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Effectiveness of a voluntary casino self-exclusion online self-management program☆

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ABSTRACT

Despite evidence for effectiveness, only a small proportion of individuals with gambling disorder ever access treatment and support resources for their problem. Voluntary self-exclusion (VSE) programs are an ideal circumstance to engage individuals who are reluctant or have not yet sought formal treatment, given that individuals are already electing to prevent themselves from gambling through self-exclusion. The present study was a randomized controlled trial of a novel, online VSE self-management intervention.

Individuals who chose to self-exclude at gambling venues ($N = 201$) were randomly assigned to participate in an online self-management program combined with VSE or to an in-person self-awareness educational workshop combined with VSE comparison group. Following a baseline assessment, participants were followed up at three, six, and twelve months via telephone interviews. Measured outcomes were gambling frequency and expenditure, problem gambling scores, problem drinking scores, type of goal set for gambling behaviour, quality of life, and treatment-seeking.

The 12-month follow-up rate was 71% ($n = 143$). Participants in both VSE groups gambled less, spent less money gambling, and reported decreased need for formal treatment. However, there were no significant group differences on any of the primary or secondary outcomes. Only 30–35% of the participants completed their assigned workshop, depending on the group. Results from the online program satisfaction survey revealed that participants generally liked the program and rated the quality of the content highly, but thought there could be improvement regarding interactivity, variety, stimulation and greater clarity around registration steps and program objectives.

The online VSE program is an effective alternative to the face-to-face VSE program. Although the outcomes between the two programs were not significantly different, the online program is easier to administer, able to reach more individuals since it only requires access to a computer and is based on motivational evidence-based principles of psychotherapy for gambling disorder.

1. Introduction

1.1. Disordered gambling and voluntary self-exclusion

National epidemiological surveys report that the lifetime prevalence of gambling problems ranges from 0.7% to 6.5%, with an average rate across jurisdictions of 2.3% (Calado and Griffiths, 2016). In general, the lowest past-year rates of disordered gambling tend to occur in Europe (up to 3.4%) and Oceania (up to 0.7%), with intermediate rates in North America and Australia (2% to 5%) and the highest rates in Asia (up to 7.6%). Canadians report 2% to 3% past-year prevalence rates of gambling disorder (Cox et al., 2005; Williams et al., 2011). Despite the moderate prevalence of this behavioural addiction, there is consistent evidence that help-seeking among disordered gamblers is low, with only 10–20% of affected individuals seeking treatment for their problems (Loy et al., 2018). Common barriers reported by gamblers for not seeking help are intent to handle gambling problems themselves, shame and stigma, lack of knowledge about treatment options, and logistical barriers around attending treatment (Suurvali et al., 2009).

A common intervention designed to call gamblers' attention to their

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problems and engage them in professional help is voluntary self-exclusion (VSE). VSE programs allow individuals to voluntarily sign an agreement to ban themselves from specific gaming establishments for a period of time. Agreements range from 6 months to lifetime, but most commonly up to 5 years. After the agreement is signed, the self-excluded individuals may be refused entry or asked to leave if identified at the excluded gambling venue(s). Such programs are designed to limit access to gambling and to a variable degree, provide opportunities for gamblers to access treatment (Blaszczynski et al., 2004; Gainsbury, 2014; Nowatzki and Williams, 2002). These opportunities range from simply providing participants with information about treatment options to requiring attendance at some type of educational program that encourages a self-assessment of the need for treatment.

1.2. Who self excludes and does it work?

VSE programs have been evaluated empirically in a small number of studies (McCormick et al., 2018; Gainsbury, 2014; Verlik, 2008). Many of these investigations were not rigorous pre-post evaluations, but rather self-report surveys or interviews with previously excluded gamblers, analyses of exclusion rosters, and epidemiological evaluations (e.g. Croucher and Croucher, 2006; Nower and Blaszczynski, 2008; Schrans et al., 2004; for a comprehensive list, see Gainsbury, 2014). According to these studies, individuals who self-exclude tend to be Caucasian and middle-aged (36 to 55 years) with an approximately equal use of VSE among men and women (Nower and Blaszczynski, 2008). As many as 95% of them meet criteria for disordered gambling at the time of self-exclusion (Ladouceur et al., 2000). On average, people in this group gamble for 7 to 17 years before making the decision to self-exclude, with older adults (56–79) gambling for a significantly longer period before committing to VSE. The top reasons for seeking self-exclusion cited by the gamblers are gaining control over gambling, needing help, and hitting rock bottom. In addition, older adults also endorse suicide prevention as a primary reason for seeking VSE (Nower and Blaszczynski, 2008).

In terms of outcomes, several studies have demonstrated that those who sign up for VSE reduce the frequency of their gambling for the exclusion period, and experience fewer disordered gambling symptoms, but that compliance with the agreements (i.e., not entering gambling venues) is low with as many as 70% of individuals in the evaluated samples continuing to gamble during exclusion (Ladouceur et al., 2000; Ladouceur et al., 2007). The effects of reduced gambling as a result of VSE also appear to help alleviate symptoms of comorbid disorders such as depression and alcohol use (Tremblay et al., 2008). Evaluations of American and European VSE programs have demonstrated that enrollment in VSE can result in significant increases in treatment seeking behaviour by the gamblers, improved relationships and improved emotional health (Hayer and Meyer, 2011; Nelson et al., 2010). One evaluation of a Canadian VSE program (McCormick et al., 2018) examined whether continuing to gamble informally (i.e., outside of gambling venues) had any impact on symptom reduction during VSE. They found no significant differences between those who gambled informally and those who completely abstained, suggesting that some individuals can successfully recover during self-exclusion while continuing to engage in some forms of gambling.

VSE programs vary in the amount of support provided to participants during the exclusion period to access treatment for gambling problems. In most reported evaluations of VSE, participants do not make good use of these resources. For example, the Montreal VSE program evaluated by Tremblay et al. (2008) included the option of an evaluation with a counsellor at the beginning of the exclusion period and the option of telephone support during the exclusion term. Only 15% of participants received the evaluation and very few accessed the telephone support.

1.3. The potential role of brief online interventions in VSE

One common reason that individuals with gambling problems do not seek treatment is a desire to “do it on their own” (Suurvali et al., 2009). Some of these individuals do recover without formal treatment, but often only after significant negative consequences occur (Hodgins and el-Guebaly, 2000). Previous research has shown that brief motivational support can effectively promote this self-recovery process (Hodgins et al., 2001, 2004, 2009). Voluntary self-exclusion (VSE) programs are an ideal circumstance to offer brief interventions, given that individuals are already electing to prevent themselves from gambling through self-exclusion. Providing information and support through individual self-management such as casino VSE programs offers an entry point into the treatment system for individuals who are reluctant or uncomfortable with taking that step.

Other common reasons that disordered gamblers report for avoiding treatment are lack of access to appropriate treatment options, and logistics related to attending treatment (Suurvali et al., 2009). To address these problems, there has been a significant recent increase in the development and evaluation of online interventions for addictive behaviours. Such interventions are hypothesized to have greater reach since they do not require face-to-face attendance; lower cost since they only require access to a computer; and greater engagement since individuals who avoid treatment due to stigma may participate in the intervention anonymously online (Gainsbury and Blaszczynski, 2011). The available evidence suggests that online interventions for drug addiction (Giroux et al., 2017), alcohol (Caudwell et al., 2018) and smoking (Graham et al., 2017) are effective in reducing symptoms and functional impairment associated with the addiction. Similar success in delivering online interventions has been reported for the treatment of gambling problems (Gainsbury and Blaszczynski, 2011; Hodgins et al., 2019). Although research studies that compare online interventions directly to face-to-face in the treatment of addiction are scarce, a select few studies have shown online delivery to have comparable efficacy and effect sizes to face-to-face interventions (e.g., Casey et al., 2017).

1.4. Present study

Given the promising role of brief and online interventions for gambling disorder and the gap in offering support for VSE participants during the exclusion period, the present study aimed to evaluate participation in a new online intervention combined with self-exclusion in Alberta, Canada, that may offer a more accessible and theory-driven alternative without sacrificing effectiveness and outcome. The primary goal was to compare the online intervention to the existing face-to-face program to establish relative effectiveness rather than evaluate the role of self-exclusion compared to natural recovery. Consistent with the efficacy literature on brief motivational support that was added in the online program, but was not part of the existing program, it was hypothesized that compared to the face-to-face group, participants who were provided access to the online self-management program would report less gambling and would be more likely to report abstinence from gambling and quality of life improvement.

2. Materials and methods

2.1. Trial recruitment and random assignment

The study was originally carried out between 2012 and 2014 and was not pre-registered. The research protocol was approved by the authors' institutional Research Ethics Board prior to carrying it out. Individuals who registered for the VSE contract were provided information about the study. The inclusion criteria for trial enrollment were: 18 years of age or older; willingness and ability to access a website in English (to ensure reading ability); willingness to be randomly assigned; willingness to provide follow-up data on gambling; and willingness to provide the

name of a collateral (family or friend) to help locate them for follow-up interviews.

Individuals who were interested in participating were contacted by telephone and if they met eligibility criteria and provided informed consent, they then received a brief telephone assessment (gambling history, gambling behaviour, and self-efficacy). Subsequently, they were randomly assigned to one of the two intervention conditions, stratified on sex and length of self-exclusion chosen using MINIM, a computer program which uses the method of minimization (Aickin, 1982).

2.2. Intervention conditions

The online intervention condition was designed with four core features: first, to facilitate access, it was offered in an online format that individuals could access from their home or other convenient locations. Second, the program content was enhanced to include motivational and self-management tools from brief self-directed gambling treatment. Third, the program required that the individuals engaged in the online program at the beginning of the exclusion term, so that the self-management tools and support and treatment were immediately and continually available to the individuals throughout the exclusion term. Finally, individuals had the option of completing a second online component of the program at the end of their exclusion term that encouraged assessment of progress, current status and future goals and needs. This component was not mandated as part of the VSE contract for privacy reasons by the Alberta Gaming and Liquor Commission (AGLC), who administered the program. As such, the researchers did not have the data necessary to distinguish those who completed part one only versus those who completed both parts of the program.

The comparison condition was the pre-existing in-person program in Alberta that included an in-person educational self-awareness group that had to be completed at any time before the end of the exclusion period. Just prior to the launch of the randomized trial, all individuals participating in the online program were asked to complete an online satisfaction survey after they completed part 1of the program. Since part 2 of the online program (see Section 2.3.1) was not mandatory to complete, the sample of respondents who provided the feedback was comprised of both individuals who completed only Part 1 and individuals who completed both parts of the online program. Consequently, we could not separate feedback for those who had experienced both parts of the program. The reported satisfaction survey results were also collected from a larger sample, which included the trial participants as well as responders who were not evaluated in the current randomized controlled trial (RCT), but used the online program and wished to provide feedback.

2.2.1. Online self-management program

Programs in both conditions were administered and managed by the ALGC and prior to this study, the VSE component of either program has not been evaluated independently in a RCT. The online self-management program had two parts. Part 1 was an online workshop that the individual completed at the beginning of their self-exclusion term. This workshop was unguided and provided interactive activities assessing gambling-related negative consequences, problem gambling severity, motivations to self-exclude, and gambling goals. The individual's responses were saved into a personal learning journal for ongoing reference, which could be accessed online at any time and downloaded in PDF format. The participant was then offered a menu of self-management tools including, for example, information on dealing with urges to gamble, dealing with debts, seeking social support, developing alternative leisure activities, and self-talk. Finally, information on locally available treatment options was provided.

To enhance the support component of the online program, an automated monthly email was sent out to participants in this condition that provided encouragement and a reminder that self-management tools and treatment information were available on an ongoing basis. A link to the website was included in the email.

Part 2 was a second online program component to be completed at the end of the self-exclusion term. The information in the individual's learning journal was presented to the individual for review and reflection on progress. The opportunity to renew their involvement or to leave the program was offered. Although the first online workshop was mandatory for all VSE enrollers, the second online workshop was not mandated by the AGLC to successfully complete the requirements of a VSE contract. As such, not all of the participants completed the second workshop and only the first workshop was used as an indicator of completion in the online condition.

2.2.2. Self-awareness educational group

The self-awareness educational group was a mandatory in-person workshop, available multiple times throughout the year, for VSE participants whose exclusion term had expired. The workshop was held throughout the year in major cities in Alberta. The aim was to provide information and resources to make informed decisions about future gambling. The educational components included an overview of the nature of gambling, the reasons why people gamble, the impacts of problem gambling and its effects on major life areas, as well as methods to help control gambling.

The in-person workshop incorporated many tools similar to the online program and unlike the online group, was guided by a facilitator. Participants explored reasons for their enrollment in VSE and progress since initial enrollment; they identified high-risk situations for gambling and generated ways to deal with them. They were also provided self-management tools to take home such as tips on building self-esteem, coping strategies, and activity lists to replace gambling. The educational group concluded with a discussion of the available treatment options and an opportunity to re-sign a VSE contract for a new term.

2.3. Assessment

2.3.1. Initial assessment

The brief telephone baseline assessment (adapted from Hodgins et al., 2009) included a demographic profile (age, sex, education, marital status, income, ethnicity and racial status, employment status). Also included was a gambling, mental health, treatment, and self-exclusion history including a timeline interview of types of gambling, frequency, and money spent for the past three months (Sobell and Sobell, 1992; Hodgins and Makarchuk, 2003). Problem gambling severity was assessed using the past year Problem Gambling Severity Index (Ferris and Wynne, 2001), a widely used and validated screening measure of gambling disorder severity. In addition, participants were asked to identify a current self-exclusion goal (quit all types of gambling, quit some types of gambling, gamble in a non-problematic manner or maintain gambling abstinence), their level of motivation toward achieving that goal (0 "not at all" to 10 "extremely"), level of perceived control over their current gambling habits (0 "no control" to 10 "complete control") and how successful they thought they would be (0 "not at all" to 10 "extremely") in the next 6 months and in the next 12 months in achieving their chosen goal. Quality of life was assessed by the WHOQoL-8, an eight-item version of a widely-used measure (Schmidt et al., 2006). This short form has been used in a number of countries, is robust psychometrically, and is strongly correlated with scores from the original WHOQoL. The Alcohol Use Disorders Identification Test alcohol consumption (AUDIT-C) questions were used to measure the level of drinking problems in the participants (Bush et al., 1998). The AUDIT-C is a widely validated, highly reliable 3-item brief screening instrument for identifying alcohol use disorder problem behaviours.

2.3.2. Follow-up assessment

After three, six and twelve months after the baseline assessment, a telephone follow-up of gambling behaviour, problem gambling severity, self-efficacy, quality of life, use of treatment resources, and breaches of

agreement was conducted. Interviewers were blind to participant assignment.

2.4. Use of interventions

The researchers had access to a record of attendance at the self-awareness educational group as well as the number of participants who completed the online program. Successful completion of the intervention was operationalized as attendance at the in-person educational group or completion of Part 1 of the online program.

2.5. Online program feedback survey

Online program users who participated in the RCT or who completed part 1 of the workshop without consenting to be in the study were asked to complete a satisfaction survey in order to evaluate the strengths and weaknesses of the online program. The survey consisted of 14 items (4-point Likert scale, strongly disagree to strongly agree) relating to various components of the program such as interactivity, objective clarity, course content utility, usefulness of monthly reminders and journal tools, as well as ease of navigation. Survey responders also responded to a checklist of areas of the online program that they thought need improvement, ranging from interactivity and more media variety, to updating content, clarifying objectives and improving course organization.

In addition, program feedback was solicited at the end of Part 2 of the online workshop. All participants who used the online program during the pre-trial and trial phases (the website was accessible to the general public) who completed Part 2 were asked three open-ended questions: 1) What did you find most valuable about the course? 2) What did you find least valuable about the course? 3) What changes would you recommend for the course?

2.6. Data analyses

2.6.1. Primary and secondary outcomes

Primary outcomes were gambling frequency and expenditure, quality of life, and problem gambling screener scores. Secondary outcomes were treatment-seeking, current goal for gambling, and problem drinking scores.

2.6.2. Data preparation

Days gambled, and dollars spent gambling were calculated for the three months pre-intervention and for each follow-up period. All variables were inspected for approximate normality, extreme outliers, and missing data. Outliers more than three standard deviations from the mean were windsorized to the value corresponding to three standard deviations (Kwak and Kim, 2017). Since the chosen statistical method of linear mixed modeling was robust against missing data, missing data were imputed only if the variables were used as either a predictor or an

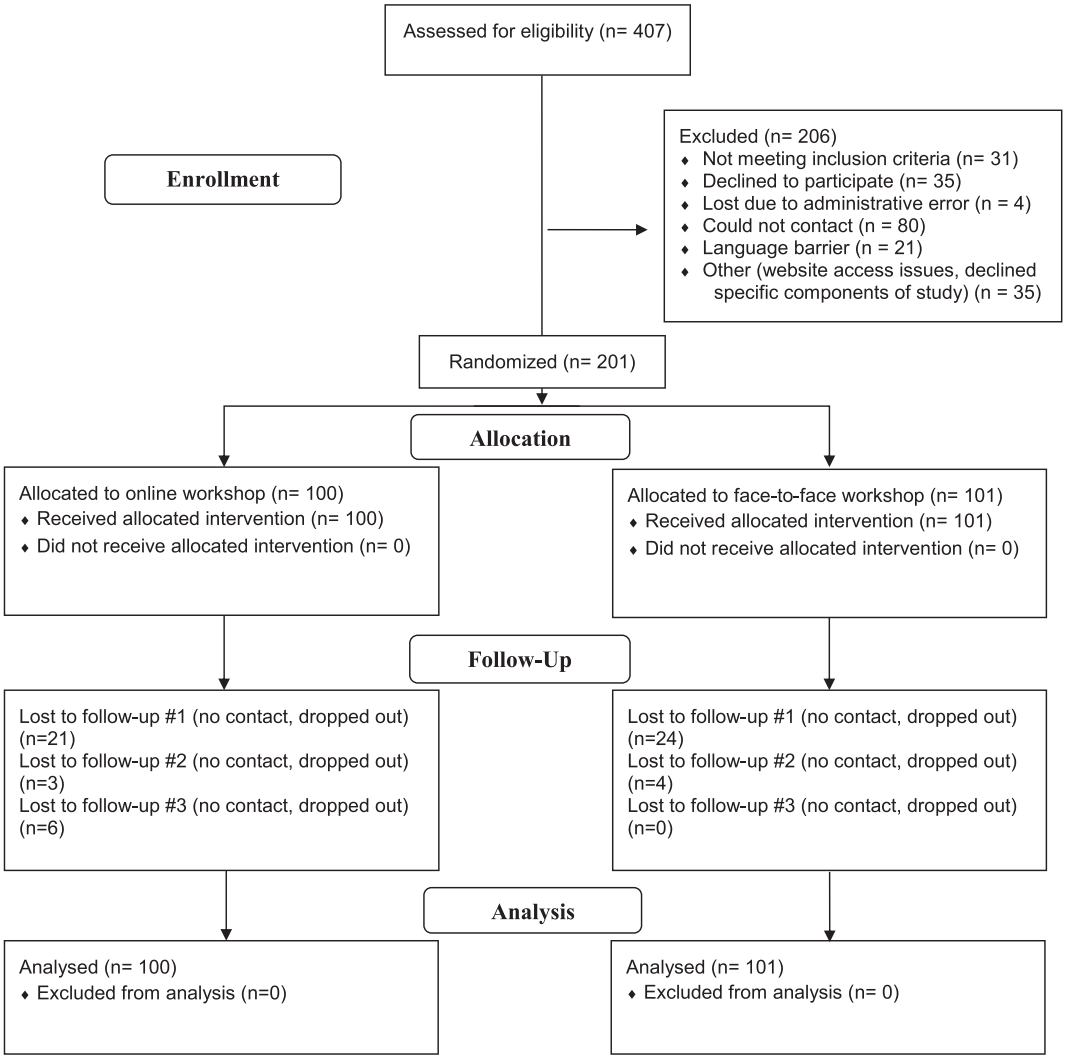

Fig. 1. CONSORT flow diagram.

outcome in the zero-inflated hurdle models or if the outcome was a categorical variable (treatment seeking) since these procedures did not allow for missing data. Multiple imputation was used to impute missing data when necessary. Employment, education and marital status demographic variables were recoded into fewer categories to ensure that cell sample sizes were sufficient for the analyses.

Fig. 1 presents a CONSORT figure summarizing recruitment and follow-up. The final sample size was 201, with 101 participants in the face-to-face condition and 100 in the online condition. The sample sizes and rates at the follow-up assessments were the following for the face-to-face group: 3 months (n = 77; 76%), 6 months (n = 73; 75%) and 12 months (n = 73; 72%). The sample sizes and rates at the follow-up assessments were the following for the online group: 3 months (n = 79; 79%), 6 months (n = 76; 76%) and 12 months (n = 70; 70%). There were no significant differences between completers and non-completers on any of the demographic characters in either of the groups.

2.6.3. Analyses

All analyses were carried out using R version 3.4.2. Separate analyses were conducted for each primary and secondary outcome variable. Analyses for the hypothesis comparing gambling outcomes for the two groups was addressed using mixed effects modeling to properly account for the longitudinal nature of this data. Condition (2) and Time (0, 3, 6, 12) were modeled as fixed effects while the participants were modeled as random effects nested within time. A baseline model was developed for each outcome variable that included condition and time variables; a quadratic or a linear trend function, depending on which fit better; confidence ratings for the participants' six months gambling goals; and ratings of perceived control over one's gambling. Following the establishment of baseline fit, the following variables were added to the model one at a time and evaluated for improvement in model fit and significance as predictors/covariates: gender, employment (full time, part time, other), marital status (married, never married, other), age, and workshop completion status (yes/no). Variables that did not improve fit were excluded from subsequent models, eventually resulting in one model that included only the relevant predictive variables for the specific outcome. Consequently, each variable in the model was evaluated together with the others at some point in the model building process. If a variable was not included in the final results, it indicates that it was neither significant predictor of the outcome nor contributed to improved fit of the overall model. Analysis of workshop completion rates was conducted using chi square analysis. For the analysis of drinking problems, individuals who reported never consuming alcohol during the baseline assessment were excluded, resulting in a total sample size of 160 for that analysis, with 80 individuals in the face-to-face group and 80 in the online group.

The present gambling goal variable was recoded to be a continuous variable from 0 to 4 with increasing numbers corresponding to more abstinence-oriented goals. The final result corresponded to general change in goals toward or away from abstinence.

For the gambling expenditure and frequency variables, a zero-inflated hurdle model analysis was employed to account for the large number of individuals who were not gambling during their VSE period. Each analysis consisted of two sub-models: a logistic regression model to evaluate whether the participant engaged in any gambling at all or was abstinent (i.e., 1 or 0); and a truncated negative binomial regression count model that predicted the magnitude of gambling expenditure and frequency once someone initiated any gambling at all. The procedure permitted the ability to describe separate predictors for engaging in any gambling (heretofore likelihood of gambling) versus increasing one's gambling after beginning to gamble. This methodology has been previously used to successfully model frequency of drinking behaviour and was adapted from Atkins et al., 2013. One participant's expenditure data contained a negative value (i.e., he/she won $500 over 3 months). Since hurdle models do not accept negative integers, this value was recoded to zero.

Responses to the online program feedback questions were collated and summarized in the form of number and/or percentage of responders who endorsed specific categories of responses.

2.6.4. Sample size justification

A sample of 200 participants was targeted (based upon Hodgins et al., 2009) to ensure a heterogeneous sample of individuals that provided a valid assessment of all outcomes. The sample size was estimated to be sufficient to detect a difference of about two gambling days per month between conditions at each follow-up interval and a difference of 15% in categorical outcomes (abstinence and treatment-seeking) at 0.80 power. This degree of difference is clinically meaningful in terms of gambling involvement based on reported effect sizes in brief motivational support literature (Yakovenko et al., 2015). Given the complexity of estimating power for multilevel models, these calculations were based upon a more simple repeated measures ANOVA model (G.Power 3.1.2; Faul et al., 2007), with an attrition rate estimated at 15% while also accounting for multiple primary and secondary outcome variables. The employed multilevel analysis likely had greater statistical power because all observed data were included.

3. Results

3.1. Sample description

Table 1 provides a summary of all baseline variables and demographics compared by group. The average age of the participants was 41.84 (SD = 13.23), with the most endorsed demographic categories being male (59%), never married (37.5%), employed full-time (77%), of Canadian culture (66.5%), and some college or university education (28%; second highest was high school diploma at 27%). At baseline, the most common reported type of gambling played in the last year was lottery (83.5%), followed by slot machines (82%). The most common length of the current VSE contract was five years (35.5%), followed by one year (27%), with the majority reporting that this was their first VSE program enrollment (55.5%). More participants reported that their present goal for gambling was "quit all types of gambling" (26%) followed by "gamble in a non-problematic manner" (21%). At the start of the study, most of the participants (57.5%) did not report currently receiving any assistance from any service or person for a gambling-related problem.

On a scale of 0–10, the mean reported rating of current control over gambling at baseline was 6.31 (SD = 3.16) and confidence in gambling goal success over the next 6 months was rated at 8.94 (SD = 1.55). At baseline, in the last 3 months, participants reported gambling an average of 26.17 days (SD = 22.90) and spending approximately $9610.33 (SD = 14,493.03) on gambling out of pocket. The mean PGSI score of the sample was 14.86 (SD = 6.59), where a score of 8 or above indicates a likely disordered gambler (Ferris and Wynne, 2001). The mean AUDIT-C score for the total sample (N = 80 for each group) was 4.56 (SD = 2.73), where scores of 3 and 4 are indicative of likely hazardous drinking for women (M = 3.68, SD = 2.51) and men (M = 5.12, SD = 2.72) respectively (Bush et al., 1998). Overall, the baseline characteristics of the sample reported above could be qualitatively described as being consistent with severe levels of gambling-related problems, likely hazardous drinking, and a moderate quality of life.

3.1.1. Workshop completion

Of the face-to-face group, 34.7% completed their mandatory workshop within 90 days. 30.3% of the online group completed their mandatory Part 1 of the online workshop within 90 days. There were no significant differences in workshop completion rates between the two groups, χ^2 (1) = 0.50, p = .48. There were no significant differences at baseline on any of the demographic or primary outcome variables between individuals who completed their assigned workshop and those who did not, with the exception of PGSI score: those who did not

Table 1
Sociodemographic and baseline variables by VSE group.

Variable	Online (n = 100)	Face-to-face (n = 101)	χ^2 or t	p
Culture			2.90	0.24
Canadian	68 (68.7)	65 (64.4)		
Native North American	6 (6.1)	9 (8.9)		
Other	25 (25.3)	27 (26.7)		
Sex				
Female	40 (40.4)	42 (41.6)	0.12	0.73
Age, mean (SD)	42.07 (12.92)	41.60 (13.63)	−0.25	0.80
Marital status			0.45	0.80
Never married	39 (39.4)	36 (35.6)		
Married	27 (27.3)	27 (26.7)		
Other	33 (33.3)	38 (37.6)		
Employment status			0.46	0.80
Full-time	78 (78.8)	76 (75.2)		
Part-time	5 (5.1)	7 (6.9)		
Other	16 (16.2)	18 (17.8)		
Education			8.98	0.25
Some college or university	29 (29.3)	27 (26.7)		
High school diploma or equivalent	21 (21.2)	33 (32.7)		
Bachelor's degree	19 (19.2)	9 (8.9)		
Other	30 (30.3)	32 (31.7)		
Most common gambling activities	Lottery, slot machines	Lottery, slot machines		
Previous VSE enrollment				
Yes	44 (44.4)	45 (44.6)	0.00	0.99
Current gambling treatment				
Yes	46 (46.5)	39 (38.6)	1.26	0.26
Program workshop completed				
Yes	30 (30.3)	35 (34.7)	0.43	0.51
Control over gambling, mean (SD)	6.27 (3.22)	6.35 (3.12)	0.19	0.85
Six months goal success, mean (SD)	9.02 (1.54)	8.86 (1.56)	−0.75	0.46
Quality of life, mean (SD)	29.75 (6.15)	29.37 (5.26)	−0.47	0.64
Past 3 months frequency of gambling, mean days (SD)	23.91 (22.10)	28.39 (23.55)	1.39	0.17
Past 3 months gambling expenditure, mean dollars (SD)	10,740.26 (18,263.78)	8502.77 (9412.66)	−1.09	0.28
PGSI score, mean (SD)	14.87 (6.43)	14.90 (6.77)	0.04	0.97
AUDIT-C score, mean (SD)	4.76 (2.64)	4.34 (2.82)	−1.55	0.12

Note: All data are presented as n (%) unless otherwise noted. AUDIT-C scores are presented only for drinkers (n = 80 per group), PGSI = Problem Gambling Severity Index, AUDIT-C = Alcohol Use Disorders Identification Test-Consumption.

complete their workshop in the online condition reported greater gambling problem severity, $t(98) = 2.70$, $p = .01$; they also endorsed lower likelihood of currently receiving assistance for gambling-related problems, χ^2 (1) = 6.45, $p = .01$.

3.2. Primary outcomes

For all presented results and tables, baseline variables from Table 1 that are not listed did not improve model fit (nor were they significant predictors), and as per *Analyses*, they were excluded from the final best-fitting model. Graphs for all primary and secondary outcomes are presented in the Appendix A. PGSI scores (past three months) decreased over time for both groups. However, they did not significantly vary between groups over time. The trend over time was best explained by a quadratic function. Compared to males, females endorsed greater PGSI scores over time and across groups. Those with higher confidence in achieving six months gambling goal and rating of control over gambling had significantly lower PGSI scores across time points and groups, but did not vary between groups. Full model results for PGSI scores are presented in Table 2 and Fig. A1.

Quality of life scores significantly improved over time in the in-person group and did not improve in the online group, but this group difference was not statistically significant over time. The trend over time was best explained by a quadratic function. Those with higher ratings of control over their gambling reported higher quality of life across all time points and groups. Those who were not employed part-time or full-time (i.e., student, disability, unemployed, etc.) reported decreased quality of life scores across time points and groups. Confidence in the six months gambling goal was not related to quality of life. Full model results for quality of life scores are presented in Table 2 and Fig. A2.

Table 2
Multilevel model results for past three months PGSI and quality of life scores.

	PGSI			Quality of life		
	B	SE	p	B	SE	p
Time	−13.93	0.93	<0.001	1.60	0.70	0.02
Condition (online)	−14.05	1.23	<0.001	1.52	1.04	0.14
Condition (in person)	−14.30	1.33	<0.001	2.23	0.89	0.01
Quadratic trend function	2.38	0.18	<0.001	−0.27	0.14	0.046
Control over gambling	−0.79	0.12	<0.001	0.53	0.09	<0.001
Confidence in gambling goal	−0.45	0.16	0.01	0.18	0.13	0.15
Gender (female)	2.19	0.59	<0.001			
Employment (part-time)				0.38	0.76	0.61
Employment (other)				−1.36	0.51	0.007
Time x condition	−0.54	0.38	0.15	0.35	0.25	0.16

Note: where specified, the table value corresponds to the category in the parentheses compared to the baseline value of the variable. The reference category for employment is full-time. For *Condition*, each line represents the within-group change over time for the specified group.

Likelihood of gambling in the past three months did not change over time in either group nor did it differ between groups. The trend over time was best explained by a linear function. However, for individuals who did gamble at least one day, the average number of days gambled decreased over time in both groups. There were no differences in mean days gambled between the groups. Those who reported greater control over their gambling had a lower likelihood of gambling at least one day and of gambling fewer days overall. Having greater confidence in six months gambling goal was not related to frequency of gambling. Full model results for gambling frequency are presented in Table 3 and Figs. A3 and A4.

Likelihood of gambling at least $1 in the past three months went up over time but did not differ between groups. The trend over time was best explained by a linear function. The amount of money spent once the person started gambling went down over time in both groups. There were no differences in mean dollars gambled between the groups. Individuals who reported higher levels of control over their gambling spent fewer dollars gambling, but this was not related to the likelihood of starting to gamble. Confidence in six months gambling goal was not associated with gambling expenditure. Full model results for gambling expenditure are presented in Table 4 and Figs. A5 and A6.

3.3. Secondary outcomes

Likelihood of participants endorsing current treatment seeking for gambling problems decreased over time for both groups, but there were no differences between groups. The trend over time was best explained by a linear function. Those who completed their assigned workshop (i.e., in-person workshop or Part 1 of the online program) were less likely to report treatment involvement than those who did not complete it. Full model results for current treatment seeking for gambling problems are presented in Table 5 and Fig. A7.

Present goal for gambling did not change over time and there were no differences between groups. Those who endorsed more control over their gambling were also more likely to have abstinence as their goal. Confidence in achieving six-month gambling goal was not related to

Table 3
Zero-inflated hurdle model results for past three months gambling frequency.

	Logistic sub-model				Count sub-model			
		95% CI for OR				95% CI for RR		
	OR	Lower	Upper	*p*	RR	Lower	Upper	*p*
Condition (online)	1.01	0.62	1.39	0.85	0.90	0.80	0.99	0.03
Condition (in person)	0.98	0.75	1.37	0.99	0.83	0.74	0.91	<0.001
Time	0.94	0.69	1.34	0.84	0.82	0.74	0.91	0.002
Control over gambling	0.91	0.77	1.00	0.04	0.98	0.93	1.01	<0.001
Confidence in gambling goal	0.78	0.64	1.03	0.11	0.99	0.92	1.05	0.26
Gender (female)	1.56	0.77	2.75	0.24	0.91	0.69	1.08	0.12
Employment (part-time)	1.68	0.73	5.66	0.17	1.03	0.77	1.54	0.86
Employment (other)	1.13	0.59	1.87	0.83	0.85	0.67	1.06	0.40
Marital status (married)	0.82	0.52	1.71	0.89	0.86	0.68	1.10	0.24
Marital status (other)	0.99	0.57	1.86	0.83	0.96	0.73	1.16	0.57
Time x condition	0.87	0.63	1.28	0.60	1.12	0.93	1.25	0.30

Note: RR = Rate ratio; OR = Odds ratio; 95% CI = 95% confidence interval. The reference category for employment is full-time. The reference category for marital status is never married. Where specified, the table value corresponds to the category in the parentheses. For *Condition*, each line represents the within-group change over time for the specified group.

Table 4
Zero-inflated hurdle model results for past three months gambling expenditure.

	Logistic Sub-Model				Count Sub-Model			
		95% CI for OR				95% CI for RR		
	OR	Lower	Upper	*p*	RR	Lower	Upper	*p*
Condition (online)	1.47	1.18	1.96	<0.001	0.58	0.48	0.70	<0.001
Condition (in person)	1.53	1.21	1.93	<0.001	0.86	0.81	0.94	<0.001
Time	1.78	1.35	2.09	<0.001	0.63	0.54	0.75	<0.001
Control over gambling	1.00	0.87	1.11	0.70	0.89	0.82	0.94	<0.001
Confidence in gambling goal	0.99	0.82	1.16	0.76	0.88	0.81	1.00	0.06
Employment (part-time)	1.32	0.50	2.61	0.71	0.93	0.56	1.73	0.88
Employment (other)	0.56	0.29	1.13	1.00	1.08	0.66	1.47	0.91
Time x condition	0.95	0.69	1.27	0.67	1.01	0.74	1.18	0.55

Note: RR = Rate ratio; OR = Odds ratio; 95% CI = 95% confidence interval. The reference category for employment is full-time. Where specified, the table value corresponds to the category in the parentheses. For *Condition*, each line represents the within-group change over time for the specified group.

Table 5
Multilevel model results for likelihood of current treatment seeking for gambling problems.

		95% CI for OR		
	OR	Lower	Upper	*p*
Time	0.63	0.51	0.78	<0.001
Condition (online)	0.52	0.41	0.66	<0.001
Condition (in person)	0.61	0.49	0.77	<0.001
Confidence in gambling goal	1.02	0.90	1.16	0.75
Workshop completion (yes)	0.52	0.27	0.97	0.04
Time x condition	0.91	0.67	1.22	0.52
Condition x workshop completion	0.64	0.26	1.62	0.35

Note: OR = Odds ratio; 95% CI = 95% confidence interval. Where specified, the table value corresponds to the category in the parentheses. For *Condition*, each line represents the within-group change over time for the specified group.

present gambling goal. The trend over time was best explained by a linear function. Full model results for present gambling goal are presented in Table 6 and Fig. A8.

Average AUDIT-C total scores went down over time in the online condition and did not change in the in-person condition, but this group difference was not statistically significant over time. The trend over time was best explained by a quadratic function. Across all other variables, women on average endorsed lower AUDIT scores than men. Being younger was also associated with higher AUDIT scores. Across both groups, those who completed the required workshop scored higher on the AUDIT than those who did not complete it. Full model results for AUDIT-C total scores are presented in Table 6 and Figs. A9.

Table 6
Multilevel model results for present gambling goal and AUDIT-C scores.

	Gambling goal			AUDIT-C		
	B	SE	*p*	B	SE	*p*
Time	0.08	0.11	0.47	−1.20	0.31	<0.001
Condition (online)	0.04	0.13	0.76	−1.68	0.42	<0.001
Condition (in person)	0.12	0.11	0.26	−0.82	0.45	0.07
Quadratic trend function	−0.02	0.02	0.35	0.21	0.06	<0.001
Control over gambling	0.03	0.01	0.01	−0.04	0.03	0.13
Confidence in gambling goal	−0.01	0.02	0.50	0.04	0.04	0.38
Gender (female)				−0.93	0.44	0.04
Marital status (married)				−0.52	0.40	0.19
Marital status (other)				−0.45	0.32	0.17
Age				−0.05	0.02	0.01
Workshop completion (yes)	−0.05	0.09	0.61	1.46	0.60	0.02
Time x condition	0.07	0.04	0.10	−0.10	0.11	0.33

Note: where specified, the table value corresponds to the category in the parentheses. The reference category for marital status is never married. For *Condition*, each line represents the within-group change over time for the specified group. The sample size for AUDIT-C results is 80 participants per group.

3.4. Online program satisfaction survey

In total, 291 online program users provided feedback about the relative strengths and weaknesses of the program using a 4-point Likert scale from Strongly Disagree to Strongly Agree. With the exception of monthly email reminders, all components of the program were rated relatively positively with at least 85% of responders agreeing that each component was useful, helpful or good quality. However, only 54% of

the responders reported that they looked forward to the monthly reminder emails, suggesting that almost half of the users did not feel positive about the email reminders. With regard to program improvement, the following elements were the top three most frequently endorsed components that needed to be changed: "Add more interactivity" ($n = 65$), "add more media variety to the course" ($n = 63$), and "make course activities more stimulating" ($n = 62$).

A large group of online program users ($N = 641$) responded to a separate feedback survey after completing Part 2 of the online workshop inquiring about the most valuable parts of the program (compared to the first feedback survey which asked about strengths/weaknesses). When asked about the most valuable part of the program, participants endorsed the content of the course (25.2% of total responses), stating that it was informative and provided novel facts. They also answered that the course provided ample opportunities for self-reflection and an increased level of self-awareness (23.1% of total responses). When asked about the least valuable part of the program, many participants stated that they found everything valuable (42.0% of total responses). Some participants found the content to be the least valuable (20.2%), stating primarily that there was too much content in the course.

When asked about changes they would recommend for the program, more than half the participants stated they would make no changes to the course (52.3% of total responses). Of the recommend changes, the most common was to improve the presentation of the course, including fixing broken links, adding more media, and offering the course in more languages (17.6% of total responses). Other categories that were mentioned for possible changes included making the course less redundant and shorter in length (9.7% of total responses), making the course more thorough (e.g., adding more content, diversifying content; 5.7% of total responses), and personalizing the content (3.9%). Full results for the online program satisfaction survey can be found in the Supplementary Online Materials.

4. Discussion

4.1. Main findings

The present study aimed to evaluate the effectiveness of an online self-management intervention compared to an in-person workshop when combed with VSE. Based on the results of the study, the hypothesis that the online VSE program will be superior to the face-to-face program was rejected. The results of this randomized controlled trial support the conclusion that participation in either of the evaluated VSE programs was associated with improved functioning. Participants in both groups experienced reductions in problem gambling severity, and money and days spent gambling. The primary outcome results point to a meaningful impact of participating in the evaluated programs on principal indicators of disordered gambling. Problem gambling screener scores were on average halved, with frequency and expenditure of gambling decreasing three to five-fold. An important consideration is that for primary outcomes, there was evidence of a rebound phenomenon toward the end of the study window. Although all of the primary disordered gambling outcomes were still lower at 12 months post-randomization than the baseline, it is possible that the effectiveness of the programs diminishes over time and may require booster interventions or supplemental monitoring to ensure success.

Despite the abstinence-oriented nature of a VSE contract, participants in both groups, on average, continued to gamble throughout the whole study period, as evidenced by non-zero days and dollars gambled self-reports. The result suggests that the programs are not completely effective in preventing gambling, and many disordered gamblers continue finding ways to gamble during their exclusion period despite the contract being a self-initiated agreement. This finding is consistent with previous VSE studies, which show that enforcement of VSE contracts is typically difficult (Gainsbury, 2014). Since in many jurisdictions the burden of detection of self-excluders is on venue staff rather than an automated or a computerized procedure, many gamblers go undetected when entering gambling venues. Furthermore, because VSE contracts are limited to specific venue types (e.g., casinos), an excluded gambler could simply go to another type of venue (e.g., bar) to continue gambling during the exclusion period. Lastly, a recent evaluation of the VSE program in British Columbia found that many individuals who self-excluded continued to gamble informally (e.g., gambling in-house) and non-problematically (e.g., lottery) during the exclusion period and still endorsed signs of recovery and problem severity attenuation (McCormick et al., 2018). Consequently, our findings of a reduction in problem severity over the course of exclusion while the majority of the sample continued to gamble concur with extant data on VSE.

Despite participants' odds of gambling remaining the same or going up over time, the frequency of gambling and money spent once gambling was initiated decreased in both groups. Since our analysis separated the likelihood of beginning to gamble as an outcome versus how much one gambled once any gambling was initiated, the results may reflect the fact that even though urge to initiate gambling sessions is difficult to control and may remain unchanged, there is a positive effect of the programs on curbing the extent and amount of gambling involvement if any gambling occurs. Theoretically, this could be the participants' self reflections about their gambling resulting in more control, as well as the forced abstinence of VSE creating more awareness of loss of control.

Participants in both VSE programs also reported decreased likelihood of being in treatment for gambling problems; participants in the online group endorsed decreased hazardous drinking likelihood over time; and participants in the in-person group endorsed increased quality of life over time. The results once again reflect an overall improvement in mental health for all participants, impacting co-morbid substance use, improving quality of life as well as seemingly satisfying a need for treatment. This is important because gambling problems most frequently co-occur with substance use problems, and programs that address co-morbidity are more reflective of real-world symptom presentation (Yakovenko and Hodgins, 2017). An interesting result was that the participants in the in-person group did not experience a reduction in hazardous drinking. One possible reason for this is that individuals who completed the online program experienced a greater therapeutic effect. Since the online program contained more evidence-based motivational interviewing components, the difference may be consistent with the heavier online program emphasis on resolving ambiguity and building intrinsic motivation to change. Participants could also return to the online program over time to seek treatment or other information, although we do not know if this occurred. Conversely, participants in the online group did not report improved quality of life over time, which may be reflective of the fact that changes in self-reported gambling severity symptoms were not of sufficient magnitude to impact subjective quality of living. In light of this finding, it is important for future VSE evaluations to incorporate health outcomes beyond gambling symptoms such as quality of life, as self-exclusion may not improve well-being in such areas.

Although the results are not causal, the findings support continued use of VSE programs as an effective responsible gambling policy component. There were no significant differences between the groups on any of the outcomes over time, suggesting that the online program is an effective alternative to the face-to-face workshop. While the original intent of the online program was to potentially increase effectiveness of VSE due to greater use of evidence-based components, the findings nevertheless support the adoption of the online platform over the existing in-person version. This is in part due to the potential wider reach of the online administration format, making it easier to access VSE for individuals in rural communities or those who are unable to attend workshops in person (e.g., disability), ultimately reaching a wider intended audience. Future research should evaluate different types of online interventions for the effectiveness in supplementing VSE. At present, little research has been done to evaluate the impact of guided

versus unguided (i.e., self-guided) interventions for addictive behaviours. Although self-guided online interventions have been shown to have a positive impact on symptoms of gambling disorder (Gainsbury and Blaszczynski, 2011), a recent systematic comparison of self-guided treatments for disordered gambling demonstrated worse results for this type of intervention than face-to-face treatments (Goslar et al., 2017). However, the review was not limited to online interventions.

4.2. Program uptake

Only 35% of the face-to-face group and 30% of the online group completed their mandatory program workshop requirements. The results are consistent with previous VSE studies (Gainsbury, 2014), which demonstrate difficulties in getting gamblers to use the VSE program and its services. Due to the low completion rates of the workshop, the positive improvements in gambling-related primary outcomes may be due to the VSE contract itself rather than participation in the workshop. Indeed, the present study did not evaluate the self-exclusion component itself, rather the addition of an online or an in-person intervention component to VSE. Furthermore, the original face-to-face VSE program in Alberta was never evaluated for its effectiveness prior to being compared to the online option. In addition, the timing of the workshop completion in the two conditions was not controlled, making it possible that participants across the groups received their intervention component during significantly different time points in the VSE agreement period. Therefore, the results make it difficult to discern how much participation in either of the workshops contributed to success in recovery above and beyond VSE alone. Additional research is required to disentangle the relationship between exclusion and participation in supports during exclusion.

It is important to highlight that in the online condition, participants who did not complete the workshop reported greater gambling problem severity and lower likelihood of currently being in treatment for gambling problems. This finding suggests that some gamblers of greater problem severity and who most need treatment chose to not engage with the online material despite its theoretically easier access. It would be important to explore in future studies why the most vulnerable gamblers may not engage with online intervention supports.

Although the online intervention should theoretically be easier to access and have greater reach, the lack of difference in completion rates between the two groups may be explained by usability factors gathered from the satisfaction survey. Specifically, a moderate portion of responders indicated that there was too much content on the site and that there was room for improvement in how interactive it was. Both of these factors could contribute to unwillingness to try or continuously use the online intervention during the exclusion period. Consequently, the lack of a completion advantage for the online participants may be due to the interface and content design of the intervention rather than its online format.

One reason for the observed low engagement in program supports is the previously discussed continuation of gambling by many VSE enrollers. At present, it is easy for a gambler who is excluded from all casinos in a province to gamble elsewhere (e.g., go to a bar with VLTs). A potential way to combat this issue is to expand the types of venues and formats that a VSE contract covers. For example, online gambling sites typically offer self-exclusion programs, but these often include very brief terms and have limited impact. Combining VSE terms to cover online gambling, as well as multiples types of venues in a given jurisdiction would increase the effectiveness of the VSE contract and reduce the chance for continued gambling during the exclusion period. Greater coverage may result in greater program engagement since participants will be less likely to gamble and may focus more on self-help and recovery. Another possible reason for the low engagement may be the continued engagement in informal gambling that was previously discussed, reflecting a lack of motivation to participate in treatment resources (McCormick et al., 2018).

Another way to increase program uptake and effectiveness is to increase awareness of VSE and its supports. In the present study, the online program attempted to maximize support awareness by allowing participants to save their learning journal data and use all program tools at any point during the study period. In addition, monthly reminder emails were sent to the individuals in the online group to direct them to the website on an ongoing basis. Despite these measures, the online program did not have greater uptake and the monthly emails were among the least liked components of the program based on participant feedback. As such, additional research is required to explore different options for increasing awareness of VSE supports, and reminding enrollers to engage with available self-help.

4.3. Mediators of program effectiveness

A consistent finding was that confidence in meeting one's gambling goals and perceived control over one's gambling were significant predictors of positive outcomes in both VSE groups. The result speaks to the potential role of self-efficacy as a significant mediator of success during self-exclusion. Although a mediation analysis is beyond the scope of this study, the findings support future examinations of the impact of self-efficacy on program engagement, and effectiveness. Furthermore, it may be fruitful to specifically design VSE program components that target self-efficacy. In that regard, building upon the online program's motivational tools, which attempt to build intrinsic value for recovery may also improve gamblers' self-efficacy since their engagement in the program may shift toward being self-motivated rather than externally pressured. Therefore, it is recommended that jurisdictions looking to revamp their VSE programs incorporate self-directed motivational interviewing tools.

4.4. Online program improvements

Based on the online program user feedback survey, the design of the online VSE program was well received. Over 85% of program users provided positive feedback about a variety of the online intervention components. The negative feedback about reminder emails is consistent with the low uptake of the workshop, suggesting that the emails did not work as well as anticipated and they were not particularly liked by a large portion of the participants. As such, one focus of future research on online interventions for gambling disorder should be how to make participants more aware and reminded of available supports. It is possible that less frequent but more personalized messages might be more engaging.

When asked about which elements of the online course needed improvement, the responses generally fell into the category of stimulation and interactivity, which suggests that future internet interventions for gambling may need to incorporate better graphical design, use of video/sound, and other more interactive components beyond text-based learning. The components that were the least cited for improvement were all related to course content and organization. The high rating of course content provides a data-driven endorsement for the revamped online motivational tools, further supporting their continued implementation in any future versions of the VSE program.

4.5. Limitations

Despite a stringent RCT design and robust methodology, the current study has a number of weaknesses that may be improved upon in future studies. All data came from self-report, which may provide a biased interpretation of actual gambling behaviour. For example, previous research has shown that the wording of gambling expenditure self-report questions changes the accuracy of the reported data (Wood and Williams, 2007). It is also possible that response bias as a result of demand characteristics may lead participants to underreport gambling behaviour in self-report format. There was also likely measurement

error during the procedure itself, as there are some conceptually inconsistent findings. For example, likelihood of gambling at least one day did not change over time, but likelihood of gambling at least one dollar went up over time. In theory, spending money on gambling, but not time should be impossible. As such, this is likely related to recall bias in the participants' self-report or data collection errors during the study. Furthermore, since the online program could technically be accessed by the general public during the trial, it is possible that some participants in the face-to-face group may have inadvertently requested and received access to the online program despite being assigned to the other RCT group. However, given that the program was not advertised explicitly to face-to-face participants and that there was an account creation and approval process in place to receive access, it is unlikely that this was a large source of bias.

The length of the follow-up period may not have captured the long-term impact of the VSE program. Given the observed rebound effect of many participants beginning to regress at the last assessment, it would have been ideal to monitor whether this trend was temporary or would indeed result in the eventual return to baseline on problematic gambling. The quadratic trend of the findings may be indicative of VSE's poor ability to prevent relapse.

The two-group pretest-posttest design employed in the study has weaknesses since it prioritizes internal validity in lieu of external validity (Harris et al., 2006). For example, the baseline assessment may have prompted gamblers to self-reflect about their gambling behaviour which would not generalize to all gamblers. It is important to acknowledge possible selection bias during the recruitment for the study since more than half of participants reported currently receiving treatment for gambling problems at baseline. Participants who are seeking treatment are likely to be more motivated to engage with interventions and to achieve their recovery goals. Lastly, given that the study did not include a natural recovery control group, it is impossible to attribute any positive outcomes to self-exclusion as a form of intervention in comparison to the mere passage of time given that both study groups contained the self-exclusion component.

5. Conclusion

The results of the study support the effectiveness of voluntary self-exclusion as an intervention for gambling disorder. Participants in both VSE workshop formats gambled less, spent less money gambling, and reported decreased need for formal treatment. Our findings support the addition of an online intervention component during the VSE period. The self-directed program evaluated in this study was well received by the users, praising its high content quality. Continuing to evaluate and implement online interventions as part of large jurisdictional harm reduction policies such as VSE is important as such interventions are easier to administer, able to reach more individuals since they only require access to a computer, and they can be based on motivational evidence-based principles of psychotherapy for gambling disorder.

Declaration of competing interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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Appendix A

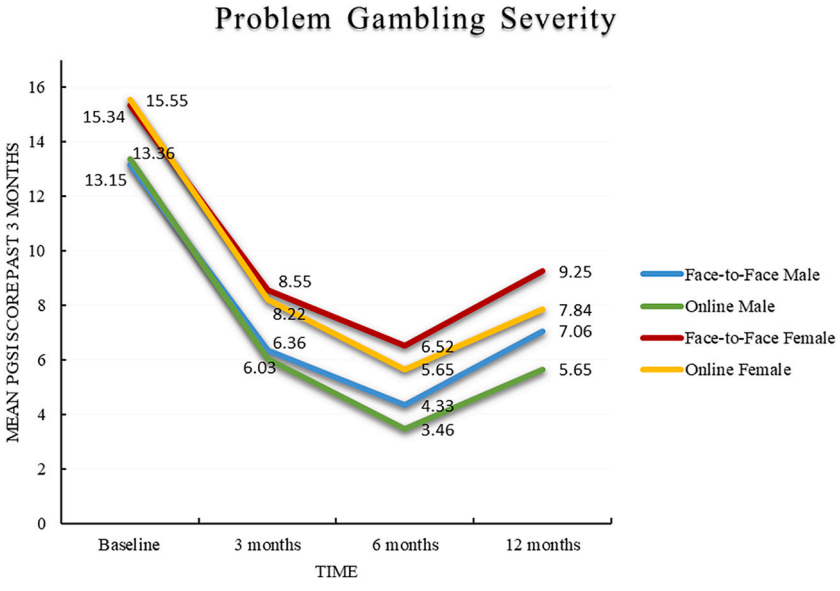

Fig. A1. Problem gambling severity changes over time.

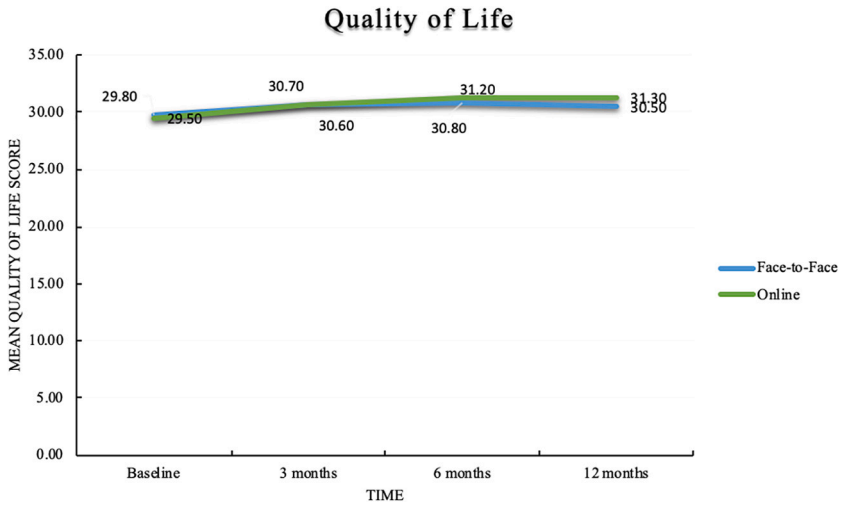

Fig. A2. Quality of life changes over time.

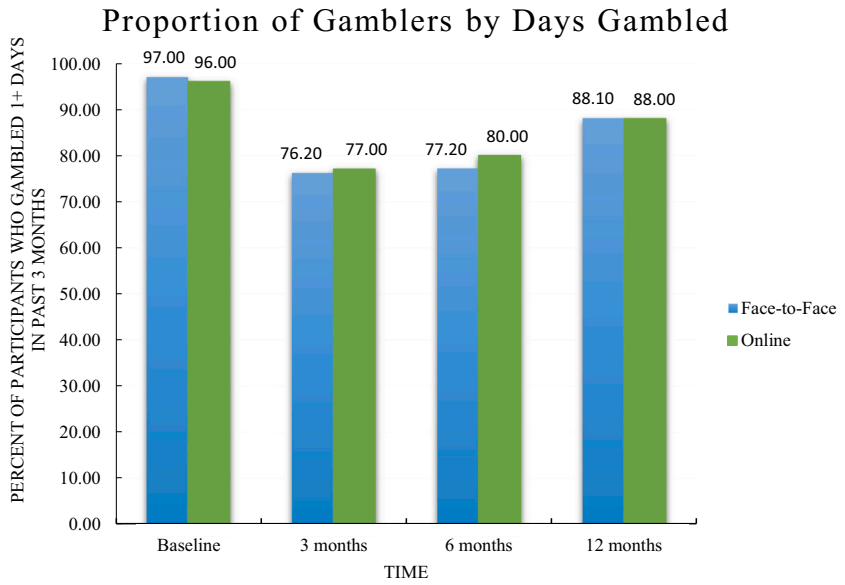

Fig. A3. Proportion of participants who gambled at least one day (past three months) over time.

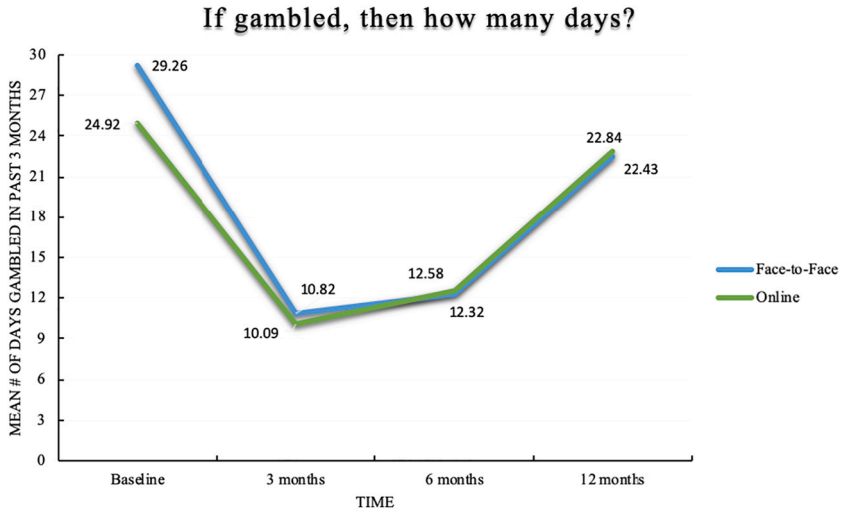

Fig. A4. If participants gambled, how frequently did they gamble over time?

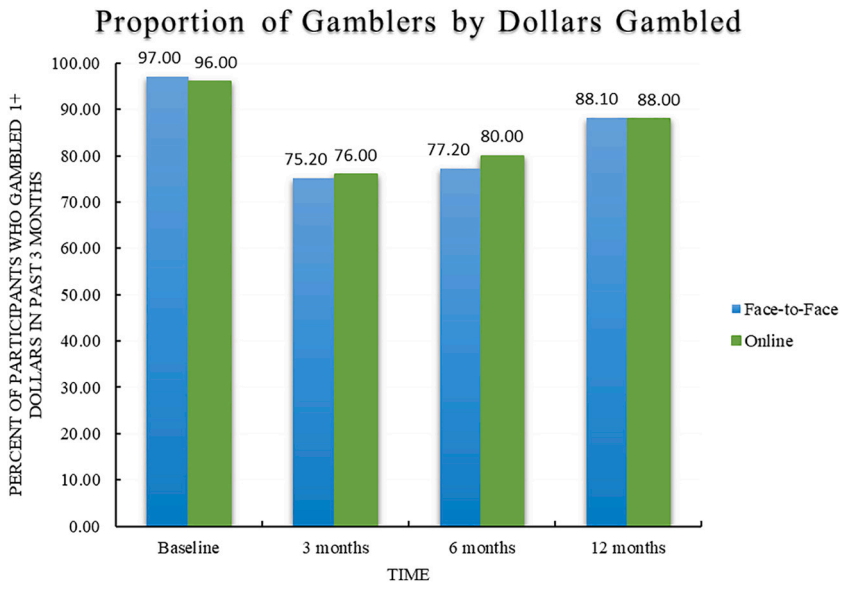

Fig. A5. Proportion of participants who gambled at least one dollar (past three months) over time.

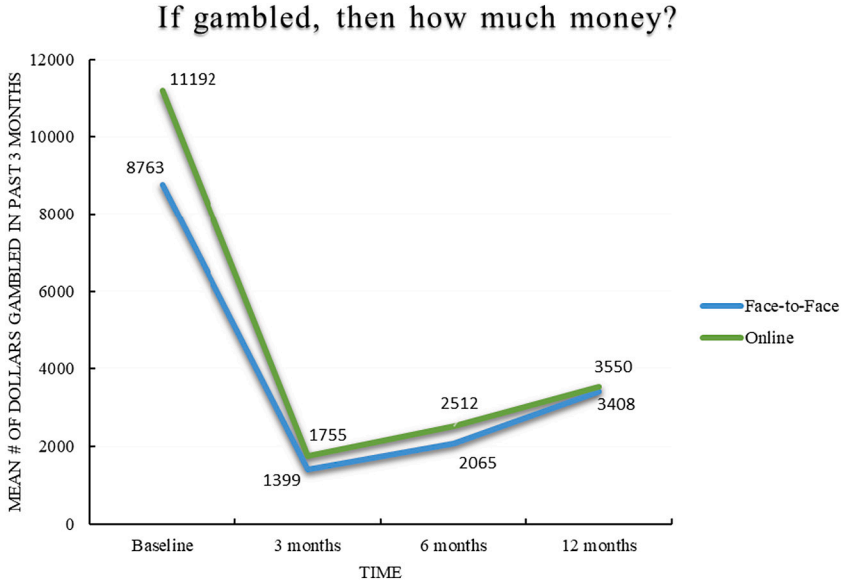

Fig. A6. If participants gambled, how much money did they spend on gambling over time?

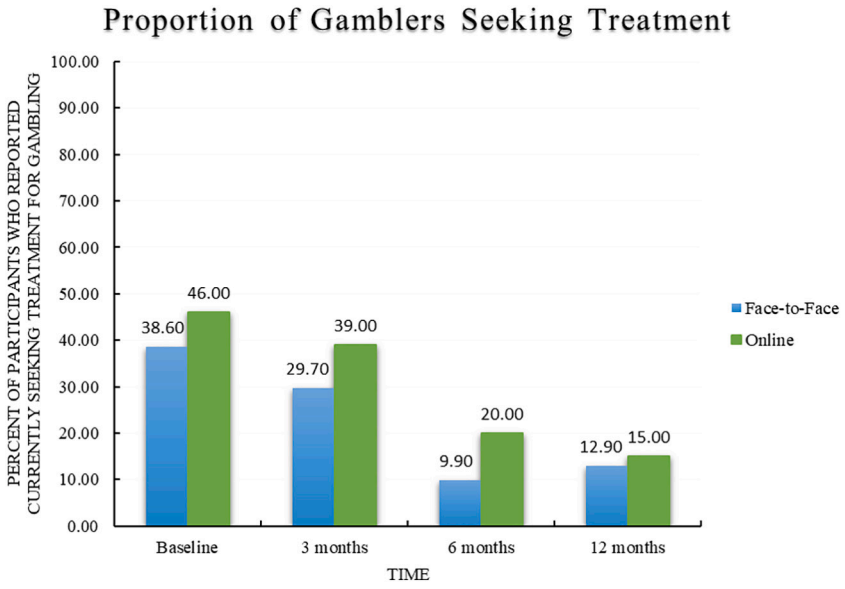

Fig. A7. Proportion of participants who reported currently attending gambling treatment over time.

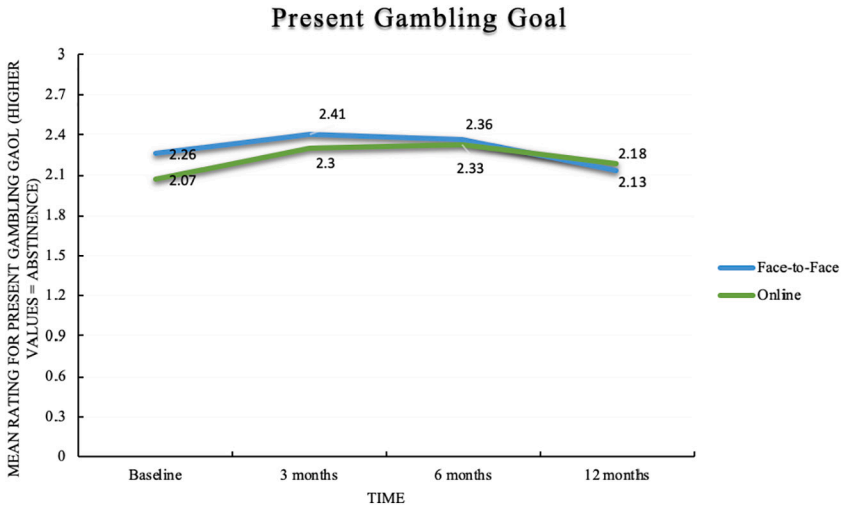

Fig. A8. Present gambling goal changes over time.

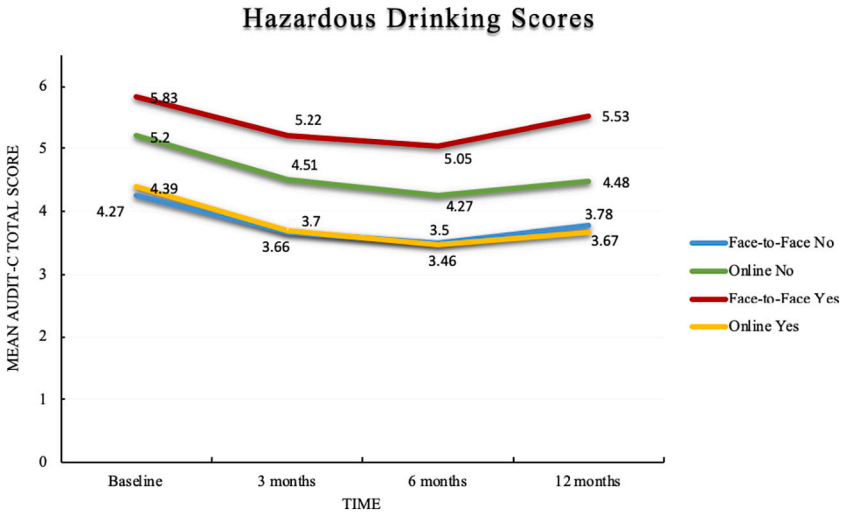

Fig. A9. Hazardous drinking scores over time by workshop completion status.
Note: "Yes" and "No" legend labels correspond to "completed the workshop" and "did not complete the workshop" respectively.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.invent.2020.100354.

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