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NEW ZEALAND NATIONAL GAMBLING STUDY: CORRESPONDENCE BETWEEN CHANGES IN GAMBLING AND GAMBLING RISK LEVELS AND HEALTH, QUALITY OF LIFE, AND HEALTH AND SOCIAL INEQUITIES

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EXECUTIVE SUMMARY

A plethora of cross-sectional studies have identified that problematic gambling is significantly associated with a variety of negative health, behavioural and sociologic factors. Conversely, there are far fewer reported studies of transitional relationships between problematic gambling and such factors. Previous cross-sectional and longitudinal analyses of the New Zealand National Gambling Study identified predictors of problem gambling onset and gambling risk level transitions but understanding of the connections between gambling risk level transitions and changes in various health and lifestyle behaviours over time had not been examined. Thus, in order to assess how changes in gambling risk levels are associated with changes over time in health, wellbeing, disability, deprivation and social connectedness, relevant data from the four data collection years (2012 to 2015) of the National Gambling Study were analysed using a Markov Modelling process. This statistical method is designed to understand transitional events in an individual's life, when that individual occupies one of a possible number of states at any given time.

The analyses identified several significant associations that were **more likely** to occur between gambling risk level transitions and changes in health and lifestyle behaviours, and some that were **less likely** to occur.

Starting gambling (i.e. changing from non-gambler to non-problem gambler) was significantly *more likely* to correspond with:
- Both reducing hazardous alcohol consumption and continuously drinking alcohol in a hazardous manner vs. never drinking alcohol hazardously
- Reducing tobacco smoking vs. never smoking tobacco.

However, starting gambling was significantly *less likely* to correspond with continuously having a chronic illness vs. not reporting a chronic illness during the study.

Stopping gambling (i.e. changing from non-problem gambler to non-gambler) was significantly *more likely* to correspond with repeatedly experiencing some level of deprivation vs. not experiencing deprivation during the study. However, stopping gambling was significantly *less likely* to correspond with:
- Continuously drinking alcohol in a hazardous manner vs. never drinking alcohol hazardously
- Continuously having a chronic illness or developing a chronic illness vs. not having a chronic illness during the study.

Transitioning into risky gambling (i.e. changing from non-problem gambler to low risk/moderate risk/ problem gambler) was significantly *more likely* to correspond with:
- Continuously smoking tobacco vs. never smoking tobacco
- Continuous low quality of life vs. average or higher quality of life
- Repeatedly experiencing one or more major life events in the prior year vs. no major events in prior year
- Starting to experience levels of individual deprivation vs. not experiencing deprivation during the study
- Stopping memberships of organised groups vs. continuously being a member of organised groups.

Transitioning into risky gambling was not significantly less likely to be associated with changes or stability in any factor.

Transitioning out of risky gambling (i.e. changing from low risk/moderate risk/problem gambler to non-problem gambler) was not significantly associated with changes or stability in any factor. However, it was significantly *less likely* to correspond with:

- Continuously drinking alcohol in a hazardous manner vs. never drinking alcohol hazardously
- Continuous low quality of life vs. average or higher quality of life.

Overall, the transition into risky gambling was the most likely to be associated with maintaining or starting several negative health and lifestyle factors. It is likely that other, unexamined factors (such as personality), might also have influenced some of the associations. More research is required to further understand transitions in gambling behaviour in relation to changes in health and lifestyle factors, and to inform public health policies.

BACKGROUND

Widely viewed as a socially acceptable recreational activity, most people partake in gambling activities without experiencing negative consequences. However, there is a substantial subset of people who experience significant gambling urges, addictive behaviour and negative consequences associated with problematic gambling. These negative consequences can be far-reaching, affecting individuals, their family and whānau, and communities.

More than two decades ago, Korn and Shaffer (1999) encouraged the adoption of a public health approach as a response to the growing gambling industry and gambling-related harms. Since then, a large number of prevalence studies have been conducted to examine patterns of gambling behaviour, identify risk and protective factors, and enhance understanding of coexisting mental health and addiction disorders (for reviews see Abbott & Clarke, 2007; Calado et al., 2016; Lorains et al., 2011). In more recent years, the interest in adopting public health approaches to gambling has grown (see e.g. Abbott 2020a, 2020b). A public health approach offers a broad perspective on gambling, recognising that there are physical and mental health, and social and economic costs as well as benefits for individuals, their family and whānau, and communities. Policy and intervention strategies are, therefore, developed to minimise harms while balancing the benefits gained from gambling.

Problematic gambling behaviour is increasingly recognised as non-linear, with most individuals experiencing transitions in and out of periods of problematic gambling (Luce et al., 2016; Mutti-Packer et al., 2017; Reith & Dobbie, 2013; Samuelsson et al., 2018; Williams et al., 2015). Researchers have recently focused on the assessment of gambling-related harms and determining the effects on health, quality of life and other health determinants. Epidemiological and clinical studies have found particularly high rates of coexistence between problematic gambling and other addictive, affective and personality disorders (e.g. Lorains et al., 2011; Petry, 2005; Petry et al., 2005; Rupcich et al., 1997). However, as research examining associations between problem gambling and coexisting health determinants is predominantly cross-sectional, the nature of these relationships is unclear. It is not known to what extent the various coexisting issues and correlates contribute to, or are consequences of, risky or problematic gambling behaviours. Additionally, the extent to which they might be a consequence of some shared underlying attribute, or attributes, is unclear.

The New Zealand National Gambling Study (NGS) is a nationally representative longitudinal survey of adults aged 18 years and older (Abbott et al., 2014a; Abbott et al., 2017). The NGS questionnaire included a wide range of measures on gambling participation, strategies, cognitions and attitudes; problem gambling and gambling harm; as well as other factors of health and wellbeing, psychological status, substance use/misuse, major life events, social capital/support and demographic information. As most of the measures were repeated in each data collection year, this has meant that changes over time, as well as factors predictive of change in gambling and problem gambling, could be identified (Abbott et al., 2017). The purpose of the NGS was to provide information on the prevalence, incidence, nature and effects of gambling in New Zealand over time.

Participants (N=6,251) were recruited in 2012 via face-to-face household recruitment and computer-assisted personal interviews. It was designed as a multi-stage, stratified, probability-proportional-to-size sample with over-sampling of Māori, Pacific people and Asian people, so that statistical analyses could be conducted on subsamples by ethnicity. In 2013, 3,745 participants were re-interviewed. An insufficient budget to re-contact all baseline participants contributed to the reduced sample. The third interview took place in 2014 when 3,115 participants were re-interviewed; 2,770 participants were interviewed in 2015.

To date, analysis of data from the NGS has focused on the prevalence and incidence of gambling, problem gambling and risky gambling, and their associations with a range of sociodemographic, health, wellbeing and other factors. The major focus was on their role as risk factors for commencing gambling and the development of risky and problematic gambling. Considered individually, deprivation, major life events, low quality of life, higher psychological distress, hazardous alcohol consumption, tobacco, cannabis and other drug use all predicted movement from non-problem gambling to risky or problematic gambling. When these factors were considered together in multivariate analyses, along with socio-demographic and gambling participation risk factors, deprivation, major life events, cannabis use and psychological distress were retained as independent risk factors. Māori and Pacific ethnicity and residence in low income households were also retained as independent risk factors, as were gambling frequently, spending large amounts of time and money gambling and participating in some forms of gambling including on electronic gaming machines (EGMs). For a detailed look at the previous findings from the NGS see Abbott et al. (2014a, 2014b, 2015a, 2015b, 2016, 2018a) and Bellringer et al. (2018, 2019).

In the previous NGS reports and related journal articles, these factors were examined cross-sectionally and prospectively to assess their role in predicting problem gambling onset and other transitions between gambling risk levels. The original purpose of the study was not to determine the degree to which gambling risk levels and health, quality of life and other factors change together across the three years of the study. Neither had analysis been extended to determine the degree to which changes in gambling risk levels affect health and quality of life. Thus, the current study was designed so that NGS data could be examined to assess how changes in gambling risk levels are associated with changes over time in health, wellbeing, disability, deprivation and social connectedness.

LITERATURE REVIEW

This chapter presents research literature exploring the association between gambling and health outcomes, quality of life and social inequities. First, gambling prevalence, problematic gambling and risk factors for problem gambling are examined. Next, gambling-related harms, health outcomes, quality of life and ethnicity/sociodemographic differences in the experiences of harms are discussed. Finally, the possible cyclical interaction between risk factors, problematic gambling, and gambling outcomes is discussed, providing a rationale for the current study.

Gambling prevalence

In the last three decades, there has been significant growth in gambling availability and participation in many countries (Abbott, 2017; Abbott & Volberg, 1996a; Armstrong et al., 2018; Markham & Young, 2015; Marshall, 1998). Alongside growth in the gambling industry, the first nationally representative study was conducted by Abbott and Volberg (1991) in New Zealand. Following this, prevalence studies have been conducted in numerous countries including Australia (Billi et al., 2014; Markham et al., 2017; Paterson et al., 2019); Canada (el-Guebaly et al., 2015; Williams et al., 2015); Finland (Salonen et al., 2015); Iceland (Olason et al., 2015); New Zealand (Abbott & Volberg 1996b; Abbott et al., 2014a); Spain (Legarda et al., 1992), Sweden (Abbott et al., 2014c, 2018b; Fröberg et al., 2015; Romild et al., 2014); the United Kingdom (Gambling Commission, 2019); and the United States of America (Welte et al., 2015). A review of prevalence studies concluded that most adults had gambled at least once in their life and there were more gamblers than non-gamblers (Calado & Griffiths, 2016). Researchers in New Zealand concluded that lifetime probable pathological and problem gambling prevalence have remained stable since 1999 (Abbott et al., 2014a, 2014b).

The New Zealand National Gambling Study (NGS) is one of only two nationally representative prospective studies of gambling and problem gambling (Abbott et al., 2017; Romild et al., 2014). These, and similarly designed jurisdictional studies, have advanced understanding of factors that precede and predict future problem gambling development (Abbott et al., 2018a). Gambling participation measures are generally the strongest predictors, including past problem gambling. In New Zealand, around two-thirds of people who become a problem gambler in any 12-month period are not new cases; they are relapsing (Abbott et al., 2018a).

Gambling participation ranges from occasional and recreational gambling to risky and problematic gambling. As outlined previously, most adults have participated in gambling (Kessler et al., 2008; Petry, 2005), and the past year rate of problem gambling ranges between 0.5% and 7.6% depending on country (Williams et al., 2012). In the 2012 NGS data collection year, 80% of adults (18 years and older) had participated in at least one gambling activity in the 12 months before data collection (Abbott et al., 2014a); 0.6% were categorised as problem gamblers, 1.7% were moderate risk gamblers, and 4.6% and 68% were low risk and non-problem gamblers, respectively. Of those who had gambled, 43% had participated in one or two gambling activities and 22% had participated in four or more activities (Abbott et al., 2014a). In 2015, the percentage of individuals who had gambled in the previous year was 75%; 0.2% of participants were problem gamblers, 1.8% were moderate risk gamblers, 4.6% were low risk gamblers and 68% were non-problem gamblers (Abbott et al., 2018a). The authors concluded that moderate risk/problem gamblers were more likely to gamble weekly (or more often), gamble on multiple activities (seven to nine), have higher levels of expenditure ($101 or more per month) and spend more than 60 minutes at a time gambling on electronic gaming machines (EGMs) (Abbott et al., 2018a).

Abbott et al. (2014a) highlighted that over the past 25 years, growth in commercial gambling has been unprecedented. The introduction or expansion of state lotteries and other lottery products often preceded the growth; however, jurisdictions where urban casinos and EGMs were introduced experienced particularly robust increases in gambling participation. In many countries, official gambling expenditure has levelled out or declined despite gambling activities being readily available and novel activities continuing to be introduced (Abbott et al., 2014a; Productivity Commission, 2010). In New Zealand, total gambling expenditure has remained around $2 billion per annum since it reached a peak in 2003; after adjusting for inflation, total expenditure has since decreased by 19%. However, New Zealand remains among the highest ranked countries for gambling expenditure per capita (The Economist, 2014). Nonetheless, despite overall gambling participation and expenditure levelling out or declining in New Zealand and other jurisdictions (Abbott, 2017; Abbott et al., 2014c; Abbott et al., 2015c; Hare, 2015), problem gambling and low risk and moderate risk gambling prevalence remained similar from 2012 to 2015 (Abbott et al., 2018a).

Problematic gambling

Gambling becomes problematic when an individual and/or their family and whānau, peers/colleagues, or the wider community experiences negative consequences because of the gambling behaviour. In 1980, a serious gambling problem was officially defined as a mental health disorder, initially classed as a disorder of impulse control in the Diagnostic and Statistical Manual of Mental Health Disorders (3rd edition; DSM-III). In the most recent edition of the DSM (DSM-5), problematic gambling is termed gambling disorder and is defined as "persistent and recurrent problematic gambling behaviour leading to clinically significant impairment or distress" (p. 586); gambling disorder is the only behavioural addiction within the category of Substance-Related and Addictive Disorders (American Psychiatric Association, 2013a, p. 585-588).

From a clinical perspective, gambling disorder has similarities in expression and aetiology with substance-related disorders and is considered a chronic and persistent condition (American Psychiatric Association, 2013b). According to the DSM-5, gambling disorder generally develops over time and there are two forms of disordered gambling, episodic and persistent. In episodic gambling, DSM-5 diagnostic criteria are met across multiple points in time with symptoms decreasing between time points. In persistent gambling, diagnostic criteria must be met continuously over multiple years. Some individuals experience spontaneous, and sometimes, long-term recovery.

Gambling disorder or problematic gambling has traditionally been considered a chronic, persistent and progressive disorder. However, a growing body of research, including longitudinal prevalence surveys, has demonstrated that the natural course of gambling behaviour is more likely to be inconsistent and episodic, and can change during the life course of an individual (e.g. Abbott et al., 2014c, 2018a; Billi et al., 2014; Blaszczynski & Nower, 2002; Reith & Dobbie, 2013; Slutske, 2006). For example, Blaszczynski and Nower (2002), proposed the Pathways Model of problem gambling development, rather than 'types' of gamblers. The authors suggested that the nature of problem gambling is heterogeneous, multidimensional, and cannot be conceptualised as either a 'categorical disorder or as an end point on a continuum of gambling involvement' (p. 489). The Pathways Model is based on trajectories of gambling behaviour which form the basis for three distinct sub-groups of gamblers: 'behaviourally conditioned', 'emotionally vulnerable' and 'antisocial impulsivist'. These sub-groups are largely distinguished by psychological and physiological characteristics, such as coping skills, arousal and neurological functioning, impulsivity and irrational beliefs (Blaszczynski & Nower, 2002).

Factors associated with increases and decreases in gambling behaviour

Information regarding factors that contribute to increases in gambling behaviour and risk has largely resulted from quantitative studies (e.g. Abbott et al., 2014a, 2015c, 2016; Cyders & Smith, 2008; Griffiths et al., 2009; Scholes-Balog et al., 2014). There are numerous factors associated with the development of problematic gambling or risk category increases. For example, several researchers have found that low socioeconomic status, unemployment, low income, male gender, younger age, larger household size, and a minority status are associated with an increased risk for developing a gambling problem (Abbott et al., 2014a; Billi et al., 2014; el-Guebaly et al. 2015; Wardle et al., 2011a). Other researchers have found that increased gambling is related to major life events, changes in family function and relationships, childhood trauma and abuse, and as a response to stressful events and mental health problems (Reith & Dobbie, 2013; Samuelsson et al., 2018; Victorian Responsible Gambling Foundation, 2012). Additionally, personality factors and cognitive distortions (Cunningham et al., 2014), the drive to win money (Abbott et al., 2014a), boredom and seeking entertainment or stimulation (Abbott et al., 2012; Mutti-Packer et al., 2017), the gambling activity and availability (Abbott et al., 2014a; Breen & Zimmerman, 2012; St-Pierre et al., 2014; Reith & Dobbie, 2013; Welte et al., 2016) and substance use (Abbott et al., 2004; el-Guebaly et al., 2015; Ellery et al., 2005) are all associated with increased gambling risk or intensifying gambling behaviour. Abbott and colleagues (2018a) also identified that moderate risk/problem gamblers were more likely experience five or more individual levels of deprivation (out of an eight item index, NZiDep; Salmond et al., 2006), have severe or high levels of psychological distress, be of Māori or Pacific ethnicity, and be aged 18 to 39 years.

As outlined previously, decreases in gambling behaviour and risk are the norm for many individuals experiencing problematic gambling (LaPlante et al., 2008; Luce et al., 2016). Several studies have examined natural recovery from gambling problems (Hodgins & el-Guebaly, 2000; Hodgins et al., 1999; Slutske, 2006); that is, recovery without professional assistance. Other researchers have found that many individuals are able to return to controlled gambling after reducing their risk level (Slutske et al., 2010). These findings suggest that gamblers can recover, and maintain recovery, without professional assistance. Factors that prompted help-seeking or problem gambling resolution includes significant life events, financial concerns such as running out of money or significant monetary losses, reduced gambling availability, a shift in life perspective or maturation, realising that gambling was incompatible with their perception of self, developing a negative attitude toward gambling, and because of the negative consequences associated with gambling and/or reaching "rock bottom" (Anderson et al., 2009; Cunningham et al., 2009; Hodgins & el-Guebaly, 2000; Reith & Dobbie, 2013; Suurvali et al., 2010; Toneatto et al., 2008).

Gambling behaviour has increasingly been recognised as unlikely to remain at consistent levels over time. Reith and Dobbie (2013) concluded that gambling behaviour was marked with instability. A similar conclusion was found in the qualitative phase of the NGS (Bellringer et al., 2019). That is, the pattern for the majority of gamblers was non-linear with periods of problematic or excessive gambling often followed by a time of reduced gambling or abstinence. The survey phases of the NGS had similar findings whereby, although the prevalence of problem gambling did not change significantly between 2012 and 2015, risk level transitions were evident. The authors reported that low-risk and moderate risk gambler groups were the least stable over time, followed by the problem gambling group. Conversely, the non-problem and non-gambling groups were the most stable over time (Abbott et al., 2018a). While this inconsistency can be short-term, in some cases, a period of abstinence may last several months, or even years, before a return to gambling occurs (Abbott et al., 2018a; Bellringer, et al., 2019). Reith and Dobbie's (2013) longitudinal study explored patterns and trajectories of gambling behaviour. A cohort of 50 gamblers took part in four interviews across five years; 38 took part in the first three interviews and 28 took part in the final interview. The authors emphasised the complex nature of exploring gambling behaviour and concluded that change, rather than consistency, was the

norm for most gamblers. One of the key findings was contrary to many studies that had found that natural recovery may be a common phenomenon for individuals with gambling problems. In Reith and Dobbie's study, only a small number of participants followed a recovery trajectory, compared to those who demonstrated periods of reduced gambling followed by resumption of activities (Reith & Dobbie, 2013). This finding indicates the iterative nature of the relationship between gambling involvement, discontinuation and relapse.

There are differing definitions of relapse within the literature. Hodgins and el-Guebaly (2004) defined relapse as "the resumption of gambling after a period of cessation" (p. 72), while Ledgerwood and Petry (2006) made the distinction between a lapse (any gambling activity or behaviour that violates an individual's reduction or abstinence goals) and a relapse (a loss of control over gambling behaviour or resuming compulsive gambling). A lapse may be a single gambling session while a relapse involves more than a single incidence and a sense of loss of control. Although experiencing a lapse may not have negative consequences, a relapse may result in increased gambling risk. Factors that contribute to a gambling relapse include cognitive distortions or erroneous thinking, financial pressures or a desire to chase losses, boredom or feeling a lack of alternative activities, inability to deal with urges, and requiring gambling to deal with negative situations or challenging emotions (Hodgins & Peden, 2005; Hodgins & el-Guebaly, 2004; Oakes et al., 2012a, 2012b). Relapses and lapses have been increasingly recognised as frequent occurrences.

The impact of problematic gambling

As outlined previously, there has been increasing interest in adopting a public health approach to gambling. A public health approach recognises that the potential negative consequences of gambling can affect an individual's holistic health and wellbeing. That is, the consequences associated with problematic gambling can affect not only an individual but also their family and whānau, and the wider community. The cost of problematic gambling on communities is significant; research has demonstrated that problem gambling is associated with mental health issues such as depression and anxiety, family violence, criminal behaviour, substance misuse, suicidal ideation and suicide, and financial troubles (Black et al., 2013; Browne et al., 2016, 2017b; Grinols, 2004; Li et al., 2017; Petry et al., 2005; Petry & Kiluk, 2002; Shaw et al., 2007). Recently, researchers have begun measuring the burden of harm associated with problematic gambling and its related outcomes. Browne and colleagues (2017a) found that in New Zealand the individual harm experienced with problem gambling was similar to that experienced with severe alcohol use disorder. Additionally, the researchers demonstrated that the aggregate harms from problem gambling were three times the harm resulting from drug use disorders, and more than twice the harm caused by chronic conditions such as osteoarthritis and diabetes (Browne et al., 2017a).

Problem gambling and health correlates

There is a significant body of research demonstrating associations between problem gambling and various comorbidities, risky behaviours, and negative health effects. For example, strong associations between problem gambling and other addictions such as nicotine dependence, alcohol use or drug use disorder (Hodgins et al., 2005; Holdsworth et al., 2012; Martin et al., 2014), and mental health problems and mood disorders have been found (Bakken et al., 2009; Hodgins et al., 2005; Hounslow et al., 2011; Najavits at al., 2011; Petry et al. 2005). However, causation has not been identified, for example, an alternative factor might account for some of the interactions described. It is for this reason that causal sequences or the direction of an interaction can be difficult to determine.

A number of clinical and epidemiological studies have reported a relationship between problematic gambling and adverse health effects on an individual and their partner/spouse or family (e.g. Dickson-Swift et al., 2005; Lorenz & Yaffee, 1986; Shaw et al., 2007; Sobrun-Maharaj at al., 2012). Black and colleagues (2013) examined several health outcomes in people who met the criteria for DSM-IV pathological gambling and people who did not. The researchers conducted a case control study, matching on age and gender, for 95 participants with DSM-IV pathological gambling and 91 control participants without pathological gambling. Although a causal sequence between gambling behaviour and health outcomes was not established, in general, the severity of the gambling disorder was positively correlated with various medical conditions and risk factors. Compared to participants without pathological gambling, those who met the DSM-IV criteria had more medical and mental health conditions, were less likely to participate in regular exercise, had a higher body mass index (BMI) and were more likely to be obese. They were also more likely to engage in risky or unhealthy lifestyle behaviours including smoking, excessive alcohol consumption and higher daily caffeine intake. Furthermore, due to financial reasons, they were less likely to seek medical or dental health care. Overall, participants with pathological gambling had poorer health outcomes (Black et al., 2013).

One study has examined the relationship between recreational gambling and health outcomes. Humphreys et al. (2011) used data collected from the Canadian Community Health Survey (CCHS) in 2003 (Ontario and Saskatchewan), 2005 (New Brunswick) and 2007 (Ontario and Saskatchewan). The study was a cross-sectional, nationally representative survey that examined health status, health care utilisation and other health determinants, and included 82,729 observations. The survey included detailed questions on gambling and used the Problem Gambling Severity Index (PGSI) to characterise gambling risk levels (Ferris & Wynne, 2001). To determine causation, gambling was considered an exogenous regressor in their health outcome equation. The study highlighted that recreational (non-problem) gambling either had no impact or a negative relationship with the probability of having health conditions such as high blood pressure, diabetes, mood disorders and anxiety, and heart disease. Despite being able to provide evidence for some causation, the direction of the relationship is difficult to determine; that is, are individuals with a better health status more likely to gamble non-problematically and avoid developing a gambling problem? Or does a non-problematic level of gambling avoid the negative health outcomes associated with problem gambling? In other words, if these participants were to gamble more excessively, would their health status decline?

In New Zealand, research has found a relationship between problem gambling and self-reported physical health (Abbott et al., 2012, 2014a; Browne et al., 2017a; Mason & Arnold, 2007; Walker et al., 2012). Similar to international research, the NGS found that people experiencing problem gambling were more likely be smokers, more often reported cannabis use and higher levels of alcohol misuse, and were more likely to engage with other substances including ecstasy, amphetamines, party pills, stimulants, and benzodiazepines (Abbott et al., 2014a). In terms of self-reported health status, an increased risk of problem gambling was associated with a decrease in 'good' or 'excellent' reported levels of health. For example, compared with 57% of non-gamblers and 54% of non-problem gamblers, lower percentages of low risk, moderate risk and problem gamblers reported good or excellent general health (44%, 36% and 22% respectively; Abbott et al., 2014a). Increased gambling involvement was also associated with lower levels of self-reported health outcomes in another New Zealand study conducted with 7,010 participants from the general population (SHORE, 2008).

A strong association between problem gambling and mental health and psychological wellbeing has been found both in New Zealand and internationally (e.g. Abbott et al., 2012, 2014a; Black et al., 2013; Martin et al., 2014; SHORE, 2008). In a randomised controlled trial involving individuals seeking treatment for their gambling, 58% met the diagnostic criteria for major depression, 56% had high levels of psychological distress, and 12% experienced minor depression (Abbott et al., 2012; Ranta et al., 2019). Similarly, in the NGS, 46% of people with problem gambling had high levels of psychological

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distress. Furthermore, compared to non-gamblers and non-problem gamblers, individuals with a gambling problem reported greater levels of depression and anxiety (Abbott et al., 2014b). Another New Zealand study found that people who reported higher levels of gambling involvement had significantly poorer self-rated mental wellbeing and feelings about self, compared to those who did not gamble or rarely gambled (SHORE, 2008).

To date, most of the studies examining the relationship between problematic gambling and health outcomes have been cross-sectional. Therefore, it has been difficult to determine causation or the direction of the relationship between problem gambling and health status. As the NGS was a longitudinal study, the associations over time can be examined to gain a detailed understanding of how changes in gambling risk levels are associated with changes over time in health. This is one of the aims of the current study.

Problem gambling and quality of life

The World Health Organisation defines quality of life (QoL) as an "individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. It is a broad ranging concept affected in a complex way by the person's physical health, psychological state, level of independence, social relationships, and their relationship to salient features of their environment" (WHOQoL Group, 1995, p. 1405). From this definition, it is clear that problematic gambling can alter quality of life by negatively affecting an individual's physical and mental health, relationships with others, or other aspects of their life via involvement in illegal activities, financial struggles, or negative work/study related consequences.

Quality of life is measured using two types of instruments (Bonfils et al., 2019); one measures overall quality of life regardless of health factors, and the other examines health-related quality of life (HRQoL) relating to physical health, physical wellbeing, psychological health, and social relations (Schmidt et al., 2005). General QoL instruments report subjective satisfaction with life based on categories that are important to an individual, whereas HRQoL reports the subjective perception of a disease, disorder or health determinant and the impact on daily life and physical and mental health functioning (Bonfils et al., 2019).

Given the many negative consequences of gambling, and the high rates of co-existing mental health issues and substance use disorders, a number of researchers have found that people experiencing problematic gambling report lower levels of quality of life compared to those without a gambling problem (Abbott et al., 2014b; Black et al., 2003, 2013; Browne at al., 2017a; Kohler, 2014; Mythily et al., 2017; Reid et al., 1999; SHORE, 2008). Black and colleagues (2013) reported that compared to non-gamblers, problem gamblers reported significantly lower scores on the majority of health-related quality of life measures including physical function, vitality, mental health and social functioning. Generally, participants with problem gambling reported a lower quality of life compared to those without gambling problems (Black et al., 2013).

In the NGS, quality of life was measured using the WHOQOL-8, a brief version of the WHOQOL-100 (Schmidt et al., 2005) and found that problem gambling was associated with lower overall quality of life; 76.8% of problem gamblers and 68.3% of moderate risk gamblers rated below the median score for the study sample (Abbott et al., 2014b). In the most recent NGS report, quality of life was found to be consistent across the four waves of the study, and a lower quality of life was significantly associated with being a past year moderate risk or problem gambler (Abbott et al., 2018a).

Problematic gambling does not just affect the gambler. For example, in the NGS, compared with non-problem gamblers, problem gamblers more often reported an increase in the number of arguments with someone close (Abbott et al., 2014a). One study found that immediate family members (partner/spouse, children, parents, siblings) reported the most negative effects from another's gambling. The same study reported that gambling problems in wider family members, friends and colleagues was not associated with significantly negative effects on other people (SHORE, 2008). Despite the findings reported by SHORE (2008), there is a significant body of literature that has demonstrated that the negative effects of problem gambling are far reaching (e.g. Abbott et al., 2014b; Bellringer et al., 2013; Clarke et al., 2006; Dyall, 2004, 2010; Dyall et al., 2009a; Guttenbeil-Po'uhila et al., 2004; Sobrun-Maharaj et al., 2012; Watene et al., 2007). Indeed, much of this research has reported that the harm from gambling can have direct and indirect effects on immediate family and whānau members, friends and colleagues, and the wider community. A common negative consequence reported in the literature is financial pressure and associated repercussions; for example, due to increased debt and financial strain, household items and quality food may be omitted, bill payments may be missed, or individuals may resort to illicit activities to increase their funds (Abbott et al., 2014b; Browne et al., 2017a; Dickson-Swift et al., 2005; Holdsworth et al., 2013b; SHORE, 2008). Moreover, the relationship between a gambler and their partner or spouse can be negatively affected through loss of trust following concealment of gambling behaviour, conflict over gambling frequency and expenditure, and experience of family violence (Abbott et al., 2014b; Afifi et al., 2010; Dowling et al., 2016; Holdsworth et al., 2013b; Korman et al., 2008; Palmer du Preez et al., 2018; Suomi et al., 2013, 2019). The mental wellbeing and physical health of family members/affected others can be negatively affected due to the development of maladaptive coping strategies, inability to afford medical care, increased sense of isolation and self-blame (Dickson-Swift et al., 2005; Holdsworth et al., 2013a). Finally, a community can be directly or indirectly affected by a person's problematic gambling. Direct harms include crime (Bellringer et al., 2009; Rankine & Haigh 2003) and the costs of treating problem gambling (Browne et al., 2017a; Black et al., 2013). Indirect harms can be related to the association between the placement of gambling venues and overall wellbeing of a community (Dyall, 2007; Wall et al., 2010). That is, increased density of gambling venues (particularly EGMs) is associated with decreased social capital and community wellbeing (Dyall, 2003, 2007) and increased utilisation of social services and food parcels (Wall et al., 2010). Other community level harms can include reduced engagement in cultural rituals or reduced participation in community activities, and lost connection to community and culture (Browne at al., 2017a).

Lin and colleagues (2011) examined how various gambling activities affected quality of life for different ethnic groups in New Zealand. Telephone interviews were completed with 4,068 Pākehā/ European people, 1,162 Māori, 1,031 Pacific people, and 984 Chinese and Korean people. The gambling activities included lottery products, EGMs in a pub/club/casino, casino table games, poker or other card games for money, racetrack/Totalisator Agency Board (TAB) venue betting, housie/bingo for money, and internet gambling. The main findings from the study were that Māori and Pacific participants showed significant negative associations between gambling involvement, particularly time spent on non-casino EGMs, and ratings on quality of life, whereas the same associations were positive or non-significant for Pākehā/ European participants. For Chinese and Korean participants, the findings were varied; for example, playing poker at home was associated with better relationships but poorer self-rated study-related performance (Lin et al., 2011).

Taken together, the negative consequences experienced by an individual alongside the broader effects of their gambling on their family and living situation can be significantly detrimental to overall quality of life.

Gambling-related socioeconomic and demographic differences

Similar to international jurisdictions, in New Zealand, problem gambling disproportionately affects minority ethnic groups. Since the first national gambling and problem gambling study in 1990 (Abbott & Volberg, 1991) there have been large and persistent problem gambling disparities between major ethnic groups (e.g. Abbott, 2017; Abbott & Volberg, 2000; Abbott et al., 2018a; Browne et al., 2017a). For example, Māori and Pacific people have, and continue to, experience very high levels of problematic gambling and gambling-related harm more broadly (Abbott, 2017; Abbott et al., 2018a; Browne et al., 2017a). Several other population groups also have a high risk for developing problematic gambling including younger adults, people without formal qualifications, unemployed people, people living in large households and those domiciled in the most deprived neighbourhoods (Abbott et al., 2014). Ethnic disparities are partly explained by these other factors.

Gambling-related health and social inequities are substantial. Māori account for approximately 11.4% of the total New Zealand adult population but make up 35.2% of individuals seeking help for their gambling, and Pacific people[1] account for 5.3% of the total adult population while making up 19.1% of individuals seeking help for their gambling. Asian people[2] represent 8.9% of the total adult population and represent 9.9% of individuals seeking help for their gambling (Ministry of Health, 2019). Furthermore, 4.6% of Māori and 2.9% of Asian people were moderate risk/problem gamblers in 2016, followed by 1.8% of Pacific people and 0.8% of European/Other people (Thimasarn-Anwar et al., 2017). In other words, compared to one in 48 European/Other males, one in 16 Māori males, one in eight Pacific males, and one in 22 Asian males are problem or moderate risk gamblers. The corresponding figures for females are one in 71 European/Other compared with one in 15 Māori, one in 20 Pacific, and one in 67 Asian females (Abbott et al., 2014a).

In the NGS, typical monthly gambling expenditure was highest amongst Māori participants (mean $116), followed by Pacific adults ($112), Asian adults ($74) and then European/Other adults ($66) (Abbott et al., 2014b). Compared to family members of European/Other (19%) problem gamblers, Māori (30%), Pacific people (23%) and Asian people (23%) more often reported adverse financial consequences (Abbott et al., 2014a).

Researchers have posited that cultural influences may have contributed to the ethnic inequities in problematic gambling. For example Dyall et al. (2009b) highlighted the use of ethnic or cultural icons within gambling advertising; a dancing dragon at the Chinese New Year festival, New Zealand native flora and fauna, and Māori carvings placed at casino entrances to provide a sense of welcoming and protection were examples given by the authors (Dyall et al., 2009b). Moreover, cultural practices appeared to have contributed to gambling becoming a 'normal' or 'usual' activity. For example, gambling on housie/bingo is common for fundraising purposes within some Pacific church communities (Bellringer et al., 2013; Urale et al., 2015).

Some researchers have suggested that gambling has developed into a representation of hope with the possibility of changing financial position, and to escape boredom and trauma (Dyall et al., 2009a; SHORE, 2008; Urale et al., 2015). Coupled with this is the consistent concern that gambling products are readily available in low income communities where many Māori reside (Clarke et al., 2006; Dyall, 2007). Indeed, numerous studies have highlighted the recurrent patterns of harm experienced by Māori. A study conducted by SHORE (2008) found unique gambling consequences for Māori which included

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[1] The term 'Pacific people' includes several ethnicities from the South Pacific region with the largest five Pacific groups in New Zealand being Samoan, Cook Islander, Tongan, Niuean, and Fijian (Statistics New Zealand, 2014).
[2] The term 'Asian people' includes several ethnicities with Chinese, Indian, Korean, Filipino and Japanese being the five largest communities in New Zealand (Statistics New Zealand, 2014).

the destruction of family values and cultural capital, damage to mana (prestige, spiritual power, authority), and emotional harms relating to an individual's wairua (spirit/soul) and identity. Other studies have highlighted damage to social and cultural capital, as well as damage to Māori family values, whakamā (shame, embarrassment), child neglect, and harms to relationships from financial strain, distrust, loss of respect, and time spent away from the family (Dyall, 2007; Dyall & Hand, 2003).

In Pacific communities, gambling problems are often persistent. Although Pacific people are less likely to gamble, those who do gamble are significantly more likely to develop gambling problems compared to other ethnic groups (Abbott & Volberg, 2000; Abbott et al., 2014a; Ministry of Health, 2009). Research has noted that, amongst Pacific people, gambling participation is associated with cultural beliefs, practices and obligations such as traditional gift-giving during significant events such as births, weddings or funerals in Samoan and Tongan communities (Bellringer et al., 2006; Cowley et al., 2004; Guttenbeil-Po'uhila et al., 2004; Kolandai-Matchett et al., 2017; Perese & Faleafa, 2000; Tse et al., 2005, 2012; Urale et al., 2015). Studies of gambling outcomes and harms in Pacific communities have identified breakdowns in family relationships, extended family members being left with financial and caregiving burdens, budgeting and financial issues, reduced community contribution, declines in health and wellbeing; and negative influences on employment and education (Bellringer et al., 2013; Guttenbeil-Po'uhila et al., 2004; Perese & Faleafa, 2000).

Within Asian communities, seeking help outside the family is uncommon due to 'face-saving' and the avoidance of shame. Additionally, an unfamiliarity with appropriate services, may delay help-seeking behaviour (Radermacher et al., 2017; Sobrun-Maharaj et al., 2012; Wong & Tse, 2003). Furthermore, a disconnection or sense of alienation from the community can be fostered by problematic gambling, which can also contribute to the avoidance of support (Wong & Tse, 2003). A study in New Zealand examined the negative consequences of gambling on Asian families and communities, via focus groups and interviews with gambling treatment provider staff and individuals from an Asian community (Sobrun-Maharaj et al., 2012). Negative effects from gambling were reported by gamblers, their families and general community members. The authors reported that, for Asian individuals, significant consequences of problematic gambling included the loss of social connection and increased isolation, loss of financial security, engagement in illicit activities to support gambling, and mental health issues. Wong and Tse (2003) noted that the loss of money is a particularly important issue as, without funds, the ability to find suitable accommodation, and employment or study opportunities, may be jeopardised; all of these are essential for establishing a life in a new country (Wong & Tse, 2003). Overall, the harms from problematic gambling on Asian families and communities included family conflict, missed opportunities, physical and mental wellbeing issues such as stress and stress-related illness, material and monetary loss within the community, and deterioration of trust and social support mechanisms in the community (Sobrun-Maharaj et al., 2012).

Socioeconomic factors have also been found to affect gambling participation and experience of gambling-related harms. In New Zealand, the NGS found that individuals who experienced problem gambling reported high levels of deprivation; half indicated they had been out of paid work for more than a month in the past 12 months and about a third had received financial support from a benefit programme. Three-quarters of problem gamblers indicated that, in the previous 12 months, they had been forced to buy cheaper food compared to a quarter of adults overall (Abbott et al., 2014a). Another New Zealand study found that people with a higher loss-to-income ratio reported significantly poorer physical and mental health, perceived themselves as having poorer relationships with family and friends, and reported lower overall quality of life and satisfaction with life (SHORE, 2008).

Summary

The findings from the studies discussed in this literature review raise significant questions about the direction of the association between problematic gambling and related health and quality of life correlates. For example, does problem gambling contribute to poor physical health and mental wellbeing concerns? Do individuals with mental health problems or worse physical health turn to gambling more readily than those with few health concerns? As gambling behaviour is likely to be variable and follow a trajectory in and out of problematic gambling, is it an iterative relationship between problem gambling and health outcomes?

Recently, there has been growing international interest in adopting a public health approach to gambling. This has included a wider focus than problem gambling and incorporated consideration of a broad spectrum of gambling-related harms. Research has consistently found that problem gambling is associated with poorer health outcomes and lower quality of life. Additionally, the burden of harm associated with gambling appears to be substantially higher than that associated with some other health conditions such as diabetes, osteoarthritis, and drug use disorder (Browne et al., 2017a; Kohler, 2014). Furthermore, gambling-related burden of harm is carried disproportionately by disadvantaged and marginalised groups, contributing to social and health inequities (Abbott et al., 2018a; Browne et al., 2017a).

To date, a major shortcoming of gambling harm and quality of life studies has been their cross-sectional nature and lack of a longitudinal perspective. Longitudinal studies are required to assess the consequences of problem gambling development (incidence), cessation, and relapse on quality of life and harm. They are also required to determine the contribution of other factors, including ethnicity and socio-economic status, on these outcomes.

STUDY AIMS

This study was designed to extend previous research and increase understanding of the effects of changes in gambling and problem gambling behaviour in relation to a range of important health, social and related outcomes. It also expected to determine whether those effects differed across major ethnic groups, and some other population sectors, and advance understanding of the role of gambling in relation to inequities in population health status and social wellbeing. To achieve these aims, data from the four data collection years of the National Gambling Study (NGS) were analysed.

The aims of this study were to:
- Identify correspondence between changes in gambling status over time with changes in other addictive behaviours.
- Identify correspondence between changes in gambling status over time with changes in health and wellbeing status.
- Identify correspondence between changes in gambling status over time with changes in social engagement and deprivation.
- Develop a final analysis model incorporating the above-mentioned factors, adjusting for demographic variables.
- Examine the differences in Māori and non-Māori models.

RESEARCH METHODS

Ethical approval

This study involved secondary analysis of existing NGS data sets for the purpose of increasing knowledge relating to the New Zealand population's gambling activities and the consequences associated with those activities. As the analyses continued the intended purpose of the NGS (to which participants consented at each data collection year), the data sets were anonymised (i.e. participant identifying details were not present), and as new data were not collected, ethical approval for this study was not required.

Markov modelling

Markov models are widely used to study chronic physical diseases and were developed in recent years to examine changes in psychological/mental health and addictive behaviours, being treated as dynamic processes (de Haan-Rietdijk et al., 2017a, 2017b). With addictions, people who exhibit risky behaviours may also experience abstinence and relapse cycles. Thus, it is necessary to consider this time-varying component in any statistical modelling.

Yeh et al. (2012) analysed the transition of smoking status in a two-year randomised smoking cessation trial (individuals selected were smokers at enrolment) applying a first-order Markov chain incorporating other covariates. This example involved consideration of the variable of interest as an observed variable. Status of addiction, or mental health status is not always stated as observable but sometimes as a latent variable (the real state of addiction is considered as unknown and unobservable but can be approached by a variable or set of variables giving information related to the latent variable, e.g. the number of cigarettes smoked per day can be a good instrumental variable of the degree of addiction to tobacco).

Markov models can be used to model longitudinal multivariate studies. In a longitudinal study among cocaine addicts, Song et al. (2017) focused on cocaine addiction and used the number of days of cocaine use per month as an instrumental variable. The Markov model (Continuation-ratio logit transition model) with covariates of treatment received and psychological problems was used. In this context, the number of states that cocaine addicts may go through over time was unknown.

For the current study, utilising Markov modelling, models were developed to examine changes in factors associated with changes in gambling risk levels over time, both relative to baseline characteristic and time-varying factors. These methods have been developed in recent years to examine modelling changes in state over time, and specifically for addictions (Cai et al., 2018; de Haan-Rietdijk et al., 2017; Song et al., 2017; Yeh et al., 2012).

Descriptive statistics were first produced to examine the time varying characteristics of variables to identify those variables that changed enough over the whole time period to be examined as a changing state variable.

Initial models were developed to examine the change in gambling risk levels over time. The confounding effect of baseline characteristics was examined in the final model. Each of the following time-varying factors was examined for their addition to the model accounting for their time-varying effects: tobacco-use, recreational drug-use, hazardous alcohol-use, mental health status, life events and socio-economic status. As some of these factors had complex reciprocal relationships with gambling risk levels, several models were investigated and examined for the best fit.

Data analysis

Data

The data sets from the 2012, 2013, 2014 and 2015 data collection years of the NGS were used in the analysis. Forty-four percent of the participants present at baseline remained in the study in 2015 (2,770 participants and 11,080 observations) (Figure 1). It is of note that an insufficient budget to re-contact all baseline participants in 2013 contributed to the overall reduced sample. After investigating distributions of demographic variables (i.e. age, gender, ethnicity and region) along with PGSI score, the structure of the initial 2012 data set and that of 2013 showed no evidence of any differentials between the two time points. Although the sample size was less in 2013 compared with 2012, the proportions in distribution of demographic variables and PGSI score remained similar, indicating that data were missing at random.

Figure 2 presents the data by the four major ethnic groups; note that the numbers do not match the total numbers in Figure 1 as ethnicity data were missing for 63 participants. As this study focuses on transitions in gambling risk levels (measured via the Problem Gambling Severity Index; PGSI, Ferris & Wynne, 2001), *only participants present for all four data points were retained in the models*. The distributions of gambling risk levels for the overall population and those who were retained were similar.

The purpose of this study was not to look at population prevalence estimates but to model transition in gambling risk levels, and to understand how transitions are associated with a participant's characteristics. For this reason, *raw values instead of weighted values were used*.

Figure 1: Number of participants over time
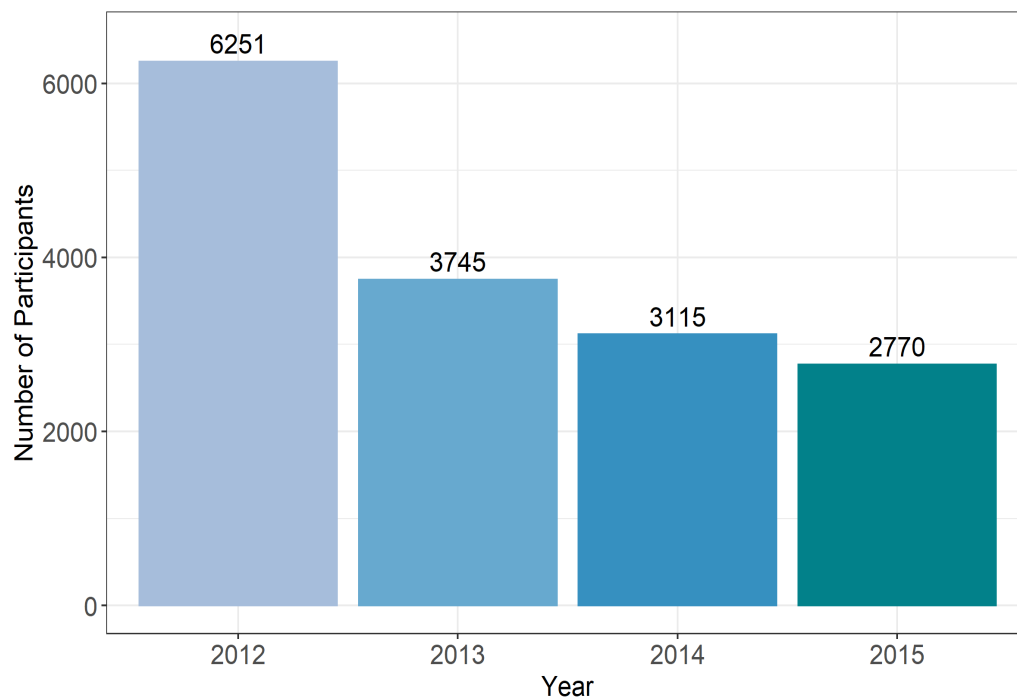
Figure 2: Number of participants over time by ethnicity
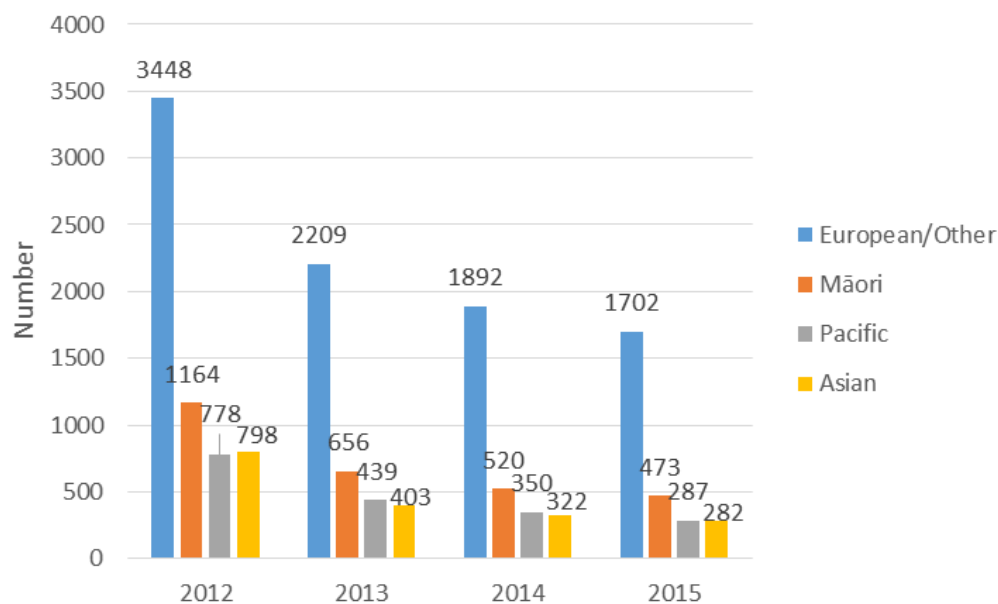
Problem Gambling Severity Index

The PGSI is a nine-item questionnaire with each item scored on a scale from 0 to 3. Thus, the range of scores possible is 0 to 27. In the prior NGS reports, five categories of past year gambling behaviour were identified and used in the analyses, using cut-off scores as defined by the developers of the PGSI

(Ferris & Wynne, 2001). For consistency, the same categorisations were used for the current analysis of data.
1. Non-gambler (did not gamble in the past 12 months)
2. Non-problem gambler (score 0)
3. Low risk gambler (score 1-2)
4. Moderate risk gambler (score 3-7)
5. Problem gambler (score 8+)

Table 1 shows the number and percentage of participants in each category over time for the 2,770 participants included in the analysis.

Table 1: Distribution of PGSI (5 categories) over time

PGSI	2012		2013		2014		2015		Total	
	N	%	N	%	N	%	N	%	N	%
Non-gambler	516	18.6	579	20.9	582	21.0	667	24.1	2344	21.2
Non-problem gambler	2053	74.1	1939	70.0	1953	70.5	1883	68.0	7828	70.6
Low risk gambler	124	4.5	173	6.2	154	5.6	144	5.2	595	5.4
Moderate risk gambler	51	1.8	59	2.1	61	2.2	61	2.2	232	2.1
Problem gambler	26	0.9	20	0.7	20	0.7	15	0.5	81	0.7

The low risk gambler, moderate risk gambler and problem gambler categories comprised a small proportion of the population (8.2% in total). Modelling transitions and identifying patterns among such small samples can be problematic. Thus, these three categories of gamblers were combined into one category ("At-risk gambler"). The distribution of the new three-category PGSI is shown in Table 2.

Table 2: Distribution of PGSI (3 categories) over time

PGSI	2012		2013		2014		2015		Total	
	N	%	N	%	N	%	N	%	N	%
Non-gambler	516	18.6	579	20.9	582	21.0	667	24.1	2344	21.2
Non-problem gambler	2053	74.1	1939	70.0	1953	70.5	1883	68.0	7828	70.6
At-risk gambler	201	7.3	252	9.1	235	8.5	220	7.9	908	8.2

The proportion of participants who were non-gamblers in the prior year slightly increased over time from 18.6% in 2012 to 24.1% in 2015, whilst the proportion of non-problem gamblers slightly decreased from 74.1% in 2012 to 68.0% in 2015.

The distribution of the three-category PGSI by ethnicity is shown in Appendix A, Table A1. Note that the numbers do not match the total numbers the previous table, as ethnicity data were missing for 63 participants.

Transitions in PGSI

Some transitions from one PGSI risk level to another occurred from 2012 to 2013, 2013 to 2014 and 2014 to 2015 (Table 3).

Table 3: Distribution of transitions in PGSI

Year	Transition in PGSI	Non-gambler		Non-problem gambler		At-risk gambler		Total
		N	%	N	%	N	%	N
2012 – 2013	Non-gambler	329	63.8	175	33.9	12	2.3	516
	Non-problem gambler	241	11.7	1675	81.6	137	6.7	2053
	At-risk gambler	9	4.5	89	44.3	103	51.2	201
2013 – 2014	Non-gambler	363	62.7	198	34.2	18	3.1	579
	Non-problem gambler	204	10.5	1634	84.3	101	5.2	1939
	At-risk gambler	15	6.0	121	48.0	116	46.0	252
2014 – 2015	Non-gambler	413	71.0	159	27.3	10	1.7	582
	Non-problem gambler	243	12.4	1606	82.2	104	5.3	1953
	At-risk gambler	11	4.7	118	50.2	106	45.1	235

There were few transitions from non-gambler to at-risk gambler (and vice versa): 40 and 35 transitions over the entire period. These low numbers led to model estimation issues and difficulties in the estimation of coefficients. Thus, those two transitions were entirely removed, meaning that if a participant had one of those transitions, he/she was removed from the study. This resulted in 60 participants (2.1%) being removed.

Thus, the following transition model was selected (Figure 3). The letters are transitions from:
    A = non-gambler to non-problem gambler (i.e. starting gambling)
    B = non-problem gambler to non-gambler (i.e. stopping gambling)
    C = non-gambler to at-risk gambler (i.e. transitioning into risky gambling)
    D = at-risk gambler to non-problem gambler (i.e. transitioning out of risky gambling).

Figure 3: Modelled transitions in PGSI

With this model, the transition matrix is shown in Table 4 as the conditional probabilities of transition from one state to another. For instance, non-gamblers (at year t) have a 32% probability of starting gambling (i.e. transitioning to non-problem gambler) the following year (t+1). The probabilities of transitions from one gambling risk level to another are the average values observed for the overall study period (2012 to 2015).

Table 4: Percentage distribution of transitions in 3-category PGSI

Transition	Non-gambler	Non-problem gambler	At-risk gambler
Non-gambler	68	32	-
Non-problem gambler	11	83	6
At-risk gambler	-	49	51

When the distribution of transitions was examined by ethnicity (Appendix A, Table A2), some differences between the ethnic groups were apparent. At-risk Māori gamblers were more likely to remain at-risk (63%) than any other ethnicity (42% to 56%). A high proportion of Māori non-problem gamblers, along with European/Other non-problem gamblers, were also more likely to remain in that category over time (81% and 86%, respectively), compared with the other ethnicities (70% to 77%). Asian non-gamblers had the highest likelihood of remaining as non-gamblers (78%) compared with the other ethnicities (56% to 72%). Whilst a low percentage of European/Other participants transitioned into risky gambling from non-risky gambling (4%), the percentage was double for Māori and Asian participants (both 8%), and three times higher for Pacific participants (13%).

Covariates

The aim of the study was to model the associations between transitions in gambling risk status and covariates on the transition matrix. Three sets of covariates were used.

1. Transitions in substance use:
   a. Tobacco smoking (smoker, non-smoker)
   b. Hazardous alcohol use (AUDIT-C; at-risk, not at-risk)
   c. Cannabis use (smoker, non-smoker)

2. Transitions in health-related:
   a. Quality of life (WHOQoL-8; below median, above median)
   b. Chronic illness (cancer, diabetes, lung disease, heart/blood pressure/cholesterol issues; yes, no)
   c. Anxiety (yes, no)
   d. Depression (yes, no)
   e. General health (fair/poor, good/very good/excellent)
   f. Disability (yes, no)
   g. Past trauma (yes, no)
   h. Obesity (yes, no)

3. Transitions in major life events, deprivation and social connectedness:
   a. Number of major life events experienced in past year (0, 1+)
   b. Individual level of deprivation (NZiDep; 0, 1+)
   c. Can get help from family, friends or neighbours when needed (yes, sometimes/no)
   d. Member of an organised group such as sports group or church (yes, no)
   e. Like living in the community (yes, no)
   f. Overall quality of services in community (poor/okay, good)

Each variable considered in the model is represented as a set of dummy variables. The main interest of the analysis was to study the association of changes in gambling risk level behaviours with health, well-being, and social connectedness.

Confounders

Socio-demographic variables were included in the final model as confounders. These were:
- Gender
- Age category at baseline
- Ethnicity (European/Other, Māori, Pacific, Asian) - participants could belong to more than one category
- Household size at baseline (1-2, 2-4, 5+)
- Educational level at baseline (university, secondary school, vocational/trade, no formal qualification)
- Employment status (full time, part time, unemployed, retired)
- Annual personal income (up to $20,000, $20,001-$80,000, greater than $80,000)
- Location at baseline (Auckland, Wellington, Christchurch, other)

Missing values

Some covariates contained missing values. Individuals with at least one missing variable value were not included in the estimation of the models. The individual was removed only if the variable was used as a covariate in a particular model. In the final model, missing values were associated with 16 participants (64 observations).

The missing data were:
- Hazardous alcohol use (AUDIT-C): 3 participants
- Quality of life (WHOQoL-8): 8 participants
- Can get help from family, friends or neighbours: 2 participants
- Like living in the community: 1 participant
- Overall quality of services in community: 23 participants.

Multi-State Markov Model

Multi-State Markov Modelling was used as described by Jackson (2011). Due to the data set structure (longitudinal data, t = 1,…, 4), it was possible to model changes as a Markov chain, defined by a matrix of transition: probabilities to transition from an initial state (at time t) to another (at time t+1), with the initial state being known.

$$P_{S_T, S_{T+1}} = P(State_{T+1} \mid State_T)$$

Transition probability matrix of a three-state outcome:

$$\mathbf{P} = \begin{bmatrix} p_{1|1} & p_{1|2} & p_{1|3} \\ p_{2|1} & p_{2|2} & p_{2|3} \\ p_{3|1} & p_{3|2} & p_{3|3} \end{bmatrix}$$

In the present situation, the states of gambling risk level were known and defined by the PGSI. For this reason, the choice of a Markov Model was made, using a Multi-State Markov Model. The outcome of interest was defined by a matrix of transition. The model estimated the associations with gambling risk level transitions and time-varying and transitioning covariates by:

$$P(t) = exp(t * Q)$$

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With $exp(X) = 1 + X^2/2! + X^3/3! + ...$

Where Q = transition intensity matrix (risk of moving from one state to another), and P = transition probability matrix.

The transition intensity matrix is obtained with:

$$q_{r,s}(z(t)) = q_{r,s}^{(0)} * exp(\beta_{r,s}^T z(t))$$

And:

$$P_{r,s}(t) = exp(t * q_{r,s})$$

With:

r, s = two successive states.

Pr,s(t) = probability of being in state s at time t+1, given the state at time t is r.

Z(t) = time-varying or transitioning covariates.

β = coefficients associated with the covariates.

exp(β) = the displayed coefficients are hazard ratios (risk in covariate divided by gambling risk level). Coefficients were considered significant if the 95% confidence interval did not include the value 1 (p-value < 0.05).

If the coefficient was greater than 1, the dummy covariate had a positive association with the probability of transition.

The intensity matrix was defined as:

$$\mathbf{Q} = \begin{bmatrix} -(q_{12}+q_{13}) & q_{12} & q_{13} \\ q_{21} & -(q_{21}+q_{23}) & q_{23} \\ q_{31} & q_{32} & -(q_{31}+q_{32}) \end{bmatrix}$$

It defines which transitions can occur in the Markov process. Fitting the model is a process of finding values of the six unknown transition intensities which maximise the likelihood.

According to the constraints on transitions in PGSI, we have the following probability matrix of intensity:

$$\mathbf{Q} = \begin{bmatrix} -q_{12} & q_{12} & 0 \\ q_{21} & -(q_{21}+q_{23}) & q_{23} \\ 0 & q_{32} & -q_{32} \end{bmatrix}$$

The application of the model was carried out using R version 3.5.2 (R Core Team, 2018) and the msm package (Jackson, 2011).

The covariates were considered as sets of categorical variables (each covariate was defined by a set of dummy variables). The initial step consisted of examining associations with covariates separately with a bivariate Multi-State Markov Model. We considered that a covariate had a significant impact in the model if at least one dummy variable had a significant impact (hazard ratio significantly different from 1) on at least one transition.

The covariates were classified into three separate domains (substance-use variables, health-related variables and variables related to connectedness, deprivation and number of major life events experienced).

From the initial bivariate models, three intermediate models were estimated (according to the domains of variables). The coefficients were only estimated when the covariates had a significant association with a specific transition.

The final model including every significant covariate was estimated. The profiles of individuals being more likely to have a specific transition were determined from the final model. Demographic variables were a fourth domain in the bivariate and intermediate models but were adjusted for as confounders in the final model.

Sensitivity analysis was conducted to assess the robustness of the final model using two subsets of the data. One subset involved the initial two years of data (N = 3,745), and the other subset involved the first three years (N = 3,115). These subsets were then fitted with the final model and significance of the coefficients were examined. There was little difference between using three or all four years of data and, thus, the final model was used. The use of more years of data provided more information about an individual capturing more gambling risk level transitions and transitions in the model covariates. The results are presented and explained in Appendix F (Tables F1 to F4).

RESULTS

Descriptive results

The covariates were considered as two kinds of variables that change over time, namely "transitioning" and "time varying" variables. *Transitioning variables* were those that were likely to change in state over the three time periods (2012 to 2013, 2013 to 2014, and 2014 to 2015). For example, transition of tobacco use was when a participant went from being a smoker to becoming a non-smoker from 2012 to 2013. The *time varying covariates* were those with low probabilities for transition, meaning that they were unlikely to change in state over a time period (i.e. they stayed the same between any two consecutive years) but they could change over the course of the three time periods (i.e. from 2012 to 2015). As there was a low percentage of transitions for time varying variables, the value at year t was kept for analyses. Univariate descriptive statistics for the covariates and their changes over time are presented in Appendix B (Tables B1 to B8).

Only three covariates were categorised as time varying. These were all health-related variables and comprised anxiety, depression and obesity. All other covariates were transitioning variables in that they were likely to change over each time period of the study. These included all the substance use, major life events, deprivation and social connectedness variables, and the remaining health-related variables that were not time-varying. Table 5 describes the final format of the covariates.

Table 5: Format of covariates

Covariate	Time varying (t)	Transition (t to t+1)
Substance use		
Tobacco smoking		Yes
Hazardous alcohol use		Yes
Cannabis use		Yes
Health-related		
Anxiety	Yes	
Depression	Yes	
Obesity	Yes	
Disability		Yes
Chronic illness		Yes
Quality of life		Yes
Past trauma		Yes
General health		Yes
Number of major life events, deprivation and social connectedness		
Number of major life events		Yes
Deprivation		Yes
Can get help from family, friends or neighbours		Yes
Member of an organised group		Yes
Like living in the community		Yes
Overall quality of services in community		Yes

Of the demographic variables, gender, age, ethnicity, household size, educational level and location at baseline were static variables as, generally, these did not change over time. Employment status and annual personal income were time varying. Table 6 describes the final format of the demographic variables.

Table 6: Format of demographic variables

Covariate	Time varying (t)	Static
Gender		Yes
Age		Yes
Ethnicity		Yes
Educational level		Yes
Household size		Yes
Employment	Yes	
Annual personal income	Yes	
Location		Yes

Univariate descriptive statistics for the demographic variables are presented in Appendix B (Tables B9 and B10). As participants could belong to more than one ethnicity category, there was no reference category for the ethnicity covariate.

Bivariate model

The bivariate models that are detailed in Appendix C, Tables C1 to C17, were used to select the intermediate models (shown below).

Intermediate model results

The association between transitions in gambling risk level and the different covariates in the intermediate models are detailed in this section. Tables of intermediate data for the demographic variables are presented in Appendix D, Table D1. The intermediate model results were used to select the significant variables for the final model. All statistically significant associations were shown at the 0.05% level.

Substance use

Table 7 shows the association between transitions in gambling risk level and transitions in substance use.

Participants who quit smoking (Yes to No; i.e. was a smoker who then stopped) were more likely to start gambling (Transition A; Hazard Ratio [HR] = 1.79), whilst participants who continuously smoked tobacco were more likely to transition into risky gambling (Transition C; HR = 1.86), compared with participants who had never smoked tobacco.

Both participants who continuously had hazardous alcohol consumption and those who stopped drinking alcohol in a hazardous manner were more likely to start gambling (HR = 1.56 and 1.58, respectively), compared with participants who never drank alcohol hazardously. However, continuous hazardous alcohol consumption was *less likely* to be associated with stopping gambling (Transition B) and transitioning out of risky gambling (Transition D) (HR = 0.72 and 0.65, respectively), than never drinking alcohol hazardously. Starting or stopping hazardous alcohol consumption were also *less likely*

to be associated with transitioning out of risky gambling (HR = 0.62 and 0.64, respectively), than never drinking alcohol hazardously.

Starting to smoke cannabis and continuously smoking cannabis were both more likely to be associated with transitioning into risky gambler (HR = 2.20 and 2.40, respectively), than people who reported not smoking cannabis during the study.

Table 7: Transitions in gambling risk level and associations with substance use (Intermediate model)

Gambling transition	Substance	Substance transition	No. of observations	Hazard ratio	[95% CI]
A: Starting gambling	Tobacco	Ref: No to No	402	1.00	-
		No to Yes	20	1.38	[0.88-2.16]
		Yes to **No**	**26**	**1.79**	**[1.20-2.67]**
		Yes to Yes	70	1.26	[0.97-1.62]
	Hazardous alcohol	Ref: No to No	346	1.00	-
		No to Yes	30	1.41	[0.95-2.10]
		Yes to **No**	**49**	**1.58**	**[1.15-2.18]**
		Yes to **Yes**	**93**	**1.56**	**[1.22-2.00]**
B: Stopping gambling	Hazardous alcohol	Ref: No to No	432	1.00	-
		No to Yes	48	0.99	[0.71-1.37]
		Yes to No	62	1.10	[0.82-1.47]
		Yes to **Yes**	**123**	**0.72**	**[0.58-0.90]**
C: Transitioning into risky gambling	Tobacco	Ref: No to No	209	1.00	-
		No to Yes	16	1.58	[0.94-2.65]
		Yes to No	17	1.58	[0.96-2.61]
		Yes to **Yes**	**88**	**1.86**	**[1.43-2.43]**
	Cannabis	Ref: No to No	265	1.00	-
		No to **Yes**	**15**	**2.20**	**[1.29-3.76]**
		Yes to No	9	1.05	[0.53-2.05]
		Yes to **Yes**	**41**	**2.40**	**[1.69-3.40]**
D: Transitioning out of risky gambling	Hazardous alcohol	Ref: No to No	171	1.00	-
		No to **Yes**	**18**	**0.62**	**[0.39-1.00]**
		Yes to **No**	**26**	**0.64**	**[0.43-0.97]**
		Yes to **Yes**	**93**	**0.65**	**[0.51-0.84]**

Note: Bold font shows significant covariates at the 0.05 level.

Health-related

Table 8 shows the association between transitions in gambling risk level and transitions in health-related factors.

Compared with participants who reported not having a chronic illness during the study, participants who developed a chronic illness were more likely to start gambling (HR = 1.38) and *less likely* to stop gambling (HR = 0.55). Participants who continuously had a chronic illness were also *less likely* to stop

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Auckland University of Technology, Gambling and Addictions Research Centre
Final Report, 7 September 2020

gambling (HR = 0.77) and recovering from a chronic illness was *less likely* to be associated with transitioning into risky gambling (HR = 0.53).

Participants who had anxiety and those who continuously experienced past trauma were more likely to transition into risky gambling (HR = 1.51 and 1.43, respectively), compared with participants who had not experienced anxiety or past trauma.

Compared with participants who continuously had an average/high quality of life (median level or higher), participants with a low quality of life (always below median level), or who increased their quality of life from low to median level or higher were more likely to transition into risky gambling (HR = 1.88 and 1.47, respectively). Conversely, low, increased or decreased quality of life were *less likely* to be associated with transitioning out of risky gambling (HR = 0.62, 0.60 and 0.68, respectively).

Table 8: Transitions in gambling risk level and associations with health-related factors (Intermediate model)

Gambling transition	Health factor	Health transition	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Chronic illness	Ref: No to No	291	1.00	-
		No to Yes	**55**	**1.38**	**[1.02-1.86]**
		Yes to No	29	1.01	[0.68-1.51]
		Yes to Yes	144	0.86	[0.70-1.06]
B: Stopping gambling	Chronic illness	Ref: No to No	392	1.00	-
		No to Yes	**26**	**0.55**	**[0.36-0.83]**
		Yes to No	53	1.19	[0.88-1.63]
		Yes to Yes	**194**	**0.77**	**[0.64-0.93]**
C: Transitioning into risky gambling	Anxiety	Ref: No	299	1.00	-
		Yes	**30**	**1.51**	**[1.03-2.24]**
	Chronic illness	Ref: No to No	181	1.00	-
		No to Yes	36	1.36	[0.95-1.95]
		Yes to No	**12**	**0.53**	**[0.30-0.96]**
		Yes to Yes	100	0.80	[0.62-1.03]
	Quality of life	**Below Median to Below Median**	**144**	**1.88**	**[1.41-2.51]**
		Below Median to Median or above	**51**	**1.47**	**[1.02-2.13]**
		Median or above to Below Median	34	1.08	[0.71-1.65]
		Ref: Median or above to Median or above	100	1.00	-
	Past trauma	Ref: No to No	369	1.00	-
		No to Yes	150	1.24	[0.88-1.74]
		Yes to No	457	0.99	[0.66-1.48]
		Yes to Yes	**208**	**1.43**	**[1.10-1.87]**

Gambling transition	Health factor	Health transition	No. of observations	Hazard Ratio	[95% CI]
D: Transitioning out of risky gambling	Quality of life	**Below Median to Below Median**	**127**	**0.62**	**[0.47-0.81]**
		Below Median to Median or above	**35**	**0.60**	**[0.40-0.90]**
		Median or above to Below Median	**42**	**0.68**	**[0.47-0.99]**
		Ref: Median or above to Median or above	104	1.00	-

Note: Bold font shows significant covariates at 0.05 level.

Major life events, deprivation and social connectedness

Table 9 shows the association between transitions in gambling risk level and transitions in major life events, deprivation and social connectedness.

Participants who continuously experienced one or more major life events in the prior year were more likely to both start gambling and to transition into risky gambling (HR = 1.38 and 2.17, respectively), than participants who did not experience any major life events in the prior year.

Compared with participants who reported no past year deprivation during the study, those who had continuously experienced one or more individual levels of deprivation were more likely to stop gambling (HR = 1.29) and transition into risky gambling (HR = 2.00). Transitioning into levels of deprivation was also more likely to be associated with transitioning into risky gambling (HR = 2.50).

Whilst stopping membership of an organised group was more likely to be associated with transitioning into risky gambling (HR = 1.52), participants who reported not being a member of an organised group during the study were *less likely* to stop gambling (HR = 0.81), compared with participants who retained membership of group/s. Additionally, not, or no longer, being able to access help from family, friends and neighbours was more likely to be associated with transitioning into risky gambling (HR 1.90 and 2.31, respectively), compared with always being able to access help.

Participants who continuously reported poor/okay services in the neighbourhood were *less likely* to transition out of risky gambling (HR = 0.65) than participants who reported continual good neighbourhood services.

Table 9: Transitions in gambling risk level and associations with major life events, deprivation and social connectedness (Intermediate model)

Gambling transition	Life event/ deprivation/ connectedness	Connectedness/life event transition	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Number of life events	Ref: 0 to 0	60	1.00	-
		0 to 1+	85	1.36	[0.98-1.88]
		1+ to 0	85	1.28	[0.92-1.78]
		1+ to 1+	**278**	**1.38**	**[1.05-1.82]**
B: Stopping gambling	Deprivation	Ref: 0 to 0	278	1.00	-
		0 to 1+	65	1.22	[0.93-1.61]
		1+ to 0	91	1.20	[0.94-1.53]
		1+ to 1+	**195**	**1.29**	**[1.04-1.59]**
	Member of an organised group	**No to No**	**207**	**0.81**	**[0.68-0.98]**
		No to Yes	71	1.05	[0.79-1.38]
		Yes to No	52	0.78	[0.57-1.06]
		Ref: Yes to Yes	322	1.00	-
C: Transitioning into risky gambling	Number of life events	Ref: 0 to 0	26	1.00	-
		0 to 1+	44	1.48	[0.91-2.41]
		1+ to 0	33	1.00	[0.60-1.68]
		1+ to 1+	**221**	**2.17**	**[1.44-3.27]**
	Deprivation	Ref: 0 to 0	104	1.00	-
		0 to 1+	**52**	**2.50**	**[1.77-3.53]**
		1+ to 0	33	1.14	[0.76-1.70]
		1+ to 1+	**121**	**2.00**	**[1.48-2.72]**
	Can get help from family, friends or neighbours	**No to No**	**19**	**1.90**	**[1.17-3.08]**
		No to Yes	23	1.45	[0.93-2.27]
		Yes to No	**34**	**2.31**	**[1.58-3.38]**
		Ref: Yes to Yes	248	1.00	-
	Member of an organised group	No to No	118	1.15	[0.89-1.49]
		No to Yes	36	1.19	[0.82-1.73]
		Yes to No	**44**	**1.52**	**[1.07-2.16]**
		Ref: Yes to Yes	126	1.00	-
D: Transitioning out of risky gambling	Quality of services in neighbourhood	Ref: Good to Good	176	1.00	
		Good to Poor/Ok	41	0.95	[0.66-1.36]
		Poor/Ok to Good	42	0.80	[0.56-1.15]
		Poor/Ok to Poor/Ok	**44**	**0.65**	**[0.46-0.92]**

Note: Bold font shows significant covariates at the 0.05 level.

Associations between the different covariates with transitions in gambling risk level in the final model are detailed in this section. The full table of data, showing covariates and confounding demographic variables, is presented in Appendix E, Table E1.

Table 10 details the factors significantly associated with the different gambling risk level transitions. Some of these factors were associated with each of the gambling risk level transitions.

Confounding demographic factors that were adjusted for in the model included age, ethnicity, educational level and employment status (Table 10; Appendix E, Table E2).

Substance use

Substance use was significantly associated with all the gambling risk levels transitions.

Participants who stopped smoking tobacco, moved out of hazardous alcohol consumption, or continuously consumed alcohol at a hazardous level were all more likely to be associated with starting gambling (HR = 1.76, 1.46 and 1.31, respectively), compared with participants who had never smoked tobacco or never consumed alcohol in a hazardous manner.

Participants who continuously smoked tobacco (HR = 1.37), and those who started to use cannabis or continuously used cannabis (HR = 1.80 and 2.13, respectively) were more likely than participants who did not smoke tobacco or use cannabis to transition into risky gambling.

Health-related

All the gambling risk levels transitions were significantly associated with one of two health-related factors: **chronic illness and quality of life**.

Compared with participants who reported not having a chronic illness during the study, those who continuously had a chronic illness were *less likely* to start or to stop gambling (HR = 0.81 and 0.79, respectively). Additionally, participants who developed a chronic illness were *less likely* to stop gambling (HR = 0.56).

Continuously having a low (below median level) quality of life was more likely to be associated with transitioning into risky gambling (HR = 1.42), whilst continuously having a low quality of life was *less likely* to be associated with transitioning out of risky gambling (HR = 0.70), compared with continuously having an average/high quality of life.

Gambling risk level transitions were not associated with transitions or changes in other health factors such as anxiety, depression, general health, disability, past trauma or obesity.

Major life events, deprivation and social connectedness

The only gambling transitions associated with **number of major life events, deprivation and social connectedness** experienced in the past 12 months were stopping gambling and transitioning into risky gambling.

Compared with reporting no experience of deprivation during the study, continuously experiencing at least one level of deprivation was more likely to be associated with stopping gambling (HR = 1.34), whilst starting to experience deprivation (HR = 1.82) was more likely to be associated with transitioning into risky gambling.

Stopping being a member of an organised group (HR = 1.51) and continuously having one or more major life events in the prior year (HR = 1.92) were also both more likely to be associated with transitioning into risky gambling, compared with always being a member of a group or not experiencing any major life events in the prior year, respectively.

Gambling risk level transitions were not associated with transitions or changes in other social connectedness factors of being able to access help from family, friends or neighbours; liking living in the community; and the quality of services available in the community.

Table 10: Transitions in gambling risk level and significant associations with substance use; health; and major life events, deprivation and social connectedness (Final model)

Variable	A: Starting gambling	B: Stopping gambling	C: Transitioning into risky gambling	D: Transitioning out of risky gambling
Substance use				
Tobacco: Yes to No	1.76	--	--	--
Tobacco: Yes to Yes	--	--	1.37	--
Hazardous alcohol: Yes to No	1.46	--	--	--
Hazardous alcohol: Yes to Yes	1.31	0.68	--	0.60
Cannabis: No to Yes	--	--	1.80	--
Cannabis: Yes to Yes	--	--	2.13	--
Health-related				
Chronic illness: No to Yes	--	0.56	--	--
Chronic illness: Yes to Yes	0.81	0.79	--	--
Quality of life: Below Median to Below Median	--	--	1.42	0.70
Life events				
Number of life events: 1+ to 1+	--	--	1.92	--
Deprivation				
NZiDep: 0 to 1+	--	--	1.82	--
NZiDep: 1+ to 1+	--	1.34	--	--
Social connectedness				
Member of an organised group: Yes to No	--	--	1.51	--
Confounders				
Age: 25-44 years	--	0.55	--	--
Age: 45-64 years	--	0.42	--	--
Age: 65+ years	--	0.46	--	--
Ethnicity: Asian	0.68	--	--	--
Ethnicity: European/Other	--	--	0.50	--
Ethnicity: Māori	1.32	--	--	--

Variable	A: Starting gambling	B: Stopping gambling	C: Transitioning into risky gambling	D: Transitioning out of risky gambling
Educational level: University degree	--	--	0.64	--
Employment: Part time	--	1.25	--	--
Employment: Retired	--	1.44	--	--
Employment: Other	--	1.37	--	--

DISCUSSION AND CONCLUSION

It has long been recognised that problematic gambling is significantly associated with a variety of negative factors including substance use, poor mental and physical health, lower quality of life, poorer social connectedness, and higher levels of deprivation. However, transitional relationships between problematic gambling and these factors have not been well studied nor identified. One of the major reasons is because such analyses can only be undertaken in longitudinal studies where the same participants are repeatedly interviewed over time. Such studies are, by their very nature, time consuming to conduct as well as expensive. These are two reasons why funding bodies are often reluctant to fund such ventures, particularly when the data necessary to assist with policy and strategy decisions are generally required rapidly.

In New Zealand, we have been fortunate to have been able to conduct the National Gambling Study, which had repeated data collection on four consecutive years from 2012 to 2015. Using these data, the aims of the present study were to:
- Identify correspondence between changes in gambling status over time with changes in other addictive behaviours.
- Identify correspondence between changes in gambling status over time with changes in health and wellbeing status.
- Identify correspondence between changes in gambling status over time with changes in social engagement and deprivation.

These aims were achieved using a Multi-State Markov Modelling approach. This statistical method is valuable to understand transitional events in an individual's life, when that individual occupies one of a possible number of states at any given time. It is a useful approach to model event-related dependence and recurrent events (Hougaard, 1999).

A further intended aim was to examine the differences in Māori and non-Māori models. However, the small numbers of the different transitions when the data were split thus by ethnicity precluded those analyses. A major consideration was that only participants who provided data for all four of the data collection years could be considered in the analyses, since the focus was on transitions across the years.

Four gambling risk level transitions were identified and investigated in this study. These were:
A) Changing from non-gambler to non-problem gambler (i.e. starting gambling)
B) Changing from non-problem gambler to non-gambler (i.e. stopping gambling)
C) Changing from non-gambler to at-risk gambler (low risk, moderate risk or problem gambler; i.e. transitioning into risky gambling)
D) Changing from at-risk gambler (low risk, moderate risk or problem gambler) to non-problem gambler (i.e. transitioning out of risky gambling)

Changes in gambling risk levels over time and associations with changes in substance use behaviours

Many research studies, including the various data collection years of the National Gambling Study, have shown that problematic gambling is strongly associated with substance use, abuse and/or dependence (alcohol, tobacco, and other legal and illegal drugs). These have included population level prevalence studies within New Zealand (Abbott et al., 2014b; Rossen, 2015; Thimasarn-Anwar et al., 2017) and overseas (Billi et al., 2014; el-Guebaly et al., 2015; Public Health Agency of Sweden, 2016;

Wardle et al., 2011b; Williams et al., 2015) and cross-sectional studies (see Cowlishaw et al., 2014 and Lorains et al., 2011 for reviews).

The present study identified that *changing* gambling behaviour was significantly associated with either changing alcohol, tobacco or other drug consumption behaviour or maintaining the same substance use behaviour over time.

Starting gambling was significantly more likely to be associated with reducing both tobacco smoking and alcohol consumption. Specifically, participants who stopped smoking tobacco and/or who changed from hazardous alcohol consumption to non-hazardous alcohol consumption were more likely to start gambling, than participants who had never smoked tobacco or drunk alcohol hazardously. These changes in substance use behaviour may have been due to some replacement of these substances with gambling, as was identified by Carnes et al., 2004 (p. 35) when they iterated that addiction replacement is where "one addiction replaces another with a majority of the emotional and behavioural features of the first". Although people who started gambling were not categorised as risky gamblers, it is possible that this was the start of replacement of substance use with the gambling behaviour. An alternative explanation is that these participants had fewer opportunities to smoke or drink alcohol (because their time was occupied with gambling) or they may have had less disposable income to spend on those substances because it was spent on gambling.

Starting gambling was also more likely to be associated with continuously drinking alcohol in a hazardous manner, whilst **stopping gambling and transitioning out of risky gambling were both <u>less</u> likely to be associated with continuously drinking alcohol in a hazardous manner**, than with never drinking alcohol hazardously. These findings suggest that increasing gambling behaviour is more likely to be associated with a sustained high level of alcohol consumption, and decreasing gambling behaviour is not, perhaps because of lifestyle changes or changes in circumstances. It is of note, however, that the transition from non-problem gambler to at-risk gambler did not show any association with hazardous alcohol consumption transitions or stability, so the relationship is likely to be complex with many factors being involved. The qualitative phase of the NGS, where 50 participants took part in comprehensive semi-structured interviews, found that for a few participants, increased gambling behaviour was believed to be linked to alcohol consumption because of the lowered inhibition and increased risk taking (Bellringer et al., 2019).

The finding that starting gambling was more likely to be associated both with reducing hazardous alcohol consumption <u>and</u> with maintaining hazardous consumption indicates that, indeed, the relationship between gambling behaviour and risky alcohol consumption is complicated and is undoubtedly influenced by many other factors including personality, such as a propensity for risk taking (Mishra et al., 2010; Samuelsson et al., 2018), and environment (e.g. electronic gaming machines are usually located in venues that provide alcohol, such as pubs, clubs and casinos). The present study controlled for socio-demographic confounders; however, other factors such as personality and environmental factors could not be considered since those data were not collected. The common co-location of alcohol availability with gambling opportunities is a consideration for public health policy makers. Whilst the harm minimisation approach that ensures gambling availability, particularly for the more harmful forms of gambling such as electronic gaming machines, is not the major focus of a business (unless in a gambling destination such as a casino), the current findings indicate that co-location of gambling and alcohol availability could have unintended consequences, perpetuating hazardous alcohol consumption or initiating gambling behaviour for some people.

Although **transitioning into risky gambling behaviours** was not associated with hazardous alcohol consumption, it **was more likely to be associated with continuous tobacco smoking** over time, compared with never smoking tobacco. This finding is interesting in the context of starting gambling

being associated with stopping smoking. It suggests that gamblers who increase their gambling to a high, and potentially harmful, level are more likely to be regular smokers, suggesting a strong link between problematic gambling and smoking. This has, in fact, been found in cross-sectional studies whereby problematic gambling has been found to be associated with smoking along with other unhealthy behaviours (Black et al., 2013; McGrath & Barrett, 2009). The same explanation may also be the reason that **transitioning into risky gambling was more likely to be associated with cannabis use**, both with starting to use cannabis, and with continued consumption of cannabis over time (compared with no cannabis use), since cannabis consumption is most often via smoking. A relatively recent cross-sectional study of Spanish adolescents identified that smoking tobacco and alcohol consumption were both associated with cannabis use and with problematic gambling (Míguez & Becoña, 2015). This finding is important given the current debate around legalising cannabis consumption in New Zealand.

Changes in gambling risk levels over time and associations with changes in health and wellbeing

Both starting and stopping gambling were less likely to be associated with continuously having a chronic illness (such as cancer, diabetes, lung disease, heart disease, high blood pressure or high cholesterol), compared with people who reported not having a chronic illness during the study. Similarly, **stopping gambling was less likely to be associated with developing a chronic illness**. These findings are perhaps related to such people being too incapacitated by, or pre-occupied with, their ongoing health condition to change their gambling behaviours. The present study did not identify a correlation between a transition into risky gambling and development of a chronic illness.

However, **transitioning into risky gambling was more likely to be associated with continuous low quality of life** (i.e. staying below median level), whilst **transitioning out of risky gambling was less likely to be associated with continuous low quality of life**, compared with continuous average/high quality of life. This finding is not surprising. Several cross-sectional studies have found an association between problem gambling and low quality of life (e.g. Black et al., 2013; Mythily et al., 2017). People gambling in a risky manner experience at least some level of harm from their gambling (Browne et al., 2017a; Rawat et al., 2018) and these harms can lead to detrimental effects on quality of life (Bellringer et al., 2013; Browne et al., 2017a; Langham et al., 2016; Lin et al., 2011). Conversely, it is plausible that transitioning out of risky gambling would have an opposite effect - with a reduction or cessation of gambling harms, quality of life is likely to improve. Browne et al. (2017c), using a Health Related Quality of Life approach to measure Disability Weights, identified that the quality of life of a typical problem gambler was detrimentally affected about three times more than for low risk gamblers, with moderate risk gamblers in the middle. Whilst the Browne et al. study does not indicate causality, the decreasing level of quality of life with increasing gambling problems, and the fact that quality of life is negatively affected by any level of risky gambling, could help to explain the current findings.

The present study found that **gambling risk level transitions were not associated with transitions or changes in other mental or physical health factors such as anxiety, depression, general health, disability, past trauma or obesity**. However, a substantial body of cross-sectional and qualitative research has shown that problematic gambling *is* associated with mental health issues including depression and anxiety, general health and wellbeing, and physical health issues such as obesity (Bellringer et al., 2019; Lorains et al., 2011; Mutti-Packer et al., 2017, Reith & Dobbie, 2013, Victorian Responsible Gambling Foundation, 2012). This suggests that whilst problematic gambling and health issues are related, the temporal sequencing of changes in gambling behaviour and changes in these health conditions may not be associated or may be affected by confounders other than socio-demographic factors. This supposition is partly borne out by the intermediate model results in the

present study, which indicated an association between transitioning into risky gambling and transitions in having anxiety or experiencing past trauma. The disappearance of these statistically significant associations in the final model, when all the variable models were combined to remove confounding influences, confirms the complexity of the associations and the fact that a variety of factors influence changes in state or behaviour.

In the main, previous studies have been cross-sectional although some longitudinal analyses have been conducted that showed some influences of gambling transitions on health conditions at a particular point in time (i.e. these have not investigated health transitions in concurrence with gambling transitions). For example, at a population level in a study of people seeking help for problematic gambling, the prevalence of concurrent depression was noted to reduce when gambling risk reduced (Ranta et al., 2019); however, this finding was not investigated at an individual level as in the present study. Further research is required in order to understand the complex relationship between gambling transitions and changes in health and wellbeing.

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Changes in gambling risk levels over time and associations with changes in major life events, deprivation and social connectedness

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Gambling and gambling transitions have previously, including in the NGS, been shown to be associated with the experience of one or more major life events in the prior year (Abbott et al., 2016; Billi et al., 2014; el-Guelbaly et al., 2015, Williams et al., 2015). These events may be positive (e.g. marriage, moving to a new house or starting a new job) or negative (e.g. death of a family member, divorce or legal difficulties) but have in common that they are all inherently stressful situations.

Transitioning into risky gambling was more likely to be associated with repeatedly experiencing one or more major life events in the prior year, than with not experiencing any major life events. This is not unexpected given the large body of research that has shown that people, especially women, use gambling to escape from stressful situations (Bellringer et al., 2019; Samuelsson et al., 2018, Victorian Responsible Gambling Foundation, 2012) or to 'zone out' from reality, even temporarily (Dow Schüll, 2005, Oakes et al., 2012a). The intermediate model results also found that starting gambling was more likely to be associated with repeatedly experiencing one or more major life events in the prior year; however, this finding disappeared in the final model indicating that the important change in gambling behaviour is not increased gambling, per se, but the increase in gambling behaviour to a risky level. It may be that having a wider availability of support systems available to people who experience stressful situations could help to prevent the transition from harmless gambling to harmful (i.e. risky) gambling. This is important from a public health perspective.

Problematic gambling has been previously shown to be associated with deprivation in the NGS and is partly related to the disproportionately high density of gambling venues in areas of higher deprivation (Abbott et al., 2018a). It is unsurprising that problematic gambling is associated with levels of deprivation as gambling involves financial transactions, which means that people gambling in a risky manner inevitably spend more on gambling. Financial harms are the most well-known of the many harms from gambling experienced by risky gamblers (Browne et al., 2016; Langham et al., 2016) and having a lack of money means that people start to experience levels of individual deprivation such as being forced to buy cheaper food, or requiring a government benefit or allowance. This is a logical explanation in the present study for the finding that **transitioning into risky gambling was more likely to be associated with starting to experience levels of individual deprivation** (i.e. changing from a level of no deprivation to some deprivation), than with reporting no experience of deprivation during the study. Conversely, the present study also identified that **stopping gambling was more likely to be**

associated with repeatedly experiencing some deprivation over time. Although this might seem counter intuitive, since stopping gambling should conceivably increase financial resources, there are two possible explanations. First, living in repeated deprivation could mean that there is no longer any money available to fund gambling behaviours and, thus, the gambling stops whilst the deprivation continues. Alternatively, even though the gambling behaviours may have stopped, the long-term consequences of the behaviour may continue. For example, if all financial reserves have been exhausted, it may be a long time, if ever, before they are replenished to a sufficient state to enable a person to cease to experience some level of deprivation. These long-term harms are termed 'legacy' harms and were discussed in recent research in Australia and New Zealand (Browne et al., 2016; Browne et al, 2017a; Langham et al., 2016). They are also the topic of an ongoing study in New Zealand, with results due in 2021.

There was only one social connectedness factor associated with gambling transitions. This was **transitioning into risky gambling, which was more likely to be associated with stopping memberships of organised group/s**, compared with always having been a member of a group/s. Types of groups that the participants were asked about included sports, church, and other community groups including those online. This finding could imply that people who are gambling in a risky manner no longer have the time or inclination to participate in social groups, presumably because their leisure time is taken up with the increased gambling behaviour (Browne et al, 2017a). The Victorian Gambling Study found that problem gamblers were significantly less likely to participate in community activities than non-problem gamblers (Billi et al., 2014). Studies of gambling harms in Pacific communities have identified reduced community contribution as a negative cultural consequence of risky gambling behaviours (Bellringer et al., 2013; Guttenbeil-Po'uhila et al., 2004; Perese & Faleafa, 2000). Similarly, negative effects from gambling for Asian people have been found to include the loss of social connection (Sobrun-Maharaj et al., 2012). Although the sample sizes in the present study were too small to allow analyses by different ethnic groups, it is possible that reduced community contribution by way of group memberships could be exacerbated in ethnic populations with a community-focused way of life (e.g. Māori, Pacific and Asian communities) rather than populations with a more individualistic approach to life (e.g. European/Pākehā communities). This requires further research to fully understand and before any community-level interventions could be considered to reduce such population level harms from gambling.

Gambling risk level transitions were not associated with other social connectedness factors such as being able to access help from family, friends or neighbours; liking living in the community; and the quality of services available in the community. This suggests that a person's gambling behaviours may not be directly affected by these social factors.

Conclusion

This study aimed to identify relationships between *changes* in gambling behaviour over time (during the period of 2012 to 2015) with changes or stability in substance use, health status, major life events, deprivation and social engagement.

It found that transitioning into risky gambling behaviours was significantly more likely to be associated with continued or repeated negative life factors such as smoking, low quality of life and experiencing stressful life events. It was also more likely to be associated with increased deprivation and reduced community interaction. Conversely, taking up gambling in a non-risky manner was more likely to be associated with reduced alcohol consumption and tobacco smoking, which could be positive benefits

linked with recreational gambling as long as the gambling behaviour does not become risky. Stopping gambling was more likely to be associated with repeated experience of deprivation.

Transitioning out of risky gambling was less likely to be associated with continuous hazardous alcohol consumption and low quality of life. In other words, people who stopped gambling in a risky manner, were also less likely to drink alcohol in a risky manner and were more likely to have a better quality of life. Similarly, people who stopped gambling were less likely to drink alcohol hazardously, or to develop or maintain a chronic illness, meaning that these people were more likely to have better health and to drink alcohol recreationally. People who started gambling were also less likely to continuously have a chronic illness.

These findings demonstrate that, whilst different gambling transitions are more, or less, associated with different health and lifestyle factors, transitioning into risky gambling is associated with the highest number of significant factors, including the maintenance or development of several negative health and lifestyle factors, which may possibly be alleviated by transitioning out of risky gambling. It is highly likely that additional, unexamined factors (such as personality) have also influenced, or been confounding factors, in some of the associations. It is also possible that there could be some transitional lag effects that were not identified because the current study focused on concurrent changes. That is to say, the study examined changes in gambling behaviour from 2012 to 2015 with changes in substance use, health status, major life events, deprivation and social engagement also from 2012 to 2015. However, some associations might not have been immediately obvious but might have become apparent after a prolonged period, when the consequences of, for example, increased or decreased risky gambling behaviour manifested in the longer-term. It was not possible to measure longer term associations in this study. More research is, thus, required to further understand transitions in gambling behaviour in relation to changes in health and lifestyle factors, and to understand implications for minimising gambling harms.

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Table A1: Distribution of PGSI (3 categories) over time by ethnicity

PGSI	2012		2013		2014		2015		Total	
	N	%	N	%	N	%	N	%	N	%
European/Other										
Non-gambler	280	16.5	312	18.3	322	18.9	379	22.3	1293	19.0
Non-problem gambler	1344	79.0	1292	75.9	1290	75.8	1235	72.6	5161	75.8
At-risk gambler	78	4.6	98	5.8	90	5.3	88	5.2	354	5.2
Māori										
Non-gambler	55	11.6	73	15.4	73	15.4	82	17.3	283	15.0
Non-problem gambler	358	75.7	327	69.1	332	70.2	330	69.8	1347	71.2
At-risk gambler	60	12.7	73	15.4	68	14.4	61	12.9	262	13.8
Pacific										
Non-gambler	103	36.5	112	39.7	105	37.2	107	37.9	427	37.9
Non-problem gambler	164	58.2	146	51.8	152	53.9	154	54.6	616	54.6
At-risk gambler	15	5.3	24	8.5	25	8.9	21	7.4	85	7.5
Asian										
Non-gambler	70	24.4	76	26.5	74	25.8	92	32.1	312	27.2
Non-problem gambler	169	58.9	154	53.7	161	56.1	145	50.5	629	54.8
At-risk gambler	48	16.7	57	19.9	52	18.1	50	17.4	207	18.0

Table A2: Percentage distribution of transitions in 3-category PGSI by ethnicity

Transition	Non-gambler	Non-problem gambler	At-risk gambler
European/Other			
Non-gambler	62	38	-
Non-problem gambler	10	86	4
At-risk gambler	-	58	42
Māori			
Non-gambler	56	44	-
Non-problem gambler	11	81	8
At-risk gambler	-	37	63
Pacific			
Non-gambler	72	28	-
Non-problem gambler	17	70	13
At-risk gambler	-	44	56
Asian			
Non-gambler	78	22	-
Non-problem gambler	15	77	8
At-risk gambler	-	50	50

Table B1: Distribution of substance use transition variables by year

Covariate	Category	2012		2013		2014		2015		Total	
		N	%	N	%	N	%	N	%	N	%
Tobacco	Never	1468	53.0	1465	52.9	1448	52.3	1471	53.1	5852	52.8
	Past	791	28.6	806	29.1	833	30.1	831	30.0	3261	29.4
	Current	511	18.4	499	18.0	489	17.7	468	16.9	1967	17.8
Hazardous Alcohol	Yes	931	33.6	885	31.9	849	30.7	787	28.4	3452	31.2
	No	1838	66.4	1885	68.1	1919	69.3	1983	71.6	7625	68.8
Cannabis	Yes	254	9.2	202	7.3	206	7.4	212	7.7	874	7.9
	No	2516	90.8	2568	92.7	2564	92.6	2558	92.3	10206	92.1

Table B2: Distribution of substance use transition variables over time

Covariate	Transitions	2012 to 2013		2013 to 2014		2014 to 2015	
		N	%	N	%	N	%
Tobacco	No to No	2087	77.0	2072	76.5	2145	79.2
	No to Yes	132	4.9	86	3.2	59	2.2
	Yes to No	71	2.6	132	4.9	100	3.7
	Yes to Yes	420	15.5	420	15.5	406	15.0
Hazardous alcohol consumption	No to No	1610	59.4	1647	60.8	1703	62.9
	No to Yes	185	6.8	192	7.1	170	6.3
	Yes to No	230	8.5	226	8.3	231	8.5
	Yes to Yes	684	25.2	643	23.7	604	22.3
Cannabis	No to No	2414	89.1	2455	90.6	2451	90.4
	No to Yes	53	2.0	58	2.1	59	2.2
	Yes to No	99	3.7	55	2.0	52	1.9
	Yes to Yes	144	5.3	142	5.2	148	5.5

Table B3: Distribution of health-related time varying variables by year

Covariate	Category	2012		2013		2014		2015		Total	
		N	%	N	%	N	%	N	%	N	%
Anxiety	Yes	158	5.7	143	5.2	154	5.6	153	5.5	608	5.5
	No	2612	94.3	2627	94.8	2616	94.4	2617	94.5	10472	94.5
Depression	Yes	203	7.3	194	7.0	199	7.2	191	6.9	787	7.1
	No	2567	92.7	2576	93.0	2571	92.8	2579	93.1	10293	92.9
Obesity	Yes	273	9.9	285	10.3	301	10.9	319	11.5	1178	10.6
	No	2497	90.1	2485	89.7	2469	89.1	2451	88.5	9902	89.4

Table B4: Number of health-related time varying variable transitions by gambling risk level transition

Health-related transitions	A: Starting gambling	B: Stopping gambling	C: Transitioning into risky gambling	D: Transitioning out of risky gambling
Anxiety				
No to No	**477**	**623**	**287**	**266**
No to Yes	13	17	13	13
Yes to No	10	10	13	15
Yes to Yes	**19**	**17**	**17**	**15**
% of transitions	*4*	*4*	*7*	*9*
Depression				
No to No	**470**	**598**	**283**	**261**
No to Yes	15	24	12	12
Yes to No	14	19	8	12
Yes to Yes	**20**	**26**	**27**	**24**
% of transitions	*5*	*6*	*6*	*7*
Obesity				
No to No	**446**	**586**	**269**	**246**
No to Yes	23	21	21	14
Yes to No	15	21	9	18
Yes to Yes	**35**	**39**	**31**	**31**
% of transitions	*7*	*6*	*9*	*10*

Table B5: Distribution of health-related transition variables by year

Covariate	Category	2012 N	2012 %	2013 N	2013 %	2014 N	2014 %	2015 N	2015 %	Total N	Total %
Disability	Yes	531	*19.2*	506	*18.3*	506	*18.3*	536	*19.4*	2079	*18.8*
	No	2239	*80.8*	2264	*81.7*	2264	*81.7*	2234	*80.6*	9001	*81.2*
Chronic illness											
Cancer	Yes	67	*2.4*	68	*2.5*	70	*2.5*	64	*2.3*	269	*2.4*
	No	2703	*97.6*	2702	*97.5*	2700	*97.5*	2706	*97.7*	10811	*97.6*
Lung conditions	Yes	280	*10.1*	294	*10.6*	285	*10.3*	291	*10.5*	1150	*10.4*
	No	2490	*89.9*	2476	*89.4*	2485	*89.7*	2479	*89.5*	9930	*89.6*
Diabetes	Yes	190	*6.9*	193	*7.0*	221	*8.0*	220	*7.9*	824	*7.4*
	No	2580	*93.1*	2577	*93.0*	2549	*92.0*	2550	*92.1*	10256	*92.6*
Heart, blood pressure, cholesterol issues	Yes	791	*28.6*	818	*29.5*	828	*29.9*	877	*31.7*	3314	*29.9*
	No	1979	*71.4*	1952	*70.5*	1942	*70.1*	1893	*68.3*	7766	*70.1*
Quality of life	Below median (Score 0-24)	1214	*43.9*	1212	*43.8*	1197	*43.3*	1179	*42.6*	4802	*43.4*
	Median (Score 25)	279	*10.1*	281	*10.2*	258	*9.3*	257	*9.3*	1075	*9.7*
	Above median (Score 26-32)	1274	*46.0*	1275	*46.1*	1312	*47.4*	1332	*48.1*	5193	*46.9*
Past trauma	No major problem	2031	*73.3*	-	-	-	-	-	-	2031	*18.3*
	Major problem	735	*26.5*	-	-	-	-	-	-	735	*6.6*
	Strongly agree	-	-	299	*10.8*	296	*10.7*	289	*10.4*	884	*8.0*
	Agree	-	-	608	*21.9*	638	*23.0*	625	*22.6*	1871	*16.9*
	Disagree	-	-	947	*34.2*	983	*35.5*	982	*35.5*	2912	*26.3*
	Strongly disagree	-	-	915	*33.0*	849	*30.6*	868	*31.3*	2632	*23.8*
	Not reported	4	*0.1*	1	*0.0*	4	*0.1*	6	*0.2*	15	*0.1*
General health	Excellent	491	*17.7*	460	*16.6*	469	*16.9*	408	*14.7*	1828	*16.5*
	V. good	919	*33.2*	938	*33.9*	919	*33.2*	927	*33.5*	3703	*33.4*
	Good	912	*32.9*	944	*34.1*	950	*34.3*	952	*34.4*	3758	*33.9*
	Fair	350	*12.6*	346	*12.5*	338	*12.2*	383	*13.8*	1417	*12.8*
	Poor	97	*3.5*	82	*3.0*	94	*3.4*	100	*3.6*	373	*3.4*

Table B6: Distribution of health-related transition variables over time

Covariate	Transitions	2012 to 2013		2013 to 2014		2014 to 2015	
		N	%	N	%	N	%
Quality of life	Below median to Below median	823	30.4	813	30.1	813	30.1
	Below median to Median or above	356	13.2	361	13.3	341	12.6
	Median or above to Below median	351	13.0	342	12.6	323	11.9
	Median or above to Median or above	1176	43.5	1189	44.0	1228	45.4
Chronic illness	No to No	1495	55.2	1477	54.5	1438	53.1
	No to Yes	191	7.0	194	7.2	192	7.1
	Yes to No	176	6.5	153	5.6	159	5.9
	Yes to Yes	848	31.3	886	32.7	921	34.0
Disability	No to No	1999	73.8	2003	73.9	1990	73.4
	No to Yes	195	7.2	217	8.0	225	8.3
	Yes to No	221	8.2	212	7.8	194	7.2
	Yes to Yes	295	10.9	278	10.3	301	11.1
Past trauma	No to No	2001	36.9	1813	33.5	1835	33.9
	No to Yes	709	13.1	897	16.5	875	16.1
	Yes to No	1835	33.9	2001	36.9	1813	33.5
	Yes to Yes	875	16.1	709	13.1	897	16.5
General health	Fair/Poor to Fair/Poor	218	8.0	217	8.0	239	8.8
	Fair/Poor to Good	214	7.9	200	7.4	179	6.6
	Good to Fair/Poor	199	7.3	201	7.4	223	8.2
	Good to Good	2078	76.7	2092	77.2	2069	76.3

Table B7: Distribution of major life events, deprivation and social connectedness transition variables by year

Covariate	Category	2012		2013		2014		2015		Total	
		N	%	N	%	N	%	N	%	N	%
Number of major life events	0	757	27.3	823	29.7	825	29.8	878	31.7	3283	29.6
	1	741	26.8	812	29.3	773	27.9	829	29.9	3155	28.5
	2	526	19.0	533	19.2	555	20.0	507	18.3	2121	19.1
	3	341	12.3	320	11.6	352	12.7	300	10.8	1313	11.9
	4	211	7.6	151	5.5	142	5.1	135	4.9	639	5.8
	5	98	3.5	73	2.6	65	2.3	60	2.2	296	2.7
	6	53	1.9	32	1.2	30	1.1	37	1.3	152	1.4
	7	29	1.0	19	0.7	14	0.5	10	0.4	72	0.6
	8	6	0.2	1	0.0	9	0.3	10	0.4	26	0.2
	9	3	0.1	3	0.1	3	0.1	2	0.1	11	0.1
	10	1	0.0	1	0.0	1	0.0	1	0.0	4	0.0
	11	1	0.0	2	0.1	1	0.0	1	0.0	5	0.0
	12	2	0.1	-	-	-	-	-	-	2	0.0
Can get help	Yes	2497	90.1	2495	90.1	2523	91.1	2532	91.4	10047	90.7
	Some-times	220	7.9	226	8.2	212	7.7	193	7.0	851	7.7
	No	53	1.9	49	1.8	34	1.2	44	1.6	180	1.6
Member organised group	Yes	1533	55.3	1509	54.5	1549	55.9	1597	57.7	6188	55.8
	No	1237	44.7	1261	45.5	1221	44.1	1173	42.3	4892	44.2
Like living in community	Yes	2458	88.7	2470	89.2	2512	90.7	2522	91.0	9962	89.9
	Some-times	228	8.2	231	8.3	192	6.9	194	7.0	845	7.6
	No	30	1.1	22	0.8	24	0.9	22	0.8	98	0.9
	No feeling about it	54	1.9	47	1.7	41	1.5	32	1.2	174	1.6
Quality of services in community	V. poor	41	1.5	37	1.3	37	1.3	32	1.2	147	1.3
	Poor	122	4.4	129	4.7	113	4.1	107	3.9	471	4.3
	Ok	661	23.9	626	22.6	599	21.7	595	21.5	2481	22.4
	Good	1118	40.5	1165	42.1	1154	41.8	1116	40.4	4553	41.2
	V. good	819	29.7	810	29.3	861	31.2	913	33.0	3403	30.8

Table B8: Distribution of major life events, deprivation and social connectedness transition variables over time

Covariate	Transitions	2012 to 2013		2013 to 2014		2014 to 2015	
		N	%	N	%	N	%
Number of major life events	0 to 0	375	13.8	377	13.9	387	14.3
	0 to 1+	371	13.7	436	16.1	427	15.8
	1+ to 0	438	16.2	437	16.1	477	17.6
	1+ to 1+	1526	56.3	1460	53.9	1419	52.4
Individual level of deprivation	0 to 0	1210	44.6	1351	49.9	1455	53.7
	0 to 1+	283	10.4	253	9.3	243	9.0
	1+ to 0	394	14.5	347	12.8	337	12.4
	1+ to 1+	823	30.4	759	28.0	675	24.9
Can get help from family, friends or neighbours	No to No	106	3.9	97	3.6	92	3.4
	No to Yes	156	5.8	169	6.2	145	5.4
	Yes to No	160	5.9	140	5.2	135	5.0
	Yes to Yes	2288	84.4	2303	85.0	2336	86.3
Member of an organised group	No to No	940	34.7	945	34.9	921	34.0
	No to Yes	275	10.1	283	10.4	274	10.1
	Yes to No	288	10.6	250	9.2	227	8.4
	Yes to Yes	1207	44.5	1232	45.5	1288	47.5
Like living in the community	No to No	128	4.7	118	4.4	100	3.7
	No to Yes	169	6.2	174	6.4	148	5.5
	Yes to No	164	6.1	130	4.8	137	5.1
	Yes to Yes	2249	83.0	2287	84.4	2324	85.8
Overall quality of services in community	Good to Good	1559	57.8	1617	59.9	1650	61.2
	Good to Poor/Ok	338	12.5	315	11.7	327	12.1
	Poor/Ok to Good	368	13.6	363	13.4	340	12.6
	Poor/Ok to Poor/Ok	433	16.0	406	15.0	381	14.1

Table B9: Distribution of baseline demographic static variables

Confounder	Category	N	%
Gender	Male	1146	*42.3*
	Female	1564	*57.7*
Age	18 - 24 years	150	*5.5*
	25 - 44 years	940	*34.7*
	45 - 64 years	1026	*37.9*
	65+ years	593	*21.9*
Ethnicity	Asian	280	*10.3*
	European/Other	1945	*71.8*
	Māori	458	*16.9*
	Pacific	298	*11.0*
Educational level	No formal qualification	444	*16.4*
	Vocational or trade qualification	612	*22.6*
	Secondary school qualification	602	*22.2*
	University degree or higher	1052	*38.8*
Household size	1 - 2	1372	*50.6*
	3 - 4	912	*33.7*
	5+	426	*15.7*
Location	Auckland	858	*31.7*
	Wellington	301	*11.1*
	Christchurch	173	*6.4*
	Rest of New Zealand	1378	*50.8*

Table B10: Distribution of demographic time-varying variables

Confounder	Category	2012		2013		2014		2015	
		N	%	N	%	N	%	N	%
Employment	Not full or part time	542	*20.0*	454	*20.0*	421	*20.0*	405	*20.0*
	Part time	493	*18.2*	515	*18.2*	493	*18.2*	475	*18.2*
	Full time	1198	*44.2*	1205	*44.2*	1217	*44.2*	1232	*44.2*
	Retired	476	*17.6*	536	*17.6*	579	*17.6*	598	*17.6*
Annual personal income	≤ $20,000	874	*33.3*	835	*32.9*	756	*33.2*	703	*32.7*
	$20,001 - $80,000	1479	*56.3*	1544	*55.7*	1571	*56.2*	1637	*55.3*
	≥ $80,001	275	*10.5*	278	*10.4*	303	*10.5*	334	*10.3*

Table C1: Transitions in gambling risk level and associations with transitions in smoking tobacco

Transition gambling	Transition tobacco	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No to No	403	1.00	-
	No to Yes	20	1.60	[0.99-2.59]
	Yes to No	**26**	**2.08**	**[1.35-3.21]**
	Yes to Yes	**70**	**1.44**	**[1.10-1.87]**
B: Stopping gambling	Ref: No to No	526	1.00	-
	No to Yes	23	1.12	[0.71-1.77]
	Yes to No	24	1.14	[0.72-1.80]
	Yes to Yes	94	1.00	[0.79-1.27]
C: Transitioning into risky gambling	Ref: No to No	209	1.00	-
	No to Yes	16	1.73	[0.99-3.01]
	Yes to No	17	1.61	[0.94-2.76]
	Yes to Yes	**88**	**2.11**	**[1.61-2.76]**
D: Transitioning out of risky gambling	Ref: No to No	199	1.00	-
	No to Yes	15	0.91	[0.52-1.59]
	Yes to No	14	0.90	[0.51-1.60]
	Yes to Yes	81	0.80	[0.61-1.05]

Bold font shows significant covariates at the 0.05 level

Table C2: Transitions in gambling risk level and associations with transitions in hazardous alcohol consumption

Transition gambling	Transition hazardous alcohol	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No to No	346	1.00	-
	No to Yes	30	1.45	[0.98-2.15]
	Yes to No	**49**	**1.67**	**[1.22-2.30]**
	Yes to Yes	**93**	**1.67**	**[1.31-2.12]**
B: Stopping gambling	Ref: No to No	432	1.00	-
	No to Yes	48	0.99	[0.71-1.36]
	Yes to No	62	1.1	[0.82-1.48]
	Yes to Yes	**123**	**0.73**	**[0.59-0.90]**
C: Transitioning into risky gambling	Ref: No to No	161	1.00	-
	No to Yes	32	1.46	[0.96-2.22]
	Yes to No	30	1.11	[0.73-1.67]
	Yes to Yes	**107**	**1.35**	**[1.04-1.76]**
D: Transitioning out of risky gambling	Ref: No to No	171	1.00	-
	No to Yes	18	0.69	[0.41-1.14]
	Yes to No	**26**	**0.64**	**[0.42-0.98]**
	Yes to Yes	**93**	**0.64**	**[0.49-0.83]**

Bold font shows significant covariates at the 0.05 level

Table C3: Transitions in gambling risk level and associations with transitions in cannabis

Transition gambling	Transition cannabis	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No to No	471	1.00	-
	No to Yes	14	1.37	[0.78-2.39]
	Yes to No	14	1.68	[0.94-2.99]
	Yes to Yes	19	0.96	[0.60-1.55]
B: Stopping gambling	Ref: No to No	602	1.00	-
	No to Yes	11	0.93	[0.49-1.75]
	Yes to No	19	1.35	[0.81-2.26]
	Yes to Yes	33	1.04	[0.72-1.51]
C: Transitioning into risky gambling	Ref: No to No	265	1.00	-
	No to Yes	**15**	**2.64**	**[1.46-4.77]**
	Yes to No	9	1.31	[0.65-2.64]
	Yes to Yes	**41**	**2.74**	**[1.92-3.91]**
D: Transitioning out of risky gambling	Ref: No to No	250	1.00	-
	No to Yes	10	0.94	[0.47-1.87]
	Yes to No	18	0.96	[0.58-1.59]
	Yes to Yes	**30**	**0.63**	**[0.42-0.93]**

Bold font shows significant covariates at the 0.05 level

Table C4: Transitions in gambling risk level and associations with anxiety

Transition gambling	Anxiety	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No	490	1.00	-
	Yes	29	0.90	[0.61-1.32]
B: Stopping gambling	Ref: No	640	1.00	-
	Yes	27	0.82	[0.55-1.22]
C: Transitioning into risky gambling	Ref: No	300	1.00	-
	Yes	**30**	**2.08**	**[1.37-3.16]**
D: Transitioning out of risky gambling	Ref: No	279	1.00	-
	Yes	30	1.07	[0.71-1.61]

Bold font shows significant covariates at the 0.05 level

Table C5: Transitions in gambling risk level and associations with depression

Transition gambling	Depression	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No	485	1.00	-
	Yes	34	0.89	[0.62-1.27]
B: Stopping gambling	Ref: No	622	1.00	-
	Yes	45	1.03	[0.75-1.41]
C: Transitioning into risky gambling	Ref: No	295	1.00	-
	Yes	**35**	**1.76**	**[1.20-2.57]**
D: Transitioning out of risky gambling	Ref: No	273	1.00	-
	Yes	36	0.97	[0.67-1.40]

Bold font shows significant covariates at the 0.05 level

Table C6: Transitions in gambling risk level and associations with obesity

Transition gambling	Obesity	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No	469	1.00	-
	Yes	50	1.03	[0.76-1.40]
B: Stopping gambling	Ref: No	607	1.00	-
	Yes	59	0.85	[0.64-1.12]
C: Transitioning into risky gambling	Ref: No	289	1.00	-
	Yes	40	1.28	[0.89-1.82]
D: Transitioning out of risky gambling	Ref: No	259	1.00	-
	Yes	49	1.12	[0.81-1.54]

Table C7: Transitions in gambling risk level and associations with transitions in disability

Transition gambling	Transition disability	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No to No	399	1.00	-
	No to Yes	33	0.99	[0.74-1.33]
	Yes to No	33	0.75	[0.48-1.18]
	Yes to Yes	54	0.77	[0.49-1.20]
B: Stopping gambling	Ref: No to No	505	1.00	-
	No to Yes	49	1.09	[0.84-1.43]
	Yes to No	44	0.96	[0.65-1.40]
	Yes to Yes	68	0.88	[0.59-1.30]
C: Transitioning into risky gambling	Ref: No to No	238	1.00	-
	No to Yes	34	0.94	[0.65-1.36]
	Yes to No	20	1.35	[0.81-2.24]
	Yes to Yes	37	0.81	[0.45-1.44]
D: Transitioning out of risky gambling	Ref: No to No	211	1.00	-
	No to Yes	27	1.00	[0.69-1.44]
	Yes to No	34	1.12	[0.66-1.90]
	Yes to Yes	36	1.10	[0.68-1.81]

Table C8: Transitions in gambling risk level and associations with transitions in chronic illness

Transition gambling	Transition chronic illness	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No to No	291	1.00	-
	No to Yes	**55**	**1.37**	**[1.01-1.85]**
	Yes to No	29	0.99	[0.66-1.47]
	Yes to Yes	144	0.86	[0.70-1.06]
B: Stopping gambling	Ref: No to No	392	1.00	-
	No to Yes	**27**	**0.56**	**[0.38-0.85]**
	Yes to No	53	1.18	[0.87-1.61]
	Yes to Yes	**194**	**0.77**	**[0.65-0.93]**
C: Transitioning into risky gambling	Ref: No to No	181	1.00	-
	No to Yes	36	1.50	[0.99-2.26]
	Yes to No	12	0.65	[0.35-1.22]
	Yes to Yes	100	0.83	[0.64-1.08]
D: Transitioning out of risky gambling	Ref: No to No	177	1.00	-
	No to Yes	19	1.06	[0.64-1.77]
	Yes to No	23	1.33	[0.83-2.11]
	Yes to Yes	89	0.78	[0.60-1.02]

Bold font shows significant covariates at the 0.05 level

Table C9: Transitions in gambling risk level and associations with transitions in quality of life

Transition gambling	Transition quality of life	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Below Median to Below Median	148	0.95	[0.77-1.18]
	Below Median to Median or above	74	1.16	[0.89-1.53]
	Median or above to Below Median	67	0.98	[0.74-1.29]
	Ref: Median or above to Median or above	228	1.00	-
B: Stopping gambling	Below Median to Below Median	181	0.94	[0.77-1.13]
	Below Median to Median or above	82	0.96	[0.74-1.25]
	Median or above to Below Median	92	1.12	[0.88-1.44]
	Ref: Median or above to Median or above	311	1.00	-
C: Transitioning into risky gambling	**Below Median to Below Median**	**144**	**2.02**	**[1.52-2.67]**
	Below Median to Median or above	**51**	**1.51**	**[1.04-2.18]**
	Median or above to Below Median	34	1.14	[0.75-1.73]
	Ref: Median or above to Median or above	100	1.00	-
D: Transitioning out of risky gambling	**Below Median to Below Median**	**127**	**0.61**	**[0.47-0.81]**
	Below Median to Median or above	**35**	**0.60**	**[0.40-0.90]**
	Median or above to Below Median	**42**	**0.68**	**[0.47-0.99]**
	Ref: Median or above to Median or above	104	1.00	-

Bold font shows significant covariates at the 0.05 level

Table C10: Transitions in gambling risk level and associations with transitions in past trauma

Transition gambling	Transition past trauma	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: No to No	369	1.00	-
	No to Yes	150	1.23	[0.94-1.60]
	Yes to No	458	0.79	[0.56-1.11]
	Yes to Yes	208	1.18	[0.94-1.48]
B: Stopping gambling	Ref: No to No	208	1.00	-
	No to Yes	121	1.11	[0.86-1.44]
	Yes to No	179	1.07	[0.82-1.40]
	Yes to Yes	129	1.12	[0.91-1.38]
C: Transitioning into risky gambling	Ref: No to No	369	1.00	-
	No to Yes	150	1.33	[0.92-1.91]
	Yes to No	458	1.05	[0.69-1.61]
	Yes to Yes	**208**	**1.65**	**[1.25-2.17]**
D: Transitioning out of risky gambling	Ref: No to No	208	1.00	-
	No to Yes	121	0.93	[0.63-1.37]
	Yes to No	179	0.91	[0.60-1.38]
	Yes to Yes	129	0.90	[0.69-1.17]

Bold font shows significant covariates at the 0.05 level

Table C11: Transitions in gambling risk level and associations with transitions in general health

Transition gambling	Transition general health	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Fair/Poor to Fair/Poor	38	0.92	[0.66-1.30]
	Fair/Poor to Good	40	1.12	[0.80-1.57]
	Good to Fair/Poor	29	0.78	[0.53-1.14]
	Ref: Good to Good	412	1.00	-
B: Stopping gambling	Fair/Poor to Fair/Poor	58	1.06	[0.79-1.41]
	Fair/Poor to Good	41	0.88	[0.63-1.23]
	Good to Fair/Poor	51	0.97	[0.72-1.31]
	Ref: Good to Good	517	1.00	-
C: Transitioning into risky gambling	**Fair/Poor to Fair/Poor**	**39**	**1.64**	**[1.13-2.38]**
	Fair/Poor to Good	24	1.01	[0.65-1.57]
	Good to Fair/Poor	**38**	**1.68**	**[1.16-2.44]**
	Ref: Good to Good	229	1.00	-
D: Transitioning out of risky gambling	Fair/Poor to Fair/Poor	34	0.95	[0.65-1.40]
	Fair/Poor to Good	**25**	**0.65**	**[0.43-1.00]**
	Good to Fair/Poor	31	0.86	[0.58-1.27]
	Ref: Good to Good	219	1.00	-

Bold font shows significant covariates at the 0.05 level

Table C12: Transitions in gambling risk level and associations with transitions in number of major life events

Transition gambling	Transition life events	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: 0 to 0	62	1.00	-
	0 to 1+	86	1.38	[0.99-1.94]
	1+ to 0	87	1.24	[0.88-1.73]
	1+ to 1+	**284**	**1.45**	**[1.09-1.92]**
B: Stopping gambling	Ref: 0 to 0	89	1.00	-
	0 to 1+	108	1.20	[0.90-1.61]
	1+ to 0	95	0.92	[0.68-1.25]
	1+ to 1+	375	1.21	[0.95-1.54]
C: Transitioning into risky gambling	Ref: 0 to 0	27	1.00	-
	0 to 1+	44	1.63	[0.98-2.71]
	1+ to 0	33	1.20	[0.70-2.05]
	1+ to 1+	**226**	**2.57**	**[1.69-3.90]**
D: Transitioning out of risky gambling	Ref: 0 to 0	21	1.00	-
	0 to 1+	29	1.35	[0.76-2.41]
	1+ to 0	**43**	**1.75**	**[1.02-2.99]**
	1+ to 1+	216	1.54	[0.97-2.43]

Bold font shows significant covariates at the 0.05 level

Table C13: Transitions in gambling risk level and associations with transitions in individual levels of deprivation

Transition gambling	Transition deprivation	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: 0 to 0	233	1.00	-
	0 to 1+	51	1.00	[0.73-1.36]
	1+ to 0	60	0.85	[0.63-1.14]
	1+ to 1+	174	1.08	[0.88-1.33]
B: Stopping gambling	Ref: 0 to 0	295	1.00	-
	0 to 1+	66	1.28	[0.97-1.70]
	1+ to 0	93	1.23	[0.96-1.57]
	1+ to 1+	**213**	**1.61**	**[1.33-1.94]**
C: Transitioning into risky gambling	Ref: 0 to 0	111	1.00	-
	0 to 1+	**52**	**2.56**	**[1.77-3.69]**
	1+ to 0	36	1.42	[0.95-2.14]
	1+ to 1+	**131**	**2.49**	**[1.90-3.27]**
D: Transitioning out of risky gambling	Ref: 0 to 0	104	1.00	-
	0 to 1+	25	0.86	[0.54-1.37]
	1+ to 0	53	1.21	[0.85-1.72]
	1+ to 1+	127	0.87	[0.66-1.14]

Bold font shows significant covariates at the 0.05 level

Table C14: Transitions in gambling risk level and associations with transitions in ability to get help from family, friends or neighbours

Transition gambling	Transition can get help	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	No to No	22	0.92	[0.59-1.43]
	No to Yes	23	0.66	[0.43-1.01]
	Yes to No	25	0.81	[0.54-1.23]
	Ref: Yes to Yes	449	1.00	-
B: Stopping gambling	No to No	24	1.19	[0.78-1.84]
	No to Yes	44	1.23	[0.89-1.70]
	Yes to No	38	1.18	[0.83-1.66]
	Ref: Yes to Yes	560	1.00	-
C: Transitioning into risky gambling	**No to No**	**19**	**2.28**	**[1.36-3.83]**
	No to Yes	**25**	**1.70**	**[1.09-2.65]**
	Yes to No	**34**	**2.28**	**[1.54-3.38]**
	Ref: Yes to Yes	252	1.00	-
D: Transitioning out of risky gambling	No to No	23	1.10	[0.69-1.76]
	No to Yes	30	0.92	[0.62-1.38]
	Yes to No	20	0.76	[0.47-1.23]
	Ref: Yes to Yes	236	1.00	-

Bold font shows significant covariates at the 0.05 level

Table C15: Transitions in gambling risk level and associations with transitions in being a member of an organised group

Transition gambling	Transition member of group	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	No to No	154	1.00	[0.81-1.23]
	No to Yes	**64**	**1.35**	**[1.01-1.80]**
	Yes to No	48	1.08	[0.79-1.49]
	Ref: Yes to Yes	253	1.00	-
B: Stopping gambling	**No to No**	**212**	**0.82**	**[0.68-0.98]**
	No to Yes	72	1.04	[0.79-1.37]
	Yes to No	54	0.79	[0.59-1.07]
	Ref: Yes to Yes	328	1.00	-
C: Transitioning into risky gambling	No to No	121	1.14	[0.88-1.50]
	No to Yes	36	1.31	[0.87-1.96]
	Yes to No	**45**	**1.56**	**[1.07-2.26]**
	Ref: Yes to Yes	128	1.00	-
D: Transitioning out of risky gambling	No to No	105	0.84	[0.64-1.10]
	No to Yes	42	1.13	[0.78-1.63]
	Yes to No	26	0.79	[0.51-1.22]
	Ref: Yes to Yes	136	1.00	-

Bold font shows significant covariates at the 0.05 level

Table C16: Transitions in gambling risk level and associations with transitions in like living in the community

Transition gambling	Transition like community	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	No to No	19	0.99	[0.61-1.59]
	No to Yes	39	1.23	[0.87-1.74]
	Yes to No	28	0.94	[0.63-1.39]
	Ref: Yes to Yes	433	1.00	-
B: Stopping gambling	No to No	30	1.10	[0.75-1.63]
	No to Yes	43	1.25	[0.90-1.75]
	Yes to No	35	1.09	[0.76-1.56]
	Ref: Yes to Yes	558	1.00	-
C: Transitioning into risky gambling	No to No	19	1.33	[0.81-2.18]
	No to Yes	24	1.26	[0.81-1.96]
	Yes to No	**27**	**1.91**	**[1.23-2.97]**
	Ref: Yes to Yes	259	1.00	-
D: Transitioning out of risky gambling	No to No	13	0.60	[0.34-1.07]
	No to Yes	21	0.65	[0.41-1.04]
	Yes to No	27	1.05	[0.68-1.61]
	Ref: Yes to Yes	247	1.00	-

Bold font shows significant covariates at the 0.05 level

Table C17: Transitions in gambling risk level and associations with transitions in overall quality of services in the community

Transition gambling	Transition quality of services	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ref: Good to Good	299	1.00	-
	Good to Poor/Ok	59	1.01	[0.76-1.36]
	Poor/Ok to Good	79	1.25	[0.97-1.62]
	Poor/Ok to Poor/Ok	77	0.95	[0.73-1.22]
B: Stopping gambling	Ref: Good to Good	410	1.00	-
	Good to Poor/Ok	93	1.15	[0.90-1.46]
	Poor/Ok to Good	78	0.93	[0.72-1.20]
	Poor/Ok to Poor/Ok	81	0.80	[0.62-1.03]
C: Transitioning into risky gambling	Ref: Good to Good	168	1.00	-
	Good to Poor/Ok	**52**	**1.55**	**[1.10-2.19]**
	Poor/Ok to Good	**56**	**1.42**	**[1.02-1.97]**
	Poor/Ok to Poor/Ok	50	1.08	[0.77-1.51]
D: Transitioning out of risky gambling	Ref: Good to Good	178	1.00	-
	Good to Poor/Ok	41	0.96	[0.67-1.38]
	Poor/Ok to Good	42	0.78	[0.55-1.12]
	Poor/Ok to Poor/Ok	**46**	**0.66**	**[0.47-0.92]**

Bold font shows significant covariates at the 0.05 level

Table D1: Transitions in gambling risk level and associations with demographic variables

Transition gambling	Demographic	Category	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ethnicity	**Asian**	**65**	**0.66**	**[0.45-0.97]**
		European/Other	337	1.13	[0.84-1.53]
		Māori	**78**	**1.46**	**[1.11-1.93]**
		Pacific	59	0.89	[0.62-1.28]
B: Stopping gambling	Age (years)	Ref: 18-24	54	1.00	-
		25-44	**235**	**0.56**	**[0.41-0.77]**
		45-64	**203**	**0.46**	**[0.33-0.63]**
		65+	**136**	**0.50**	**[0.32-0.78]**
	Employment status	Ref: Full time	130	1.00	-
		Part time	123	1.16	[0.92-1.47]
		Retired	**248**	**1.46**	**[1.02-2.09]**
		Other	**128**	**1.37**	**[1.07-1.74]**
C: Transitioning into risky gambling	Ethnicity	Asian	31	1.03	[0.58-1.81]
		European/Other	**178**	**0.57**	**[0.38-0.84]**
		Māori	71	0.87	[0.60-1.26]
		Pacific	64	1.48	[0.92-2.38]
	Educational level	Ref: No qual.	78	1.00	-
		Secondary school	64	0.84	[0.59-1.19]
		Vocational/trade	85	0.83	[0.59-1.18]
		University deg.	**83**	**0.52**	**[0.37-0.75]**
D: Transitioning out of risky gambling	Ethnicity	Asian	25	0.90	[0.50-1.61]
		European/Other	168	1.15	[0.78-1.71]
		Māori	**69**	**0.63**	**[0.44-0.91]**
		Pacific	66	0.91	[0.59-1.40]

Bold font shows significant covariates at the 0.05 level

Table E1: Transitions in gambling risk level and associations with covariates

Transition gambling	Covariate	Category	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Tobacco	Ref: No to No	399	1.00	-
		No to Yes	20	1.43	[0.91-2.25]
		Yes to No	**26**	**1.76**	**[1.17-2.64]**
		Yes to Yes	68	1.20	[0.92-1.57]
	Hazardous alcohol	Ref: No to No	343	1.00	-
		No to Yes	30	1.32	[0.89-1.98]
		Yes to No	**48**	**1.46**	**[1.05-2.04]**
		Yes to Yes	**92**	**1.31**	**[1.01-1.70]**
	Chronic illness	Ref: No to No	288	1.00	-
		No to Yes	54	1.34	[0.98-1.82]
		Yes to No	28	0.90	[0.59-1.35]
		Yes to Yes	**143**	**0.81**	**[0.66-1.00]**
B: Stopping gambling	Hazardous alcohol	Ref: No to No	430	1.00	-
		No to Yes	48	0.92	[0.66-1.28]
		Yes to No	62	1.01	[0.75-1.35]
		Yes to Yes	**122**	**0.68**	**[0.54-0.84]**
	Chronic illness	Ref: No to No	390	1.00	-
		No to Yes	**26**	**0.56**	**[0.37-0.86]**
		Yes to No	53	1.15	[0.84-1.58]
		Yes to Yes	**193**	**0.79**	**[0.64-0.97]**
	Deprivation	Ref: 0 to 0	294	1.00	-
		0 to 1+	66	1.20	[0.92-1.58]
		1+ to 0	92	1.17	[0.92-1.48]
		1+ to 1+	**210**	**1.34**	**[1.09-1.64]**
C: Transitioning into risky gambling	Tobacco	Ref: No to No	209	1.00	-
		No to Yes	16	1.24	[0.73-2.09]
		Yes to No	17	1.32	[0.80-2.20]
		Yes to Yes	**87**	**1.37**	**[1.03-1.82]**
	Cannabis	Ref: No to No	265	1.00	-
		No to Yes	**14**	**1.80**	**[1.02-3.17]**
		Yes to No	9	0.94	[0.47-1.85]
		Yes to Yes	**41**	**2.13**	**[1.47-3.10]**
	Quality of life	**Below Median to Below Median**	**145**	**1.42**	**[1.04-1.93]**
		Below Median to Median or above	50	1.22	[0.82-1.79]
		Median or above to Below Median	34	0.87	[0.57-1.35]
		Ref: Median or above to Median or above	100	1.00	-
	Number of life events	Ref: 0 to 0	27	1.00	-
		0 to 1+	44	1.34	[0.83-2.19]
		1+ to 0	33	0.94	[0.56-1.57]
		1+ to 1+	**225**	**1.92**	**[1.27-2.89]**
	Deprivation	Ref: 0 to 0	111	1.00	-
		0 to 1+	**52**	**1.82**	**[1.29-2.57]**
		1+ to 0	36	0.95	[0.65-1.40]
		1+ to 1+	130	1.25	[0.93-1.69]

Transition gambling	Covariate	Category	No. of observations	Hazard Ratio	[95% CI]
	Member of an organised group	No to No	120	1.14	[0.87-1.48]
		No to Yes	36	1.04	[0.71-1.52]
		Yes to No	**45**	**1.51**	**[1.06-2.14]**
		Ref: Yes to Yes	128	1.00	-
D: Transitioning out of risky gambling	Hazardous alcohol	Ref: No to No	170	1.00	-
		No to Yes	18	0.68	[0.42-1.10]
		Yes to No	26	0.72	[0.48-1.08]
		Yes to Yes	**92**	**0.60**	**[0.46-0.78]**
	Quality of life	**Below Median to Below Median**	**127**	**0.70**	**[0.52-0.93]**
		Below Median to Median or above	34	0.67	[0.44-1.02]
		Median or above to Below Median	42	0.75	[0.51-1.11]
		Ref: Median or above to Median or above	103	1.00	-

Bold font shows significant covariates at the 0.05 level

Table E2: Transitions in gambling risk level and associations with demographic confounders

Transition gambling	Covariate	Category	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ethnicity	**Asian**	**69**	**0.68**	**[0.47-1.00]**
		European/Other	350	1.10	[0.81-1.50]
		Māori	**81**	**1.32**	**[1.00-1.76]**
		Pacific	60	0.78	[0.55-1.11]
B: Stopping gambling	Age (years)	Ref: 18 - 24	58	1.00	-
		25 - 44	**246**	**0.55**	**[0.41-0.74]**
		45 - 64	**211**	**0.42**	**[0.30-0.57]**
		65+	**146**	**0.46**	**[0.30-0.71]**
	Employment status	Ref: Full time	135	1.00	-
		Part time	**134**	**1.25**	**[1.00-1.55]**
		Retired	**258**	**1.44**	**[1.03-2.02]**
		Other	**135**	**1.37**	**[1.09-1.72]**
C: Transitioning into risky gambling	Ethnicity	Asian	35	1.03	[0.60-1.76]
		European/Other	**188**	**0.50**	**[0.34-0.74]**
		Māori	73	0.80	[0.55-1.15]
		Pacific	68	1.48	[0.96-2.29]
	Educational level	Secondary school	67	0.94	[0.68-1.32]
		Vocational/trade	91	0.95	[0.68-1.33]
		University deg.	**89**	**0.64**	**[0.45-0.90]**
		Ref: no formal qualification	82	1.00	-
D: Transitioning out of risky gambling	-	-	-	-	-

Bold font shows significant covariates at the 0.05 level

APPENDIX F: Sensitivity analysis

Sensitivity analysis was conducted to assess the robustness of the final model using two subsets of the data. These subsets were then fitted with the final model and significance of the coefficients were examined. Summary tables showing significant coefficients mainly detail the same variables in the same order as those in Table 10 for ease of comparison between the models, apart from some newly included categories that resulted from the sensitivity analyses.

Sensitivity analysis #1

The first sensitivity analysis used the initial two years of data (2012 to 2013) and was fit with the final model. This subset increased the sample size of participants used in the final model by 975 (N = 2,770 to 3,745); however, there was nearly a 30% reduction in the number of transitions (10,840 to 7,420) as the total number of years reduced from four to two. Table F1 shows no similarities in variables associated with starting gambling (Transition A), as well as no transitions out of risky gambling (Transition D). Additionally, there were fewer significant variables remaining in the model compared to the final model. There were notable similarities in the two models including age being significant and comparable to those of the final model for stopping gambling (Transition B), and employment status and level of deprivation being similar in hazard ratio (greater than 1) although there was a decrease in statistical significance. The significant variables for transitions into risky gambling (Transition C) in this subset were similar in hazard ratio and statistical significance to those in the final model. Table F2 shows the data summarised.

Table F1: Transitions in gambling risk level and associations with covariates for years 2012 to 2013

Transition gambling	Covariate	Category	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Tobacco	Ref: No to No	175	1.00	-
		No to Yes	8	0.76	[0.36-1.61]
		Yes to No	4	0.65	[0.24-1.82]
		Yes to Yes	**46**	**1.62**	**[1.14-2.30]**
	Hazardous alcohol	Ref: No to No	143	1.00	-
		No to Yes	16	1.40	[0.79-2.49]
		Yes to No	21	1.36	[0.83-2.26]
		Yes to Yes	**53**	**1.77**	**[1.20-2.60]**
	Member of an organised group	No to No	76	1.04	[0.76-1.41]
		No to Yes	**31**	**1.56**	**[1.04-2.34]**
		Yes to No	21	0.79	[0.49-1.27]
		Ref: Yes to Yes	105	1.00	-
B: Stopping gambling	Age (years)	Ref: 18 - 24	37	1.00	-
		25 - 44	**136**	**0.60**	**[0.41-0.88]**
		45 - 64	**96**	**0.39**	**[0.26-0.59]**
		65+	**63**	**0.45**	**[0.25-0.82]**
	Employment status	Ref: Full time	89	1.00	-
		Part time	64	1.31	[0.96-1.79]
		Retired	127	1.21	[0.71-2.04]
		Other	**52**	**1.49**	**[1.09-2.02]**
	Deprivation	Ref: 0 to 0	118	1.00	-
		0 to 1+	39	1.37	[0.94-1.99]
		1+ to 0	**56**	**1.40**	**[1.01-1.94]**
		1+ to 1+	119	1.33	[0.99-1.79]
C: Transitioning into risky gambling	Ethnicity	Asian	21	1.15	[0.55-2.41]
		European/Other	**91**	**0.44**	**[0.27-0.73]**
		Māori	52	1.14	[0.71-1.84]
		Pacific	46	1.78	[0.99-3.20]
	Cannabis	Ref: No to No	146	1.00	-
		No to Yes	8	1.89	[0.88-4.02]
		Yes to No	8	1.00	[0.48-2.10]
		Yes to Yes	**26**	**2.35**	**[1.44-3.84]**
	Quality of life	**Below Median to Below Median**	**85**	**1.65**	**[1.10-2.49]**
		Below Median to Median or above	25	1.15	[0.66-2.00]
		Median or above to Below Median	21	0.93	[0.53-1.65]
		Ref: Median or above to Median or above	57	1.00	-
	Number of life events	Ref: 0 to 0	10	1.00	-
		0 to 1+	17	1.78	[0.80-3.93]
		1+ to 0	21	1.96	[0.91-4.22]
		1+ to 1+	**140**	**3.66**	**[1.90-7.07]**
	Member of an organised group	No to No	67	1.07	[0.75-1.53]
		No to Yes	20	0.84	[0.50-1.40]
		Yes to No	**32**	**1.77**	**[1.14-2.74]**
		Ref: Yes to Yes	69	1.00	-

Bold font shows significant covariates at the 0.05 level

Table F2: Transitions in gambling risk level and significant associations with substance use; health; and major life events, deprivation and social connectedness for years 2012 to 2013

Variable	A: Starting gambling	B: Stopping gambling	C: Transitioning into risky gambling	D: Transitioning out of risky gambling
Substance use				
Tobacco: Yes to No	--	--	--	--
Tobacco: Yes to Yes	1.62	--	--	--
Hazardous alcohol: Yes to No	--	--	--	--
Hazardous alcohol: Yes to Yes	1.77	--	--	--
Cannabis: No to Yes	--	--	--	--
Cannabis: Yes to Yes	--	--	2.35	--
Health-related				
Chronic illness: No to Yes	--	--	--	--
Chronic illness: Yes to Yes	--	--	--	--
Quality of life: Below Median to Below Median	--	--	1.65	--
Life events				
Number of life events: 1+ to 1+	--	--	3.66	--
Deprivation				
NZiDep: 0 to 1+	--	--	--	--
NZiDep: 1+ to 0	--	1.40	--	--
NZiDep: 1+ to 1+	--	--	--	--
Social connectedness				
Member of an organised group: No to Yes	1.56	--	--	--
Member of an organised group: Yes to No	--	--	1.77	--
Confounders				
Age: 25-44 years	--	0.60	--	--
Age: 45-64 years	--	0.39	--	--
Age: 65+ years	--	0.45	--	--
Ethnicity: Asian	--	--	--	--
Ethnicity: European/Other	--	--	0.44	--
Ethnicity: Māori	--	--	--	--
Educational level: University degree	--	--	--	--
Employment: Part time	--	--	--	--
Employment: Retired	--	--	--	--
Employment: Other	--	1.49	--	--

Sensitivity analysis #2

The second sensitivity analysis used the initial three years of data (2012 to 2014) and was fit with the final model. This subset increased the sample size of participants used for the final model by 345 (N = 2770 to 3115). The reduction in the number of transitions, compared to sensitivity analysis #1, was considerably lower at approximately 15% (10,840 to 9,186 transitions). This can be seen in the model estimates shown in Table F3, which are similar to those of the final model.

For significant variables associated with starting gambling (Transition A), ethnicity and hazardous alcohol consumption were similar in hazard ratio compared to the final model, with some subtle differences in statistical significance. For stopping gambling (Transition B), all significant variables except deprivation, were similar in hazard ratio and statistical significance compared to those of the final model. This was also the case for transitioning into risky gambling (Transition C), with all significant variables, apart from educational level and tobacco smoking, comparable to those in the final model. For transitioning out of risky gambling (Transition D), all variables were the same in hazard ratio and statistical significance as in the final model. Table F4 shows the data summarised.

Table F3: Transitions in gambling risk level and associations with covariates for years 2012 to 2014

Transition gambling	Covariate	Category	No. of observations	Hazard Ratio	[95% CI]
A: Starting gambling	Ethnicity	**Asian**	**52**	**0.50**	**[0.32-0.77]**
		European/Other	266	0.90	[0.63-1.29]
		Māori	56	1.05	[0.74-1.48]
		Pacific	57	0.73	[0.49-1.08]
	Hazardous alcohol	Ref: No to No	262	1.00	-
		No to Yes	27	1.30	[0.84-2.01]
		Yes to No	37	1.30	[0.89-1.89]
		Yes to Yes	**79**	**1.35**	**[1.01-1.80]**
	Member of an organised group	No to No	133	1.16	[0.92-1.47]
		No to Yes	**51**	**1.54**	**[1.13-2.10]**
		Yes to No	39	1.09	[0.77-1.54]
		Ref: Yes to Yes	182	1.00	-
B: Stopping gambling	Age (years)	Ref: 18 - 24	56	1.00	-
		25 - 44	**174**	**0.44**	**[0.32-0.60]**
		45 - 64	**155**	**0.34**	**[0.25-0.48]**
		65+	**109**	**0.39**	**[0.25-0.63]**
	Employment status	Ref: Full time	113	1.00	-
		Part time	98	1.26	[0.97-1.62]
		Retired	186	1.36	[0.91-2.04]
		Other	**97**	**1.46**	**[1.13-1.90]**
	Hazardous alcohol	Ref: No to No	315	1.00	-
		No to Yes	38	0.96	[0.65-1.40]
		Yes to No	43	0.91	[0.64-1.30]
		Yes to Yes	**98**	**0.71**	**[0.55-0.91]**
	Chronic illness	Ref: No to No	291	1.00	-
		No to Yes	**17**	**0.49**	**[0.29-0.81]**
		Yes to No	39	1.15	[0.80-1.67]
		Yes to Yes	147	0.88	[0.70-1.12]
C: Transitioning into risky gambling	Ethnicity	Asian	32	1.32	[0.74-2.36]
		European/Other	**142**	**0.54**	**[0.35-0.83]**
		Māori	58	0.94	[0.63-1.41]
		Pacific	**62**	**1.88**	**[1.17-3.04]**

Transition gambling	Covariate	Category	No. of observations	Hazard Ratio	[95% CI]
	Deprivation	Ref: 0 to 0	87	1.00	-
		0 to 1+	**42**	**1.67**	**[1.13-2.47]**
		1+ to 0	30	0.90	[0.58-1.37]
		1+ to 1+	104	1.08	[0.77-1.50]
	Cannabis	Ref: No to No	216	1.00	-
		No to Yes	11	1.65	[0.87-3.13]
		Yes to No	6	0.71	[0.31-1.63]
		Yes to Yes	**30**	**1.90**	**[1.23-2.94]**
	Quality of life	**Below Median to Below Median**	**115**	**1.54**	**[1.08-2.19]**
		Below Median to Median or above	43	1.49	[0.96-2.32]
		Median or above to Below Median	29	0.94	[0.58-1.51]
		Ref: Median or above to Median or above	76	1.00	-
	Number of life events	Ref: 0 to 0	18	1.00	-
		0 to 1+	34	1.64	[0.92-2.93]
		1+ to 0	24	1.13	[0.61-2.10]
		1+ to 1+	**187**	**2.55**	**[1.56-4.19]**
	Member of an organised group	No to No	92	1.04	[0.77-1.39]
		No to Yes	28	0.92	[0.60-1.41]
		Yes to No	**38**	**1.49**	**[1.02-2.19]**
		Ref: Yes to Yes	105	1.00	-
D: Transitioning out of risky gambling	Hazardous alcohol	Ref: No to No	132	1.00	-
		No to Yes	15	0.62	[0.36-1.05]
		Yes to No	21	0.97	[0.61-1.52]
		Yes to Yes	**60**	**0.52**	**[0.38-0.71]**
	Quality of life	**Below Median to Below Median**	**91**	**0.70**	**[0.50-0.98]**
		Below Median to Median or above	28	0.85	[0.52-1.37]
		Median or above to Below Median	30	0.74	[0.47-1.16]
		Ref: Median or above to Median or above	79	1.00	-

Bold font shows significant covariates at the 0.05 level

Table F4: Transitions in gambling risk level and significant associations with substance use; health; and major life events, deprivation and social connectedness for years 2012 to 2014

Variable	A: Starting gambling	B: Stopping gambling	C: Transitioning into risky gambling	D: Transitioning out of risky gambling
Substance use				
Tobacco: Yes to No	--	--	--	--
Tobacco: Yes to Yes	1.62	--	--	--
Hazardous alcohol: Yes to No	--	--	--	--
Hazardous alcohol: Yes to Yes	1.77	--	--	--
Cannabis: No to Yes	--	--	--	--
Cannabis: Yes to Yes	--	--	2.35	--
Health-related				
Chronic illness: No to Yes	--	--	--	--
Chronic illness: Yes to Yes	--	--	--	--
Quality of life: Below Median to Below Median	--	--	1.65	--
Life events				
Number of life events: 1+ to 1+	--	--	2.55	--
Deprivation				
NZiDep: 0 to 1+	--	--	1.67	--
NZiDep: 1+ to 0	--	--	--	--
NZiDep: 1+ to 1+	--	--	--	--
Social connectedness				
Member of an organised group: No to Yes	1.54	--	--	--
Member of an organised group: Yes to No	--	--	1.67	--
Confounders				
Age: 25-44 years	--	0.44	--	--
Age: 45-64 years	--	0.34	--	--
Age: 65+ years	--	0.39	--	--
Ethnicity: Asian	0.5	--	--	--
Ethnicity: European/Other	--	--	0.54	--
Ethnicity: Māori	--	--	--	--
Ethnicity: Pacific	--	--	1.88	--
Educational level: University degree	--	--	--	--
Employment: Part time	--	--	--	--
Employment: Retired	--	--	--	--
Employment: Other	--	1.46	--	--