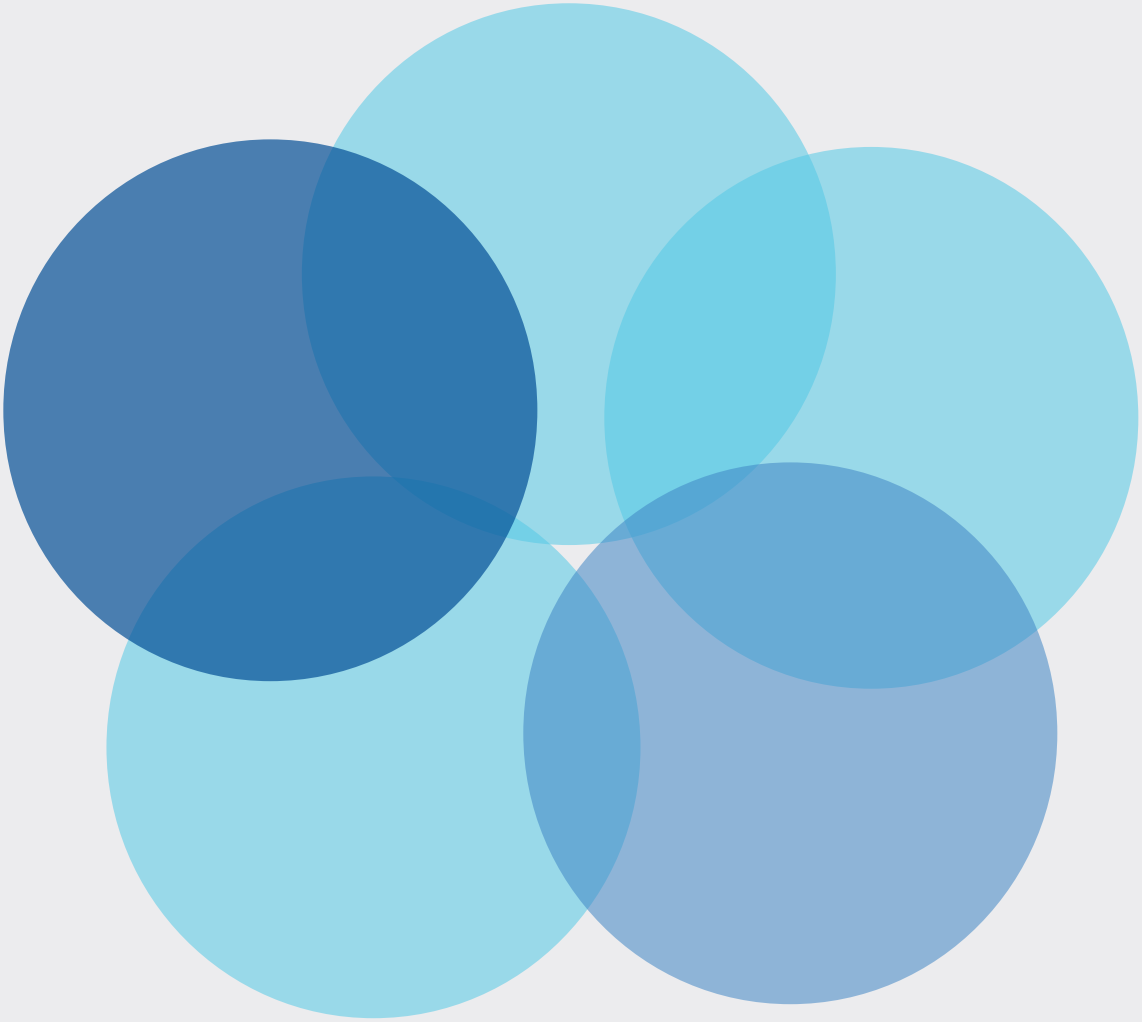

THE VICTORIAN GAMBLING STUDY

A LONGITUDINAL STUDY OF GAMBLING AND HEALTH IN VICTORIA 2008–2012

TECHNICAL REPORT FOUR

SOCIAL DETERMINANTS AND CO-MORBIDITIES: MULTIVARIATE MODELS OF CO-MORBIDITIES

responsiblegambling.vic.gov.au

January 2016

Victorian Responsible Gambling Foundation

The *Victorian Gambling Study* was originally funded and managed by the Department of Justice and was transferred to the Victorian Responsible Gambling Foundation on 1 July 2012.

Disclaimer

While the data and findings of the technical papers have been carefully prepared and considered correct, the information, views and referenced material in this report is provided solely on the basis that the reader will be responsible for making their own assessment of the information provided. No warranty is given as to the accuracy of the information provided and if you rely on it, you do so at your own risk.

To cite this report

Stone, C, Yeung, K & Billi, R 2016, *The Victorian Gambling Study: a longitudinal study of gambling and health in Victoria 2008-2012, Technical report four - Social determinants and co-morbidities: multivariate models of co-morbidities*, Victorian Responsible Gambling Foundation, Melbourne

Enquiries

contact@responsiblegambling.vic.gov.au

Victorian Responsible Gambling Foundation
Level 6, 14-20 Blackwood Street
North Melbourne, Victoria 3051
PO Box 2156
Royal Melbourne Hospital
Victoria 3050
Telephone: +61 3 9452 2600
Facsimile: +61 3 9452 2660
ABN: 72 253 301 291

Our vision: A Victoria free from gambling-related harm

Contents

Summary

A series of secondary analyses were undertaken from *The Victorian Gambling Study- A longitudinal study of gambling and health 2008-2012* (*The Victorian Gambling Study*) (Billi, Stone, Abbott and Yeung 2014; Billi, Stone, Marden and Yeung 2014). This paper is the fourth of a series of technical reports. The focus of this paper is on the interplay between social determinants, co-morbidities and the level of gambling problems (PGSI score) in gamblers. Non-gamblers were excluded from the analysis. The purpose was to investigate a range of possible determinants (for example - physical, mental health conditions, smoking, alcohol, socio-demographics) to indicate which showed the strongest association with levels of gambling problems. The analysis is underpinned by a public health approach which views problem gambling as part of a gambling continuum and explores the broader personal, social, economic and environmental as well as biological determinants of gambling problems.

This multivariate analysis investigated which characteristics of the determinants were associated with an increase (more gambling problems) or a decrease (less gambling problems) in the PGSI score, having taken into account other important determinants. Determinants that best explain the level of gambling problems are identified as well as the size of the effect of different characteristics.

Models were developed with logical groupings of determinants before the final model was developed. The logical groupings included:

- Socio-demographics multivariate model
- Smoking and alcohol use and abuse multivariate model
- Health and health conditions multivariate model
- Final multivariate model

Final multivariate models

Two final models were developed. The first model explored the effects of the Kessler 10, general psychological distress, which was the most important determinant based on the model fit statistics. The second model which excluded the Kessler 10 explored the effects of anxiety and depression which were also important determinants in the univariate analysis.

The first model, model one, produced the best model for the relationship between PGSI score and comorbidities. It consisted of

- the Kessler 10 score: The PGSI score tends to increase by 1.09 (1.08, 1.10) times for each unit increase in the Kessler 10 score.
- Past year smoking is associated with an increase in PGSI score of 1.77 (1.53, 2.06) compared with those who did not.
- Alcohol abuse or dependence is associated with of 1.61 (1.23, 2.10) compared with those who did not drink over the past 12 months.
- Obesity is associated with an increase in PGSI score of 1.74 (1.42, 2.13) times.
- Socio-demographics: gender and LOTE improved the model whereas age and educational attainment did not.

A second model was developed which excluded the Kessler 10 variable. In this model, PGSI score was best described by

- current depression which increases the PGSI score by 1.85 (1.47, 2.33) compared with those who were not
- current anxiety which increases the PGSI score by 1.63 (1.28, 2.08) compared with those who were not,
- past year smoker increases by 1.85 (1.59, 2.15) times compared with those who did not,
- Alcohol abuse or dependence by 1.59 (1.22, 2.08) times compared with those who did not drink over the past 12 months,
- obesity by 1.64 (1.32, 2.04) times compared with those who were not, and
- self-rated health reported as poor by 1.62 (1.17, 2.24), as fair by 1.57 (1.22, 2.00) and as good by 1.33 (1.09, 1.63) compared with reported as excellent.
- Socio-demographics: gender and LOTE improved the model whereas age and educational attainment did not.

Implications

When considering the implications of the findings it is important to consider also the timespan implied in the survey questions. The level of psychological distress over the previous four weeks, the Kessler 10 score, is the most important factor associated with gambling problems. It is even more important than current depression and anxiety which also result in a strong model of factors influencing the level of gambling problems. Addition of anxiety and depression to model one, did not improve the Kessler 10 model fit statistics. These models demonstrate the importance of mental health issues, high levels of psychological distress, anxiety and depression experienced by gamblers with higher levels of problems. Past year smoking and alcohol use and abuse provide further explanatory power to both models. Problem gambling is now defined as a substance abuse disorder in the DSM-V. The findings of this study indicate that use or abuse of these other substances, are associated with additional risk for higher levels of gambling problems. Obesity also provides further explanatory power to both models, after taking into account mental health and substance use. Self-rated health improved the second model but not the first model which contained the Kessler 10 score. It may be the self-rated health has captured some of the psychological distress measured by the Kessler 10.

1. Introduction

Technical Report Four describes a detailed analysis of the complex interplay between social determinants, comorbidities, and the PGSI score in gamblers. The secondary analysis of *The Victorian Gambling Study- A longitudinal study of gambling and health 2008-2012* (*The Victorian Gambling Study*) (Billi, Stone, Abbott and Yeung 2014; Billi, Stone, Marden and Yeung 2014) was conducted with the aim of building on the current knowledge and understanding of the relationship between these factors. It uses a public health approach by treating problem gambling as part of a continuum and explores the broader personal, social, economic and environmental as well as biological determinants of gambling problems. In this case the determinants studied are social determinants, and comorbidities (smoking and alcohol use and abuse, physical and mental health conditions, and self-rated health and psychological distress).

The findings from the secondary analyses may vary from the literature as a result of the approach to the analysis and reporting. Firstly, this analysis treats the PGSI score as count data. This choice enables the use of the full range of the score from 0 to 27 rather than condensing to four or five risk categories. Much of the literature contains findings from analyses that compare the pathological or problem gambling group with the non-problem gamblers. Others convert the data to binary and compare the pathological or problem gambling group with the rest of the population i.e. the non-pathological or non-problem gambling group. Sometimes the highest risk groups are combined to achieve sufficient numbers and then comparative analyses are conducted.

Secondly, these cross sectional analyses indicate which determinants are the most important explanatory factors for the level of gambling problems. The model fit statistics are used to indicate which individual determinants best explain the variations in the PGSI score. The descriptive analyses of a single determinant and PGSI score are reported in the Technical Report Two. This importance or strength of association is rarely reported in the literature.

Finally, multivariate analyses were conducted to enable identification of the independent effects of determinants after taking into account other important determinants. Various models were explored to build a picture of the more important determinants from each group of determinants. These models were then combined. Often only descriptive analyses are reported with proportions and odds ratios only.

Technical report series

This report is part of a series of technical reports commissioned by the Victorian Responsible Gambling Foundation.

The Victorian Gambling Study: a longitudinal study of gambling and health in Victoria 2008–2012, Technical report one – Social determinants and co-morbidities: social determinants and co-morbidities of gamblers and non-gamblers. The first technical report describes a secondary analysis of *The Victorian Gambling Study- A longitudinal study of gambling and health 2008-2012* (*The Victorian Gambling Study*) (Billi, Stone, Abbott and Yeung 2014; Billi, Stone, Marden and Yeung 2014) which compares the social determinants, trauma and life events, social capital, and comorbidities between gamblers and non-gamblers over the four years of *The Victorian Gambling Study*.

The Victorian Gambling Study: a longitudinal study of gambling and health in Victoria 2008–2012, Technical report two – Social determinants and co-morbidities: univariate analysis of gamblers. The second technical report describes a secondary analysis of gamblers from the first year of *The Victorian Gambling Study*. Each of the variables describing the social determinants, trauma and life events, social capital, and comorbidities were explored to determine which have the best or strongest

individual association with the PGSI score. It investigated which characteristics of the determinants were associated with an increase (more gambling problems) or a decrease (less gambling problems) in the PGSI score.

The Victorian Gambling Study: a longitudinal study of gambling and health in Victoria 2008–2012, Technical report three – Social determinants and co-morbidities: multivariate models of trauma and social capital. The third technical report describes a secondary analysis of *The Victorian Gambling Study* which examined in detail the complex interplay between social determinants, trauma and life events, and social capital, and their association with the PGSI score in gamblers. This multivariate analysis indicated which determinants best explain the PGSI score after having taken into account other important determinants.

The Victorian Gambling Study: a longitudinal study of gambling and health in Victoria 2008–2012, Technical report four – Social determinants and co-morbidities: multivariate models of co-morbidities. The fourth technical report describes a secondary analysis of *The Victorian Gambling Study* which examined in detail the complex interplay between social determinants and comorbidities, and their association with the PGSI score in gamblers. This multivariate analysis indicated which determinants best explain the PGSI score after having taken into account other important determinants.

Structure of the report

Technical Report Four describes a more comprehensive exploration of comorbidities, adjusted for socio-demographics, and their relationship with the PGSI score in gamblers. Multivariate models were developed for each logical grouping of determinants, socio-demographics model, smoking and alcohol model, physical health model and mental health model. Two comprehensive models containing the most important factors were found to best describe the relationship between these factors and the PGSI score. The report is divided into eleven sections.

Summary

The summary section outlines the key findings of the report.

1. Introduction

The introduction describes the approach to this secondary analysis of the data from *The Victorian Gambling Study* and how it differs from the traditional approach. The aim of the study is to add to the understanding of the complex interplay between gambling problems and comorbidities taking into account the social determinants.

2. Materials and methods

Materials and methods section details the analytical approach and how to interpret the results.

3. Socio-demographics multivariate model

This section describes the multivariate modelling of the socio-demographic determinants of gambling problems.

4. Smoking and alcohol multivariate model

This section describes the multivariate modelling of smoking and alcohol factors adjusted for the important socio-demographic determinants of gambling problems.

5. Health and health conditions multivariate models

This section describes the multivariate modelling of the physical health and health conditions models and mental health and health conditions models adjusted for the important socio-demographic determinants of gambling problems. It also describes the final comorbidities model adjusted for important socio-demographic determinants of gambling problems.

6. Discussion and implications

This section outlines the key findings of the various multivariate models and their relationship with the literature. It outlines the strengths and weaknesses, what the study adds and the implications of the findings.

Appendix One

This section consists of tables of results of analysis of single factors adjusted for socio-demographics.

Appendix Two

This section contains some of the relevant questions from the CATI survey

Appendix Three: Glossary

This section provides a glossary of the key terms in the document.

Appendix Four: References

This section consists of the references used.

2. Materials and methods

This section describes the materials and methods used to conduct the analyses for the third technical report. The aim of this work was to explore in detail the relationship between social determinants, comorbidities and gambling problems. The Problem Gambling Severity Index (PGSI) score was used to define the level of gambling problems. A public health approach was applied to the analysis. Rather than treat problem gambling as the only outcomes of interest, the analytical technique in this study uses the full range of the PGSI score to explore the relationship between the parameters of interest and the level of gambling problems.

Study design

The study design was a cross sectional observational study using data on all gamblers (n=4,677) from the first year of the Longitudinal Study of Gambling and Health in Victoria 2008-2012 (Billi, Stone, Abbott and Yeung 2014). Briefly *The Victorian Gambling Study* collected information from a representative sample (n=15,000) of the Victorian adult population (18 years and older) using computer assisted telephone interviewing (CATI) in 2008. Areas with higher electronic gaming machine expenditure were oversampled in order to enrich for participants with higher risk gambling.

Gambling problems measure

The PGSI consists of the nine questions from the Canadian Problem Gambling Index (CPGI) which are scored. The Queensland modification of the PGSI (Queensland Treasury 2001; Billi, Stone, Abbott and Yeung 2014) was used to measure problem gambling. This modification of the item response scale uses five-points (never, rarely, sometimes, often and always) rather than the original four-point scale (never, sometimes, often, almost always). Responses of ‘rarely’ and ‘sometimes’ were combined and given a score of 1, so that the range of scores remained from 0 to 27 as in the original PGSI. Cut-points for the total PGSI score were: 0, non-problem gamblers; 1-2, low-risk gamblers; 3-7, moderate-risk gamblers; and ≥8, problem gamblers.

The PGSI score is an indicator of gambling problems. The questions are listed in Appendix One. Gamblers score 0 on the PGSI measure when they respond ‘never’ to each question in the series of 9 questions on gambling behaviour or consequences of gambling. A higher PGSI score can occur in two ways: a gambler responds to one or more of the questions (more problems) and/or responds more frequently (problems are experienced more often).

Determinants or correlates of gambling problems

The determinants of gambling problems that were studied were those that described the person’s socio-demographics and comorbidities. Most comorbidities are indicative of current status or over the previous 12 months so are concurrent with the measure of gambling problems, the PGSI. The comorbidities investigated were the Kessler 10 (a measure of general psychological distress) over previous four weeks; self-rated health over last 12 months; current health conditions (Heart conditions, high blood pressure or high cholesterol; diabetes; cancer; lung conditions including asthma; depression; anxiety disorders; obesity; Any other physical or mental health conditions); smoking over past 12 months; and alcohol use and abuse.

An alcohol use and abuse variable was derived by combining alcohol over previous twelve months and the CAGE questions. This produced a variable consisting of three categories: No alcohol use over previous twelve months; alcohol use and no signs of abuse; and alcohol use with signs of abuse

or dependence. Measures of area level socio-economic status, the ABS SEIFA, were merged into the database using the postcode of residence which was collected in the first wave of the study.

Analytical technique

The relationship between comorbidities, socio-demographic variables and PGSI score was modelled using the negative binomial regression. These analyses were conducted using STATA SE 12 and were unweighted because the model fit statistics could not be applied to weighted data.

The negative binomial was chosen for a number of reasons. Firstly it treats the PGSI score as a count variable in contrast to the usual reduction to four or five PGSI categories using the currently recognised cut-points. It makes use of the information from the full range of the score from 0 to 27 rather than reduction to the usual four categories which provides for a more statistically robust analysis. It is not limited by the low numbers of problem gamblers in the sample. Frequently, because of the low prevalence of problem gamblers, studies combine the problem gamblers with the moderate risk gamblers to achieve sufficient numbers for a statistically robust analysis of the determinants of problem gambling (Crockford, Quickfall, Currie, Furtado et al. 2008; Afifi, Cox, Martens, Sareen et al. 2010). In spite of evidence that indicates moderate risk and problem gamblers are quite distinct groups and that original cut-points between moderate and low risk are in need of revision (Currie, Hodgins and Casey 2013).

In addition, this technique identifies which factors are associated with a higher (or lower) PGSI score and therefore more (or less) gambling problems. The most frequent analytical technique of logistic regression depends on conversion of the PGSI score to categories and then to dichotomous variable of problem gambling (yes/no). This is a more clinical ‘case finding’ method rather than a public health approach. Finally the distribution of the PGSI scores is over-dispersed i.e. the variance is greater than the mean. Use of a Poisson regression, the usual model for count data, would result in standard errors that are biased downwards (Long and Freese 2006). The results are reported as the incidence rate ratios (IRR), the p-value and BIC’.

How to interpret the IRR, p-value and the BIC’

We report the incidence rate ratios (IRR) from the negative binomial regression to indicate the size of the effect. For example an IRR of 2.0 for gender indicates that the PGSI score increased by a rate of 2 times for males when compared to females. IRRs less than one indicate a decrease in score. For example an IRR of 0.5 indicates that the PGSI score decreases by a rate of 0.5 times (or a half) for females when compared to males

The 95 per cent confidence interval (CI) of the IRR demonstrates the precision of the model estimation at a traditional p-value of 0.05, the narrower the CI the more precise the estimation. The p-value indicates the certainty of the IRR estimation, the likelihood that the estimation is not mere chance.

In these analyses model fit statistics are used to identify the most **important determinants** and the **best models** for each logical group of variables. Model fit was determined using the Bayesian information criteria (BIC) calculated by the *fitstat* (Long and Freese 2000) post-estimation command. Concern has been raised over the use of p-values particularly in large samples (Raftery 1995). Conventionally p-values are set at 0.05, however in large samples a p-value at this level results in many significant associations. Lowering the p-value is recommended but is not totally satisfactory. BIC allows the comparison between models with different samples or non-nested samples and considers uncertainty in measuring the overall fit of a regression model (Raftery, 1995).

There are two versions of Bayesian information criteria, BIC and BIC'. BIC is the value returned when the current model is compared with a baseline model that is fully saturated. Whereas BIC' is the value returned when the current model is compared with a baseline model that is a null model i.e. it has no variables in it at all. If the BIC' is positive then the null model is preferred. The more negative the BIC' the better overall fit the model. The guidelines for the strength of evidence of overall model fit between two models based on a difference in BIC' are: an absolute difference of 0-2 indicates weak evidence, a difference of 2-6 indicates positive evidence, 6-10 indicates strong and more than 10 indicates very strong evidence (Raftery 1995).

Model development

Model development was based literature review as well as on the findings from the analyses reported in technical report two. Individual models were developed for each group of determinants. A social determinants model was developed first. Determinants were added to the model one by one, starting with the strongest predictors of the social determinants group, until the model fit was optimised. That is the model that had the lowest or most negative BIC'. Preference was given to the more parsimonious model. This formed the baseline model. Similarly a smoking and alcohol use model including social determinants, and a health and health conditions model including social determinants were developed. Finally the full model was developed to identify which determinants best explained the level of gambling problems as well as the size of the effect of these determinants.

3. Socio-demographics multivariate model

Exploration of **socio-demographic variables** of gamblers to predict PGSI score using the negative binomial regression showed that the important socio-demographic variables were age as a continuous variable, gender, only speaking English at home and educational level. The results are shown in Table 1.

The IRR of 0.99 [CI 0.99, 1.00] indicates that the PGSI score decreased by a rate of 0.99 times for each increase in age of one year. The IRR of 1.44 [CI 1.24, 1.66] indicates that the PGSI score was increased by a rate of 1.44 times for male gamblers compared with females. The IRR of 0.56 [CI 0.46, 0.69] indicates that the PGSI score almost halved in gamblers who report only English language at home when compared with those who speak a language other than English at home. Compared with the PGSI score of those with a post graduate degree, those having completed year 12 have 1.50 times score and those who have schooling to year 10 or less have 1.92 times score.

In other words, all things being equal, being male or having a lower educational level was associated with a higher PGSI score whereas being older or speaking only the English language at home tend to decrease the PGSI.

Occupation was the only determinant that was significant in the univariate analysis but did not add any explanatory value to the multivariate model after age, gender, LOTE and educational achievement were taken into account.

The other socio-demographic determinants investigated were a poor fit in the univariate models. The determinants that were investigated included age as a categorical variable, migration in past five years, Number of dependent children, Internet type, household type, employment status, household income, personal income, EGM spend band, SEIFA (socioeconomic advantage and disadvantage) ABS, SEIFA (socioeconomic disadvantage) ABS, SEIFA (economic resources) ABS, SEIFA (education and occupation) ABS, Metro/rural area of residence. Based on the BIC's, there were no evidence to support adding extra social demographic variables would improve the model fit.

Table 1 Regression model for important socio demographic variables

	Final multivariate model		
Socio-demographic	**IRR**	**p-value**	**Model BIC'**
Male gender	1.44 (1.24,1.66)	0.000	-47.7
Age 2008 in years	0.99 (0.98,0.99)	0.000	
Not speaking LOTE at home	0.56 (0.46,0.69)	0.000	
Education			
Post-graduate degree	ref		
Bachelor's degree	0.92 (0.67,1.26)	0.608	
Advanced diploma/diploma/ certificate/TAFE	1.31 (0.97,1.77)	0.080	
Completed year 12	1.50 (1.11,2.02)	0.008	
Schooling year 10 or less	1.92 (1.45,2.55)	0.000	
Don't know or refused	1.82 (0.94,3.55)	0.077	

4. Smoking and alcohol multivariate model

In the final model (Table 2), after adjusting for age, gender, LOTE and educational attainment, the independent effect on PGSI score of past year smoking is an increase of 2.07 (1.77, 2.43) times. Those with signs of clinical alcohol abuse tended to have a PGSI score of 1.87 (1.41, 2.47) times compared with non-drinkers. On the other hand drinkers with no sign of alcohol abuse tended to have a lower PGSI score of 0.81 (0.67, 0.98) times however this result is only just significant.

Age and gender do not appear to be important correlates of PGSI score, once smoking and alcohol are taken into consideration. A model with smoking and alcohol only is improved by addition of gender and LOTE but not age or education.

Table 2 Final regression model for the relationship between PGSI score and smoking and alcohol

Variable	**IRR* (CI)**	**p-value**	**BIC'**
			-177.0
Past year smoking	2.07 (1.77,2.43)	0.000	
CAGE clinical alcohol abuse categories			
Non-drinker	ref		
No signs of alcohol abuse	0.81 (0.67,0.98)	0.035	
Alcohol abuse or dependence	1.87 (1.41,2.47)	0.000	

**adjusted for age, gender, LOTE and educational attainment*

5. Health and health conditions multivariate models

Physical health and health conditions

The best model for the relationship between PGSI score and physical health and health conditions consisted of self-reported health and obesity, as well as the socio-demographics of gender, age, LOTE and educational attainment.

The PGSI score tends to increase as the self-reported health worsens. The PGSI score of those who reported their health as good was 1.63 (1.32, 2.00) times, fair was 2.30 (1.80, 2.95) times and poor was 3.44 (2.50, 4.72) times that of those who reported their health as excellent. Obesity was associated with an increase in PGSI score of 1.66 (1.33, 2.08) times.

The other health conditions investigated were either a poor fit in the univariate models or did not improve the model fit. The determinants that were investigated included Heart conditions, high blood pressure or high cholesterol; Diabetes; Cancer; and Lung conditions including asthma.

Table 3 Final multivariate model for relationship between PGSI score and physical health conditions

Variables	IRR* (CI)	p-value	Model BIC'
			-193.8
Self-reported health status			
Excellent			
Very good	0.94 (0.77,1.15)	0.588	
Good	1.63 (1.32,2.00)	0.000	
Fair	2.30 (1.80,2.95)	0.000	
Poor	3.44 (2.50,4.72)	0.000	
Obesity	1.66 (1.33,2.08)	0.000	

**adjusted for age, gender, LOTE and educational attainment*

Mental health conditions

The Kessler 10 parameter exhibited the strongest relationship with the PGSI score of all the variables tested. This was true whether the Kessler 10 was tested as a continuous or a categorical variable. The strength of the association with depression or anxiety was strong as well but not as strong as the Kessler 10.

The best model for the relationship between PGSI score and mental health and mental health conditions is the Kessler 10 score alone. Addition of number of mental health conditions, depression or anxiety to the Kessler 10 model did not improve the model fit above that achieved with the Kessler 10 parameter.

Table 4 Final regression model for the relationship between PGSI score and mental health

Variables	IRR (CI)	p-value	Model BIC'
			-398.8
Kessler 10 score	1.11 (1.10,1.13)	0.000	

Analysis treating the Kessler 10 as a categorical variable resulted in a strong model but not as strong as when Kessler 10 was treated as a continuous variable.

Variables	IRR* (CI)	p-value	Model BIC'
			-290.9
Kessler 10 category			
Low distress	ref		
Moderate distress	2.69 (2.04,3.53)	0.000	
High distress	4.70 (3.27,6.75)	0.000	
Very high distress	7.60 (5.21,11.1)	0.000	

**adjusted for age, gender, LOTE and educational attainment*

Depression and anxiety

A model with the presence of mental health conditions, depression and anxiety, without the Kessler 10 parameter produces reasonably strong model fit. This model was explored because it may be that the Kessler 10 is measuring the distress of problem gambling rather than the presence of a mental health issue.

Those who reported currently having depression tended to have a PGSI of 2.57 (2.05, 3.23) times those who did not. Those who reported currently having anxiety tended to have a PGSI of 1.78 (1.38, 2.28) times those who did not.

Variables	IRR* (CI)	p-value	Model BIC'
			-239.2
Depression	2.57 (2.05,3.23)	0.000	
Anxiety	1.78 (1.38,2.28)	0.000	

**adjusted for age, gender, LOTE and educational attainment*

Final comorbidities models

The best model for the relationship between PGSI score and mental and physical health conditions consists of the Kessler K10, self-reported health and obesity, as well as the socio-demographics of gender, age, LOTE and educational attainment. The PGSI score tends to increase by 1.09 (1.08, 1.10) times for each unit increase in the K10 score.

Past year smoking is associated with an increase in PGSI score of 1.77 (1.53, 2.06) compared with those who did not. Alcohol abuse or dependence is associated with of 1.61 (1.23, 2.10) compared with those who did not drink over the past 12 months. Obesity is associated with an increase in PGSI score of 1.74 (1.42, 2.13) times. Inclusion of self-reported health did not improve the model.

Age and gender do not appear to be important correlates of PGSI score, once comorbidities are taken into consideration. A model with comorbidities only is improved by addition of gender and LOTE but not age or education.

Table 5 Final regression model for relationship between PGSI score and mental health (K10)

Variables	IRR* (CI)	p-value	Model BIC'
			-478.5
K10 score	1.09 (1.08,1.10)	0.000	
Past year smoking	1.77 (1.53,2.06)	0.000	
CAGE clinical alcohol abuse categories			
Non-drinker	ref		
No signs of alcohol abuse	0.95 (0.79,1.13)	0.590	
Alcohol abuse or dependence	1.61 (1.23,2.10)	0.000	
Obesity	1.74 (1.42,2.13)	0.000	

**adjusted for age, gender, LOTE and educational attainment*

A second model was developed using self-reported mental health conditions, anxiety and depression, and excluding the Kessler 10 variable. In this model, PGSI score was best described by current depression, current anxiety, past year smoker, signs of alcohol abuse, obesity and self-rated health.

The PGSI score increases by 1.85 (1.47, 2.33) in those reporting current depression, by 1.63 (1.28, 2.08) in those with current anxiety, by 1.85 (1.59, 2.15) for past year smokers, by 1.64 (1.32, 2.04) for obesity compared with those who did not, and by 1.59 (1.22, 2.08) for those reporting alcohol abuse or dependence compared with non-drinkers, and by 1.62 (1.17, 2.24) for those reporting self-rated health as poor, by 1.57 (1.22, 2.00) for fair and by 1.33 (1.09, 1.63) for good as compared with reported as excellent self-rated health.

Age and gender do not appear to be important correlates of PGSI score, once comorbidities are taken into consideration. A model with comorbidities only is improved by addition of gender and LOTE but not age or education.

Table 6 Final regression model for relationship between PGSI score and mental health (anxiety and depression)

Variables	IRR* (CI)	p-value	Model BIC'
			-358.2
Depression	1.85 (1.47,2.33)	0.000	
Anxiety	1.63 (1.28,2.08)	0.000	
Past year smoking	1.85 (1.59,2.15)	0.000	
CAGE clinical alcohol abuse categories			
Non-drinker	ref		
No signs of alcohol abuse	0.89 (0.74,1.07)	0.227	
Alcohol abuse or dependence	1.59 (1.22,2.08)	0.001	
Obesity	1.64 (1.32,2.04)	0.000	
Self-rated Health			
Excellent	ref		
Very good	0.88 (0.72,1.08)	0.250	
Good	1.33 (1.09,1.63)	0.005	
Fair	1.57 (1.22,2.00)	0.000	
Poor	1.62 (1.17,2.24)	0.004	

**adjusted for age, gender, LOTE and educational attainment*

6. Discussion and implications

The focus of this paper is on the interplay between social determinants, co-morbidities and the level of gambling problems (PGSI score) in gamblers. Non-gamblers were excluded from the analysis. The purpose was to investigate a range of possible determinants (for example - physical, mental health conditions, smoking, alcohol, socio-demographics) to indicate which showed the strongest association with levels of gambling problems. The analysis is underpinned by a public health approach which views problem gambling as part of a gambling continuum and explores the broader personal, social, economic and environmental as well as biological determinants of gambling problems.

Technical Report Four builds on the findings from the previous three reports. It describes the detailed multivariate analysis of the relationship between gambling problems (PGSI score) and the determinants of socio-demographics, and comorbidities. Many of these determinants are inter-related. It is important to understand which determinants best describe the association with gambling problems taking into account other important determinants. These cross-sectional analyses were performed on the responses from gamblers only. Non-gamblers were excluded.

Assumptions were not made about temporality between the determinants and gambling problems. Comorbidities were essentially concurrent with the gambling problems which were measured over the previous 12 months. The comorbidities studied included past year smoking and alcohol use, current physical and mental health, and past four weeks feelings of psychological distress.

This multivariate analysis investigated which characteristics of the determinants were associated with an increase (more gambling problems) or a decrease (less gambling problems) in the PGSI score, having taken into account other important determinants. Determinants that best explain the level of gambling problems are identified as well as the size of the effect of different characteristics.

Models were developed with logical groupings of determinants before the final model was developed. The logical groupings included:

- Socio-demographics multivariate model
- Smoking and alcohol use and abuse multivariate model
- Physical and mental health, and health conditions multivariate models
- Final comorbidities multivariate model

Socio-demographics model

This discussion about the socio-demographics model was included in the Technical Report Three – Multivariate models of trauma and social capital. It is also relevant to the development of the comorbidities model so is repeated in this report.

Socio-demographic determinants were not the best determinants of gambling problems. In the existing literature many socio-demographic determinants have been linked with problem gambling. Socio-demographics are probably the most frequently collected variables across all gambling studies. This is particularly true for prevalence studies, in which basic demographic details are used in population prevalence studies to weight the sample to the population. The frequency of their collection and reporting has resulted in their domination of the risk factor list, out of proportion to their real contribution to gambling problems. In the univariate analysis of *The Victorian Gambling Study* reported in Technical Report Two, the model fit statistics indicate that the PGSI score was better explained by the variation in other determinants such as mental health, number of life events and some individual life events, self-reported health, smoking and alcohol, and some social capital indicators than the socio-demographic determinants.

The determinants of age, gender, whether a language other than English (LOTE) is spoken at home and educational attainment produced the best socio-demographic model for gambling problems. While many determinants were tested in the univariate analysis only age, gender, LOTE and occupation showed model fit statistics that were better than the null model. In the multivariate model it was educational attainment rather than occupation that proved to be an improvement to the age, gender and LOTE model. Model fit statistics showed a BIC' of -47.7.

The gambling problems risk factors of male gender, low educational attainment younger age are frequently reported in the literature although other age groups have been identified. The results for ethnicity or racial identity as risk factors are more varied in Australia and elsewhere. The 2003 Victorian prevalence study found problem gamblers were more often male, of low educational attainment and those whose main language at home was not English however the age group at risk was 39 to 64 years (The Centre for Gambling Research: Australian National University 2004). Recent Australian studies have all found that male gender and lower educational attainment are linked with problem gambling (Davidson and Rodgers 2009; Department of Justice and Attorney-General 2012; Sproston, Hing and Palankay 2012; Office for Problem Gambling 2013). Younger age group was identified as a determinant in NSW (Sproston, Hing and Palankay 2012), in Queensland (Department of Justice and Attorney-General 2012) and the ACT (Davidson and Rodgers 2009) but not in South Australia (Office for Problem Gambling 2013). Being Australian born was identified as a risk factor in the ACT (Davidson and Rodgers 2009) but not in NSW (Sproston, Hing and Palankay 2012), Queensland (Department of Justice and Attorney-General 2012) or South Australia (Office for Problem Gambling 2013).

Male gender followed by younger age are the most frequently identified risk factors for problem gambling (Williams, Volberg and Stevens 2012). The same review of 202 studies reported minority or immigrant groups (25) and lower education than average (65) as risk factors. Recent prevalence studies from Sweden and New Zealand, using multivariate analysis, found being male, of younger age group, with low level of education and belonging to an ethnic group or being born outside Sweden as predictors of problem gambling (Abbott, Romild and Volberg 2013; Abbott, Bellringer, Garrett and Mundy-McPherson 2014). In Canada the LLLP study found male gender to be a risk factor however the QLS study did not (el-Guebaly, Casey, Currie, Hodgins et al. 2015; Williams, Hann, Schopflocher, West et al. 2015). Both Canadian studies found that being non-Caucasian was a correlate of problem gambling in the univariate analysis. In New Zealand, the New Zealand deprivation index, religion and labour force statistics were linked to problem gambling. Sweden found big city residence and civic status (household composition) as risk factors.

Smoking and alcohol model

Addition of smoking and alcohol use and abuse to the socio-demographic model showed a strong improvement over socio-demographics only. In the univariate analysis smoking over the previous twelve months was a strong explanatory determinant and alcohol abuse or dependence was a moderate explanatory determinant. The model fit statistics improved from -47.7 to -177.0.

After adjustment for socio-demographics, past year smokers tended to have a PGSI of about two times those who did not smoke. After adjustment for socio-demographics, those with signs of alcohol abuse or dependence tended to have a PGSI of 1.87 times whereas drinkers with no signs of alcohol abuse or dependence tended to have a reduced or 0.81 times PGSI score compared with those who did not drink.

Gambling problems and gambling frequency have been shown to be associated with smoking and alcohol use or abuse in other Australian prevalence studies. The 2003 Victorian prevalence study found that 44% of problem gamblers consumed alcohol or drugs while gambling compared with 36per cent of non-problem regular gamblers (The Centre for Gambling Research: Australian National

University 2004). In New South Wales 41 per cent of moderate risk and problem gamblers reported drinking alcohol most of the time while gambling compared with 15per cent of non-problem gamblers. Around 14per cent of moderate risk and problem gamblers reported feeling they had an alcohol or drug problem compared with 3 per cent of non-problem gamblers (Sproston, Hing and Palankay 2012). In Queensland 40 per cent of problem gamblers reported they felt they had an alcohol or drug problem compared with 8.7 per cent low-risk gamblers (Department of Justice and Attorney-General 2012). In South Australia, moderate risk and problem gamblers reported more substance use while gambling particularly alcohol 65 per cent compared with 34 per cent in all past year gamblers. Tobacco use was also increased in moderate risk and problem gamblers, 30 per cent reported daily smoking compared with 14 per cent of all gamblers (Office for Problem Gambling 2013). Only the ACT reported smoking and hazardous/harmful alcohol consumption adjusted for age and gender. About 40 per cent of moderate risk and problem gamblers were smokers compared with 4.6 per cent of non-gamblers and 23 per cent of moderate risk and problem gamblers reported harmful/hazardous alcohol consumption compared with 3.2 per cent of non-gamblers (Davidson and Rodgers 2009).

International prevalence studies are indicative of links between problem gambling and tobacco, alcohol use and substance abuse. Of the 202 prevalence studies reviewed by Williams, Volberg and Stevens (2012), 13 studies showed links with substance abuse in and 12 with tobacco use although it is not clear how many of the studies included questions about alcohol and tobacco in their surveys. Another meta-analysis of general population studies by Lorains, Cowlishaw and Thomas (2011) found that problem and pathological gamblers had high rates of nicotine dependence (60 per cent) and substance use disorder (5 7per cent) however they also report that across 11 studies the range of results for prevalence in problem gamblers varied for alcohol use disorders between 10-49 per cent and nicotine dependence, 15-76 per cent. Another review study with even stricter inclusion criteria identified alcoholism as a probable risk factor but not a well-established factor (Johansson, Grant, Kim, Odlaug et al. 2009).

A recent systematic review and meta-analysis of 36 studies of psychiatric comorbidities in treatment seeking problem gamblers identified high rates (both 75 per cent) of current and lifetime comorbid disorders. Highest mean prevalence was nicotine dependence (56 per cent), alcohol abuse (18 per cent) and dependence (15 per cent), and cannabis use disorder (11 per cent). They caution that although these are all from treatment settings there is a great degree of variability between the studies. The variability was not explained by problem gambling severity, treatment facility type or study jurisdiction (Dowling, Cowlishaw, Jackson, Merkouris et al. 2015).

The National Comorbidity Survey Replication (NCS-R) showed that pathological gamblers have higher risk of substance use disorder (5.5 times) (Kessler, Hwang, LaBrie, Petukhova et al. 2008). A large psychiatric epidemiological survey, the National Epidemiological Survey on Alcohol and Related Conditions (NESARC) showed that, compared with non-gamblers, pathological gamblers have higher risk of lifetime alcohol misuse (6 times) and substance use (4.4) (Petry, Stinson and Grant 2005). In Canada tobacco use was higher in problem gamblers in the LLLP study 59 per cent and the QLS study 54per cent compared with 16 per cent and 20 per cent respectively in non-gamblers (el-Guebaly, Casey, Currie, Hodgins et al. 2015; Williams, Hann, Schopflocher, West et al. 2015).

Physical health conditions model

Addition of only self-rated health and obesity, but not lung conditions including asthma, to the socio-demographic model showed a strong improvement over socio-demographics only. In the univariate analysis participants' self-rated health was a strong explanatory determinant, obesity was a moderate and lung conditions including asthma was a weak determinant. As a person's self-rated health decreased the PGSI score increased. The model fit statistics improved from -47.7 to -193.8.

After adjustment for socio-demographics and obesity, the PGSI increased for those who rated their health as poor by 3.44 times, as fair by 2.30 times compared with those who rated their health as excellent. After adjustment for socio-demographics and self-rated health, those with obesity tended to have a PGSI of 1.66 times those who did not.

Gambling problems and physical health has not been studied well in Australia or overseas. In Australian prevalence studies only self-rated health was assessed. In South Australia fair/poor self-rated health was almost twice as prevalent: 26 per cent in moderate risk and problem gamblers compared to14 per cent all adults (Office for Problem Gambling 2013). The ACT results were 13 per cent in moderate risk and problem gamblers compared to 9per cent all adults (Davidson and Rodgers 2009). Persons with and without pathological gambling were studied to assess their self-reported chronic medical conditions, medication usage, lifestyle choices, health care utilization, quality of life variables, and body mass index (BMI). This American study showed that pathological gambling is associated with obesity, chronic medical conditions, poor lifestyle choices, worse quality of life, and the use of costly forms of medical care. (Black, Shaw, McCormick and Allen 2013). Problem gambling was shown to be associated with unhealthy behaviours and obesity in a Danish study (Algren, Ekholm, Davidsen, Larsen et al. 2014). Adults from the NESARC 2001-2002 were evaluated for the relationship between gambling disorders and health problems. Gambling severity was found to be related to behavioural risk factors such as BMI as well as alcohol abuse and dependence, nicotine dependence, and mood and anxiety disorders (Morasco, Pietrzak, Blanco, Grant et al. 2006).

Mental Health models

The mental health measures, the Kessler 10 model and combined anxiety/depression model provide the strongest models to explain the variation in the PGSI score out of all the determinants studied in this secondary analysis. The level of psychological distress, the Kessler 10 score or the Kessler 10 as a categorical variable, exhibited the strongest explanation of the variation in the PGSI score. A higher Kessler 10 score or worse category were associated with more gambling problems. Addition of the Kessler 10 score to the socio-demographics model greatly improved the model fit from -47.7 to -399. Addition of the Kessler 10 as a categorical variable to the socio-demographics model greatly improved the model fit from -47.7 to -291. Models that included the Kessler 10 could not be improved by addition of current depression or current anxiety. However, anxiety and depression are also strong explanatory determinants of PGSI score. Addition of current depression and current anxiety to the socio-demographics model greatly improved the model fit from -47.7 to -239.

After adjustment for socio-demographics, the PGSI increased by 1.11 times for each unit increase in the Kessler 10 score. If the Kessler 10 was analysed as a categorical variable and after adjustment for socio-demographics, the PGSI increased by 7.60 times for those with very high distress, by 4.70 times for those with high distress and 2.69 times for those with moderate distress compared with those with low levels of distress. In the second model, after adjustment for socio-demographics, the PGSI increased by 2.57 times for those who reported depression and by 1.78 times for those who reported anxiety compared with those who did not.

The evidence is growing about the relationship between gambling problems and other psychiatric conditions (Petry 2005). Links between mental health and gambling problems have been explored in some Australian prevalence studies. In the 2003 Victorian prevalence study problem gamblers reported higher rates of being severely depressed (59per cent) compared to 13.1 per cent of non-problem regular gamblers over the last 12 months and 10per cent reported being severely depressed because of their gambling (The Centre for Gambling Research: Australian National University 2004). Problem gamblers (11.5 per cent) more often report seriously thinking about or attempting suicide than non-problem gamblers (1.1 per cent) (The Centre for Gambling Research: Australian National University 2004). Recent prevalence studies in Australia report 47 per cent of problem gamblers as seriously depressed compared with 20per cent of low risk gamblers in Queensland (Department of

Justice and Attorney-General 2012) and 61 per cent of problem gamblers compared with 12 per cent of non-gamblers as having poor scores on the Mental Health Index 5 (Davidson and Rodgers 2009).

Studies around the world have also explored the links between mental health and gambling problems. In the review of 202 international prevalence studies (Williams, Volberg and Stevens 2012), only a small number of studies reported associations mental health problems (12), and poor physical health and/or disabled (9) although the review does not state in how many of the studies were these comorbidities considered. Another meta-analysis of general population studies by Lorains, Cowlishaw and Thomas (2011) found that problem and pathological gamblers had high rates of any mood disorder (38 per cent) and any type of anxiety (38 per cent) however they also report that across 11 studies the range of results for prevalence in problem gamblers varied for major depression (9-47 per cent), bipolar disorder/manic episodes (3-48 per cent), any anxiety disorder (14-60 per cent), generalised anxiety disorder (8-30 per cent), any mood disorder (12-56 per cent) and associated personality disorder (23-45 per cent). Another review study with even stricter inclusion criteria comorbid disorders (Obsessive compulsive disorder (OCD), drug abuse) as well established risk factors (3 or more well performed studies) and depression, anxiety and alcoholism as probable risk factors (1 or 2 well performed studies) (Johansson, Grant, Kim, Odlaug et al. 2009).

A recent systematic review and meta-analysis of 36 studies of psychiatric comorbidities in treatment seeking problem gamblers identified high rates (both 75 per cent) of current and lifetime comorbid disorders. Highest mean prevalence was nicotine dependence (56 per cent) and major depressive disorder (30 per cent). Alcohol abuse (18per cent) and dependence (15 per cent), social phobia (15 per cent), GAD (14per cent), panic disorder (14 per cent), post-traumatic stress disorder (12 per cent), cannabis use disorder (11per cent), attention deficit hyperactivity disorder (8 per cent), adjustment disorder (9 per cent), bipolar disorder (9 per cent) and OCD (8 per cent). They caution that although these are all from treatment settings there is a great degree of variability between the studies. The variability was not explained by problem gambling severity, treatment facility type or study jurisdiction (Dowling, Cowlishaw, Jackson, Merkouris et al. 2015).

Two large American studies have explored the relationship between psychiatric disorders and pathological gambling. The National Comorbidity Survey Replication (NCS-R) showed that pathological gamblers have higher risk of substance use disorder (5.5 times), mood disorder (3.7 times) and anxiety (3.1 times) (Kessler, Hwang, LaBrie, Petukhova et al. 2008). A large psychiatric epidemiological survey, the National Epidemiological Survey on Alcohol and Related Conditions (NESARC) showed that, compared with non-gamblers, pathological gamblers have higher risk of lifetime alcohol misuse (6 times), substance use (4.4), major depression (3.3), dysthymia (3.3), Generalised Anxiety Disorder (3.1) and panic disorders (4.2) (Petry, Stinson and Grant 2005).

Final comorbidities models

Two final models were developed to describe the relationship between gambling problems and comorbidities. They are designated as the Kessler 10 model and the depression/anxiety model for convenience.

The Kessler 10 model

The model that demonstrated the best model fit (BIC' -478), consisted of the Kessler 10 score, past year smoking, alcohol use and abuse, and obesity. The Kessler 10 score was found to be a better explanatory factor than anxiety and depression were. In other words a gamblers' level of general psychological distress over the previous four weeks demonstrated a stronger relationship with the PGSI score than current anxiety and/or depression. Addition of information on behavioural risk factors of past year smoking, alcohol use and abuse, and obesity improved the model over the Kessler 10

score alone. Presence of any of these factors was linked with increased PGSI score (or more gambling problems).

It is interesting to note that once the full model was developed that only gender and LOTE contributed to the comorbidities model, whereas age and educational attainment did not add to the model fit.

The depression/anxiety model

The second model which demonstrated a strong model fit (BIC' -358), consisted of anxiety, depression, past year smoking, alcohol use and abuse, obesity and self-rated health. While the Kessler 10 score was found to be a better explanatory factor than anxiety and depression. When the Kessler 10 score was excluded from the model, current anxiety and/or depression were found to demonstrate a strong relationship with the PGSI score. Addition of information on behavioural risk factors of past year smoking, alcohol use and abuse, and obesity improved the model over anxiety/depression alone as it did in the Kessler 10 model. Presence of any of these factors was linked with increased PGSI score (or more gambling problems). Also an additional factor, self-rated health, improved the depression/anxiety model but not the Kessler 10 model. As a gamblers' self-rated health decreased the PGSI increased.

It is interesting to note that once the full model was developed that only gender and LOTE contributed to the comorbidities model, whereas age and educational attainment did not add to the model fit.

Strengths and weaknesses

The strength of the report is that *The Victorian Gambling Study* is a large jurisdiction prevalence study that was well conducted.

A limitation of the study is those of most jurisdiction-wide gambling surveys. They are population based but miss subgroups who may be at greater risk of problem gambling, such as those who are homeless or in prisons, hospital and mental health institutions.

This is a cross sectional study design and therefore demonstrates association rather than indicate causality.

Using the selected analytical method, which treats the PGSI score as count data, is both a strength and a weakness. The strength is that it uses the full array of information from the PGSI score rather than reduce the score to four or five categories. The limitation is that there is an assumption that an increase at the lower end of the scale is equivalent to an increase in the higher end of the scale.

This study is limited by the measures of the socio-demographics and comorbidities as collected in the CATI survey of Victorian Gambling Study. Any lack of evidence of association may be the result of an inappropriate or poor measure.

What does this study add?

Further analysis of the relationship between gambling problems and determinants of socio-demographics and comorbidities was conducted. This multivariate analysis identified which of these determinants were associated with gambling problems and the importance of these determinants when other important determinants are considered.

Gambling problems were associated with socio-demographic determinants of younger age, male gender, speaking a language other than English at home (LOTE) and lower educational achievement however this association was not as strong or important as many of the comorbidities. In fact once the

other comorbidities were included in the model only gender and LOTE remained important determinants of gambling problems.

Individuals who report higher levels of psychological distress (Kessler 10) over the four weeks prior to the CATI survey were more likely to have increased gambling problems. This relationship was strongest of all tested in this secondary analysis. Addition of depression and anxiety to the Kessler 10 model do not improve the model.

Exploration of current depression and anxiety, rather than psychological distress, showed that these factors were also strongly linked with gambling problems. Therefore a second model, the depression/anxiety model was developed which excluded the psychological distress factor.

Addition of information on behavioural risk factors of past year smoking and alcohol use and abuse, improved both models. Presence of any of these factors was linked with further increases PGSI score (or more gambling problems).

Similarly, when obesity was added, it improved both models so its presence was linked with further increases in PGSI score (or more gambling problems).

Addition of self-rated health improved the depression/anxiety model but the Kessler 10 model. In the depression/anxiety model, as the self-rated health worsened the effect on the PGSI score (or gambling problems) further increased. It likely that there is more correlation between the psychological distress and self-rated health than there is between depression and anxiety, and self-rated health. Therefore addition of self-rated health adds little to the Kessler 10 model whereas it adds another dimension to the depression/anxiety model.

Implications

When considering the implications of the findings it is important to consider also the timespan implied in the survey questions. The level of psychological distress over the previous four weeks, the Kessler 10 score, is the most important factor associated with gambling problems. It is even more important than current depression and anxiety which also result in a strong model of factors influencing the level of gambling problems. Addition of anxiety and depression to model one, did not improve the Kessler 10 model fit statistics. These models demonstrate the importance of mental health issues, high levels of psychological distress, anxiety and depression experienced by gamblers with higher levels of problems. Past year smoking and alcohol use and abuse provide further explanatory power to both models. Problem gambling is now defined as a substance abuse disorder in the DSM-V. The findings of this study indicate that use or abuse of these other substances, are associated with additional risk for higher levels of gambling problems. Obesity also provides further explanatory power to both models, after taking into account mental health and substance use. Self-rated health improved the second model but not the first model which contained the Kessler 10 score. It may be the self-rated health has captured some of the psychological distress measured by the Kessler 10.

Appendix One: Single parameters adjusted for socio-demographics

This section contains the univariate models unadjusted and adjusted for key socio-demographics.

Smoking and alcohol

Exploration of the **smoking and alcohol** of gamblers to predict PGSI score using the negative binomial regression showed that any measure of smoking and alcohol abuse but not having consumed alcohol in past year are strongly associated with higher PGSI scores. The results of the univariate regressions on the best measure of smoking and alcohol are shown in Table 7.

Those who reported smoking over the past year tended to have a 2.35 (2.01, 2.76) times higher PGSI score than non-smokers, after adjusting for age, gender, LOTE and educational attainment. Those with a CAGE category for clinical alcohol abuse of high level, moderate level or had signs of clinical alcohol abuse tended to have a 3.94 (1.51,10.20) times, 2.34 (1.54,3.56) times and 1.75 (1.26,2.44) times respectively after adjusting for age, gender, LOTE and educational attainment.

Table 7 Regression models for smoking and alcohol

	Univariate models			**Adjusted models***		
	IRR (CI)	**p-value**	**BIC'**	**IRR (CI)**	**p-value**	**BIC'**
Past year smoking	2.33 (1.99,2.73)	0.000	-107.6	2.35 (2.01,2.76)	0.000	-147.1
CAGE2 clinical alcohol abuse categories			-51.2			-100.9
Non-drinker	ref			ref		
No signs of alcohol abuse	0.71 (0.59,0.86)	0.001		0.79 (0.65,0.96)	0.019	
Alcohol abuse or dependence	1.79 (1.35,2.37)	0.000		2.03 (1.53,2.70)	0.000	

**each analysis adjusted for gender, age, LOTE and education*

Physical Health conditions

Exploration of physical health conditions to predict PGSI score using the negative binomial regression showed that many measures of physical health are associated with PGSI scores. The strongest association was seen with self-reported health status and the effect on PGSI score increased as the reported health worsened. After adjustment for age, gender, LOTE and education and compared with those who reported their health as 'excellent', the PGSI score increased by 1.67 (1.36,2.06) times for those reporting 'good' health; by 2.60 (2.04,3.32) times for those reporting only 'fair' health and by 3.94 (2.87,5.39) times who reported their health as poor. Each unit increase in number of physical health conditions was associated with an increase in the PGSI score of 1.45 (1.32,1.58) times. Increases in PGSI score for other conditions includes by 2.24 (1.80,2.80) times for obesity, by 1.77 (1.42,2.20) times for lung conditions including asthma, by 1.41 (1.19,1.67) times for heart conditions, high blood pressure or high cholesterol and by 1.45 (1.08,1.94) times for diabetes.

Table 8 Regressions on physical health conditions

	Univariate model			Adjusted model*		
	IRR (CI)	p-value	Model BIC'	IRR (CI)	p-value	Model BIC'
Self-reported health status						
			-114.6			-173.3
Excellent	ref					
Very good	0.96 (0.78,1.18)	0.718		0.94 (0.77,1.16)	0.609	
Good	1.66 (1.35,2.04)	0.000		1.67 (1.36,2.06)	0.000	
Fair	2.53 (1.98,3.24)	0.000		2.60 (2.04,3.32)	0.000	
Poor	3.75 (2.72,5.16)	0.000		3.94 (2.87,5.39)	0.000	
1. Heart conditions, high blood pressure or high cholesterol						
Yes	1.18 (1.01,1.39)	0.035	3.9	1.41 (1.19,1.67)	0.000	-55.5
2. Diabetes						
Yes	1.33 (0.99,1.78)	0.056	4.6	1.45 (1.08,1.94)	0.011	-46.0
3. Cancer						
Yes	1.18 (0.76,1.82)	0.455	7.9	1.46 (0.95,2.24)	0.081	-42.5
4. Lung conditions including asthma						
Yes	1.70 (1.36,2.12)	0.000	-15.8	1.77 (1.42,2.20)	0.000	-68.3
7. Obesity						
Yes	2.11 (1.68,2.64)	0.000	-38.9	2.24 (1.80,2.80)	0.000	-97.4
Physical health condition (1,2,3,4 or 7) count						
Count	1.31 (1.20,1.42)	0.000	-33.3	1.45 (1.32,1.58)	0.000	-112.6

** Adjusted for age, gender and LOTE*

Note: Adjust No.4 lung conditions for smoking – not removing effect may need ever smoked?

Mental Health conditions

Exploration of mental health conditions to predict PGSI score using the negative binomial regression showed that all measures of mental health are associated with PGSI scores. Many of the mental health measures are the strongest of all the psychosocial aspects investigated in this study. The strongest association were seen, in order of strength of association: The K10, reporting depression or anxiety, depression, anxiety or considering suicide. After adjustments for age, gender and LOTE, the increases in PGSI score for each unit increase in K10 score are by 1.11 (1.09,1.12) times. After adjustments for age, gender, LOTE and educational attainment, the increases in PGSI score are by 2.17 (1.93,2.43) times for each increase in mental health conditions, by 3.50 (2.89,4.25) times for reported depression and by 3.23 (2.61,4.01) times for anxiety.

Table 9 Regressions for mental health conditions

	Univariate model			Adjusted model		
	IRR (CI)	**p-value**	**Model BIC'**	**IRR (CI)**	**p-value**	**Model BIC'**
K10 score	1.12 (1.10,1.13)	0.000	-360.8	1.11 (1.09,1.12)	0.000	-405.3
5. Depression						
Yes	3.53 (2.91,4.31)	0.000	-174.6	3.50 (2.89,4.25)	0.000	-226.6
6. Anxiety disorders						
Yes	3.35 (2.69,4.17)	0.000	-131.8	3.23 (2.61,4.01)	0.000	-176.0
Mental health condition (5 or 6) count						
Count	2.18 (1.93,2.45)	0.000	-194.3	2.17 (1.93,2.43)	0.000	-244.7

Physical and mental health conditions

After adjustments for age, gender, LOTE and educational attainment, the increases in PGSI score are by 2.06 (1.70,2.50) times for those reporting that disability that affected your day-to-day life and by 1.57 (1.28,1.91) times for those with other physical or mental health conditions.

Table 10 Regressions for mixed physical and mental health conditions

	Univariate model			Adjusted model		
	IRR	**p-value**	**Model BIC'**	**IRR**	**p-value**	**Model BIC'**
8. Any other physical or mental health conditions						
Yes	1.47 (1.20,1.80)	0.000	-6.5	1.57 (1.28,1.91)	0.000	-60.5
Disability that affected your day-to-day life						
Yes	1.91 (1.56,2.32)	0.000	-36.6	2.06 (1.70,2.50)	0.000	-97.7

Appendix Two: Relevant questions from survey

This appendix contains some of the questions as they were asked in the CATI survey.

Smoking and alcohol

Respondents were asked 'Have you smoked at all in the past 12mths?' (score 1. Yes or 2. No)

CAGE is an acronym for 'cut-down, annoyed, guilty, eye opener'.

CAGE four-item alcohol screen (2 or more = clinically significant alcohol abuse) (only if Q31.=Yes - drinks alcohol)

The next questions are being asked to help work out if there is any link between alcohol and gambling patterns in the community. May I ask ...

1. Have you ever felt you should cut down on your drinking? (1. Yes, 2. No)
2. Have people annoyed you by criticizing your drinking? (1. Yes, 2. No)
3. Have you ever felt bad or guilty about your drinking? (1. Yes, 2. No)
4. Have you ever had a drink first thing in the morning to steady your nerves or to get rid of a hangover (ie. An eye opener)? (1. Yes, 2. No)

CAGE 2 parameter was created which adds back in non-drinker category so use maximum number of participants.

Health conditions

Self-rated Health

Over the past 12mths, would you say that in general your health has been ... (prompt)

1. Excellent
2. Very good
3. Good
4. Fair
5. Poor

Health conditions

Which of the following health conditions do you currently have?

1. Heart conditions, high blood pressure or high cholesterol (Y/N)
2. Diabetes (Y/N)
3. Cancer (Y/N)

4. Lung conditions including asthma (Y/N)

5. Depression (Y/N)

6. Anxiety disorders (Y/N)

7. Obesity (Y/N)

8. Any other physical or mental health conditions (record) (Y/N)

Disability

Do you have a disability that affected your day-to-day life over the past 12mths?

1. Yes (If so, record _____)

2. No

Kessler-10 for non-specific psychological distress

The next questions are about how you have been feeling during the past 4wks. During the past 4wks, about how often did you feel...? (prompt items and scale - Would you say...? Start with > All of the time...)

1. Tired out for no good reason

2. Nervous

3. So nervous that nothing could calm you down

4. Hopeless

5. Restless or fidgety

6. So restless that you could not sit still

7. Depressed

8. That everything was an effort

9. So sad that nothing could cheer you up

10. Worthless

Appendix Three: Glossary

This appendix provides a glossary of the key terms in the document.

ABS
Australian Bureau of Statistics

Alcohol use and abuse
An alcohol use and abuse variable was derived by combining the alcohol over previous twelve months and the CAGE questions. This produced a variable consisting of three categories: No alcohol use over previous twelve months; alcohol use and no signs of abuse; and alcohol use with signs of abuse or dependence. See *CAGE*.

Association
Association refers to the statistical dependence between two variables, that is, the degree to which the rate of disease in persons with a specific exposure is either higher or lower than the rate of disease among those without that exposure. (Hennekens, Buring and Mayrent 1987) In statistical analysis, association is measured by correlation coefficient. See *correlate*.

BIC (Bayesian Information Criterion)
A model fit statistics using saturated model as a point of comparison. See *saturated model* and *model fit statistics*.

BIC'
An alternative form of Bayesian Information Criterion using null model with no independent variables as a point of comparison. See *null model* and *model fit statistics*.

BMI (Body Mass Index)
It is defined as the body mass divided by the square of the body height and is expressed in units of kg/m2. The BMI is usually use as an indicator of obesity or anorexia in population research.

CAGE
A brief screening tool for alcohol use and disorder. It measures patterns of drinking that results in harm to one's health, relationship problems or inability to perform work functions. See *Alcohol use and abuse*.

Case finding
Case finding in this document refers to the tendency to concentrate on the small number of 'cases' of problem gambling and ignore the impact of the large number of gamblers with lower levels of problems.

CATI (Computer Assisted Telephone Interviews)
CATI is a telephone surveying tool where telephone interviews are supported by a computer application. The interviewers follow a script promoted by an application and input the responses obtained into the application.

Cohort
A group of persons followed or traced over time.

Comorbidity
Condition(s) or disease(s) that exist in a study participant in addition to the index condition that is the subject of study (i.e. gambling). (Last 2001)

Confidence interval (CI)
A computed interval with a given probability (usually 95per cent) that the true value of the variable of interest (e.g. a mean, proportion or rate) is contained within that interval.

Confounders or confounding variables
A variable that can cause or prevent the outcome of interest, is not an intermediate variable and is associated with the factor under investigation (Last 2001).

Correlate
Two variables (for example, variable x and variable y) are correlated or associated when the two variables change according to each other. Negative correlation means x decreases when y increase and a positive correlation means x increase when y increase. A correlation coefficient (r) ranges from -1 to 1. While r = 0 indicates no correlation, r = -1 indicates perfect negative correlation and r = 1 indicates perfect positive correlation. Note that correlation detected in observed data can be a completely random observation and correlation does not imply causal relationship. See *association*.

Count data continuum
Count data is a form of numerical discrete data. All values consist of whole numbers. In the case of the PGSI score, the only possible values are whole numbers along the continuum between 0 and 27. Therefore only 28 values are possible.

Decile
One-tenth (e.g. of a population)

Determinants
A factor which decisively affects the nature or outcome of something (Oxford University Press 2015). Whether people are healthy or not, is determined by many factors relating to their circumstances and their environment. These factors have many names including determinants, indicators, risk factors, predictors and influencers.

Dichotomous
Dichotomous variables are nominal variables which have only two categories or levels. For example, if we were looking at gender, we would most probably categorize somebody as either "male" or "female".

DK/refused
Don't know/Refused

DSM-IV (Diagnostic and Statistical Manual of Mental disorders, fourth edition)
DSM-IV is a manual published by the American Psychiatric Association (APA) in 1994, describing all recognised mental health disorders at the time of publication. It is regarded as a handbook for mental health professionals to identify the features of a given mental disorder and distinguished the disorder from similar problems. The latest manual is DSM-V published in 2013.

EGM (Electronic gaming machine)
A slot machine that has three or more reels that spin when a button is pushed. Often referred to ‘poker machines’ or ‘pokies’ (Australia), ‘the slots’ (Canada) or ‘fruit machines’ (United Kingdom).

Epidemiology
The study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems.

Factor
A factor is an influence/effect that contributes to a health outcome.

GAD (Generalised Anxiety Disorder)
A psychological disorder that describe a disproportionate anxiety about several aspects of life, such as work, relationships, health and financial matters for a long period of time (Beyond Blue 2015a).

Gambling continuum
Gambling is considered a continuum disorder. The continuum varies from occasional non-problematic gambling to extreme over-involvement resulting in problems or harms for the gambler, and their family, friends and community.

HILDA
The Household, Income and Labour Dynamics in Australia (HILDA) Survey is a household-based panel study which began in 2001. It is a large longitudinal study.

IRR (Incidence Rate Ratio)
In regression analysis, IRR refers to the marginal change of the outcome variable in relation to a unit of change in a given exposure variable. For binary exposure variable, IRR refers the marginal change of the outcome variable in relation to the present of the exposure variable compared to the absence of the exposure variable.

Item response scale
Response options to questions or items can be designed so that the options describe variations in intensity or frequency of a characteristic along an increasing or decreasing scale.

Kessler Psychological Distress Scale (K10)
A measure of distress based on 10 questions about the anxiety and depression an individual has experienced in the previous four weeks (Kessler, Andrews, Colpe, Hiripi et al. 2002).

Life events
A list of significant events (e.g. death, marriage, divorce, new employment and others) used in *The Victorian Gambling Study*

LLLP (Leisure, Lifestyle, Life Cycle Project)
LLLP is a Canadian population longitudinal study conducted in Alberta, Canada between 2006 and 2011. The study aimed to 1) identify the normal patterns of continuity and discontinuity in gambling and problem gambling behaviours; 2) identify biopsychosocial variables and behaviour patterns that predict current and future problem gambling and 3) identify an etiological model of problem gambling that is best supported by the longitudinal findings. QLS was a very similar to a study conducted in the Quinte region of Ontario, Canada during the same time period. With overlapping of researchers involved in QLS and LLLP, a set of parallel analyses were conducted in both the studies for comparison. See *Quinte Study*.

LOTE (Language Other Than English)
In population surveys, the question “Do you speak a language other than English at home?” is usually used to identify people from a culturally and linguistically diverse (CALD) background.

Logistic regression
Statistical method for analysing data used when the outcome/dependent variable is dichotomous (e.g. yes/no, true/false).

- univariable: logistic regression using only one exposure/independent variable and a dichotomous outcome variable
- multiple: logistic regression using multiple exposure/independent variables and a dichotomous outcome variable

Longitudinal
A study that involves repeated observations of a population over a long period of time (usually years).

Meta-analysis
A meta-analysis is the use of statistical methods to summarise the results of systematic reviews by contrasting and combining results from different studies to identify patterns among study results

Model
In statistical analysis, a theoretical model is used to describe the observed data. A theoretical model usually features a specific distribution and a selection of criteria.

Model fit statistics
A collection of statistic indicators for models comparison. The indicators provide information on whether a model better describes the observed data when compared to another model. BIC' (Bayesian Information Criterion) was used as the model fit statistic in this report. See *BIC* and *BIC'*.

NCS-R (National Comorbidity Survey Replication)
A National Comorbidity Survey (NCS) was conducted in 1990-92 in order to assess the prevalence and correlates of DSM-III-R disorders in America. Ten years later, respondents of the NCS were reinterviewed in NCS-2. The NCS-2 conducted in 2001-02 aimed to study the patterns and predictors of the course of mental and substance use disorders and to evaluate the effects of primary mental disorders in predicting the onset and course of secondary substance disorders. (Harvard Medical School 2005)

Negative binomial regression
The negative binomial regression is a statistical method for analysing data when the outcome/dependent variable is count data (i.e. discrete and positive number). Negative binomial regression model assumes variances increases with means and therefore better describes over-dispersed data. (See *over-dispersed* and *Poisson regression*)

- univariate: negative binomial regression using only one exposure/independent variable and a count outcome variable
- multiple: negative binomial regression using multiple exposure/independent variables

NESARC (National Epidemiological Survey on Alcohol and Related Conditions)
The NESARC in a longitudinal study and the first wave of the study was conducted in 2001-02 by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) in America. The second wave of the study was conducted in 2004-05. The study included questions on past and current alcohol consumption, and the use of alcohol treatment services. It also asked the respondents questions on tobacco and illicit drug use as well as mental wellbeing. (National Institute on Alcohol Abuse and Alcoholism 2006).

Null model
A null model is a model without any independent/exposure variables apart from the intercept. It is usually used in model fit statistics to compare between models with and without fitted independent variables. This is to find out whether the fitted variables improve the model in describing the observed data compared to the intercept only model. See *BIC* and *model fit statistics*.

OCD (Obsessive Compulsive Disorder)
OCD is an anxiety disorder and people who suffer from the disorder feel the necessity to perform an obsession or compulsion to release their anxiety. (Beyond Blue 2015b)

OECD (Organisation for Economic Co-operation and Development)
The OECD was officially established on 30 September 1961 to facilitate the co-operation between countries, addressing the challenges facing global economy. There are 34 OECE member countries worldwide in 2015. (OECD 2015)

Outcome
In epidemiology the outcome variable is the main variable of interest in the study. It is also called the dependent variable whose presence or absence, or level of severity may be 'dependent' on a particular exposure or circumstance which are often referred to as independent variables. In this report the outcome of interest was the PGSI score and its level of severity was dependent on socio-demographics variables, comorbidities, and trauma and life events.

Over-dispersed
The observed the data is over-dispersed when the variance observed is greater than the mean in the theoretical model that used to describe the data. See *Poisson regression* and *negative binomial regression*.

Parameter
Parameter is usually unknown and is estimated from observed data through statistical method.

Poisson regression
The Poisson regression is a statistical method for analysing data which is used when the outcome/dependent variable is count data (i.e. a discrete and positive number). Poisson regression model assumes that the mean equals the variance. See *over-dispersed* and *negative binominal regression*.

P-value
Probability value, represented by *P*. The probability that a test statistic would be as extreme as or more extreme than observed if the null hypothesis were true (Last, 2001). See *Statistical significance*.

Predicting
In regression analysis, a selection of exposure/independent variables are fitted in a model to describe the outcome/dependent variable. In statistical terms, the independent variable "predicts" the dependent variable. However, this does not imply any causal relationship.

Problem Gambling Severity Index (PGSI) score
A score based on nine questions, from the Canadian Problem Gambling Index, which can be used to estimate an individual's gambling risk status in the preceding 12 months.

Psychological distress
Negative emotional states that impact on a person's level of functioning. In this study general psychological distress was measured using the 10 questions that make up the Kessler 10. See also *Kessler Psychological Distress Scale*.

Public health approach
This approach views problem gambling as part of a gambling continuum. It recognises that vulnerability to gambling problems are due to complex interplay between personal, social, economic and environmental as well as biological factors. It is a practice which focuses on improving the health of populations, that is, the health of groups or sub groups, rather than the health of individuals.

QLS (Quinte Longitudinal Study)
The QLS is a longitudinal prospective study of gambling and problem gambling conducted in the Quinte region of Ontario, Canada from 2006 to 2011. The study aimed to investigate the patterns of continuity and discontinuity in gambling and problem gambling over time, identify individual, social, and structural variables mediating the development of responsible gambling and problem gambling and examine the etiological model of gambling and problem gambling based on the study. The study also explored the implications of the study findings in the prevention of problem gambling. LLLP was a very similar study conducted in Alberta during the same time period. With overlapping of researchers involved in QLS and LLLP, a set of parallel analyses were conducted in both the studies for comparison. See *LLLP.*

Saturated model
A saturated model is a model with all the selected independent/exposure variables fitted. It is usually used in model fit statistics to compare between models with and without fitted independent variables. This is to find out whether the fitted variables improve the model in describing the observed data. See *null model* and *BIC*.

South Oaks Gambling Screen (SOGS)
A self-administered screen that contains 20 questions based on DSM-III criteria for pathological gambling (Lesieur and Blume 1987).

SEIFA (Australian Bureau of Statistics four indices of SocioEconomic Indexes For Areas)
SEIFA was developed by the ABS in order to rank areas in Australia according to relative socio-economic advantage and disadvantage, based on the five-yearly Census. The latest version of SEIFA 2011 consisted of four indexes: 1) Index of Socioeconomic Advantage and Disadvantage (IAD); 2) Index of Education and Occupation (IEO); 3) Index of Economic Resources (IER) and 4) Index of Socioeconomic Disadvantage (IRSD). Each index summarise a different subset of Census variables and focuses on a different aspect of socio-economic advantage and disadvantage. It is used in public health research, usually to examine the relationship between socio-economic disadvantage and various health and educational outcomes at the area rather than at the individual level. (Australian Bureau of Statistics 2013)

SEIFA IAD
Index of Socioeconomic advantage and Disadvantage. See *SEIFA*.

SEIFA IEO
Index of Education and Occupation. See *SEIFA*.

SEIFA IER
Index of Economic Resources. See *SEIFA*.

SEIFA IRSD
Index of Socioeconomic Disadvantage. See *SEIFA*.

Size of the effect
The magnitude of the difference between points of comparison in relation to an exposure or intervention.

Secondary analysis
Analysis undertaken on data from an existing database

Social capital
Social capital has been defined in many ways. It frequently refers to the features of social structures that make resources, advantages and opportunities available to individuals, and that can facilitate collective action. Most definitions of social capital are common in that they focus on networks among people that lead to cooperation and beneficial outcomes for all. Social capital affects health risk behaviour and, inversely, a lack of social capital can impair health. The association between strong social networks as a buffer to morbidity and mortality has been widely reported (Baum 2003; Lin, Smith and Fawkes 2014).

Social determinants of health
The social determinants of health (SDH) are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems. (World Health Organisation 2015)

Socio demographics
Socio-demographics in this study individual characteristics such as education, occupation, income, household type and area level characteristics such as residence in urban or rural regional areas or areas with high or low socioeconomic status.

STATA/SE 12
A statistical software to compute statistical analysis developed and licensed by StataCorp. (StataCorp 2011)

Statistical significance
A mathematical technique to measure whether the results of a study are likely to be true. Statistical significance is calculated as probability that an effect observed in a research study is occurring because of chance. Statistical significance is usually expressed as a P-value. The smaller the P-value, the less likely that the results are due to chance (and more likely that the results are true). Researchers generally believe the results are probably true if the statistical significance is a P-value less than 0.05 (P<.05).

Statistical test
A procedure that is intended to determine whether a hypotheses about the distribution of one or more variables should be rejected or accepted.

Swelogs (Swedish Longitudinal Study)
Swelogs is a prospective study of Swedish citizens aged 16-84 years at baseline in 2008 and who were follow for a further three waves. The main objective of this study was to estimate prevalence and incidence of problem and at-risk gambling. (Romild, Volberg and Abbott 2014)

Systematic review
A systematic review answers a defined research question by collecting and summarising all empirical evidence that fits pre-specified eligibility criteria. It is a critical assessment and evaluation of all research studies that address a particular clinical issue.

TAFE (Technical and Further Education)
TAFE refers to tertiary education providing vocational education and training in Australia.

Temporal
Relating to, or denoting, time

Variable
In statistical analysis, a variable refers to some unknown quantity fitted in a model. A model is used to describe and/or estimate the unknown quantities based on observed data. See model.

Variance
In statistics, variance refers to the variation between individual observations within a sample.

Weighted/unweighted
Adjustments or weightings are applied to the data to make it more representative of a broader population (such as the Victorian adult population). They are based on the combined probabilities of a person being selected in the survey. In *The Victorian Gambling Study*, the household selection probability, the intraregional selection probability and the population benchmark selection probability.

WHO HPR/HEP
World Health Organisation Division of Health Promotion, Education and Communications (WHO HPR/HEP 1998)

Appendix Four: References

Abbott, M., M. Bellringer, N. Garrett and S. Mundy-McPherson (2014). New Zealand 2012 National Gambling Study: Gambling Harm And Problem Gambling. Report Number 2.

Abbott, M., U. Romild and R. Volberg (2013). "Gambling and Problem Gambling in Sweden: Changes Between 1998 and 2009." Journal of Gambling Studies: 1-15.

Afifi, T. O., B. J. Cox, P. J. Martens, J. Sareen and M. W. Enns (2010). "The relation between types and frequency of gambling activities and problem gambling among women in Canada." Canadian Journal of Psychiatry 55(1): 21-28.

Algren, M. H., O. Ekholm, M. Davidsen, C. V. Larsen and K. Juel (2014). "Health behaviour and body mass index among problem gamblers: results from a nationwide survey." Journal of Gambling Studies: 1-10.

Australian Bureau of Statistics. (2013). "SEIFA." Retrieved September 22, 2015, from http://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa.

Baum, F. (2003). The new public health, Oxford University Press.

Beyond Blue. (2015a). "Generalised Anxiety Disorder." Retrieved September 22, 2015, from https://www.beyondblue.org.au/the-facts/anxiety/types-of-anxiety/gad.

Beyond Blue. (2015b). "Obsessive Compulsive Disorder." Retrieved September 22, 2015, from https://www.beyondblue.org.au/the-facts/anxiety/types-of-anxiety/ocd.

Billi, R., C. Stone, M. Abbott and K. Yeung (2014). "*The Victorian Gambling Study* (VGS) a Longitudinal Study of Gambling and Health in Victoria 2008–2012: Design and Methods." International Journal of Mental Health and Addiction: 1-23.

Billi, R., C. A. Stone, P. Marden and K. Yeung (2014). *The Victorian Gambling Study*: A longitudinal study of gambling and health in Victoria, 2008-2012. Victoria, Australia, Victorian Responsible Gambling Foundation.

Black, D. W., M. Shaw, B. McCormick and J. Allen (2013). "Pathological Gambling: Relationship to Obesity, Self-Reported Chronic Medical Conditions, Poor Lifestyle Choices, and Impaired Quality of Life." Compr Psychiatry 54(2): 97-104.

Crockford, D., J. Quickfall, S. Currie, S. Furtado, O. Suchowersky and N. El-Guebaly (2008). "Prevalence of problem and pathological gambling in Parkinson's disease." Journal of Gambling Studies 24(4): 411-422.

Currie, S. R., D. C. Hodgins and D. M. Casey (2013). "Validity of the Problem Gambling Severity Index interpretive categories." Journal of gambling studies 29(2): 311-327.

Davidson, T. and B. Rodgers (2009). "Survey of the nature and extent of gambling, and problem gambling, in the Australian Capital Territory." Australian National University: Canberra.

Department of Justice and Attorney-General (2012). Queensland Household Gambling Survey 2011-12. Queensland.

Dowling, N. A., S. Cowlishaw, A. C. Jackson, S. S. Merkouris, K. L. Francis and D. R. Christensen (2015). "Prevalence of psychiatric co-morbidity in treatment-seeking problem gamblers: A systematic review and meta-analysis." Australian and New Zealand Journal of Psychiatry.

el-Guebaly, N., D. M. Casey, S. R. Currie, D. C. Hodgins, D. P. Schopflocher, G. J. Smith and R. J. Williams (2015). The Leisure, Lifestyle, & Lifecycle Project (LLLP): A Longitudinal Study of Gambling in Alberta. Final Report for the Alberta Gambling Research Institute. .

Harvard Medical School. (2005). "National Comorbidity Survey." Retrieved September 22, 2015, from http://www.hcp.med.harvard.edu/ncs/.

Hennekens, C. H., J. E. Buring and S. L. Mayrent (1987). Epidemiology in medicine, Boston: Little Brown and Company, 1987.

Johansson, A., J. E. Grant, S. W. Kim, B. L. Odlaug and K. G. Götestam (2009). "Risk factors for problematic gambling: a critical literature review." Journal of gambling studies / co-sponsored by the National Council on Problem Gambling and Institute for the Study of Gambling and Commercial Gaming 25(1): 67-92.

Kessler, R. C., G. Andrews, L. J. Colpe, E. Hiripi, D. K. Mroczek, S.-L. Normand, . . . A. M. Zaslavsky (2002). "Short screening scales to monitor population prevalences and trends in non-specific psychological distress." Psychological Medicine 32(06): 959-976.

Kessler, R. C., I. Hwang, R. LaBrie, M. Petukhova, N. A. Sampson, K. C. Winters and H. J. Shaffer (2008). "DSM-IV pathological gambling in the National Comorbidity Survey Replication." Psychological Medicine 38(09): 1351-1360.

Last, J. M. (2001). A dictionary of epidemiology, Oxford Univ Press.

Lesieur, H. R. and S. B. Blume (1987). "The South Oaks Gambling Screen (SOGS): a new instrument for the identification of pathological gamblers." Am J Psychiatry 144(9): 1184-1188.

Lin, V., J. Smith and S. Fawkes (2014). "Public Health Practice in Australia."

Long, J. S. and J. Freese (2000). "Scalar Measures of Fit for Regression Models." Stata Technical Bulletin 56: 34-40.

Long, J. S. and J. Freese (2006). Regression models for categorical dependent variables using Stata. College Station, TX, Stata press.

Lorains, F. K., S. Cowlishaw and S. A. Thomas (2011). "Prevalence of comorbid disorders in problem and pathological gambling: systematic review and meta-analysis of population surveys." Addiction 106(3): 490-498.

Morasco, B. J., R. H. Pietrzak, C. Blanco, B. F. Grant, D. Hasin and N. M. Petry (2006). "Health problems and medical utilization associated with gambling disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions." Psychosomatic Medicine 68(6): 976-984.

National Institute on Alcohol Abuse and Alcoholism. (2006). "National Epidemiological Survey on Alcohol and Related Conditions." Retrieved September 15, 2015, from http://pubs.niaaa.nih.gov/publications/AA70/AA70.htm.

OECD. (2015). "History - OECD." Retrieved September 22, 2015, from http://www.oecd.org/about/history.

Office for Problem Gambling (2013). Gambling Prevalence In South Australia (2012). Social Research Centre. North Melbourne.

Oxford University Press. (2015). "Oxford dictionaries,." Retrieved 22 October 2015, from http://www.oxforddictionaries.com/definition/english/determinant.

Petry, N. M. (2005). Pathological gambling: Etiology, comorbidity, and treatment. Washington, DC, US, American Psychological Association.

Petry, N. M., F. S. Stinson and B. F. Grant (2005). "Comorbidity of DSM-IV pathological gambling and other psychiatric disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions." The Journal of clinical psychiatry(66): 564-574.

Queensland Treasury (2001). Queensland Household Gambling Survey. Queensland, Queensland Government.

Raftery, A. E. (1995). "Bayesian model selection in social research." Sociological methodology 25: 111-164.

Romild, U., R. Volberg and M. Abbott (2014). "The Swedish Longitudinal Gambling Study (Swelogs): design and methods of the epidemiological (EP-) track." Int J Methods Psychiatr Res: n/a-n/a.

Sproston, K., N. Hing and C. Palankay (2012). "Prevalence of gambling and problem gambling in New South Wales." Sydney: NSW Office of Liquor, Gaming and Racing.

StataCorp (2011). Stata Statistical Software: Release 12. College Station, TX: , StataCorp LP.

The Centre for Gambling Research: Australian National University (2004). 2003 Victorian Longitudinal Community Attitudes Survey. Gambling Research Panel Report No. 6. Melbourne, Gambling Research Panel.

WHO HPR/HEP. (1998). "Health promotion glossary." Retrieved 26 March 2015, from http://www.who.int/healthpromotion/about/HPR%20Glossary%201998.pdf.

Williams, R., R. Hann, D. Schopflocher, B. West, P. McLaughlin, N. White, . . . T. Flexhaug (2015). Quinte Longitudinal Study of Gambling and Problem Gambling. Report prepared for the Ontario Problem Gambling Research Centre. Guelph, Ontario.

Williams, R. J., R. A. Volberg and R. M. G. Stevens (2012). The Population Prevalence of Problem Gambling: Methodological Influences, Standardized Rates, Jurisdictional Differences, and Worldwide Trends. Retrieved on 27 January 2016 from Gambling Research Exchange Ontario website: http://greo.ca/sites/default/files/documents/Williams%20et%20al%282012%29The_population_prevalence_of_problem_gambling.pdf.

World Health Organisation. (2015). "Social determinants of health." Retrieved 22 October 2015, from http://www.who.int/social_determinants/en/.