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Forms of gambling, gambling involvement and problem gambling: evidence from a Swedish population survey

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ABSTRACT

The purpose of this study was to explore the association between problem gambling (PG) and participation in different forms of gambling in order to elucidate relationships between PG, gambling involvement and gambling intensity. Using data from the first wave of the Swedish Longitudinal Gambling Study (Swelogs) (n = 4,991), the study tested four hypotheses, namely that (1) some forms of gambling are more closely associated with PG than other forms; (2) high gambling involvement is associated with PG; (3) gambling involvement is positively associated with the intensity of gambling; and (4) the relationship between gambling involvement and PG is influenced by the specific forms of gambling in which individuals participate. All four hypotheses were supported. More specifically, the study found that while many PGs regularly participate in multiple forms of gambling, half of PGs participate regularly in only one or two forms of gambling. The study concluded that some forms of gambling are more closely associated with problem gambling than other forms, and that gambling policy and regulation, as well as the development of responsible gambling initiatives, should focus on these forms.

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KEYWORDS

Gambling; problem gambling; involvement; games

Introduction

Problem gambling (PG) is recognized in many countries as a public health issue that needs to be addressed through regulation of the gambling market and preventive initiatives. An important question when designing such regulations and initiatives is whether some forms of gambling are more harmful and risky than others; if so, regulations and initiatives should focus on these forms. As we outline below in the literature review, research results published in recent years appear to give conflicting answers to this question. Most of the literature presents findings in line with the conventional view that some forms of gambling, in particular electronic gaming machines (EGMs), are more likely to cause harm than other forms. However, recently published research suggests that involvement in multiple forms of gambling is a more important factor and that participation in specific forms of gambling is more or less irrelevant. In this article, we will analyse data from a Swedish population

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study in order to elucidate the relationships between PG, forms of gambling and gambling involvement. We will explain the apparently discordant results of previous studies and offer a comprehensive view of how these factors are related in the Swedish context.

Differences between forms of gambling

Commercial gambling is not a single homogeneous activity but instead takes many forms. Although there is no widely accepted classification, gambling forms that are usually recognized include lotteries, sports and horse betting, bingo, EGMs, card games, and chance-based casino table games such as roulette and craps. These forms of gambling may be offered in 'brick and mortar' venues or via the Internet; they include variants and hybrids of many kinds.

Forms of gambling have a common core – the chance of winning something of greater value than the amount staked – but differ in terms of structural characteristics (Abt, Smith, & Christiansen, 1985, pp. 39–44; Parke, Parke, & Blaszczynski, 2016) and the experiences they offer to the gambler (Binde, 2013). For example, the appeal of lotteries is mainly to place a minor stake for the chance of winning a huge sum of money; bingo often has a social dimension; sports betting includes a perceived or actual element of skill; and EGMs make it possible for the gambler to engage in lengthy sessions of play in which small stakes are made repeatedly in rapid succession, which may induce a dissociative state of mind.

These different experiences mean that the motives for participating in particular forms of gambling vary. It is therefore reasonable to assume that these forms are associated with PG in different ways and to varying degrees (Balodis, Thomas, & Moore, 2014; Flack & Morris, 2014; Holtgraves, 2009). Behavioural as well as addiction theories assume that continuous games with a high reward frequency (e.g. EGMs) are more closely associated with PG than discontinuous and slow games (e.g. weekly lotteries) (Haw, 2008; Linnet, Rømer Thomsen, Møller, & Buhl Callesen, 2010). Cognitive theories assume that games that induce many cognitive fallacies have a closer association with PG than other forms (Goodie & Fortune, 2013). According to sociological theory, excessive gambling is likely to be associated with forms of gambling that involve subcultures in which players assume social identities that are valuable to them (Ocean & Smith, 1993; Rosecrance, 1986). From a neuroscientific perspective, some types of gambling have a higher capacity to tap into the neural substrates responsible for decision-making, which may increase the risk of developing gambling addiction through a complex interaction between the features of the gambling product and individual vulnerabilities (Murch & Clark, 2016).

Forms of gambling and PG

Given the theoretical underpinnings outlined above, it is not surprising that there is solid evidence that some forms of gambling (e.g. EGMs, casino games and some types of sports betting) are more closely associated with PG than other forms (e.g. weekly sports and horse pools, traditional lotteries and instant lottery tickets). Population studies have typically shown elevated PG rates among those who regularly participate in certain forms of gambling (for overviews, see Binde, 2011; MacLaren, 2016; Williams, Volberg, & Stevens, 2012, Appendix G). Numerous studies from many countries have shown that among help seekers and in samples made up only of problem gamblers, some forms of gambling and particularly EGMs and online gambling are especially problematic (Breen, 2004; Grant & Kim, 2001; Stea, Hodgins, & Fung, 2015). The assumption that some forms of gambling include components, such as reward frequency and jackpot size, that contribute to excessive gambling in varying degrees has led to the development of a number of risk assessment tools (Airas, 2011; Gamgard, n.d.; Meyer, Fiebig, Häfeli, & Mörsen, 2011). Theoretically, these tools make it possible to identify particularly risky forms of gambling and to modify these forms to be less harmful. Empirically, a Swedish longitudinal population study showed that participation in forms of gambling with a high score on a risk potential index, based on the principles of risk assessment tools, was positively related to incidence of problem gambling (Public Health Agency, 2016). Finally, numerous first-person accounts and data from qualitative studies of problem gamblers have suggested that these problems are driven principally by one specific form of gambling (Doiron & Mazer, 2001; Dow Schüll, 2013; Petry, 2003).

Most of these data are correlational, showing an association between PG and particular forms of gambling. This type of data does not tell us whether starting to regularly engage in a particular form of gambling elevates the risk of developing PG, or if people who already are problem gamblers are attracted to these forms of gambling, which thereby sustains and possibly worsens their problems.

Greater availability of a specific form of gambling potentially increases the number of people who might have problems with that form. However, forms of gambling with limited availability might nevertheless be closely associated with PG. For example, in Sweden during the time when the data analysed in this study was collected, there were about three times as many lotto retailers as places with EGMs (Svenska Spel, 2009). Nevertheless, problematic gambling (PGSI 3+) was nearly 10 times higher among regular EGM players compared with regular lotto players (Public Health Agency, 2016).

Gambling involvement (versatility) and PG

While the association between particular forms of gambling and PG is well established, increasing attention has recently been given to involvement in multiple forms of gambling. Statistical analyses of population surveys and other large datasets have shown that high involvement in gambling is positively associated with PG (Holtgraves, 2009; Phillips, Ogeil, Chow, & Blaszczynski, 2013; Volberg & Banks, 2002; Welte, Barnes, Wieczorek, Tidwell, & Parker, 2004). 'Involvement' is defined here as *participation in multiple forms of gambling*; low involvement means that the individual participates in relatively few forms of gambling. 'Versatility' is another term for involvement that has sometimes been used in the literature (Welte et al., 2004).

On the population level, the more numerous and varied the forms of gambling, the more likely that individuals will find some form(s) of gambling attractive, participate regularly and run the risk of developing gambling problems (Welte, Tidwell, Barnes, Hoffman, & Wieczorek, 2016). On the individual level, a recent longitudinal study of gambling involvement found that one specific trajectory, followed by 8% of the sample and characterized by high gambling involvement at both age 15 and at age 30, was associated with a heightened risk for problem gambling (Carbonneau, Vitaro, Brendgen, & Tremblay, 2015). The authors of the study speculate that extended high gambling involvement may be a marker of high novelty seeking, which is a relatively stable personality trait.

A few analyses have suggested that when statistically controlling for involvement, the association between PG and most or all forms of gambling is significantly attenuated, disappears or is even reversed (LaPlante, Afifi, & Shaffer, 2013; LaPlante, Nelson, & Gray, 2014; LaPlante, Nelson, LaBrie, & Shaffer, 2011). Such results should not, however, be interpreted to mean that most or all forms of gambling are equally harmful. The results principally show that high gambling involvement is more common among problem gamblers and this in itself is stronger than the effect of participation in any one particular form of gambling. It should also be noted that the results of regression analyses in these studies may be affected by the inherent collinearity between variables, where the involvement measure is the sum of the variables measuring participation in individual forms of gambling. Such collinearity may lead to bias in estimates of regression coefficients and standard errors. The correlations between overall gambling involvement, participation in specific forms of gambling, and PG are likely to be complex (Afifi, LaPlante, Taillieu, Dowd, & Shaffer, 2014; Gainsbury et al., 2014; Ronzitti et al., 2016; Welte, Barnes, Tidwell, & Hoffman, 2009).

Theoretically, there is no inevitable causal mechanism that associates high gambling involvement with PG. For example, it is entirely plausible that a recreational gambler could participate infrequently and for low stakes in many forms of gambling. Conversely, an individual may gamble problematically on only one form of gambling. The association between high gambling involvement and PG might be due to the fact that the former is related to high intensity of gambling. 'Intensity' is defined as the amount of time or money spent gambling, with low intensity meaning relatively little time or money and high intensity meaning relatively large amounts of time or money. In other studies, the term 'depth involvement' has been used to denote frequency (i.e. intensity) of play, in contrast to 'breadth involvement' which denotes the number of games engaged in (LaPlante et al., 2014). Intensity of gambling is inherently related to PG. For example, five of the nine items in the Problem Gambling Severity Index (PGSI, Ferris & Wynne, 2001) concern the intensity of gambling: betting more than you can afford to lose; needing to gamble with larger amounts of money to get the same feeling of excitement; going back another day to try to win back the money lost; borrowing money or selling anything to get money to gamble; gambling causing financial problems for an individual or their household.

Hypotheses

Based on the above theoretical considerations and our review of past studies, the following four hypotheses were tested in this study.

H1. Some forms of gambling are more closely associated with PG than other forms.

H2. High involvement in gambling is positively associated with PG.

H3. Gambling involvement is positively associated with the intensity of gambling.

H4. The relationship between involvement and PG is influenced by the specific forms of gambling in which individuals participate.

Method

Data and measures

The present study was based on 4,991 Swedish inhabitants aged 16–84 years who participated in wave one of the Swedish Longitudinal Gambling Study (Swelogs) 2008/2009 (Public

Health Agency, 2016) and had gambled at least once in the past 12 months on at least 1 of the 8 major forms of gambling in Sweden: lotteries, number games (such as lotto), sports betting, horse betting, poker, EGMs, casino games or bingo. All these forms of gambling are offered in physical venues and online although, because of the structure of the question-naire, we were unable to clearly distinguish between these two modes of access in our data. Also in our analyses, quick pick betting on horse pool games (*Harry Boy*) was classified as a lottery since this is how it is marketed and largely functions in Sweden.

The participants in Swelogs were a stratified random sample from the Swedish Register of the Total Population. The total number of participants in the baseline survey was 8,165 and the unweighted response rate was 57% (weighted: 63%). Details of the sample demographics, oversampling procedure and calibration weighting can be found in a methodological overview of the study (Romild, Volberg, & Abbott, 2014). The Swelogs study was approved by the Regional Ethical Review Board in Umeå, Sweden, before data collection began in 2008.

The nine-item PGSI (Ferris & Wynne, 2001) was used to measure gambling problems. As recommended in several recent analyses of prevalence data (Currie, Hodgins, & Casey, 2013; Stone et al., 2015; Williams & Volberg, 2014), a cut-off of five or more was used in classifying respondents as problem gamblers. In the sample, 142 individuals (1.5% of the weighted sample) were classified as problem gamblers.

Gambling involvement was measured as the number of major forms of gambling that respondents had engaged in at least once in the past year or monthly or more often, where participation at least monthly was a derived variable based on the highest frequency of participation in any subtype within each major gambling form. Gambling monthly or more often in at least one type of game is referred to as 'regular gambling' throughout the rest of this article. Intensity was measured as time and money spent on gambling.

Statistical analyses

The variables used for gambling involvement, gambling intensity and problem gambling were all skewed, with most observed values below the mean. The variables for gambling intensity also contained a few outliers. Therefore, most analysis was done using non-parametric measures and tests, where all numbers were converted into ranks.

We calculated 95% confidence intervals for the proportions of problem gamblers in the subgroups based on the number of gambling forms to explore H1.

H2 was evaluated by calculation and testing of Spearman's correlation between the number of gambling forms and the full PGSI score. We also used ROC analysis to evaluate the predictive power of gambling involvement in relation to PG. Furthermore, 95% confidence intervals for the proportion of gamblers with PG related to the number of forms of gambling on an annual basis were calculated and the proportion of problem gamblers in relation to regular involvement was tested using the Mann-Whitney U-test.

H3 was evaluated by calculation of Spearman's correlation, and 95% confidence intervals calculated using Fischer's z-transformation as we wanted to compare the correlations rather than test them against the null hypothesis of no correlation.

To investigate H4 we chose to plot PG values for each form of gambling across increasing numbers of gambling activities, which allowed a detailed inspection of how participation in specific forms of gambling influenced the relationship between overall gambling involvement and PG (for a similar approach analysing frequency rather than involvement, see Currie et al., 2006).

Calibration weights adjusting for unequal sampling probabilities and non-response were used for all of the statistical analyses except the ROC analysis. The weights were created to adjust estimates at a population level. Before analysis, they were transformed to permit analysis based on the number of respondents who had gambled at least once in the past year (n = 4,991). The range for the transformed weights was 0.0013–9.52 for all past-year gamblers, 0.0013–9.53 for non-problem gamblers and 0.0018–5.79 for problem gamblers. The unequal weighting effects (UWE) were 2.61, 2.58 and 3.80, respectively. Data analysis was carried out in SPSS 22.0.

Results

H1. Some forms of gambling are more closely associated with PG than other forms

The proportion of problem gamblers differed among past-year as well as among regular participants in different forms of gambling (see Figure 1). With regard to yearly participation, the proportion of problem gamblers was significantly higher among EGM, poker, casino and bingo gamblers compared to those playing lotteries and lotto/number games as well as horse bettors. The proportion of problem gamblers among sports bettors was significantly higher only in relation to people playing the lotteries and significantly lower only in relation to casino gamblers.

With regard to regular participation, the highest proportions of problem gamblers – 13% to 19% – were found among those gambling on EGMs, casino games and bingo. Furthermore, these rates were two to four times higher than rates among past-year gamblers in each gambling form. The same holds true for regular sports bettors and poker players,



■ Gambled past year ■ Gambled regularly

Figure 1. Percentage of problem gamblers among past-year and regular gamblers in different gambling forms.

Note: 95% confidence intervals. A table with frequencies can be sent on request.

among whom 5% and 9%, respectively, were problem gamblers. This difference in PG rates between past-year gamblers and regular gamblers reflects the fact that problem gamblers were more likely to gamble frequently.

These results support Hypothesis 1: some forms of gambling were more closely related to PG than other forms.

H2. High involvement in gambling is positively associated with PG

The median number of gambling forms in which survey respondents participated in the past year was 2 with the mean number only slightly higher at 2.22 (see Table 1). Past-year gambling involvement had a Spearman's correlation of 0.20 with the PGSI full range scale while regular gambling involvement had a correlation of 0.17, meaning that PG was significantly associated with participating in multiple forms of gambling. The predictive power according to the ROC analysis, which assesses a binary result of non-PG and PG, was even stronger at 0.71 (past-year) and 0.67 (regular participation). Gambling involvement thus had high predictive power and explained about 70% of the variation in PG status.

The overall proportion of gamblers with PGSI scores of 5 or more was 1.5% (95%, CI 1.2–1.8) in the sample. In general, this proportion increased with the number of different games played in the past year (see Figure 2). Compared with the entire sample, there were about 3 times as many problem gamblers among those who participated in 5 forms of

	At least once past 12 months	Regularly
Min	1	0
Max	8	8
Median	2	1
Mean	2.22	1.04
Standard deviation	1.29	1.06
Spearman's Correlation vs. PGSI	0.20**	0.17**
Area, ROC	0.71 (0.66–0.76)	0.67 (0.63-0.71)

Table 1. Gambling involvement in major gambling forms.

***p*>.01.





Note: 95% confidence intervals.



Figure 3. Percentage of non-problem and problem gamblers in relation to involvement in number of forms of gambling, regular participation.

Note: Non-problem gamblers (PGSI 0-4), n = 4,918; problem gamblers (PGSI 5+), n = 75. p>.001 (Mann-Whitney U-test).

gambling, nearly 5 times as many among those who participated in 6 forms, and 14 times as many among those who participated in 7 or 8 forms of gambling.

Figure 3 shows that the relationship between PG and regular gambling involvement was primarily due to the overall tendency for the proportion of problem gamblers to increase as the number of forms of gambling increased. However, it should be noted that 40% of problem gamblers participated regularly in only one form of gambling and another 10% participated in only two forms. It is also worth noting that 12% of problem gamblers did not participate in *any* form of gambling on a regular basis. These might be binge gamblers or problem gamblers who have abstained from regular gambling for a period of time during the past year. The average number of forms of gambling in which problem gamblers regularly participated was 2.1 (median = 1).

These results support Hypothesis 2: high involvement in gambling is associated with PG. Nevertheless, half of all problem gamblers participated regularly in only one or two forms of gambling.

H3. Gambling involvement is positively associated with the intensity of gambling

Table 2 shows that the correlation between past-year gambling involvement and the intensity of gambling in money or hours spent was .54 (95% CI .52–.57) and .61 (95% CI .59–.63) respectively. When gambling involvement was measured as the number of forms engaged in regularly, the correlation was .56 (95% CI .54–58) in both cases. Correlations between .5 and .7 are generally regarded as strong. These results support Hypothesis 3: gambling involvement is positively associated with the intensity of gambling.

H4. The relationship between involvement and PG is influenced by the specific forms of gambling in which individuals participate

Figure 4 shows PG prevalence among regular participants in specific forms of gambling within groups of gamblers involved in an increasing number of forms of gambling. Thus, the lines in the figure represent constellations of gambling participation. For example, the

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	Number of major gambling forms past year	Number of major gambling forms at least monthly past year	Money spent on gambling past 30 days (SEK)	Hours spent on gambling past 30 days
Number of major gambling forms past year	_			
Number of major gam- bling forms at least monthly past year	.53 (.51–.55) (n = 4,756)	-		
Money spent on gambling past 30 days (SEK)	.54 (.52–.57) (n = 3,759)	.56 (.54–.58) (<i>n</i> = 3,759)	-	
Hours spent on gam- bling past 30 days	.61 (.59–.63) (<i>n</i> = 3,759)	.56 (.54–.58) (<i>n</i> = 3,759)	.71 (.69–.73) (<i>n</i> = 3,759)	-

Table 2. Correlation	between gambling	involvement and the intens	ty of o	ambling.

Note: Spearman's correlation with 95% confidence intervals.





Note: Bingo and casino games excluded in the figure due to small numbers. A table with frequencies can be sent on request.

first point on the EGM line represents those who only participate in EGM gambling, the second data point represents those who participate in EGM gambling and one other form of gambling, the third data point represents those who participate in EGM gambling and two other forms of gambling, etc. Individuals may thus belong to multiple constellations (e.g. individuals participating in two forms of gambling are included in both of the lines representing these forms). For this reason, confidence intervals cannot be calculated in conventional ways. All of the data points in the graph include at least five problem gamblers, which allowed us to calculate proportions. We chose to focus our analysis on regular

participation rather than past year because regular participation is characteristic of PG, although this had the disadvantage of excluding bingo and casino games due to small numbers of participants.

Figure 4 shows a complex pattern in which regular participation in specific gambling forms influenced the relationship between involvement and PG. There are some striking differences between the eight forms of gambling. For example, gambling on EGMs was most clearly related to PG, with the highest proportion of problem gamblers (between 20% and 28%) of all forms of gambling at all levels of involvement. For all other gambling forms except horse betting, the proportion of problem gamblers increased with the number of other forms played regularly. Constellations of gambling involvement that included poker were above average in terms of PG at all levels of involvement. The proportion of problem gamblers among those betting monthly on sports was very similar to the total sample. There were fewer problem gamblers than average among those who participated in lotteries and number games. The proportion of problem gamblers among those betting regularly on horses was lowest of all, except for those who gambled either only on horses or on horses and four or more additional forms of gambling.

Differences in problem gambling prevalence were smallest among those who participated regularly in five or more forms of gambling – between 20% and 28% of participants in each of the six forms of gambling shown in Figure 4 were problem gamblers. At this high level of involvement, each curve includes many of the same individuals included in the other curves due to the small size (weighted n = 75; unweighted n = 142) of the PG group in the sample.

These results support Hypothesis 4: the relationship between gambling involvement and PG was influenced by the specific gambling forms in which an individual participated. Regular participation in EGM gambling and poker was more closely associated with PG than regular participation in other forms of gambling, regardless of a person's overall level of gambling involvement.

Discussion

In this study, we explored the relationships between PG, gambling involvement, gambling intensity and participation in specific forms of gambling. We also examined the question of whether the relationship between gambling involvement and PG is influenced by participation in specific forms of gambling. All four hypotheses regarding these relationships were supported.

Our first hypothesis, that some forms of gambling are more closely associated with PG, was supported since we found that the proportion of problem gamblers was higher than average among those who participate in some forms of gambling compared with others. The association with PG was stronger for regular participation compared with past-year participation. In the Swedish context, regular participation in EGM gambling, casino games, poker and bingo was particularly strongly associated with PG.

It is worth noting that associations between particular forms of gambling and PG are not necessarily fixed and stable over time. If features of the form are modified – for example, if reward frequency is made lower or higher – the association with PG may become weaker or stronger. This is the rationale of risk assessment tools developed over the last decade (Airas, 2011; Gamgard, n.d.; Meyer et al., 2011). The strength of the association is also likely affected by the availability of the form of gambling, the mix of products on the gambling market, and sociocultural factors that influence how various forms of gambling are perceived and marketed.

Our second hypothesis, that high gambling involvement is positively associated with PG, was also supported. The ROC analysis (binary, PG versus Non-PG) showed a stronger association between PG and involvement than the Spearman correlation test (PGSI full range). This suggests that involvement was more strongly associated with having a gambling problem or not, rather than with incremental differences in PGSI scores.

In general, problem gamblers participated in more forms of gambling than recreational gamblers. This finding is consistent with most previous studies. There may be several reasons for such versatility, including impaired impulse control, high novelty seeking, a desperate hope that a big win will cover losses accumulated in other forms of gambling or simply a desire for variety among those who gamble a great deal; it is a general observation that addicts tend to be versatile in the products they consume (Williams, West, & Simpson, 2012, p. 29).

However, 40% of problem gamblers participated regularly in only one form of gambling and another 10% participated in two forms. Only 25% of problem gamblers participated regularly in four or more forms of gambling (see Figure 3). This is consistent with research showing that one specific form of gambling is the principal source of harm for a large number of problem gamblers (Productivity Commission, 2010, p. F.8; Williams, Belanger, & Arthur, 2011, p. 168). Another indicator of this is the relatively low average number of forms of gambling in which problem gamblers participate regularly. In this study, the average number was 2.1 forms, similar to results from several other studies (mean: 1.9 forms, Grant & Kim, 2001; mean: 2.4 forms, Petry, 2003; mean: 2.5 forms, Teo, Mythily, Anantha, & Winslow, 2007).

Our third hypothesis, that gambling involvement is positively associated with intensity of gambling measured in money and time spent, was supported. This holds true for all gamblers, regardless of whether they have a gambling problem. Nevertheless, an association between PG and involvement might be caused or strengthened by the intensity factor, which, as we argued in the introduction, is an essential aspect of PG.

Finally, our fourth hypothesis, that the relationship between involvement and PG is influenced by the specific forms of gambling in which individuals participate, was supported.

Regardless of overall level of gambling involvement, regular participation in EGMs and poker was particularly closely associated with PG in the Swedish context. Between 20% and 28% of those who regularly participate in EGM gambling were problem gamblers, across all levels of involvement. Among all forms of gambling, EGM gambling stood out in this study as the form most closely associated with PG. This is consistent with results from many other studies which have concluded that EGMs are a high-risk form of gambling (e.g. Abbott, Stone, Billi, & Yeung, 2016; MacLaren, 2016).

Our analysis showed that the prevalence of PG was lower than average among regular horse bettors in Sweden, except for those who regularly participated either only in horse betting or in four or more additional forms of gambling. Although horse betting has been identified as a form of gambling with a moderately strong association with PG in numerous studies, there have been indications of relatively low prevalence of PG among horse bettors in a few other studies (LaPlante et al., 2011; Westfelt, 2006). Our data did not provide an explanation for this finding but we can speculate that horse betting, more than other forms of gambling, often involves social interaction in which expertise in betting is highly valued and which may protect against problem gambling (Rosecrance, 1985; Scott, 1968). The extent to which a social context protects against PG likely varies between countries and gambling settings, which may explain the contradictory findings in the research literature.

There was a general tendency across all of the forms of gambling, except regular EGM gambling, for participation in each additional form to increase the probability of having a gambling problem in a stepwise fashion (Figure 2). This is consistent with the view that involvement in gambling is closely associated with intensity of gambling which in turn is associated with PG severity.

However, we have noted that the association between PG and gambling involvement was influenced by participation in specific forms of gambling and was quite complex. Most of the curves in Figure 4 differ, to a small or large degree, from the 'total' curve. It is possible that these differences reflect different types of gamblers, types that are formed by constellations of personality factors, motives for gambling and the structural characteristics of the various forms of gambling (Balodis et al., 2014; Bonnaire, Bungener, & Varescon, 2006; Ronzitti et al., 2016).

For example, and allowing a bit of speculation, the first point on the EGM curve might represent people who escape into gambling, seeking dissociation, or have become addicted to EGMs (Dow Schüll, 2013). Such individuals have little interest in any other forms of gambling than EGMs; they can be described as high intensity and low involvement gamblers. At the next two points on the curve – regular participation in EGMs and in one or two other forms of gambling – the proportion of problem gamblers is slightly lower. This might be because fewer of these gamblers focus on EGMs. However, the proportion of problem gamblers among those who regularly participated in EGM gambling again increased when they participated in three or more other forms of gambling, perhaps because these individuals tended to engage in whatever form of gambling came their way.

Similarly, the first three points on the horse betting curve (participation in one, two or three forms of gambling, Figure 4) may reflect a tendency among regular horse bettors to gamble in a non-problematic way, as this is valued in the social context of horse betting. Such circumspection might influence participation in one or two more forms of gambling, but if involvement increases to three or more additional forms, the ensuing high intensity of gambling might make the proportion of problem gamblers increasingly higher. As to regular participation in lotteries, it could be argued that recreational gamblers may complement their lottery play with one or two other similar forms of gambling that have a relatively weak association with PG – for example, number games and sports pools. The intensity of gambling among these individuals may be low despite relatively high involvement, which would explain the low proportion of problem gamblers. However, addition of a fourth form of gambling would likely be a form with a stronger association with PG, such as poker, casino games or EGMs. This may explain why the proportion of PG increased from 3% to 12% in this group.

The preceding discussion presents possible interpretations of our results, based on findings from previous studies on EGMs and horse betting. Future research might illuminate the validity of these different interpretations. Research on constellations of gambling activities among problem gamblers would greatly extend our understanding of the interactions between particular forms of gambling and gambling involvement.

One important strength of this study is the large data-set from a representative population study with a reasonably good response rate. Another strength is that participation in gambling was not only measured on a yearly basis but also monthly or more often, which allowed for comparison between less and more fine-grained renderings of gambling behaviour. Because regular participation is more closely associated with PG than past-year participation, we recommend including regular participation as an important and possibly preferred measure in future studies of gambling involvement.

This study also has some limitations. One limitation relates to the cross-sectional design, which does not allow for the exploration of causal relationships. In the future, longitudinal cohort studies could investigate to what extent high involvement is a consequence of developing PG (Carbonneau et al., 2015) and to what extent it is a risk factor for developing PG. A person who participates in many forms of gambling but without problems may be at a higher risk for developing problems because he or she is exposed to a wider variety of risk factors. If the heightened risk eventually leads to gambling problems, gambling involvement may continue to be high. High involvement would then be an independent factor related to the development of PG.

Another limitation of this study is that we could not distinguish between participating in a form of gambling in a physical venue and online, which may obscure associations with PG particular to these different modes of access. This limitation could be addressed in future studies.

Finally, our analyses focused on involvement in relation to specific forms of gambling. Even in this large data-set, some groups were quite small, which leads to large confidence intervals around the point estimates. Some of our results must therefore be regarded as indicative only. In the future, it will be interesting to analyse clusters of gambling forms and examine differences in the relationship of relatively 'slow' games with small stakes and the possibility of very large jackpots (e.g. lotteries, number games, horse pools) and more 'rapid' games (e.g. casino games, EGMs, sports betting) to both gambling involvement and PG. Further research on gambling involvement might also benefit from identifying individuals' primary gambling activity, if any, since this would add detail to the picture of gambling participation offered by past year and monthly time frames.

Conclusion

At the beginning of this article, we noted the apparent discordance between previous research results in this field of inquiry. Our study showed that PG was associated both with particular forms of gambling and with overall involvement. We have pointed out several methodological reasons why some previous studies have found that involvement is more important, in relation to PG, than particular forms of gambling. By building hypotheses based on different bodies of literature and using statistical approaches carefully chosen for testing the hypotheses, we have advanced understanding of the harms that might be caused by participating in specific forms of gambling and the distinct roles of involvement and intensity in PG.

In our analyses of the Swedish data, EGMs, casino games, bingo and poker stood out as closely associated with problem gambling. Problem gamblers participated in more forms of gambling than non-problem gamblers. However, this was a general observation and not true for the substantial number of problem gamblers in this study who regularly participated in only one form of gambling. EGMs were closely associated with PG at all levels of involvement in this study. Among other forms of gambling, there was a complex relationship

between participation and overall involvement, suggesting that specific forms of gambling, as well as combinations of forms, influenced the association with PG.

We found a strong correlation between intensity of gambling and involvement in gambling. Intensity is an intrinsic characteristic of PG, which is why PG screens typically include questions related to the intensity of gambling. Involvement, however, is not intrinsic to PG. In this study, only 25% of problem gamblers regularly participated in four or more forms of gambling, while 40% participated regularly in only one form of gambling. Thus, the association between intensity and involvement means that, in a sample of gamblers, the higher the intensity, the higher the probability of high involvement, and vice versa. However, for PG to occur, intensity *must* be high although involvement meed not necessarily be high. These observations suggest that, to a large extent, involvement may be an aspect of gambling intensity rather than the other way around. In our view, the fundamental issue is that problem gamblers spend too much time and money gambling, not that they may participate in several forms of gambling.

The results of this study have policy implications. First, some forms of gambling – in this study EGMs, casino games, bingo and poker – are more closely associated with PG than other forms of gambling. Authorities regulating the gambling market, those overseeing public health prevention, and companies engaged in responsible gambling efforts should focus their preventive and harm-minimization efforts on these forms of gambling. Second, the association between gambling intensity, gambling involvement and PG can help gambling companies as well as public health authorities identify at-risk gamblers who would benefit from targeted preventive efforts (Heiskanen & Toikka, 2015). However, it makes little sense to recommend a specific limit on the number of forms of gambling that individuals participate in. It is more important to warn people about regular participation in specific forms of gambling with a strong association with PG and about high intensity gambling; that is, spending too much money and time on any form of gambling.

Conflicts of interest

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Competing interests

Per Binde has no conflicts of interest to declare in relation to this article. The author has no current or past affiliations with the industry. All his research funding has come from government-funded research or public health agencies, with the exception of a minor grant, for writing a research review, received in 2014 from the Responsible Gambling Trust in the UK, which is an independent national charity funded by donations from gambling companies.

Ulla Romild has no conflicts of interest to declare in relation to this article. She has no current or past affiliations with the gambling industry. All her research activity in gambling is made as an employee of the Public Health Agency of Sweden.

Rachel A. Volberg has no conflicts of interest to declare in relation to this article. She has no current affiliations with the gambling industry. She has received research funding from several government agencies, including the Massachusetts Gaming Commission, the Canadian Consortium for Gambling

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Constraints on publishing

This study has been conducted according to the policy of the Public Health Agency to produce and present evidence-based research results. Apart from that general constraint on publishing, the Agency had no involvement in formulating research questions, data analysis or the preparation of this article. The authors retain full scientific responsibility for the article.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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