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NAD

Research report

Changes in youth gambling after the removal of slot machines in Norway

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ABSTRACT

AIMS – To examine whether the ban and complete removal of slot machines in Norway in 2007 may have led to: a) changes in gambling behaviour and changes in prevalence of problem gambling among adolescents, and b) changes in gambling behaviour among adolescent problem gamblers. DATA & METHODS – Two school surveys were conducted, one before (in 2006) and one after the intervention (in 2008), comprising students aged 13 to 18 years (net samples = 4,912 in 2006 and 3,855 in 2008). Identical measures of gambling behaviour and problem gambling were obtained in both surveys. RESULTS – After the intervention, a small proportion reported that they had changed their gambling behaviour, mainly in terms of having stopped gambling. Comparisons of self-reports of gambling behaviour showed that slot machine gambling had decreased significantly, while gambling on other games had increased, yet frequent gambling on any game had decreased after the intervention. However, the change in prevalence of at-risk and problem gambling differed across instruments. The prevalence of self-perceived gambling problems had decreased whereas the prevalence of at-risk and problem gambling as assessed by SOGS-RA had increased. Among at-risk and problem gamblers frequent gambling and perceived gambling problems were reported less frequently in 2008 compared to 2006. CONCLUSION – The ban and removal of slot machines in Norway was succeeded by a decrease in frequent gambling among adolescents in general as well as among at-risk and problem gamblers.

KEYWORDS – gambling, availability, evaluation, youth

Submitted 08.04.2013 Final version accepted 04.06.2013

Introduction

Gambling problems imply considerable health and social costs for individuals and for societies (Griffiths, 2009) and are subject to growing public health concern (Korn, Gibbins, & Azmier, 2003; Messerlian, Derevensky, & Gupta, 2005). Among adolescents, gambling for money is widespread (Volberg, Gupta, Griffiths, Olason, & Delfabbro, 2010). Recent literature reviews of adolescent gambling (Blinn-Pike, Worthy, & Jonkman, 2010; Gupta & Derevensky, 2011) found that gambling is more popular among males, and compared to other adolescent gamblers, problem gamblers are greater risk takers and they are also at increased risk of substance abuse. It seems

Acknowledgements

This study was funded by the Norwegian Research Council and the Norwegian Institute for Alcohol and Drug Research (Sirus). The authors are grateful for constructive comments by two anonymous reviewers on an earlier version of this paper.

that adolescents are especially vulnerable regarding the negative consequences of gambling (Derevensky & Gupta, 2004), and that early adolescent gambling elevates the risk for developing problem gambling later on (Gupta & Derevensky, 2001). While 1 to 5 percent of the adult population report problem gambling (Stucki & Rihs-Middel, 2007), the prevalence of problem gambling among adolescents often tends to be considerably higher (Blinn-Pike et al., 2010; Shaffer & Hall, 2001; Volberg et al., 2010; Welte, Barnes, Tidwell, & Hoffman, 2009).

Applying a public health perspective on gambling, Korn and Reynolds made the argument that youth participating in gambling activities requires priority (Korn & Reynolds, 2009). Effective measures to curb problem gambling and its negative consequences are therefore warranted. So far, a number of studies have demonstrated that psychological treatment (Pallesen, Mitsem, Kvale, Johnsen, & Molde, 2005) and pharmacological treatment (Pallesen et al., 2007) may be effective, but less is known about effective measures to *prevent* problem gambling. It has been suggested that the prevalence of problem gambling is closely tied to the availability to gambling venues (Welte, Barnes, Wieczorek, Tidwell, & Hoffman, 2007) and that adolescents are especially attracted to such gambling as slot machines, characterised by high speed, frequent win and continuous play (Griffiths, 1999). Consequently, the expansion of gambling both nationally and internationally is a matter of concern, and particularly so with respect to young people (Moodie & Hastings, 2008). A substantial research literature from other areas of addiction shows that policy measures regulating availability can have a significant impact on consumption and related harm (Babor et al., 2010; WHO, 2009). This may be relevant also for problem gambling, given the suggested commonality between substance use and gambling behaviour with respect to etiological factors, clinical expression and underlying motives (Thomas, Allen, Phillips, & Karantzas, 2011) as well as public policies and strategies (Orford, 2005). Within gambling research, some studies have demonstrated a close association between the overall level of gambling in a society and the prevalence of problem gambling (Grun & McKeigue, 2000; Hansen & Rossow, 2008; Lund, 2008; Room, Turner, & Ialomiteanu, 1999). This is much in line with Rose and Day's general notion that "the population mean predicts the number of deviant individuals" (Rose & Day, 1990) and is therefore suggestive of the potential of population strategies, such as availability regulations, to prevent problems or disease (Rose, 2001; Rose & Day, 1990).

In many countries, restrictions on availability of gambling are exercised, but a tendency over the past few decades has been in the direction of liberalisation of restrictive measures (Orford, 2009). Yet, there are examples also of further restrictions on availability of gambling. A recent example is from Norway. Here, casino gambling is unavailable, and youth gambling on slot machines and sports betting have been restricted with age limits (mainly 18 years), although these limits have not been enforced. Until 2006, slot machines were numerous and easily available in corner stores, shopping centres, petrol stations, etc., and slot machines constituted the main gambling problem for people seeking help and treatment (Hansen, 2006).

By changes of national regulations, the availability of slot machine gambling in Norway was reduced in two steps. First, banknote acceptors on slot machines were prohibited and removed in July 2006, which implied a restriction on the availability of large bets and long gambling sessions. Next, in 2007, a government slot machine monopoly was established, and as part of this, all existing slot machines were prohibited and removed. The slot machine removal was completed by July 1, 2007. The government monopoly gradually introduced new slot machines with less addictive potential on the Norwegian market, starting in two counties in the autumn 2008 and continuing in the rest of the country in 2009. Thus, slot machines were not available in Norway for more than a year, from July 1, 2007, to the autumn of 2008. The regulation in 2007 meant a complete removal of the most popular game for money in Norway at that time. The focus of this study was to assess the possible impact of such a significant natural experiment of restricting availability of gambling.

Prior to these restrictions in Norway, not many studies had addressed the impact of changes in availability on gambling problems, but some findings are suggestive of an association between availability of gambling and problem gambling. Abbot shows that the prevalence of problem gambling tends to be positively associated with the availability of slot machines across jurisdictions (Abbott, 2006). There are also studies of the impact of changes in availability within a jurisdiction. For instance, Room and co-workers (1999) found that the introduction of a casino in Ontario, Canada, was associated with increased problem gambling. Correspondingly, Grun and McKeigue (2000) found that the introduction of a national lottery in the UK was associated with an increase in household expenditure on gambling and in the prevalence of problem gambling. Moreover, an Australian study found that a reduction in banknote denominations on slot machines[1] reduced expenditure, gambling frequency and bet size among at-risk and problem gamblers (Brodie, Honeyfield, & Whitehead, 2003), whereas no significant changes in gambling behaviour were observed subsequent to a very minor reduction in the number of slot machines (EGMs) in South Australia (Delfabbro, 2008).

The restrictions in the availability of slot machines in Norway in 2006 and 2007 have also been discussed in some previous studies (Hansen & Rossow, 2010; Kavli, 2007; Lund, 2009; Øren & Leistad, 2010). In the adult population, Kavli (2007) reported that problem gambling decreased significantly after the removal of banknote acceptors, while Øren and Leistad (2010) and Lund (2009) found reduced gambling participation among excessive gamblers and a lower proportion of at-risk gamblers after the slot machine ban. Among Norwegian teenagers, a significant decrease in overall gambling and the prevalence of problem gambling was observed from 2005 to 2006, i.e. before and after the banknote acceptor ban (Hansen & Rossow, 2010). In all these studies, the observed reductions in gambling and problem gambling subsequent to the restrictions were, with some reservations, interpreted as intervention effects. So far, no study has addressed any possible impact of the slot machine removal among adolescents, and in this paper we explore the possible impact of

this removal with respect to adolescent gambling behaviour. More specifically, we aimed at assessing whether this restriction may have led to: a) changes in gambling behaviour and changes in prevalence of problem gambling among adolescents, and b) changes in gambling behaviour among adolescent problem gamblers.

Method

Design, participants and procedures

This study is based on data from Norwegian school surveys conducted at the same schools in 2006 and 2008. The first survey was conducted in October/November 2006 (Pape, Rossow, & Storvoll, 2007), that is, after the removal of banknote acceptors and before the removal of the slot machines. This survey served as post-intervention assessments of outcomes of two interventions; alcohol and drug interventions at the local level and the removal of banknote acceptors on slot machines, and as a pre-intervention assessment of the slot machine ban and removal. The school survey in 2008 was conducted in April 2008, nine months after the removal of slot machines was completed and was designed to assess the possible impact of this intervention.

In 2006, all students in grades 8 to 13 (mainly 13–19-year-olds) in 16 municipalities were invited to participate in the survey (see Pape et al., 2007 and Hansen & Rossow 2010 for more detailed information). In 2008, a fraction of the preceding sample was followed up (25 of the original 91 schools), due to limited resources. In both surveys, participants completed the questionnaire at school. Written informed parental consent was obtained in line with the guidelines from the Norwegian Social Science Data Services, i.e. from all students in grades 8 to 10 (mainly ages 13 to 15). For other students below the age of 18, a passive informed parental consent was requested.

The response rate was 85.7% in 2006 and 77.7% in 2008. All schools that did not participate in 2008 were excluded from the analysis so that the samples comprised only students from the same schools in both survey years. Moreover, the analyses were confined to students aged 13 to 18 years. Thus, the net samples in this study comprised 4,912 students in 2006 and 3,855 students in 2008.

Measures

In the 2008 survey, the respondents were asked whether they had noticed the ban and removal of the slot machines and whether they had changed their gambling behaviour subsequent to this ban and removal. Those who stated that they had changed their gambling behaviour were then asked to state whether they had stopped gambling, whether they had decreased their gambling, and whether they gambled more on other games than slot machines. The respondents could tick off one or several of these behavioural changes.

In both surveys, gambling frequency during the preceding 12 months was assessed for seven types of games: slot machines, scratch cards, poker on internet, other internet gambling, horse racing, other sports betting and lotteries, and a category called "other forms of gambling". There were six response categories: "not gambled last year", "less than once a month", "several times a month", "once a week", "several times a week", and "daily or almost daily". The answers were recoded into a semi-continuous scale using a value reflecting

approximate annual gambling frequency for each category (0, 10, 25, 52, 100 and 220 times). Over the observation period from 2006 to 2008, bingo games became more available via terminals in bingo halls and on the internet, and poker became more available both on the internet and as a card-playing game among youth. In order for us to obtain comparable measures of different forms of gambling over this period, it was important that the respondents could distinguish between slot machines and bingo machines and between poker on the internet and poker at home. In 2008 two additional questions were asked; one on gambling frequency on bingo machines and another on gambling frequency on poker other than on the internet. The highest frequency of the responses to these two questions and to the question of gambling frequency on other forms of gambling was applied when these three variables were collapsed together into a single variable on frequency of other forms of gambling in the 2008 survey.

Based on the seven semi-continuous variables described above, we constructed a sum score for total number of times gambled last year. In this paper, we have applied dichotomous variables on gambling frequency in order to separate frequent gamblers from others; i.e. those who gambled >100 times per year across all games; those who gambled at least weekly on any game, and those who gambled at least weekly on each of the seven forms of gambling; slot machines, scratch cards, poker on internet, other internet gambling, horse races, other sports bets and lotteries, and other forms of gambling.

Problem gambling and at-risk gambling were assessed by three instruments and a total of five outcome measures. The South Oaks Gambling Screen – Revised for Adolescents, SOGS-RA (Winthers, Stinchfield, & Fulkerson, 1993) is a 12-item screening instrument that covers various problems due to gambling in the preceding 12 months. The instrument is assumed to have moderate to high sensitivity and specificity (Winthers et al., 1993) and to be applicable for adolescents (Rossow & Molde, 2006; Winthers et al., 1993). The 12 items are scored 0 or 1, and thus the sum score on SOGS-RA ranges from 0 to 12. A score of 4 or higher on SOGS-RA was defined as *problem gambling*, whereas a score of 2 or above includes *at-risk and problem gambling*. The Lie/Bet Questionnaire (Johnson et al., 1997) consists of two items (having lied about gambling losses and felt the need to increase money bets), and refers to lifetime prevalence of at-risk or problem gambling. This instrument is also assumed to have moderate to high sensitivity and specificity (Johnson, Hamer, & Nora, 1998; Johnson et al., 1997). The two items are scored 0 or 1 (range 0–2), and those who score 1+ and 2 were categorised as at-risk gamblers. Finally, a single question about self-perceived gambling problems – "Do you think that you have problems due to your gambling?" – was applied, resembling the single item used in previous work (Cronce, Corbin, Steinberg, & Potenza, 2007). Response categories were "Yes, substantial problems", "Yes, some problems", "Not sure" and "No, no problems at all". The first two categories were collapsed into one, indicating some degree of self-perceived gambling problems, while those who responded "not sure" were excluded from the analysis.

The gender distribution was equal in

both surveys (49.2% girls in 2006 and 49.8% girls in 2008). The two samples differed with respect to age distribution (F=20.0, df=2, p <0.001) and slightly with respect to non-Nordic immigrant background (whether both parents were born in another country than a Nordic country) (Chi square = 2.24, df=1, p=0.13). To secure comparable samples, we included these variables as covariates in the analysis.

Strategies of analysis and statistical analyses

The question of whether Norwegian teenagers had changed their gambling behaviour subsequent to the slot machine ban was analysed in three ways. First, we examined whether the respondents in the 2008 survey had noticed that slot machines had been banned and removed; whether they felt they had changed their gambling behaviour subsequent to this ban and removal, and if so whether they had stopped gambling, decreased gambling or increased their gambling on other games. Second, we assessed whether the prevalence of weekly gambling and the mean frequency of gambling for each of the seven forms of gambling had changed from 2006 to 2008. This was explored in bivariate analyses, applying cross-tabulations and chi-square tests for the categorical variables and means and F-tests for semi-continuous variables. Third, we assessed whether the prevalence of past year gambling and past year frequent gambling had changed from 2006 to 2008. The question of whether the prevalence of at-risk and problem gambling had changed subsequent to the slot machine removal was assessed in bivariate analyses for the five outcome measures. In these analyses we applied cross-tabulations and Chi-square statistics and next in multivariate binary logistic regression analyses we adjusted for age and non-Nordic immigrant background. Finally, we addressed whether gambling behaviour had changed among problem gamblers by comparing the prevalence of weekly gambling on various games for the two survey years in subsamples of at-risk and problem gamblers. Again, cross-tabulations and Chi-square statistics were applied.

Results

Among all the 2008 survey respondents, under a third (29.7%) said they had noticed the ban and removal of slot machines. About one in 12 respondents (8.8 %) reported that they had changed their gambling behaviour in some way after this regulation; some reported that they had stopped gambling, while others said that they gambled less and some reported gambling more on other games; these constituted 5.1%, 2.2%, and 1.0% of all respondents, respectively. Among those who had noticed the ban and removal, one in four (27.8%) stated that they had changed their gambling behaviour in some way after the regulation. Among those who changed their behaviour, two thirds reported that they had stopped gambling (Table 1). Moreover, some of those who had stopped gambling reported also that they gambled less, and some reported that they gambled more on other games.

We then examined whether gambling on various forms of games had changed from 2006 to 2008. As could be expected, reports of weekly slot machine gambling had decreased significantly, yet it had not

Table 1. Proportion of respondents in 2008 who had noticed the slot machine ban and who reported that they had changed their gambling behaviour in various ways among all respondents (A), and proportion of respondents who reported that they had changed their gambling behaviour in various ways among respondents who had noticed the slot machine ban (B) and among respondents who had changed their gambling behaviour (C).
Percent.

Noticed ban/changed behaviour	A) % of all respondents n= 4088	B) % of respondents who had noticed the ban n=1216	C) % of respondents who had changed their gambling behaviour n=519
Noticed slot machine ban	29.7	-	
Changed gambling behaviour in some way	8.8	27.8	-
Changed behaviour and stopped gambling	5.1	17.1	69.4
gambled less	2.2	8.8	27.9
gambled more on other games	1.0	5.2	15.0

completely vanished in 2008. Moreover, a significant decrease in weekly gambling on sports bets and lotteries and a significant increase in gambling on other games were observed. A similar picture was obtained when comparing frequency means (Table 2).

When comparing the prevalence of gambling behaviour reported by respondents in 2006 and 2008, the proportion of those who reported any gambling in the past year and the proportion of those who reported frequent gambling, i.e. at least weekly gambling on any game and overall gambling frequency exceeding 100 times past year, had decreased statistically significantly from 2006 to 2008. These differences remained significant also after adjustment for age and non-Nordic immigrant background in multivariate analyses (Table 3).

We then examined whether the prevalence of at-risk and problem gambling had changed among Norwegian teenagers subsequent to the removal of slot machines. These results were mixed across the

Table 2. Distribution of various games by survey year among all respondents: prevalence of weekly gambling and mean gambling frequency and statistical tests of differences between survey years.

	Prevalence of weekly gambling			Mean gambling frequency		
Type of games	2006	2008	χ^2	2006	2008	F
Slot machines	7.3	2.0	128.4***	13.8	5.5	83.3***
Scratch cards	4.7	4.4	0.6ns	12.6	12.3	0.2 ns
Poker on internet	3.0	3.8	3.2ns	7.4	8.7	1.7 ns
Other internet gambling	2.0	1.9	0.1ns	4.9	4.7	0.1 ns
Horse race bets	1.8	1.3	2.9ns	4.7	3.6	2.0 ns
Other sports bets, lotteries	6.8	5.0	11.7**	11.1	7.9	13.7***
Other forms of gambling	3.3	6.4	46.6***	7.1	13.7	44.7***

Levels of statistical significance: ns = not significant, *= p<0.05, **= p<0.01, ***= p<0.001

Table 3. Prevalence of any gambling and of frequent gambling before (2006) and after (2008) slot machine ban (percent) and test of difference (in bivariate analysis); and association between gambling behaviour and survey year controlling for age and non-Nordic immigrant background in multivariate logistic regression analysis.

	Bivariate analysis			Multivariate analysis			
Gambling behaviour	Prevalence in 2006	Prevalence in 2008	Test of difference from 2006 to 2008	Regression coefficient	SE	OR	95% CI
Any gambling in past year	69.3	67.0	χ^2 =4.8* df=1	-0.05	0.02	0.95	0.91, 1.00
Total gambling frequency past year >100	8.6	7.3	χ^2 =4.7* df=1	-0.09	0.04	0.91	0.84 , 0.99
Weekly gambling on any game	13.7	11.7	χ^2 =8.1** df=1	-0.10	0.03	0.91	0.85, 0.97

Levels of statistical significance: ns = not significant, *= p<0.05, **= p<0.01, ***= p<0.001

various measures of at-risk and problem gambling. While there was a statistically significant decrease in the prevalence of self-perceived gambling problems, there was no statistically significant difference in the prevalence of LieBet score 1+ and LieBet score 2. There was a statistically significantly higher prevalence of SOGS-RA 2+ and SOGS-RA 4+ in 2008 compared to 2006. Similar findings were obtained in multivariate analyses adjusting for age and non-Nordic immigrant background (Table 4). Analyses of item-specific changes revealed no indications that certain items in the SOGS-RA instrument accounted for the increase in SOGS-RA scores.

Finally, we explored whether frequent gambling on various games had changed from 2006 to 2008 among those categorised as at-risk and problem gamblers. Among

Table 4. Prevalence of at-risk/problem gambling before (2006) and after (2008) slot machine ban (percent) and test of difference (in bivariate analysis); and association between at-risk/problem gambling and survey year controlling for age and non-Nordic immigrant background in multivariate logistic regression analysis.

	Bivariate analysis			Multivariate analysis			
Measure of at-risk/problem gambling	Prevalence in 2006	Prevalence in 2008	Test of difference from 2006 to 2008	Regression coefficient	SE	OR	95% CI
Self-perceived gambling problem	3.6	2.3	χ^2 =7.7** df=1	-0.25	0.09	0.78	0.66 , 0.93
SOGS-RA 2+	5.5	8.8	χ^2 =34.8*** df=1	0.46	0.09	1.58	1.33,1.88
SOGS-RA 4+	2.3	3.1	χ^2 =4.9* df=1	0.13	0.07	1.14	1.0, 1.30
LieBet 1+	11.2	11.9	χ^2 =1.15ns df=1	0.07	0.07	1.07	0.93,1.23
LieBet 2	3.0	3.4	χ^2 =1.28ns df=1	0.06	0.06	1.07	0.94, 1.20

Levels of statistical significance: ns = not significant, *= p<0.05, **= p<0.01, ***= p<0.001

Table 5. Prevalence of weekly gambling on various games and on any game, and prevalence of self-perceived gambling problems among at-risk and problem gamblers (SOGS2+) and among problem gamblers (SOGS4+) by survey year. Percent. Statistical tests of differences between survey years.

	Among SOGS2+			Among SOG4+		
Weekly gambling/ self-perceived gambling problems	Prevalence in 2006 n =242	Prevalence in 2008 n = 314	Test of difference from 2006 to 2008	Prevalence in 2006 n = 93	Prevalence in 2008 n = 107	Test of difference from 2006 to 2008
Slot machines	47.5	17.6	60.5 ***	67	34	24.7 ***
Scratch cards	29.3	27.3	0.3 ns	49	43	0.8 ns
Poker on internet	27.9	25.3	0.5 ns	45	44	0.02 ns
Other internet gambling	19.2	16.9	0.5 ns	37	36	0.02 ns
Horse races	16.9	12.3	2.4 ns	36	30	0.8 ns
Other sports bets, lotteries, etc.	37.5	24.3	12.1***	60	42	7.5 **
Other forms of gambling	26.7	38.3	8.9 ***	46	61	4.5*
Any gambling	65.2	52.1	10.5 **	83	71	4.0 *
Self-perceived gambling problems	31.6	24.0	4.4 *	51	45	0.7 ns

Levels of statistical significance: ns = not significant, *= p<0.05, **= p<0.01, ***= p<0.001

those who scored 2+ on SOGS-RA weekly gambling on slot machines, weekly gambling on sports bets, lotteries, etc., weekly gambling on any game and self-perceived gambling problems all decreased statistically significantly from 2006 to 2008, and only weekly gambling on other games increased from 2006 to 2008 (Table 5). Differences in the same direction were also found among those who scored 4+ on SOGS-RA, yet fewer of these differences were statistically significant (Table 5).

Discussion

The results of our study show that after the ban and removal of slot machines in Norway, a small proportion of Norwegian teenagers reported that they had changed their gambling behaviour. Most of those who reported such change had stopped gambling or gambled less. Comparison of gambling behaviour before and after this slot machine regulation showed that the prevalence of weekly gambling on slot machines had decreased significantly, weekly gambling on any game had decreased slightly, whereas weekly gambling on other games had increased. However, the change in prevalence of at-risk and problem gambling differed across instruments. The prevalence of self-perceived gambling problems had decreased whereas the prevalence of at-risk and problem gambling as assessed by SOGS-RA had increased. Among at-risk and problem gamblers weekly gambling on slot machines and weekly gambling on any game had decreased significantly, as had self-perceived gambling problems, whereas weekly gambling on other games had increased.

The observed decrease in frequent overall gambling subsequent to the slot machine ban and removal is in line with theoretical expectations about behavioural change in response to availability change (Rose & Day, 1990) and empirical findings in previous studies of availability change and gambling behaviour (Brodie et al.,

2003; Grun & McKeigue, 2000; Hansen & Rossow, 2010; Room et al., 1999). However, the finding that the prevalence of problem gambling, as assessed with SOGS-RA, had not decreased correspondingly was not in line with what could be expected from previous studies of availability change and problem gambling (Hansen & Rossow, 2010; Lund, 2009; Room et al., 1999; Øren & Leistad, 2010). A possible explanation to this apparent inconsistency in the changes of frequent gambling and problem gambling could be that frequent gambling on slot machines had been substituted by frequent gambling on other games that impose a higher risk of problem gambling. For instance, several recent studies have found that internet gamblers are more likely to be problem gamblers compared to other gamblers (Brunelle et al., 2012; Griffiths & Barnes, 2008). However, several methodological aspects should be considered when interpreting these findings.

First, a significant problem with assessing a possible impact of a national market regulation, such as the slot machines ban and removal, is the inevitable lack of a control group in the study design. We do not know how gambling behaviour and problem gambling would have developed among Norwegian teenagers from 2006 to 2008 if slot machines had continued to be available. There were no national prevention campaigns targeting youth gambling in the observation period that could have contributed to reduced gambling, however, and the rapid changes in online gambling and other gambling opportunities seem to have led to more frequent gambling in other areas, which in turn may have led to problem gambling. Thus, we do not know whether the prevalence of problem gambling would have been even higher if there had been no ban and removal of slot machines.

Second, we did not have the opportunity to follow the individual teenagers over time, and hence our observations pertain to changes at the aggregate level. It is therefore difficult to assess whether the changes in gambling behaviour occurred mainly among the same individuals who gambled frequently, or whether – or to what extent – the frequent slot machine gamblers and problem gamblers in 2006 were other people than those who were frequent gamblers and problem gamblers in 2008. However, the findings reported in Table 1 suggest that both these types of changes probably occurred.

Third, it is noteworthy that those who filled criteria for at-risk gambling and problem gambling to a significantly lesser extent reported gambling at least once a week and perceived a gambling problem in the 2008 survey compared to the 2006 survey. This suggests that problem gambling in the 2008 survey encompassed less frequent gambling and perhaps also less severe and less problematic gambling, as compared to the 2006 survey.

Finally, a few additional study limitations and study strengths should be noted. There are several threats to the validity of self-reported gambling behaviour and problem gambling (Hodgins & Makarchuk, 2003). Problem behaviour is often under-reported in surveys, and in this study it may therefore be suspected that the observed prevalence figures for at-risk and problem gambling may be downward biased. Moreover, the self-reports of frequent slot machine gambling in the 2008 survey seem incompatible with the com-

plete removal of these machines more than 9 months prior to the survey. While some of the reported slot machine gambling may have occurred abroad or on illegal machines, it seems probable that some of this gambling activity refers to gambling on the internet with games resembling slot machines. One may also ask whether the measures of internet gambling frequencies are sufficient or optimal measures of exposure to risk for gambling problems due to internet gambling, and thus whether they are adequate to account for changes in such exposure. Perhaps other measures such as gambling intensity and gambling expenditure would be better indicators. Moreover, we do not know what kind of gambling the adolescents were referring to when they answered that they had gambled on other games, or to what extent this included internet-based games.

Among the study strengths is its contribution to a fairly meagre literature on the possible impact of availability regulations in the gambling market on gambling behaviour and problem gambling. Furthermore, the study comprised fairly large samples of students and obtained fairly high response rates, which allowed for assessment of possible changes in low-prevalent problems as at-risk and problem gambling.

The study findings are not unambiguous with respect to the likely impact of the ban and removal of slot machines and thus with respect to the implications for gambling policy. The high prevalence of frequent internet gambling among at-risk and problem gamblers underscores the concern for adolescent gambling on internet and digital media (Derevensky & Gupta, 2007; Griffiths, Parke, & Derevensky, 2011; King, Delfabbro, & Griffiths, 2010). This, and the very meagre literature so far on evaluations of restrictive policies on availability of gambling, implies that there is a need for more studies of possible impacts of policies that regulate the availability of gambling. Moreover, in Norway the complete ban of slot machines in 2007 was succeeded by a monopoly on slot machines, which implies that fewer slot machines with less addictive potential were available and the 18-year age limit could more easily be enforced. The possible impacts of these changes do also warrant evaluation in future studies. If regulatory and legal changes in the availability of gambling include funding for systematic evaluation research, such studies are more likely to be undertaken and provide a better scientific foundation for informing policy makers on the likely outcomes of such interventions.

Declaration of interest None.

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NOTE

1 Called EGMs (electronic gambling machines).

REFERENCES

Abbott, M. (2006). Do EGMs and problem gambling go together like a Horse and Carriage? *Gambling Research: Journal of the National Association of Gambling Studies (Australia), 18*, 7–38.

Babor, T., Caetano, R., Casswell, S., Edwards, G., Giesbrecht, N., Graham, K., . . . Rossow, I. (2010). *Alcohol: No ordinary commodity. Research and public policy. Second edition.* Oxford: Oxford University Press.

Blinn-Pike, L., Worthy, S. L., & Jonkman, J. N. (2010). Adolescent gambling: a review of an emerging field of research. *Journal of Adolescent Health, 47*, 223–236.

Brodie, M., Honeyfield, N., & Whitehead, G. (2003). Change in bank note acceptors on electronic gambling machines in Queensland – Outcome evaluation. Retrieved from http://www.responsiblegambling.org/articles/change_in_bank_note_acceptors_on_electronc_2003.pdf

Brunelle, N., Leclerc, D., Cousineau, M.-M., Dufour, M., Gendron, A., & Martin, I. (2012). Internet gambling, substance use, and delinquent behavior: An adolescent deviant behavior involvement pattern. *Psychology of Addictive Behaviors, 26*(2), 364–370.

Cronce, J., Corbin, W., Steinberg, M., & Potenza, M. (2007). Self-perception of gambling problems among adolescents identified as at-risk or problem gamblers. *Journal of Gambling Studies, 23*(4), 363–375.

Delfabbro, P. (2008). Evaluating the effectiveness of a limited reduction in electronic gaming machine availability on perceived gambling behaviour and objective expenditure. *International Gambling Studies, 8*(2), 151–165.

Derevensky, J., & Gupta, R. (2007). Internet gambling amongst adolescents: A growing concern. *International Journal of Mental Health and Addiction, 5*(2), 93–101.

Derevensky, J. L., & Gupta, R. (2004). Adolescents with gambling problems: A synopsis of our current knowledge. *Journal of Gambling Issues, 10*, 119–140.

Griffiths, M. D. (1999). Gambling technologies: Prospects for problem gambling. *Journal of Gambling Studies, 15*, 265–283.

Griffiths, M. D. (2009). Minimizing harm from gambling: What is the gambling industry's role? *Addiction, 104*, 696–697.

Griffiths, M. D., & Barnes, A. (2008). Internet gambling: An online empirical study among student gamblers. *International Journal of Mental Health and Addiction, 6*(2), 194–204.

Griffiths, M. D., Parke, J., & Derevensky, J. L. (2011). Remote gambling in adolescence. In J. L. Derevensky, D. T. L. Shek & J. Merrick (Eds.), *Youth gambling: The hidden addiction* (pp. 125–142). Berlin: Walter de Gruyter GmbH & Co. KG.

Grun, L., & McKeigue, P. (2000). Prevalence of excessive gambling before and after introduction of a national lottery in the United Kingdom: Another example of the single distribution theory. *Addiction, 95*(6), 959–966.

Gupta, R., & Derevensky, J. L. (2001). An examination of the differential coping styles of adolescents with gambling problems. Report to the Ministry of Health and Long-Term Care, Ontario, Canada Montreal, Canada: International Centre of Youth Gambling Problems and High-Risk Behaviors, McGill University.

Gupta, R., & Derevensky, J. L. (2011). Understanding the etiology of youth gambling. In J. L. Derevensky, D. T. L. Shek & J. Merrick (Eds.), *Youth gambling: The hidden addiction*. Berlin: de Gruyter.

Hansen, M. (2006). Treatment of problem & pathological gambling in the Nordic countries: Where we are now and where do we go next? *Journal of Gambling Issues, 18*, 91–105.

Hansen, M., & Rossow, I. (2008). Adolescent gambling and problem gambling: Does the total consumption model apply? *Journal of Gambling Studies, 24*, 135–149.

Hansen, M., & Rossow, I. (2010). Limited cash flow on slot machines: Effects of prohibition of note acceptors on adolescent gambling behaviour. *International Journal of Mental Health and Addiction, 8*(1), 70–81.

Hodgins, S. C., & Makarchuk, K. (2003). Trusting problem gamblers: Reliability and validity of self-reported gambling behavior. *Psychology of Addictive Behaviors, 17*(3), 244–248.

Johnson, E. E., Hamer, R., & Nora, R. M. (1998). The Lie/Bet Questionnaire for screening pathological gamblers: A follow-up study. *Psychological reports, 83*, 1219–1224.

Johnson, E. E., Hamer, R., Nora, R. M., Tan, B., Eisenstein, N., & Engelhart, C. (1997). The Lie/Bet Questionnaire for screening pathological gamblers. *Psychological reports, 80*(1), 83–88.

Kavli, H. (2007). Spillevaner og spilleproblemer i den norske befolkningen [Gambling behaviour and gambling problems in the Norwegian population]. Oslo: Synnovate, MMI.

King, D., Delfabbro, P., & Griffiths, M. (2010). The convergence of gambling and digital media: Implications for gambling in young people. *Journal of Gambling Studies, 26*(2), 175–187. doi: 10.1007/s10899-009-9153-9

Korn, D., Gibbins, R., & Azmier, J. (2003). Framing public policy towards a public health paradigm for gambling. *Journal of Gambling Studies, 19*(2), 235–256.

Korn, D., & Reynolds, J. (2009). Global discourse on gambling: The importance of a public health perspective. *Gambling and Public Health International Alliance, newsletter*, 1–7.

Lund, I. (2008). The population mean and the proportion of frequent gamblers: Is the theory of total consumption valid for gambling? *Journal of Gambling Studies, 24*, 247–256.

Lund, I. (2009). Gambling behaviour and the prevalence of gambling problems in adult EGM gamblers when EGMs are banned: A natural experiment. *Journal of Gambling Studies, 25*(2), 215–225.

Messerlian, C., Derevensky, J. L., & Gupta, R. (2005). Youth gambling problems: A public health perspective. *Health Promotion Internatinal, 20*(1), 69–79.

Moodie, C., & Hastings, G. (2008). Gambling with the future of young people. *Addiction Research & Theory, 16*, 107–110.

Orford, J. (2005). Disabling the public interest: Gambling strategies and policies for Britain. *Addiction, 100*(9), 1219–1225.

Orford, J. (2009). Governments as promotors of dangerous consumptions. *Addiction, 104*(5), 693–695.

Pallesen, S., Mitsem, M., Kvale, G., Johnsen, B.-H., & Molde, H. (2005). Outcome of psychological treatments of pathological gambling: A review and meta-analysis. *Addiction, 100*(10), 1412–1422.

Pallesen, S., Molde, H., Arnestad, H. M., Laberg, J. C., Skutle, A., Iversen, E., . . . Holsten, F. (2007). Outcome of pharmacological treatments of pathological gambling: A review and meta-analysis. *Journal of Clinical Psychopharmacology, 27*(4), 357–364.

Pape, H., Rossow, I., & Storvoll, E. E. (2007). Metoderapport for Skoleundersøkelsene 2004, 2005 og 2006 i tilknytning til SIRUS' evaluering av Regionprosjektet. . Oslo: Statens institutt for rusmiddelforskning.

Room, R., Turner, N. E., & Ialomiteanu, A. (1999). Community effects of the opening of the Niagara casino. *Addiction, 94*(10), 1449–1466.

Rose, G. (2001). Sick individuals and sick populations. *International Journal of Epidemiology, 30*(3), 427–432. doi: 10.1093/ije/30.3.427

Rose, G., & Day, S. (1990). The population mean predicts the number of deviant individuals. *BMJ, 301*, 1031–1034.

Rossow, I., & Molde, H. (2006). Chasing the criteria: Comparing SOGS-RA and the Lie/Bet screen to assess prevalence of problem gambling and "at-risk" gambling among adolescents. *Journal of Gambling Issues* (18), 57–71. doi: 10.4309/jgi.2006.18.9

Shaffer, H. J., & Hall, M. N. (2001). Updating and refining prevalence estimates of disordered gambling behaviour in the United States and Canada. *Canadian Journal of Public Health, 92*(3), 168–172.

Stucki, S., & Rihs-Middel, M. (2007).

Prevalence of adult problem and pathological gambling between 2000 and 2005: An update. *Journal of Gambling Studies, 23*(3), 245–257.

Thomas, A. C., Allen, F. L., Phillips, J., & Karantzas, G. (2011). Gaming machine addiction: The role of avoidance, accessibility and social support. *Psychology of Addictive Behaviors, 25*(4), 738–744.

Volberg, R., Gupta, R., Griffiths, M. D., Olason, D. T., & Delfabbro, P. (2010). An international perspective on youth gambling prevalence studies. *International Journal of Adolescent Medicine and Health, 22*(1), 3–38.

Welte, J. W., Barnes, G. M., Tidwell, M.-C. O., & Hoffman, J. (2009). The association of form of gambling with problem gambling among American youth. *Psychology of Addictive Behaviors, 23*(1), 105–112.

Welte, J. W., Barnes, G. M., Wieczorek, W. F., Tidwell, M.-C. O., & Hoffman, J. H. (2007). Type of gambling and availability as risk factors for problem gambling: A Tobit regression analysis by age and gender. *International Gambling Studies, 7*, 183–198.

WHO. (2009). *Evaluating the effectiveness of smoke-free policies* (Vol. 13). Geneva: World Health Organization.

Winthers, K. C., Stinchfield, R. D., & Fulkerson, J. (1993). Toward the development of an adolescent gambling problem severity scale. *Journal of Gambling Studies, 9*(1), 63–84.

Øren, A., & Leistad, L. (2010). Endringer i den norske befolkningens pengespillvaner og påvirkning av spilleautomatforbudet [Changes in gambling behaviour in the Norwegian population after the slot machine ban]. Trondheim: SINTEF, Health.