In search of lower risk gambling levels using behavioral data from a gambling monopolist

JAKOB JONSSON[1,2]* ⓘ, DAVID C. HODGINS[3] ⓘ, AXEL LYCKBERG[4] ⓘ, SHAWN CURRIE[3] ⓘ, MATTHEW M. YOUNG[5,6] ⓘ, STÅLE PALLESEN[7,8,9] ⓘ and PER CARLBRING[1] ⓘ

[1] Department of Psychology, Stockholm University, Stockholm, Sweden

[2] Department of Clinical Neuroscience, Centre for Psychiatry Research, Karolinska Institutet, Sweden

[3] Department of Psychology, University of Calgary, Canada

[4] Playscan, Svenska Spel, Sweden

[5] Canadian Centre on Substance Use and Addiction, Ottawa, Canada

[6] Department of Psychology, Carleton University, Ottawa, Canada

[7] Department of Psychosocial Science, University of Bergen, Bergen, Norway

[8] Norwegian Competence Center for Gambling and Gaming Research, University of Bergen, Bergen, Norway

[9] Optentia, The Vaal Triangle Campus of the North-West University, Vanderbijlpark, South Africa

FULL-LENGTH REPORT

ABSTRACT

Background and aims: Lower-risk recommendations for avoiding gambling harm have been developed as a primary prevention measure, using self-reported prevalence survey data. The aim of this study was to conduct similar analyses using gambling company player data. *Methods:* The sample ($N = 35,753$) were Norsk Tipping website customers. Gambling indicators were frequency, expenditure, duration, number of gambling formats and wager. Harm indicators (financial. social, emotional, harms in two or more areas) were derived from the GamTest self-assessment instrument. Receiver operating characteristics (ROC) curves were performed separately for each of the five gambling indicators for each of the four harm indicators. *Results:* ROC areas under the curve were between 0.55 and 0.68. Suggested monthly lower-risk limits were less than 8.7 days, expenditure less than 54 €, duration less than 72–83 min, number of gambling formats less than 3 and wager less than 118–140€. Most risk curves showed a rather stable harm level up to a certain point, from which the increase in harm was fairly linear. *Discussion:* The suggested lower-risk limits in the present study are higher than limits based on prevalence studies. There was a significant number of gamblers (5–10%) experiencing harm at gambling levels well below the suggested cut-offs and the risk increase at certain consumption levels. *Conclusions:* Risk of harm occurs at all levels of gambling involvement within the specific gambling commercial environment assessed in an increasingly available gambling market where most people gamble in multiple commercial environments, minimizing harm is important for all customers.

*Corresponding author.
E-mail: jakob.jonsson@ki.se

INTRODUCTION

Gambling is associated with various degrees of harm and problematic gambling is considered a public health issue in many countries. Harm includes, in addition to obvious financial negative impact, relationship problems, emotional or psychological distress, impaired health,

cultural harm, impaired academic or work performance as well as criminal activity (Langham et al., 2016). At the extreme, gambling disorder is the formal medical diagnosis that is characterized by impairment of control, continued gambling despite significant negative consequences and increasing priority given to gambling over other activities (American Psychiatric Association, 2013).

There is a common interest for society, the gambling industry and individuals and their families to prevent gambling problems. Prevention requires a multifaceted approach (Christensen, 2020; Hing et al., 2019) focusing on the parameters of the gambling products and environment as well as individual-level initiatives. Prevention can take place at the primary, secondary and tertiary level (Caplan, 1964). In the alcohol field, a primary prevention measure since the 1990s has been to develop recommendations for "low-risk drinking", advice to consumers on the maximum number of standard drinks a person can drink per day and per week and still have a relatively low risk of developing negative, typically physical health, consequences. Inspired by this, attempts have been made to develop similar recommendations for gambling (Brosowski et al., 2015; Currie et al., 2009, 2012, 2017; Dowling et al., 2018). Unlike alcohol, where physical harm can be defined and measured reliably, gambling-related harm is multidimensional and more challenging to measure. Moreover, whereas it is assumed that people of the same sex and body weight are affected fairly equally by the physical harmful effects of alcohol, the harmful effects of gambling are partially determined by how much time and money a person has at their disposal. A person with very scarce financial circumstances can experience negative gambling-related consequences at lower losses than one with more financial resources.

Solutions to some of the challenges associated with identifying lower risk gambling guidelines have evolved over the course of a number of studies by different investigator groups (Brosowski et al., 2015; Currie et al., 2012; Dowling et al., 2021). For example, one way to handle individual differences in financial means is to examine gambling expenditure as a proportion of the individual's income versus simple expenditure (Currie et al., 2017). Using actual player data from gambling accounts is another approach with unique strengths and limitations (Gainsbury, 2011). Two studies have addressed the issue of the accuracy of gambling behaviour as measured in population surveys by using actual recorded player data versus retrospectively self-reported gambling. In the first of these studies, Brosowski, Meyer, and Hayer, (2012) applied lower risk guidelines calculated from Canadian survey data collected in the same timeframe (Currie et al., 2006) to player data from BWin, a European online gambling provider. They reported that involvement in a larger number of gambling formats increased the likelihood of exceeding the limits, and that exceeding the limits was associated with increased likelihood of players choosing to close their accounts due to gambling-related problems. More recently, Louderback, LaPlante, Currie, and Nelson (2021), also using data from BWin, compared the performance of lower risk guidelines calculated from a Canadian longitudinal

survey sample (Currie et al., 2017) to limits they calculated from online gambling data. The latter limits were higher, and, for some harm indicators, more strongly predictive. They concluded that online gambling might require different limits than land-based gambling because of its higher risk profile (Brosowski, Olason, Turowski, & Hayer, 2021; Gainsbury, 2015).

The Louderback et al. (2021) study had a number of limitations. The authors noted that their study focused on predicting risk of gambling disorder and not harms conceptualized more broadly as in other studies. Individuals not meeting the criteria for gambling disorder experience significant amounts of harm (Langham et al., 2016). Another limitation is that the entirety of individuals' gambling was not available for analysis. Many online gamblers also gamble on land-based venues (Lind et al., 2021). Although the participants' Bwin gambling was reliably assessed, land-based and gambling on other online sites were not included. In the current study we use player data that reflects both online and venue-based gambling, capturing the majority of individuals' gambling involvement by accessing data from a Norwegian monopoly gambling company.

Cross national study

Lower-risk gambling guidelines (LRGGs) based on self-report data from eight different countries were recently released (Young et al., 2022). The development of the guidelines followed a careful methodology that used the highest quality epidemiological datasets of gambling and gambling-related harms to calculate risk curves, which were subsequently validated through a series of follow-up studies (Hodgins et al., 2022). The study is unique in that it conducted identical analyses across 11 datasets from 8 countries instead of relying on a single data source. Based upon very similar results cross nationally, the guidelines recommend that people in general gamble no more than 1% of their net family income per month, 4 days per month, and avoid regularly gambling at more than 2 types of games. The guidelines also note that people with mental health or substance use struggles or who have a family or personal history of problem gambling should consider gambling even more conservatively, if at all. Individuals are also cautioned that gambling to escape problems is associated with increased risk of harm. Finally, the guidelines indicate that fast paced games can be particularly problematic (Young et al., 2022).

These guidelines provide people the information necessary to make better-informed and more responsible decisions about their gambling behaviour. The guidelines also potentially provide regulators and industry with direction on how to offer gambling products most safely. They also provide healthcare providers with standards for evaluating the potential of harm in their patients.

The current study

Although the cross-national data sets used in the risk curve analyses incorporated the best validated self-report items for assessing gambling behaviour involvement (Currie, 2019),

the reliance on self-report is imperfect. In this current study, we use behavioural player tracking data obtained from the Norwegian Playscan dataset, which, uniquely, records individual behavioural data from all online and land-based gambling platforms owned and operated by the national monopolist, Norsk Tipping (NT). NT is a state-owned company with a broad gambling portfolio with retail and online lotteries and sports betting, online bingo and casino games[1] and VLTs at land-based venues. They have around 2 million customers, 74% play online to some extent. Only physical lottery ticket sales are not captured. Thus, this Norwegian Playscan dataset captures behavioural with almost 100% coverage of the participants gambling at NT.

In addition to behavioural gambling involvement data, we also had access to self-reported gambling related harm data among a subset of those gambling on NT products. People gambling on NT products can access their personal data through Playscan. Playscan provides individuals feedback on their gambling behaviour and encourages use of responsible gambling (RG) tools and provides recommendations based on their gambling risk level. When accessing Playscan, people are encouraged to complete GamTest, a brief self-assessment of gambling-related harm (Jonsson, Munck, Volberg, & Carlbring, 2017).

Aims

The goal of this study was to calculate risk curves describing the relationship between recorded behavioural gambling involvement and self-reported gambling harms. More specifically we wished to assess: (1) whether it was possible to find low-risk thresholds for gambling using behavioural data and the GamTest (Jonsson et al., 2017) harm items as harm indicators; and (2) whether these thresholds differ from those assessed by Young et al. (2022). A secondary goal was to explore low-risk thresholds for the age-group 18–25.

METHOD

Participants

The sample ($N = 35,753$) consisted of NT customers who had completed an online GamTest self-assessment (Jonsson et al., 2017) within the Playscan platform on the NT website between April 2019 and April 2020. The mean age was 43 years (SD 15, range 18–90) and 33% were women.

Measures

Risk indicators. GamTest consists of 15 items with a 0–10 response format that capture five dimensions of problematic gambling with high reliability; overconsumption of money and time, and monetary, social and emotional negative consequences. The GamTest dimensions correlate highly with the PGSI and self-perceived gambling problems

[1]Slots and table games, but not Poker.

(Forsström, Lindner, Jansson-Fröjmark, Hesser, & Carlbring, 2020; Jonsson et al., 2017). GamTest scores among the sample indicated 85.7% were non-problem gamblers, 10.7% at-risk gamblers and 3.7% problem gamblers.

Following the methods employed by Currie et al. (2017), the 8 GamTest items specifically assessing harm were used to calculate four dichotomous harm indicators: Monetary (items GT3, GT7, GT8, GT10 with a cut-off of 4 for harm), Social (items GT11, GT12, cut-off of 3) Emotional (items GT14, GT15, cut-off of 8), and "Two plus" (scoring positive on two or more of the 8 GT items). The GamTest items are available in Jonsson et al. (2017).

Gambling indicators. Information about gambling participation, three months prior to taking the GamTest, was derived from behavioural tracking data from the NT database. Participation was measured using five behavioural gambling indicators (mean calculated across the last three months): (1) frequency (mean monthly frequency); (2) expenditure (mean monthly net loss or win in Euro, sum of wager minus winnings across all game types. Wins were included to mirror all customers); (3) duration (mean monthly time spent gambling in minutes); (4) number of gambling formats played in the past three months, possible gambling formats were lotteries, bingo, casino, VLT and betting; and (5) wager size (mean monthly wager in Euros).

Statistical methods

SPSS, version 26 was used for the statistical analysis. Following Currie et al. (2012), receiver operating characteristics (ROC) curves were performed separately for each of the five gambling indicators for each of the four harm indicators. For each gambling indicator, except number of gambling formats, participants were categorized into 20 equal size bins to reflect increasing gambling. The number of format categories was limited to five, the maximum number of formats possible. To visualize the relationship between gambling activity and risk of harm, risk curves were constructed and presented. Area under the curve (AUC) with 95% CIs for each risk curve and the optimal cut-off as indicated by the gambling level showing maximum specificity while maintaining a sensitivity >0.70 are reported. Optimal cut-offs for 18–25 year olds are also presented.

To examine the relative contributions of the five gambling indicators in terms of increase in harm, four separate binary logistic regressions with different harm indicators as dependent variables (financial, social, emotional and two plus) were performed. To document the increase in risk associated with increasing gambling, another set of binary logistic regressions was performed for each of the five gambling indicators for each of the harm variables as dependent variables. For each gambling variable, the lowest group was the reference group, and the other groups were treated as categorical. The number of groups formed was based on meaningful ranges of the gambling indicator and varied among the indicators (categories are available in Table 4). For net expenditure, winners were excluded in the analysis. The resulting odds ratio for each analysis was

transformed to percentage change in risk for each group compared to the reference category. The increase in risk was rounded off to increments of 5.

Ethics

The study plan was approved by the Regional Ethical Review Board in Linköping, Sweden, in 2020. Participants had previously agreed in their customer agreement that their personal data could be used for the purpose of preventing the negative consequences of gambling.

RESULTS

Risk curve analysis

Frequency. As seen in Fig. 1, a high proportion is reporting harm even at a low frequency of gambling and a linear increase of harm is found from a frequency around 9 days, forming a J-shaped curve. As seen in Table 1, AUCs for the four harm indicators ranged from 0.55 to 0.59 and 8.68 days per month was identified as the optimal cut-off across all four indicators. Optimal cut-off for 18–25 year olds was 5–5.67 days. The proportion of people reporting harm reported below the cut-off is between 11% and 18% and the increase in risk above the cut-off is between 1.4 and 1.8 times across the four harm categories.

Expenditure. As seen in Fig. 1, the proportion of the sample reporting harm was quite high at all levels of expenditure. Higher harm was found among players winning and losing more than around 55 €, forming U-shaped curves. As seen in Table 1, AUC for the four harm indicators was between 0.55 and 0.58, with 53.8 €/month as the suggested optimal cut-off across all indicators. It corresponds to approximately 1% of median household gross income in Norway[2]. Optimal cut-off for 18–25 year olds was 32.6 €. The percentage of the sample reporting harm who were below the cut-off ranges between 11% and 18% and the increase in risk above the cut-off is between 1.6 and 1.8 times across the four harm categories.

Duration. As seen in Fig. 1, the proportion of the sample reporting harm is above 10% at all duration levels. Starting flat, a linear increase is found from a duration just above one hour, forming J-shaped curves. As seen in Table 1, AUC for the four harm indicators was between 0.63 and 0.67, with 72 min as suggested optimal cut-off for Two plus harm. The cut-off for the GamTest dimensions was >83 min. Optimal cut-off for 18–25 year olds was 45–57 min. The proportion of the sample reporting harm below the cut-off was between 9% and 15% and the increase in risk above the cut-off is between 2.3 and 2.7 times across the four harm categories.

Number of gambling formats. As seen in Table 1, AUC for the four harm indicators ranged between 0.64 and 0.66, with more than two gambling forms as suggested cut-off. As seen

in Fig. 1, there was a linear increase in risk of harm with an increased number of formats played. As seen in Table 1, the harm reported below the cut-off was between 11% and 18% and the increase in risk above the cut-off is between 2.5 and 2.7 times across the four harm categories.

Wager size. As seen in Fig. 1, the proportion of the sample reporting harm is around 10% at the lower wager sizes. Starting flat, a linear increase is found from a wager just above 100 € forming J-shaped curves. As seen in Table 1, AUC for the four harm indicators was between 0.64 and 0.68, and >118.2 € as suggested cut-off for Two plus harm. The optimal cut-off for the GamTest dimensions was >139.6 €. It corresponds to approximately 2.1%–2.5% of median household gross income in Norway. Optimal cut-off for 18–25 year olds was 81.5 €. The harm reported below the cut-off is between 9% and 15%, and the increase in risk above the cut-off is between 2.4 and 2.9 times.

Risk and change in risk

Table 2 summarizes the lower risk cut-offs and Table 3 displays the reference group definitions, the percentage of participants gambling at that level, and the percentage experiencing harm. The percentage of participants gambling at the reference group level which ranged from 12.2% to 60.4% depending on the gambling indicator. The percentage of individuals experiencing harm ranged from 9.5% to 16.7% depending on the harm indicator.

Table 4 shows the increase in risk with increasing gambling involvement for each gambling indicator and the cumulative percentage of participants gambling at each level or lower.

Low risk limits and harm

As seen above, there are persons gambling below the low-risk limits who experience harm. Table 5 presents gender, age and gambling participation for four groups: below all low-risk limits and no harm, below all low-risk limits and harm, above any low-risk limit and no harm, above any low-risk limit and harm. Comparing the two below low-risk limit groups shows that the group experiencing harm are younger, have a higher proportion of men and a higher participation in betting and online casino than the group with no harm who have higher participation in lottery. For the two groups above low-risk limits, we see the same pattern and also a higher participation in VLT in the harm group.

DISCUSSION

Data from a specific gambling commercial environment, comprising actual gambling behaviour, were analyzed in a search for reliable and valid lower risk limits. GamTest (Jonsson et al., 2017) items were used as harm indicators for financial, social and economic harm.

In the ROC analyses, AUCs were just below 0.60 for Frequency and Expenditure and for Duration, Number of gambling formats and Wager AUC were around 0.65.

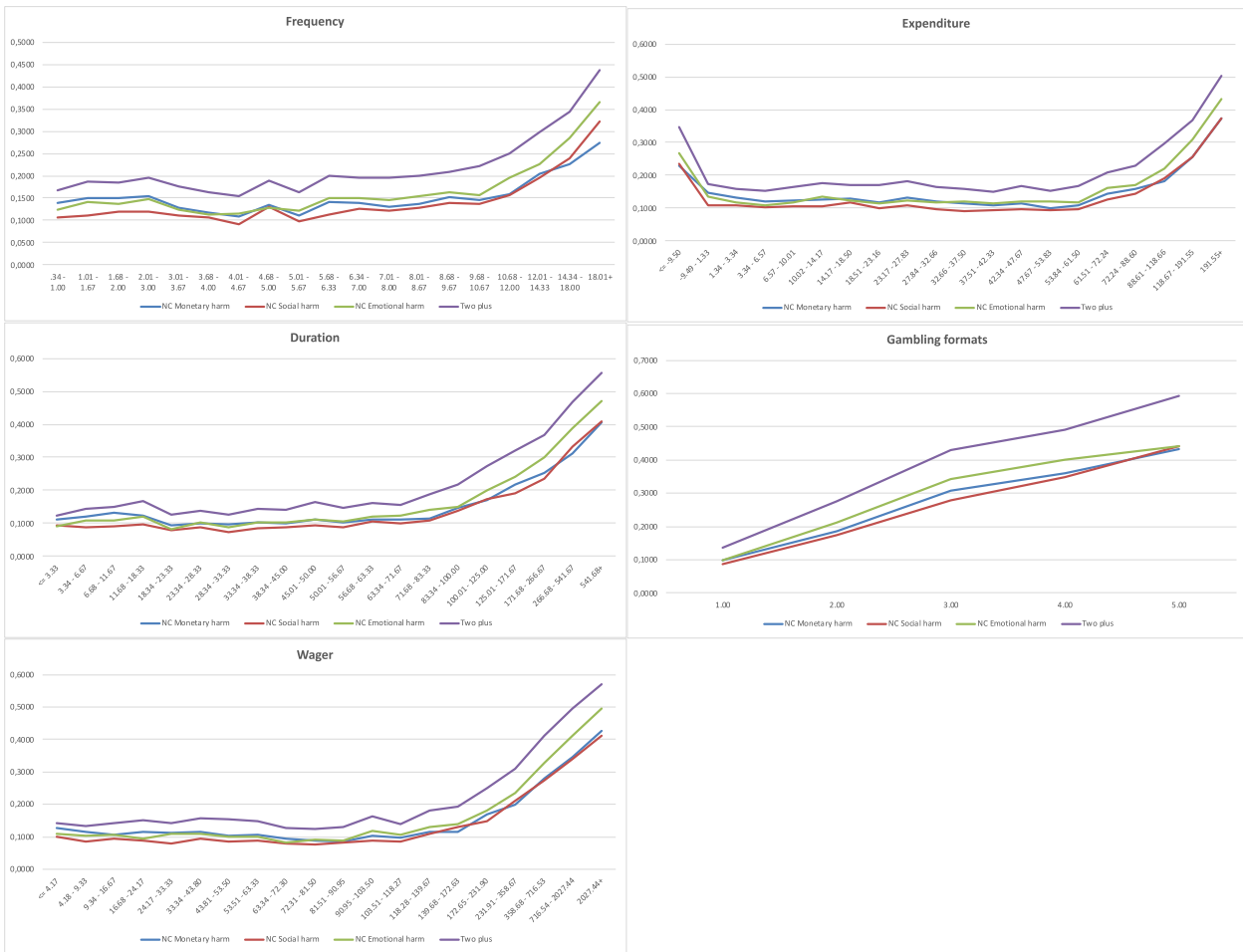[2]66 816 € in 2020 according to Statistics Norway https://www.ssb.no/en.

Fig. 1. Risk curves for frequency, expenditure, duration, gambling formats and wager on Two plus harm and financial harm, social harm and emotional harm

Although AUC of 0.60 is considered adequate for longitudinal prediction (Currie et al., 2017), these AUC values are somewhat lower than previous research with data from prevalence studies, which is surprising given that the current objectively recorded gambling data include less measurement error than reported data. However, because only the individuals gambling with NT was captured, gambling on other platforms may also be contributing to gambling-related harms. In previous risk curve analyses using prevalence data, all gambling is normally included in an individual's self-report, albeit influenced by memory and other reporting biases.

The suggested low-risk limits in the present study are higher than limits suggested by the lower risk guidelines derived from international data sets (Young et al., 2022) and those identified by Currie et al. (2017). In contrast, the limits for frequency and wager are lower and net loss higher compared to Louderback et al. (2021) who also used data from a gambling company versus prevalence survey data. Their datasets are older, from between the years 2005 and 2011, which partly could explain the differences. In addition, Bwin and NT's have different returns to the player. As a monopoly company, NT has lower

return to player than common offshore companies, partly due to product mix. This in turn yields higher net losses for the same wager.

The low-risk limits for 18–25 years old presented in this study are significantly lower than the low-risk limits based on the whole sample. This is unsurprising since younger people are more vulnerable to gambling problems and generally have fewer financial resources. This result indicates that one should consider special low-risk recommendations for younger persons.

One notable observation of these findings is that there is a significant number of gamblers experiencing harm in the reference groups which reflect gambling levels well below the suggested cut-offs. Those gambling below low-risk levels and experiencing harm tend to be younger and playing high-risk games to a greater extent than those playing below low-risk limits with no harm. In fact, even at the lowest levels of gambling, at least 5% and typically 10% of individuals report harm. This could partly be explained by the fact that many customers at NT also play at other companies. It is also a consequence of using a relative risk approach to cut-off development which identifies a threshold that optimizes the identification of harm versus no harm, above and below the

Table 1. Gambling related harm categories and ROC results for gambling frequency, expenditure, duration, gambling formats and wager

| Gambling frequency | AUC (95% CI) | ROC results | | OR | % harm below cut-off | % harm above cut-off |
		Sensitivity/ Specificity	Optimal cut-off (18–25 year old)			
Financial harm	0.55 (0.56–0.58)	0.37/72	8.68 days (5.67 days)	1.45	13.4	19.5
Social harm	0.59 (0.58–0.60)	0.42/73	8.68 days (5.67 days)	1.77	11.2	19.9
Emotional harm	0.59 (0.58–0.60)	0.42/73	8.68 days (5.67 days)	1.74	13.4	23.3
2+ harms	0.59 (0.58–0.59)	0.40/0.74	8.68 days (5 days)	1.63	18.0	29.4

| Expenditure | AUC (95% CI) | ROC results | | OR | % harm below cut-off | % harm above cut-off |
		Sensitivity/Specificity	Optimal cut-off (18–25 year old)			
Financial harm	0.55 (0.54–0.56)	0.40/0.72	53.8 € (32.6 €)	1.57	12.9	20.3
Social harm	0.57 (0.56–0.58)	0.43/72	53.8 € (32.6 €)	1.77	11.2	19.8
Emotional harm	0.58 (0.57–0.59)	0.44/0.73	53.8 € (32.6 €)	1.80	13.1	23.6
2+ harms	0.57 (0.56–0.58)	0.42/0.73	53.8 € (32.6 €)	1.66	17.8	29.6

| Duration | AUC (95% CI) | ROC results | | OR | % harm below cut-off | % harm above cut-off |
		Sensitivity/Specificity	Optimal cut-off (18–25 year old)			
Financial harm	0.63 (0.62–0.64)	0.50/0.73	>83 min (57 min)	2.29	10.9	25.0
Social harm	0.66 (0.65–0.67)	0.54/0.74	>83 min (57 min)	2.68	9.1	24.5
Emotional harm	0.66 (0.65–0.67)	0.54/0.74	>83 min (57 min)	2.68	10.7	29.0
2+ harms	0.66 (0.65–0.67)	0.56/0.71	>72 min (45 min)	2.36	14.8	36.4

| Number gaming formats | AUC (95% CI) | ROC results | | OR | % harm below cut-off | % harm above cut-off |
		Sensitivity/Specificity	Optimal cut-off (18–25 year old)			
Financial harm	0.64 (0.63–0.65)	0.27/0.90	<3 (<3)	2.54	12.7	32.2
Social harm	0.65 (0.64–0.66)	0.28/0.90	<3 (<3)	2.63	11.4	30.0
Emotional harm	0.66 (0.65–0.67)	0.28/0.90	<3 (<3)	2.68	13.4	35.9
2+ harms	0.66 (0.65–0.67)	0.27/0.91	<3 (<3)	2.50	17.9	44.8

| Wager | AUC (95% CI) | ROC results | | OR | % harm below cut-off | % harm above cut-off |
		Sensitivity/Specificity	Optimal cut-off (18–25 year old)			
Financial harm	0.64 (63–0.64)	0.51/0.74	139.6 € (81.5 €)	2.40	10.7	25.6
Social harm	0.66 (0.66–0.67)	0.55/0.74	139.6 € (81.5 €)	2.84	8.9	25.2
Emotional harm	0.68 (0.67–0.68)	0.55/0.75	139.6 € (81.5 €)	2.87	10.4	29.9
2+ harms	0.66 (0.66–0.67)	0.57/0.71	118.2 € (81.5 €)	2.41	14.6	37.2

Table 2. Suggested optimal cut-offs for low-risk limits maximizing sensitivity while maintaining specificity >0.70

Gambling involvement indicator (per month)	Low risk limit	Low risk limit age 18–25
Frequency	8.7 days	5.0–5.7 days
Expenditure	53.8 €	32.6 €
Duration	72–83 min	45–57 min
Number of gambling types	3	3
Wager	118.2–139.6 €	81.5 €

Note: Lower risk is below these values.

cut-off. It does not determine the best cut-off that prevents all harm.

The shape of risk curves for gambling problems and their meaning have been subject to debate. The risk curves presented by Currie et al. (2009, 2012, 2017) for different gambling behaviours were J-shaped. Markham et al. (2016) found r-shaped risk curves for gambling frequency in three different countries and a linear risk curve in Norway. Using quintiles on the x-axis, Louderback et al. (2021) describe the risk curves as J-shaped when using online gambling data, but these could also be described as having a shape fairly close to linear. In the present study, the shapes of most risk
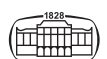
Table 3. Reported harm among the reference groups

	Frequency	Expenditure (excl winners)	Duration	Gambling formats	Wager
Definition reference group (per month)	≤1 day	≤6.8 €	≤1 h	1 format	≤20 €
% of sample gambling at this level	12.2	14.0	58.2	60.4	17.2
% of reference group reporting harm					
Financial harm	14.0	13.1	10.6	10.0	14.3
Social harm	10.7	10.4	9.0	8.7	11.8
Emotional harm	12.3	11.6	10.2	9.9	9.5
2+ harms	16.7	15.8	13.9	13.6	10.5

Table 4. Change in risk occurring when different gambling behaviours predict financial, social and emotional harms. The increase in risk for the gambling levels above the optimal cutoffs derived from the risk curve analyses are bolded.

Frequency (days)	≤1 day (Ref)	1.33–4	4.33–8	8.33–12	12.33–16	16.33–20	20.33–24	24.33–28	≥28.33
% of sample below upper point	12.2	32.61	64.9	84.2	92.6	96.5	98.4	99.6	
△ risk from reference group									
Financial harm		25%	10%	30%	**95%**	170%	175%	180%	280%
Social harm		15%	15%	45%	**135%**	235%	310%	385%	515%
Emotional harm		30%	30%	65%	**155%**	320%	320%	435%	740%
2+ harms		35%	35%	70%	**165%**	305%	365%	375%	570%
Expenditure (excluding winners)	≤6.8 € (Ref)	>6.8–40.2		>40.2–60.3		>60.3–80.4		>80.4–134	>134
% of sample below upper point	14.8	54.7		72.4		81.5		91	
△ risk from reference group									
Financial harm		−10%		−20%		**5%**		**60%**	215%
Social harm		0%		−5%		**25%**		**105%**	315%
Emotional harm		5%		5%		**45%**		**120%**	375%
2+ harms		10%		5%		**40%**		**125%**	335%
Duration (minutes)	≤60 (Ref)	61–120		121–180		181–240		241–300	301–360
% of sample below upper point	58.2	79.1		85.6		89		91	
△ risk from reference group									
Financial harm		25%		**135%**		**175%**		**235%**	270%
Social harm		45%		**150%**		**200%**		**285%**	405%
Emotional harm		50%		**185%**		**265%**		**395%**	455%
2+ harms		55%		**200%**		**240%**		**350%**	435%
Gambling formats	1 (Ref)	2		3		4		5	
% of sample below upper point	60.4	87.1		96.8		99.7			
△ risk from reference group									
Financial harm		110%		**300%**		**405%**		**590%**	
Social harm		120%		**305%**		**460%**		**725%**	
Emotional harm		145%		**375%**		**515%**		**620%**	
2+ harms		145%		**380%**		**515%**		**825%**	
Wager	0–20 € (Ref)	20.1–70	70.1–120	120.1–170	170.1–220	220.1–270	>270		
% of sample below upper point	17.2	43.8	65.4	74.7	79.2	82			
△ risk from reference group									
Financial harm		−10%	−20%	−5%	**50%**	**75%**	260%		
Social harm		−15%	−10%	30%	**65%**	**130%**	345%		
Emotional harm		−5%	−5%	35%	**85%**	**150%**	425%		
2+ harms		0%	−5%	40%	**95%**	**155%**	415%		

curves show a rather stable harm level up to a certain point, from which the increase in harm is fairly linear. From a gambling company's perspective, this indicates that customers at-risk of harm can be found at all levels of consumption. This is contrary to the "Reno Model" (Blaszczynski, Ladouceur, & Shaffer, 2004) that recommends that social gamblers should not be subject to prevention measures that might disturb their play. In a gambling market where gambling through the internet has become increasingly available and most gamblers are active at several companies, minimizing harm is important for all customers.

Although the present study used player data from a large sample of NT customers, it still comes with some limitations. One limitation is that the respondents are self-selected

Table 5. Gender, age and gambling participation among four groups defined by gambling under/over low-risk level and experiencing no harm/harm

	Women	Age	Online Bingo	Lottery *	Betting *	VLT	Online Casino
Under low risk limits & no harm (n=15 091)	39.7 %	42.1	1.2 %	96.5 %	13.4 %	0.4 %	4.5 %
Under low risk limits & harm (n=3272)	29.4 %	35.5	2.3 %	89.9 %	21.4 %	0.6 %	10.4 %
Over low risk limits & no harm (n=11259)	26.3 %	46.7	10.5 %	97.0 %	38.6 %	4.1 %	29 %
Over low risk limits and harm (n=6186)	22.7 %	42.7	18.8 %	91.3 %	50.8 %	12.0 %	54.2 %

*Both retail and online

as they had elected to take the GamTest to assess gambling impacts. The NT Playscan system provides messaging to all players, including invitations to self-assess problematic gambling. The GamTest is a validated measure of problematic gambling and is a face valid measure of harm, but self-completion measures are imperfect (Swets, Dawes, & Monahan, 2000). It should also be noted that the sample was restricted to customers of one of two monopolists in Norway, which further limits the generalizability of the findings. Another limitation is the low AUC values, probably due to the fact that an unknown number of customers also are playing at other sites than NT or because other variables than those assessed may be related to harm. The player data used stemmed from three months before the GamTest was completed, hence it cannot be ruled out that other time spans of data could have provided different results. In studies using self-report data, the questions on gambling activity asked people to estimate 'typical' monthly consumption. To replicate this approach with actual gambling activity in this study, the mean over three months is used as a proxy for 'typical' consumption. Also, as with all ROC-analysis there will be some misclassifications, implying the cutoffs do not apply to all individuals. It should also be noted that fixing the sensitivity to a minimum of >0.70 could have resulted in somewhat lower cut-offs than allowing lower sensitivity values.

The results in the present study require replication and because predictive validity is limited, refinements in methodology are also important to capture accurate and complete gambling data. One possibility would be to ask the customers as part of the self-assessment about gambling with other gambling sites. Another more challenging way would be to ask the participants for permission to collect gambling data directly from all their sites they use. This would however require cooperation of numerous providers. Asking customers about their financial situation (e.g., household income) would provide the possibility to suggest low-risk limits regarding this as well as the possibility for the gambling companies to use it in their duty of care.

The lower risk gambling guidelines published by Young et al. (2022) incorporate the feedback and reactions to various draft versions of individuals who gamble, ranging from light to heavy gambling engagement. This type of validation research is also important with online gamblers.

Moreover, assessing how individuals use this advice in monitoring and modifying their play is crucial.

In summary, the suggested lower-risk limits in the present study are higher than limits based on prevalence studies. There was a significant number of gamblers (5–10%) experiencing harm at gambling levels well below the suggested cut-offs and the risk increase at certain consumption levels. Customers at-risk of harm can be found at all levels of consumption. In an increasingly available gambling market where most gamblers are active at several companies, minimizing harm is important for all customers.

project. AL is employed by AB Svenska Spel and involved in the responsible gambling work of the company. He has also worked for Norsk Tipping through the by them licensed responsible gambling tool Playscan. SC received consulting fees from the Canadian Centre on Substance Use and Addiction related to this project. MMY reports no conflicts of interest. SP reports no conflict of interest. PC reports research funding by several gambling providers in Sweden, Finland and Norway, as well as ongoing academia-industry research collaborations on scientific evaluations of responsible gambling tools.

REFERENCES

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Blaszczynski, A., Ladouceur, R., & Shaffer, H. J. (2004). A science-based framework for responsible gambling: The Reno model. *Journal of Gambling Studies*, *20*(3), 301–317. https://doi.org/10.1023/B:JOGS.0000040281.49444.e2.

Brosowski, T., Hayer, T., Meyer, G., Rumpf, H. J., John, U., Bischof, A., & Meyer, C. (2015). Thresholds of problematic gambling involvement for the German population: Results of the Pathological Gambling and Epidemiology (PAGE) study. *Psychology of Addictive Behaviors*, *29*(3), 794–804. https://doi.org/10.1037/adb0000088.

Brosowski, T., Meyer, G., & Hayer, T. (2012). Analyses of multiple types of online gambling within one provider: An extended evaluation framework of actual online gambling behaviour. *International Gambling Studies*, *12*(3), 405–419. https://doi.org/10.1080/14459795.2012.698295.

Brosowski, T., Olason, D. T., Turowski, T., & Hayer, T. (2021). The gambling consumption mediation model (GCMM): A multiple mediation approach to estimate the association of particular game types with problem gambling. *Journal of Gambling Studies*, *37*(1), 107–140. https://doi.org/10.1007/s10899-020-09928-3.

Caplan, G. (1964). *Principles of preventive psychiatry*. New York: Basic Books.

Christensen, D. R. (2020). Effective harm minimisation practices. Public health implications. In H. Bowden-Jones, C. Dickson, C. Dunand, & O. Simon (Eds.), *Harm reduction for gambling. A public health approach* (pp. 78–90). London: Routledge.

Currie, S., Hodgins, D., Wang, J., el-Guebaly, N., Wynne, H., & Chen, S. (2006). Risk of harm among gamblers in the general population as a function of level of participation in gambling activities. *Addiction*, *101*, 570–580. https://doi.org/10.1111/j.1360-0443.2006.01392.x.

Currie, S. R., & the Low Risk Gambling Guidelin, & es Scientific Working Group (2019). A research plan to define Canada's first low-risk gambling guidelines. *Health Promotion International*, *34*(6), 1207–1217. https://doi.org/10.1093/heapro/day074.

Currie, S. R., Hodgins, D. C., Casey, D. M., el-Guebaly, N., Smith, G. J., Williams, R. J., & Schopflocher, D. P. (2017). Deriving low-risk gambling limits from longitudinal data collected in two independent Canadian studies. *Addiction*, *112*(11), 2011–2020. https://doi.org/10.1111/add.13909.

Currie, S. R., Hodgins, D. C., Casey, D. M., el-Guebaly, N., Smith, G. J., Williams, R. J., … Wood, R. T. (2012). Examining the predictive validity of low-risk gambling limits with longitudinal data. *Addiction*, *107*(2), 400–406. https://doi.org/10.1111/j.1360-0443.2011.03622.x.

Currie, S. R., Miller, N. V., Hodgins, D. C., & Wang, J. (2009). Defining a threshold of harm from gambling for population health surveillance research. *International Gambling Studies*, *9*, 19–38. https://doi.org/10.1080/14459790802652209.

Dowling, N., Youssef, G. J., Greenwood, C., Merkouris, S., Suomi, A., & Room, R. (2018). *The development of empirically derived Australian responsible gambling limits*. Melbourne: Victorian Responsible Gambling Foundation.

Dowling, N. A., Youssef, G. J., Greenwood, C., Merkouris, S. S., Suomi, A., & Room, R. (2021). The development of empirically derived Australian low-risk gambling limits. *Journal of Clinical Medicine*, *10*(2), 167. https://doi.org/10.3390/jcm10020167.

Forsström, D., Lindner, P., Jansson-Fröjmark, M., Hesser, H., & Carlbring, P. (2020). Gamtest: Psychometric evaluation in a low-gambling general population. *Journal of Gambling Issues*, *44*, 77–102. https://doi.org/10.4309/jgi.2020.44.5.

Gainsbury, S. M. (2011). Player account-based gambling: Potentials for behaviour-based research methodologies. *International Gambling Studies*, *11*(2), 153–171. https://doi.org/10.1080/14459795.2011.571217.

Gainsbury, S. M. (2015). Online gambling addiction: The relationship between internet gambling and disordered gambling. *Current Addiction Reports*, *2*(2), 185–193. https://doi.org/10.1007/s40429-015-0057-8.

Hing, N., Browne, M., Russell, A. M. T., Rockloff, M., Rawat, V., Nicoll, F., & Smith, G. (2019). Avoiding gambling harm: An evidence-based set of safe gambling practices for consumers. *PloS One*, *14*(10), e0224083. https://doi.org/10.1371/journal.pone.0224083.

Hodgins, D. C., Young, M. M., Currie, S. R., Abbott, M., Billi, R., Brunelle, N., … Nadeau, L. (2022). Cross national consistency in lower-risk gambling limits: Linked analyses across eight countries. Manuscript submitted for publication.

Jonsson, J., Munck, I., Volberg, R., & Carlbring, P. (2017). GamTest: Psychometric evaluation and the role of emotions in an online self-test for gambling behavior. *Journal of Gambling Studies*, *33*(2), 505–532. https://doi.org/10.1007/s10899-017-9676-4.

Langham, E., Thorne, H., Browne, M., Donaldson, P., Rose, J., & Rockloff, M. (2016). Understanding gambling related harm: A proposed definition, conceptual framework, and taxonomy of harms. *BMC Public Health*, *16*, 80. https://doi.org/10.1186/s12889-016-2747-0.

Lind, K., Marionneau, V., Järvinen-Tassopoulos, J., & Salonen, A. H. (2021). Socio-demographics, gambling participation, gambling settings, and addictive behaviors associated with gambling modes: A population-based study. *Journal of Gambling Studies*. https://doi.org/10.1007/s10899-021-10074-7.

Louderback, E. R., LaPlante, D. A., Currie, S. R., & Nelson, S. E. (2021). Developing and validating lower risk online gambling thresholds with actual bettor data from a major internet gambling operator. *Psychology of Addictive Behaviors*, *35*(8), 921–938. https://doi.org/10.1037/adb0000628.

Markham, F., Young, M., & Doran, B. (2016). The relationship between player losses and gambling-related harm: Evidence from nationally representative cross-sectional surveys in four countries. *Addiction*, *111*(22), 320–330. https://doi.org/10.1111/add.13178.

Swets, J. A., Dawes, R. M., & Monahan, J. (2000). Psychological science can improve diagnostic decisions. *Psychological Science in the Public Interest*, *1*(1), 1–26. https://doi.org/10.1111/1529-1006.001.

Young, M. M., Hodgins, D., Currie, S., Brunelle, N., Dufour, M., Flores-Pajot, M.- C., & Nadeau, L. (2022). Not too much, not too often, and not too many: The results of the first large-scale, international project to develop lower-risk gambling guidelines. *International Journal of Mental Health and Addiction*. https://doi.org/10.1007/s11469-022-00896-w.