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Patterns of problem behaviours among a representative sample of youth in Ontario

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Abstract

Behavioural addictions among adolescents are becoming a growing public health concern. It is well established that problem behaviours, particularly substance use behaviours, tend to cluster together. Some research indicates that gambling is associated with substance use, aligning with Problem Behaviour Theory, which suggests that problem behaviours stem from an underlying disposition toward deviance. This study sought to assess whether a) behavioural addictions, including gambling, video gaming and technology use, cluster together and with substance use and b) profiles of problem behaviours are associated with age, race, socioeconomic status, grade achievement, school connectedness, and antisocial behaviour in the total sample and by sex. Participants included 3,631 secondary students from the Ontario Student Drug Use and Health Survey. Latent profile analysis revealed four distinct profiles overall and three profiles in both males and females. Behavioural addictions did not cluster with substance use. This study highlights important patterns in adolescent emerging problem behaviours.

Keywords

Problem Behaviour, Behavioural Addiction, Adolescents, Gambling, Video Game Playing, Technology, Alcohol, Cannabis, Tobacco, Drug Use

Summary for Lay Audience

Behavioural addictions (such as gambling, technology use, and video game playing) among adolescents are becoming a growing public health concern. It is well established that problem behaviours, behaviours deemed socially unacceptable, particularly substance use behaviours, tend to cluster together. Moreover, research indicates that gambling is associated with substance use(Dickson et al, 2002), aligning with Problem Behaviour Theory developed by Jessor & Jessor (1977), which suggests that multiple problem behaviours stem from a unified disposition toward deviance. This study sought to assess whether a) behavioural addictions, including gambling, video gaming and technology use, cluster together and also whether they cluster with substance use and b) profiles of problem behaviours are associated with age, race, socioeconomic status, grade achievement, school connectedness, and antisocial behaviour in the total sample and by sex. Participants included 3,631 secondary students from the Ontario Student Drug Use and Health Survey. Latent profile analysis, a method used to organize individuals into homogeneous subgroups based on their response patterns, revealed four distinct profiles overall, including “No Problems”, “Dabblers”, “Serious Dabblers” and “Drug Problems.” However, three profiles were identified in the male (i.e., “No Problems”, “Dabblers” and “Drug Problems”) and female samples (i.e., “No Problems”, “Dabblers” and “Drug Problems”). Behavioural addictions did not cluster with substance use, with such addictions found equally across all subgroups. Older age, White race, lower academic achievement, and antisocial behaviour were found to be associated with profile membership in the total and female sample. Male sex was found to be associated with profile membership in the total sample.

The findings in this study support previous literature that substance use problems cluster together. Furthermore, the results support the need for development of health services for addressing these multiple problem behaviours.

Dedication

I dedicate this thesis to my nephews and nieces; you can accomplish anything you want in life with hard work, dedication and perseverance, do not allow anyone to tell you otherwise.

“You can’t be what you can’t see”

- Marian Wright Edelman

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Chapter 1

1 Introduction

Participation in a broad range of problem behaviours, including substance use and gambling, is common in the adolescent population despite regulations and laws restricting access. A recent report found that 58% of Ontario high school students had consumed alcohol over the past year, 28% used marijuana, and 11% smoked tobacco (Boak et al., 2015). Additionally, 32% of students reported participating in at least one gambling activity (betting money on card games, dice games, dares, etc.). Video game playing and technology use (including Internet use) are also very common among adolescents, on average males were found to spend over 2 hours a day playing video games and females spend around an average of 40 minutes (Leatherdale et al., 2015). Moreover, females spent over 2 hours a day surfing the Internet, compared to males at just under 2 hours a day (Leatherdale et al., 2015). Research has indicated that frequent participation in substance use activities can lead to later health consequences for these adolescents (Gordis, 1998). Studies have revealed that these individuals often engage in multiple problem behaviours, making it important to determine patterns of these problematic behaviours and the direct impact they can have on an individual's life (Tomczyk, Isensee, & Hanewinkel, 2016).

According to Problem Behaviour Theory (Jessor & Jessor, 1977), adolescents who participate in at least one problem behaviour are often more likely to participate in another. Previous research has shown evidence to support this theory, with numerous studies indicating that adolescents who use substances tend to use multiple substances (e.g., cannabis and alcohol) rather than a single substance (Tomczyk, Isensee, & Hanewinkel, 2016).

An important question is whether young people who use substances also engage in other problem behaviours such as gambling, gaming and technology use. There is a vast amount of literature that has looked at multiple substance use and only a few that have

examined if youth participate in both substances and gambling, gaming and technology use respectively.

This thesis will extend previous research to examine the extent to which behavioural addictions including, gambling, video game playing, and technology use, cluster with substance use (alcohol, drug use, cannabis, and tobacco). Data for this study were obtained from the 2017 Ontario Student Drug Use and Health Survey (OSDUHS), a provincially representative cross-sectional survey of adolescents. Based on a complete case analysis, a total of 3,631 high school students were included in the analyses. Weighted proportions were calculated for all variables of interest. Latent profile analysis was used to identify patterns of problem behaviours in this sample and to identify distinct profiles that characterize youth based on these patterns. Lastly, multiple regression analysis was performed to determine the associations between literature-based explanatory variables and the unique profiles of problem behaviours identified. This study will improve our understanding of how multiple problem behaviours are grouped together among adolescents and may help inform the development of prevention and treatment programming to address problem behaviours.

1.1 Primary Objectives and Rationale

The overarching aim of this thesis is to assess whether a) behavioural addictions (gambling, video game playing, and technology use) cluster together and with substance use among Ontario public high school students, and b) profiles of problem behaviours are associated with age, race, socioeconomic status, grade achievement, school connectedness, and antisocial behaviour in the total sample and by sex. The specific objectives of the thesis project are described below.

1.1.1 Objective 1

Identify whether behavioural addictions (gambling, technology use, and video-game playing) cluster together with substance use (alcohol use, cannabis use, tobacco use, and drug use) in Ontario high school students: (a) in the overall sample; and (b) in a sample stratified by sex.

General use of substances can be considered a problem behaviour for youth, as substance use is prohibited for youth (under a certain age) by law, moreover there are known health risks associated with substance use. Behavioural addictions such as gambling, video-gaming and technology use are not clearly defined as problem behaviours, because just participating in these activities are not considered problematic. Therefore, for behavioural addictions, alcohol and drug use, measures were used in this study that assess the degree to which respondents' behaviours are problematic. For all problem behaviours, higher scores indicate more problematic participation in the activity.

1.1.2 Objective 2

Identify characteristics (sex, age, race, socioeconomic status, school connectedness, academic achievement, and antisocial behaviour) associated with profile membership among high school students in Ontario: (a) conducted in the total sample and; (b) in a sample stratified by sex.

This objective will provide us a better understanding of characteristics associated with profile membership. A model will be developed that assesses the association between profile membership and potential explanatory variables that are described in more detail in the literature review. The variables of interest are race, age, socioeconomic status, academic achievement, antisocial behaviour, and school connectedness.

Chapter two of this thesis provides an overview of the existing literature, including more details about multiple problem behaviours, and how Problem Behaviour Theory can be used to conceptualize observations seen in the youth population. Chapter three describes the methods that will be used in this study to address the objectives -- including data collection and analysis -- and chapter four presents the findings. Lastly, chapter five provides a discussion regarding the results of the descriptive and analytic findings, provides the implications of the research, and suggests future directions for research in this area. Chapter five also discusses the strengths, limitations, and provides final conclusions.

Chapter 2

2 Literature Review

2.1 Problem Behaviour Theory

Problem Behaviour Theory provides a conceptual framework for understanding how youth develop problem behaviours. The premise of this theory is that all behaviour is a result of person-environment interaction (Jessor & Jessor, 1977). This framework of the theory encompasses three major systems of explanatory variables: personality system (e.g., value, expectations, beliefs, etc.), perceived environment system (e.g., support, social control, etc.) and behaviour system (e.g., problem behaviours and conventional behaviour) (Jessor, 1987; Jessor & Jessor, 1977). All systems work together to either instigate involvement in, or control against problem behaviour. Problem behaviours that are common in youth are: substance use, general deviant behaviour, precocious sexual intercourse, and truancy (Child & Sullivan, 2014). Jessor & Jessor (1977) found that involvement in one problem behaviour increases the likelihood of involvement in other problem behaviours (Jessor, 1987: Jessor & Jessor, 1977). Based on this early work, the concept of problem behaviour syndrome was developed, which is the tendency to engage in multiple problem behaviours that form a unified disposition toward deviance (Child & Sullivan, 2014).

2.2 Multiple Problem Behaviours among Youth

Despite age restrictions and laws restricting access to psychoactive substances and gambling, many adolescents engage in problem behaviours such as drinking alcohol, and using tobacco, cannabis, and illicit drugs. The 2015 Ontario Student Drug Use and Health Survey (OSDUHS) reported that 58% of high school students had consumed alcohol over the previous year (Boak et al., 2015). Also, 28% used marijuana and 11% smoked tobacco (Boak et al., 2015). Alcohol, tobacco, cannabis, and other illicit drugs have been the focus of many studies in adult and adolescent populations; however, these studies have mostly focused on one problem behaviour in isolation. While this research provides

important information regarding the prevalence of these problem behaviours and factors associated with them, which can be important for informing prevention and policy, they often do not consider engagement in multiple problem behaviours. Studies have revealed that individuals often engage in multiple problem behaviours making it important to determine patterns in the use of multiple substances. Researchers have begun to explore the prevalence, negative consequences, risk and protective factors for use and misuse of multiple substances (i.e., poly-substance use), as a result, a growing body of research has emerged looking at poly-substance use among youth.

Substance use during adolescence is an important public health concern because it is associated with later substance use problems across the lifespan. For example, youth binge drinking has been linked to an increased risk of adult alcohol dependence. Early adolescent smoking is associated with a greater likelihood of continuing to smoke in adulthood (Viner & Taylor, 2007; Orlando, 2004). Of even greater concern is the risk of developing health problems for poly-substance users. For example, the use of alcohol with cigarettes has known synergistic effects, which increases the negative consequences of smoking tobacco (Gordis, 1998); that is, individuals who use alcohol and smoke cigarettes are 38 times more likely to develop mouth and throat cancer than those who use neither substance and are six times more likely than those who use alcohol alone, and seven times more likely than those who use cigarettes alone to develop mouth and throat cancer (Gordis, 1998). These studies elucidate that adolescent poly-substance use is a major public health concern and needs to be further examined in order to develop appropriate prevention, policy and practice.

In 2008, Leatherdale and colleagues were interested in changes in the prevalence of and co-morbid use of alcohol, tobacco, and marijuana over time among Canadian youth. This study used the 2002 (n=11,757) and 2004 (n=16,705) waves of the Canadian Youth Smoking Survey (YSS), which is a nationally representative data set. The target population was young Canadian residents in grades five to nine attending public and private schools in ten Canadian provinces. Results indicated that a large proportion of youth had only used alcohol (43.2% in 2004). In 2002, around 0.3% had ever smoked a

whole cigarette and tried cannabis (0.2% in 2004), without ever trying alcohol. Interestingly, a larger proportion of youth had tried alcohol, cannabis and tobacco (11.9% in 2002 and 8.8% in 2004). Few youths had used tobacco or cannabis without also using alcohol.

Conway and colleagues (2013) identified subgroups of poly-substance users among a nationally representative school-based cohort of grade 10 students in the United States using latent class analysis. All participants completed the NEXT Generation Health Study baseline survey in spring 2010 (Conway, et al., 2013). Researchers found four distinct classes in their sample of 2,524 students: non-users (59.3%), predominant alcohol users (22.6%), predominant cannabis users (10.5%), and poly-substance users (7.6%) (cannabis, alcohol, tobacco, medication to get high, etc.) (Conway et al., 2013). This study further revealed that some youth are using various substances.

Overall, these studies provided evidence of multiple substance use among youth. It is important that we better understand patterns and problems associated with multiple substance use in this population. However, it is also important to examine emerging problem behavours and behavioural addictions including: gambling, video game playing and technology use.

2.3 Emerging Problem Behaviours and Their Association with Substance Use

2.3.1 Gambling Behaviour

Gambling can be defined as risking money or something of value on the outcome of an event when the probability of winning is uncertain (Korn & Shaffer, 1999). Evidence indicates that gambling is prevalent among youth in Canada (Huang & Boyer, 2007). In Ontario, gambling activities that youth most commonly participate in include card games and betting in sports pools (Elton-Marshall et al., 2016). A study conducted during 2012-2013 in three Canadian provinces found that, of the 10,035 students (aged 13-19) who responded to the Youth Gambling Survey, around 42% had gambled in the past three months (Elton-Marshall, Leatherdale & Turner, 2016; Wijesingha et al., 2017). Similarly,

the 2015 biannual Ontario Student Drug Use and Health Survey (OSDUHS), conducted by the Centre for Addiction and Mental Health (CAMH), found that around 32% of youth in grades 7 to 12 gambled at least once in the past 12 months (Boak et al., 2016). Gambling in adolescence is a concern because research has suggested that for some adolescents, it can lead to more serious problem gambling behaviour in the future (Mutti-Packer, et al., 2017; Turner, et al., 2011).

Youth gambling problem severity is measured on a continuum, ranging from no problem gambling to high severity of problem gambling (Stinchfield, 2010; Tremblay et al., 2010). Huang and Boyer (2007) conducted a secondary analysis of the Canadian Community Health Survey, administered by Statistics Canada in 2002. Their results indicated that youth aged 15 to 24 had a moderately higher prevalence of problem gambling than adults aged 25 and older, around 2.22% (95% CI: 1.69-2.76%) compared to 1.90% (95% CI: 1.69-2.14%) respectively. Similarly, a study using the 2009 OSDUHS, reported that 2.8% (95% CI: 2.0-3.9%) of students in grades 7 to 12 showed signs of problem gambling (Cook et al, 2012).

Youth characterized as problem gamblers have demonstrated multiple gambling problem symptoms, such as using their lunch money and/or allowance for gambling, chasing losses, lying to family members and friends about gambling, and skipping activities to gamble (Tremblay, et al., 2010). Problem gambling can be harmful, having a detrimental and long-term impact on the individual and their family (Elton-Marshall et al, 2017). The harms often associated with youth gambling problems, include, but are not limited to lower self-image, higher rates of depression, poor school performance, and disruption of peer, familial and social relationships (Browne et al., 2016; Gupta & Derevensky, 1998b; Dickson et al.,2002; Hardoon & Dervensky, 2008).

Consistent with Problem Behaviour Theory (Jessor & Jessor, 1977), several studies have demonstrated that there is an association between problem gambling and substance use (i.e. smoking, drinking, drug use/abuse) (Dickson et al., 2002; Elton-Marshall et al, 2017; Hardoon & Dervensky, 2008; Messerlian, Derevensky & Gupta, 2005). Willoughby and

colleagues (2004) explored the concept of problem behaviour syndrome (Jessor & Jessor, 1977) by examining a wide variety of adolescent problem behaviours, including substance use as well as delinquency, aggressive behaviours and gambling. Their population of interest was high school students in southern Ontario, who completed a self-reported questionnaire. In a sample of 7,290 respondents (Willoughby et al., 2004), ten behaviours were examined: alcohol use, smoking frequency, marijuana use, use of illicit drugs, sexual activity, minor delinquency, major delinquency, direct aggression, indirect aggression, and gambling. The researchers examined the participation in all ten of the behaviours (Willoughby et al., 2004). Results indicated that involvement in one behaviour was associated with a greater likelihood of participating in another (Willoughby et al., 2004). Also, results indicated that adolescents reporting high-risk involvement (i.e. heightened level of risk exposure due to repeated participation in a given risky behaviour) with one behaviour had an increased likelihood of reporting high-risk involvement with another behaviour. For example, adolescents classified as high-risk alcohol users (binge drinking) were 38 times more likely to report high-risk use of marijuana than those who reported no alcohol use. Additionally, it was found that involvement in a given problem behaviour increases high-risk involvement with other behaviours (Willoughby et al., 2004).

Problem gambling has also been examined in relation to other problematic behaviours among youth. One study applying the Problem Behaviour Theory looked at the both problem gambling symptomatology and alcohol misuse among adolescents. The Leisure, Lifestyle, and Lifecycle Project, a prospective cohort study based in Alberta was conducted in four waves between 2006 and 2011 (Mutti-Packer, 2017). At baseline, 436 adolescents were recruited at the age of 13 to 16 years and were 17 to 21 years at the time of their last interview (Mutti-Packer, 2017). The study found that high baseline levels of alcohol misuse were positively associated with high baseline levels of problem gambling symptoms ($r=0.31$, $p=0.03$) (Mutti-Packer, 2017). Individuals with baseline levels of problem gambling symptoms were not associated with alcohol misuse over time ($r=0.10$, $p=0.45$) (Mutti-Packer, 2017). However, individuals with baseline levels of alcohol misuse were associated with a decrease in problem gambling over time ($r= -0.25$, $p=0.03$)

(Mutti-Packer, 2017). Interestingly, when covariates (sex, parental household income, smoking status, and past-year illicit drug use) were added to the model, all associations previously found were no longer significant (Mutti-Packer, 2017). Mutti-Packer and colleagues (2017) suggested that their final conditional model results may be due to the survey acting as an intervention itself, prompting the respondents to think about their behaviours and make changes over time.

A nationally representative survey conducted between 2005 and 2007 in the U.S. examined gambling using the Massachusetts Gambling Screen (MAGS), a validated measure of the DSM-IV pathological gambling criteria. In a sample of 2,274 youth aged 14 to 21, it was determined that among non-drinkers, 11% were heavy gamblers, whereas 37% of those who were heavy drinkers were classified as heavy gamblers (Barnes et al., 2009). Similarly, a Connecticut based study, surveying 2,484 students from multiple high schools during 2006 to 2007, found that problem/pathological gamblers were more likely to report moderate (OR = 2.22, $p=0.005$) and heavy (OR=5.03, $p<0.0001$) current alcohol use when compared to low-risk gamblers (Yip et al. 2011) whereas problem/pathological gamblers were twice as likely to report moderate (OR=2.03, $p=0.011$) and heavy (OR=4.54, $p<0.0001$) current alcohol use when compared to at-risk gamblers (Yip et al. 2011). Lastly, non-gamblers had a lower likelihood of alcohol use compared with gamblers (Yip et al. 2011).

Associations between gambling and use of cannabis in youth have also been found. In a study of Ontario high school students, cannabis use was found to be 8.8 times more likely in youth with problem gambling behaviours compared to the rest of the student population; this association remained significant ($p<0.001$) after adjusting for sex, age, and hazardous/harmful drinking (Cook et al., 2015). Similar findings were found in another study, where problem/pathological gamblers were more likely to report any lifetime marijuana use compared to low-risk gamblers (OR=3.31, $p<0.001$) (Yip et al. 2011). These problem/pathological gamblers were also more likely to report lifetime marijuana use compared to at-risk gamblers (OR=3.12, $p<0.001$) (Yip et al. 2011). Likewise, a study conducted by Petry and colleagues (2001) assessed the prevalence of

problem gambling within participants in the Cannabis Youth Treatment project, a multi-site study evaluating the efficacy of outpatient treatment for cannabis abuse. A subsample of 225 adolescents in the Philadelphia and Hartford site were asked questions regarding gambling (Petry et al., 2001). Around 18% of the individuals were problem gamblers, and 3.2% met DSM criteria for diagnosis of pathological gambling (Petry et al., 2001).

A study conducted by Turner and colleagues (2011) explored the clustering of gambling/ problem gambling, a behavioural addiction, with use of substances among Ontario secondary students. Using cluster analysis, a quantitative method to identify typologies or patterns of responses to observed variables, they found four distinct subgroups reflecting different patterns in substance use and gambling behaviour. Four subgroups were: "Mainstreamers" (lowest rate of alcohol, cigarette, and drug use; the lowest gambling frequency and lowest problem gambling score; and the highest self-esteem score), "Party Goers" (compared to "Mainstreamer", higher rates of alcohol, cigarette and cannabis use and higher alcohol disorder scores, higher gambling frequency, and higher problem gambling scores; and lower self-esteem), "Drug Takers" (highest rates of alcohol, cigarette, and cannabis, and other drug use; highest alcohol disorder and problem drug use scores; higher problem gambling scores compared to "Party Goers") and "Heavy Gamblers" (highest gambling frequency, highest problem gambling score, lower cigarette and cannabis use than "Party Goers" , lower substance use than "Drug Takers"). "Heavy Gamblers" was distinct from the others, comprised of youth who were most strongly defined by their gambling behaviour. These results suggest that adolescent problem gamblers may form their own subpopulation that is separate from substance using adolescents (Turner et al., 2011).

2.3.2 Video Game Playing

Video gaming has become very popular especially among youth, with 86.1% of Ontario youth reporting they play video games (Boak et al., 2015). Previous research has identified numerous harms associated with excessive video game playing, such as, preoccupation, tolerance, loss of control, withdrawal, family or school disruption and lying (Turner et al., 2012; Carlton et al. 1987; Goodman 1990; Goudriaan et al. 2004;

Griffiths and Hunt 1998). In 2018 the World Health Organization (WHO) included gaming disorder in the 11th Revision of the International Classification of Disease (WHO, 2018). The WHO defines gaming disorder as a pattern of gaming behaviour characterized by losing control, increasing gaming as a priority over other activities to the extent that gaming is more important than other interests and daily activities, and continuous playing regardless of these negative consequences (WHO, 2018).

A study conducted by Turner and colleagues (2012) explored the prevalence of video game playing using the 2007 cycle of the OSDUHS, with a population of students in grades 7 to 12 (n=2832). Video game playing in this sample was common, as 85.9% reported playing video games over the last 12 months. Moreover, 30.2% played about three times a month or less; 9.3% played once a week; and 18.3% usually played daily or almost daily. This study also examined potential video game playing problems within this youth population. Video game playing problems were measured using a modified version of Problem Video Game Playing (PVP) scale developed by Tejeiro Salguero and Bersabe Moran (2002). Results indicated that around 9.4% (95% CI: 8.2%-10.8%) of all students were experiencing problematic video gaming.

It has been suggested that video game playing is conducive to gambling in adolescents as they use both activities as coping mechanisms to deal with daily struggles (Griffiths & Wood, 2004). Gambling mediums such as slot machines have several features similar to video-game playing, including intermittent reinforcement schedules, and the use of extensive light, colour and sound effects (Griffiths & Wood, 2000; Fisher & Griffiths, 1995). Perceived excitement, relaxation, and escape while engaged in gambling and video-game playing were associated with excessive use of both habits (Wood et al. 2004; Griffiths & Wood, 2004). In a Montreal based study, 1,276 Colleges d'enseignement general et professionnel (CEGEPs) students aged 16-24 completed a questionnaire inquiring about the nature of video-game playing and gambling activities (McBride & Derevensky, 2016). The results indicated that 604 students reported participating in both gambling and video game playing. Those that gambled had a significantly higher prevalence of video game playing (94.1%) than those that do not gamble (85.7%).

Moreover, it was found that significantly more students that are addicted to gaming than social or non-gamers were identified as problem gamblers (McBride & Derevensky, 2016).

A more recent study conducted in South Australia sampled 2,669 students from grades 8 to 13 across six schools, and investigated the association between gambling and video-game playing (Delfabbro et al., 2009). It was found that individuals who were classified as pathological gamblers participated more frequently in hand-held games and arcade games than at-risk gamblers and those at-risk had a higher gaming frequency than those not at risk (Delfabbro et al., 2009). Furthermore, pathological gamblers and at-risk gamblers each played TV games and phone games more frequently than those not at risk (Delfabbro et al., 2009).

Associations between gaming and substance use have also been found. The yearly cross-sectional Dutch Monitor Study 'Internet and Youth' was used to explore problematic gaming in secondary students (Van Rooij, 2014). The researchers used data from 2009, 2010 and 2011, having a final sample of 8,478 complete cases. Video game playing was measured several ways: duration of gaming, mode of use (i.e online, browser games, and offline gaming), and video game addiction (Van Rooij, 2014). The study found that males who drink alcohol (RR=1.9), smoke cigarettes (RR=1.8) and use cannabis (RR=2.4) were more likely to score high on problematic video gaming measures (Van Rooij, 2014). They also found that female alcohol drinkers (RR=9.0) and cannabis users (RR=3.3) were more likely to be problematic video gamers (Van Rooij, 2014).

2.3.3 Technology Use

Youth continue to spend more and more of their time with technology online (using social media, etc.) making it important to understand the potential impact of excessive use (Witt, Massman, & Jackson, 2011). Excessive use of Internet and electronic devices has recently been identified as a growing public health concern by the World Health Organization (WHO, 2014). Currently there is no formal definition of what is considered to be 'health conditions' associated with 'excessive use' of 'modern technologies'

(WHO, 2014). However, the concept of this excessive use as a behavioural addiction is framed based on key features of substance use disorders (WHO, 2014). A common description of behavioural addictions described by WHO (2014) is the following: "irresistible urge, impulse or drive to repeatedly engage in an activity (non-substance use), and an inability to reduce or cease this behaviour (loss of control) despite serious negative consequences to the person's physical, mental, social and/or financial well-being". Technology use has been a difficult area to research, as defining what is considered to be 'excessive use' has been debated (Wallace, 2014; WHO, 2014). The Internet is now widely accessible and used for many purposes, including: social media, texting, streaming videos, video games, gambling and online pornography (Sussman et al., 2018). The development of technology has allowed for this accessibility, for example smartphones, tablets, and laptops that have Internet access almost anywhere. For these reasons merely taking Internet use duration over a period of time may not be an indication of problematic use. Problematic technology use (also referred to as problematic Internet use or electronic device use) can be characterized by excessive use of, and poorly controlled preoccupation with, devices (such as smartphones or tablets/laptops that are typically connected to the Internet), which have negative effects on an individual's life (Boak et al., 2018).

Canadian adolescents and young adults are more connected to the Internet than any other generation according to Statistic Canada (2018). They found that nearly 100% of youth aged 15-24 uses the Internet daily or own a smartphone (Statistics Canada, 2018). Dufour and colleagues (2016) conducted a study in Quebec, Canada comparing the influence of gender on Internet use and addiction. This is one of the first studies to look at Internet addiction (IA) problems among adolescents in Canada and the province of Quebec. A total of 3,938 adolescents from grades 9 to 11 answered the Internet Addiction Test. The results indicated that around 18% of adolescents were considered to have a problem with Internet use. Moreover, when compared across gender, there was no significant difference found. However, males were found to spend significantly more time on the Internet than females. It is important to keep in mind that there is no gold standard

measure for Internet addiction, which was noted as a weak point in this field of research (Dufour et al., 2016).

As this was the first study on Internet addiction in a Canadian adolescent population, there is a large knowledge gap. However, literature around this topic has been developed in other parts of the world over the last couple decades. Some of this literature has explored the participation of Internet use with other potentially problematic behaviours. A study conducted in Guangzhou city, China explored several factors associated with Internet addiction among adolescents (Lam et al, 2009). High school students, aged 13 to 18 years completed the Internet Addiction Test. They found that 10.2% of adolescents Internet use was moderate while 0.6% were severely addicted to the Internet (Lam et al, 2009). Moreover, the results suggested a 70% increase in the odds that adolescents with drinking behaviours are also addicted to the Internet (Lam et al, 2009).

Existing research examining the association between Internet addiction and gambling is limited and generally focuses on youth populations. This research suggests a positive association between Internet addiction and gambling. For example, a cross-sectional study conducted in Athens, Greece, assessed 529 students in grades 9 and 10 for the prevalence and association between Internet gambling and problematic Internet use (Tsitsika et al., 2011). Internet gambling practices were based on self-reporting frequency of online gambling and Internet addiction (Tsitsika et al., 2011). The study found that those who participated in Internet gambling were 1.81 times (95% CI: 1.03-3.19) more likely to report problematic internet use compared to the control group (Tsitsika et al., 2011). Moreover, adolescents considered frequent Internet gamblers were 3.36 times (95% CI: 1.60-7.05) more likely to present concurrently with problematic Internet use (Tsitsika et al., 2011).

As mentioned in section “2.3.2 Video Gaming”, video games can be played in several different modes (i.e. online, browser games, offline, etc.) (Van Rooij, 2014), making the Internet key for some forms of video game playing. A study conducted in the Eastern part of Turkey assessed the association between video game playing and Internet addictions

among 200 high school students. An important finding in this study was that adolescents who played online video games had a higher mean score on Internet addiction compared to those that play games offline ($p<0.05$) (Gunuc, 2015).

A study conducted by Rücker and colleagues (2015) examined the association between Internet use and substance use (tobacco, alcohol, cannabis, and other drugs) among young adolescents in Switzerland. They found that there was a significant association between problematic Internet users and each substance when assessed at the bivariate level, with adjusted odds ratio of 2.05 for tobacco, 1.72 for alcohol, 1.94 for cannabis, and 2.73 for other drugs. However, when all substances were added in the model together, only tobacco use (AOR=1.71) was found to be significantly associated with problematic Internet use (Rücker et al., 2015). Moreover, this study supports that problematic internet use is associated with other problem behaviours.

2.4 Explanatory Variables

Participation in multiple problem behaviours has been shown to be associated with a number of important explanatory variables, which are reviewed below. These are important to assess, as it can help to better predict the risk factors of multiple problem behaviours. Moreover, several of these covariates are key variables indicated in Jessor's (1987) conceptual framework of Problem-Behaviour Theory.

2.4.1 Demographics

2.4.1.1 Sex

Sex plays a very important role when examining problem behaviours in youth, as males are more likely to engage in risk-taking behaviours compared to females (Wood et al., 2004). There is an overwhelming amount of evidence to support that males are more likely to participate in gambling activities and to have problem gambling behaviour compared to females (Stinchfield, 2004;). Cook et al. (2015) depicted this relationship in their study, showing that males were four times more likely than females to report problem gambling after controlling for differences in substance use, internalizing

behaviour and delinquency ($p<0.001$). Moreover, males were found to be more likely to participate in or have problem behaviour with alcohol (Mutti-packer et al., 2017; Cook et al., 2015), drug use (Turner et al., 2011, Yip et al. 2011), cannabis (Cook et al., 2015; Turner et al., 2011), tobacco (Weinberger et al., 2015), Internet use (Wallace, 2014), and video game playing (Turner et al., 2012).

2.4.1.2 Age

Studies have indicated that the likelihood and prevalence of substance use in youth tends to increase as age increases (Leatherdale & Ahmed, 2010; Taylor et al., 2017). The prevalence of frequent marijuana use increased between the ages of 13 to 18 years (0.0% and 4.4% respectively) (Taylor, et al., 2017). A student in grade 9 (aged 13-14) compared to grade 7 (aged 11-12) has a 2.29 times greater odds of having ever tried alcohol, tobacco and marijuana (Leatherdale & Ahmed, 2010). Witt and colleagues (2010) conducted a longitudinal study to determine the prevalence of video game playing, overall computer use, and communication technology use over time in youth. They found that over a 3-year interval, youth increased their overall computer and communication technology use but decreased their video game playing. A similar trend in video game playing was found in a study conducted by Mentzoni and colleagues (2011). They surveyed 816 individuals aged 16 to 40 and found that the younger the individual the more likely they were to spend more time playing video games. Moreover, they found that being younger was a predictor of problem video game playing (Mentzoni et al., 2011). A significant relationship was found between age and gambling; however, not for gambling problems (Barnes et al., 2009). Furthermore, the results indicated that as age increased from 14 to 21 years, heavy gambling also significantly increased with each year of age (Barnes et al., 2009).

2.4.1.3 Race/Ethnicity

Research has indicated that problem behaviours are associated with ethnicity. A study conducted by Watt (2005) explored race/ethnic differences in alcohol abuse among youth. The results indicated that Black youth have lower rates of alcohol abuse relative to White youth. Furthermore, Hispanic youth were also found to be less likely to drink heavily compared to White youth (Watt, 2005). Conway et al. (2013), found that

compared to Whites, Hispanic and other minorities are more likely to use other illicit drugs than to use medication and marijuana to get high. However, when looking at the patterns of substance use (marijuana, medication to get high, other illicit drugs, tobacco, and alcohol) using latent class analysis, race was not found to be associated with class membership when compared to the non-users class (Conway et al., 2013). In contrast, another study that conducted a latent class analysis with substances (tobacco, alcohol, cannabis, other illicit drugs, nonmedical use of prescription drug, and medical use of any prescription drug), in an adolescent population, found that ethnicity was associated with class membership (Cranford et al., 2013). The results suggested that students who identified as White, had an increased odds of being in the "Multiple use class" (OR: 2.8; 95% CI: 2.0-3.8) (Cranford et al., 2013). When various substances (example: alcohol) are independently studied with race, they have been found to be associated, however when clustered with other substances (example: alcohol, tobacco, marijuana, etc.) the results are not found to be consistent (Cranford et al., 2013).

An association between race and gambling behaviour has also been found. A study conducted in the United States by Barnes and colleagues (2009), found that heavy gambling was higher among Black youth (24%) compared to White youth (15%). Moreover, Barnes et al. (2009) found that the odds of a Black youth being a heavy gambler was 1.8 times the odds of a White youth. A National study conducted in America explored pathological video game use among youth aged 8 to 18 years, and found that race was not statistically different when comparing non-pathological video gamers to pathological video gamers (Gentile, 2009).

2.4.1.4 Socioeconomic Status

A study on cannabis use in a high school population found that regular cannabis users were 1.08 ($p<0.0001$) times more likely to come from a household income in the low quintile, compared to those at the highest quintile (Taylor et al., 2017). A study indirectly assessing socioeconomic status using 'weekly spending money' in youth found similar results to that of Taylor et al. (2017). Leatherdale and Ahmed (2010) found that youth reported having $21 or more spending money a week had 1.59 greater odds of having

ever tried alcohol, tobacco and marijuana compared to those who had no spending money. A study conducted on 4311 Turkish adolescents in grades 9 to 12 found a positive significant correlation between family income and total Internet addiction test scores (Ak et al., 2013), suggesting that total Internet addiction score rises with family income. A latent class analysis looking at subtypes of adolescent video game players found that socioeconomic status was significantly associated with class membership (Faulkner et al., 2015). The odds that a high school student would be classified in the "Severe Problem Video Game Playing" (OR:0.65; 95% CI:0.47-0.89) or the "High Problem Video Game Playing" (OR:0.68; 95% CI: 0.60-0.77) classes than the "Normative" class were significantly reduced as their socioeconomic score increased (Faulkner et al., 2015).

Little research has examined SES in relation to multiple problem behaviours. The study conducted by Turner and colleagues (2011) mentioned above that explored clustering of several problem behaviours among a high school population in Ontario found that SES was not associated with profile membership reflecting distinct clusters of multiple problem behaviours (Turner et al., 2011).

2.4.2 Academic Performance

Youth problem behaviours have been connected to having poor academic performance (Stinchfield, 2004). The directionality of the relationship has not been determined in the literature, as it has only been explored in cross-sectional studies. A study conducted by Winters, Stinchfield, and Fulkerson (1993) found that youth who participate in gambling activities frequently were more likely to have poor academic grades than those who gambled infrequently. Moreover, several researchers have indicated in their studies that youth who participate in multiple problem behaviours (gambling, tobacco, cannabis, illicit drugs, and alcohol) tend to have lower grades (Leatherdale et al., 2008; Turner et al., 2012) than those who engage in these activities at a lower rate or not at all. Crosnoe (2006) conducted a longitudinal study in adolescents to determine whether academic failure was a risk factor for adolescent drinking. The study revealed that the number of classes failed in one year predicted alcohol use a year later more than early alcohol use

predicted later class failure (Crosnoe, 2006). Hsieh (2016) conducted a systematic review of problem video gaming effects in children and youth and they found lower academic achievement was found to be associated with problem video game playing. Moreover, it was found that Internet use addiction was associated with lower academic achievement in adolescents (Xu et al., 2012).

2.4.3 School Connectedness

"School connectedness is the belief among students that teachers and other adults within the school care about them as individuals and about their learning" (Wingspread Declaration on School Connections, 2004; Hamilton et al., 2012). There is limited research on the association between school connectedness and problem behaviours mentioned above. However, connectedness to school and peers has been suggested to influence youth behaviours. Feelings of school connectedness may prevent youth from engaging in problem behaviours. A study conducted by Azagba and Asbridge (2013) explored the association of school connectedness and smoking susceptibility. Canadian adolescents aged 11 to 14 years were part of the 2010-2011 Youth Smoking Survey. The results indicated that school connectedness was a protective factor for smoking conditions. Bond and colleagues (2007) conducted a longitudinal study of high school students and found that low school connectedness was associated with an increased risk of using several substances. Low school connectedness was found to increase the odds of drinking (OR: 1.7; 95% CI: 1.3-2.2), cannabis use (OR: 2.0; 95% CI: 1.6-2.5) and regular smoking (OR: 2.0; 95% CI: 1.4-2.9). Suggesting that school connectedness at baseline or earlier waves was associated with subsequent substance use. These studies support that school connectedness can have an impact on students' behavioural patterns.

Katapally and colleagues (2018) conducted a study in Alberta and Ontario on 44,861 youth aged 13 to 18 years on several screen time behaviours. One of their main objectives was to determine the association of school connectedness with multiple screen time behaviours. They found that Ontario males who felt like they were part of their school reported less time playing video games and surfing the Internet. There was no significant relationship found between school connectedness and video game playing and Internet

use in Alberta males. Ontario females who reported feeling happy and safe at school reported less time surfing the Internet, but no significant association was found with video game playing. Alberta females who felt that they were part of their school reported significantly less time playing video games, however, no significant difference was found for Internet use (Katapally et al., 2018). Gambling behaviour was also found to be significantly associated with school connectedness, as Dickson and colleagues reported in their 2008 study. They found that probable pathological gamblers were less likely than social and non-gamblers to feel connected to their school (Dickson et al., 2008).

2.4.4 Antisocial Behaviour

Antisocial behaviour, such as criminal acts, violence and bullying are behaviours that have a negative impact not only at the individual level, but also the society as a whole (Boak et al., 2016). Several researchers have indicated youth who have antisocial behaviour have an increased likelihood of participating in other problem behaviours, such as gambling, alcohol use, cannabis, drug use, and tobacco (Cook et al., 2015; Turner et al., 2011; Willoughby et al., 2004). A study conducted by Holtz and Appel (2011) explored the relationship between patterns of Internet and video game use, and externalizing problems (i.e. delinquent and aggressive behaviour) in early adolescence. They found that Internet use for gaming and communication was associated with a higher probability of showing signs of clinically relevant externalizing behaviour. Moreover, adolescents who preferred to play first-person shooter video games were significantly more likely to have externalizing problems than those who do not (Holtz and Appel, 2011).

2.5 Sex Specific Analysis

To our knowledge previous research has only conducted latent profile analysis by the total population and assessed sex as predictor of membership. Due to the overwhelming amount of literature presented above that suggests that males are more likely to participate in problem behaviours than females, we decided that it would be important to compare the sex profiles by separating them by sex.

2.6 Study Rationale

There is limited research available that assesses multiple problem behaviours, especially the more recent behavioural addictions, including gambling, video gaming and technology use. The majority of studies that have examined multiple behaviours focused on the use of substances (tobacco, cannabis, alcohol, and illicit drugs), sexual activity, and delinquency. However, a wide set of problem behaviours that are prevalent among youth are rarely examined together in one study, leaving a gap in the literature about problem behaviour associations.

Our study will be one of the first to measure the relationships among several problem behaviours that include not only substances, but also gambling, technology use and video gaming behaviour in an Ontario youth population, representing emerging problems for youth. Measuring these multiple-problem behaviours is important because it accurately represents the experiences of many youth and may be an important focus for risk factor identification and program attention.

Chapter 3

3 Methods

This study aims to identify profiles of participation in multiple problem behaviours in youth, and to examine variables associated with profile membership using a series of descriptive characteristics and behavioural factors. Secondary analyses were conducted on cross-sectional data from the 2017 Ontario Student Drug Use and Health Survey (OSDUHS) for this study. OSDUHS is a biannual provincially representative survey of youth in grades 7 to 12. The survey is designed to assess the mental and physical well-being of students. It is conducted in four regional strata in Ontario: Greater Toronto Area (City of Toronto, Durham Region, York Region, Peel Region, and Halton Region); Northern Ontario (Parry Sound District, Nipissing District, and areas farther north); Western Ontario (Dufferin County and areas farther west); and Eastern Ontario (Simcoe County and areas farther east) (Boak et al., 2017).

3.1 Ontario Student Drug Use and Health Survey

Below is a brief summary of the methods used for the OSDUHS, full details can be found in the Boak et al. (2017) "Drug use among Ontario students, 1977-2017: Detailed findings from the Ontario Student Drug Use and Health Survey (OSDUHS) (CAMH Research Document Series No. 46)."

3.1.1 Inclusion Criteria

The target population for OSDUHS is students in grades 7 to 12 enrolled in Ontario's publicly funded school sectors. Individuals enrolled in private schools, home-schooled, those institutionalized for correctional or health reasons, those schooled in First Nations communities, military bases, or in the remote northern region of Ontario were not included (Boak et al., 2017). Schools with low enrolment and in remote northern regions of the province were excluded from the sampling frame in order to reduce the cost and mitigate any potential estimation difficulties due to sparse data.

3.1.2 Recruitment Procedures and Data Collection Procedure

School Recruitment: Within each of the 18 region-by-school level primary-stage strata, a probability proportionate-to-size selection of schools by means of systematic selection was drawn. Schools were selected with systematic sampling without replacement. Schools were not compensated for their participation (Boak et al., 2017).

Class Recruitment: A subsample list of grade-stratified eligible classes was created for each recruited school. This list was used to randomly select one class per grade with equal probability and without replacement. For smaller secondary school populations within a certain public health unit, double the number of classes were selected. Classes excluded were special education classes, English as a Second Language classes, and classes with fewer than four students enrolled or returning a consent form. Teachers were given a $15 gift card to a chain restaurant if permitted by the school (Boak et al., 2017).

Student Recruitment: All schools recruited were provided with parental consent forms that were sent home with students. Students in the selected classes who could read English or French and who returned a signed parental consent form were eligible to participate. Students also signed a consent form before participating. Students were not compensated for their participation (Boak et al., 2017).

Data Collection: Selected classes in a school were surveyed in one day. Students who were absent or did not return their consent form did not participate. The survey was administered by trained field staff from November 2016 to June 2017 across Ontario. In order to reduce any risk in disclosure by asking for assistance, any questions they did not understand they were asked to skip. Students recorded their answer directly on printed questionnaires. The field staff collected all completed questionnaires, and data capturing was conducted by using the Computer-Assisted Survey Execution System software. The quality of the data entry was verified by independently re-keying a random sample of 3% of all questionnaires (Boak et al., 2017).

3.1.3 Questionnaire

The questionnaire covers an array of topics related to mental and physical well-being. There were two versions (Form A and Form B) of the questionnaire in order to maximize the data collected and data usability while reducing cost and questionnaire length. However, the number of questions was minimized for elementary students, thus producing a total of four versions of the questionnaire. The average completion time was 30 minutes for secondary school students, and 31 minutes for elementary school students. The survey did not include any skip patterns, to ensure that all students would finish around the same time. For example response option such as: “never used”, “did not currently use”, or “did not know what a drug was” were used for drug related questions. Another advantage of this layout was minimizing navigational errors (Boak et al., 2017).

To maximize validity and to enhance cross-study comparability, many of the OSDUHS questionnaire items were derived from international guidelines and recognized student surveys (Monitoring the Future, Health Behaviour in School-aged Children, and Youth Risk Behaviour Survey) that have shown to produce valid responses. The 2017 OSDUHS questionnaire included validated scales and screeners. Any newly introduced items into the questionnaire were evaluated by both expert reviewers and pre-tested by York University’s Institute for Social Research on a small convenience sample of youth. The readability of the 2017 questionnaire showed a 7th-grade reading level according to the Flesch-Kincaid reading score (Boak et al., 2017).

3.1.4 Sample Participation

In total, 353 schools (285 initial selections plus 68 replacements) were invited to participate. Of these, 214 schools (94 elementary/middle schools and 120 secondary schools) participated, resulting in a rate of 61% school participation. A total of 764 classes met the inclusion criteria and the class participation rate was 94% (255 from elementary/middle schools, 509 from secondary schools). There were 18,773 students enrolled in the 764 classes with 11,596 (62%) of students participating, leaving a total of 11,435 students that met all the ‘complete’ case criteria. An ‘incomplete’ case meant any of the following: (1) had a missing value for sex, (2) reported using a fictitious drug, (3)

reported using a core illicit drug 40 or more times in the past year, (4) completed only the demographic questions in the questionnaire, (5) completed the questionnaire with assistance from the teacher (Boak et al., 2017).

Questions pertaining to the variables of interest for this thesis were included in Form A only and distributed to high school students only (n= 4,298 students). Complete data were used in all analyses (descriptive, latent profile analysis, bivariate analysis, and multivariable model). This complete data set excluded students who were missing data on any of the study variables of interest. Overall, 3,631 students were included in all analyses based on this criterion. Figure 3 provides a detailed breakdown of the sample size derivation for the present study.

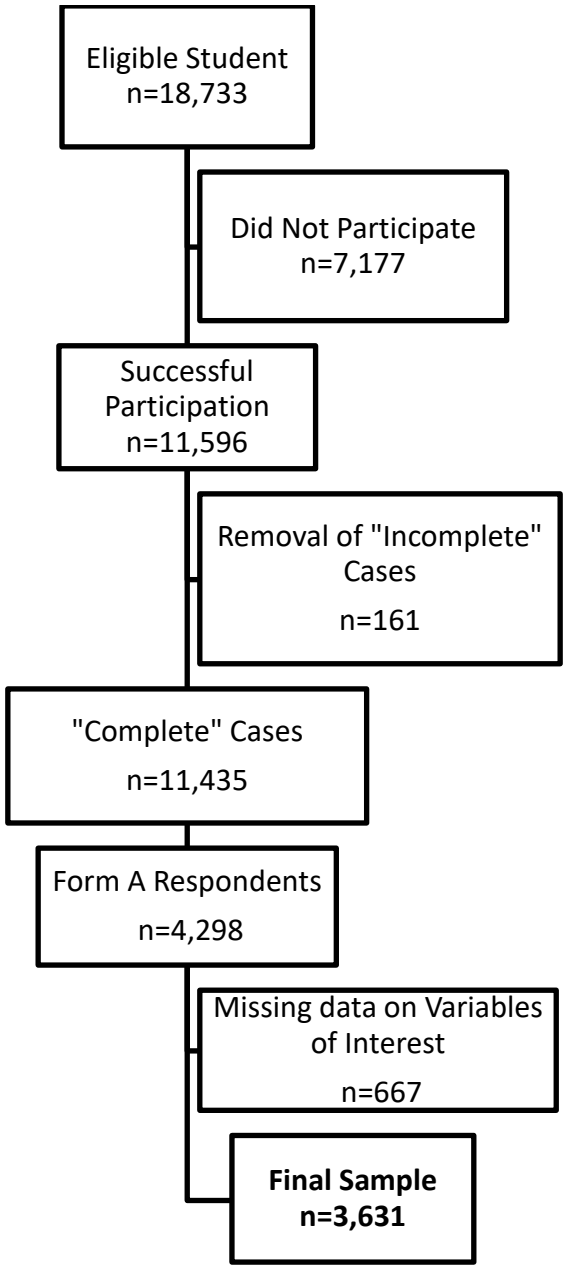

Figure 1: Sample Size Derivation.

3.1.5 Data Weighting

The objective of the OSDUHS was to have a representative sample of the Ontario student population. For each student, the final case weight is based on the product of five components: (1) the probability of a school being selected; (2) the probability of a class being selected within a selected school; (3) a student unit nonresponse adjustment factor;

(4) a regional post stratification adjustment to restore regional representation; and (5) a final post stratification adjustment to restore the sex-by-grade distribution, using the most currently available provincial enrolment numbers (Boak et al., 2017).

3.2 Measures

3.2.1 Problem Behaviour Variables

For all variables below, the continuous measure (i.e. total summary score) was used rather than creating a categorical or dichotomous variable, to reduce the loss of information. Moreover, all measures included individuals that answered all items used in each scale. Cronbach's alpha was conducted to assess the internal consistency, which is how closely related a set of items are as a group, for each measure. It is considered to be a measure of scale reliability.

3.2.1.1 Gambling Behaviour

The OSDUHS measures problem gambling using the Canadian Adolescent Gambling Inventory Problem Gambling Severity Subscale (CAGI GPSS), which is a nine-item instrument (Stinchfield, 2010; Tremblay, Stinchfield, Wiebe, & Wynne, 2010). This validated measure (Turner et al., 2018; Tremblay, Stinchfield, Wiebe and Wynne, 2010) is the only measure of problem gambling specifically designed and tested among adolescents (Stinchfield et al., 2010). It is therefore considered the "gold standard" measure of problem gambling in this population. Prior to the problem gambling questions, students were asked to list the amount of times they have participated in various gambling or betting activities. This allowed students to have a better understanding of what activities are considered gambling. Such activities listed are, betting money on, card games, dice games, bingo, sport pools, and more. Problem gambling symptoms during the past three months were measured using the following questions: "How often have you skipped practice or dropped out of activities due to your gambling?"; "How often have you skipped hanging out with friends who do not gamble to hang out with friends who do?"; "How often have you planned your gambling activities?"; "How often have you felt bad about the way you gamble?"; "How

often have you gone back another day to try to win back the money you lost while gambling?"; "How often have you hidden your gambling from your parents, other family members, or teacher?"; "How often have you felt that you might have a problem with gambling?"; "How often have you taken money that you were supposed to spend on lunch, clothing, movies, etc., and used it for gambling or for paying off gambling debts?"; and "How often have you stolen money or other things of value in order to gamble or to pay off your gambling debts?" The responses option for each item was: "1=Never"; "2=Sometimes (1 to 3 times)", "3=Most of the time (4 to 6 times)", and "4=Almost Always (7 or more times)." These values were recoded from "0=Never"; to "3=Almost Always". Students also had the option of responding that they have never gambled in their lifetime, or never gambled in the last three months, which was categorized as "0 =Never". The scores on these nine items were summed together to provide a total score from 0 to 27. Scores of zero to one represent individuals who are non-gamblers or non-problem gamblers, and scores of two or more are individuals that have low-to-high problem gambling severity (Turner et al., 2018; Tremblay, Stinchfield, Wiebe and Wynne, 2010) (Cronbach's α=0.79).

3.2.1.2 Video Game Playing

The Problem Video Game Playing (PVP) scale assesses problems with video gaming, which was determined using nine items (Tejeiro Salguero & Moran, 2002). These items assessing problem video gaming over the last twelve months included: "When you were not playing video games, did you keep thinking about them?"; "Did you spend an increasing amount of time playing video games?"; "Did you try to cut back or stop playing video games, OR did you play for longer than you had planned to?"; "Did you get restless or irritated when you could not play video games?"; "Did you play video games more often when you felt bad or had problems?"; "When you lost in a game or did not get the results you wanted, did you keep playing to achieve your target?"; "Did you skip school or work, or lie or steal, or argue with someone so that you could play video games?"; "Did you ignore homework, go to bed late, or spend less time with family and friends because of your video game playing?"; and "Did you ever hide your video game playing from your family or friends?" Responses to these items were coded as, "1=No"

and “2=Yes”. Students had the option of reporting that they do not play video games, which was re-coded as “0=No”. Each student was given a score ranging from 0 to 9. Students are considered to have a problem video game playing if they report having at least five of the nine symptoms on the PVP scale (Tejeiro Salguero & Moran, 2002) (Cronbach’s α=0.79).

3.2.1.3 Technology Use

The Short Problematic Internet Use Test (SPIUT) was used to assess problematic technology use, using six-items (Siciliano et al., 2015). These items included: “How often do you find that you are staying on electronic devices longer than you intended?”; “How often do you neglect homework because you are spending more time on electronic devices?”; “How often are you criticized by your parents or your friends about how much time you spend on electronic devices?”; “How often do you lose sleep because you use electronic devices late at night?”; “How often do you feel nervous when you are not using electronic devices and feel relieved when you do go back to using them?”; and “How often do you choose to spend more time on electronic devices rather than go out with your friends?” Students had the option of selecting responses from “1=Never”, “2=Rarely”, “3=Sometimes”, “4=Quite often”, “5=Very often” and “6=Don’t use these devices in my free time.” These variables were re-coded “0=Never” to “4=Very often”, with the response “Don’t use these devices in my free time” also coded as “0=Never”. A summated score ranging from 0 to 24 was calculated for each student who answered all six-items. Individuals that had a score of 14 to 18 are considered as having a moderate problems with technology use and those with a score of 19 or higher are considered having a serious problem with technology use (Siciliano et al., 2015) (Cronbach’s α=0.82).

3.2.1.4 Alcohol Use

The World Health Organization’s Alcohol Use Disorders Identification Test (AUDIT) is a validated ten-item instrument identifying hazardous and harmful drinking behaviour (Saunders et al., 1993). Hazardous drinking refers to an established pattern of drinking that increases the likelihood of future physical, social, or mental health problems (e.g.,

dependence), whereas harmful drinking refers to a pattern of drinking that is already causing harm (e.g., alcohol-related injuries) (Saunders et al., 1993). These items for AUDIT include 12 questions about alcohol intake: 1. “How often in the last 12 months have you consumed alcohol?”; 2. “How many drinks containing alcohol do you typically have in one day when drinking?”; 3. “How often do you have 5 or more drinks on one occasion”; 4. “How often in the last 12 months have you found that you were not able to stop drinking once you had started?”; 5.“How often in the last 12 months have you failed to do what is normally expected of you because of your drinking?”; 6. “How often in the last 12 months have you needed a first alcoholic drink in the morning to get yourself going after a heavy drinking session?”; 7. “How often in the last 12 months have you had a feeling of guilt or remorse after drinking?”; 8. “How often in the last 12 months have you been unable to remember what happened the night before because you had been drinking?”; 9. “Have you or someone else been injured as a result of your drinking?”; 10. “Has a relative or friend or a doctor or other healthcare worker been concerned about your drinking or suggesting you cut down?” For item 1, response options were coded “0=Never”, “1=Once a month or less”, “2=2 to 4 times a month”, “3=2 or 3 times a week” and “4=4 or more times a week.” For item 2, response options were coded “0=1 drink”, “1=2 to 3 drinks”, “2=4 drinks”, “3=5 to 7 drinks”, and “4=8 or more drinks.” For items 3 to 8 response options were coded “0=Never”, “1=Less than once a month”, “2=About once a month”, “3=About once a week”, and “4=Daily or almost daily.” For items nine and ten response options were coded “0=No”, “2=Yes, but not in the last 12 months” and “4=Yes, in the last 12 months.” Students who responded that they don’t drink alcohol or never drank alcohol in their lifetime were coded “0=Never”. Item 1 had additional responses, “Had a sip of alcohol to see what it’s like”, “Drank only at special events”, and “Drank, but not in the last 12 month”, which were re-coded to “0=Never.” The scores on these ten-items were summed together to provide a total score ranging from 0 to 40. A score of eight or more on this scale is an indication of hazardous and/or harmful drinking (Cronbach’s α=0.83).

3.2.1.5 Tobacco Use

Tobacco use was assessed through the question “Which of the following statements best describes your use of tobacco cigarettes in your lifetime?” Responses to this question included, “1=Never had a cigarette, not even one puff in my lifetime”, “2=Smoked from a few puffs to a whole cigarette in my life”, “3=only 2 to 3 cigarettes in my life”, “4= more than 3, but fewer than 100 cigarettes in my life”, “5= 100 or more cigarettes in my life, but none in the last month”, “6=100 or more cigarettes in my life and some during the last month, but not every day”, and “7= 100 or more cigarettes in my life and at least 1 cigarette every day during the last month.” This question was recoded to “0=Never had a cigarette” to “6=100 or more cigarettes in my life and at least 1 cigarette every day during the last month.” This question was coded on a scale of 0 to 6 for ease of interpretation.

3.2.1.6 Cannabis Use

Students were asked about cannabis use through the question “In the last 12 months, how often did you use cannabis?” Students were required to select one of the following responses “1=1 or 2 times”, “2=3 to 5 times”, 3=6 to 9 times”, “4=10-19 times”, “5=20-39 times”, and “6=40 or more times.” These items were recoded from “0=1 or 2 times” to “5=40 or more times”. Students were also given the option of responding that they have used cannabis, but not in the last 12 months, never used in their lifetime, or do not know what cannabis is, these responses were re-coded as zero. This question was coded on a scale of 0 to 6 for ease of interpretation.

3.2.1.7 Drug Use

Drug use problems experienced by students were assessed using the six-item CRAFFT screening test (Knight et al., 1999). CRAFFT is a mnemonic for the first letter of the key word in each question: Car, Relax, Alone, Forget, Friends, and Trouble. CRAFFT is the most well-studied and well-validated youth substance use-screening tool available (Knight et al., 1999). These six-items pertain to problems with any drug use other than alcohol over the last twelve months. Items included: 1. “How often did you ride in a

vehicle driven by someone who had been using drugs (other than alcohol)?"; 2. "Did you use drugs to relax, feel better about yourself, or fit in?"; 3. "Did you use drugs while you were by yourself?"; 4. "Did you forget things you did while using drugs?"; 5. "Did you get into trouble while you were using drugs?"; and 6. "Did your family or friends tell you that you should cut down on your drug use?" Responses to item 1 was, "1=Never", "2=Once" to "9=8 or more times" and "10=Not sure." Responses for items 2 to 6 were, "1=No" and "2=Yes." These responses were recoded to "0=No" and "1=Yes". Students were able to respond if they did not use drugs in the last 12 months or have never used drugs in their lifetime, these were re-coded as 0. The scores on these six-items were summed together to provide a total score ranging from 0 to 6. Individuals were considered to have a drug use problem if they scored two or more on the CRAFFT scale (Knight et al., 1999) (Cronbach's α=0.76).

3.2.2 Explanatory Variables

3.2.2.1 Sex

Sex at birth was assessed through the question, "Were you born male or female?" Responses to this item included "0=female and "1=male."

3.2.2.2 Age

Students were asked their age with the question "How old are you?" with response options ranging from "10=10 years of age or younger", "11=11 years", "12=12 years", etc., to "20=20 years or older." Age was used as a continuous variable in the analysis.

3.2.2.3 Race/Ethnicity

Students were asked "Which of the following best describes your background? Are you…?" with response options, White, Chinese, South Asian, Black, Aboriginal, Filipino, Latin American/Central American/South American, Southeast Asian, West Asian or Arab, Korean, Japanese, and Not sure. Due to small cell size for some ethnicity groups, race was re-coded to "0=Others" and "1=White."

3.2.2.4 Socioeconomic Status

The MacArthur Scale of Subjective Social Status-Youth Version developed by Goodman and colleagues (2001) was used to assess youth's perception of their families' socioeconomic status. Students were asked to imagine a ladder in which Canadian society is constructed. At the top of the ladder are people who are "best off" (most money, good education, and a respectful job) and at the bottom are those "worst off" (least money, little education, and no job/job that no one wants). Students were then asked "Now think about your family. Please check off the box that best shows where you think your family would be on this ladder." Responses were on a continuous scale from 1 to 10, 1 being "worst off" and 10 being "best off".

3.2.2.5 Academic Achievement

Students were asked their average academic achievement with the question "On average, what marks do you usually get in school?" Responses options were: "1= 90-100% (Mostly A+)", "2=80-89% (Mostly As or A-)", "3=70-79% (Mostly Bs)" and "4=60-69% (Mostly Cs)" "5=50-59 (Mostly Ds)" and "6=below 50% (Mostly Fs)." Due to insufficient cases in each cell (especially in the lowest and highest categories), academic achievement was recoded into a binary variable, where individuals with grades 70% or higher were coded as 0, and those with 69% or lower were coded as 1.

3.2.2.6 Antisocial Behaviour

Antisocial Behaviour Index was derived from the National Institute on Drug Abuse's Monitoring the Future Survey. These items have been shown to produce valid responses in several studies, moreover, this index has been used in the OSDUHS since 1991. It was measured by asking "How often (if ever) in the last 12 months have you done each of the following?, with response options "Taken a car, truck, or SUV for a ride without the owner's permission?", "Banged up or damaged something (on purpose) that did not belong to you?", "Sold marijuana or hashish?", "Taken things worth $50 or less that did not belong to you?", "Taken things worth more than $50 that did not belong to you?", "Beat up or hurt anyone (on purpose), not counting fights you may have had with a

brother or sister?", "Broken into a locked building other than your own home?", "Carried a weapon, such as a gun or knife (not for hunting)?", and "Run away from your home (left home without the permission of one of both of your parents/guardians)?" Students reported the number of times they participated in each of these activities. In this study, antisocial behaviour was dichotomized, with students who reported participating in 3 or more of these activities considered expressing antisocial behaviour.

3.2.2.7 School Connectedness

School connectedness was determined by asking youth to report on the extent to which they agreed with the following three items: 1."I feel safe in my school", 2. "I feel close to people at this school" and 3. "I feel like I am part of this school" These items were adapted to create the school connectedness measure used in many studies (Sampsa-Kanyinga & Hamilton 2017; Trinh et al., 2014), originally developed by Bollen and Hoyle (1991). Response options were "1=Strongly agree", "2=Somewhat agree", "3=Somewhat disagree", and "4=Strongly disagree." This variable was reversed coded such that higher numbers represent greater school connectedness, where "0=Strongly disagree" and "3=Strongly agree". A summated score was created for each individual ranging from 0-9. Only individuals who answered all three questions were included. The Cronbach's reliability coefficient for these items is 0.72.

3.3 Statistical Analyses

All statistical analyses in this study were conducted using MPlus Version 6 and Stata-MP-64. It is important to note that all analyses accounted for the complex sample data. Stata's *svy* suite of survey commands was used in order to account for the complex sample data. The analyses involved descriptive and multivariable statistics all conducted with sample weights to ensure approximate representation of the Ontario youth population. Descriptive statistics were calculated for the observed variables and explanatory variables of interest. Mixture modelling (latent profile analysis) was conducted on the problem behaviour variables in order to identify profile membership. Lastly, multinomial logistic regression was conducted to assess factors associated with

latent profile membership. These analytic approaches are described in further detail for each objective as follows.

3.3.1 Analytic Strategy

3.3.1.1 Sample Characteristics Analyses

Weighted descriptive analyses, including frequencies and cross-tabulations, were conducted in order to have a better understanding of the distributions of all problem behaviour and explanatory variables in the total sample and by sex. Frequency distributions are reported, with percentages and overall means with 95% confidence intervals.

3.3.1.2 Analyses for each Objective

3.3.1.2.1 Primary Objectives

3.3.1.2.1.1 Objective 1

Identify whether behavioural addictions (gambling, technology use, and video-game playing) cluster together with substance use (alcohol use, cannabis use, tobacco use, and drug use) in Ontario high school students: (a) in the overall sample; and (b) in a sample stratified by sex.

This study objective was accomplished through conducting a weighted latent profile analysis (LPA) using MPlus. LPA is a form of mixture modelling that uses observed variables as indicators to identify a latent variable, which is categorical and comprised of a set of latent profiles (Collins & Lanza, 2010). LPA assumes that it is relevant to find subgroups of individuals for whom the observed variables are independent. In other words, in the total sample, the latent variable distinguishing the profiles is the only thing that accounts for the observed variables to be related to each other (Collins & Lanza, 2010; Hagenaars & McCutcheon, 2002).

As shown in Figure 1, the observed variables (i.e., adolescent problem behaviours) are a function of the unobserved latent variable. Individuals are then organized into two or more meaningful homogeneous subgroups (i.e., most likely profiles) based on their response patterns to the observed variables (Collins & Lanza, 2010). In this study we used LPA to identify a latent variable using seven observed/indicator variables assessing problem behaviours: gambling problems, harmful or hazardous drinking, cannabis use, tobacco use, drug use problems, problem video-game playing, and problem technology use. In order to identify the best fitting model for the LPA, several statistical parameters will be used, including bayesian information criterion (BIC), log likelihood ratio, entropy, and average latent profile probabilities. Lowest BIC is deemed to be the most accurate parameter to use when determining the best fitted model (Nylund et al., 2007). Log likelihood ratio is also considered to be a good indicator for model fit (Nylund et al., 2007). Entropy provides an overall probability that an individual placed in a profile fits to that profile, with a value closest to 1.00 indicating a good fitted model. Lastly, average latent profile probabilities estimate the probability for most likely latent profile membership by latent profile, with values that are closest to 1.00 indicating good model fit.

Finite Mixture Models (FMM), such as Latent Profile Analysis (LPA), is a person-centred approach rather than variable-centred (Tomczyk, Isensee, & Haneqinkel, 2016). FMM can create subgroups of behaviours that are homogenous and mutually exclusive by analysing response patterns on various variables. This analysis is based on a probabilistic model that describes the distribution of the data (Hagenaars & McCutcheon, 2002; Tomczyk, Isensee, & Haneqinkel, 2016). Compared to conventional methods such as cluster analysis, FMM are not strongly affected by distribution restrictions, meaning that if variables exhibit skewness or low cell frequencies, FMM would most likely reveal a small group of users that still allows for further testing (Tomczyk, Isensee, & Haneqinkel, 2016). Moreover, in order to reduce any loss of information we decided to keep all problem behaviour variables continuous, which is why we used a LPA, verse a latent class analysis, which is for binary variables.

The mean differences for each observed/indicator variables between profiles were further tested for significance using Somers'D, a nonparametric test, by a pair-wise comparison. Bonferroni correction was completed to the critical *P*-value (α=0.05) by the number of comparisons being made.

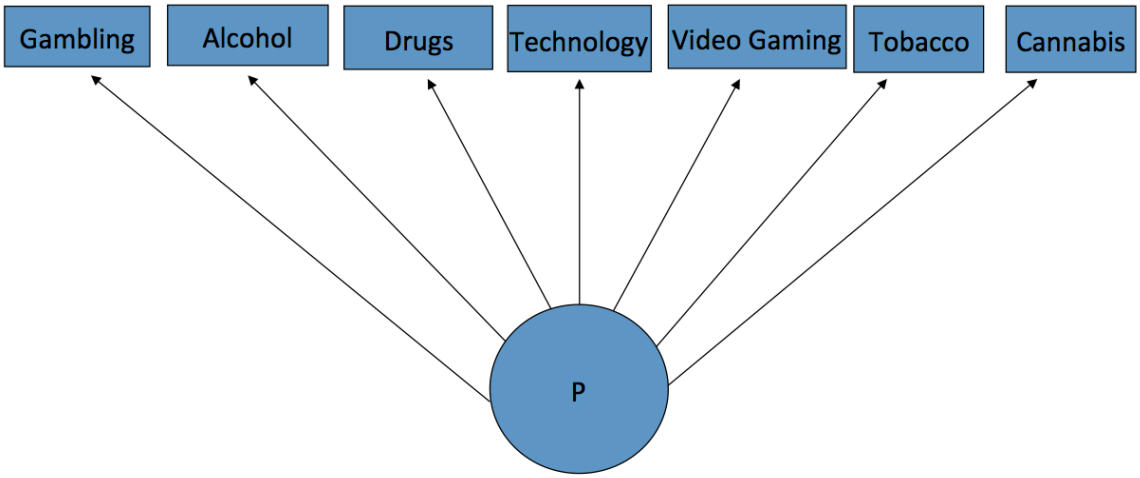

Figure 2: Latent profile analysis diagram. The circle with the P represents a categorical latent variable (latent profiles) formed based on the seven problem behaviours located at the top.

3.3.1.2.1.2 Objective 2

Identify characteristics (sex, age, race, socioeconomic status, school connectedness, academic achievement, and antisocial behaviour) associated with profile membership among high school students in Ontario: (a) conducted in the total sample and; (b) in a sample stratified by sex.

A series of weighted descriptive statistics were conducted for all variables of interest by profile membership in Stata. This included frequency distributions and overall means with 95% confidence intervals. Overall associations were tested for significance using design based F-test. As well, significance of means where tested using Somers'D, conducting a pair-wise comparison. Again, bonferroni correction was completed to the critical *P*-value (α=0.05) by the number of comparisons being made.

A weighted bivariate multinomial logistic regression analyses was conducted with two-tailed Wald testing a 95% level of confidence to analyse the associations between the explanatory variables predicting most likely profile membership. Multinomial logistic regression results were expressed as relative risk ratios representing the relative risk of being categorized in a specific profile. The exponentiated coefficients produced by Stata's mlogit command used for conducting multinomial logistic regressions are ratios of relative risk.

Finally, weighted multivariable multinomial logistic regression was used in order to examine the associations between latent profile membership and the explanatory variables using Stata. The latent profile membership, a variable created and assigned to individuals. Sufficient sampling size were satisfied for the outcome variable (latent profiles), due to large sample size. A test for multicollinearity was conducted for each explanatory variable using variance inflation factors (VIF). VIFs below 5.0 were considered to meet assumptions of non-multicollinearity (O'Brien, 2007). The latent-profile with the overall lowest average scores for all problem behaviours will be used as the reference group. The overall associations between each explanatory variable and the outcome was tested for adjusted significance using a design-based F-test.

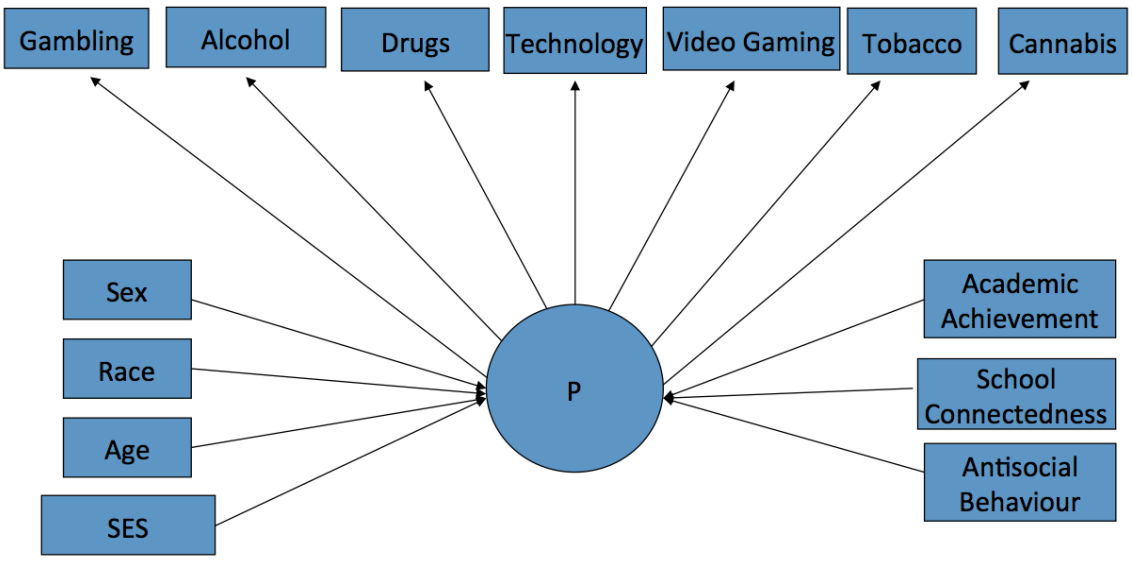

Figure 3: Latent Profile Analysis diagram. The circle with the P represents a categorical latent variable (latent profiles) formed based on the seven problem behaviours located at the top. The boxes on the left and right are explanatory variables that was regressed onto the profiles.

3.4 Missing Data

Initial analyses were conducted without removing missing data, latent profile analysis is robust and can sort students in profiles with various amounts of missing data. These analyses was compared to the results of the complete case analysis, which showed little variation. Based on these results, we decided to proceed with the complete case analysis for this study. Data that were missing can be characterized as a combination of missing at random (MAR) and missing not at random (MNAR). For the variables examined in this study, underreporting often occurs because of the sensitive nature of the questions and possible stigma related to illegal or unacceptable behaviours (Brener, Billy, Grady, 2003; Boak et al., 2017). Thus, MNAR can be assumed for such questions as they may be intentionally skipped. As shown in Table 1, missingness was low for all variables (<6%), with the highest rate of missingness found for problem video gaming and anti-social behaviour.

Table 1: Missingness on study variables of interest for total sample of interest (n=4,298).

	Count	%
Problem Behaviours		
Problem Gambling	183	4.3%
Problem Alcohol Use	132	3.1%
Problem Drug Use	13	0.3%
Problem Technology Use	188	4.4%
Problem Video Gaming	221	5.1%
Cannabis Use	40	0.9%
Tobacco Use	15	0.3%
Explanatory Variables		
Sex	0	0%
Age	1	0%
Race	20	0.5%
SES	85	2.0%
Academic Achievement	7	0.2%
School Connectedness	59	1.4%
Antisocial Behaviour	223	5.2%

Chapter 4

4 Results

4.1 Total Sample Characteristics

Weighted sample characteristics for the total sample are presented in Table 2. The sample was evenly split between the sexes: 49.1% male and 50.9% female. The mean age of the students was 16 years (SD: 1.3). The majority of students identified as White (53.6%). Mean socioeconomic status was 6.8 (SD: 1.7) on a 10-point scale. The vast majority (94.9%) of students reported achieving grades 70% or above. The mean score for feelings of school connectedness was 6.9 (SD: 1.8) on the 9-point scale. Finally, the prevalence of antisocial behaviour among students was low (7.0%).

The mean problem gambling scale score for all students in the study was 0.4 (SD: 1.5) on the 27-point scale. While most students did not report symptoms of problem gambling (92.0%), 8.1% reported gambling scores that were indicative of low-to-high problem gambling severity. The mean problem technology use score was 9.0 (SD: 5.1) on the 24-point scale, and 18.3% of the sample had scores in the range of a moderate-to-serious problem with technology. Individuals in this study on average scored 1.7 (SD: 2.0) on the 9-point scale for the problem video game playing measure, with 12.3% showing indication of problem video game playing.

The mean score for alcohol use disorder (AUDIT) was 3.1 (SD: 4.6) on the 40-point scale, with around 14.7% exceeding the cut off score for indications of alcohol use disorder. Problem drug use (CRAFFT) had a mean score of 0.5 (SD: 1.1) on a 6-point scale; 12.4% met criteria for having a drug use problem. The mean score for cannabis use was 0.7 (SD: 1.6) on a 5-point scale while the mean score for tobacco use was 0.5 (SD: 1.1) on a 6-point scale.

Table 2: Weighted proportions and means with standard deviations (SD) for all study variables of interest in the total sample (n=3631).

Study Variables	Count	%	Mean (SD)
Explanatory variables			
Sex			
Male	1458	49.1%	-
Female	2173	50.9%	-
Race			
White	2140	53.6%	-
Other	1491	46.4%	-
Academic Achievement			
70%+	3418	94.9%	-
69%-lower	213	5.1%	-
Antisocial Behaviour			
No indication	3413	93.0%	-
Indication	218	7.0%	-
School Connectedness	-	-	6.9 (1.8)
Age	-	-	16.0 (1.3)
SES	-	-	6.8 (1.7)
Problem Behaviours			
Problem Gambling	-	-	0.4 (1.5)
Non-gamblers/No problem gambling	3441	92.0%	
Low-to-high problem gambling severity	190	8.1%	
Problem Technology Use	-	-	9.0 (5.1)
No problem technology use	2956	81.7%	
Moderate to serious problem technology use	675	18.3%	
Problem Video Game Playing	-	-	1.7 (2.0)
No problem video gaming	3270	87.8%	
Problem video gaming	361	12.3%	
Alcohol Use Disorders	-	-	3.1 (4.6)
no	3156	85.3%	
yes (8+)	475	14.7%	
Problem Drug Use	-	-	0.5 (1.1)
no	3169	87.6%	
yes (2+)	462	12.4%	
Cannabis Use	-	-	0.7 (1.6)
Tobacco Use	-	-	0.5 (1.1)

4.2 Sample Characteristics by Sex

Weighted sample characteristics for the sample by sex are presented in Table 3. A larger proportion of females (96.0%) than males (93.8%) reported achieving grades within 70% and up. The mean score for feelings of school connectedness was 7.0 (SD: 1.8) for males and 6.4 (SD: 1.8) on the 9-point scale ($p<0.0001$).

The mean CAGI score for males was 0.6 (SD: 1.8) and 0.2 (SD: 1.2) for females on the 27-point scale ($p<0.0001$). While most students did not report symptoms of problem gambling, 11.2% of males and 5.0% of females reported gambling scores that were indicative of low-to-high problem gambling severity. The mean problem technology use score was 8.0 (SD: 4.7) for males and 10.1 (SD: 5.2) for females on the 24-point scale ($p<0.0001$), and 12.2% of males and 24.3% of females had scores in the range of a moderate-to-serious problem with technology. Males in this study on average scored 2.4 (SD: 2.1) on the 9-point scale for the problem video game playing measure, where females scored an average of 1.0 (SD: 1.6) ($p<0.0001$). A higher proportion of males (12.3%) compared to females (6.8%) showed indication of problem video game playing. All of these behavioural addictions were found to be significantly different across sexes ($p<0.05$).

A significantly ($p<0.05$) greater proportion of males (14.1%) compared to females (10.7%) met criteria for having a drug use problem.

Table 3: Weighted proportions and means with standard deviations (SD) for all study variables of interest by sex (n=3631).

	Males n=1458			Females n=2173			
Study Variables	**Count**	**%**	**Mean (SD)**	**Count**	**%**	**Mean (SD)**	**F /p-value**
Explanatory Variables							
Race							
White	899	56.6%	-	1241	50.7%	-	F=(1, 109)=1.26
Other	559	43.5%	-	932	49.3%	-	p=0.26
Academic Achievement							
70%+	1346	93.8%	-	2072	96.0%	-	F(1, 109)=4.90
69%-lower	112	6.2%	-	101	4.1%	-	p=0.03
Antisocial Behaviour							
No indication	1345	91.5%	-	2068	94.4%	-	F(1, 109)=1.50
Indication	113	8.5%	-	105	5.6%	-	p=0.22
School Connectedness	-	-	7.0(1.8)	-	-	6.4(1.8)	p<0.0001
Age	-	-	16.0(1.3)	-	-	15.9(1.3)	p=0.33
SES	-	-	6.8(1.7)	-	-	6.8(1.7)	p=0.87
Problem Behaviours							
Problem Gambling	-	-	0.6(1.8)	-	-	0.2(1.2)	p<0.0001
No problem gambling	1329	88.8%		2112	95.0%		F(1,109)=14.56
Low-to-high problem gambling severity	129	11.2%		61	5.0%		p<0.001
Problem Technology Use	-	-	8.0(4.7)	-	-	10.1(5.2)	p<0.0001
No problem technology use	1297	87.8%		1659	75.7%		F(1,109)=30.9
Moderate to serious problem technology use	161	12.2%		514	24.3%		p<0.0001

Table 3: Continued

Problem Video Game Playing	-	-	2.4(2.1)	-	-	1.0(1.6)	p<0.0001
No problem video gaming	1209	87.8%		2061	93.2%		F(1,109)=68.7
Problem video gaming	249	12.3%		112	6.8%		p<0.0001
Alcohol Use Disorders	-	-	3.2(4.8)	-	-	2.9(4.5)	p=0.55
no	1250	85.2%		1906	85.5%		F(1,109)=0.03
yes (8+)	208	14.8%		267	14.5%		p=0.87
Problem Drug Use	-	-	0.5(1.2)	-	-	0.4(1.0)	p=0.10
no	1251	85.9%		1918	89.3%		F(1,109)=5.60
yes (2+)	207	14.1%		255	10.7%		p=0.02
Cannabis Use	-	-	0.8(1.7)	-	-	0.6(1.4)	p=0.19
Tobacco Use	-	-	0.5(1.3)	-	-	0.4(1.0)	p=0.23

Note: Full Somers'D results are found in Appendix I

4.3 Primary Analyses

The results relating to the primary objectives of this thesis are described below.

4.3.1 Objective 1

Identify whether behavioural addictions (gambling, technology use, and video-game playing) cluster together with substance use (alcohol use, cannabis use, tobacco use, and drug use) in Ontario high school students: (a) in the overall sample; and (b) in a sample stratified by sex.

4.3.1.1 Total Sample

The first objective of the present study consisted of the classification of homogenous subgroups by finding distinct patterns of seven problem behaviours in the study sample. Using the decision criteria outlined in Nylund et al. (2007), the results indicated that the best-fitted latent model consisted of four profiles. The four-profile model had the highest entropy (0.998), where values closer to one indicate a better classification quality (Table 4). The five-profile solution had the lowest Bayesian Information Criterion (BIC) and log likelihood ratio, however when comparing the difference across models, four-profile model and five-profile model had a smaller difference for both criteria than the three-profile model and four-profile model. Moreover, the posterior probabilities that individuals belong to their assigned profiles and not to other profiles were high in the four-profile model (1.00-0.996); therefore, the profiles in the four-profile model were distinguishable from one another (Table 5). Therefore, when considering all these statistical parameters, we concluded that the four-profile model would be the best fit.

Table 4: Model fit statistics for models with one to five latent profiles.

	Fit Statistics		
Model	**BIC**	**Log-likelihood**	**Entropy**
One-Profile	108271.69	-54078.46	n/a
Two-Profile	99505.73	-49662.70	0.983
Three-Profile	96676.02	-48215.05	0.988
Four-Profile	94206.39	-46947.45	0.998
Five-Profile	92545.71	-46084.35	0.982

Table 5: Average latent profile probabilities for most likely latent profile membership (row) by latent profile (column) for the four-profile model.

Profile	n	No Problems	Dabblers	Serious Dabblers	Drug Problems
No Problems	2765	**1.000**	0.000	0.000	0.000
Dabblers	440	0.004	**0.996**	0.000	0.000
Serious Dabblers	219	0.000	0.000	**1.000**	0.000
Drug Problems	207	0.000	0.000	0.000	**1.000**

A plot of the standardized means for each of the four latent profiles is presented in Figure 4 along with their associated labels. Each group was assigned a descriptive name on the basis of their modal behavioural patterns (Slater et al., 1999; Turner et al., 2011). These names are a mnemonic device and are not intended to oversimplify the differences or similarities between or within groups (Slater et al., 1990; Turner et al., 2011). The four-profiles that have differing sizes and behavioural configurations include: (1) “No Problems” (n=2765; 75.7%); (2) “Dabblers” (n=440; 12.5%); (3) “Serious Dabblers” (n=219; 5.8%) ; (4) “Drug Problems” (n=207; 6.0%) (Table 6). The “No Problem” subgroup reported the lowest scores for most problem behaviours, including gambling, problem technology use, alcohol use disorder, problem drug use, cannabis use, and tobacco use. However, there was no statistical difference across all subgroups for problem gambling, problem technology, and problem video game playing scores. “Serious Dabblers” and “Drug Problems” subgroups were both statistically different from each the “No Problems” and “Dabblers” subgroup for alcohol use disorder and tobacco use scores. Lastly, all subgroups were found to be significantly different from each other for problem drug use and cannabis use scores, with the “Drug Problems” subgroup having the highest score.

A breakdown of the proportion of adolescents with drug, alcohol, gambling, technology use, and video gaming problems by latent profile is provided in Table 7. The proportion of individuals that have problem gambling, technology use, and video game playing were not found to be statistically different across the latent profile groups. The proportion of students that indicated alcohol use disorder was significantly different across the four groups, with 5.6% of “No Problems”, 36.3% of “Dabblers”, 43.4% of “Serious Dabblers”, and 56.6% of “Drug Problems” having an alcohol use disorder. The proportion of individuals that reported having a drug use problem also varied significantly across groups: 1.3% of “No Problems”, 23.2% of “Dabblers”, 55.6% of “Serious Dabblers”, and 87.4% of “Drug Problems”.

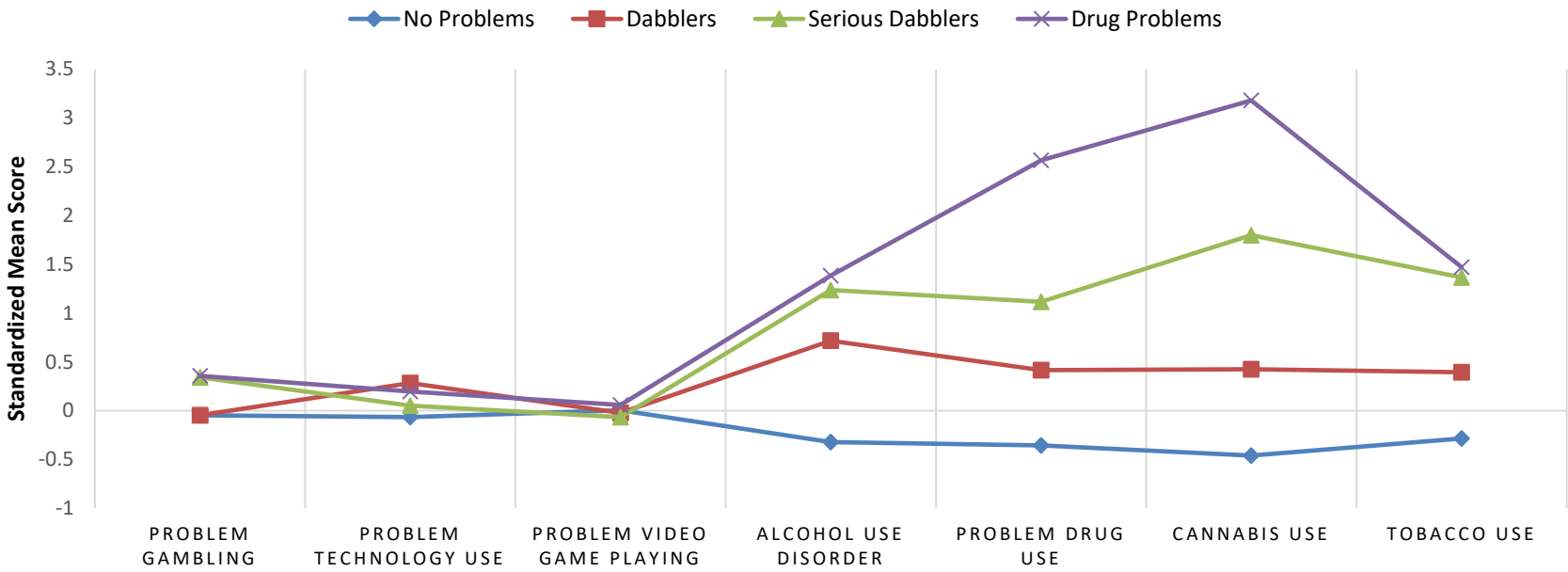

Figure 4: Weighted standardized mean score for all observed variables (problem behaviours) by each latent profile in the four-profile model (n=3631).

Table 6: The weighted mean scores for observed variables (problem behaviours) according to latent profile with standard error (SE) for total sample (n=3631).

Variables	Latent Profile							
	No Problems n=2765		Dabblers n=440		Serious Dabblers n=219		Drug Problems n=207	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Problem Gambling	0.33[a]	0.05	0.33[a]	0.07	0.92[a]	0.51	0.95[a]	0.53
Problem Technology Use	8.70[a]	0.22	10.47[a]	0.62	9.28[a]	0.48	10.02[a]	0.47
Problem Video Game Playing	1.69[a]	0.08	1.64[a]	0.28	1.55[a]	0.23	1.80[a]	0.34
Alcohol Use Disorders	1.60	0.13	6.38	0.37	8.77[a]	0.64	9.45[a]	0.69
Problem Drug Use	0.08	0.01	0.93	0.08	1.70	0.16	3.30	0.29
Cannabis Use	0.00	0.00	1.40	0.05	3.58	0.06	5.76	0.05
Tobacco Use	0.14	0.03	0.91	0.11	2.01[a]	0.17	2.13[a]	0.22

Note: Means followed by the same letter in a row do not significantly differ from each other (critical α =0.05 level after Bonferroni correction is α=0.008). Full Somers'D pair-wise comparison results are found in Appendix J

Table 7: Weighted proportions (%) of students with gambling, technology use, video game playing, alcohol, and drug use problems (categorical variables only) by latent profile for total sample (n=3631).

Variables	Latent Profiles								
	No Problems n=2765		Dabblers n=440		Serious Dabblers n=219		Drug Problems n=207		
	Count	%	Count	%	Count	%	Count	%	F
Problem Gambling									
Non-gamblers/No problem gambling	2640	92.6%	417	92.6%	196	87.8%	188	87.3%	F(1.97, 214.42)=0.64
Low-to-high problem gambling severity	125	7.4%	23	7.4%	23	12.2%	19	12.7%	p=0.53
Problem Technology Use									
No problem technology use	2289	83.4%	335	71.5%	174	82.7%	158	80.6%	F(1.71, 186.89)=1.99
Moderate to serious problem technology use	476	16.6%	105	28.5%	45	17.3%	49	19.4%	p=0.15
Problem Video Game Playing									
No problem video gaming	2476	88.0%	404	86.3%	202	91.0%	188	84.5%	F(1.29, 140.67)=0.20
Problem video gaming	289	12.0%	36	13.7%	17	9.1%	19	15.5%	p=0.72
Alcohol Use Disorders									
no	2633	94.4%	304	63.8%	128	56.6%	91	43.4%	F(2.32, 253.33)=96.87
yes (8+)	132	5.6%	136	36.3%	91	43.4%	116	56.6%	p<0.0001
Problem Drug Use									
no	2724	98.7%	325	76.8%	86	44.4%	34	12.6%	F(2.59,282.45)=149.68
yes (2+)	41	1.3%	115	23.2%	133	55.6%	173	87.4%	p<0.0001

4.3.1.2 By Sex

The classification of homogenous subgroups by distinctive patterns of seven observed variables (i.e. problem behaviour) was separated by sex. Using the decision criteria outlined in Nylund et al. (2007), the results indicated that the best-fitted latent model consisted of three profiles. The three-profile solution had the lowest Bayesian Information Criterion (BIC) due to model non-identification for the four-profile model (Table 8). Results in Table 8 indicate that the entropy statistics were the highest in the two-profile model (0.992); however, BIC value is the best indication for best-fitted model (Nylund, 2007). The posterior probabilities that individuals belong to their assigned profiles and not to other profiles were high (1.00-0.946) in the three-profile model; therefore, the profiles were distinguishable from one another (Table 9).

Table 8: Model fit statistics for models with one to three latent profiles by sex.

	Fit Statistics		
Model	**BIC**	**Log likelihood**	**Entropy**
One-Profile	112603.16	-56211.41	n/a
Two-Profile	103889.29	-51793.00	0.992
Three-Profile	100704.07	-50138.91	0.991

Table 9: Average latent profile probabilities for most likely latent profile membership (row) by latent profile (column) for three-profile model by sex.

Profile	**No Problems** *(Males)*	**Dabblers** *(Males)*	**Drug Problems** *(Males)*	**No Problems** *(Females)*	**Dabblers** *(Females)*	**Drug Problems** *(Females)*
No Problems *(Males)*	**0.986**	0.010	0.004	0.000	0.000	0.000
Dabblers *(Males)*	0.000	**1.000**	0.000	0.000	0.000	0.000
Drug Problems *(Males)*	0.004	0.000	**0.996**	0.000	0.000	0.000
No Problems *(Females)*	0.000	0.000	0.000	**0.946**	0.054	0.001
Dabblers *(Females)*	0.000	0.000	0.000	0.007	**0.993**	0.000
Drug Problems *(Females)*	0.000	0.000	0.000	0.006	0.000	**0.994**

4.3.1.2.1 Males

A plot of the standardized means for each of the three latent profiles for males is presented in Figure 5 along with their associated labels. The three-profiles that were found are: (1) “No Problems” (n=1175; 80.9%); (2) “Dabblers” (n=166; 11.8%); (3) “Drug Problems” (n=117; 7.3%) (Table 10). As shown in Table 10, the mean scores by profile membership are presented for the seven-problem behaviour variables used in the latent profile analysis. “No problems” had the lowest mean score for most problem behaviour (gambling, technology use, alcohol use, drug use, cannabis and tobacco use). There was no significant difference across all subgroups for problem gambling and problem video game playing scores. “Drug Problems” had the highest mean scores for all problem behaviours except gambling. Problem drug use and cannabis use were found to be statistically different across all subgroup comparisons. Alcohol use disorder and tobacco use were found to be statistically different across all subgroups comparisons except between “Dabblers” and “Drug Problems.” Problem technology use was only statistically different between “No Problems” and “Drug Problems” subgroups.

Lastly, a breakdown of the proportion of male adolescents with drug, alcohol, gambling, technology use, and video gaming problems by latent profile is provided in Table 11. The proportion of individuals that have problem gambling, technology use, and video game playing were not found to be statistically different across profiles. The proportion of students that indicated alcohol use disorder was significantly different, with 7.7% of “No Problems”, 37.6% of “Dabblers”, and 57.3% of “Drug Problems”. The proportion of individuals that reported having a drug use problem also varied across groups: 2.3% of “No Problems”, 46.9% of “Dabblers”, and 91.6% of “Drug Problems”.

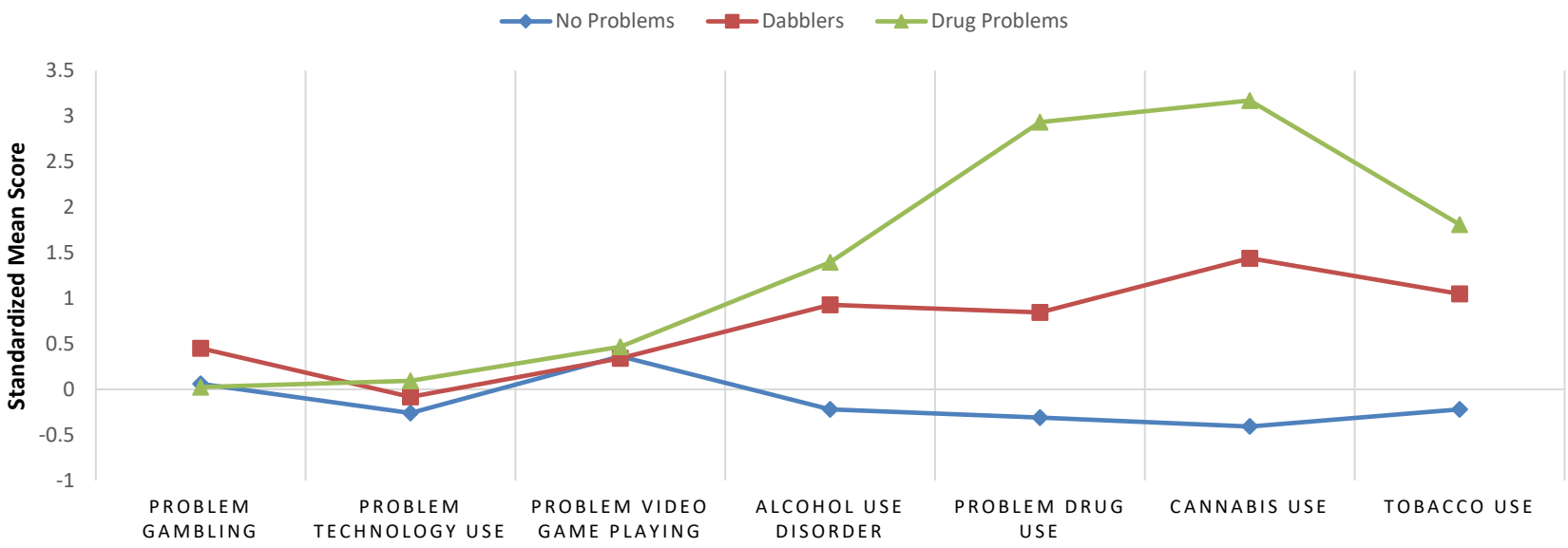

Figure 5: Weighted standardized mean score for all observed variables (problem behaviours) by each latent profile in the three-class model for male sample.

Table 10: Weighted mean scores for observed variables (problem behaviours) according to latent profile with standard error (S.E.) for male sample.

Variables	Latent Profile					
	No Problems n=1175		Dabblers n=166		Drug Problems n=117	
	Mean	S.E	Mean	S.E	Mean	S.E
Problem Gambling	0.50[a]	0.08	1.09[a]	0.52	0.44[a]	0.13
Problem Technology Use	7.72[a]	0.30	8.61[ab]	0.52	9.49[b]	0.55
Problem Video Game Playing	2.42[a]	0.13	2.37[a]	0.24	2.62[a]	0.43
Alcohol Use Disorders	2.06	0.22	7.35[a]	0.70	9.49[a]	1.12
Problem Drug Use	0.13	0.03	1.40	0.14	3.70	0.40
Cannabis Use	0.08	0.02	3.01	0.14	5.75	0.09
Tobacco Use	0.21	0.05	1.65[a]	0.20	2.52[a]	0.26

Note: Means followed by the same letter in a row do not significantly differ from each other (critical α =0.05 level after Bonferroni correction is α=0.008). Full Somers'D pair-wise comparison results are found in Appendix K

Table 11: Weighted proportions (%) of students with gambling, technology use, video game playing, alcohol, and drug use problems (categorical variables only) by latent profile for the male sample.

Variables	Latent Profile								
	No Problems		Dabblers		Drug Problems		Total		
	n= 1175		n=166		n=117		n=1458		
	Count	%	Count	%	Count	%	Count	%	F
Problem Gambling									
No problem gambling	1084	89.4%	142	81.9%	103	93.2%	1329	88.9%	F(1.43, 152.76)=2.10
Low-to-high problem gambling severity	91	10.6%	24	18.1%	14	6.8%	129	11.2%	p=0.14
Problem Technology Use									
No problem technology use	1055	88.1%	114	87.8%	98	84.9%	1297	87.8%	F(1.98, 212.02)=0.22
Moderate to serious problem technology use	120	11.9%	22	12.2%	19	15.1%	161	12.2%	p=0.80
Problem Video Game Playing									
No problem video gaming	966	82.2%	142	86.3%	101	74.7%	1209	82.1%	F(1.25, 133.71)=0.72
Problem video gaming	209	17.8%	24	13.7%	16	25.3%	249	17.9%	p=0.43
Alcohol Use Disorders									
no	1092	92.4%	98	62.4%	60	42.8%	1250	85.2%	F(1.85, 198.32)=41.95
yes	83	7.7%	68	37.6%	57	57.3%	208	14.8%	p<0.0001
Problem Drug Use									
no	1144	97.7%	93	53.1%	14	8.4%	1251	85.9%	F(1.84, 196.62)=181.40
yes	31	2.3%	73	46.9%	103	91.6%	207	14.1%	p<0.0001

4.3.1.2.2 Females

A plot of the standardized means for each of the three latent profiles is presented in Figure 6 along with their associated labels. Consistent with findings for males, the three-classes that were found were: (1) “No Problems” (n=1811; 82.1%); (2) “Dabblers” (n=211; 10.7%); (3) “Drug Problems” (n=151; 7.2%) (Table 12). As shown in Table 12, the mean scores by profile membership are presented for the seven-problem behaviour variables used in the latent profile analysis. “No problems” had the lowest mean score for most problem behaviours (technology use, alcohol use, drug use, cannabis and tobacco use). However there was no significant difference across subgroups for problem gambling, problem technology and problem video game playing scores.
“Drug Problems” subgroup had the highest mean scores for most problem behaviours (problem gambling, alcohol use disorder, problem drug use, cannabis use, and tobacco use. However, problem drug use and cannabis use was found to be statistically different across all subgroup comparisons. Alcohol use disorder and tobacco use was found to be statistically different across all subgroup comparisons except between “Dabblers” and “Drug Problems.”

A breakdown of the proportion of adolescents with drug, alcohol, gambling, technology use, and video gaming problems by latent profile is provided in Table 13. The proportion of individuals that have problem technology use and video game playing were not found to be statistically different across profiles. The proportion with low-to-high problem gambling severity was found to be significantly different across the groups, with 4.3% among those with “No Problems”, 1.3% of “Dabblers”, and 18.4% of “Drug Problems”. The proportion of students that indicated alcohol use disorder was also significantly different across the three groups: 6.6% of “No Problems”, 4.8% of “Dabblers”, and 54.5% of “Drug Problems”. Finally, the proportion of individuals that reported having a drug use problem varied across groups: 1.0% of “No Problems”, 37.1% of “Dabblers”, and 82.6% of “Drug Problems”.

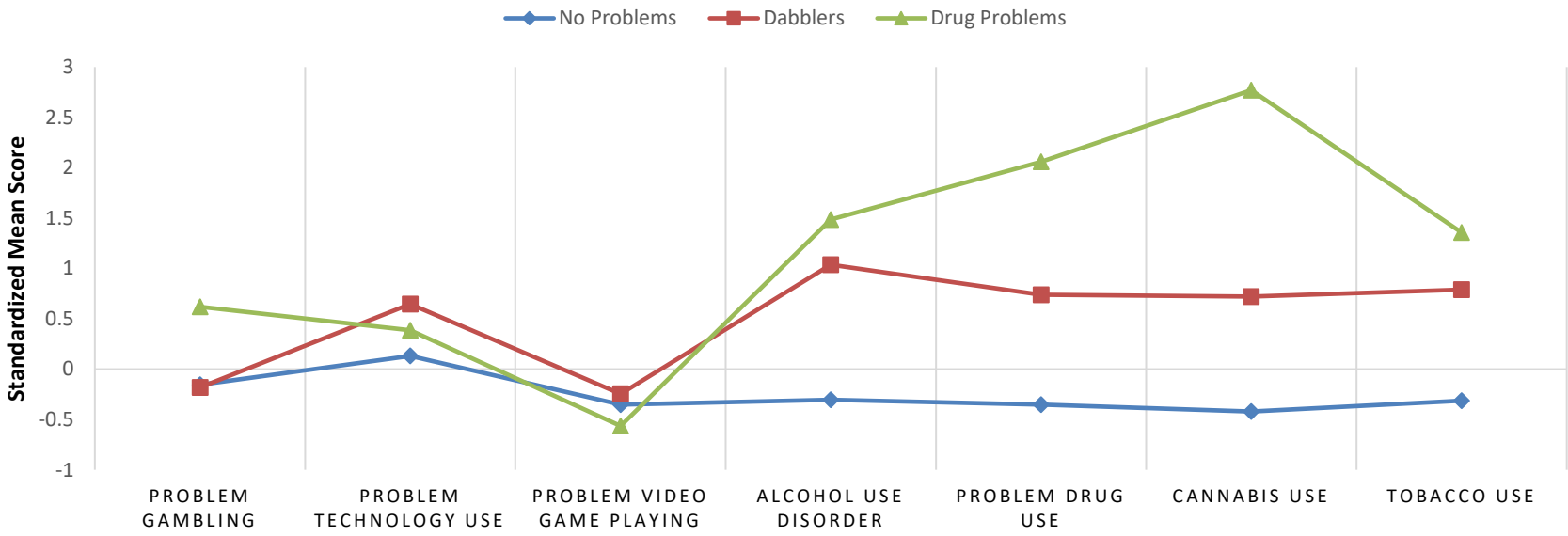

Figure 6: Weighted standardized mean score for all observed variables (problem behaviours) by each latent profile in the three-class model for females.

Table 12: Weighted mean scores for observed variables (problem behaviours) according to latent profile with standard error (S.E.) for female sample.

Variables	Latent Profile					
	No Problems n=1811		Dabblers n=211		Drug Problems n=151	
	Mean	S.E	Mean	S.E	Mean	S.E
Problem Gambling	0.16[a]	0.05	0.12[a]	0.04	1.35[a]	0.83
Problem Technology Use	9.69[a]	0.29	12.31[a]	1.06	11.00[a]	0.69
Problem Video Game Playing	0.97[a]	0.11	1.18[a]	0.35	0.54[a]	0.13
Alcohol Use Disorders	1.68	0.17	7.86[a]	0.53	9.92[a]	0.75
Problem Drug Use	0.09	0.01	1.29	0.16	2.74	0.21
Cannabis Use	0.06	0.01	1.87	0.14	5.11	0.14
Tobacco Use	0.11	0.02	1.36[a]	0.16	2.00[a]	0.28

Note: Means followed by the same letter in a row do not significantly differ from each other (α =0.05 level after Bonferroni correction (α=0.008)). Full Somers'D pair-wise comparison results are found in Appendix L

Table 13: Weighted proportions (%) of students with gambling, technology use, video game playing, alcohol, and drug use problems (categorical variables only) by latent profile for the female sample.

Variables	Latent Profiles								
	No Problems		Dabblers		Drug Problems		Total		
	n=1811		n=211		n=151		2173		
	Count	%	Count	%	Count	%	Count	%	F
Problem Gambling									
No problem gambling	1767	95.7%	205	98.7%	140	81.6%	2112	95.0%	F(1.28, 138.21)=10.44
Low-to-high problem gambling severity	44	4.3%	6	1.3%	11	18.4%	61	5.0%	p<0.001
Problem Technology Use									
No problem technology use	1422	77.9%	139	61.3%	98	75.7%	1659	75.7%	F(1.47, 159.02)=3.24
Moderate to serious problem technology use	389	22.1%	72	38.7%	53	24.3%	514	24.3%	p=0.06
Problem Video Game Playing									
No problem video gaming	1715	93.5%	199	86.9%	147	99.0%	2061	93.2%	F(1.09, 118.21)=1.46
Problem video gaming	96	6.5%	12	13.1%	4	1.0%	112	6.8%	p=0.23
Alcohol Use Disorders									
no	1715	93.4%	131	51.8%	60	45.5%	1906	85.5%	F(1.66, 179.49)=60.09
yes	96	6.60%	80	4.8%	91	54.5%	267	14.5%	p<0.0001
Problem Drug Use									
no	1785	99.0%	103	63.0%	30	17.4%	1918	89.3%	F(1.66, 179.47)=240.90
yes	26	1.0%	108	37.1%	121	82.6%	255	10.7%	p<0.0001

4.3.2 Objective 2

Identify characteristics (sex, age, race, socioeconomic status, school connectedness, academic achievement, and antisocial behaviour) associated with profile membership among high school students in Ontario: (a) conducted in the total sample and; (b) in a sample stratified by sex.

4.3.2.1 Total Sample

To examine associations of latent profile membership with each explanatory variable, a weighted bivariate and multivariate multinomial logistic regression analysis and was conducted for the total sample. Prior to conducting the analyses, cross-tabulations were conducted between all variables of interest by profile-membership, which is presented in Table 14. The results of the multinomial regressions are presented in Table 15 and Table 16.

All explanatory variables were found to be significantly associated with profile membership ($p < 0.05$). Sex was statistically different across profiles, with those in the "Serious Dabblers" and Drug Problems" groups being more likely to be male than female (61.7% and 60.1% respectively). Age was found to be statistically different across all subgroup comparisons except between those in the "Serious Dabblers" and "Drug Problems" Groups. Mean age was highest in the "Drug Problems" group (16.8; SD: 1.0) and lowest in the "No Problems" subgroup (15.8; SD: 1.2). "Serious Dabblers" had the highest proportion individuals identifying as White (72.1%). Moreover, "No Problems" had the highest proportion of students who achieved grades in the range of 70% to 100% (96.0%) and "Drug Problems" had the lowest (86.4%). "No Problems" had the lowest prevalence of antisocial behaviour across latent profiles (2.7%) and "Drug Problems" had the highest (37.1%).

Table 14: Weighted proportions (%) and means (with standard deviations (SD)) of explanatory variables by latent profile for total sample (n=3631).

Explanatory	Latent Profiles								
	No Problems n=2765		Dabblers n=440		Serious Dabblers n=219		Drug Problems n=207		
	Count	%	Count	%	Count	%	Count	%	F
Sex									
Male	1074	48.2%	165	43.4%	99	61.7%	120	60.1%	F(2.44, 266.02)=3.98
Female	1691	51.8%	275	56.6%	120	38.3%	87	39.9%	p=0.01
Race									
White	1557	51.0%	284	56.9%	152	72.1%	147	61.2%	F(1.80, 195.75)=3.78
Other	1208	49.0%	156	43.1%	67	27.9%	60	38.8%	p=0.03
Academic Achievement									
70%+	2641	96.0%	409	93.8%	197	92.2%	171	86.4%	F(2.76, 300.78)=7.8
69%-lower	124	4.0%	31	6.2%	22	7.8%	36	13.6%	p=0.0001
Antisocial Behaviour									
No indication	2703	97.3%	393	85.2%	184`	84.1%	133	62.9%	F(1.87, 203.88)=68.39
Indication	62	2.7%	47	14.8%	35	15.9%	74	37.1%	p<0.0001
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age	15.8	1.2	16.2	1.1	16.6[a]	1.0	16.8[a]	1.0	
SES	6.8[a]	1.7	6.7[a]	1.8	6.9[a]	1.6	6.4[a]	2.3	
School Connectedness	6.8[a]	1.8	6.5[a]	1.8	6.7[a]	2.0	6.3[a]	1.9	

N=Note: Means followed by the same letter in a row do not significantly differ from each other (critical α =0.05 level after Bonferroni correction is α=0.008).
Full Somers'D pair-wise comparison results are found in Appendix M

A weighted bivariate multinomial logistic regression was used to estimate the relative risk of latent profile membership with each individual explanatory variables for the total sample (Table 15).

Males had a 1.73 times the relative risk (95% CI: 1.15-2.59) of being in the “Serious Dabblers” subgroup compared to “No Problems” subgroup and 1.62 times the relative risk (95% CI: 1.08-2.43) of being a male in the “Drug Problems” subgroup compared to “No problems”. The results of the total sample indicated that for every one-unit increase in age the risk of being a member of the “Dabblers”, “Serious Dabblers” or “Drug Problems” subgroup than the “No Problems” subgroup would significantly increase (RRR= 1.38 (95% CI: 1.16-1.67); RRR=1.74 (95% CI: 1.43-2.12); RRR=2.00 (95% CI: 1.66-2.42), respectively). For whites compared to other races, the relative risk would increase by a factor of 2.48 (95% CI: 1.29-4.76) for being a “Serious Dabblers” relative to “No Problems”. For every one-unit increase in SES, there was 11% decrease in relative risk (95%: 0.79-0.99) for being classified in the “Drug Problems” group relative to “No Problems”. A one-unit increase in feelings of school connectedness was associated with 11% decrease in relative risk (95% CI: 0.80-0.98) for being classified in the “Drug Problems” groups relative to “No Problems”. Students with grade achievements in the range of 69% or lower compared to those of 70% or higher, have a significantly increased risk for being in the “Drug Problems” group than “No Problems” (RRR=3.74; 95% CI: 2.04-6.85). Individuals that show indication for antisocial behaviour have an increase in risk of being a “Dabbler” (RRR=6.32; 95% CI: 3.90-10.35), “Serious Dabblers” (RRR=6.88; 95% CI: 3.57-13.25), and “Drug Problems” (RRR=21.42; 95% CI: 14.09-32.54) compared to “No Problems”.

Table 15: Weighted bivariate multinomial logistic regression analysis examining associations between latent profile membership and explanatory variables of interest.

Explanatory	Latent Profiles							
	Dabblers n=440		Serious Dabblers n=219		Drug Problems n=207			
	RRR	95% CI	RRR	95% CI	RRR	95% CI	F	p
Sex								
Male	0.82	0.55-1.23	1.73**	1.15-2.59	1.62*	1.08-2.43	F(3, 107)=6.82	<0.0001
Female (ref)								
Age	1.27**	1.08-1.49	1.74***	1.43-2.12	2.00***	1.66-2.42	F(3, 107)=47.07	<0.0001
Race/Ethnicity								
White	1.27	0.88-1.83	2.48**	1.29-4.76	1.52	0.90-2.56	F(3, 107)=8.35	<0.0001
Other (ref)								
SES	0.97	0.87-1.07	1.05	0.93-1.20	0.89*	0.79-0.99	F(3, 107)=1.80	0.15
School Connectedness	0.93	0.85-1.00	0.97	0.85-1.11	0.89*	0.80-0.98	F(3, 107)=3.19	0.03
Academic Achievement								
69% & lower	1.56	0.93-2.63	2.02	0.91-4.49	3.74***	2.04-6.85	F(3, 107)=6.40	<0.001
70%-100% (ref)								
Antisocial Behaviour								
Indication of Antisocial Behaviour	6.32***	3.90-10.25	6.88***	3.57-13.25	21.42***	14.09-32.54	F(3, 107)=111.28	<0.0001
No Indication of Antisocial Behaviour (ref)								

n=3631, reference is No Problems; RRR= relative risk ratio; *p<0.05, **p<0.01, ***p<0.001; 95% CI= 95% Confidence Interval

Weighted multivariate multinomial logistic regression was used to estimate the relative risk of latent profile membership with all explanatory variables for the total sample (Table 16).

The results presented are under the assumption that all other variables in the model are held constant. Males had a 48% increase in relative risk for being a “Serious Dabblers” compared to females. The results of the total sample indicated that the relative risk of being a member of the “Dabblers”, “Serious Dabblers” or “Drug Problems” compared to “No Problems” group would significantly increase for every one-unit increase in age (RRR= 1.29 (95% CI: 1.10-1.52); RRR=1.82 (95% CI: 1.48-2.23); RRR=2.16 (95% CI: 1.79-2.61), respectively). For whites compared to other races, there would be a significant increase in relative risk for being a “Dabbler” (RRR=1.40; 95% CI: 1.04-1.89), “Serious Dabblers” (RRR=2.64; 95% CI: 1.55-4.49) and “Drug Problems” (RRR=2.03; 95% CI: 1.09-3.77) relative to “No Problems”.

Students with academic achievements in the range of 69% or lower compared to those of 70% or higher, have a significantly increased relative risk for being in the “Drug Problems” group than “No Problems” (RRR=3.79; 95% CI: 2.02-7.13). Individuals that show indication for antisocial behaviour have an increase in relative risk of being a “Dabbler” (RRR=6.89; 95% CI: 4.50-10.56), “Serious Dabblers” (RRR=8.66; 95% CI: 4.39-17.10), and “Drug Problems” (RRR=26.58; 95% CI: 17.49-40.41) compared to “No Problems”.

Table 16: Weighted multivariate multinomial logistic regression analysis examining associations between latent profile membership and explanatory variables of interest.

Explanatory	Latent Profiles							
	Dabblers n=440		Serious Dabblers n=219		Drug Problems n=207			
	RRR	95% CI	RRR	95% CI	RRR	95% CI	F	p
Sex								
Male	0.76	0.55-1.07	1.48*	1.02-2.16	1.27	0.84-1.91	F(3, 107)=2.87	0.04
Female (ref)								
Age	1.29**	1.10-1.52	1.82***	1.48-2.23	2.16***	1.79-2.61	F(3,107)=6.84	<0.001
Race/Ethnicity								
White	1.40*	1.04-1.89	2.64***	1.55-4.49	2.03*	1.09-3.77	F(3,107)=11.48	<0.001
Other (ref)								
SES	0.97	0.88-1.07	1.07	0.94-1.21	0.96	0.83-1.10	F(3,107)=0.82	0.48
School Connectedness	0.97	0.91-1.03	0.97	0.86-1.10	0.95	0.84-1.09	F(3,107)=0.65	0.58
Academic Achievement								
69% & lower	1.68	0.95-2.96	2.14	1.03-4.43	3.79***	2.02-7.13	F(3, 107)=5.87	<0.01
70%-100% (ref)								
Antisocial Behaviour								
Indication of Antisocial Behaviour	6.89***	4.50-10.56	8.66***	4.39-17.10	26.58***	17.49-40.41	F(3,107)=105.55	<0.001
No Indication of Antisocial Behaviour (ref)								

n=3631, reference is No Problems; F(21, 89)=38.45; p<0.0001; RRR=relative risk ratio; *p<0.05, **p<0.01, ***p<0.001; 95% CI= 95% Confidence Interval

4.3.2.2 By Sex

4.3.2.2.1 Males

To determine factors associated with latent profile membership for the male sample, a weighted bivariate and multivariate multinomial logistic regression analysis was conducted for all explanatory variables. The results of the analyses are presented in Table 18 and Table 19. Prior to conducting the regression analyses, cross-tabulations were conducted for each explanatory variable by profile-membership (Table17).

The mean age increased across groups, from “No Problems” (15.9; SD: 1.3), “Dabblers” (16.4; SD: 1.1), to “Drug Problems” (16.9; SD: 1.1). Age was found to be statistically different across all subgroup comparisons expect between “Dabblers” and “Drug Problems.” There were a higher proportion of students that identified their race/ethnicity as White across all groups. “Dabblers” had the highest proportion individuals identifying as White (71.3%). Moreover, “No Problems” had the highest proportion of students who achieved grades in the range of 70% to 100% (94.6%) and “Drug Problems” had the lowest (86.4%). “No Problems” had the lowest prevalence of antisocial behaviour across latent profiles (4.0%) and “Drug Problems” had the highest (43.6%).

Table 17: Weighted proportions (%) and means (with standard deviations (SD)) of explanatory variables by latent profile with for the male sample.

Explanatory	Latent Profiles						
	No Problems n=1175		Dabblers n=166		Drug Problems n=117		
	Count	**%**	**Count**	**%**	**Count**	**%**	**F**
Race							
White	696	54.0%	121	71.3%	82	61.3%	F(1.85, 197.86)=2.84
Other	479	46.0%	45	28.7%	35	38.7%	p=0.07
Academic Achievement							
70%-100%	1097	94.6%	151	93.1%	98	86.4%	F(1.99, 213.46)=3.18
69%-lower	78	5.4%	15	6.9%	19	13.6%	p=0.04
Antisocial Behaviour							
No indication	1130	96.0%	139	82.2%	76	56.4%	F(1.84, 197.34)=45.04
Indication	45	4.0%	27	17.8%	41	43.6%	p<0.0001
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age	15.86	1.28	16.41[a]	1.13	16.89[a]	1.07	
SES	6.79[a]	1.70	7.02[a]	1.54	6.11[a]	2.33	
School Connectedness	7.03[a]	1.73	6.83[a]	2.18	6.82[a]	1.73	

n=1458; Note: Means followed by the same letter in a row do not significantly differ from each other (critical α =0.05 level after Bonferroni correction is α=0.008). Full Somers'D pair-wise comparison results are found in Appendix N

A weighted bivariate multinomial logistic regression was used to estimate the relative risk of latent profile membership with each explanatory variable. The results of the analyses are presented in Table 18. The results of the male sample indicated that the relative risk of being a member of the “Dabblers” (RRR=1.42; 95% CI: 1.14-1.78) or the “Drug Problems” subgroup (RRR=1.99; 95% CI: 1.46-2.72) compared to “No Problems” subgroup would significantly increase for every one-unit increase in age. For whites compared to other races, the relative risk would increase by a factor of 2.12 (95% CI: 1.21-3.72) for being a “Dabbler” relative to “No Problems”. Academic achievement was found to be associated with latent profile membership as students with grades 69% and lower had a 2.75 times the relative risk of being classified in the “Drug Problems” subgroup. Students that show indication for antisocial behaviour are 5.25 (95% CI: 2.68-10.27) times as likely to be a “Dabbler” and 18.68 (95% CI: 8.53-40.91) times as likely to have “Drug Problems” compared to “No Problems”. It’s important to note that the confidence intervals are very wide for this variable. Therefore, caution should be used when interpreting this finding.

Table 18: Weighted bivariate multinomial logistic regression analysis examining associations between latent profile membership and explanatory variables of interest for males.

Explanatory	Latent Profiles					
	Dabblers n=166		Drug Problems n=117			
	RRR	**95% CI**	**RRR**	**95% CI**	**F**	***p***
Age	1.42**	1.14-1.78	1.99***	1.46-2.72	F(2, 106)=23.30	<0.0001
Race/Ethnicity						
White	2.12**	1.21-3.72	1.35	0.58-3.14	F(2, 106)=3.82	0.03
Other (ref)						
SES	1.08	0.92-1.28	0.81	0.58-1.14	F(2,106)=2.05	0.13
School Connectedness	0.94	0.79-1.12	0.94	0.83-1.06	F(2,106)=0.78	0.46
Academic Achievement						
69% & lower	1.29	0.55-3.05	2.75*	1.20-6.32	F(2,106)=2.93	<0.05
70%-100% (ref)						
Antisocial Behaviour						
Indication of Antisocial Behaviour	5.25***	2.68-10.27	18.68***	8.53-40.91	F(2,106)=34.73	<0.0001
No Indication of Antisocial Behaviour (ref)						

n=1458, reference is No Problems; RRR= relative risk ratio; *p<0.05, **p<0.01, ***p<0.001; 95% CI= 95% Confidence Interval

Weighted multivariate multinomial logistic regression was used to estimate the relative risk of latent profile membership with all explanatory variables. The results of the analyses are presented in Table 19.

The results presented are under the assumption that all other variables in the model are held constant. The results indicated that the relative risk of being a member of the "Dabblers" or "Drug Problems" compared to "No Problems" subgroup would significantly increase for every one-unit increase in age (RRR= 1.47 (95% CI: 1.18-1.85); RRR=2.12 (95% CI: 1.63-2.77), respectively). For Whites compared to other races, there would be an increase in relative risk for being a "Dabbler" (RRR=2.18; 95% CI: 1.18-4.02), and "Drug Problems" (RRR=2.07; 95% CI: 1.00-4.27) relative to "No Problems". While academic achievement was significant in the bivariate analyses it was non-significant in the multivariable analyses.

Students that show indication for antisocial behaviour have an increased relative risk of being a "Dabbler" (RRR=6.12; 95% CI: 2.84-13.21), and "Drug Problems" (RRR=24.50; 95% CI: 10.97-54.71) compared to "No Problems". Again, the confidence intervals are very wide for this variable. Therefore, caution should be used when interpreting this finding.

Table 19: Weighted multivariate multinomial logistic regression analysis examining associations between latent profile membership and explanatory variables of interest for males.

Explanatory	Latent Profiles					
	Dabblers n=366		Drug Problems n=269			
	RRR	**95% CI**	**RRR**	**95% CI**	**F**	***p***
Age	1.47**	1.18-1.85	2.12***	1.63-2.77	F(2,106)=25.36	<0.001
Race/Ethnicity						
White	2.18*	1.18-4.02	2.07*	1.00-4.27	F(2,106)=5.32	<0.01
Other (ref)						
SES	1.11	0.93-1.33	0.92	0.72-1.16	F(2,106)=1.94	0.15
School Connectedness	0.94	0.80-1.12	1.05	0.89-1.25	F(2,106)=0.32	0.73
Academic Achievement						
69% & lower	1.43	0.63-3.25	2.93*	1.10-7.84	F(2,106)=2.50	0.09
70%-100% (ref)						
Antisocial Behaviour						
Indication of Antisocial Behaviour	6.12***	2.84-13.21	24.50***	10.97-54.71	F(2,106)=39.10	<0.001
No Indication of Antisocial Behaviour (ref)						

n=1458, reference is No Problems; F(12, 96)=16.11; p<0.0001; RRR=relative risk ratio; *p<0.05, **p<0.01, ***p<0.001; 95% CI= 95% Confidence Interval

4.3.2.2.2 Females

Each explanatory variable was examined for association with latent profile membership for the female sample, a weighted bivariate and multivariate multinomial logistic regression analysis was conducted. The results of the analyses are presented in Table 21 and Table 22. Cross-tabulations of all exploratory variables by profile membership were conducted prior to analyses (Table 20).

The mean age increased across groups, from “No Problems” (15.8; SD: 1.3), “Dabblers” (16.3; SD: 1.0), to “Drug Problems” (16.7; SD: 1.0). Age was found to be statistically different across all subgroup comparisons except between “Dabblers” and “Drug Problems.” There were higher proportions of students that identified their race/ethnicity as White across all groups, however it was not found to be statistically significant ($p<0.05$). Feelings of school connectedness was the lowest in the “Drug Problems” group as the mean score was 5.7 (SD:1.9), and was the highest in the “No Problems” group (6.5; SD: 1.8). Feelings of school connectedness was found to be statistically different between “No Problems” and “Drug Problems” subgroup. Moreover, “No Problems” had the highest proportion of students who achieved grades in the range of 70% to 100% (97.2%) and “Drug Problems” had the lowest (87.4%). “No Problems” had the lowest prevalence of antisocial behaviour across latent profiles (1.8%) and “Drug Problems” had the highest (24.6%).

Table 20: Weighted proportions (%) and means (with standard deviations (SD)) of predictor variables by latent profile for the female sample.

Explanatory	Latent Profiles						
	No Problems n= 1811		Dabblers n=211		Drug Problems n=151		
	Count	**%**	**Count**	**%**	**Count**	**%**	**F**
Race							
White	1010	48.1%	124	62.0%	107	64.2%	F(1.24, 134.32)=1.88
Other	801	51.9%	87	38.0%	44	35.8%	p=0.17
Academic Achievement							
70%-100%	1757	97.2%	190	92.2%	125	87.4%	F(1.96, 211.57)=13.49
69%-lower	54	2.8%	21	7.8%	26	12.6%	p<0.0001
Antisocial Behaviour							
No indication	1783	98.2%	180	78.4%	105	75.4%	F(1.61, 173.38)=38.42
Indication	28	1.8%	31	21.7%	46	24.6%	p<0.0001
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age	15.78	1.27	16.29[a]	1.00	16.69[a]	0.98	
SES	6.76[a]	1.68	6.76[a]	1.56	6.85[a]	1.97	
School Connectedness	6.52[a]	1.79	6.28[ab]	1.83	5.72[b]	1.92	

n=2173; Note: Means followed by the same letter in a row do not significantly differ from each other (critical α =0.05 level after Bonferroni correction is α=0.008). Full Somers'D pair-wise comparison results are found in Appendix O

Weighted bivariate level analyses were conducted for each explanatory variable, results are presented in Table 21. The results of the female sample indicated that the relative risk of being a member of the "Dabblers" (RRR=1.41; 95% CI: 1.16-1.71) or the "Drug Problems" (RRR=1.89; 95% CI: 1.60-2.24) than the "No Problems" would significantly increase for every one-unit increase in age. For Whites compared to other races, the relative risk would increase by a factor of 1.93 (95% CI: 1.24-3.01) for having "Drug Problems" relative to "No Problems". Every one-unit increase in school connectedness there is a 20% decrease in relative risk of being in the "Drug Problems" subgroup relative to "No Problems". Students with academic achievements in the range of 69% or lower compared to those of 70% or higher, have a significantly increased relative risk for being in the "Dabbler" (RRR=2.95; 95% CI: 1.38-6.33) or "Drug Problems" subgroup (RRR=5.01; 95% CI: 2.47-10.16) compared to "No Problems". Students that show indication for antisocial behaviour are 14.83 (95% CI: 5.19-42.35) times as likely to be a "Dabbler" and 17.55 (95% CI: 8.60-35.83) times as likely to be a "Drug Problems" compared to "No Problems". However, it is notable that the confidence intervals are very wide for this variable. Therefore, caution should be used when interpreting this finding.

Table 21: Weighted bivariate multinomial logistic regression analysis examining associations between latent profile membership and predictor variables of interest for female.

Explanatory	Latent Profiles					
	Dabblers n=211		Drug Problems n=151			
	RRR	**95% CI**	**RRR**	**95% CI**	**F**	*p*
Age	1.41**	1.16-1.71	1.89***	1.60-2.24	F(2,107)=33.01	<0.0001
Race/Ethnicity						
White	1.76	0.63-4.95	1.93**	1.24-3.01	F(2,106)=4.85	<0.01
Other (ref)						
SES	1.00	0.87-1.15	1.04	0.75-1.43	F(2,106)=0.02	0.98
School Connectedness	0.93	0.79-1.09	0.80**	0.69-0.93	F(2,106)=5.06	<0.01
Academic Achievement						
69% & lower	2.95**	1.38-6.33	5.01***	2.47-10.16	F(2,106)=10.83	<0.001
70%-100% (ref)						
Antisocial Behaviour						
Indication of Antisocial Behaviour	14.83***	5.19-42.35	17.55***	8.60-35.83	F(2,106)=31.75	<0.0001
No Indication of Antisocial Behaviour (ref)						

n=2173, reference is No Problems; RRR= relative risk ratio; *p<0.05, **p<0.01, ***p<0.001; 95% CI= 95% Confidence Interval

Weighted multivariate multinomial logistic regression was used to estimate the relative risk of latent profile membership with all explanatory variables for the total sample. The results of the analyses are presented in Table 22.

The results presented are under the assumption that all other variables in the model are held at constant. The results indicated that the relative risk of being a member of the "Dabblers" or "Drug Problems" compared to "No Problems" group would significantly increase for every one-unit increase in age (RRR= 1.50 (95% CI:1.19-1.90); RRR=2.07 (95% CI: 1.74-2.47), respectively). For Whites compared to other races, there would be an increase in relative risk for being in the "Drug Problems" group (RRR=2.69; 95% CI: 1.63-4.44) relative to "No Problems". Students with academic achievements in the range of 69% or lower compared to those of 70% or higher, have a significantly increased risk for being a "Dabbler" (RRR= 3.24; 95% CI: 1.54-6.83) or the "Drug Problems" (RRR= 5.69; 95% CI: 2.59-12.52) group relative to "No Problems". Individuals that show indication for antisocial behaviour have an increase in risk of being a "Dabbler" (RRR=19.55; 95% CI: 7.64-50.07), and "Drug Problems" (RRR=22.88; 95% CI: 10.95-47.79) compared to "No Problems". Again, confidence intervals are very wide for this variable and therefore caution should be used when interpreting this finding.

Table 22: Weighted multivariate multinomial logistic regression analysis examining associations between latent profile membership and predictor variables of interest for females.

Explanatory	Latent Profiles					
	Dabblers n=366		Drug Problems n=269			
	RRR	**95% CI**	**RRR**	**95% CI**	**F**	***p***
Age	1.50**	1.19-1.90	2.07***	1.74-2.47	F(2,107)=34.64	<0.001
Race/Ethnicity						
White	2.18	0.86-5.52	2.69***	1.63-4.44	F(2,107)=8.38	<0.001
Other (ref)						
SES	0.97	0.86-1.09	1.05	0.78-1.42	F(2,107)=0.23	0.80
School Connectedness	0.99	0.88-1.12	0.84*	0.70-1.00	F(2,107)=2.00	0.14
Academic Achievement						
69% & lower	3.24**	1.54-6.83	5.69***	2.59-12.52	F(2,107)=10.18	<0.001
70%-100% (ref)						
Antisocial Behaviour						
Indication of Antisocial Behaviour	19.55***	7.64-50.07	22.88***	10.95-47.79	F(2,107)=35.85	<0.001
No Indication of Antisocial Behaviour (ref)						

n=2173, reference is No Problems; F(12, 97)=18.18; p<0.0001; RRR=relative risk ratio; *p<0.05, **p<0.01, ***p<0.001; 95% CI= 95% Confidence Interval.

Chapter 5

5 Discussion

The present study assessed clustering of problem behaviours in a provincially representative sample of high school students from the 2017 Ontario Student Drug Use and Health Survey. Based on our literature review, we believe this is the first study that looks at the clustering of substance use, gambling, technology use and video gaming.

There were two primary objectives of this study. The first objective aimed to determine how problem behaviours cluster together and to develop a latent variable with categories reflecting profile membership. The second objective of the study was to identify potential explanatory variables of profile membership within this study population.

Three major findings were demonstrated. First, four profiles representing similar patterns of problem behaviours were identified in the total sample, and three profiles identified when separating profiles by sex. Second, the mean score for problem gambling, technology use and video-game playing were not found to be significantly different between any of the profiles (total sample and by sex). However, when problem gambling was dichotomized it was found to be significantly different across latent profiles in the female sample. Finally, when examining the associations between the explanatory variables and profile membership, sex (total sample only), age, race, academic achievement (female only) and antisocial behaviour were found to be significantly associated.

5.1 Patterns of Problem Behaviours

This study provides important information on the predominant patterns of problem behaviours among adolescents in Ontario by identifying four distinct subgroups in the total sample. Students reporting no problems or low scores on the problem behaviour scales formed the largest subgroup (“No Problems”; 76%). Similar results were found in Turner and colleagues (2011) study, where “Mainstreamers” (those with the lowest rates

of substance use, gambling frequency, problem gambling score, etc.) comprised the largest group. By contrast, the 2005 Youth Risk Behaviour Survey (YRBS), which had a much larger sample size and a different sample population, found that alcohol users formed the largest group (Connell, et al., 2009). The current study also found that students reporting multiple problem behaviours were the smallest group ("Drug Problems"; 6%). These results are also consistent with Turner et al. (2011), who also found that 6% of the sample identified as poly-substance users and in Connell et al. (2009), with 13% of the sample identified as poly-substance users (Connell, et al., 2009). Similar patterns emerged in the total sample population subgroups, as alcohol use disorder, cannabis use, and tobacco were defining behaviours for two groups in the total sample ("Serious Dabblers" and "Drug Problems"), whereas problem drug use, was also a defining behaviour in the "Drug Problems" subgroup.

The profiles that emerged were distinguished based on problem substance use (i.e., alcohol, drugs, tobacco and cannabis use) and not behavioural addictions. Similar results were found in Willoughby and colleagues (2004); gambling behaviour was among the least common for high-risk involvement. As well, high-risk gambling behaviour was infrequently observed among those reporting high-risk involvement with other problem behaviours (Willoughby, et al., 2004). In contrast, using cluster analysis Turner and colleagues (2011) found a subgroup of youth with the highest score on the problem gambling scale and high average frequency of gambling; however, this group comprised only 2% of the sample. The results in this study suggest that problem gambling, technology use, and video game playing do not cluster with substance use in the total and male sample. Contrary to our findings, the literature suggests that gambling behaviour clusters with substance use, which was partially supported in the results found in the female sample. Moreover, these results may be an indication that behavioural addictions or the lack of (specifically technology use and video game playing) among youth are not different across groups of youth who have unique patterns of substance use behaviours or problems. Thus, Problem Behaviour Theory, which suggests that problem behaviours cluster together due to an underlying disposition toward deviance, may not apply to behavioural addictions and substance use behaviours. A potential explanation for these

results may be due to limitations in the measurement of the behavioural addictions. These limitations will be further discussed later in this chapter, however they have the potential to underestimate the prevalence of these behavioural addictions found in the sample. It is possible that the extremely low frequency of the behavioural addictions within the sample population may be the reason for why we were unable to detect any clustering.

Of major interest are the individuals in the "Drug Problems" subgroup, who were found to have significantly higher average score for problem drug use, as well high scores for cannabis compared to other subgroups. For problem drug use, scores in this range are considered to be indicative of drug use problem that may need intervention. Moreover, they had the highest average score for cannabis use, suggesting that they used cannabis over 20 to 39 times in the past 12 months. Furthermore, "Drug Problems" also had high scores for alcohol use and tobacco use, when compared to "No Problems" and "Dabblers" however it was not significantly different from the "Serious Dabblers". The clustering of these problem behaviours are similar to other studies that have found a subgroup with high frequency in alcohol, cannabis, tobacco, and other illicit drugs (Conway, et al., 2013; Connell, et al., 2010; Cranfored et al., 2013) and is consistent with Problem Behaviour Theory.

5.2 Patterns of Problem Behaviours by Sex

The patterns found when separating the profiles by sex were different from those found in the total sample. The study found three distinct subgroups when separating by males and females. It was not possible to compare the findings pertaining to the patterns of problem behaviours by sex with other studies in the literature, as to our knowledge previous research has only conducted latent profile analysis by the total population and assessed sex as predictor of membership. Similar to what was found in the total sample, students reporting no problems or low scores on the problem behaviour scales formed the largest subgroup (No Problems), 81% in males; and 82% in females. Moreover, students reporting multiple problem behaviours were found to be the smallest group in both males (7%) and females (7%). Similar the total sample, the "Drug Problems" group was defined

by the use of multiple substances. However, the “Serious Dabblers” subgroup identified in the total sample, was not found when the profiles were separated by sex.

Similar to what was found in the total sample, profiles were distinctive for their differences in substance use (i.e., alcohol, drug, cannabis, and tobacco use) in both the males and females. In both the male and female sample, problem gambling, problem technology use, and problem video game playing were not found to be significantly different across subgroups. However, when the problem gambling variable was dichotomized into non-problem gamblers and low-to-high problem gamblers, it was found to be significantly different across the female subgroups. The female “Drug Problems” subgroup was found to have the highest proportion students indicating low-to-high problem gambling severity. This finding is in line with previous literature that has suggested that gambling does cluster with substance use.

In both sexes the “Drug Problems” subgroup had very similar behavioural patterns as the total sample “Drug Problems” subgroup. They were found to have an average score reaching levels indicating problem behaviours in regards to alcohol use and drug use. As such, students in this group may have harmful and hazardous drinking behaviours as well as a problem with drug use that may suggest a need for treatment. Moreover, similar to the total sample, individuals in the “Drug Problems” group both in the male and female sample had the highest average score for cannabis use (i.e., used cannabis over 20-39 times in the past 12 months) and the highest average score for tobacco use (i.e., smoked 2 to 3 cigarettes in their lifetime). It is important to note that although this is the highest score for tobacco across all subgroups, the actual use of tobacco is very low. However, only problem drug use and cannabis use scores were found to be significantly different across all subgroups. Alcohol use and tobacco use were only significantly different when compared to the “No Problems” subgroup. Overall, this group is engaging in a wide range of substance use behaviours that may result in addiction and physical health problems.

5.3 Factors Associated with Profile Membership

Several covariates were assessed in this study to help identify the characteristics of individuals by group membership as well as potential underlying risk factors for clusters of problem behaviours. Sex was found to be associated with profile-membership in the total sample and age, race, academic achievement, and antisocial behaviour were found to be associated with profile-membership in the total and female sample. However, in the male sample, academic achievement was not found to be associated with profile membership.

5.3.1 Sex

In the total sample, sex was found to be significantly associated with profile membership in the bivariate analysis, with males being significantly more likely to be classified in the "Serious Dabblers" or "Drug Problems" subgroup than females. Sex was found to be significantly associated with being classified in the "Serious Dabblers" subgroup in the multivariable model. The literature on sex as an explanatory factor for latent profile membership has been mixed (Tomczyk, Isensee, & Hanewinkel, 2016). One study found similar results, with males being more likely to belong to the "binge drinking and marijuana" class (Lanza et al., 2010), whereas another study found that females were more likely to be "moderate poly-substance users" but less likely to be classified as "frequent poly-substance users" (Gilreath et al., 2014). In general, it is known that males are more likely than females to engage in risk-taking behaviours, making our results consistent with the literature.

5.3.2 Age

Age was found to be significantly associated with profile membership at both the bivariate and multivariable level for the total and by sex samples. The results indicated that as age increases, the risk of being classified in any subgroup compared to the "No Problems" subgroup increases. Hence the older you are, the more likely you are to be classified in the "Dabbler", "Serious Dabblers" (total sample only), or "Drug Problems" subgroup. This is consistent with the literature, as several studies conducting latent class analyses have found that age is positively associated with poly-substance use (Tomczyk, Isensee, & Hanewinkel, 2016). For example, Riehman and colleagues (2009) found that

as age increased by one year, there was a 48% increase in the odds of being classified as a “High Polydrug user” compared to “Cigarette Only.” One theory for this trend is that as adolescents get older, access to and opportunities to engage in many risky behaviours increase (Duell, et al., 2018).

5.3.3 Race/ Ethnicity

Race was found to be a significant explanatory variable for profile membership in all the samples. Identifying as White was found to be significant across all subgroups in the total and male sample; however, among females, race was only found to be different for those in the “Drug Problems” subgroup compared with the “No problems” group. This finding is consistent with Cranford et al. (2013) who found that identifying as White predicted membership in the “Multiple Use” class. They also found that White adolescents had a 2.8 (95% CI: 2.0-3.8) greater odds of being classified in the “Multiple Use” class than the “Low/no use” class compared to Non-white (Cranford et al, 2013). Primary socialization theory, suggests that substance use emerges from interactions with primary socialization sources such as, family and peers. Moreover, the notion that some drinking practices are developed across generations within a family, ethnic, or cultural group, and these cultural groups can influence the likelihood of consuming alcohol (Dickens et al, 2016; Oetting et al., 1998). Perhaps this may explain the results found in this study regarding the association between race and profile membership.

5.3.4 Socioeconomic Status

Socioeconomic status (SES) was not found to be significantly associated with profile membership at the bivariate or multivariable level for the total and by sex samples. This finding is consistent with prior literature, as other studies that conducted similar analyses also found that SES was not predictive of profile membership (Riehman et al., 2009; White et al., 2013; Turner et al., 2011). However, a study conducted by Leatherdale and Ahmed (2010), assessing the behaviour of adolescents by their ‘weekly spending money’ found that adolescents who reported having $21 or more spending money a week (ref. $0 per week) had 1.59 greater odds of having ever tried alcohol, tobacco and marijuana compared to those who have only tried one of those substances. Thus, there seems to be inconstancy within the literature to whether or not socioeconomic status is associated

with multiple substance use/ problem behaviours. This may be due to differences in samples or differences in how SES is measured, as in this study SES was measured by perceived family social standing compared to how much allowance adolescents got weekly (Leatherdale and Ahmed, 2010).

5.3.5 Academic Achievement

Academic achievement was found to be significantly associated with profile-membership in the total and female sample. The results indicated that receiving grades in the range of 69% or lower predicted profile membership, with those in the "Drug Problems" subgroups having lower grades in the total sample. In the female sample, both "Dabblers" and "Drug Problems" subgroup had lower grades than those in the "No Problems" subgroup. These results are supported by previous literature, in which poor grades have been linked to poly-substance use (Connell et al., 2010; Turner et al., 2011; Tomczyk, Isensee, & Hanewinkel, 2016). Connell and colleagues found that higher academic grades were associated with decreased odds of both occasional and frequent poly-substance use subgroup membership (OR: 0.21 (95% CI: 0.09-0.49); OR: 0.20 (95% CI: 0.007-0.52) respectively). These results are in line with Problem Behaviour Theory as it posits that low academic achievement and substance use are linked because they share a common risk and protective factors, such as family structure, parental involvement, etc. (Jessor 1987). An interesting finding was that the overall effect of academic achievement was not found to be significantly associated with profile membership in the multivariate model for the male sample, but was found in the bivariate model. Perhaps the association between academic achievement and profile membership is being attenuated when other variables are added to the model.

5.3.6 School Connectedness

In the bivariate analyses, in the total sample and female sample, school connectedness was found to be associated with "Drug Problems" subgroup membership. The results suggested that as feelings of school connectedness increased, students were less likely to be classified in the "Drug Problems" subgroup. However, school connectedness was not significantly associated with profile membership in any of the samples in the multivariable model. This suggests that the association between school connectedness

and profile membership is being attenuated when other variables are added to the model. The results indicate that the effect seen in the bivariate model was confounded by another explanatory variable, which is why school connectedness is not significant in the multivariable model. Few studies have assessed school connectedness in association with profile-membership. Turner and colleagues (2011) found that individuals in the "Drug Takers" subgroup (identified by indication of alcohol use disorder and high frequency of drug use) were significantly more likely to report low school attachment compared to "Mainstreamers" (those with the lowest rates of substance use, gambling frequency, problem gambling score, etc.). Moreover, a study conducted by Weatherson and colleagues (2018) found that school connectedness acted as a protective factor against substance abuse in adolescents. The evidence suggests that school connectedness is associated with problem behaviours (and multiple problem behaviours), although it was not significant in the multivariable model.

5.3.7 Antisocial Behaviour

Antisocial behaviour was associated with profile membership at the bivariate and multivariable level across all subgroups in the total and by sex sample. This is consistent with the literature, as antisocial behaviour has been found to be a prominent predictor for multiple substance use (Connell et al., 2010; Dierker et al., 2007; Turner et al., 2011; Willoughby et al., 2004). A study conducted by Connell and colleagues (2010) found that when compared to "Non-users", "Alcohol experimenters" (OR:1.90; 95% CI: 1.16-3.09), "Occasional poly-substance users" (OR: 2.90; 95% CI: 1.54-5.49), and "Frequent poly-substance users" (OR: 4.51; 95% CI: 2.35-8.64) had an increased odds of reporting antisocial behaviour. This is in line with Problem Behaviour Theory, as antisocial behaviour is often considered part of the problem behaviour syndrome, where youth that have multiple problem behaviours tend to participate in other deviant behaviours (Jessor, 1987). Again this is due to the belief that substance use and antisocial behaviour share common risk and protective factors.

5.4 Study Strengths

There are several noteworthy strengths of the present study. This study makes an important contribution to the previous literature on this topic within this population by

addressing knowledge gaps in the literature and improvements in methodology. For example, Turner and colleagues (2011) conducted a cluster analysis to organize youth into groups that are similar to each other across several variables. Cluster analysis is a conventional method often used for identifying distinct groups within a population; however more modern techniques such as Finite Mixture Models (FMM) have emerged as a good alternative, as they are less prone to errors like other methods (Tomczyk, Isensee, & Haneqinkel, 2016).

To the best of our knowledge, this is the first study to conduct a latent profile analysis with indicators that include both substances and other behavioural addictions (i.e. gambling, video game playing, and technology use). Although some studies have explored the clustering of gambling with substances (Turner et al., 2011; Willoughby et al., 2004), no studies have looked at video gaming and technology use and these are emerging problem behaviours. Furthermore, to our knowledge this is the first study to conduct a latent profile analysis with these indicators and separate the profiles by sex. In addition, a large sample size was used with an equal number of males and females, which is attributable to the sampling strategy used. This sample is also an approximate representation of the Ontario public high school student population, as weights were used throughout all analyses.

5.5 Study Limitations

Despite the strengths of this study there are several limitations that must be considered. There are a few limitations to the measurements used in this study, however, these limitation was out of our control due to what was available to us in the data set. An important limitation relates to the measurement of the tobacco variable used in the latent profile analysis. The measurement of tobacco was assessed by asking about lifetime use, where all other variables in the latent profile analysis were based on past year/ past month experience. Another variable limitation was the dichotomization of race into White and Others, which did not allow for any exploration of other races. This dichotomization was necessary for having sufficient cell sizes for analyses, as well it allowed for easy comparability across other studies that used the same measure for race. As this was a self-

report survey, SES was measured by students' subjective perception of their family social status, which can also be a limitation as some students may view their family's social status better or worse than it really is. Antisocial behaviour was assessed by a count score for the amount of different delinquent activities they participated. This does not allow for the frequency of the activities to be considered. For example, one student may have participated in three activities but only once each over the last 12 months, and another student may have participated in three activities but several times for each, both students' score would have been three. This poses a limitation as we are not able to truly distinguish between these individuals, who have different frequency of participation in these activities. Lastly, the measures used for the problem behaviours can also pose as a limitation, as some of the language in the measures may lead participants to not complete the survey fully. Problem video-game playing, had response options of "Yes" and "No" which may not reflect students' perception of their video-game playing behaviour. If a student experienced one of the symptoms of problem video-game playing once or twice over the last 12 months, they may feel inclined to respond to the item as "No", when in actuality they did experience it. Response options such as "Never", "Sometimes", "Most of the time" and "Almost always" may capture these students. This would contribute to the amount of missing data there was, thus, contributing to the underestimate the prevalence for this variable. Another limitation is related to the analytic strategy. For latent profile analysis there is no commonly accepted statistical indicator for deciding on the number of profiles in a study population. However, the method used in this study to determine best fit is currently the most commonly and widely used method. Moreover, based on the results found in this study and what has been found in the literature on patterns of problem behaviours, even with these crude measures, the profiles appear to be consistent with the literature and maybe potentially useful.

Furthermore, a cross-sectional study design was used in the present study to address the research objectives. This design limits the ability to make any causal inferences due to the lack of temporality, aside from fixed indicators (age, sex and race). For example, adolescents may have developed multiple problem behaviours (addictive behaviours) prior to showing indications of antisocial behaviour. It's important to take this into consideration when interpreting the association between the study variables. In order to

better understand the relationship among predictors and profile-membership, longitudinal research is needed.

The self-reported nature of the study is also a limitation within the study, as the data collected is prone to recall and social desirability biases. Although steps were taken in order to reduce social desirability bias, some questions are sensitive in nature and could then be under reported. It is also possible that youth whom may be high-risk or 'troubled' would have been less likely to be in attendance the day the survey was administered, or to complete the survey. If this occurred, this would cause an underestimation of problem behaviours.

5.6 Study Implications & Future Directions

The findings in this study continue to support previous literature that substance use clusters together. Therefore, when treating problem behaviours, it is important to not treat them in isolation. It is clear that adolescents that have one substance use problem may be more likely to have another. It may also be important to target youth that engage in antisocial behaviour, as they are more likely to participate in multiple problem behaviours. Targeting these youth may help to prevent future substance use or provide treatment to those who are in need. Further support is needed for development of health services for addressing these multiple problem behaviours.

Behavioural addictions are an emerging area of research, as literature specifically on technology use and video gaming are slowly being developed in Canada. It is evident that behavioural addictions are becoming an important area of research as the World Health Organization is taking steps to further understand the impact these addiction have on public health (WHO, 2014). Behavioural addictions (aside from gambling in females) did not cluster with substance use in this study, rather there was no difference found across the subgroups. Interventions for addressing these behavioural addictions should be targeted at all youth. However, future research needs to continue to explore technology use and video game playing in the Canadian context, specifically among adolescents as they are the primary users. The prevalence of the behavioural addictions in this study were extremely low, which could be explained by the lack of clustering seen at the

population level. However, future research should assess at the clinical level, which will allow for a large enough sample for the behavioural addictions. Sampling at the clinical level will allow for us to determine if problem behaviours, substance use and behavioural addictions, cluster together.

These findings need to be considered in the context of new policy changes that have been implemented in Canada and Ontario, which have the potential to significantly impact public health, particularly among adolescents. These policies have increased access to alcohol, gambling, and cannabis. In 2015, the Ontario government passed legislature permitting the sale of beer and wine in grocery stores. That same year, PlayOLG.ca, the inaugural government-sanctioned online gambling platform in Ontario, was launched. More recently, since October 2018 when recreational cannabis was legalized in Canada, Ontarians have been able to easily purchase cannabis products online via the Ontario Cannabis Store. Moreover, the first cannabis store front in Ontario opened in April 2019 with plans for more stores to open in the coming months.

Taking Problem Behaviour Theory (Jessor & Jessor, 1977) into account, these changes in policy around increasing access to not one, but three potentially harmful substances and activities could increase the likelihood that adolescents will engage in these problem behaviours. The effects of these policy changes on adolescents, particularly on multiple substance use and behavioural addictions is unknown. Future research will be important to assess whether these policy changes will increase the prevalence of these problem behaviours and the effect this will have on public health. Furthermore, future research will need to assess whether these policy changes will affect the patterns of the problem behaviour profiles.

Moreover, future research should replicate this study at a national level to see if the results are consistent in the Canadian youth demographic. Longitudinal studies should also be conducted in order to help determine the temporality of the development of multiple problem behaviours and its maintenance overtime.

5.7 Conclusions

This thesis set out to determine whether behavioural addictions cluster with substance use in adolescents. The clustering of behavioural addictions with substance use was very weak in this study. In the total sample the “Drug Problems” subgroup had the highest average score for gambling, but was not found to be significantly different when assessed across subgroups. Problem video game playing and problem technology use were not different across subgroups. The current study did not find clustering between behavioural addictions and substance use at the population level,however, that does not mean that clustering does not exist. Future studies need to be conducted assessing the clustering of behavioural addictions, especially at a clinical level. Moreover, future studies should improve upon the measurement limitations mentioned in this study.

This is the first study to look at how behvioural addictions cluster with substance use, which has improved our understanding of how multiple problem behaviours group together among adolescents. Moreover, the patterns of substance use behaviours found in this study are consistent with other literature, providing an overwhelming amount of evidence to support that adolescents that show indication for one substance use problem may also be struggling with another substance issue.

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Appendices

Appendix A: Original coded questions for AUDIT

B3. In the LAST 12 MONTHS, how often did you drink ALCOHOL — liquor (rum, whiskey, etc.), wine, beer, coolers?

- 01 ☐ Had a sip of alcohol to see what it's like
- 02 ☐ Drank only at special events (for example, holidays or at weddings)
- 03 ☐ Once a month or less often
- 04 ☐ 2 or 3 times a month
- 05 ☐ Once a week
- 06 ☐ 2 or 3 times a week
- 07 ☐ 4 or 5 times a week
- 08 ☐ Almost every day – 6 or 7 times a week
- 09 ☐ Drank, but not in the last 12 months
- 10 ☐ Never drank alcohol in lifetime

D6. How many drinks containing alcohol do you have on a typical day when you are drinking?

- 1 ☐ 1 drink
- 2 ☐ 2 to 3 drinks
- 3 ☐ 4 drinks
- 4 ☐ 5 to 7 drinks
- 5 ☐ 8 or more drinks
- 6 ☐ Don't drink alcohol
- 7 ☐ Never drank alcohol in lifetime

D6a-s. How often do you have 5 or more drinks on one occasion?

- 1 ☐ Never
- 2 ☐ Less than once a month
- 3 ☐ About once a month
- 4 ☐ About once a week
- 5 ☐ Daily or almost daily
- 6 ☐ Don't drink alcohol
- 7 ☐ Never drank alcohol in lifetime

D6b-s. How often in the LAST 12 MONTHS have you found that you were not able to stop drinking once you had started?

- 1 ☐ Never in the last 12 months
- 2 ☐ Less than once a month
- 3 ☐ About once a month
- 4 ☐ About once a week
- 5 ☐ Daily or almost daily
- 6 ☐ Don't drink alcohol
- 7 ☐ Never drank alcohol in lifetime

D6g-s. Have you or someone else been injured as a result of your drinking?

- 1 ☐ No
- 2 ☐ Yes, but not in the last 12 months
- 3 ☐ Yes, in the last 12 months
- 4 ☐ Don't drink alcohol
- 5 ☐ Never drank alcohol in lifetime

D6c-s. How often in the LAST 12 MONTHS have you not done things you were supposed to because of drinking?

- 1 ☐ Never in the last 12 months
- 2 ☐ Less than once a month
- 3 ☐ About once a month
- 4 ☐ About once a week
- 5 ☐ Daily or almost daily
- 6 ☐ Don't drink alcohol
- 7 ☐ Never drank alcohol in lifetime

D6d-s. How often in the LAST 12 MONTHS have you needed a first drink of alcohol in the morning to get yourself going after a heavy drinking session?

- 1 ☐ Never in the last 12 months
- 2 ☐ Less than once a month
- 3 ☐ About once a month
- 4 ☐ About once a week
- 5 ☐ Daily or almost daily
- 6 ☐ Don't drink alcohol
- 7 ☐ Never drank alcohol in lifetime

D6e-s. How often in the LAST 12 MONTHS have you had a feeling of guilt or remorse after drinking?

- 1 ☐ Never in the last 12 months
- 2 ☐ Less than once a month
- 3 ☐ About once a month
- 4 ☐ About once a week
- 5 ☐ Daily or almost daily
- 6 ☐ Don't drink alcohol
- 7 ☐ Never drank alcohol in lifetime

D6f-s. How often in the LAST 12 MONTHS have you been unable to remember what happened the night before because you had been drinking?

- 1 ☐ Never in the last 12 months
- 2 ☐ Less than once a month
- 3 ☐ About once a month
- 4 ☐ About once a week
- 5 ☐ Daily or almost daily
- 6 ☐ Don't drink alcohol
- 7 ☐ Never drank alcohol in lifetime

D6h-s. Has a relative or friend or a doctor or other health care worker been concerned about your drinking or suggested you cut down?

- 1 ☐ No
- 2 ☐ Yes, but not in the last 12 months
- 3 ☐ Yes, in the last 12 months
- 4 ☐ Don't drink alcohol
- 5 ☐ Never drank alcohol in lifetime

Appendix B: Original coded questions for CRAFFT

G2. In the LAST 12 MONTHS, how often did you ride in a vehicle driven by someone who had been using drugs (other than alcohol)?

- 01 ☐ Never
- 02 ☐ Once
- 03 ☐ 2 times
- 04 ☐ 3 times
- 05 ☐ 4 times
- 06 ☐ 5 times
- 07 ☐ 6 times
- 08 ☐ 7 times
- 09 ☐ 8 or more times
- 10 ☐ Not sure

D7a-s. In the LAST 12 MONTHS, did you use drugs to relax, feel better about yourself, or fit in?

- 1 ☐ Yes
- 2 ☐ No
- 3 ☐ Did not use drugs in last 12 months
- 4 ☐ Never used drugs in lifetime

D7b-s. In the LAST 12 MONTHS, did you use drugs while you were by yourself?

- 1 ☐ Yes
- 2 ☐ No
- 3 ☐ Did not use drugs in last 12 months
- 4 ☐ Never used drugs in lifetime

D7c-s. In the LAST 12 MONTHS, did you forget things you did while using drugs?

- 1 ☐ Yes
- 2 ☐ No
- 3 ☐ Did not use drugs in last 12 months
- 4 ☐ Never used drugs in lifetime

D7d-s. In the LAST 12 MONTHS, did you get into trouble while you were using drugs?

- 1 ☐ Yes
- 2 ☐ No
- 3 ☐ Did not use drugs in last 12 months
- 4 ☐ Never used drugs in lifetime

D7e-s. In the LAST 12 MONTHS, did your family or friends tell you that you should cut down on your drug use?

- 1 ☐ Yes
- 2 ☐ No
- 3 ☐ Did not use drugs in last 12 months
- 4 ☐ Never used drugs in lifetime

Appendix C: Original coded questions for CAGI

L2a-s. In the LAST 3 MONTHS, how often have you skipped practice or dropped out of activities (such as team sports or band) due to your gambling?

1 ☐ Never
2 ☐ Sometimes
3 ☐ Most of the time
4 ☐ Almost always

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

L2b-s. In the LAST 3 MONTHS, how often have you skipped hanging out with friends who do not gamble to hang out with friends who do?

1 ☐ Never
2 ☐ Sometimes
3 ☐ Most of the time
4 ☐ Almost always

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

L2c-s. In the LAST 3 MONTHS, how often have you planned your gambling activities?

1 ☐ Never
2 ☐ Sometimes
3 ☐ Most of the time
4 ☐ Almost always

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

L2d-s. In the LAST 3 MONTHS, how often have you felt bad about the way you gamble?

1 ☐ Never
2 ☐ Sometimes
3 ☐ Most of the time
4 ☐ Almost always

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

L2e-s. In the LAST 3 MONTHS, how often have you gone back another day to try to win back the money you lost while gambling?

1 ☐ Never
2 ☐ Sometimes
3 ☐ Most of the time
4 ☐ Almost always

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

L2f-s. In the LAST 3 MONTHS, how often have you hidden your gambling from your parents, other family members, or teachers?

1 ☐ Never
2 ☐ Sometimes
3 ☐ Most of the time
4 ☐ Almost always

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

L2g-s. In the LAST 3 MONTHS, how often have you felt that you might have a problem with gambling?

1 ☐ Never
2 ☐ Sometimes
3 ☐ Most of the time
4 ☐ Almost always

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

L2h-s. In the LAST 3 MONTHS, how often have you taken money that you were supposed to spend on lunch, clothing, movies, etc., and used it for gambling or for paying off gambling debts?

1 ☐ Never
2 ☐ 1 to 3 times
3 ☐ 4 to 6 times
4 ☐ 7 or more times

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

L2i-s. In the LAST 3 MONTHS, how often have you stolen money or other things of value in order to gamble or to pay off your gambling debts?

1 ☐ Never
2 ☐ 1 to 3 times
3 ☐ 4 to 6 times
4 ☐ 7 or more times

5 ☐ Did not gamble in the last 3 months
6 ☐ Never gambled in lifetime

Appendix D: Original coded questions for PVP

L3c. In the LAST 12 MONTHS, when you were not playing video games, did you keep thinking about them (such as planning your next game, remembering past games)?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

L3d. In the LAST 12 MONTHS, did you spend an increasing amount of time playing video games?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

L3e. In the LAST 12 MONTHS, did you try to cut back or stop playing video games, OR did you play for longer than you had planned to?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

L3f. In the LAST 12 MONTHS, did you get restless or irritated when you could not play video games?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

L3g. In the LAST 12 MONTHS, did you play video games more often when you felt bad (sad, angry or nervous) or had problems?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

L3h. In the LAST 12 MONTHS, when you lost in a game or did not get the results you wanted, did you keep playing to achieve your target?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

L3i. In the LAST 12 MONTHS, did you skip school or work, or lie or steal, or argue with someone so that you could play video games?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

L3j. In the LAST 12 MONTHS, did you ignore homework, go to bed late, or spend less time with family and friends because of your video game playing?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

L3k. In the LAST 12 MONTHS, did you ever hide your video game playing from your family or friends?

1 ☐ Yes
2 ☐ No
3 ☐ Don't play video games

Appendix E: Original coded questions for SPIUT

L4b-s. How often do you find that you are staying on electronic devices longer than you intended?

1 ☐ Never
2 ☐ Rarely
3 ☐ Sometimes
4 ☐ Quite often
5 ☐ Very often

6 ☐ Don't use these devices in my free time

L4c-s. How often do you neglect homework because you are spending more time on electronic devices?

1 ☐ Never
2 ☐ Rarely
3 ☐ Sometimes
4 ☐ Quite often
5 ☐ Very often

6 ☐ Don't use these devices in my free time

L4d-s. How often are you criticized by your parents or your friends about how much time you spend on electronic devices?

1 ☐ Never
2 ☐ Rarely
3 ☐ Sometimes
4 ☐ Quite often
5 ☐ Very often

6 ☐ Don't use these devices in my free time

L4e-s. How often do you lose sleep because you use electronic devices late at night?

1 ☐ Never
2 ☐ Rarely
3 ☐ Sometimes
4 ☐ Quite often
5 ☐ Very often

6 ☐ Don't use these devices in my free time

L4f-s. How often do you feel nervous when you are not using electronic devices and feel relieved when you do go back to using them?

1 ☐ Never
2 ☐ Rarely
3 ☐ Sometimes
4 ☐ Quite often
5 ☐ Very often

6 ☐ Don't use these devices in my free time

L4g-s. How often do you choose to spend more time on electronic devices rather than go out with your friends?

1 ☐ Never
2 ☐ Rarely
3 ☐ Sometimes
4 ☐ Quite often
5 ☐ Very often

6 ☐ Don't use these devices in my free time

Appendix F: Original coded questions for tobacco and cannabis

B2. Which of the following statements best describes your use of tobacco cigarettes IN YOUR LIFETIME?

1 ☐ Never had a cigarette, not even one puff, in my life
2 ☐ Smoked from a few puffs to a whole cigarette in my life
3 ☐ Only 2 to 3 cigarettes in my life
4 ☐ More than 3, but fewer than 100 cigarettes in my life
5 ☐ 100 or more cigarettes in my life, but none in the last month
6 ☐ 100 or more cigarettes in my life and some during the last month, but not every day
7 ☐ 100 or more cigarettes in my life and at least 1 cigarette every day during the last month

B4. In the LAST 12 MONTHS, how often did you use CANNABIS (also known as marijuana, "weed", "pot", "grass", hashish, "hash", hash oil, etc.)?

1 ☐ 1 or 2 times
2 ☐ 3 to 5 times
3 ☐ 6 to 9 times
4 ☐ 10 to 19 times
5 ☐ 20 to 39 times
6 ☐ 40 or more times

7 ☐ Used, but not in the last 12 months
8 ☐ Never used in lifetime
9 ☐ Don't know what cannabis is

Appendix G: Original coded questions for demographic variables

A1. How old are you?

- 10 ☐ 10 years of age or younger
- 11 ☐ 11 years
- 12 ☐ 12 years
- 13 ☐ 13 years
- 14 ☐ 14 years
- 15 ☐ 15 years
- 16 ☐ 16 years
- 17 ☐ 17 years
- 18 ☐ 18 years
- 19 ☐ 19 years
- 20 ☐ 20 years or older

A2. Were you born male or female?

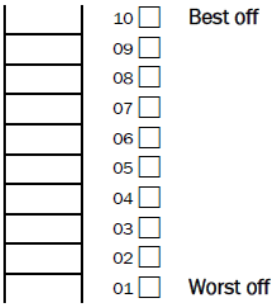
- 1 ☐ Male
- 2 ☐ Female

A8. Which of the following best describes your background? (You may choose more than one category.) Are you...?

- a ☐ **White** (for example, British, French, Italian, Portuguese, Ukrainian, Russian, Israeli)
- b ☐ **Chinese**
- c ☐ **South Asian** (for example, East Indian, Pakistani, Bangladeshi, Sri Lankan)
- d ☐ **Black** (African, Caribbean, North American)
- e ☐ **Aboriginal** (First Nations, Inuit, Métis, non-status Indian)
- f ☐ **Filipino**
- g ☐ **Latin American, Central American, South American** (for example, Mexican, Brazilian, Chilean, Guatemalan, Venezuelan, Colombian, Argentinian, Salvadoran, Costa Rican)
- h ☐ **Southeast Asian** (for example, Vietnamese, Cambodian, Indonesian, Malaysian, Laotian)
- i ☐ **West Asian or Arab** (for example, Egyptian, Saudi Arabian, Syrian, Iranian, Iraqi, Lebanese, Afghan, Palestinian)
- j ☐ **Korean**
- k ☐ **Japanese**
- l ☐ Not sure

A20. Imagine this ladder below shows how Canadian society is set up. At the top of the ladder are people who are the "best off" – they have the most money, the most education, and the jobs that bring the most respect. At the bottom are the people who are "worst off" – they have the least money, little education, no jobs or jobs that no one wants.

Now think about your family. Please check off the numbered box that best shows where you think your family would be on this ladder.



Appendix H: Original coded questions for grade achievement, school connectedness and antisocial behaviour.

A9. On average, what marks do you usually get in school? (Please choose only one answer.)

1 ☐ 90% - 100% (Mostly A+)
2 ☐ 80% - 89% (Mostly As or A-)
3 ☐ 70% - 79% (Mostly Bs)
4 ☐ 60% - 69% (Mostly Cs)
5 ☐ 50% - 59% (Mostly Ds)
6 ☐ below 50% (Mostly Fs)

A10. I feel safe in my school.

1 ☐ Strongly agree
2 ☐ Somewhat agree
3 ☐ Somewhat disagree
4 ☐ Strongly disagree

A11. I feel close to people at this school.

1 ☐ Strongly agree
2 ☐ Somewhat agree
3 ☐ Somewhat disagree
4 ☐ Strongly disagree

A12. I feel like I am part of this school.

1 ☐ Strongly agree
2 ☐ Somewhat agree
3 ☐ Somewhat disagree
4 ☐ Strongly disagree

M1. How often (if ever) in the LAST 12 MONTHS have you done each of the following? (Write "0" if you have not done it.)

a) Taken a car, truck, or SUV for a ride without the owner's permission? _____ times

b) Banged up or damaged something (on purpose) that did not belong to you? _____ times

c) Sold marijuana or hashish? _____ times

d) Taken things worth $50 or less that did not belong to you? _____ times

e) Taken things worth more than $50 that did not belong to you? _____ times

f) Beat up or hurt anyone (on purpose), not counting fights you may have had with a brother or sister? _____ times

g) Broken into a locked building other than your own home? _____ times

h) Carried a weapon, such as a gun or knife (not for hunting)? _____ times

i) Run away from your home (left home without the permission of one or both of your parents/guardians)? _____ times

j) Set something on fire that you weren't supposed to? _____ times

Appendix I: Full results of the Somers'D analysis of the descriptive statistics for all continuous variables comparing by sex for the total sample.

Indicators	Coef.	t	*p*	95% CI
Age	0.04	0.99	0.326	-0.04-0.12
Socioeconomic Status	0.01	0.16	0.874	-0.08-0.09
School Connectedness	0.20	5.64	<0.001	0.12-0.26
Drug Use	0.04	1.65	0.101	-0.01-0.09
Alcohol Use	0.03	0.59	0.554	-0.06-0.11
Tobacco Use	0.03	1.21	0.231	-0.02-0.09
Cannabis Use	0.03	1.31	0.192	-0.02-0.09
Technology Use	-0.24	-10.66	<0.001	-0.28-(-)0.19
Video Game Playing	0.45	13.10	<0.001	0.38-0.52
Gambling	0.10	7.37	<0.001	0.07-0.12

Appendix J: Full results of the Somers'D analysis comparing problem behaviours by latent profiles for the total sample.

Indicators	Class	Coef.	t	*p*	95% CI
Drug Use	1 vs.2	0.54	8.74	<0.001	0.42-0.66
	1 vs.3	0.72	8.88	<0.001	0.56-0.88
	1 vs. 4	0.92	32.39	<0.001	0.86-0.98
	2 vs. 3	-0.34	-3.02	0.003	-0.6-(-)0.12
	2 vs. 4	0.76	15.61	<0.001	0.66-0.85
	3 vs. 4	0.53	7.61	<0.001	0.39-0.66
Alcohol Use	1 vs.2	0.69	19.01	<0.001	0.62-0.76
	1 vs.3	0.79	25.76	<0.001	0.73-0.85
	1 vs. 4	0.82	34.31	<0.001	0.77-0.87
	2 vs. 3	-0.23	-3.88	<0.001	-0.35-(-)0.11
	2 vs. 4	0.32	3.40	0.001	0.13-0.51
	3 vs. 4	0.08	0.7	0.483	0.13-0.51
Tobacco Use	1 vs.2	0.38	15.56	<0.001	0.32-0.42
	1 vs.3	0.71	14.09	<0.001	0.61-0.81
	1 vs. 4	0.66	13.78	<0.001	0.57-0.76
	2 vs. 3	-0.40	-6.53	<0.001	-0.53-(-)0.28
	2 vs. 4	0.39	7.3	<0.001	0.28-0.49
	3 vs. 4	0.02	0.24	0.807	-0.14-0.17
Cannabis Use	1 vs.2	0.24	15.05	<0.001	0.21-0.28
	1 vs.3	0.13	7.2	<0.001	0.10-0.17
	1 vs. 4	0.14	9.61	<0.001	0.11-0.16
	2 vs. 3	-0.44	-18.89	<0.001	-0.48-(-)0.39
	2 vs. 4	0.44	15.07	<0.001	0.38-0.50
	3 vs. 4	0.5	139.59	<0.001	0.50-0.51
Technology Use	1 vs.2	0.18	1.32	0.19	-0.09-0.45
	1 vs.3	0.08	1.2	0.235	-0.06-0.22
	1 vs. 4	0.17	2.55	0.012	0.04-0.30
	2 vs. 3	0.11	0.98	0.332	-0.12-0.34
	2 vs. 4	-0.03	-0.25	0.801	-0.24-0.19
	3 vs. 4	0.10	1.24	0.218	-0.06-0.25
Video Game Playing	1 vs.2	-0.04	-0.54	0.591	-0.22-0.12
	1 vs.3	-0.05	-0.72	0.476	-0.19-0.09
	1 vs. 4	0.03	0.48	0.631	-0.08-0.13
	2 vs. 3	0.01	0.08	0.939	-0.15-0.17
	2 vs. 4	0.07	0.6	0.551	-0.16-0.30
	3 vs. 4	0.07	0.78	0.438	-0.11-0.26
Gambling	1 vs.2	0.08	0.05	0.099	-0.02-0.18
	1 vs.3	0.07	1.24	0.218	-0.4-0.18
	1 vs. 4	0.11	2.22	0.029	0.01-0.20
	2 vs. 3	0.01	0.06	0.95	-0.19-0.20
	2 vs. 4	0.03	0.57	0.572	-0.07-0.13
	3 vs. 4	0.03	0.37	0.701	-0.13-0.20

Numbers indicate profile membership: 1=No Problems, 2=Dabblers, 3=Serious Dabblers, 4=Drug Problems.

Appendix K: Full results of the Somers'D analysis comparing continuous explanatory variables by latent profiles for the total sample.

Indicators	Class	Coef.	t	*p*	95% CI
Age	1 vs.2	0.17	2.75	0.007	0.05-0.30
	1 vs.3	0.37	5.91	<0.001	0.24-0.49
	1 vs. 4	0.44	9.49	<0.001	0.35-0.54
	2 vs. 3	-0.23	-2.76	0.007	-0.40-(-)0.07
	2 vs. 4	0.34	3.59	0.001	0.15-0.52
	3 vs. 4	0.10	0.87	0.385	-0.14-0.35
Socioeconomic Status	1 vs.2	-0.01	-0.26	0.799	-0.09-0.07
	1 vs.3	0.07	1.04	0.303	-0.07-0.21
	1 vs. 4	-0.07	-1.30	0.196	-0.17-0.04
	2 vs. 3	-0.09	-1.04	0.299	-0.25-0.08
	2 vs. 4	-0.04	-0.79	0.432	-0.16-0.07
	3 vs. 4	-0.12	-1.75	0.084	-0.26-0.02
School Connectedness	1 vs.2	-0.09	-1.46	0.146	-0.20-0.03
	1 vs.3	-0.004	-0.06	0.950	-0.14-0.13
	1 vs. 4	-0.14	-2.09	0.039	-0.28-(-)0.01
	2 vs. 3	-0.08	-0.89	0.373	-0.26-0.10
	2 vs. 4	-0.06	-0.6	0.548	-0.26-0.14
	3 vs. 4	-0.14	-1.3	0.196	-0.34-0.07

Numbers indicate profile membership: 1=No Problems, 2=Dabblers, 3=Serious Dabblers, 4= Drug Problems.

Appendix L: Full results of the Somers'D analysis comparing problem behaviours by latent profiles for the male sample.

Indicators	Class	Coef.	t	*p*	95% CI
Drug Use	1 vs.2	-0.68	-8.08	<0.001	-0.85-(-)0.52
	1 vs.3	0.95	44.58	<0.001	0.91-0.99
	2 vs. 3	0.75	10.71	<0.001	0.61-0.89
Alcohol Use	1 vs.2	-0.65	-9.92	<0.001	-0.78-(-)0.52
	1 vs.3	0.75	20.02	<0.001	0.67-0.82
	2 vs. 3	0.19	1.19	0.238	-0.13-0.52
Tobacco Use	1 vs.2	-0.58	-9.35	<0.001	-0.71-(-)0.46
	1 vs.3	0.69	8.62	<0.001	0.53-0.85
	2 vs. 3	0.24	1.78	0.078	-0.3-0.50
Cannabis Use	1 vs.2	-0.22	-11.95	<0.001	-0.26-(-)0.19
	1 vs.3	0.15	7.1	<0.001	0.11-0.20
	2 vs. 3	0.47	15.49	<0.001	0.41-0.53
Technology Use	1 vs.2	-0.12	-1.56	0.121	-0.26-0.03
	1 vs.3	0.24	2.89	0.005	0.07-0.40
	2 vs. 3	0.12	0.98	0.328	-0.13-0.39
Video Game Playing	1 vs.2	-0.002	-0.06	0.954	-0.10-0.10
	1 vs.3	0.06	0.41	0.685	-0.22-0.33
	2 vs. 3	0.05	0.34	0.737	-0.26-0.37
Gambling	1 vs.2	-0.12	-1.85	0.067	-0.24-0.01
	1 vs.3	0.02	0.34	0.731	-0.11-0.16
	2 vs. 3	-0.10	-1.20	0.233	-0.27-0.07

Numbers indicate profile membership: 1=No Problems, 2=Dabblers, and 3=Drug Problems.

Appendix M: Full results of the Somers'D analysis comparing continuous explanatory variables by latent profiles for the male sample.

Indicators	Class	Coef.	t	*p*	95% CI
Age	1 vs.2	-0.25	-3.18	0.002	-0.40-(-)0.09
	1 vs.3	0.45	5.29	<0.001	0.28-0.61
	2 vs. 3	0.24	1.53	0.13	-0.07-0.55
SES	1 vs.2	-0.10	-1.16	0.250	-0.27-0.07
	1 vs.3	-0.13	-0.80	0.427	-0.45-0.19
	2 vs. 3	-0.20	-1.39	0.168	-0.48-0.08
School Connectedness	1 vs.2	0.004	0.05	0.959	-0.18-0.19
	1 vs.3	-0.08	-0.71	0.481	-0.32-0.15
	2 vs. 3	-0.09	-1.06	0.291	-0.25-0.08

Numbers indicate profile membership: 1=No Problems, 2=Dabblers, and 3=Drug Problems.

Appendix N: Full results of the Somers'D analysis comparing problem behaviours by latent profiles for the female sample.

Indicators	Class	Coef.	t	*p*	95% CI
Drug Use	1 vs.2	-0.68	-8.03	<0.001	-0.85-(-)0.51
	1 vs.3	0.90	23.65	<0.001	0.82-0.98
	2 vs. 3	0.54	7.11	<0.001	0.39-0.69
Alcohol Use	1 vs.2	-0.77	-24.46	<0.001	-0.83-(-)0.71
	1 vs.3	0.84	39.37	<0.001	0.80-0.89
	2 vs. 3	0.19	1.99	0.049	0.00-0.37
Tobacco Use	1 vs.2	-0.62	-10.18	<0.001	-0.74-(-)0.50
	1 vs.3	0.68	7.24	<0.001	0.49-0.86
	2 vs. 3	0.19	1.6	0.113	-0.47-0.43
Cannabis Use	1 vs.2	-0.02	-8.22	<0.001	-0.25-(-)0.15
	1 vs.3	0.15	9.64	<0.001	0.12-0.18
	2 vs. 3	0.49	24.72	<0.001	0.45-0.52
Technology Use	1 vs.2	-0.23	-1.66	0.100	-0.51-0.05
	1 vs.3	0.14	1.16	0.25	-0.97-0.37
	2 vs. 3	-0.11	-1.02	0.309	-0.32-0.10
Video Game Playing	1 vs.2	-0.02	-0.14	0.886	-0.23-0.20
	1 vs.3	-0.13	-1.63	0.107	-0.28-0.03
	2 vs. 3	-0.13	-1.54	0.128	-0.31-0.04
Gambling	1 vs.2	-0.01	-0.33	0.742	-0.10-0.07
	1 vs.3	0.14	1.49	0.14	-0.05-0.33
	2 vs. 3	0.13	1.09	0.278	-0.11-0.37

Numbers indicate profile membership: 1=No Problems, 2=Dabblers, and 3=Drug Problems.

Appendix O: Full results of the Somers'D analysis comparing continuous explanatory variables by latent profiles for the female sample.

Indicators	Class	Coef.	t	*p*	95% CI
Age	1 vs.2	-0.24	-3.72	<0.001	-0.37-(-)0.11
	1 vs.3	0.41	8.73	<0.001	0.32-0.51
	2 vs. 3	0.21	2.28	0.025	0.03-0.40
SES	1 vs.2	-0.02	-0.23	0.821	-0.16-0.13
	1 vs.3	0.03	0.20	0.841	-0.29-0.35
	2 vs. 3	0.02	0.12	0.901	-0.31-0.35
School Connectedness	1 vs.2	0.08	0.86	0.391	-0.11-0.28
	1 vs.3	-0.26	-3.10	0.002	-0.42-(-)0.9
	2 vs. 3	-0.17	-1.28	0.202	-0.43-0.09

Numbers indicate profile membership: 1=No Problems, 2=Dabblers, and 3=Drug Problems.

Appendix P: Results of tests for multicollinearity

	Total	Males	Females
Variable	Variance Inflation Factor	Variance Inflation Factor	Variance Inflation Factor
Sex	1.03	-	-
Age	1.01	1.01	1.01
Race	1.02	1.01	1.01
Socioeconomic Status	1.05	1.05	1.05
School Connectedness	1.08	1.07	1.07
Academic Achievement	1.02	1.01	1.01
Antisocial Behaviour	1.02	1.02	1.02

Appendix Q: Matrix of unweighted bivariate associations (Person chi square test) and correlations (Spearman rank correlation) between explanatory variables for the total sample.

Variables		Age	Race	SES	Academic Achievement	School Connectedness	Antisocial Behaviour
Age	Rho	1					
	p-value						
Race	Rho	-0.004	1				
	p-value	0.77					
SES	Rho	-0.06	0.07	1			
	p-value	<0.001	<0.001				
Academic Achievement	Rho *(X^2)*	0.04	*0.004*	-0.07	1		
	p-value	0.03	*0.947*	<0.001			
School Connectedness	Rho	-0.04	0.12	0.2	-0.06	1	
	p-value	<0.01	<0.0001	<0.001	<0.001		
Antisocial Behaviour	Rho *(X^2)*	0.07	*0.4115*	-0.03	***20.45***	-0.09	1
	p-value	<0.001	*0.521*	0.11	***<0.001***	<0.0001	

Note: Italics is indication of Person chi square test results and bold is indication of significant Person chi square test results. There are no associations found from the Spearman rank correlation.

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