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Has gambling changed after major amendments of gambling regulations in Germany? A propensity score analysis

MONIKA LUDWIG[1,2]*, LUDWIG KRAUS[1,3], STEFANIE MÜLLER[1], BARBARA BRAUN[1] and GERHARD BÜHRINGER[1,4]

[1]IFT Institut für Therapieforschung, München, Germany
[2]Institut für Psychologie, Universität Hildesheim, Hildesheim, Germany
[3]Centre for Social Research on Alcohol and Drugs (SoRAD), Stockholm University, Stockholm, Sweden
[4]Institut für Klinische Psychologie und Psychotherapie, Technische Universitaet Dresden, Dresden, Germany

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Aims: This study examined changes in general population gambling in the light of two major amendments of the German gambling regulation, the Fifth Amendment of the German Gambling Ordinance (AGO) for commercial amusement machines with prizes (AWP) and the State Treaty on Gambling (STG) for gambling activities subject to the state monopoly. *Methods:* Applying cross-sectional data from the 2006 and 2009 Epidemiological Survey of Substance Abuse (ESA), propensity-score-matched samples of 7,970 subjects and 3,624 12-month gamblers aged 18–64 years were used for analyses. Logistic regression was employed to examine changes in gambling controlling for possible confounding variables. *Results:* Overall participation in state gambling activities, participation in lotto as well as TV lottery decreased and gambling on Internet card games increased. No changes were found for any other gambling activity, 12-month prevalence of any gambling and pathological gambling. While weekly gambling declined, overall multiple gambling increased. Effects were similar in the total sample and among current gamblers. *Conclusions:* Prohibiting specific gambling activities, e.g., Internet gambling, seem to be insufficient approaches to change gambling behavior. Supply reduction might need to be enhanced by changes in game characteristics and implementation of early intervention measures. However, long-term consequences are uncertain and further monitoring is needed.

Keywords: gambling policy, impact of gambling regulations, gambling behavior, pathological gambling, changes in gambling over time

INTRODUCTION

In the international context, a great variety of different gambling legislation systems can be found which might influence gambling behavior differently. In Germany, two separate legislation systems for gambling exist. On the one hand, provision of any gambling activity is illegal and only possible with state approval (§§284–286 German Criminal Code). With a few exceptions such as horserace betting, gambling activities are subject to the public monopoly comprising (a) casinos *(Spielbanken)* which provide gambling on slot machines and table games such as poker, roulette and black jack, (b) the German lottery association offering, amongst others, lotto tickets (e.g., six out of 49; drawing of numbers is biweekly), different kinds of lottery or sports betting, (c) TV lottery (a lottery with strong focus on charity; winning numbers are announced on TV) as well as (d) class lottery (lottery tickets with pre-assigned seven-digit numbers).

On the other hand, so-called "amusement machines with prizes" (AWP; technically a specific type of slot machine) are not considered gambling and therefore principally legal. That is, regulation of AWP is not subject to the public monopoly, but to the German Industrial Code. In contrast to regular state slot machines, AWP are operated by commercial providers and openly accessible in restaurants, pubs, and gaming arcades without personal identification. Also, stakes, wins, and losses on AWP are limited and regulated (by the German Gambling Ordinance) contrary to being mainly unlimited for slot machines. However, similar to slot machines, AWP do give cash wins. In general, gambling participation is subject to an age limit of 18 years and older.

In the past years, the German gambling legislation underwent two key changes. In 2006, the Fifth Amendment of the German Gambling Ordinance (AGO) for AWP was implemented with two major, potentially contradictory aims: (a) to ameliorate the implementation of measures for the protection of minors and consumers and (b) to improve the economic conditions for providers of AWP. To this end, setup conditions were made stricter, e.g., only two AWP were permitted to be arranged next to each other and cover panels had to be installed, but game characteristics were liberalized, e.g., shorter duration of a game (five seconds) and higher maximum win (500€) and loss (80€) per hour. In 2008, new regulations concerning state-owned gambling activities (State Treaty on Gambling, STG) were enacted after the German Federal Constitutional Court had decided the state monopoly could only be justified and maintained if it focused on consumer protection, especially the prevention of pathological gambling (PG). In detail, the STG aimed (a) to prevent the development of gambling disorder, (b) to limit the provision of gambling services, (c) to steer the natural

* Corresponding author: Monika Ludwig (nee Sassen), IFT Institut für Therapieforschung, Parzivalstr. 25, 80804 München, Germany; Phone: +49-89-360804-35; Fax: +49-89-360804-49; E-mail: monika.ludwig@uni-hildesheim.de

gaming urge, (d) to impede a switch to illegal gambling activities, and (e) to guarantee the protection of minors and gamblers. Consequently, the STG, among others, prohibited gambling advertisement and provision of Internet gambling and required personal identification for the use of slot machines and some forms of lottery.

Up to now, changes in gambling behavior and PG as response to the AGO and the STG are not well assessed. Sales figures reveal a 42.0% increase in turnover of AWP from 2005 to 2009 (Meyer, 2011). In contrast, overall annual gambling turnover of state gambling activities decreased by 22.9% from 2008 to 2009, i.e. after the STG (Meyer, 2011). A study on the effects of the AGO on current AWP gamblers points to an increase in potentially hazardous gambling, considering time spent and amount of money at stake (Bühringer, Kraus, Höhne, Küfner & Künzel, 2010). Also, the risk of losing greater amounts of money, chasing losses, and losing control over gambling was found to be elevated.

Concerning changes associated with the STG, cross-sectional studies conducted before (in 2007) and after the STG (in 2009) (Bundeszentrale für gesundheitliche Aufklärung [BZgA], 2010) reported a substantial increase in participation on AWP and lotto in the past 12 months prior to the survey. In contrast, a decreased participation in class lottery was observed. Results indicate no changes in the prevalence of any 12-month gambling and PG (BZgA, 2010). These findings, however, are subject to fundamental limitations. First, analyses were only controlled for possible confounding of gender and age, not considering other factors well known to influence gambling behavior and PG (for a review see Johansson, Grant, Kim, Odlaug & Götestam, 2009). Second, at the time of the first data collection in 2007, judicial demands had been adhered to beforehand and an increased number of prevention measures had already been implemented even though the STG was not yet officially in power. Third, there was no discrimination between effects on the total population and effects on current gamblers. This is highly relevant as the amendments could affect current gamblers differently than the entire population.

In order to allow for sound conclusions on the impact of the AGO and the STG, this study focused on short-term changes in gambling behavior after the amendments controlling for possible confounding factors, i.e. aiming at unbiased intervention effects. Based on the available evidence, it was expected that (1) overall gambling behavior within the past year declined due to the restriction of the most common gambling activities, in particular through personalized access control and advertisement restrictions, that (2) more rigorous regulations of the STG resulted particularly in a decrease of gambling on state gambling activities (per activity and overall), and that (3) liberalization of characteristics of AWP, such as higher potential wins, led to increased gambling on AWP. It was also hypothesized that (4) Internet gambling decreased due to prohibition, and (5) gambling on horserace betting and illegal table games was unaffected by the amendments and remained stable. As both measures were implemented to prevent PG, we investigated whether hazardous gambling behavior such as weekly or multiple gambling was reduced in 2009. However, because of the short observation period (6) no difference in the prevalence of PG was expected. Potential changes were assessed separately in the German general adult population and among 12-month gamblers.

METHODS

Sample

Data were taken from the 2006 and 2009 Epidemiological Survey of Substance Abuse (ESA, Kraus & Baumeister, 2008; Kraus & Pabst, 2010), a nationwide, cross-sectional household survey. Using a two-stage probability sampling design, a sample of adults aged 18 to 64 years was drawn from the German general population in both survey years. First, communities were selected relative to population size. Subsequently, a random sample of subjects aged 18 to 64 was taken from the residents' registry office. Sampling procedure was disproportional to the age distribution in the population, oversampling younger age groups and undersampling older age groups. The study was approved by the ethics committee of the German Psychological Society (DGPs; Reg.-No: GBLK06102008DGPS).

In both surveys, a mixed mode design was applied. In 2006, postal questionnaires were sent to all participants. If the questionnaire had not been answered after the third reminder, the participant was given the option of completing it via telephone interview. In 2009, participants were able to complete the questionnaire by either mail or telephone or online. A total of 7,912 and 8,030 subjects participated in 2006 and 2009, respectively, corresponding to response rates of 44.9% (in 2006) and 50.1% (in 2009) of all eligible subjects. Data of both survey years were weighted accordingly in order to ensure representativeness of gender and age distribution of Germany in a given year. Further details on the sampling design are described elsewhere (Kraus & Baumeister, 2008; Kraus & Pabst, 2010).

Cases with missing values on lifetime gambling participation (2006: $n = 81$; 2009: $n = 22$) or PG (2006: $n = 14$) were excluded. Records with inconsistent responses regarding preferred gambling activity (2009: $n = 2$) or implausible values in number of children at home (>60 children; 2006: $n = 6$) were discarded as well. Thus, the analytical sample comprised $n = 15{,}817$ valid records (99.2%), $n = 7{,}811$ (98.7%) of 2006 and $n = 8{,}006$ (99.7%) of 2009 (total sample [TS]), thereof $n = 3{,}583$ 12-month gamblers in 2006 and $n = 3{,}679$ in 2009 (subset of current gamblers [SCG]).

Measures

Outcome measures

Gambling behavior. Gambling was assessed by any, weekly and multiple gambling within the past 12 months prior to the survey. Gambling behavior was specified by asking participants about any engagement and frequency of engagement in 12 different kinds of gambling in the past 12 months: (1) lotto tickets; (2) TV lottery; (3) class lottery; (4) table games (roulette, black jack or poker available in casinos); (5) slot machines; (6) sports betting in facilities [(1) to (6) being *state gambling activities*)]; (7) AWP (operated by commercial providers); (8) Internet sports betting; (9) Internet casino (e.g., Internet roulette); (10) Internet card games (e.g., Internet poker) [(8) to (10) being referred to as *Internet gambling*]; (11) horserace betting; (12) illegal table games (e.g., card games in back rooms of pubs). Weekly gambling was coded as gambling once or several times a week vs. less than

weekly and assessed overall in both samples and differentiated for state gambling, AWP and Internet gambling in the SCG. Multiple gambling was defined as participation in more than one vs. a single gambling activity (differentiation for gambling activities not possible).

Pathological gambling. If respondents had gambled on average more than 50€ per month (about US 65$) in the past 12 months, they were screened for PG using a 19-item questionnaire (Stinchfield, 2002) mapping onto the ten DSM-IV criteria of PG (American Psychiatric Association, 1994). Meeting five or more criteria indicated PG.

Covariates

To control for possible confounding, gender, age, nationality, region, marital status, educational attainment, inflation adjusted equivalence income, and mode of data collection were used as covariates in all analyses. Age was stratified into three groups of 18 to 29, 30 to 49 and 50 to 64 years. Nationality differed between German and other nationalities; region between West and East Germany. Marital status covered being single, married, widowed, and divorced. Educational attainment was assessed by years of school (intended to be) completed and classified participants with less, equal, and more than ten years of education. Household income was adjusted for differences in household needs due to its size by dividing it by the square root of household size, thus assuming an equivalence parameter of 0.5 (Kawachi & Kennedy, 1997; Organisation for Economic Co-operation and Development [OECD], 2008). Equalized household net income per month was categorized into <1,000€, 1,000–2,000€ and >2,000€.

In order to assess changes in gambling behavior and PG from 2006 to 2009, survey year was used as an indicator with 2006 coded 0 "before the amendments" and 2009 coded 1 "after the amendments".

Statistical analyses

The complex sampling design was adjusted by using survey procedures of Stata 10.0 SE software package (StataCorp LP, 2007) in all analyses. Missing values in covariates were addressed by multiple imputation employing chained equations (Royston, 2005) generating five samples. Out of these, one sample was randomly drawn resulting in valid outcome data of 15,817 participants.

Propensity score matching

Observational data were used to assess changes before (2006) and after (2009) the implementation of the AGO and the STG. Thus, random assignment of participants to the control (survey year 2006: not exposed to amendments) or the intervention group (survey year 2009: exposed to amendments) as in randomized control trials was not possible. Consequently, covariates may differ between individuals surveyed in 2006 and those surveyed in 2009 potentially leading to biased intervention effect estimates (D'Agostino, 1998). In order to minimize this bias, propensity score matching can be applied. Propensity scores, defined as the conditional probability of being exposed given a vector of observed covariates, balance differences in the distribution of each covariate between two groups. A subset of comparison units (from 2006) similar to "exposed" units (from 2009) is selected on the basis of similar propensity scores reducing the risk of biased intervention effect estimates.

By means of logistic regression with survey year as criterion and covariates as predictors a one-dimensional propensity score was estimated. The covariates comprised socio-demographic characteristics described above. In addition, number of children at home (households without children, one to two children, three or more children), profession (blue collar, white collar, self-employed, student, miscellaneous), employment (full time, part time, not employed, miscellaneous), and federal state were included. Various chronic diseases, physical and mental health status varying from very good to very bad on a five-point scale, number of cigarettes smoked daily as well as nicotine dependence were also employed. Furthermore, prevalence of using prescription drugs (a) at least weekly within the past 30 days or (b) problematically within the past 12 months (measured by the *Kurzfragebogen zum Medikamentengebrauch* [KFM – medication use questionnaire], Watzl, Rist, Höcker & Miehle, 1991) as well as 30-day prevalence of alcohol consumption in terms of frequency, quantity (in grams of ethanol), and episodic heavy drinking were used. Moreover, prevalence and frequency of cannabis use within the past 30 days, 12-month prevalence of problematic cannabis use as indicated by the severity of dependence scale (SDS, Gossop & Darke, 1995), and 30-day prevalence of illegal drug use (other than cannabis) were included. In the sample of current gamblers, 12-month prevalence of any gambling was also used.

Exposed (survey year 2009) and control subjects (survey year 2006) were matched one-to-one using Mahalanobis metric matching technique including the propensity score within propensity score calipers (Rosenbaum & Rubin, 1985) with a caliper width of 0.2 of a linear propensity score standard deviation (Rubin, 2001). Apart from propensity score, age, gender, education, inflation adjusted equivalence income, marital status, nationality, and region were included in the metric of the TS and the SCG, respectively.

After matching, 7,970 subjects (50.4%) could be included in the analyses in the TS; 3,624 subjects (49.9%) in the SCG. Pearson χ^2 tests with Rao/Scott correction were conducted to compare descriptive statistics between survey years. Distribution of essential socio-demographic characteristics in the original unmatched and matched TS as well as SCG are presented in Table 1 (full table available on request). Indicated by changes in effect size, conformance between subjects surveyed in 2006 and 2009 on these characteristics is higher in the matched samples, apart from adjusted equivalence income which still differed between survey years. Balance of covariates in the matched samples is also improved between 2006 and 2009 as supported by smaller standardized differences (Austin, 2009) in all but one covariate (region) which differences were small.

Changes in outcome measures

In order to assess differences in outcome measures between survey years, the propensity score matched samples were used. Logistic regression was employed in all analyses. Models included all socioeconomic variables and mode of data collection. The resulting odds ratios (OR) indicate the difference between survey years in the likelihood for gambling behavior and PG.

Table 1. Comparison of selected socio-demographic characteristics in the original unmatched and matched samples before (2006) and after (2009) the amendments

	Total sample								Subset of current gamblers							
	Original unmatched				Matched				Original unmatched				Matched			
	2006 (*N* = 7,811)	2009 (*N* = 8,006)			2006 (*N* = 3,985)	2009 (*N* = 3,985)			2006 (*N* = 3,583)	2009 (*N* = 3,679)			2006 (*N* = 1,812)	2009 (*N* = 1,812)		
Socio-demographic characteristics	%	%	*p*	Stand. diff.	%	%	*p*	Stand. diff.	%	%	*p*	Stand. diff.	%	%	*p*	Stand. diff.
Gender (Male)	50.8	50.7	.669	0.00	51.4	50.8	.804	0.00	57.8	56.8	.218	0.01	57.2	56.6	.528	0.01
Age			**<.001**	0.06			.959	0.00			**<.001**	0.09			.783	0.01
18–29	21.0	22.6			22.8	21.6			16.6	20.0			19.5	18.5		
30–49	49.1	46.5			50.2	45.2			52.1	47.4			52.1	48.0		
50–64	29.9	30.9			27.0	33.3			31.3	32.5			28.3	33.5		
Education			**<.001**	0.09			.690	0.01			**<.001**	0.10			.890	0.01
<10	26.8	20.9			23.4	24.6			28.7	22.5			24.5	25.9		
=10	33.7	33.8			35.1	35.2			35.9	35.3			37.6	36.8		
>10	39.5	45.3			41.5	40.2			35.4	42.2			37.9	37.3		
Equivalence income (adjusted to inflation)			**<.001**	0.20			**.001**	0.04			**<.001**	0.20			**<.001**	0.07
<1000	32.7	23.5			29.3	29.3			28.7	21.0			25.6	27.3		
1000–2000	56.8	50.1			58.6	55.5			60.0	51.5			61.9	56.2		
>2000	10.5	26.4			12.1	15.2			11.5	27.5			12.4	16.5		
Marital status			**<.001**	0.05			.913	0.01			**<.001**	0.07			.997	0.00
Single	32.0	34.6			35.3	33.3			29.7	32.9			34.1	31.7		
Married	58.1	55.9			55.2	56.0			60.3	57.0			55.5	57.0		
Widowed	1.8	1.7			1.8	2.1			1.6	1.6			1.5	1.9		
Divorced	8.1	7.8			7.8	8.6			8.5	8.5			9.0	9.6		
Nationality (German)	93.7	94.3	.427	0.01	94.1	94.0	.401	0.01	94.0	94.8	.305	0.01	94.0	93.7	.419	0.01
Region (West)	83.2	84.6	.194	0.01	82.3	83.4	.050	0.02	84.0	85.6	.711	0.00	83.6	85.0	.196	0.02

Notes: Stand. diff.: Standardized differences. Test: χ^2.

Table 2. Comparison of outcome variables in the original unmatched and matched total sample before (2006) and after (2009) the amendments

	Total sample											
	Original unmatched						Matched					
	Before amendments (2006)		After amendments (2009)				Before amendments (2006)		After amendments (2009)			
Outcome variables	*N*	%	*N*	%	*p*	Stand. diff.	*N*	%	*N*	%	*p*	Stand. diff.
12-month prevalence	7,811	49.4	8,006	48.0	.918	0.00	3,985	51.1	3,985	47.7	.121	0.02
Overall state gambling	7,811	47.4	8,006	43.5	**<.001**	0.03	3,985	48.7	3,985	43.1	**<.001**	0.04
Lotto	7,715	38.9	7,981	36.1	**.001**	0.03	3,936	39.8	3,974	35.9	**.006**	0.03
TV lottery	7,511	10.9	7,868	10.0	.070	0.01	3,832	11.2	3,913	9.1	**.005**	0.03
Class lottery	7,434	6.0	7,837	4.8	**.003**	0.02	3,794	5.8	3,902	4.7	.176	0.02
Tables games	7,417	2.2	7,844	2.9	**<.001**	0.03	3,797	2.4	3,904	2.7	.073	0.02
Slot machines	7,415	1.0	7,839	1.4	**.016**	0.02	3,795	1.0	3,910	1.3	.213	0.02
Sports betting	7,421	3.0	7,837	2.4	**.025**	0.02	3,800	3.3	3,899	2.2	**.004**	0.03
AWP	7,424	2.9	7,845	2.6	.860	0.00	3,800	2.9	3,903	2.5	.323	0.01
Overall Internet gambling[a]	7,811	2.1	8,006	2.4	.163	0.01	3,985	2.4	3,985	2.4	1.00	0.00
Internet sports betting	7,409	1.8	7,842	1.0	**<.001**	0.04	3,794	2.0	3,902	1.3	**.001**	0.04
Internet casino	7,412	0.3	7,837	0.3	.363	0.01	3,795	0.2	3,900	0.2	.553	0.01
Internet card games	7,410	0.4	7,837	1.6	**<.001**	0.07	3,795	0.5	3,900	1.4	**<.001**	0.06
Horserace betting	7,410	0.8	7,840	0.8	.821	0.00	3,795	0.9	3,899	0.7	.080	0.02
Illegal table games	7,411	0.4	7,836	0.5	.139	0.01	3,794	0.3	3,900	0.5	.064	0.02
Weekly gambling	7,811	17.2	8,006	13.7	**<.001**	0.05	3,985	17.5	3,985	14.0	**<.001**	0.05
Multiple gambling	7,811	13.5	8,006	17.2	**<.001**	0.06	3,985	14.1	3,985	16.8	**<.001**	0.05
Pathological gambling	7,811	0.2	8,006	0.3	.092	0.01	3,985	0.1	3,985	0.2	.165	0.02

Notes: Total N varies due to item non-response. [a]Provision was illegal in Germany at time of data collection in 2009. AWP: amusement machines with prizes. Stand. diff.: Standardized differences. Test: χ^2.

Table 3. Comparison of outcome variables in the original unmatched and matched subset of current gamblers before (2006) and after (2009) the amendments

	Subset of current gamblers											
	Original unmatched						Matched					
	Before amendments (2006)		After amendments (2009)		*p*	Stand. diff.	Before amendments (2006)		After amendments (2009)		*p*	Stand. diff.
Outcome variables	*N*	%	*N*	%			*N*	%	*N*	%		
Overall state gambling	3,583	95.9	3,679	90.6	**<.001**	0.12	1,812	95.2	1,812	90.3	**<.001**	0.10
Lotto	3,494	79.6	3,656	75.4	**<.001**	0.07	1,767	78.2	1,797	75.4	**.003**	0.05
TV lottery	3,289	23.0	3,542	21.2	**.011**	0.03	1,684	23.0	1,737	20.4	**.036**	0.04
Class lottery	3,218	12.8	3,511	10.4	**<.001**	0.04	1,647	11.3	1,727	9.6	**.039**	0.02
Tables games	3,201	4.6	3,521	6.1	**<.001**	0.05	1,637	4.8	1,726	5.7	.059	0.03
Slot machines	3,199	2.2	3,516	3.0	**.033**	0.03	1,638	2.1	1,725	2.7	.495	0.01
Sports betting	3,205	6.5	3,514	5.1	**.007**	0.03	1,645	6.9	1,725	5.2	**.035**	0.04
AWP	3,207	6.3	3,522	5.6	.529	0.01	1,642	6.5	1,729	5.6	.252	0.02
Overall Internet gambling[a]	3,583	4.2	3,679	5.0	.161	0.02	1,812	4.4	1,812	4.5	.942	0.00
Internet sports betting	3,193	3.8	3,519	2.1	**<.001**	0.07	1,634	3.8	1,725	2.1	**<.001**	0.07
Internet casino	3,196	0.5	3,514	0.6	.440	0.01	1,636	0.7	1,723	0.6	.554	0.01
Internet card games	3,194	1.0	3,517	3.4	**<.001**	0.10	1,636	1.0	1,723	2.7	**<.001**	0.08
Horserace betting	3,194	1.7	3,517	1.7	.650	0.01	1,636	1.8	1,725	2.1	.616	0.01
Illegal table games	3,195	0.8	3,513	1.1	.196	0.02	1,636	0.8	1,723	1.0	.711	0.01
Weekly gambling	3,583	34.8	3,679	28.5	**<.001**	0.09	1,812	34.0	1,812	28.8	**<.001**	0.07
Weekly state gambling	3,390	35.8	3,231	30.6	**<.001**	0.07	1,701	35.0	1,594	31.0	**.003**	0.05
Weekly gaming machines	247	28.1	257	29.1	.328	0.04	133	22.1	122	31.0	**.030**	0.14
Weekly Internet gambling	189	40.9	222	44.3	.561	0.03	100	36.6	99	49.4	.224	0.09
Multiple gambling	3,583	27.4	3,679	35.8	**<.001**	0.09	1,812	27.7	1,812	34.4	**<.001**	0.07
Pathological gambling	3,583	0.4	3,679	0.5	.092	0.02	1,812	0.3	1,812	0.7	**.038**	0.03

Notes: Total N varies due to item non-response. [a]Provision was illegal in Germany at time of data collection in 2009. AWP: amusement machines with prizes. Stand. diff.: Standardized differences. Test: χ^2.

Sensitivity analysis

Different specifications of the propensity score lead to different matched samples. In the present study, different specifications were selected according to predetermined t values using a method adapted from Hirano and Imbens (2001). In a first step, those t values critical for including a covariate in the logistic regression were selected, namely t = 0, t = 1, t = 2, t = 4, t = 8, and t = ∞. Subsequently, a simple logistic regression analysis was conducted for each of the 24 covariates producing a particular t value. In a third step, six different models were specified according to the predetermined t value, i.e. the model with a specification of e.g. t > 2 only included covariates meeting the requirement of a t value greater than 2. Consequently, whereas all 24 covariates were included in the original model (t = 0), no covariates were included in the last specification (t = ∞) leading to a propensity score indicating the chance to be exposed. Finally, using the described matching technique for each of the propensity score specifications, six matched samples (the original matched sample and five additional ones) were generated (each for the TS and the SCG). The original statistical analyses were executed in each sample. Significance of the coefficients for survey year relative to the coefficients resulting for the original matched samples was used to assess whether results were sensitive to different propensity score specifications (Guo & Fraser, 2009).

RESULTS

Descriptive results

Descriptive statistics for the original unmatched and the matched TS and SCG in 2006 and 2009 are presented in Table 2 and Table 3, respectively, demonstrating the effects of matching on outcome measures. Descriptive results point to significant changes in gambling behavior between survey years: In the unmatched TS, participation in any state gambling activity, lotto, class lottery, sports betting, and Internet sports betting was lower, whereas wagering on table games, slot machines and Internet card games were higher in 2009 compared to 2006 (see Table 2). After matching, similar results were found with the exception of gambling on TV lottery gambling which was significantly lower and class lottery, table games, and slot machines which did not differ between survey years. Results were also similar in the SCG except for TV and class lottery gambling which were lower in both the unmatched and the matched SCG (see Table 3). Any gambling within the past 12 months, gambling on AWP, on any Internet gambling activity, horserace betting, and illegal table games did not vary between conditions.

In 2009, significant lower weekly gambling participation and a higher percentage of multiple gambling was found compared to 2006 in both the unmatched and the matched samples. Weekly participation in state gambling activities was lower, whereas weekly Internet gambling remained stable in both the unmatched and the matched SCG. Higher weekly gambling on AWP was found in the SCG after matching. With regard to PG, no change between survey years was found in the unmatched samples and the matched TS, but a higher prevalence was noted in the SCG after matching.

Changes in outcome measures

Results for changes between 2006 and 2009 in gambling behavior in the matched samples are presented in Table 4, controlling for confounding variables. In the observed period, participation in state gambling activities decreased (TS: OR = 0.84, p = .002; SCG: OR = 0.45, p < .001), in particular participation in lotto (TS: OR = 0.89, p = .045) and TV lottery (TS: OR = 0.79, p = .015; SCG: OR = 0.82, p = .041). Whereas overall Internet gambling remained stable, the odds of participating in Internet card games increased (TS: OR = 3.41, p < .001; SCG: OR = 2.86, p = .001) and Internet sports betting declined among current gamblers (SCG: OR = 0.58, p = .049). No significant changes were found for 12-month prevalence of any gambling, class lottery, table games, slot machines, sports betting, AWP, Internet casino, horserace betting, and illegal table games in either matched sample.

With regard to the extent of gambling involvement, weekly gambling decreased (TS: OR = 0.74, p < .001; SCG: OR = 0.77, p = .003; see Table 5). In particular, a decline was noted for weekly participation in state gambling activities (SCG: OR = 0.81, p = .018) and an increase of weekly gambling on AWP (SCG: OR = 2.44, p = .031). No effects were

Table 4. Results of regression analysis for changes in gambling behavior before (2006) and after (2009) the amendments

	Matched total sample		Matched subset of current gamblers	
	OR (95%-CI)	p	OR (95%-CI)	p
12-month prevalence	n = 7,970 0.93 (0.83–1.03)	.176	–	–
Overall state gambling	n = 7,970 0.84 (0.75–0.94)	**.002**	n = 3,624 0.45 (0.33–0.61)	**<.001**
Lotto	n = 7,910 0.89 (0.79–1.00)	**.045**	n = 3,564 0.88 (0.72–1.04)	.130
TV lottery	n = 7,745 0.79 (0.66–0.96)	**.015**	n = 3,421 0.82 (0.67–0.99)	**.041**
Class lottery	n = 7,696 0.83 (0.64–1.06)	.130	n = 3,374 0.80 (0.61–1.04)	.0.98
Tables games	n = 7,563 1.18 (0.86–1.62)	.317	n = 3,310 1.17 (0.84–1.64)	.343
Slot machines	n = 7,559 1.34 (0.85–2.12)	.208	n = 3,310 1.56 (0.99–2.46)	.057
Sports betting	n = 7,561 0.71 (0.50–1.01)	.056	n = 3,317 0.74 (0.51–1.06)	.097
AWP	n = 7,703 0.91 (0.65–1.26)	.572	n = 3,371 0.89 (0.64–1.25)	.501
Overall Internet gambling[a]	n = 7,824 1.08 (0.76–1.53)	.654	n = 3,563 1.00 (0.69–1.45)	.997
Internet sports betting	n = 7,558 0.74 (0.46–1.19)	.210	n = 3,306 0.58 (0.34–1.00)	**.049**
Internet casino	n = 7,557 0.87 (0.38–1.98)	.732	n = 3,306 0.99 (0.43–2.27)	.986
Internet card games	n = 7,557 3.41 (1.89–6.15)	**<.001**	n = 3,061 2.86 (1.58–5.16)	**.001**
Horserace betting	n = 7,556 0.77 (0.40–1.48)	.434	n = 3,308 1.33 (0.70–2.52)	.381
Illegal table games	n = 7,556 1.95 (0.96–3.94)	.064	n = 2,433 1.54 (0.80–2.95)	.192

Notes: [a] Provision was illegal in Germany at time of data collection in 2009. AWP: amusement machines with prizes. OR: odds ratio, CI: confidence interval.

found for weekly Internet gambling. An increase was noted for multiple gambling (TS: OR = 1.23, $p = .001$; SCG: OR = 1.35, $p < .001$). Concerning PG, prevalence did not change between survey years in either matched sample.

Table 5. Results of regression analysis for changes in gambling behavior and pathological gambling before (2006) and after (2009) the amendments

	Matched total sample		Matched subset of current gamblers	
	OR (95%-CI)	*p*	OR (95%-CI)	*p*
Weekly gambling	*n* = 7,970 0.74 (0.63–0.87)	**<.001**	*n* = 3,624 0.77 (0.64–0.91)	**.003**
Weekly state gambling	–		*n* = 3,295 0.81 (0.67–0.96)	**.018**
Weekly AWP gambling	–		*n* = 253 2.44 (1.09–5.46)	**.031**
Weekly Internet gambling[a]	–		*n* = 199 1.82 (0.84–3.93)	.129
Multiple gambling	*n* = 7,970 1.23 (1.11–1.50)	**.001**	*n* = 3,624 1.35 (1.14–1.59)	**<.001**
Pathological gambling	*n* = 3,538 2.62 (0.76–9.03)	.127	*n* = 3,563 2.95 (0.90–9.75)	.075

Notes: [a]Provision was illegal in Germany at time of data collection in 2009. AWP: amusement machines with prizes. OR: odds ratio, CI: confidence interval.

Sensitivity analysis

Results for 12-month prevalence of any gambling could be replicated in all analyses in the TS. Original findings on table games, sports betting, overall Internet gambling, Internet casino, Internet card games, and horserace betting could be replicated in all five additional specifications in the TS as well as in the SCG. Results were also perfectly stable for illegal gambling in the TS (replicated in three specifications in the SCG) and quite robust for AWP (replicated in four specifications in the TS and SCG). In the SCG, results of overall state gambling as well as lotto were perfectly stable. In the TS, however, result on overall state gambling was only replicated in two specifications and findings on lotto were not confirmed in any other specification. In both populations, results were less stable regarding TV lottery, class lottery, and slot machines (each replicated in three (TS) and two (SCG) specifications) and Internet sports betting (replicated in three specifications in both samples).

Results for overall weekly gambling were replicated in four specifications in the TS and in three specifications in the SCG. In the SCG, weekly Internet gambling was confirmed in all specifications, whereas weekly gambling on state gambling and on AWP was less stable (replicated in three specifications and one specification, respectively). Findings for multiple gambling were replicated in three specifications in the TS and were perfectly robust in the SCG. Furthermore, results on PG were replicated in two specifications in both matched samples.

DISCUSSION

This study examined potential changes in gambling behavior and the prevalence of PG in a sample of the German adult population and a subsample of current gamblers between 2006 and 2009 while controlling for possible confounding variables. Changes were evaluated in light of two major amendments of the German gambling legislation undertaken within this time interval, the Fifth Amendment of the German Gambling Ordinance (AGO; implemented in 2006) for AWP and the State Treaty on Gambling (STG; implemented in 2008) for gambling under the state monopoly.

Gambling behavior

A major finding of our study is that overall gambling prevalence within the past year did not differ between survey years. This result is contrary to our expectation, but in line with other findings reporting a stable 12-month prevalence of any gambling (BZgA, 2010). Thus, reduction in the overall amount of money wagered between 2006 and 2009 as indicated by annual turnover figures (Meyer, 2011) is not due to fewer individuals participating in gambling. Instead, gambling on different gambling activities and frequency of gambling must have changed. However, changes in gambling might also be related to the global recession and substantial changes in the world economy since the beginning of 2008. Yet, the effect of the economic crisis was not as pronounced in Germany as in other countries, and the economic impact on gambling behavior might have been small.

In line with our hypothesis, overall participation in most state gambling activities that are subject to access or advertisement restrictions declined. In particular, fewer subjects gambled on lotto and TV lottery in 2009 than in 2006. However, caution is warranted when interpreting the decline in gambling on lotto as sensitivity analyses revealed stable participation in lotto in all other specifications of the propensity score. Furthermore, though statistically not significant, a tendency towards a decrease of participation in class lottery and sports betting in 2009 was found. Contrary to expectations, no reductions in gambling on table games and slot machines were found. Reasons for this could be that preceding regulations on accessibility and advertisements for these gambling activities were already quite strict compared to, for example, those of lotto.

Despite sales figures indicating a substantial increase in turnover of AWP from 2006 to 2009 (Meyer, 2011) and a strong tendency of increased AWP participation among current gamblers, prevalence of gambling on AWP was not found to be significantly higher in 2009. These findings are not necessarily contradictory as participation rate, i.e. the total number of gamblers, does not need to increase in order to result in higher turnover. This might rather be the result of individuals gambling with higher stakes, longer or more frequently. The latter is supported by the observed increase from 2006 to 2009 in number of AWP gamblers that gamble on a weekly basis. This finding questions the two-sided approach of the AGO and its true effectiveness in consumer protection as spending more time and money on gambling is linked to a higher risk for PG (Currie et al., 2006; Ferris & Wynne, 2001).

With regard to Internet gambling, overall gambling did not decline, although provision was prohibited by the STG. When assessing different kinds of Internet gambling activities, however, substantial differences were found. As expected, participation in Internet sports betting was lower among current gamblers in 2009 than in 2006. The decline might result from the strict ban of previously state Internet sports betting in Germany. Yet, this trend was not significant in the total population. While Internet casino gambling re-

mained stable in both matched samples, Internet card games even increased. Based on the observed increase in Internet card games, restricting Internet gambling seems of limited effectiveness. However, there is also reason to believe that an increase in Internet gambling in recent years follows a global trend (LaBrie, Kaplan, LaPlante, Nelson & Shaffer, 2008; Wood, Williams & Lawton, 2007). For instance, the prevalence of past-year Internet gambling in Canada was found to have increased since 2004 (Wood & Williams, 2009). Furthermore, the number of Internet gambling websites increased from 2,069 online casinos and gambling sites owned by 436 different companies in July 2007 (Williams & Wood, 2007) to 2,849 sites of 788 companies in July 2012 (Casino City, 2012).

As hypothesized, gambling on horserace betting and illegal table games was unaffected by the amendments shown in the lack of change in gambling on these activities. This result also indicates that the amendments did not fuel a shift to illegal gambling, i.e. resulted in an immoderate protectionism.

Also in line with expectations, weekly gambling declined. As findings indicate an association between frequent participation and PG (Currie et al., 2006; Sassen et al., 2011; Welte, Barnes, Wieczorek, Tidwell & Parker, 2004), the decline is in accordance with the objectives of the amendments. However, as the decline is due to the decrease of weekly gambling on state gambling activities, it is questionable whether this effect was intended. This is particularly the case as weekly participation in AWP increased and Internet gambling activities did not decline, i.e. activities with an increased risk potential for gambling disorder (Meyer, Häfeli, Mörsen & Fiebig, 2010).

In contrast, multiple gambling increased, i.e. participation in more than one gambling activity. This could have resulted from the increased popularity and availability of Internet gambling activities, especially Internet poker, which might have triggered interest to test these activities in addition to usual gambling behavior. However, up to now, no reliable data exist concerning the background and reasons for this development.

Pathological gambling

Taking the short time between the amendments and the second survey into account, no change in the prevalence of PG was expected. This result is corroborated by international studies reporting stable 12-month prevalence rates of PG after changes in legal obligations and preventive measures (Bondolfi, Jermann, Ferrero, Zullino & Osiek, 2008) or qualitative and quantitative accessibility of gambling activities (Bondolfi et al., 2008; Govoni, Frisch, Rupcich & Getty, 1998; Jacques & Ladouceur, 2006). Yet, it has to be kept in mind that this result is not very stable to different propensity score specifications (replicated in two specifications while three other specifications indicate an increase).

Overall, preventive efforts are still challenged by changes towards multiple gambling and gambling activities associated with greater risk potential. As indicated by results on gambling behavior, gambling on high risk Internet card games increased (Meyer et al., 2010; Welte et al., 2004), while participation in activities with smaller risk potential, such as TV lottery, decreased. Also, the aforementioned rise in the number of weekly AWP gamblers is of great concern due to the higher risk associated with frequent as well as AWP gambling (Currie et al., 2006; Ferris & Wynne, 2001). However, conclusions on the effectiveness of the amendments concerning the prevention of PG are premature and possible effects might only be observed after some more years.

Effects in the total samples and among current gamblers

An important finding of this study is that the impact of the AGO and the STG is not greatly different between current gamblers and the total population. Significant differences were only found for participation in lotto and Internet sports betting. The odds ratios, however, point in the same direction indicating similar tendencies of reduced participation in both samples. Moreover, effects might be different for different groups of gamblers. For instance, occasional moderate gamblers might respond more to changes in accessibility of gambling activities than regular heavy gamblers. The former might have refrained from Internet sports betting after the prohibition and blocking of these offers. In contrast, the latter might have shifted to international providers instead of abandoning or cutting down on gambling.

Limitations

Our study is not without limitations. First, comparisons of matched and unmatched samples indicate that the results may not be generalized to the German general population aged 18 to 64 years. However, this paper did not aim at generalizability of results but at unbiased intervention effects. Second, a causal impact of the AGO and the STG on gambling behavior and PG can only be inferred with great caution. When assessing the impact of the amendments using observational data, intervention effect estimates may be biased due to variation in covariates. After propensity score matching, conformance in covariates was substantially improved rendering biases of observed covariates unlikely. Yet, differences in unobserved covariates may still exist and associated biases cannot be precluded. Due to the cross-sectional nature of our data and the lack of controls, that were not exposed to the changes in gambling regulations, other factors might be associated with the reported changes in gambling behavior. For instance, the Soccer World Championship took place in Germany in 2006 and might have triggered increased gambling participation, in particular on (Internet) sports betting. Also, new smoke-free laws were implemented in Germany in 2007 and 2008 prohibiting indoor smoking, including smoking in gambling facilities in most Federal States. As smoking is associated with gambling (McGrath & Barrett, 2009) and smoking bans require gamblers to smoke outside and to interrupt their gambling, these bans might have preventive impact on gambling behavior. Indeed, introducing smoking bans in gambling facilities has led to a substantial reduction in gambling participation in Australia (Hirschberg & Lye, 2010). Although a significant reduction in 12-month prevalence of any gambling was found in our study, no changes in activities such as table games, slot machines and AWP, all of which are subject to these new smoke-free laws, were noted. Third, changes could be part of a natural trend. This may be the case for the rise in Internet card gambling and declining lotto turnover rates in Germany since 2004 (Meyer, 2010) derogating the possible influence of the amendments. The influence of external variables is the greatest challenge to this analysis and requests longer periods of observation.

CONCLUSIONS

Changes in gambling regulations to prevent PG seem to have had short-term impacts on gambling behavior in the population and among current gamblers. Whether the observed changes will indeed lead to a long-term reduction in the prevalence of PG remains to be seen. In light of the limited effectiveness of the prohibition of Internet gambling activities on gambling behavior, the question arises whether quantitative supply reduction through prohibition or restriction of certain gambling activities are effective strategies to prevent PG. Qualitative changes in game characteristics such as in stakes, wins and losses, the implementation of early detection and intervention measures or a combination of restrictions of activities and monitoring of individual gambling behavior might be equally or even more effective. To learn more about the impact of either approach, long-term monitoring of gambling behavior and experimental studies are needed. This is even more crucial as it remains unclear why some indicators of gambling behavior were found to be associated with the amendments and others not.

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