reported to have been consumed by the 2004 CAS sample in the previous week was drunk in excess of previous low-risk drinking guidelines—for 19–24-year olds, this figure was almost 90 percent. Based on their responses, 20.6 percent of respondents regularly placed themselves at risk of short-term harm, while 3.9 percent indicated that they exceeded guidelines for avoiding long-term health problems. Males in all age groups consumed more than females and, overall, the probability of being an elevated risk drinker declined with age. While a minority (10 percent) of respondents consumed more than 50 percent of total consumption, a majority of drinkers also occasionally drank to excess. Thus, many Canadians put themselves at increased risk of health and safety problems due to the volume and pattern of their alcohol consumption.

Over and above the amount of alcohol people consume, it is also important to take into account why, when, with whom and where drinking occurs (Demers et al, 2002; Kairouz et al, 2002; Kairouz & Greenfield, 2007). When people drink in bars, discos or taverns, for example, the probability of heavy drinking and related problems is generally higher than if drinking occurs in a restaurant or at home (Clapp et al, 2006; Cosper et al, 1987; Single & Wortley, 1993; Snow & Landrum, 1986). By contrast, light drinking with meals may be associated with improved cardiac functioning and reduced risk of heart attack (Giesbrecht et al, 2005).

An international project that examined gender differences and drinking patterns in different countries found three main patterns of drinking in Canada (Paradis et al, 2010). Drinkers in the Maritimes tend to drink more per occasion and men largely prefer beer. In the Prairies, people tend to drink smaller amounts, less frequently, less often with a meal and are more likely to favour spirits—a type of beverage that makes up a third of their

annual intake. Finally, in Québec, Ontario and British Columbia, those who consume alcohol have a more 'Mediterranean' style: they drink more often, drink wine more often, drink spirits less often and drink more often with a meal than do drinkers from other parts of Canada. Across all age and gender groups, there was a strong relationship between drinking frequency and drinking excessively (Paradis et al, 2009). For example, young men who drank at least five days a week were seven times more likely to report heavy drinking at least once a week than those who only drank once or twice a week. Daily, low-risk drinking is quite rare in Canada.

When Complete Abstinence is Usually Recommended

The Guidelines for Low-Risk Drinking are intended to provide those who drink with the information they require to minimize the risks associated with drinking alcoholic beverages. There are many who choose to abstain from alcohol for religious, cultural, spiritual, health or other reasons. These Guidelines respect those who choose to abstain and are not intended to encourage people who drink to increase their drinking or to encourage people who do not drink to begin drinking.

Alcohol use, pregnancy and breastfeeding

Animal research has been conducted suggesting that, small doses of alcohol can affect fetal brain development (Whitehall, 2007; Kraemer et al, 2008). However, for ethical and legal reasons, definitive human studies have not been conducted. Some studies conducted on children believed to have been exposed prenatally to **low** levels of alcohol have suggested cognitive impairment persisting even into adolescence (Day et al, 2001; Wilford et al, 2004; Wilford et al, 2006; Sood et al, 2001). However, collectively these studies have not been conclusive and there is no definitive knowledge of the precise level of alcohol intake associated with harm (Public Health Agency of Canada, 2006), nor the role of other relevant variables such as poor nutrition.

It has been shown that a pregnant woman who reports having consumed 7–14 drinks per week is more likely to have a baby with birth defects or complications, and that drinking five or more drinks per occasion places the fetus at greatest risk of Fetal Alcohol Spectrum Disorder (FASD) or Fetal Alcohol Syndrome (FAS) (U.S. Department of Health and Human Services, 2005; O'Leary et al, 2010). Comprehensive reviews of the relevant literature on maternal drinking and birth defects, however, find no consistent evidence of

damage at lower levels of consumption (Holman et al, 1996; Henderson et al, 2007; Royal College of Obstetricians and Gynaecologists, 2006; Testa et al, 2003). A recent well-designed prospective study found no evidence of measurable developmental impairment in children at age 2 years whose mothers reported consuming no more than 20 g per day (1.5 Canadian standard drinks) and less than 70 g per week (less than 5 Canadian standard drinks) during gestation (O'Leary et al, 2010). However, given the low threshold at which risk has been established in some studies, the potential for misunderstanding drink sizes and the possibility of harm to the unborn child from even light drinking, the safest course of action for a pregnant woman or someone planning to become pregnant is to avoid alcohol completely.

Another reason for treating this literature circumspectly and applying the precautionary principle is that two of the meta-analyses cited above (Holman et al, 1996; Testa et al, 2003) identify significant "protective effects" for infant health associated with light drinking by the mother. For reasons discussed more fully in relation to protection against heart disease and reduced all-cause mortality associated with ‘moderate’ drinking, such findings need to be treated with a healthy dose of skepticism (Chikritzhs et al, 2009) because of evidence for bias in studies that use an ill-defined group of abstainers as the reference point. Evidence has mounted that failure to remove people from this reference group who had given up or greatly reduced their drinking due to ill health can exaggerate the extent of health benefits (Fillmore et al 2006; Stockwell et al, 2007). This issue has not to our knowledge been addressed in the literature on alcohol and pregnancy and therefore leaves open the possibility that risks to the unborn child from low-level maternal drinking have been underestimated in the published studies.

As with the unborn infant, there are also reasons to be concerned about the vulnerability of newborns to exposure to alcohol in breast milk. Newborns have a rapidly developing central nervous system and an underdeveloped ability to metabolize alcohol. There is, however, only limited research on the effects of alcohol during breastfeeding. One systematic review (Giglia & Binns, 2006) identified potential impacts on the process of breastfeeding, sleeping patterns and behaviour of the infant due to alcohol being present in the mother's milk. The authors sensibly recommend abstaining before breastfeeding and, if necessary, storing breast milk if planning to drink at levels that would result in alcohol still being present at the next feed.

Alcohol and driving

Driving a motor vehicle is a complex task that requires a variety of perceptual, cognitive and motor skills, all of which must be coordinated. Alcohol interferes with and reduces the ability to perform these skills and abilities. The extent of the resulting impairment—and the risk of traffic crash—increases as greater quantities of alcohol are consumed and BAC rises (Blomberg et al, 2009). Higher-order cognitive functions such as decision making and divided attention can be affected at very low BACs, usually long before the drinker is aware of them (Moskowitz & Fiorentino 2000). Hence, we recommend the safest course of action is to avoid alcohol completely before operating any type of vehicle, including passenger vehicles, snowmobiles, ATVs, boats and bicycles.

The Criminal Code of Canada states it is an offence to operate a motor vehicle while impaired or with a BAC in excess of 80 mg of alcohol per 100 ml of blood. Depending on sex, weight, amount of food consumed and a variety of other factors, consuming the number of drinks per day stated in these Guidelines should keep most people below this limit. However, some people may be impaired at BACs well below this limit and should reduce the amount of alcohol consumed. In fact, most provinces enforce a lower BAC limit (usually 50 or 40 mg of alcohol per 100 mL of blood) and issue licence suspensions to drivers found exceeding these limits. Even drinking within the Guidelines can put one over these lower provincial BAC limits and at risk of police action—and crash involvement. As it is extremely difficult for individuals to determine their own BAC, it is recommended that alcohol be avoided completely before operating any type of vehicle. If an individual is going to be consuming any alcohol, it is recommended that they plan ahead for safe transportation before drinking commences (e.g., a designated driver who has not been drinking, a taxi, public transportation).

Alcohol use and youth

Canada's National Youth Council defines “youth” as those who are 15–24 years of age. Teenagers and young adults within this age group are especially likely to display hazardous patterns of drinking and to experience injuries and social harms (Murray et al, 2009; Stockwell et al, 2009). Many studies have compared risk of injury for a given dose of alcohol by age among persons attending an emergency room and the great majority indicate highly significant increased relative risks of persons under 25 years of age (Macleod et al, 1999) and under 29 years of age (Borges et al, 2006; Macdonald et al,

2004) compared with older people. Evidence suggests that neurological and developmental problems are associated with use even in the late teenage years. Recent discoveries in pediatric neuropsychology reveal that adolescence is a period where major transformations—and even reconfiguration of the brain—occur, and studies have revealed vulnerability to alcohol in the developing brain (Clark et al, 2008; Lubman et al, 2008; Newbury-Birch et al, 2009). However, Dahl (2004) suggests that risk taking, sensation seeking and strong emotions are biologically linked with puberty, and thus drinking by young people may be a response to the emergence of these developmental issues. While those aged 19–24 are legally entitled to purchase and consume alcohol in Canadian provinces (and also those aged 18 in Alberta, Québec and Manitoba), there is no such neat division by age for the associated developmental and behavioural risks—nor with actual drinking behaviour. These Guidelines do not support underage youth from drinking alcohol, but recognize this is a common behaviour in Canada (Stewart et al, 2009) and that there is an urgent need to reduce hazardous drinking and harm in this age group.

It is recommended that initiation of alcohol use be delayed for as long as possible amongst young people. Moreover, the introduction to alcohol should ideally occur in a way that is consistent with local drinking age laws, within a safe environment and with parental guidance. If young people decide to drink, it is recommended that they have no more than two drinks no more than once a week, in order to minimize the risk of harmful consequences. These levels are consistent with the results of a study of Canadian adolescents examining quantity and frequency of alcohol consumption as predictors of acute harm (Murray et al, 2009), and of a study of U.S. college students that sought to identify thresholds at which risk of acute and social harms significantly increased (Gruenewald et al, 2010). It is especially important that teenagers and young adults avoid alcohol completely before operating any vehicle or engaging in activities with a physical risk that require coordination and judgement. Young drivers in most Canadian provinces are restricted to a zero BAC (at least for their first year of driving).

Other high-risk activities

Alcohol is most safely and enjoyably consumed when mental, physical and social demands on the drinker are at a minimum.

Acute physiological consequences of alcohol use are largely the result of alcohol's effects upon the central nervous system, particularly in its slowing of cognitive and motor functions (Hernandez et al, 2007), decreasing motor coordination and compromising alertness (Tiplady et al, 2001). Therefore, it is recommended that alcohol not be used prior to operating any machinery such as motorized vehicles, boats, tools or equipment of any kind. Also, people should not use alcohol prior to engaging in activities that demand judgment, physical skill, balance and endurance, or where injuries are likely (this would include most sports). There is evidence of significantly reduced alertness after drinking, even when blood alcohol levels have returned to zero (Barrett et al, 2004).

Because of the psychopharmacology of alcohol, its use is best restricted to those times when people's attention to obligations is less important. Alcohol use during times when people are fulfilling their obligations (e.g., household tasks, employment, the care of others) can compromise the quality of the activities and the safety of the situation.

Alcohol use and medication

Alcohol is contra-indicated for many medications. The combination of alcohol and medication creates pharmacological interactions that may be extremely dangerous and even deadly (Ben Amar, 2007). It has been estimated that alcohol-medication interactions may be a factor in at least 25 percent of all emergency room admissions in the United States (Holder, 1992). Alcohol can heighten the sedative effect of medications such as barbiturates (Forney & Hughes, 1964), benzodiazepines (Girre et al, 1988) or antihistamines (Seppala et al, 1979). Such combinations can severely depress the central nervous system, with consequences ranging from confusion to unconsciousness and even death. Examples of medications that can cause potentially serious physical or psychological problems when combined with alcohol are those used for the treatment of rheumatism, arthritis, pain relief, infections, depression, epilepsy and high blood pressure.

With most medications, there is the potential for some complications when they are combined with alcohol. Alcohol can also make medications less effective or interfere with their elimination from the body, rendering therapeutic effects uncertain or overly strong (Lieber, 1992). Among other factors, alcohol and drug interactions depend on the mix itself, the dose, how it is administered and the order in which the substances are taken,

as well as the person's age, sex, weight, nutritional condition, physical health and psychological state. Because of this uncertainty, anyone who receives a prescription and considers drinking should always check for warnings on the packaging and/or with their physician or pharmacist to see whether alcohol is contra-indicated. These issues are especially pertinent to persons aged 65 years and older, many of whom receive multiple prescriptions and for whom the effectiveness of medication is especially critical. In addition, the risk of accidental falls in this age group is pronounced whether from just alcohol (Mäkelä, 1998) or alcohol in combination with medication or other psychoactive substances (Weathermon & Crabb, 1998).

Alcohol use and other psychoactive substances

There is an increasing trend, especially among younger people, towards the combined use of alcohol with other psychoactive substances, both legal and illegal (Barrett et al, 2006). In many cases these present special risks, sometimes of serious and potentially fatal complications.

An emerging pattern of problematic substance use is the combined use of alcohol with stimulants such as tobacco, caffeine and energy drinks. These combinations can have both acute and chronic health and safety effects. There is also a long-standing tradition of drinking coffee to offset the depressant effects of alcohol, although the amount of coffee consumed has no effect on BAC (Liguori & Robinson, 2001). In recent years, high-caffeine energy drinks have become extremely popular, especially among young people (Simon & Mosher, 2007). It has been reported that people who mix alcohol with energy drinks tend to ingest more alcohol, more quickly and are more likely to become impaired (Ferreira et al, 2006; O'Brien et al, 2007). Moreover, research shows that those who combine alcohol and energy drinks are impaired even though the stimulant effect of the energy drinks masks some of the subjective aspects of intoxication (Marcinski & Fillmore, 2006; O'Brien et al, 2007). Therefore, the normal self-regulating mechanisms associated with drinking are no longer operational.

Cocaine appears to be used in a similar way in order to maintain energy levels, reduce feelings of excessive intoxication or incoherence, and even to attempt to sober up before driving (Brache et al, 2009). There are a number of significant risks from combining alcohol with cocaine. When alcohol is mixed with cocaine, it spreads throughout the body and reaches the brain more quickly, significantly increasing a person's BAC.

Moreover, the combined use of cocaine with alcohol appears to enable the drinker to keep drinking for longer, thus increasing risks of both acute and chronic effects and possibly dependence (Brache et al, 2009). This is likely also the case with other stimulant drugs such as amphetamines. Mixing alcohol with sedatives or opioid drugs such as heroin can severely depress the nervous system, with consequences ranging from confusion to unconsciousness to death (Coffin et al, 2003). The drug gamma hydroxybutyrate (GHB) has become popular among some young people in Canada, especially nightclub and dance party attendees (Duff et al, 2009). It has potentially dangerous sedative effects that are exacerbated when used with alcohol. Marijuana is another drug whose sedative effect is enhanced when it is mixed with alcohol. Research has shown this particular type of combination may be associated with an increased risk of motor vehicle crashes (Ramaekers et al, 2000; Ramaekers et al, 2004).

Alcohol dependence

Regular and sustained drinking above levels recommended in these Guidelines will usually be associated with some degree of alcohol dependence and carries the risk of developing a severe degree of dependence commonly referred to as ‘alcoholism’ or ‘addiction’. ’Alcohol dependence syndrome’ is defined in the International Classification of Diseases, Version 10 (WHO, 1992), as:

> *A cluster of physiological, behavioural and cognitive phenomena in which the use of alcohol takes on a much higher priority for a given individual than other behaviours that once had greater value. A central descriptive characteristic of the dependence syndrome is the desire (often strong, sometimes overpowering) to take alcohol. There may be evidence that return to alcohol use after a period of abstinence leads to a more rapid reappearance of other features of the syndrome than occurs with nondependent individuals.*

Diagnostic signs of alcohol dependence syndrome (e.g. increased tolerance, impaired control over drinking, psychophysiological signs of withdrawal after a bout of heavy drinking) can occur at mild, moderate as well as severe levels (Skinner & Allan, 1982; Stockwell et al, 1994). When an individual has become severely dependent on alcohol, complete abstinence is generally considered an essential first step of any effective treatment program (Rosenberg, 1993). Individuals who are early-stage problem drinkers and have only mild to moderate degrees of dependence may be able to return to

controlled drinking, sometimes after a period of abstinence (Heather, 2001; Rosenberg & Melville, 2005).

Individuals vary in their susceptibility to the development of alcohol dependence and there is strong evidence of genetic, personality and family background factors that can increase risk of this outcome (Janowsky et al, 1999; Dick & Bierut, 2006). It is especially important that susceptible individuals do not exceed drinking guideline levels or initiate drinking during adolescence as there is strong evidence that an early age of onset of drinking predisposes to later problems with alcohol abuse and dependence (Baumeister & Tossmann, 2005).

Harms and Benefits of Alcohol Use

Statistics on harms caused by alcohol use suggest that many are concentrated in the younger ages, especially those related to injury and acute illness. As with older drinkers, younger people often seek to feel enhanced sociability from drinking, which typically accompanies leisure pursuits with peers (Kuntsche et al. 2005). However, health benefits associated with low-risk drinking are mostly relevant from middle age onwards (i.e., when risk of cardiac illness becomes significant). The amounts teenagers and young adults often consume are mostly far in excess of recommended upper limits in drinking guidelines (Stockwell et al, 2009; Adlaf et al, 2005), and during the lives of many young people such a pattern of drinking may result in negative consequences such as physical or verbal fights, accidents, memory loss (Stewart et al, 2009; Adlaf et al, 2005) and poisoning (Ramsted, 2002; Yoon et al, 2003). Alcoholic poisoning is a potentially serious condition causing a number of hospitalizations and some deaths in Canada each year. Symptoms may start with confusion, shallow breathing and extreme unsteadiness leading to loss of consciousness. While they by no means disappear, the incidence of these kinds of risks decreases with age, perhaps reflecting factors such as a reduced propensity to take risks and to mix socially in bars and clubs.

From 45 years of age and onwards, both benefits and harms can accrue from moderate drinking (Lapidus et al, 2005; Carlsson et al, 2005; Peterson et al, 2008), while heavier drinking remains risky (Di Castelnouvo et al, 2006). Cancers and diseases of the heart are the top two leading causes of death, being responsible for more than half (52.4 percent) of all deaths in Canada in 2004 (Statistics Canada, 2009). According to the

authors of *The Cost of Substance Abuse in Canada* (Rehm et al, 2006a, Table I-A-1), an estimated 1,828 deaths from cancer (as well as several thousand other causes of death) could be attributed to alcohol use in 2002, while alcohol prevented an estimated 2,589 cardiovascular deaths.

Clearly, and as far as diseases in later life go, the story of alcohol has two sides: alcohol use can be toxic and yet at the same time may possibly improve health and add years to life itself. Both the protective and the disease-causing activities of alcohol potentially impact on the same sector of the population and at similar levels of consumption: men and women beginning in their fifth decade of life. Therefore, if advice about alcohol use is to be evidence-based, it needs to take into account the conditions and the complexities of its effects (Rehm et al, in press). The following discussions will attempt to summarize and quantify the risks and benefits of drinking and to estimate a point at which, for the average person, the probabilities of these largely balance each other out over the life course.

Alcohol Consumption and the Risk of Serious Medical Conditions

Tables 1, 2 and 3 below present estimated increases or decreases in the risk of an individual suffering from one of a number of alcohol-related illnesses, as a function of how many drinks a person consumes on average per day (Rehm et al, commissioned report for the expert working group; Rehm et al, 2003a; Rehm et al, 2006b). Appendix 3 provides some details of the meta-analysis of a number of good-quality studies upon which these estimates are based. These are not the only types of serious medical conditions causally linked to alcohol use, but are selected as having well-established causal connections with drinking and sufficient literature to estimate changes in risk with increasing consumption of alcohol.

Other conditions that are wholly caused by alcohol, but for which it is not at present possible to plot risk changes with consumption, include the following:

- alcohol dependence syndrome
- alcoholic psychosis
- nervous system degeneration due to alcohol
- alcoholic polyneuropathy, myopathy and cardiomyopathy

- alcoholic gastritis
- alcoholic liver diseases and hepatitis
- alcohol-induced pancreatitis
- fetus and newborn affected by maternal alcohol use
- fetal alcohol syndrome
- alcohol toxicity and poisoning

Table 1. Percentage change in long-term relative risk by average standard drinks per day for 12 illnesses that are similar for men and women aged below 70 years.

Type of Illness or Disease	Proportion of All Deaths, 2002–2005	Percentage Increase/Decrease in Risk Zero or Decreased Risk: 0% / -1 to -24% / -25% to -50% Increased Risk: Up to +49% / +50 to 99% / +100 to 199% / Over +200%				
		1 Drink	2 Drinks	3–4 Drinks	5–6 Drinks	+ 6 Drinks
Tuberculosis	1 in 2,500	0	0	+194	+194	+194
Oral cavity & pharynx cancer	1 in 200	+42	+96	+197	+368	+697
Oral esophagus cancer	1 in 150	+20	+43	+87	+164	+367
Colon cancer	1 in 40	+3	+5	+9	+15	+26
Rectum cancer	1 in 200	+5	+10	+18	+30	+53
Liver cancer	1 in 200	+10	+21	+38	+60	+99
Larynx cancer	1 in 500	+21	+47	+95	+181	+399
Ischemic heart disease	1 in 13	-19	-19	-14	0	+31
Epilepsy	1 in 1,000	+19	+41	+81	+152	+353
Dysrythmias	1 in 250	+8	+17	+32	+54	+102
Pancreatitis	1 in 750	+3	+12	+41	+133	+851
Low birth weight	1 in 1,000	0	+29	+84	+207	+685

Table 1 summarizes risk relationships that apply equally for both men and women under 70 years of age for 12 serious illnesses, including seven types of cancer. A ‘threshold’ effect (i.e., increased risk was only apparent above a particular threshold, such as 3–4 Canadian standard drinks) was only found for tuberculosis (Rehm et al, 2009). For nine conditions, significantly increased risk (up to a 42 percent increase) was apparent at just one drink per day, which progressively increased with increasing consumption. For ischemic heart disease, there was significantly reduced risk estimated up to 3–4 drinks per day, with zero risk at 5–to 6 drinks per day and increased risk thereafter (i.e. an example of the J-shape risk curve).

The beneficial effects mainly result in delaying death from heart disease or of stroke for older people, especially those 70 years of age or older. For this reason, when older age groups are included in these estimates, the extent of protection appears greater. In addition, detrimental effects specifically associated with alcohol appear to decrease when older groups are included—with advancing age, differences in all relative risk estimates decrease towards 1.0 or zero difference as the term of life nears its end (Rehm et al, commissioned report for the expert working group). Another reason for presenting data specifically for deaths below 70 years of age is that precise cause of death becomes increasingly unreliable in mortality statistics with older age. As outlined elsewhere in these Guidelines, this group should also be more (rather than less) cautious about their alcohol use due to a range of other risk factors (NIAAA, 1998).

Table 2. Percentage change in long-term relative risk by average standard drinks per day for five illnesses for men aged below 70 years.

Type of Illness or Disease	Proportion of All Deaths, 2002–2005	Percentage Increase/Decrease in Risk Zero or Decreased Risk: 0%; -1 to -24%; -25% to -50% Increased Risk: Up to +49%; +50 to 99%; +100 to 199%; Over +200%				
		1 Drink	2 Drinks	3–4 Drinks	5–6 Drinks	+ 6 Drinks
Hemorrhagic stroke (morbidity)	-	+11	+23	+44	+78	+156
Hemorrhagic stroke (mortality)	1 in 30	+10	+21	+39	+68	+133
Ischemic stroke (morbidity)	-	-13	0	0	+25	+63
Ischemic stroke (mortality)	1 in 80	-13	0	+8	+29	+70
Diabetes mellitus	1 in 30	-12	0	0	0	+72
Hypertension	1 in 150	+13	+28	+54	+97	+203
Liver cirrhosis (morbidity)*	-	0*	0*	+33	+109	+242
Liver cirrhosis (mortality)	1 in 90	+26	+59	+124	+254	+691

* Note: Rehm and colleagues (in press, b) estimate *reduced* risk of liver cirrhosis morbidity at these levels of consumption (at one or two drinks per day). Given that there is no known biological reason for such a result, the relative risk has been artificially put at zero.

Table 3. Percentage change in long-term relative risk by average standard drinks per day for five illnesses for women aged below 70 years.

Type of Illness or Disease	Proportion of All Deaths, 2002–2005	Percentage Increase/Decrease in Risk Zero or Decreased Risk: 0% / -1 to -24% / -25% to -50% Increased Risk: Up to +49% / +50 to 99% / +100 to 199% / Over +200%				
		1 Drink	2 Drinks	3–4 Drinks	5–6 Drinks	+ 6 Drinks
Breast cancer	1 in 45	+13	+27	+52	+93	+193
Hemorrhagic stroke (morbidity)	-	-29	0	0	+78	+249
Hemorrhagic stroke (mortality)	1 in 20	+22	+49	+101	+199	+502
Ischemic stroke (morbidity)	-	-18	-13	0	+31	+121
Ischemic stroke (mortality)	1 in 65	-34	-25	0	+86	+497
Diabetes mellitus	1 in 30	-36	-40	0	+739	+1560
Hypertension	1 in 85	0	+48	+161	+417	+1414
Liver cirrhosis (morbidity)	-	+21	+70	+125	+182	+260
Liver cirrhosis (mortality)	1 in 160	+139	+242	+408	+666	+1251

Tables 2 and 3 present separate risk estimates for males and females for conditions where these are significantly different. In general, these estimates imply greater benefits being experienced by women at lower levels of consumption for some conditions (hemorrhagic and ischemic stroke, diabetes) but more rapidly escalating risk with increased consumption. At even one drink per day on average, it is estimated that a woman's risk of getting liver cirrhosis increases by 139 percent (26 percent for males).

It is important to note that risk levels from drinking for the illnesses specified above are also significant for persons aged over 70 years of age, with similar patterns of protection and increased risk.

Each cause of death in the above tables is reported in the second column as a proportion of total deaths for four years from 2002–2005, using Statistics Canada data. With the exception of hemorrhagic stroke and breast cancer, it is apparent that the beneficial effects estimated for low levels of intake tend to impact on more common causes of death (e.g., diabetes, ischemic stroke, ischemic heart disease). There are more conditions for which even light drinking has detrimental effects, but many of these are quite rare. The next section considers one approach to balancing these competing positive and negative consequences.

All-Cause Mortality Studies: Balancing the Risks and Benefits of Drinking

It is quickly apparent from the estimates in the above tables that the risk of serious illnesses begins to increase from an average of one drink per day. It is also the case that there are several serious illnesses for which lower levels of consumption appear to be protective. One way of estimating the point at which the potential risks and benefits balance each other out is to examine how risk of death from all causes (all-cause mortality) is related to usual daily alcohol consumption. Four relatively high-quality meta-analyses of all-cause mortality related to average daily alcohol consumption were identified; the results are shown below in Table 4. These results are expressed in terms of approximate numbers of Canadian standard drinks at which different threshold risks are achieved. These meta-analyses suggest that: (i) the likelihood of experiencing the health benefits of drinking are apparent at very low levels (between a half and one drink on average per day); (ii) a level of zero net risk (i.e., where risks and benefits roughly cancel out) occurs between 1.5–2.5 standard drinks for women and between 2–3 standard drinks for men; and (iii) evidence of a significantly increased risk compared with a lifetime abstainer was between 2–4 drinks for women and 3–5 drinks for men.

It is important to emphasize once more that health benefits are only relevant from middle age onwards and that the only zero-risk consumption level for younger people is abstinence, as they have no established health benefits to cancel out the well-established health risks.

Table 4. Risk thresholds in Canadian standard drinks estimated for men and women compared with lifetime abstainers.

All-Cause Mortality Analysis	Number of Studies Included	Number of Standard Drinks for Benefit/Risk Threshold					
		Women			Men		
		Maximum Benefits	Zero Net Risk	Increased Risk	Maximum Benefits	Zero Net Risk	Increased Risk
English et al, 1995	16	0.5	1.5	2	1	2	3
Rehm et al, 2001	37	1	1.5	3	1	2.5	4
Bagnardi et al, 2004	29	0.5	2.5	[4]*	0.5	3	[5]*
Di Castelnouvo et al, 2006	34	0.5	2	[3]*	0.5	3	[4]*

* Estimated from risk curves presented in original papers but not statistically evaluated.

In the past five years, an emerging issue in alcohol epidemiology has been the importance of developing a precise definition of what constitutes a 'lifetime abstainer'. Evidence has been presented that many prospective studies of alcohol use and health outcomes fail to exclude both ex-drinkers and occasional drinkers from this category and, as a consequence, exaggerate the beneficial effects of drinking (Fillmore et al, 2006). The two more recent meta-analyses cited in Table 4 (Bagnardi et al, 2004; Di Castelnouvo et al, 2006) attempted to control for this effect (to differing degrees) but, nonetheless, still include a number of studies that will have failed in this regard. The meta-analysis conducted by Rehm and colleagues (2001) controlled for the 'ex-drinker effect' by comparing studies that either did or did not remove this category of drinker from the reference group of abstainers, and reported much lower estimates of benefits from the better-designed studies. Debate continues upon this and other questions regarding lifestyle factors that may confound the relationship between moderate alcohol use and heart disease (Naimi et al, 2005; Chikritzhs et al, 2009). Currently, studies conducted by and colleagues and Fillmore and colleagues are the only ones claiming to have presented results using only studies that excluded former drinkers and occasional drinkers from the comparison group of abstainers. As shown in the Table 4, this results in an estimate of two Canadian standard drinks on average per day for women and three for men associated with zero net risk of premature mortality due to alcohol.

The risk curves estimated at different levels of consumption by Di Castelnouvo et al (2006) are reproduced in Appendix 4. Important features of these estimates are that: (i) the point at which zero net risk occurs is at a lower level of consumption when former and occasional drinkers are mostly excluded (Panel A); (ii) more recent studies provide lower estimates of the point (Panel C); and (iii) studies with longer follow-up that include more older people estimate greater beneficial effects of low-level drinking (Panel D). As will be discussed later, other evidence suggests the advisability of at least two days abstinence per week for most people who consume alcohol to reduce risk of health problems and dependence.

Alcohol Consumption and Risk of Injury and Acute Illnesses

Emergency room (ER) studies have commonly been used to estimate the increased risk of acute consequences from drinking in a period of time before the injury event, usually

six hours. To estimate the risk, it is necessary to have control comparisons involving no alcohol consumption in this period.

One method (hospital case control) uses sick patients attending the ER for reasons other than an injury. These studies may underestimate risk because some of the sick patients will also have attended for alcohol-related reasons.

Another method involves using injured patients as their own control by asking about their alcohol consumption either in a six-hour period on another day or their usual consumption. This method can result in overestimates of relative risk from drinking for several reasons, including the fact that people can remember their drinking immediately before the injury event better than they can estimate their usual or past drinking (Gmel et al, 2007).

A final method (population case control) involves comparing persons presenting to the ER with an injury with individuals drawn from the surrounding general population; comparatively few such studies have been performed. There are a number of other differences between these studies in terms of whether they control for such important confounding variables as other substance use and the context in which the drinking occurred (e.g., setting and accompanying activity).

A recent meta-analysis was performed of 28 studies identified in a systematic review that met some basic quality criteria (Taylor et al, in press). Results are presented in the table below indicating overall increases in risk estimated for each Canadian standard drink consumed in a three-hour period for motor and non-motor vehicle injuries. All increases in risk above zero reported here were statistically significant, though some have wide confidence intervals. Only studies with a controlled design were included (i.e., case-control, case-crossover or population case-control studies). It is likely that underreporting of alcohol use by subjects, especially when involved in motor vehicle incidents, biases these estimated risks upwards.

Table 5. Relative risks by number of Canadian standard drinks consumed three hours before an injury. (Taylor et al, in press)

Canadian Standard Drinks	Motor Vehicle Injuries	Non-motor Vehicle Injuries
	Increase in risk (%)	Increase in risk (%)
0	0	0
1	57	40
2	145	92
3	283	162
4	500	256
5	838	384
6	1,369	557
7	2,198	790
8	3,496	1,107
9	5,528	1,534

It is clear that for both kinds of injury, starting at just one drink over a three-hour period, the estimated risk of injury is large and accelerates with each additional drink. The increase in risk and extent of acceleration is particularly sharp for motor vehicle injuries. It is important to note, however, that the majority of these emergency room studies failed to control for drinking context in their analysis. The risk levels reported here cannot be specifically and uniquely linked to alcohol consumption because many of the cases were also engaged in high-risk activities. Thus, it is impossible to separate risk of drinking from the context (i.e., the setting and activity) in which the drinking takes place.

Two of the studies included that looked at all types of injury outcomes (Watt et al, 2004; Stockwell et al, 2002) did attempt to control for the setting (e.g., licensed premises, workplace, physical recreation venue, home) in which the drinking and injury occurred, as well as associated activities (e.g., travelling, working, playing sports). These studies also attempted to control for the simultaneous use of other substances (e.g., cannabis, psychostimulants, prescribed medication). One study (Stockwell et al, 2002) also had the advantage of using a population-based set of control subjects who were interviewed about their substance use and activities for the same period as their matched cases who presented to the emergency room with an injury. This study found that risk of injury increased to a significant level only when the equivalent of four Canadian standard drinks was consumed in the six-hour period before the injury event, with significantly lower risk for males than females at each level of consumption. The other study (Watt et al, 2004) reported very small (1.9 percent) and non-significant increases in risk of injury

for males for each 10 g increment of ethanol consumption when drinking location, illegal substance use, and usual drinking and risk-taking personality characteristics were controlled. (Much larger—but also non-significant—effects were calculated for women.) Most of the results in the study conducted by Watt and colleagues, however, were for males and females combined, which resulted in significant overall increases in risk of injury from alcohol consumption within the present recommended guideline levels, though at a substantially lower level than that estimated in Table 5 above.

Dawson (2009) noted that most studies that examined this issue from the point of view of relative rather than absolute risk also conclude that women have greater risk of injury for a given level of alcohol consumption. An additional systematic review (Stockwell & Greer, unpublished), which identified a total of 17-case control studies looking at risk of injury, was conducted specifically to inform these Guidelines. While 11 found no significant difference between males and females, six such studies found that women tended to have a higher risk of injury at any given level of consumption. A further finding from the systematic review was that teenagers and young adult drinkers tended to have significantly higher levels of risk than those aged 25–30 years and older. At the other end of the age spectrum, alcohol with or without other substance use contributes to falls in persons aged over 60 years of age (Makela, 1998). There is additional concern in relation to this age group with evidence of lower tolerance to the effects of alcohol (NIAAA), which may also be linked to increased use of medication among older people (Aira et al, 2005).

Alcohol Consumption and Risk of Social Harm

Alcohol consumption is not only linked to acute and chronic diseases but is also connected with consequences in the social realm. Although the epidemiological evidence on the extent of alcohol's role in social harm is weak (Babor et al, 2010), various types of harm are recognized to be positively associated with drinking. Commonly reported categories of alcohol-related social harm include physical and sexual violence, vandalism, public disorder, family and interpersonal problems, financial problems, unwanted sex, and work and school-related problems (Room et al, 1995; Midanik & Greenfield, 2000), with levels of risk rising with increased consumption.

Over and above alcohol use, whether or not a person will experience social harm

depends not only on individual vulnerability, but also on their social circumstances (e.g., occupation, marital status). Clearly only those who have a spouse or partner can experience partner violence, only those who are employed can experience work-related problems, and only those who drive can receive a drink-driving charge. People who have suffered from severe alcohol-related problems for a number of years may no longer have a job, significant relationship or drive a car, and hence would not be as likely to report problems in these domains.

It is also well documented that the general context in which drinking occurs will influence the relationship between alcohol consumption and social harm. Social harm is usually contingent upon a combination of relational, locational, circumstantial and temporal characteristics (Simpura, 1991; Nyaronga et al, 2009). For example, studies have shown that bar and club characteristics are significant risk factors for physical and sexual assault (Schnitzer et al, 2009; Graham et al, 2006a). As drinking is a complex socio-cultural phenomenon, its consequences are mediated not just by pharmacological factors, but also by cultural factors such as beliefs about the effects of drinking (SIRC, 2000). One classic anthropological study of behaviour while drinking in different societies (MacAndrew & Edgerton, 1969) demonstrated how cultural norms and expectations make a crucial difference to their "drunken comportment". Some commentators have even suggested that these societal beliefs are more important than any pharmacological effects of ethanol in determining violent behaviour (Heath, 1998). More comprehensive reviews of the literature (Graham, 2001; Graham & Homel, 2008) suggest independent (though situation-specific) effects of alcohol in the causation of violence. Emergency room studies (Macdonald et al, 2006) as well as observational studies of drinking and violence in bars both suggest that risk of violence increases with increasing levels of intoxication, though this levels out at higher levels of consumption (Graham et al, 2006b). All in all, researchers agree that evaluating the association between alcohol consumption and social harm is difficult given that drinking's effects depend on a multitude of factors on various analytical levels (Babor et al, 2010).

Epidemiologists tend to agree that the risk for social harm increases proportionally with a person's BAC, while others also point out that the frequency of risky drinking is an important factor to consider. Regardless of sociodemographic variables and overall alcohol use, the likelihood for social harm increases with the frequency of heavy drinking

(Demers & Quesnel-Vallée, 1999). Recently, Dawson and colleagues (2008) analyzed a large U.S. national alcohol survey and found that frequency of drinking five or more standard drinks per day was a strong predictor of violent behavior, driving licence revocation, spousal abuse, divorce/separation, and work and school problems.

Very few studies have systematically examined the risk of acute harms occurring as a direct function of the number of drinks consumed. One notable exception is a study of patterns and levels of drinking by U.S. college students (Gruenewald et al, 2010), which used a sophisticated mathematical modelling approach to identify changing risk of harmful outcomes as a function of quantity consumed on one occasion. Clear threshold effects were identified for this relatively young group at two drinks for females and three drinks for males. Greenfield and Rogers (1999) also report that the great bulk of self-reported incidents of driving while under the influence of alcohol involved similarly low consumption levels in a U.S. national survey. In other words, females and males who had consumed two and three drinks, respectively, recognized that they were driving while intoxicated.

Limits for Daily Low-Risk Consumption: Issues to Consider

Many examples of low-risk drinking guidelines provide separate advice in relation to average daily consumption and upper limits on an occasional day. For example, Australia's National Health and Medical Research Council (2008) recently recommended daily limits for average consumption of 20 g of ethanol (approximately 1.5 Canadian standard drinks) and up to 40 g of ethanol (approximately three Canadian standard drinks) on occasional days. There are several relevant considerations:

- Risk of injury increases with each additional drink consumed in many contexts. However, if drinking is strictly limited to relatively low-risk environments, if safe transport is arranged, if consumption is paced carefully and if other precautions are made, then some of this risk can be reduced.
- The zero-net-risk levels of consumption estimated above in relation to *all causes* of death (two drinks per day for women and three for men) are only average amounts and therefore, within the context of maximum weekly amounts, include higher as well as lower consumption occasions (i.e., occasional slightly higher consumption days (e.g., three standard drinks for women, four for men) need not be inconsistent with low-risk drinking).

- There is strong evidence that sporadic consumption of five standard drinks or more during a single day results in worse long-term health outcomes than drinking the same volume of alcohol spread evenly across more days (Rehm et al, 2003a) and also reduces any health benefits (Rehm et al, 2009).

These considerations suggest the possibility that, under certain restricted conditions, a woman having up to three standard drinks on an occasional day and a man having up to four drinks could be considered only at moderate risk. As discussed earlier, in the presence of certain medical conditions, use of medication, being of young age, being pregnant, operating a vehicle or machinery or engaging in a physically risky situation, it is advisable to not drink at all. Risk of injury from drinking is primarily due to the BAC and degree of impairment. This can be minimized through such strategies as drinking alcohol with food, pacing drinks so as to consume less than one standard drink per hour, and alternating alcoholic drinks with water or other non-alcoholic beverages. Drinking alcohol after a meal can result in one third of the BAC compared with drinking on an empty stomach (Ramchandani et al, 2001). People not used to the effects of alcohol, those who have lost tolerance by not drinking for a long period of time, and those who have low bodyweight will all be likely to experience higher BAC and greater impairment from a given dose of alcohol. As mentioned elsewhere in these Guidelines, some combinations of alcohol with other types of psychoactive substance—whether legally obtained or otherwise—will also produce greater impairment and hence risk from a given dose of alcohol.

A number of studies have shown that drinkers cannot typically distinguish high from low alcohol content varieties of the same beverage (Segal et al, 2009). One naturalistic study of university students drinking at a party found that when unmarked 3% alcoholic strength beer was provided, a similar volume was consumed as when unmarked 7% strength beer was provided (Geller et al, 1991). Tellingly, significantly lower BACs were retained in the 3% condition, resulting in a greatly reduced risk of acute harm. Thus, selecting and offering drinks with lower alcohol content—whether for personal use or for providing these at social gatherings—is another strategy for reducing risk of acute harm from drinking.

These issues were considered in addition to the meta-analysis from Taylor et al (in press) and the systematic review provided by Stockwell and Greer (report prepared for expert working group). As discussed earlier, a shortcoming with much of the emergency room research reviewed is that it cannot provide unique estimates of risk from drinking separate from the context in which drinking occurs. While clearly risk of injury increases with every extra drink consumed, if a person ensures they do not consume alcohol in high-risk situations, this risk will be greatly reduced. Indeed, substantially lower estimates of risk are obtained when the type of drinking context and associated activities is controlled (Stockwell et al, 2002; Watt et al, 2004). A further method of minimizing risk is to reduce the frequency of exposure created by drinking at the upper levels for consumption recommended in these Guidelines.

Limitations of the Research Evidence

While many thousands of relevant studies linking level of alcohol consumption with various health and safety outcomes were identified in the systematic reviews utilized in the development of these Guidelines, there is still substantial room for improvement in the quality of evidence available. As discussed below, some of these problems result in upward bias in the above estimates, and some result in downward bias. Until the quality of research evidence improves, a cautious approach is to take at face value the risk estimates associated with particular drinking levels and summarized in Tables 1-3.

Underreporting of personal alcohol consumption

Apart from studies that have relied on BAC to estimate short-term risk of injury or acute illness, all other evidence relies in part upon self-reported consumption of alcohol. While it has been shown that a recent Canadian national drinking survey underestimated usual consumption by more than 60 percent (Stockwell et al, 2009), it has also been shown that with some questionnaire methods, self-reported consumption in the previous 24 hours may only underestimate by 20 percent (Stockwell et al, 2008). Furthermore, many of the larger cohort studies from which the risk of severe illness and all-cause mortality has been estimated often use either recent recall methods or validate self-report using diary methods (King et al, 1994). However, a number of the studies on risk of both acute and chronic harms have used measures of usual consumption over the past 12 months, which seriously underestimate actual consumption. A conservative assumption is that risks associated with specific drinking levels made from the above studies are

overestimated due to under reporting of drinking. In other words, because people actually drink more than they are reporting, the harmful impact of alcohol consumption could conceivably occur at higher levels of use than are assessed by self-report in the relevant studies.

Failure to take account of heavy drinking episodes

The frequency of heavy consumption occasions involving five or more drinks in one day has been associated with enhanced risk of alcohol-related morbidity and mortality (Rehm et al, 2004). More recent studies relating level of alcohol use and risk of adverse health outcomes are more likely to control for this variable, but the meta-analyses presented include many studies that have not. Thus, estimates of the risk of serious illness and all-cause mortality for a particular average drinking level are overestimated in all-cause mortality studies due to not eliminating the effects of high-consumption days.

Misclassification of former and occasional drinkers as lifetime abstainers

More recent studies and meta-analyses have been more careful to compare drinking risk against that for a strictly defined group of lifelong abstainers, making separate estimates for former drinkers. Almost invariably, former drinkers have substantially greater risk of premature death from all causes than strictly defined lifelong abstainers (e.g. Klatsky & Udaltsova, 2007). There is also debate as to whether very occasional drinkers should be grouped with lifelong abstainers, with some recommending in favour (Rehm, 2007) and others against (Fillmore et al, 2006; Chikritzhs et al, 2009). Rehm et al (2008) also demonstrate that survey respondents' self-identification as lifetime abstainers or occasional drinkers is not a stable characteristic across multiple measurement points, which adds further complication. It is clear from the above studies, however, that when greater efforts are made to report outcomes for these drinking groups separately from lifetime abstainers, the smaller the apparent benefits of light and moderate drinking reported (Stockwell et al, 2007; Di Castelnuovo et al, 2006). It is likely that as the quality of science in this area improves, estimates of the extent of cardiac protection will be reduced, and the point at which benefits and risks balance out in relation to all-cause mortality will be at a lower point than that estimated by Di Castelnuovo et al (2006). In other words, bias caused by misclassifying 'abstainers' probably results in some underestimation of the health risks from moderate alcohol use. It is important to note,

however, that the guideline levels recommended here are already conservative, being within those estimated by Di Castelnuovo et al (2006).

Failure to control for confounding effects of personality and lifestyle factors independent of alcohol

A recent review paper (Chikritzhs et al, 2009) identified other reasons why the beneficial effects of moderate alcohol use (as illustrated in Tables 1, 2 and 3) may be currently overestimated. These include evidence of publication bias (whereby researchers are more likely to publish papers finding evidence of cardiac protection than not) and a failure to control for other lifestyle factors. Light and moderate alcohol use is significantly associated with a multitude of positive health behaviours (e.g., healthy diet, regular exercise, lower bodyweight, high socioeconomic status) that are especially likely to reduce risk of cardiac and vascular illness (Naimi et al, 2005). In other words, moderate alcohol use can be a sign of healthy living rather than a cause of extra longevity. The all-cause mortality meta-analyses presented here (Di Castelnouvo et al, 2006) are therefore likely to have overestimated benefits from moderate alcohol use, and hence the zero-net-risk consumption point where health risks and benefits balance may actually be lower than estimated above.

An issue that potentially confounds many epidemiological studies relating lifestyle habits and health outcomes is that the role of having a predisposition to risk-taking or having other personality profiles is rarely assessed in these studies. For example, Murray et al (2005) found evidence that the relationship between cardiovascular disease and drinking was mediated by personality characteristics. This source of confounding is likely to increase the apparent size of both the benefits and the costs of alcohol consumption. However, one formal assessment of the role of social integration and depression as potential confounders of the observed J-shape relationship between drinking and all-cause mortality found these to have minimal impact (Greenfield et al, 2002).

Given these various methodological issues, it is suggested, once more, that until the quality of research evidence improves, the best course is to take the risk estimates cited in Tables 1, 2 and 3 associated with particular drinking levels at face value. Put another way, the above sources of both upward and downward bias may at present be considered to cancel each other out.

Importance of Drinking Frequency

The discussion so far has concentrated on the acute and chronic effects associated with consuming a particular dose of alcohol, whether on one occasion or repeatedly over time. There are a number of important reasons why the frequency of alcohol consumption needs to be taken into account in the setting of drinking guidelines. Firstly, the greater the frequency of drinking, the quicker an individual develops tolerance to the effects of alcohol (i.e., more alcohol needs to be consumed both to achieve an objective BAC and a particular subjective sense of intoxication). Increasing tolerance to the effects of alcohol has been demonstrated among social drinkers (Fillmore & Vogel-Sprott, 1996) in terms of BAC achieved for a given dose, subjective ratings of intoxication for a particular BAC (Hiltunen, 1997), and actual behavioural impairment (Beirness & Vogel-Sprott, 1984). At higher levels of consumption, a continuous period of daily drinking may be followed by some degree of 'withdrawal' when a person tries to abstain. The development of both tolerance and withdrawal symptoms are among core elements of the alcohol dependence syndrome, commonly known as alcoholism (Edwards & Gross, 1976).

Secondly, at the general-population level, there is a strong relationship between how frequently a person drinks and their likelihood both of engaging in hazardous drinking (e.g., by consuming five or more drinks on one occasion) (Paradis et al, 2009) and experiencing harm (Taylor et al, 2008). Many of the serious illnesses associated with long-term use of alcohol are caused by an accumulation of the toxic effects of drinking. For example, when the body metabolizes alcohol, the first metabolite to be created is acetaldehyde, which is implicated in some cancers (Seitz & Stickel, 2009). The risk of developing such a serious condition is directly proportional to the volume of alcohol consumed over any period of time. It follows that higher frequency of consumption is associated with high risk of adverse health effects. As discussed above, Dawson et al (2008) showed how the frequency of drinking five or more drinks per day is a major predictor of a variety of social and acute harms from drinking in the past 12 months. There is also literature on drinking patterns in relation to serious illnesses such as alcoholic liver cirrhosis, which shows how complete days of abstinence give the liver a 'break' and reduce risk (Hatton et al, 2009). Furthermore, evidence was presented above that risk of injury and other acute harms increases with amount consumed from very low levels. Limiting frequency of exposure to this risk by reducing the number of drinking

days therefore reduces the overall risk. Collectively, these lines of evidence point to a general recommendation of at least two non-drinking days per week for most drinkers.

An important footnote on the topic of drinking frequency is that among the somewhat rare group who drink just one or two drinks every day of the week, if this is a well-established and manageable drinking pattern, there is unlikely to be any excess risk associated with drinking and indeed a probability of gaining health benefits. Canadian surveys have shown that while this pattern of drinking is quite rare, especially among younger drinkers (Paradis et al, 2009), drinkers with such a profile are unlikely to report associated social problems (Walsh & Rehm, 1996; Adlaf et al, 2005).

Recommended Guidelines for Low-Risk Drinking

On the basis of the best clear evidence currently available and the considerations discussed above, the expert committee commissioned by the National Alcohol Strategy Advisory Committee reached a consensus on five specific guidelines. Some important provisos apply: (i) these Guidelines support individuals' decisions to abstain from alcohol, whether for cultural, spiritual, health or personal reasons; (ii) abstainers are not encouraged to take up drinking to achieve possible health benefits because these are not certain and there are other ways of achieving the same benefit; and (iii) the specific levels of daily and weekly drinking listed below apply to persons of average bodyweight; persons of light bodyweight should exert extra caution and drink within Guideline limits, while persons with above average bodyweight should ***not*** drink above the recommended levels.

Guideline 1

Do not drink in these situations: When operating any kind of vehicle, tools or machinery; using medications or other drugs that interact with alcohol; engaging in sports or other potentially dangerous physical activities; working; making important decisions; if pregnant or planning to be; before breastfeeding; while responsible for the care or supervision of others; or if suffering from serious physical illness, mental illness, or alcohol dependence.

Guideline 2

If you drink, reduce long-term health risks by staying within these average levels:

- **Women**: Between zero and two standard drinks a day, or a weekly maximum of 10 standard drinks.
- **Men:** Between zero and three standard drinks a day, or a weekly maximum of 15 standard drinks.

Always have some non-drinking days per week to minimize tolerance and habit formation. Do not increase drinking to the upper limits as health benefits are greatest at up to one drink per day. Do not exceed daily limits in Guideline 3 below.

Guideline 3

If you drink, reduce short-term risks by choosing safe situations and restricting your alcohol intake. Risk of injury increases with each additional drink in many situations. For both health and safety reasons, it is important not to drink more than:

- **Women:** Three standard drinks in one day.
- **Men:** Four standard drinks in one day.

Drinking at these upper levels should only happen ***occasionally*** and always be consistent with the weekly limits in Guideline 2 above. It is especially important on these occasions to drink with meals and not on an empty stomach, to have no more than two standard drinks in any three-hour period, to alternate with caffeine-free non-alcoholic drinks, and to avoid risky situations and activities. Individuals with reduced tolerance, whether due to low bodyweight, being under 25 years or over 65 years in age, are advised to never exceed the upper levels established in Guideline 2.

Guideline 4: When pregnant or planning to be pregnant

The safest option during pregnancy or when planning to become pregnant is to not drink alcohol at all. Alcohol in the mother's blood stream can harm the developing fetus. While the risk from light consumption during pregnancy appears very low, there is no threshold of alcohol use in pregnancy that has been definitively proven to be safe.

Guideline 5: Alcohol and young people

Alcohol can harm healthy physical and mental development of children and adolescents. ***Uptake of drinking by youth should be delayed at least until the late teens and be consistent with local legal drinking age laws.*** Once a decision to start drinking is made, drinking should occur in a safe environment, under parental guidance and at low levels (i.e., one or two standard drinks once or twice per week are considered to be low risk). From legal drinking age to 24 years, it is recommended that women never exceed two drinks and men never exceed three drinks in one day, and that both men and women stay well within Guideline 2 levels for both daily and weekly consumption.

Towards a Culture of Moderation

On the basis of published estimates of numbers of deaths caused by drinking above low-risk drinking guidelines similar to those proposed here (Stockwell et al, 2007), compliance with these Guidelines would reduce the annual numbers of alcohol caused deaths in Canada by approximately 4,600. On the basis of an analysis of Canadian survey data (Stockwell et al, 2009), it is estimated that if everyone currently drinking above these Guidelines reduced their consumption and all others maintained their current drinking patterns, overall consumption of alcohol in Canada would be reduced by at least 50 percent. Alternatively, if all drinkers drank to the maximum limits outlined by these Guidelines, per capita alcohol consumption would actually rise by about 10 percent.

While neither of these extreme scenarios is likely, the Guidelines are meant to reduce the proportion of drinkers who consume in excess. To this end, it should be acknowledged that publication of these Guidelines will reduce population levels of serious alcohol-related harm ***only*** if accompanied by the other comprehensive range of strategies outlined in the National Alcohol Strategy document, *Towards a Culture of Moderation* (NASAC, 2007). It is nonetheless hoped that the Guidelines will provide positive and constructive advice to support informed decisions about drinking and health by all Canadians.

Comparisons with Other Low-Risk Drinking Guidelines

It is important to stress that there are alternative criteria for establishing low-risk drinking guidelines to those adopted here. As illustrated in Appendix 2, the Guidelines recommended in this document are consistent with existing drinking guidelines promoted in some Canadian jurisdictions (e.g., the Atlantic Provinces, British Columbia), are slightly higher than the Ontario and Québec guidelines for maximum weekly intake, and are somewhat lower than those in Québec for maximum daily alcohol intake.

In comparison with guidelines issued in other countries, those proposed in this document are similar to those promoted in the United Kingdom, but are higher than those endorsed by some U.S.-based organizations as well as those recently issued by Australia's National Health and Medical Research Council (NHMRC, 2009). Given the high quality of the underpinning research to the Australian guidelines (Taylor et al, 2008) and the attention they have received by commentators both in mass media and peer-reviewed publications (Dawson, 2009), some major differences will be briefly discussed. This is not the first time that the same body of research compiled by the same research group has been interpreted quite differently for low-risk drinking guidelines by Australian and Canadian committees. The same Canadian research group performed the reviews upon which both the well-known Ontario-based Centre for Addiction and Mental Health (CAMH) guidelines (Bondy et al, 1999) and earlier Australian guidelines (NHMRC, 2001) were based. In that instance, conservative levels associated with optimal health benefits were selected by CAMH and higher levels at which benefits and risks balanced out in all-cause mortality studies (i.e., there was no additional risk of premature mortality compared with abstainers) were selected by the Australian group.

The most recent Australian guidelines were developed on the basis of a new method described by Taylor and colleagues (2008). This method combines the same relative risk estimates reported here for individual injury and illness outcomes from drinking different levels of consumption with data on the absolute risk of these outcomes for different age and gender groups in the population. Health benefits were not included in the main analyses upon which the Australian guidelines were created and, instead, an external criterion of a one-percent increase in lifetime risk of premature mortality was selected. In these proposed new Canadian Guidelines, the estimated health benefits of low-level drinking were included and the balance point at which benefits and harms appear to

cancel each other out at the general population level was used to determine an acceptable average daily level for low-risk alcohol intake.

An important implication of the different approaches concerns how gender differences in the epidemiological data are considered. In terms of absolute risk, males have a higher risk of most forms of injury and illness than females regardless of alcohol intake. While there is evidence that women have higher relative risks for both acute and chronic harms from drinking at particular consumption levels, the Australian approach argued that this extra risk for women is balanced out by the higher absolute risk for men. Following arguments recently espoused by Dawson (2009), the position taken here is that the *change* (increase or decrease) in risk of serious outcomes associated with alcohol consumption is more important than the *background* level of risk unrelated to alcohol consumption. In essence, it was judged that an individual male or female is likely to be more interested in whether their drinking doubles or triples their risk of serious outcomes than whether they are more or less at risk as a consequence of their gender.

A further important difference is that while Taylor and colleagues (2008) recommend using a small number of fatal conditions where causal relationships with alcohol have been most strongly established, the present approach uses data on all causes of death. The all-cause mortality approach has been criticized as introducing unnecessary additional confounding as many causes of death may be associated with alcohol consumption but not causally. Some counterarguments are that (i) there are likely to be additional fatal conditions, such as prostate cancer (Fillmore et al, 2009), that, in the future, will be shown to be causally related to alcohol use and are automatically incorporated in the all-cause approach; (ii) there is sometimes a reluctance by physicians to specify alcohol as a cause of death, which may bias a more disease-specific approach downwards; (iii) there is a strong *prima facie* case for a method (like plotting relative risk of all-cause mortality against drinking level) that balances probabilities of both harm and benefit; and (iv) an approach that only uses a small number of conditions with a high causal association with drinking will also suffer from confounding. As an illustration of the latter point, a recent meta-analysis on alcohol use and liver cirrhosis (Irving et al, in press) finds that light or moderate use of alcohol by men appears to be protective, a result that is hard to explain other than by confounding.

Recommendations for Future Research

The field of alcohol epidemiology and the criteria by which studies are collectively evaluated to arrive at drinking guidelines will evolve and strengthen in future years. It is recommended, therefore, that the proposed Guidelines are reviewed on a regular basis as this area of knowledge develops. Particular gaps in the present evidence base identified in the current process include:

- studies with robust measures of alcohol consumption in which underreporting biases are likely to be minimized;
- longitudinal studies of the relationship between alcohol consumption and risk of injury, illness and death that use valid measures of alcohol consumption at repeated measurement points, and rigorously exclude former and occasional drinkers from the comparison group of lifetime abstainers;
- studies of injury risk using general population control samples and simultaneously controlling for contextual risk factors (e.g., location and activity) and personality traits separately from alcohol consumption; and
- studies of how best to communicate low-risk drinking guidelines to both high-risk groups and the community at large.

Recommendations for the Communication of the Guidelines

It is intended that the present document be used to inform a rich variety of effective dissemination and knowledge-exchange activities that contribute towards the culture of moderation envisaged by the National Alcohol Strategy Working Group. These might include some or all of the following:

- materials to support health professionals providing assessment and brief advice to early-stage problem drinkers or persons whose health is compromised in some way by their drinking;
- Web-based interactive materials that enable individuals to assess their own level of alcohol consumption and risk profile. Examples of such websites presently developed in Canada include the *Alcohol Reality Check* in British Columbia (see www.carbc.ca or www.alcoholreality.ca), *Éduc'alcool* in Québec (see http://www.educalcool.qc.ca/en/publications/alcohol-and-health-the-effects-of-moderate-and-regular-alcohol-consumption/index.html) and *Check Your Drinking* in Ontario (see www.CheckYourDrinking.net, Cunningham et al, 2009);

- brief and informative leaflets to be available in various healthcare settings and for the general public summarizing the Guidelines;
- materials that enable drinkers to better understand the number of standard drinks they consume (e.g., using illustrations of popular drinks showing numbers of standard drinks they contain (NHMRC, 2009) or the labelling of alcohol containers with the number of standard drinks they contain (Stockwell and Single, 1997); and
- widespread social marketing to both youth and adults to increase their knowledge of these Guidelines, and inform their individual choices.

Finally, it is important to reiterate that many people choose to drink alcohol at levels well below the upper limits of these Guidelines or choose not to drink alcohol at all for a variety of social, spiritual, cultural, health-related or other personal reasons. These Guidelines should not be construed as encouragement for very light drinkers to increase their consumption or for abstainers to take up drinking. With the evidence of increasing alcohol consumption in Canada over the last decade, as well as increasing levels of alcohol-related harm (Kendall, 2008; Thomas et al, 2009), it is also important to recognize that there are many evidence-based alcohol policies that will be more effective at reducing the burden of alcohol-related harm in Canada than the provision of drinking guidelines alone (Anderson et al, 2009; Toumbourou et al, 2007). However, low-risk drinking guidelines can support the implementation of other evidence-based interventions such as regulating the price and availability of alcohol, brief intervention for early problem drinkers and the enforcement of drunk-driving laws (Loxley et al, 2004).

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Appendix 1: Members of Canadian Low-Risk Alcohol Guidelines Expert Advisory Panel

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Professor, Dalla Lana School of Public Health Sciences, University of Toronto

Dr. Catherine Paradis
Head Research Advisor
Éduc'alcool

Dr. Tim Stockwell
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Appendix 2: Provincial Drinking Guidelines in Canada

Source	Men	Women	Standard Drink
CAMH*	• Maximum 2 standard drinks/day • Maximum 14 standard drinks/ week	• Maximum 2 standard drinks/day • Maximum 9 standard drinks/ week	• 142 mL (5 oz.) wine (12% alcohol) • 341 mL (12 oz.) beer (5% alcohol) • 85 mL (3 oz.) fortified wine (16–18% alcohol) • 43 mL (1.5 oz.) liquor (40% alcohol)
CARBC (2007)	• Maximum 4 standard drinks/day; • Maximum 20 standard drinks/ week	• Maximum 3 standard drinks/day • Maximum 10 standard drinks/ week	• 150 mL (5 oz.) wine (12% alcohol) • 355 mL (12 oz.) beer (5% alcohol) • 50 mL (1.5 oz.) spirits (40% alcohol) • 85 mL (3 oz.) fortified wine/sherry/port (18% alcohol)
CFPC (ARAI 1994)	• Maximum 4 standard drinks/day • Maximum 12 standard drinks/week	• Maximum 3 standard drinks/day • Maximum 12 standard drinks/week	• 1.5 oz. spirits (40% alcohol) • 5 oz. wine (10–14% alcohol) • 12 oz.) beer (5% alcohol) • 3 oz. fortified wine/aperitif (20% alcohol)
Éduc'alcool (2007)	• Maximum 3 standard drinks/day • Maximum 14 standard drinks/week • Maximum 5 standard drinks on a single occasion • NO alcohol at least 1 day/week	• Maximum 2 standard drinks/day • Maximum 9 standard drinks/week • Maximum 4 standard drinks on a single occasion • NO alcohol at least 1 day/week	• 142 mL (5 oz.) wine (12% alcohol) • 341 mL (12 oz.) beer (5% alcohol) • 43 mL (1.5 oz) spirits (40% alcohol) • 85mL (3 oz.) fortified wine (20% alcohol)

** Adopted by Nova Scotia, Manitoba and Alberta, and in the draft Health Canada guidelines.*

Note: Australian drinking guidelines as of March 2009: Maximum 20 g per day to reduce lifetime risk and maximum 40 g per day to reduce risk of injury from specific occasion.

Appendix 3: Details of the Quantitative Meta-Analyses from which the Information on Dose-Response Relationships was Extracted

Disease	Articles from Main Search	Articles in Analysis	% Agreement for Data Abstraction	Total	% Male
Tuberculosis	16,527*	21	Not reported	166,893	Not reported
Incident HIV	856	10	N/A	28,584	67%
Mouth, nasopharynx other pharynx oropharynx cancer	58	15	Discrepancies to include an article and in-quality score assignment were resolved in conference.	4,507	Not reported
Esophagus cancer	51	14	Same as above.	3,233	Not reported
Colon cancer	16	16	Same as above.	5,360	Not reported
Rectum cancer	49	6	Same as above.	1,420	Not reported
Liver cancer	43	10	Same as above.	1,321	Not reported
Larynx cancer	38	20	Same as above.	3,789	Not reported
Breast cancer (female)	65	53	Not reported	153,582	0%
Diabetes mellitus	1,615	20	91.1%	437,447	33%

** 16,527 articles in a comprehensive private collection of scientific tuberculosis publications were screened; PubMed revealed 2,007 abstracts.*

Appendix 4: Risk of Premature Mortality and Level of Average Alcohol Consumption Estimated with and without Stricter Definition of "Lifetime Abstainer"

Source: Di Castelnouvo et al, 2006. Reproduced with permission from the *Archives of Internal Medicine*.

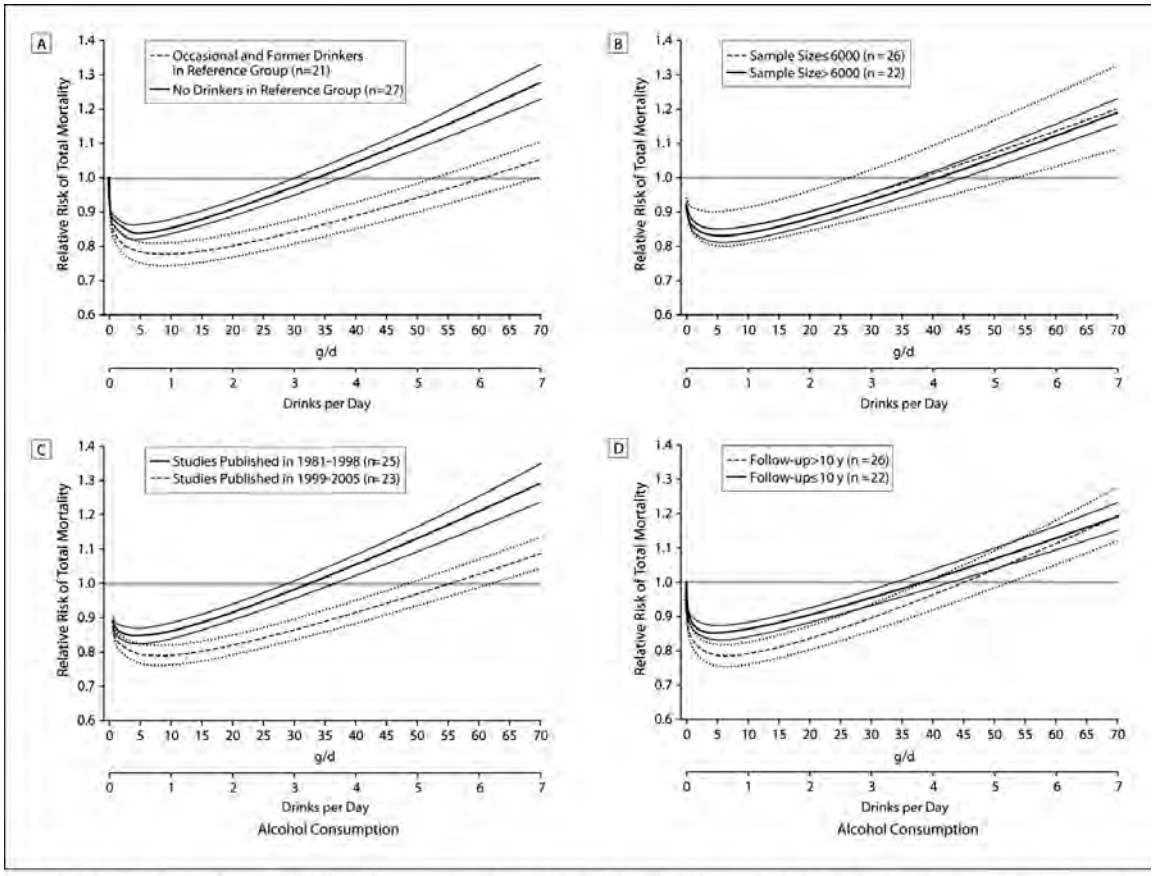

Figure 4. Relative risk of total mortality (99% confidence interval) and alcohol intake stratified according to type of reference category (A), sample size at baseline (B), year of publication (C), and follow-up duration (D).