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Shawn R. Currie*
Addiction Centre, Calgary, AB

David C. Hodgins
University of Calgary
Nady el-Guebaly
Addiction Centre, Calgary, AB

JianLi Wang
University of Calgary
Harold Wynne
Wynne Resources

Sophie Chen
University of Calgary

* Name and address for correspondence and requests for reprints

Contact: Shawn R. Currie, Ph.D.
Addiction Centre, Foothills Medical Centre
1403 – 29th St. NW, Calgary, AB
Canada T2N 2T9
Phone: (403) 944-2009. Fax (403) 944-2056
E-mail: scurrie@ucalgary.ca.

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Risk of Harm among Gamblers in the General Population as a Function of Level of Participation in Gambling Activities
Shawn R. Currie, David C. Hodgins, JianLi Wang, Nady el-Guebaly, Harold Wynne, and Sophie Chen

Aims. To examine the relationship between gambling behaviours and risk of gambling-related harm in a nationally representative population sample. Design. Risk curves of gambling frequency and expenditure (total amount and percent of income) were plotted against harm from gambling. Setting. Data derived from 19,012 individuals participating in the Canadian Community Health Survey – Mental Health and Well-being cycle, a comprehensive interview-based survey conducted by Statistics Canada in 2002. Measurement. Gambling behaviours and related harms were assessed with the Canadian Problem Gambling Index. Findings. Risk curves indicated the chances of experiencing gambling related harm increased steadily the more often one gambles and the more money one invests in gambling. Receiver operating characteristic analysis identified the optimal limits for low-risk participation as gambling no more than 2 to 3 times per month, spending no more than $501 to $1000CAN per year on gambling, and investing no more than 1% of gross family income on gambling activities. Logistic regression modeling confirmed a significant increase in the risk of gambling-related harm (odds ratios ranging from 1.98 to 7.7) when these limits were exceeded. Conclusions. Risk curves are a promising methodology for examining the relationship between gambling participation and risk of harm. The development of low-risk gambling limits based on risk curve analysis appears to be feasible.
Risk of Harm from Gambling in the General Population as a Function of Level of Participation in Gambling Activities

The explosion in gambling opportunities in the last 15 years has put the issue of gambling-related harm on the forefront of public health concerns. Like the consumption of alcohol, the majority of North Americans gamble (Ferris & Wynne, 2001; Ladouceur, 1996; Shaffer, Hall & Vander Bilt, 1997). Past year and lifetime rates of gambling among Canadians are 76% and 85%, respectively (Cox et al., 2005; Marshall & Wynne, 2003). Data from other industrialized countries suggest similar levels of gambling participation in the general population (Raylu & Oei, 2002; Shaffer et al., 2004). Gambling appears to be a socially acceptable behaviour for both adults and adolescents (Azmier, 2001; Griffiths, 1996; Ladouceur, Dube & Bujold, 1994). Furthermore, rates of gambling participation in the general population are increasing along with per capita expenditure (Azmier, 2005; Marshall & Wynne, 2003). Between 1992 and 2001, the amount of money Canadians spent on gambling annually tripled from $130 to $447 per person (Statistics Canada, 2003). Government revenue from gambling has increased accordingly with a large proportion coming from problem gamblers. In a recent review, Williams and Wood (2004) estimated that about 23% of Canadian gaming revenue now derives from problem gamblers.

Much of the research in this area has focused on problem and pathological gambling (Blaszczynski, Ladouceur & Shaffer, 2004; Room, 2005). There has been comparatively little research on what constitutes “normal” or low-risk gambling behaviour. The term ‘responsible gambling’ has been used to describe gambling at recreational levels. However, concern has been raised that this term lacks a clear definition (Blaszczynski et al., 2004). Although responsible gambling guidelines exist (see Table 1 for an example) none have been empirically derived. Moreover, the guidelines referring to expenditure and frequency of gambling provide no quantitative limits. By default, any level of gambling that is not problematic or pathological is considered responsible. Research indicates that, similar to alcohol, there is a continuum of risk associated with gambling that increases with greater participation (Shaffer, 2005). Problem gamblers tend to invest more time and money into gambling activities compared to low-risk or non-problem gamblers (Ferris & Wynne, 2001; Marshall & Wynne, 2003; Wiebe, Single & Falkowski-Ham, 2001). Gamblers deemed to be at moderate-risk assume an intermediate position between low-risk and problem gamblers in terms of frequency of play and per person expenditure. A detailed examination of the dose-response relationship between level of participation and gambling-related harm in the general population data may provide insight on a threshold of gambling participation that distinguishes low and high-risk behaviour.

This type of analysis has been conducted in the field of alcohol research for many years. Epidemiologists have consistently found a clear, often linear relationship between daily consumption of alcohol and risk of adverse consequences such as alcohol-related health problems, injury, motor vehicle accidents, violence, marital problems, and work problems (see Babor et al., 2003 for a complete review). Risk curves depicting the relationship between consumption level and chance of harm contributed to the development of low-risk drinking limits (Bondy et al., 1999; Room, 1996). These limits (maximum two drinks per day; 14 drinks per week for men and 12 drinks for women) are now widely promoted by government agencies, professional bodies, and addiction research institutions (National Institute on Alcohol Abuse and Alcoholism, 1992; Babor et al., 2003; ARF/CCSA, 1994). Drinkers who adhere to these limits
are less likely to experience harm to their physical, social and mental health (Babor et al., 2003; Bondy et al., 1999; Room, Bondy & Ferris, 1995).

Comparable limits on gambling behaviour have not been suggested. Until recently, there was little population data available on which to base such limits. Fortunately, several large population surveys on gambling activities have been conducted in Canada over the last 5 years permitting a more detailed examination of the continuum of risk in gambling. The largest is the Canadian Community Health Survey – Mental Health and Well-being (CCHS-1.2) conducted by Statistics Canada. With this data available, a population-level analysis of the relationship between gambling participation and risk of harm is now possible. The aim of the present study is to examine whether the risk curve approach used in the alcohol field could be replicated with gambling. A secondary aim was to empirically develop a set of tentative, low-risk gambling limits.

Methods

*Canadian Community Health Survey – Mental Health and Well-being (CCHS – 1.2)*

Detailed descriptions of the CCHS-1.2 in terms of target population, sampling procedures, response rate and psychiatric assessment are provided in other sources (Cox et al., 2005; Marshall & Wynne, 2003). Briefly, the CCHS-1.2 is a cross-sectional survey of a nationally representative sample of over 36,000 individuals aged 15 and older in all provinces and territories (Statistics Canada, 2002). Urban and rural areas were sampled. Individuals residing on armed forces bases, aboriginals living on reserves, and persons in some remote northern regions in Ontario and Quebec were excluded. Survey data was collected in face-to-face interviews between May and December 2002. The sample was selected according to a multistage stratified cluster design in which young persons and seniors were over-represented. The response rates for the CCHS – 1.2 were 87% at the household level and 77% at the individual level. The CCHS 1.2 content covered a range of mental disorders including major depression, anxiety disorders, substance-related disorders, psychological well-being, gambling, health services utilization, and socioeconomic status. Informed consent was obtained by Statistics Canada. Ethical approval for accessing the dataset was granted by the Social Sciences and Humanities Research Council of Canada, and the University of Calgary Research Ethics Board.

*Gambling assessment*

Gambling in the CCHS – 1.2 was assessed using the Canadian Problem Gambling Index (CPGI; Ferris & Wynne, 2001). The CPGI is the first gambling behaviour measurement tool to be rigorously tested prior to widespread use (Smith & Wynne, 2002), and one of the few measures to be specifically designed for use in general population surveys (the other being the National Opinion Research Center DSM-IV Screen for Gambling Problems [NODS]; Gerstein et al., 1999). The CPGI is a multicomponent measure that collects information on type of gambling, frequency of play (categories include daily, 2-6 times/week, once/week, 2-3
times/month, once/month, 6-11 times per year, 1-5 times per year, and never), amount spent on
gambling activities in the last year, and gambling-related harms. Types of gambling assessed in
the CCHS – 1.2 included: instant win/scratch/daily lottery tickets; lottery and raffle tickets;
Bingo; betting on cards or board games; electronic and mechanical slot machines; casino games
other than slots; Internet or arcade; horse racing; sports lotteries; and games of skill (pool, golf,
etc). Scores on the PGSI, the primary quantitative index derived from the CPGI, correlate highly
with other gambling scales (including the South Oaks Gambling Screen [SOGS]; Lesieur &
Blume, 1987) and DSM-IV measures of gambling (Ferris & Wynne, 2001).

Our primary interest was in predicting gambling-related harm rather than problem
gambling, the latter representing the extreme on the gambling continuum. In this context, low-
risk gambling would represent a level of gambling in which harms are minimal or not apparent.
Harm from gambling is assessed on the CPGI using a series of questions inquiring about
problems such as increasing bet sizes to get the same excitement (tolerance) and being criticized
by others for gambling. Each problem item was rated on a scale with the choices ‘never,’
‘sometimes,’ ‘most of the time,’ and ‘almost always.’ A total of 15 gambling-related problems
were assessed in the CCHS-1.2 version of the CPGI. Internal consistency (Cronbach’s alpha) for
the complete list of problems was calculated at .91. This list included behavioural problems
associated with gambling such as chasing losses and negative consequences such as financial
problems (Ferris & Wynne, 2001).

Determining what constitutes an acceptable level of harm is arguably subjective
(Blaszczynski et al., 2004). Therefore, we explored different definitions of low-risk and
examined the impact of each definition on the relationship between harm and level of gambling
involvement. For the purpose of this study, participants who endorsed a problem from the CPGI
as occurring ‘sometimes,’ ‘most of the time,’ or ‘all of the time’ in the last year were coded as
experiencing a gambling-related harm. In the first definition, individuals who reported less than
two gambling-related problems, including the behavioural problems, were considered low-risk.
In the second definition, individuals reporting less than two negative consequences of gambling
(i.e., excluding the behavioural problems) were classified as low-risk. From the CPGI list of
problems, eight items examined negative consequences or repercussions of gambling: gambling
caus ed health problems including stress/anxiety; gambling caused financial problem; borrowed
money or sold anything to gamble; gambling caused interpersonal problems; others criticized
your gambling; felt guilty about gambling; betting more than can afford to lose; felt you might
have a gambling problem. Internal consistency (Cronbach’s alpha) for the shorter list of
consequences was calculated at .88. In terms of two being the threshold for defining harm, we
rationalized that individuals endorsing gambling-related problems in two different areas could be
reasonably viewed as beginning to experience problems related to their gambling. A similar
threshold has been used in the analysis of alcohol-related harm (Room, Bondy & Ferris, 1995).
Notwithstanding, low-risk could also be defined as gambling without any harm. Therefore, the
last definition we examined was defining low-risk as experiencing no negative consequences of
gambling.

Other measures

Other variables included in this analysis are demographic characteristics (age, gender,
education level), ethnicity, and total household income from all sources. Ethnicity was
dichotomized as Caucasian and non-Caucasian (including black, oriental, South Asian,
aboriginal, Arab, and other).
Statistical analysis

Following in the work of Room et al. (1995) and others (Babor et al., 2003) a series of risk curves for men and women were plotted for frequency of gambling and expenditure (total amount and percent of gross family income) against harm from one’s own gambling. The sample analyses consisted of all CCHS – 1.2 participants who reported gambling at least once in the past year and answered all the CPGI questions related to harm. It is worth noting that not all persons who reported gambling activity were administered the problem questions from the CPGI. Individuals who were very low frequency gamblers (no more than one to five times per year) and self-identified as being a non-gambler in a screening item, were not administered the questions related to gambling problems. Because the categories of gambling are not mutually exclusive (67% of respondents reported more than one type of gambling), a composite index of gambling frequency was derived based on the type occurring most often (e.g., an individual who plays the lottery once per week and electronic slot machines every day was classified as a daily gambler). Annual expenditure on gambling was assessed using dollar ranges (0-$50, $51-100, $101-250, $251-500, $501-1000, >$1000), therefore percent income spent on gambling was calculated by dividing the midpoint of each dollar range by the respondent’s estimated gross family income.

The optimal low-risk limit for gambling participation was identified using receiver operating characteristic (ROC) analysis. With this approach the performance of various cut-off levels over the complete range of scores was tested. The risk curves for percent income, frequency, and dollars spent suggested that a threshold may exist for each parameter where, once crossed, the risk of harm increases substantially. Visually, each curve suggested that more than one cut-off for distinguishing low and higher-risk gambling could be defined. The choice of an optimal cut-off score is guided by several factors. Typically, researchers must weigh the relative importance of sensitivity (probability of detecting harm when it is present) in relation to specificity (minimization of false positives). One must also consider the practical value of a chosen cut-off. A threshold for defining low-risk gambling may eventually form the basis of safe gambling guidelines for the general public. Given the relative novelty of this analysis, we adopted the approach used in determining the cut-off for the Alcohol Use Disorders Identification Test (AUDIT), a widely used screening tool for identifying problem drinking (Conigrave, Hall & Saunders, 1995). Specifically, a cut-off for each gambling parameter was chosen through ROC analysis that maximized the discrimination between the presence or absence of gambling-related harms, giving equal weighting to sensitivity and specificity. The point on the curve that optimized sensitivity and specificity was chosen as the cut off for the next phase of analysis.

Logistic regression models were developed to examine the associations between the low-risk limits and harm from gambling, adjusting for the effects of demographics (age, education, gender, gross family income, and ethnicity) and extent of gambling involvement. For statistical comparisons of proportions, the $\chi^2$ value for each test was converted to an F-test that takes into consideration the sampling weights for the specific variables under study. All statistical analyses were carried out using Stata 8.0 (2003) and made use of the sampling weights and bootstrap procedures provided by Statistics Canada (Pierard, Buckley & Chowhan, 2004) to account for the complex sampling procedure. Weight assignment in the CCHS 1.2 was based on several factors including: the multistage design, stabilization of sampled dwellings, household-level non-
response, and person-level non-response. Missing data due to non-response or refusal in the CCHS – 1.2 was very low (< 1%).

**Excluding lottery play**

The composite gambling variables included all games of chance including state-run and charitable lotteries. Playing the lottery is the most common form of gambling for Canadians (Marshall & Wynne, 2003) but is generally viewed as a safe activity because of the small dollar amounts invested and delay between wager and outcome. Individuals can play the lottery every week with little risk of harm so including weekly lottery tickets as a form of gambling may skew the low-risk cut-offs. Therefore, we explored a series of models after excluding persons who endorsed the lottery as their only form of gambling (n = 4,046). Daily, instant-win ticket players were included.

**Results**

**Sample and gambling characteristics**

Of the full CCHS – 1.2 sample, 19,012 individuals gambled in the last year and were administered all the items related to gambling problems. The sample characteristics were: average age of 45.5 years (SD = 18.2), 51% male, 56% had some post-secondary education, and 85% were Caucasian. The national and provincial problem gambling prevalence rates from the CCHS – 1.2 were recently published in Cox et al. (2005) and therefore will not be repeated in the present report. The majority of Canadians who gambled in the last year reported no harm from gambling. On average, about 7.8% of Canadians reported two or more gambling-related problems (including behavioural problems and negative consequences), 7.2% reported at least one negative consequence from gambling, and 4.2% reported two or more negative consequences from gambling. The relationship between each definition of low-risk and gambling behaviour was similar (see Table 2). Defining low-risk as experiencing less than two negative consequences appeared to have a slight advantage in terms of the ROC parameters produced (sensitivity, specificity, and area under the curve). This definition is used in all subsequent analyses. The optimal cut-off was the same regardless of the definition of harm employed. Individuals who reported two or more negative consequences from gambling in the last year were more likely to be male (5.0% vs. 3.3% female; $F = 37.84; df = 1, 19011; p < .00001$), non-Caucasian (5.7% vs. 3.9% Caucasian; $F = 18.72; df = 1, 19011; p < .01$), have high school education or less (5.0% vs. 3.5% with some post-secondary; $F = 27.70; df = 1, 19011; p < .0005$), and be in the low income category for household income (6.1% vs. 4.0% in middle or high income category; $F = 14.36; df = 1, 19011; p < .005$). Risk of negative consequences also varied by age. Persons under 40 were more likely to experience two or more consequences of gambling compared to persons over 40 (4.6% vs. 3.8%; respectively; $F = 8.30; df = 1, 19011; p < .05$). In general, risk of harm from gambling declined with advancing age.

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**Risk curves**

Figure 1 displays the risk curve for frequency of any gambling activity and risk of harm stratified by gender. Risk level noticeably increases in both men and women who gamble more
than once per week. In Figure 2, total dollars spent on gambling in the last year is plotted against risk of harm. Once again, there appears to be little difference in risk for men and women. For the risk curve on percent income (Figure 3), the sample was divided into 8 groups of approximately equal size according to the proportion of gross annual income spent on gambling activities. The labels on the abscissa reflect the approximate midpoint (median) for each group. Similar to the curves for frequency and dollars spent, the relationship between percent income spent on gambling and risk of harm is J-shaped and shows no gender differentiation. Figure 4 depicts the relationship between harm and frequency of playing the six most common forms of gambling. Risk of gambling-related harm increases the more frequently one plays any electronic gaming machines (inside and outside casinos), instant-win tickets, bingo, and casino games, but not from playing the lottery. Note that the analysis of game-specific harm is limited by the absence of information on money spent on individual types of gambling and the fact that most respondents engaged in more than one form of gambling.

Establishing low-risk gambling limits

The ROC analysis indicated the optimal low-risk cut-off for frequency was gambling more than 2 to 3 times per month; for dollars it was spending more than $501-$1000CAN per year, and for percent income it was more than 1%. Sensitivity, specificity, and area under the curve values for these cut-offs are displayed in Table 2. The proportion of the Canadian population who gamble exceeding these cut-offs were 32.4% (>2 to 3 times per month), 11.1% (>501-$1000CAN per year), and 11.4% (>1% gross income), respectively.

Logistic regression

Regression modeling was undertaken with the dependent variable being two or more negative consequences from gambling and predictors being demographic variables and the low-risk limits defined above. In all models, the variable inflation factor (VIF) was less than 2 for each variable, indicating no problems with collinearity among the covariates (DeMaris, 2004). As shown in Table 3, the first model significantly predicted harm from gambling on the basis of known socioeconomic correlates of problem gambling, notably younger age, being male, lower income, non-Caucasian, and having high school or less education. After controlling for the demographic variables, each of the cut-off limits significantly predicted harm from gambling. The level of risk is expressed as an odds ratio (OR). For example, persons who gamble more than 2 to 3 times per month (i.e., weekly or more) are about thirteen times more likely to experience gambling-related harm compared to individuals who stay below this limit. Spending more $501-$1000 per year increases the risk by a factor of 13.8, while spending more than 1% gross income on gambling increases the risk by a factor of 10.5. Interaction terms were attempted in each model; however, the relationship between risk level and increasing gambling activity was independent of gender, age, educational background, ethnicity, and income level. A final model was run that included all the demographics and gambling parameters (Model 5 in Table 3). Each parameter still independently predicted harm in the presence of the demographics and the other parameters.
Excluding lottery play from the definition of gambling

The risk curves did not change substantially after excluding persons whose only form of gambling was playing the lottery. The optimal low-risk limit did not change for frequency of gambling or percent income. For dollars spent, a more conservative limit of spending no more than $251 to $500 per year was the optimal threshold for maximizing sensitivity (78.6%), specificity (67.3%) and AUC (0.80) in detecting persons experiencing two or more consequences from gambling. The regression model including this cut-off was highly significant ($\chi^2 = 653.97; df = 13726; p < .0001$) with a model $R^2 = 0.24$. In the model with all three gambling parameters, younger age (OR = 0.96; confidence interval [CI]: 0.95 to 0.97) and being non-Caucasian (OR = 1.83; CI: 1.22 to 2.76) remained significant predictors of gambling related harm along with the low-risk limits for frequency (OR = 1.96; CI: 1.34 to 2.85), dollars spent (OR = 4.82; CI: 3.39 to 6.88), and percent income (OR = 2.95; CI: 2.01 to 4.33).

Discussion

The application of risk curve analysis, extensively used in the epidemiology of alcohol-related harm, appears to have utility in the context of gambling. The relationship between risk potential and harm is mediated by level of participation. Risk of gambling-related harm increases the more often one gambles and the more money invested in games of chance. In this set of analyses we examined three different dimensions of gambling participation: frequency, total annual expenditure, and percent of gross income diverted to gambling. All three parameters show a robust relationship with risk of harm. Furthermore, each parameter independently predicted risk of gambling related harm even in the presence of the other parameters. The impact of gambling ultimately depends on the gambler’s financial means therefore percent income may be the most relevant parameter to consider when assessing risk of harm (Shaffer et al., 2004).

The nature of the relationship between risk level and gambling behaviour is best described as J-shaped rather than linear. This shape of curve is conducive to the application of a low-risk threshold for gambling. It appears that risk level remains constant at low levels of gambling participation but then increases sharply when a certain threshold is reached. The dose-response relationship for gambling is robust to variations in the definition of low-risk. The optimal low-risk cut-off was the same whether gambling-related harm was defined in terms of experiencing negative consequences or with a broader definition that included consequences and behavioural problems.

The relationship between level of risk and increasing gambling activity also seems to be independent of gender, age and even socioeconomic status. In other words, the more a person gambles, the more likely he or she is to experience harm from the gambling regardless of personal characteristics. Although the dose-response relationship is not mediated by demographics, it is affected by type of gambling. The risk of harm from electronic gaming machines and casinos increases with greater frequency of play. A similar but less pronounced trend was observed with bingo and instant-win tickets. Playing the lottery appears to be low risk
at all levels of frequency. Nevertheless, conclusions on the risk level associated with individual games are tentative at best because of the absence of expenditure data on specific forms of gambling. After excluding persons whose only form of gambling is playing the lottery, the optimal spending threshold separating low and high-risk gambling was lower. The model excluding lottery play also accounted for more variance than the one including lotteries. It is possible that low-risk limits need to be defined for each type of gambling activity (i.e., lottery, Bingo, slot machines, card games), although this would diminish their practical value.

Our identification of low-risk thresholds is preliminary but the overall approach does seem to have merit. One of the limitations of the risk curve approach is that there is no clear lower threshold of gambling below which there is no chance of harm. This caveat is also acknowledged in the epidemiology of alcohol-related harm (Midanik et al., 1996; Room et al. 1995). Gambling at any level appears to carry some level of risk and the identification of a quantitative threshold that separates lower-risk and higher-risk gambling could be seen as arbitrary. In the absence of a conceptual rationale for establishing such a threshold, we opted for an empirical approach that gave equal weighting to sensitivity with specificity.

We acknowledge that some degree of underreporting of gambling participation is inevitable in a population survey based completely on self-report. Indeed, a recent analysis of Canadian gambling data revealed a large discrepancy between the average self-reported household expenditure and the average household revenue the government obtains from games of chance (Azmier, 2005). The fact that risk of harm is still evident at very low levels of gambling involvement would suggest that some underreporting of gambling participation is occurring. Participants would have little to gain from outright deception so underreporting is more likely the product of forgetting. The most serious impact of underreporting is that the low-risk limits derived from survey responses would be on the conservative side. However, conservative limits are preferred if their intent is to provide the general public with “best advice” guiding individuals toward curtailing addictive behaviours that, if left unchecked, are likely to bring them harm.

The actual quantitative limits produced from our analysis may appear, at first glance, to be on the conservative end of gambling behaviour. For example, a limit of 1% on percent income may seem low but recall the limit applies to percent gross rather than disposable income. During the same year of the CCHS-1.2 Canadians spent an average of 5% of their disposable income on recreational activities (Statistics Canada, 2003). Utilizing different data sources, MacDonald et al. (2004) determined that the average Canadian spends less than 1% of his or her gross income on gambling activities. Hence, more than 1% of gross income is on the high end of gambling expenditure for Canadians, particularly when this could represent 20% to 40% of their total expenditure on all recreational activities.

The CPGI is a novel instrument that is slowly gaining acceptance as an assessment tool for measuring gambling on a population level. Most of the items from CPGI list of gambling-related problems can be found on better known instruments in the field such as the SOGS (Stinchfield, 2002) and the NODS (Gerstein et al., 1999). The CPGI covers problems not included on these instruments and it uses a 4-point scale for each item rather than the dichotomous yes-no format of the SOGS and NODS. Furthermore, there is little redundancy among the CPGI problem items. In contrast, the SOGS is over-represented by items concerning borrowing money. In the present study, we found high internal consistency values for the complete list of CPGI problem items and the subset that focuses on negative consequences.
The CCHS – 1.2 is a rich dataset that includes not only prevalence data on mental disorders but information on many other variables related to mental health. Although the present analysis focused on predicting harm, one could also examine protective factors associated with gambling above the low-risk limits without apparent consequences. Between 11% and 32% of gamblers exceed the low-risk thresholds but not all experience harm. Some gamblers may also experience a psychological benefit from low-risk gambling in terms of stress reduction, socialization, and satisfaction with supporting charitable causes (Desai et al. 2004). It is possible that the dose-response relationship in gambling reflects an underlying hormesis process (Shaffer, 2005). When exposure to an object is toxic at high dose levels and beneficial or protective at low dose levels a state of hormesis is achieved (Kaiser, 2003). An analysis of protective factors and psychological benefits is beyond the scope of the present study, but is certainly a worthy topic for future research.

Several limitations specific to the CCHS – 1.2 require attention. The risk curves and low-risk gambling limits may not generalize to individuals excluded from the sample, namely aboriginals living on reserves and non-Canadians. A comparable analysis of US gambling behaviours in the general population may yield a different dose-response relationship and different set of limits. Another limitation is that the CCHS – 1.2 was not specific to gambling. The CPGI questions were embedded within a very large survey covering a broad range of mental health problems. The gambling module did not collect information on time spent on gambling, and the question inquiring about expenditure used dollar ranges instead of soliciting a precise estimate. Information on time spent gambling and more exact gambling expenditure estimates were collected in several provincial gambling surveys that used the CPGI (Smith & Wynne, 2002; Wynne, 2002; Wiebe et al., 2001). Our preliminary analysis of the time variable in the provincial surveys reveals a similar relationship between time spent gambling and gambling related harm. Although more detailed information was collected in these other surveys, the CCHS – 1.2 still has many advantages. In addition to being a nationally representative and weighted sample, the response rate for the CCHS – 1.2 far exceeds the response rates from the provincial surveys, which ranged from 27% in British Columbia (Ipsos-Reid & Gemini Research, 2003) to 64% in Alberta (Smith & Wynne, 2002). Furthermore, the information in the CCHS – 1.2 was obtained through face-to-face rather than telephone interviews.

We draw two primary conclusions from this analysis. First, risk curves are a promising methodology for examining the relationship between gambling participation and risk of harm. Second, the development of low-risk gambling limits based on risk curves appears to be feasible. It should be noted that the limits proposed here are not intended to be final or definitive in any way. Gambling and gaming research are still in a state of evolution and expansion. The low-risk limits proposed are tentative only and are intended to serve as working guidelines for researchers, clinicians, and policy makers to examine for further research and consideration. Although the CCHS-1.2 survey is the largest in Canada ever to examine problem gambling, it has limitations that impact the generalization of these results. The next step is to cross validate the limits derived from the CCHS-1.2 on data derived from other provincial prevalence studies in Canada (Ferris & Wynne, 2001). Upon successful cross-validation and dissemination to other professionals in the field for feedback, the low-risk limits could have numerous implications for both prevention and treatment. For example, quantitative limits on gambling behaviour would be a useful augment to the current responsible gambling guidelines. The may also have application in treatment for gamblers wishing to control rather than abstain from gambling.
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Table 1

*Responsible Gambling Guidelines by the Responsible Gaming Council of Ontario*

- Gamble for entertainment, not as a way to make money
- Balance gambling with other leisure activities
- Gamble together with friends or family, not alone
- Do not 'chase' losses; accept losses as the cost of entertainment
- Use discretionary income, not money for everyday expenses
- Do not use cash machines to get more money for gambling than intended
- Set a budget and stick to it
- Don't borrow money to gamble
- Know that the risk of problems increases at times of loss or depression
- Take frequent breaks
- Set a time limit and quit when the time is up

Table 2

Sensitivity and specificity for different definitions of low-risk

<table>
<thead>
<tr>
<th>Definition of low-risk</th>
<th>% of population gambling outside definition</th>
<th>Frequency of gambling</th>
<th>Dollars spent on gambling</th>
<th>Percent gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AUC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 2 problems(^1)</td>
<td>7.8%</td>
<td>.79</td>
<td>2 - 3 times per month</td>
<td>$501-$1000 per year</td>
</tr>
<tr>
<td>Less than 2 negative consequences(^2)</td>
<td>4.2%</td>
<td>.81</td>
<td>2 - 3 times per month</td>
<td>$501-$1000 per year</td>
</tr>
<tr>
<td>Zero negative consequences</td>
<td>7.3%</td>
<td>.79</td>
<td>2 - 3 times per month</td>
<td>$501-$1000 per year</td>
</tr>
<tr>
<td>% of population gambling outside definition</td>
<td></td>
<td>Frequency of gambling</td>
<td>Dollars spent on gambling</td>
<td>Percent gross income</td>
</tr>
<tr>
<td></td>
<td>AUC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.79</td>
<td>86.2</td>
<td>70.3</td>
<td>68.4</td>
</tr>
<tr>
<td></td>
<td>.81</td>
<td>88.3</td>
<td>78.3</td>
<td>71.7</td>
</tr>
<tr>
<td></td>
<td>.79</td>
<td>85.3</td>
<td>69.9</td>
<td>71.2</td>
</tr>
<tr>
<td></td>
<td>2 - 3 times per month</td>
<td>Sensitivity</td>
<td>Specificity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$501-$1000 per year</td>
<td>1%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$501-$1000 per year</td>
<td>Sensitivity</td>
<td>Specificity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$501-$1000 per year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$501-$1000 per year</td>
<td>Sensitivity</td>
<td>Specificity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$501-$1000 per year</td>
<td>1%</td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) From list of 15 problems in Canadian Problem Gambling Index (CPGI).  \(^2\) Subset of CPGI problem list \((n = 8)\) identified as negative consequences of gambling.
# Table 3

**Predicting harm from gambling**

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Model 1 (Demographics alone)</th>
<th>Model 2 (Demographics, frequency)</th>
<th>Model 3 (Demographics, amount spent)</th>
<th>Model 4 (Demographics, percent income)</th>
<th>Model 5 (Demographics + all)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>p</td>
<td>OR</td>
<td>p</td>
<td>OR</td>
</tr>
<tr>
<td>Male¹</td>
<td>1.62</td>
<td>.000</td>
<td>1.31</td>
<td>.015</td>
<td>1.02</td>
</tr>
<tr>
<td></td>
<td>(1.31 - 1.99)</td>
<td></td>
<td>(1.05 - 1.63)</td>
<td></td>
<td>(0.80 - 1.29)</td>
</tr>
<tr>
<td>Age²</td>
<td>0.99</td>
<td>.000</td>
<td>0.97</td>
<td>.000</td>
<td>0.97</td>
</tr>
<tr>
<td></td>
<td>(0.98 - 0.99)</td>
<td></td>
<td>(0.97 - 0.98)</td>
<td></td>
<td>(0.96 - 0.97)</td>
</tr>
<tr>
<td>High school or less education³</td>
<td>1.50</td>
<td>.000</td>
<td>1.27</td>
<td>.034</td>
<td>1.12</td>
</tr>
<tr>
<td></td>
<td>(1.20 - 1.88)</td>
<td></td>
<td>(1.02 - 1.59)</td>
<td></td>
<td>(0.88 - 1.42)</td>
</tr>
<tr>
<td>Non-Caucasian⁴</td>
<td>1.46</td>
<td>.026</td>
<td>1.43</td>
<td>.042</td>
<td>1.51</td>
</tr>
<tr>
<td></td>
<td>(1.05 - 2.03)</td>
<td></td>
<td>(1.01 - 2.02)</td>
<td></td>
<td>(1.01 - 2.26)</td>
</tr>
<tr>
<td>Household income²</td>
<td>0.94</td>
<td>.009</td>
<td>0.93</td>
<td>.002</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>(0.90 - 0.98)</td>
<td></td>
<td>(0.89 - 0.97)</td>
<td></td>
<td>(0.83 - 0.92)</td>
</tr>
<tr>
<td>Frequency⁵</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 2-3 times per month</td>
<td>-</td>
<td></td>
<td>-</td>
<td></td>
<td>(9.60 - 18.43)</td>
</tr>
<tr>
<td>Amount spent⁶</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than $501-$1000/year</td>
<td>-</td>
<td></td>
<td>-</td>
<td></td>
<td>13.78</td>
</tr>
<tr>
<td>Percent income⁷</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1% income</td>
<td>-</td>
<td></td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model R-square</td>
<td>0.02</td>
<td></td>
<td>0.15</td>
<td></td>
<td>0.21</td>
</tr>
</tbody>
</table>
Note: Bootstrap sampling weights used. The 95% confidence interval for estimate is shown in parentheses. Dependent variable is reporting two or more negative consequences from gambling (0 = no, 1 = yes) on the Canadian Problem Gambling Index.  

1 Gender coding: female = 0, male = 1.  
2 Age and household income (total gross) entered as continuous variables.  
3 Education coding: Some post-secondary = 0, high school or less = 1.  
4 Ethnicity coding: Caucasian = 0, non-Caucasian = 1.  
5 Coding: gamble no more often than 2-3 times per week = 0, gamble more than 2-3 times per week = 1.  
6 Total amount spent per year on gambling; Coding: less than $501-$1000 per year = 0, more than $501-$1000 per year = 1.  
7 Percent of gross household income spent on gambling; Coding: up to 1% = 0, more than 1% = 1.
Figure Captions

Figure 1. Harm from gambling (proportion reporting 2 or more negative consequences in last 12 months) by frequency of any gambling activity for men (open triangles), women (open squares), and total population (circles). Separate male and female rates for 1-5 times per year not shown because of imprecision in the estimates (coefficient of variation exceeds Statistics Canada guideline for release).

Figure 2. Harm from gambling (proportion reporting 2 or more negative consequences in last 12 months) by total dollars spend in a year for men (open triangles), women (open squares), and total population (circles).

Figure 3. Harm from gambling (proportion reporting 2 or more negative consequences) by percent of gross income spent on gambling for men (open triangles), women (open squares), and total population (circles). Female rate for first category of percent income level not shown because of imprecision in the estimate (coefficient of variation exceeds Statistics Canada guideline for release).

Figure 4. Harm from gambling (proportion reporting 2 or more negative consequences) by frequency of different types of games. Shown are electronic gaming machines (EGM) inside of casinos (open triangles), EGMs outside of casinos (open squares), bingo (open circles), lottery (circles), casino games (asterisks), and instant-win tickets (closed diamonds). Proportions for daily gamblers in lottery, casino and VLT categories are not shown because of imprecision in the estimate exceeds Statistics Canada guidelines for release.
### N per category

<table>
<thead>
<tr>
<th>Category</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 times/year</td>
<td>3155</td>
<td>4518</td>
<td>7673</td>
</tr>
<tr>
<td>6-11 times/year</td>
<td>607</td>
<td>712</td>
<td>1319</td>
</tr>
<tr>
<td>Abortion once/month</td>
<td>737</td>
<td>884</td>
<td>1621</td>
</tr>
<tr>
<td>Abortion twice/month</td>
<td>857</td>
<td>912</td>
<td>1769</td>
</tr>
<tr>
<td>Abortion three/month</td>
<td>1820</td>
<td>1663</td>
<td>3483</td>
</tr>
<tr>
<td>Abortion four/month</td>
<td>1479</td>
<td>1213</td>
<td>2692</td>
</tr>
<tr>
<td>Daily</td>
<td>146</td>
<td>126</td>
<td>272</td>
</tr>
</tbody>
</table>
The graph shows the percentage of respondents reporting two or more consequences across different income categories. The data is divided into three categories for males, females, and total.

### N per category

<table>
<thead>
<tr>
<th>Category</th>
<th>0-$99</th>
<th>$61-$100</th>
<th>$101-$250</th>
<th>$251-$500</th>
<th>$501-$1,000</th>
<th>&gt;$1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>1179</td>
<td>950</td>
<td>1282</td>
<td>977</td>
<td>661</td>
<td>619</td>
</tr>
<tr>
<td>Females</td>
<td>1671</td>
<td>1127</td>
<td>1165</td>
<td>713</td>
<td>427</td>
<td>398</td>
</tr>
<tr>
<td>Total</td>
<td>2850</td>
<td>2077</td>
<td>2447</td>
<td>1690</td>
<td>1088</td>
<td>1017</td>
</tr>
</tbody>
</table>
N per category

Males: 555, 500, 642, 649, 588, 724, 635, 553
Females: 627, 573, 647, 573, 490, 526, 502, 596
Total: 1182, 1073, 1289, 1222, 1078, 1250, 1137, 1149