Exploring the association between cannabis use, depression, anxiety and flourishing in youth: a cross-sectional analysis from year 5 of the COMPASS Mental Health pilot data

by

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AUTHORS DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Cannabis use and mental health problems are highly prevalent among Canadian youth. While repercussions associated with cannabis are ubiquitous throughout the population, youth are at an increased risk as the brain is exceptionally susceptible to adverse effects during this stage of development. Youth are at a disproportionate risk for addiction, developing a cannabis use disorder, depression, anxiety and psychosis. Moreover, the risk of developing a substance use problem is doubled in people with mental illness compared to the general population, whereby at least 20% of people with a mental illness have a co-existing substance use problem. Gaps remain within the literature that explore how the effects of positive wellbeing, in the presence or absence of mental illness, can serve as a protective measure against cannabis use.

The objective of my thesis was to examine if depression or anxiety were associated with youth cannabis use; and investigate whether flourishing moderates these associations. My approach was guided by the differential susceptibility framework and used a cross-sectional analysis of the mental health module pilot data collected in year 5 (Y_5[2016-2017]) of the COMPASS study. Data from 8,179 grades 9-12 students were collected from 10 secondary schools in Ontario and British Columbia, Canada. Participants were included based on a complete case analysis for a total of 8,040 students being eligible participants. Self-report questionnaires were used to assess symptoms of depression [CESD-R-10], anxiety [GAD-7], flourishing [Deiner's Flourishing Scale] and cannabis consumption using measures that assess cannabis ever use and frequency of use. Logistic regression analysis (binary and ordinal) and product-term interactions were used to examine the associations between mental health and youth cannabis use, and the potential moderating effect(s) of flourishing.

In my sample, 33% of participants had ever used cannabis, 51% and 38% reported elevated depressive and anxiety symptoms, respectively. Associations between depression, anxiety, and cannabis use were no longer significant when flourishing was added to the models. In addition, there was no evidence suggesting a moderating effect of flourishing as all interactions were not statistically significant. Instead, robust associations were found between flourishing and cannabis use. Indicators of mental wellbeing, such as flourishing, appear to be associated with a lower likelihood of cannabis use, even after controlling for depression and anxiety. Results suggest prevention strategies for youth cannabis use should aim to foster mental wellbeing among all youth, rather than exclusively targeting those experiencing mental health problems. Future longitudinal studies should test the sequential relationship between cannabis use and changes in both positive and negative mental health.

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SECTION ONE: Introduction

Cannabis is the most widely used illicit drug by young people, where nearly 1 in 4 Canadian youth between the ages of 15 and 17 have experimented with cannabis at least once in their lifetime (1). As we move closer to the legalization of cannabis in Canada (July 2018), many concerns have been expressed pertaining to new regulations and the impact this may have on youth. Although youth will not be of legal age to purchase cannabis (must be 18 years and older under the federal law), research has demonstrated that increased use among youth populations is probable (2–4).

Prior to this legislation being enacted, important questions remain about current cannabis use among Canadians and correlations to other health-related issues common among youth (e.g., depression, anxiety, co- occurring substance use). Of particular concern to many health promotion and public health professionals is the link between cannabis use and mental illnesses, specifically depression and anxiety. Research has highlighted a presumable interaction between cannabis use and mental health (5–9).There is, however, limited knowledge related to the patterns of youth cannabis use and possible factors associated with initial uptake and the frequency of use. A greater understanding of how mental health and aspects of wellbeing are correlated with cannabis use can inform targeted prevention strategies, and in turn, minimize possible health consequences that may accompany the legalization of cannabis in Canada.

To successfully implement new regulatory laws on cannabis, further research is required, particularly regarding how to appropriately target youth who are at high risk for using cannabis. The COMPASS study is a prospective cohort study utilizing a quasi-experimental design to collect and evaluate various youth health behaviours (e.g., diet, physical activity, obesity, cannabis, alcohol, tobacco, sedentary behaviours and mental wellbeing) from a sample of Canadian secondary students (10). During the 2016/2017 data collection, a newly developed module of COMPASS focused on mental health was implemented in a pilot sample of schools. This project will examine the association between mental health and cannabis use among youth using the first wave of the pilot data from the Mental Health Module (MH-M) of the COMPASS study.

SECTION TWO: Literature Review

2.1 The importance of understanding cannabis use patterns

Greater knowledge and exploration of cannabis use patterns and trends is essential for good policy creation that will help guide possible outcomes and minimize risk through evidence-based decision making. Cannabis use has been associated with considerable harmful effects resulting in addiction (11), cognitive impairments (12,13), impaired motor function (14–17) and poor mental wellbeing (18–25). While cigarette smoking prevalence continues to decrease (26), reported prevalence of regular cannabis use has steadily increased to almost 3% of Canadians (age 15+) being daily users and may soon surpass daily tobacco use (27). This trend has also been demonstrated in a U.S. sample of grade 12 students (28). Regular cannabis use during adolescence is of particular concern given the continued rapid and extensive brain development during this life stage (12,13) and the potential lifelong consequences that are associated with use in with this age group (14).

Observed trends of cannabis use have been found to cluster by demographics, geography, mental wellbeing and other health behaviours. According to Statistics Canada, past-year and daily cannabis users were most likely to be male and between the ages 18-24 years old (1). Geographical and regional differences of cannabis use patterns have been observed, with Atlantic (Nova Scotia) and Western (British Columbia) provinces reporting the highest past-year use compared to other provinces within Canada (1). Variability was also evident in urban dwellers, which were the most common past year cannabis users relative to rural communities (1). Indigenous (Nunavik) youth are at a particularly high risk where approximately two-thirds of 15-19 year olds reported past year use in 2010 (29). Cannabis use in both youth and adults has been robustly correlated with mental illness (30–33) and is particularly prevalent in individuals with schizophrenia and psychosis (18–22), anxiety (34,35), and depression (23–25). However, limited research has explored how flourishing may moderate this link as a potential protective factor. Other risky health behaviours as such tobacco and alcohol use (36,37) and early sexual activity (37) and impaired driving (14) are found to co-occur with cannabis use and therefore demonstrates the demand for our understanding of this correlation. To better inform policy, it is important to recognize how public perception of cannabis may change after legalization, and how to best prepare for latent consequences associated with the legalization of cannabis.

The role of cannabis as a gateway drug remains an important political and public health issue within Canada. Theories state that psychoactive component in cannabis, tetrahydrocannabinol (THC), and the dopamine reaction that follows its use may prime the brain for addiction (38) and enhanced responses

to other drugs (39). This cascading effect may be a result of substance users having a higher propensity for sensation seeking (40) or subsequent social interactions (41). As previously described, cannabis use remains problematic in subpopulations and therefore understanding patterns related to use and misuse is relevant for policy makers involved with the creation and modification of the Cannabis Act going forward.

2.2 Harms of cannabis use

Short and long term cannabis use has been associated with number of negative health outcomes including acute, chronic and social adversities (42). Use can lead to the development of problematic uptake or addiction and some groups are disproportionately susceptible to cannabis use disorders. Research suggests that 30% of cannabis users are problematic users (43) and those who begin using before the age of 18 are up to seven times more likely to develop a cannabis use disorder (44). High vulnerability to addiction in adolescents is hypothesized to be related to the active development of the brain (11). However, unknowns about physical and psychological harms associated with cannabis use is persistent throughout the literature and demonstrates the need for further exploration (45).

2.2.1 Acute Harms of Cannabis

Cannabis smoking can produce acute impairments to lung function and lead to serious or fatal injury. Inflammation and resistance of the airways as well as lung hyperinflation are associated with regular cannabis use (46) and may compromise immune function leading to respiratory infection or pneumonia (47). Moreover, cannabis is the most commonly used illicit drug while driving impaired and has become progressively more prevalent in reported fatal accidents (14). In turn, drugged driving has become an important public health issue within Canada with a particular focus on adolescents (14). Youth propensity for sensation seeking was directly related to substance use; this relationship is suggestive that sensation seekers have an increased risk of motor vehicle accidents (48). Research has linked non-alcohol substances, particularly cannabis, to impaired reckless driving and accidents with fatal outcomes (15–17). Additionally, there is currently no good test to identify drivers under the influence of cannabis, making this difficult to monitor.

2.2.2 Chronic Harms of Cannabis

Chronic effects that have been observed in relation to cannabis use include respiratory ailments, mental illness, as well as cognitive and intellectual impairments. Regular use of cannabis is suggestive of having detrimental acute and long term effects on the lungs and airways (46). Acute harms of cannabis smoking coincide with regular cannabis smokers being more likely to report chronic bronchitis (46).

Numerous studies have shown cannabis use and the risk of schizophrenia and psychosis (18–22) appears to be dose-dependent where higher risk of schizophrenia is predicted by the earlier age of cannabis use (22,49). Schizophrenia usually appears in early adulthood where the risk is doubled in heavy cannabis users (50). Moreover, the risk of psychosis is increased by an approximate 40% in youth cannabis users and also demonstrates a dose-response relationship with the frequency of use (32,51). Regular cannabis use by adolescents has also been found to increase the risk of depression (23,24) and exacerbate symptoms of depression and anxiety (25). Research shows that compared to non-users, adults who used cannabis twice monthly or more during their adolescence, had fewer fibers in brain regions that were responsible for alertness and self-conscious awareness as well as learning and memory (12) ultimately leading to lower IQ-test scores .

Cannabis use and schizophrenia and psychosis has been robustly studied in an adolescent population and findings demonstrate that frequent cannabis exposure at a young age may exacerbate the course of illness, advancing earlier onset of a first-time episode by 2 to 6 years (52,53). Additionally, frequent cannabis use is correlated with an increased risk of depression and anxiety (5). A growing body of research suggests that adolescent cannabis use is correlated with increased rates of psychological distress and anxiety (35). A large cohort study found a link between frequent cannabis use and the incidence of anxiety symptoms in young adults (34). Additionally, robust research highlights an increased risk of depression in cannabis users compared to non-users, and the level of risk increases with younger initiation and more frequent use (5,23,24,54). Patton and colleagues (5) found a dose response with the frequency of cannabis use predicting later depression and anxiety in adolescent girls with daily user presenting the highest risk. Compared to occasional users, regular cannabis use has been linked to significantly lower quality of life in women (55).

2.2.3 Social Harms of Cannabis

Cannabis use that is initiated in adolescence has been linked to lower IQ compared to adult-onset cannabis use and findings are suggestive of a neurotoxic effect on the developing (adolescent) brain (13). Compounding decreased IQ, cannabis use has also been found to impair academic performance (56–58), engagement (56) and aspirations (56), as well as increase the risk of dropping out of school (57,58). These adverse effects on brain development and functional connectivity are especially obvious in adolescent-onset cannabis users (12).

2.3 Current and future laws on cannabis use and distribution in Canada

Under the Controlled Drug and Substance Act, cannabis remains a *schedule II drug* that is not permitted for recreational consumption across Canada (59). Unlicensed vendors or stores selling cannabis continue to be illegal and sell unregulated products that may be dangerous for consumption. Regardless of age, individuals purchasing and consuming cannabis for medical reasons must possess documentation from a health care provider and the prescription is to be filled through a licensed producer and/or authorized individuals (60).

The Government of Canada expects to implement the Cannabis Act no later than July 2018, permitting recreational (non-medical) cannabis use. The proposed Act aims to create a legal framework that is targeted towards protecting youth by closely controlling the production, distribution, sale and possession of cannabis (61). Any person under the age of 18 would be prohibited from using or possessing cannabis. Federally controlled access will allow adults (18 years or older) to legally possess ≤30 g, share ≤30 g with others who are of legal age, purchase cannabis through a licensed retailer and cultivate up to 4 cannabis plants (61). In addition to the restrictions proposed by the federal government, regulatory laws may vary for different jurisdictions as provincial governments may decide to increase restrictions or supplement the minimal federal conditions. For example, Ontario has increased the minimum age to purchase and consume cannabis at 19 years old (62).

2.4 Cannabis use in Canadian youth

According to the World Health Organization, 33.3% of Canadian youth have used cannabis at least once by the age of 15 and are the highest ranked users across 43 North American and European countries and regions (63). Nearly two-thirds of Indigenous youth reported past year use (29) and 20% of Ontario youth reported using cannabis at least once a month (2). In Ontario high school students, age is an evident risk factor in substance use uptake with current cannabis use increasing by 160% between grade 9 and 12, where students in grade 12 reported the highest frequency of use (2,64).

2.4.1 Trends and patterns of substance use in youth: tobacco and alcohol literature

Reflecting on the well-established domain of tobacco literature, many researchers have defined critical stages of smoking and the multiple social, psychological and biological factors that are associated with different stages, particularly in youth (65). When considering the progression of smoking, research highlights important differences in adolescents who have never smoked, who have contemplated smoking, who have ever tried smoking and various levels of frequency ranging from experimenting to daily use (65). Adolescents who have never tried smoking likely have no desire to smoke and are resistant or unaware to the appealing reasons to try (65). The initiation or ever use of cigarettes is characterized by

being susceptible to peer pressure and is motivated by academic achievements and social engagement (65). Lastly, increases in frequency of smoking are categorized into three stages: “experimenter”, “regular” and “daily smoker”. Adolescents who classify as “experimenters” will more commonly draw attention to the positive aspects of smoking and may self-identify as a smoker. The transition into “regular” smoking is demonstrated when negative aspects originally associated with smoking become positively perceived. This stage is associated with the greatest physiological and stimulating reaction (65) where the user moves past sporadic smoking to regular or weekly uptake. Both initial levels and frequency rate of substance use in an adolescent population have been related to age, gender, family and peer factors (66–68). Substance use trajectories were predicted by inter-individual differences and attitudes, where positive perceptions were related to any stage of smoking (69). The differences in characteristics and corresponding attitudes of each smoking stage illustrates the importance of distinguishing between types of users in substance use research.

The stages of smoking defined previously can also be applied to cannabis use. Cannabis research has demonstrated outcomes in various domains (e.g., school performance, mental health) that are directly associated with the frequency of cannabis use. Compared to non-users, women who used cannabis occasionally had higher odds of reporting low levels of accomplishment and vigilance as a result of emotional problems (55). Academic ambitions, school engagement and dropout rates have also been linked to cannabis use and frequency. One study found that students who had used cannabis at any frequency while attending high school were 2.3 times more likely to drop out compared to students who had never used cannabis (58). A study in Ontario youth showed that cannabis ever use was associated with academic disengagement and poor school performance (56). Similar to the stages of smoking, cannabis ever use and frequency of use among ever users are important measures to consider in this domain of research.

2.4.2 Neuropathology of cannabis on the developing brain

Brain development is an active process throughout adolescence and is guided by both personal experiences and environmental factors (70). Compared to adults, whose brains are developed, exposure to cannabis during adolescence is particularly concerning given the chemical and structural changes associated with cannabis use and the susceptibility of the brain during neurological development (71,72). The psychoactive component of cannabis, THC, artificially stimulates cannabinoid receptors and the endocannabinoid system and can lead to perceptual and emotional changes (73). Cannabis use in adolescence has been found to result in structural changes within the brain leading to lower brain volumes

and white matter, different folding patterns, thinning of the cortex and low levels of neural connectivity (73). Research also shows that youth who use cannabis regularly, demonstrate increased neural activity where the brain must overcompensate to perform tasks (74). While most research has demonstrated important neuropathological changes in heavy cannabis users, recent findings show that similar changes are evident in infrequent users as well and can impact fundamental brain regions involved with emotional and behavioural regulation (75). Moreover, even occasional use of cannabis has been shown to induce transient psychotic reactions in healthy individuals (76).

2.5 Mental health in Canadian youth

Canadians between the ages of 15 and 24 experience mental illness more commonly than any other age group (77) by which 70% of mental illnesses will emerge by adolescence (78). The two most common mental illnesses are depression and anxiety (78). In Ontario high school students, 34% report moderate to serious levels of psychological distress, symptoms of depression and/or anxiety, and 14% of these students report these symptoms at a severe level (79). Medical visits related to youth mental health nearly doubled in the past two decades (80) demonstrating the vastness of human and economic burden resulting from mental illness (81). Mental health is directly related to physical health and people with a mental illness are at a much higher risk for developing a long term medical condition (82).

2.5.1 The mental illness and health continua

Mental health is an important part of overall wellbeing. However, it is important to recognize the distinction between mental health and illness whereby the absence of mental illness does not necessarily indicate mental wellbeing. Statistics Canada states that one third of Canadians will experience one of the six main mental illnesses (including substance use disorders) in their lifetime (77). Mental illnesses, such as depression, anxiety and schizophrenia, are diagnosed conditions that alter our thinking, mood and behaviours, and impact how we function in our lives (78). Mental health is a positive concept that relates to our ability to enjoy and manage life and is more than the absence of mental illness (83), but rather a sense of emotional and spiritual wellbeing (84). Research shows that mental health and illness should be regarded as separate yet interconnected concepts that are to be looked at as two related continua, the mental health continua and the mental illness continua (refer to Appendix B for diagram and description).

2.5.2 Depression

According to the World Health Organization, depression is recognized as the leading cause of disability worldwide (85). Depression is characterized by feelings of sadness and a lack of interest in

daily activities for more than two consecutive weeks (85). It is usually accompanied by impaired social and work function, and changes in sleep, activity, concentration and mood (85). While depression can occur at any life stage, onset peaks during late adolescents (86) and rates have been found to be the highest among youth aged 15-24 (77). Research shows that depression is more common and persistent in females than males (87,88). This is consistent among youth as the prevalence for depression in females (ages 15-24) is nearly double the prevalence in males (89).

2.5.3 Anxiety

Generalized anxiety disorder (GAD) is defined as persistent worry that is exaggerated and unrealistic and can hinder social and occupational functioning (90). It is the most common anxiety disorder, affecting approximately 3% of the general population (91,92) and is the most prevalent mental illness in youth as GAD often begins during childhood (90). Anxiety related disorders were consistently the most common reason for ED visits (91) and have resulted in serious economic burden (81). In addition to economic burden, anxiety disorders can result in significant human burden and cause impairments to quality of life that have been found to be comparable to that which result from major depressive disorder (81). Of those with GAD, 52.6% also met the criteria for depression (77). The co-occurrence of the two illnesses is a commonly found pattern in other research (93,94) and provides rationale for depression and anxiety to be examined separately as well as co-occurring diseases.

2.5.4 Mental Wellbeing and Flourishing

Mental wellbeing has been operationalized to include measures of emotional, psychological and social wellbeing and represents the concept of flourishing (95,96). As previously outlined, the absence of mental illness does not imply good mental health and positive mental health (wellbeing) and mental illness can coexist (97). Flourishing is defined as a state of overall wellbeing and the presence of positive mental health (97). The absence of flourishing has been used to predict the incidence and future risk of mental illness (98) where one study found that probability of all-cause mortality in adults increased in the absence of flourishing (100). While flourishing individuals have been found to function better than all others, just one fifth of the U.S. adult population is flourishing (97,101–104). Statistics Canada estimates that in 2012, 72.5% of Canadians ages 15 or older did not meet the criteria for a mental illness and reported flourishing, categorizing them as having “complete mental health” (84). Complete mental health was positively associated with good physical health and strong spirituality whereas people living in urban environments and who are of low income status were less likely to report complete mental health. Additionally, flourishing is much less common in people with a mental illness and only 4.5% of these individuals will report good wellbeing (84).

2.6 Mental health and youth cannabis use

While repercussions associated with cannabis can occur at any age, youth are at an increased risk as the brain is exceptionally susceptible to adverse effects during this stage of development. As highlighted above, youth are at a disproportionate risk for addiction, developing a cannabis use disorder, depression, anxiety and psychosis. Research shows that the risk of developing a substance use problem is doubled in people with mental illness compared to the general population. At least 20% of people with a mental illness (105) have a co-existing substance use problem and this risk increases to 50% in people with schizophrenia (106). Moreover, people with substance use problems are three times more likely to have a coexisting mental illness (106).

2.6.1 Neurotoxic effect of cannabis use and mental illness

The psychoactive component of cannabis, THC, artificially stimulates cannabinoid receptors within the endocannabinoid system interfering with the regulatory capacity of this system (73). Abnormal functioning of the endocannabinoid system may be directly related to the development of mental illness through long term damages to brain function. Current research suggests that the detrimental effects associated with cannabis use in relation to depression and anxiety may be linked to decreased activity of the endocannabinoid system, inhibition of endogenous cannabinoid production and cannabinoid receptor expression (107,108). Blockage of the cannabinoid receptor have been shown to induce feeling of depression and anxiety (108); individuals who are genetically more vulnerable to mental illnesses have been found to be at an increased risk to the adverse effects associated with cannabis use (53,109). Although research suggest a neuropathological link between cannabis use and mental illness, findings are inconsistent and require continued study.

2.6.2 Gaps in current cannabis use and mental illness research

Several studies have linked frequent cannabis use with an increased risk of depression and anxiety (5). However, opposing studies have demonstrated insignificant correlations or a decrease in the relationship after controlling for important confounding variables and demographic factors (110,111). Although research has suggested a strong association between daily cannabis use and mental illness, evidence is inconsistent and demonstrates the need for further rigorous exploration (34,112).

While existing research suggests that mental impairments develop as a result of cannabis use and not the reverse (5,9), contrasting epidemiological evidence shows that cannabis is used disproportionately by individuals with mental health disorders (6) and that mental distress directly contributes to the etiology

of a cannabis use disorder (6). Much of the available research that considers cannabis use as result of a previous mental illness have looked at PTSD (6), externalized and internalizing behaviours (7) and social deviance (8). Limited research exists exploring the early onset of cannabis use with co-occurring depression and/or anxiety. It is likely that factors triggering mental illness may also contribute to cannabis use behaviours and confounding variables that may go overlooked add to the difficulty in establishing the direction of the causal pathway. Moreover, the author is unaware of any studies that have examined how flourishing may interact with the association between depression and/or anxiety and cannabis use in youth. Given the contrasting evidence for both arguments, and the gaps in literature that explore the protective elements of mental wellbeing, future research within this domain is required.

2.7 Differential susceptibility model

The differential susceptibility hypothesis (model) is a framework used to interpret psychological findings. The model suggests that individuals vary in susceptibility to experiences whereby biological and environmental factors guide development and emotional affect relative to how plastic a person is (113). The differential susceptibility hypothesis examines positive or negative events and the variance in individual susceptibility to both supportive and adverse conditions (113). That is, some people are more sensitive than others to given experience and those who are highly susceptible will be more affected by both negative and positive experiences. These individuals are seen to be most malleable. This theory embodies the concepts of the mental illness and health continua (see section 2.5.1) illustrating individuals with a mental illness can still display optimal mental wellbeing. That is, those with a mental illness may remain plastic where they are particularly sensitive to positive conditions (i.e., optimal mental wellbeing). Since this study explores the influence of both positive and negative affect in cannabis use patterns, the application of a differential susceptibility framework will allow us to examine malleability among students who are depressed and anxious, using flourishing as a plasticity factor.

2.8 Covariates of interest

According to previous research, cannabis is disproportionately used by specific subpopulations which will guide the selection for variables to control for in the analysis.

2.8.1 Demographic Characteristics

Research has shown that cannabis use increases with age (2,114). Grade has been used as a proxy for age as this is a more relevant measure for school stakeholders. Sex has also been found to be associated with cannabis use and mental health. Females are at greater risk for depression and anxiety disorders than males (77,89), and males report higher rates of cannabis use (2,27,114) and substance use

disorders (77). Ethnic differences have been previously observed in cannabis use trends, where White youth are less likely to use cannabis than other races (115) and Indigenous youth are more likely to report ever trying cannabis and being regular users compared to non-Indigenous youth (116). Amount of weekly spending money has been positively associated with substance use in youth (117). Weekly spending money is a good measure to represent socioeconomic status which has been shown to be a strong predictor for substance use (118).

2.8.2 Behavioural Characteristics

Cannabis use has been robustly linked to the use of other substances, particularly alcohol and tobacco. Binge drinking and smoking among youth is strongly associated with cannabis use and cross-sectional (119–121) and longitudinal (26,27,36,122–124) studies have demonstrated a clustering of these three behaviours in adolescents. As well, truancy was controlled for within all analyses.

SECTION THREE: Study rationale and Research questions

3.1 Study Rationale

The proposed Cannabis Act has been designed to monitor and control the production, distribution, sale and possession of cannabis in Canada. This new legislation is expected to be implemented no later than July 2018 (61), and although the legalization of cannabis has been widely supported by the public (125), important knowledge about use is not yet available. Recently, various U.S. states, including Colorado, California and Washington, have implemented new legislations regarding the recreational use of cannabis. Research has found decriminalization of cannabis to be associated with permissive attitudes among youth leading to a decrease in risk perception (126). Additionally, youth have reported an increase in perception of easy access to cannabis (127). Results from literature that explore trends relative to the decriminalization of cannabis, provide empirical evidence that suggest the commercialization of cannabis may be a risk factor for increases in youth uptake and future drug dependence (126,128).

A link between cannabis use and mental illness has been clearly identified in current literature, with much of the evidence focused on psychotic disorders, depression and anxiety. The risk of developing psychosis has been directly related to cannabis use and has been well established by robust research (51). A longitudinal, population based study found that individuals using cannabis at baseline were almost three times more likely to display symptoms of psychosis at the three year follow up period and exhibited a dose-response relationship between cannabis use and psychotic reactions (49) where even occasional use has been found to induce transient psychosis in healthy individuals (76). In addition to psychosis, one study found that daily and weekly cannabis use in adolescents significantly increased the odds of depression and anxiety in adult women (5). Longitudinal and cross-sectional evidence has shown long term exposure to cannabis, high frequency of use (5,33,129), as well as a younger age of onset for cannabis use (5,32) are important risk factors in developing a mental illness. Pathological changes in the brain, similar to heavy cannabis use, has also been observed in infrequent users (75).

Studies exploring patterns associated with the use of e-cigarettes and synthetic cannabinoids have found that ever users exhibit a higher propensity to engage in risky behaviours (e.g., drug and alcohol use, tobacco use, sexual behaviours) than never users of these substances (130,131). This trend highlights the importance of establishing the differences between the two cohorts as *ever users* of cannabis have an "experimenter's profile" for sensation seeking and will likely have a greater disposition to engage in risky

behaviours than youth who have never used cannabis. Additionally, those who use cannabis daily will have distinct outcomes compared to occasional users. The frequency of cannabis use has been shown to be an important measure contributing to overall wellbeing (5), academic ambitions (56) and pathological changes within the brain (73). One study found that the frequency of cannabis use in adolescent girls predicted later depression and anxiety and the risk increased with higher frequency of use (5). Prevention strategies in the past have primarily focused on the process and predictors of problem behaviour. These evolving approaches and have been criticized for focusing too closely on antecedent predictors while overlooking co-occurring problems and factors that promote health (132). Positive youth development has been largely embedded in preventing problematic behaviours (133,134) and have the ability to buffer against many risk factors for negative outcomes (98,135). To explore positive youth development and how these factors may offset mental health trajectories as a function of cannabis use, I have included flourishing as a moderating measure.

While there is a large body of evidence exploring the relationship between cannabis use and mental illnesses, inconsistencies within the literature and contrasting findings indicate the importance of continued research. As well, critical knowledge gaps remain that consider how positive aspects of wellbeing, such as flourishing, may co-exist and serve as a protective measure against the use of cannabis in high risk populations (i.e., youth with poor mental health or with mental illnesses). Cannabis use and some mental illnesses have been negatively associated with flourishing levels (99), however research has not yet considered the role of flourishing in youth with mental illness and co-occurring cannabis use. This author is not aware of any studies that have examined how flourishing may offset the use of cannabis in youth experiencing depression and/or anxiety. My research aims to generate knowledge that is necessary for creating evidence-based policies and programs, and add to existing literature while introducing a level of novelty by exploring the protective elements of mental wellbeing.

COMPASS is a robust research platform designed to evaluate youth health behaviours over time and foster practice-based evidence that is used to guide program and policy creation (10). COMPASS has recently developed and tested a new mental health module (MH-M) to be added to the original student questionnaire. The MH-H was first piloted in a subsample of the fifth wave (2016-2017), and in some Ontario and BC schools only, giving reason to the transversal nature of this study. This cross-sectional work will highlight possible correlations between cannabis use and mental health in youth and help guide and inform future longitudinal research.

3.2 Research Questions

For my thesis, I explored the following research questions:

Research Question 1a: Among students in Year 5 of the COMPASS MH-M Pilot study, are clinically relevant levels of depression and/or anxiety associated with *ever use* of cannabis, controlling for known demographic, social and behavioural correlates (e.g. sex, grade, ethnicity, spending money, truancy, binge drinking and smoking)?

Research Question 1b: Are different levels of depression and/or anxiety associated with associated with *ever use* of cannabis?

Research Question 1c: Does flourishing moderate the effect of being depressed and/or anxiety on cannabis ever use?

Research Question 2a: Among students in Year 5 of the COMPASS study, are clinically relevant levels of depression and/or anxiety associated with frequency of cannabis use?

Research Question 2b: Are different levels of depression and/or anxiety associated with associated with frequency of cannabis use?

Research Question 2c: Does flourishing moderate the effect of being depressed and/or anxious on frequency of cannabis use?

3.3 Hypothesis

Research Question 1a:

I hypothesized that students who report relevant levels of depression and/or anxiety would more likely be ever users of cannabis compared to students who do not experience depression and/or anxiety.

Research Question 1b:

I hypothesized that there would be a positive association between levels of depression and/or anxiety and the *ever use* of cannabis. As levels of depression and/or anxiety increased, the likelihood of a student being an *ever users* of cannabis was expected to increase respectively.

Research Question 1c:

Based on existing evidence, I hypothesized that high flourishing would moderate the *ever use* of cannabis by reducing the observed association between cannabis *ever use* and depression and/or anxiety. Flourishing was expected to have a similar effect on students who did not indicate depression and/or anxiety and were expected to be less susceptible to cannabis use.

Research Question 2a:

For the second objective, I hypothesized that relevant levels of depression and/or anxiety would be directly associated with the frequency of cannabis use. Students who did not report depression and/or anxiety were expected to be less frequent users of cannabis than students who reported depression and/or anxiety.

Research Question 2b:

I hypothesized that there would be a positive association between levels of depression and/or anxiety and the frequency of cannabis use. Least frequent users of cannabis were expected to be students who reported no depression and/or anxiety and the most frequent use of cannabis was to be seen in students reporting the highest levels of depression and/or anxiety.

Research Question 2c:

Similarly, I hypothesized that that flourishing would provide a protective element against the frequency of cannabis use and act as a moderator in students who are depressed and/or anxious. A similar effect was expected to be observed in students who did not indicate depression or anxiety.

SECTION FOUR: Methodology

4.1 COMPASS Host Study

COMPASS is a longitudinal, prospective cohort study that annually (2012-2017) collects data from students in grades 9 to 12 attending participating secondary schools in jurisdictions across Canada (10). COMPASS is the first study of its kind with a rigorous foundation to evaluate school programs, policies, and environmental factors that could potentially impact student health behaviours and outcomes over time. By implementing a quasi-experimental design that collects hierarchical data at the student, school and environmental level, COMPASS provides a research platform with robust internal control and external validity (10). Student-level data are collected through the COMPASS questionnaire – student survey (Cq). Individual student-level data are collected on demographics, weight status, diet, physical activity, sedentary behaviour, substance use, bullying, academic achievement, and mental wellbeing (see section 4.2. for more details). School-level data on school programs and policies related to the COMPASS behaviours of interest are collected through the online School Policies and Practices Questionnaire (SPP). The SPP is completed by the COMPASS school contact, usually most knowledgeable about the school environment (i.e., teacher, principal, school nurse). COMPASS also collects measures on the within and surrounding built environments, such as physical infrastructure, parks and community centres. As a prevention research system, COMPASS facilitates knowledge translation and exchange for participating schools by providing them with individualized health profiles, tailored intervention recommendations, and prevention resources through funding and/or connections via the schools assigned knowledge broker. Given the pilot stage of the mental health module, this current study will conduct a cross-sectional analysis using the student-level data (Cq) from Year 5 (2016-2017) of the COMPASS study.

4.1.1 Study Design

My thesis will employed a cross-sectional study design. All schools that piloted the mental health module (MH-M) in both British Columbia (N=5 schools) and Ontario (N=9 schools) and all students who completed the survey (n=8179) in Year 5 of the COMPASS study, were included in the analysis. This provided sufficient sample size and power to detect a correlation if one exists, and the ability to highlight differences between provinces. Complete-case analysis was used for all models in the proposed research questions. Descriptive statistics and cross-sectional analysis was conducted in the software SAS version 9.4 to explore outcomes of research questions 1 and 2.

4.2 The COMPASS Student Questionnaire

The COMPASS student questionnaire (Cq) includes 73 questions, inclusive of the mental health module piloted within a select sample in 2016-2017 (refer to section 4.2.1 below for more details). The Cq collects self-reported information pertaining to sociodemographic characteristics and health behaviours specifically related to physical activity, weight perception, healthy eating, tobacco, alcohol and cannabis use, bullying, sedentary behaviours, sleep, academic achievements, school connectedness and mental health. Items were selected to echo both science and practice-base interests (10) and are consistent with measures used in national surveillance tools or public health guidelines (136–138), demonstrating good reliability and validity (139–141). During the selected time of the data collection, students are given a full class period to complete the Cq and a COMPASS researcher is present to collect the surveys, as well as deal with any student or teacher questions. A copy of the original Cq can be found in Appendix A.

4.2.1 Pilot Mental Health Module

The mental health module (MH-M) was first implemented in select Ontario and British Columbia schools in 2016-2017. This module included eight additional subsections about youth mental health to supplement the original Cq. The development of the MH-M included both quantitative (pilot testing) and qualitative (focus groups) approaches, and was designed based on other youth mental health research and government strategic priorities (142). To reflect both research and practice concerns, stakeholders (i.e., schools, clinicians and school boards) were involved in the creation of the tool, and focus groups were conducted in an Ontario school. Focus groups allowed for students (grade 9-12) to give constructive feedback on the propriety and comprehension of the MH-M as well as suggestions for its improvement. Using this feedback, revisions were made to the MH-M and an updated version has been integrated into the Cq for data collections. The MH-M and highlights from the focus group interviews can be found in in the Tech Report previously cited (142).

4.3 Participants

4.3.1 School Recruitment and Sampling

Schools and boards were purposefully selected to participate in the mental health module. All Ontario secondary schools within the Simcoe-Muskoka Catholic District School Board (Number of Schools N=5) and British Columbia (BC) secondary schools (from school boards including: Vancouver School Board (N=1), Sooke Board of Education (N=2), Chilliwack Board of Education (N=1) and

Coquitlam District School Board (N=1)) were invited to participate in the pilot testing of the MH-M. Specific schools were recruited to participate in the pilot stage based on expressed interests in the mental health data. This recruiting strategy allowed for a diversified population and comparisons across jurisdictions.

4.3.2 Student Recruitment and Sampling

COMPASS follows an active-information passive-consent protocol. Parents/guardians of students at participating schools receive information letters before the date of each annual data collection. Students are withdrawn from participating in the survey if guardians contact the researchers, or returned a no permission form to the office or homeroom teacher prior to the survey. Students can also choose not to participate at any point during the data collection (10). Year 5 of the student-level sample, inclusive of the mental health module, was 8179 students.

4.3.3 Ethics

The COMPASS study has received ethics approval from the Office of Research Ethics at the University of Waterloo (ORE #: 17264). School boards, schools and students participating in the study have also provided permission.

4.4 Measures and Operational Definitions

4.4.1 Response Variables

Cannabis Use

To assess cannabis use, students were asked about *ever use* and frequency of use. For *ever use* of cannabis, respondents were asked “In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash)”. The response options were: “I have never used marijuana”; “I have used marijuana but not in the last 12 months”; “Less than once a month;” “Once a month;” “2 or 3 times a month;” “Once a week;” “2 or 3 times a week;” “4 to 6 times a week;” and “Every day”. Responses were recoded into *never users* if the student had never used cannabis, and all other responses were coded as *ever users*. For frequency of use, responses were recoded into “never,” if students were never users, “rare/sporadic” if respondent used cannabis less than once month, “monthly” if reported use was once to 3 times per month, “weekly” if use ranged from once to 6 times a week, and “daily. Substance use measures (cannabis, alcohol and tobacco) correspond with national surveys of youth substance use (136).

4.4.2 Explanatory Variables

Depression

Student depression was measured with the Center for Epidemiological Studies Depression Scale Revised (CES-D-10), a 10-item scale designed to assess self-reported depressive symptoms in adolescent and adult populations over a 1-week period (143–145). The scale includes items on positive and negative affect, somatic activity, and interpersonal relations. A four-point Likert scale is used to rate the frequency of symptoms experienced; higher scores (range: 0-30) indicate greater frequency of depressive symptoms and individuals reporting scores ≥10 are considered to be depressed (145). Depression will be coded as both a categorical variable and a continuous variable. This study will use scores ≥10 to establish the presence of depression and use a binary coding system to categorize students with and without depressive symptoms (control=0, depressed=1). Additionally, the level of depression will be coded for as a continuous variable using scores ranging from 0 to 30. Test-retest reliability for the CES-D-10 was high (Pearson r=0.83) (146).

Anxiety

General Anxiety Disorder-7 (GAD-7) (147) is a valid and efficient screening tool used to assess generalized anxiety in both clinical practice and research. The GAD-7 is a brief, self-report scale that describes necessary items that reflect the DSM-IV criteria for assessing GAD (147). A four-point scale is used to score each of the 7-items, where total scores range from 0 to 21. Scores 5-9, 10-14 and 15+ represent mild, moderate and severe anxiety, respectively. Anxiety will be fit as either a categorical or continuous variable. To be consistent with other research, this measure will be coded as binary where students reporting scores <10 will not be considered as having GAD and those with scores ≥10 will be classified as being anxious (control=0, anxious=1) (147). Anxiety as a continuous independent variable will have scores ranging from 0 to 21, where increasing scores will indicate higher levels of anxiety. Test-retest reliability (intraclass correlation=0.83) of the GAD-7 is very good (147).

4.4.3 Interaction Variable

Flourishing

Levels of psychosocial prosperity and wellbeing among students were measured using the Diener Flourishing Scale (FS) (148). The FS is a brief, 8-item scale that surveys the domains of human functioning, including information about relationships, feelings of competence, and perceptions of leading a purposeful life (148). To match the format of the original Cq and maintain suitability for large school-based studies among youth (142), the original 7-point likert scale was cut down to a 5-point response scale with total scores ranging from 8 to 40. All item statements are positively framed, where

high scores denoting a strong agreement with all items will reflect that the respondent has many psychological strengths and resources for support (148). To generate results that are interpretable, the FS will be coded so that low scores represent flourishing and high scores represent languishing. The FS is a new measure developed based on contemporary theories of psychosocial wellbeing. This measure has been highly correlated to other measures of wellbeing (149).

4.4.4 Student Covariates

Sociodemographic characteristics and modifiable risk factors are collected in the Cq from participating students. Key covariates will be included in the analysis to reduce potential for confounding.

Sociodemographic Characteristics

Demographic characteristics to be included in the analysis are as follows: Grade (9, 10, 11, 12); sex (female, male); ethnicity (White, off-reserve Aboriginal, mixed/missing) and weekly spending money ($0, $1-$20, $21-$100, more than $100, I don't know). Weekly spending money is used as a proxy for socioeconomic status as this is a more accessible value for youth to report on than household income (116) and has been aggregated into these categories. Remaining congruous with other health behaviour research, these covariates were controlled for to reduce potential confounding.

Modifiable Risk Factors

Respondents were asked to report, "In the last 12 months, how often did you have five or more drinks of alcohol on one occasion?". Consistent with previous research (2), those who responded binge drinking one or more times in the past month will be considered current binge drinkers in the analysis (non-current binge drinker=0, current binge drinker=1). Smoking status was assessed by asking respondents, "On how many of the last 30 days did you smoke one or more cigarettes". Students who reported any 1 day or more will be considered current smokers (non-smoker=0, current smoker=1). Substance use items in the Cq were based on measures used in national surveys of youth substance use (136).

4.5 Data Analysis

The independent variables, depression and anxiety, will be coded as both continuous and categorical measures. The categorical measure will represent not having GAD or depression (absent=0) versus having GAD or depression (present=1). The continuous measure will represent the various levels of both mental illnesses and how cannabis use correlates respectively. Ever use of cannabis (dichotomous

dependent variable) will be fit using logistic models and these results will be the primary focus of this study. The frequency of cannabis use (ordinal dependent variable) will be fit using ordinal logistic regression models. The independent variables of interest will be fit as both dichotomous and continuous in two separate models to triangulate data and will be used primarily for a sensitivity analysis. Internal consistency values were calculated for the GAD-7 (α= 0.986) and the CES-D-10 (α= 0.983) to ensure good reliability of the mental health scales.

Once all logistic regression models have been fit, flourishing will be included as a moderator to test whether cannabis use in correlation to depression and/or anxiety will differ based on the presence or absence of flourishing. Logistic regression analysis will be used to test flourishing as an interaction (moderator) variable (150). The moderation models will employ a single regression equation:

$$Y = i5 + \beta 1X + \beta 2Z + \beta 3XZ + e5$$

$\beta 1$ is the effect of depression and/or anxiety on cannabis use (when Z= 0); $\beta 2$ is the effect of flourishing on cannabis use (when X = 0), $\beta 3$ is the effect of the product of depression and/or anxiety and flourishing on cannabis use, $i5$ is the intercept and $e5$ is the residual in the equation. The regression coefficient ($\beta 3$) provides an estimate of the effect flourishing; if $\beta 3$ is found to be statistically different from zero, flourishing will significantly moderate the association between mental health and cannabis use (refer to Appendix B for diagram and description) (150).

I used a stepwise modeling approach to build the final models that included 3 main steps. I evaluated both main effects, 2-way interaction and 3-way interaction effects for each of the 4 regression models. Each model followed a similar building strategy: 1) the main effects of depression and anxiety were tested, 2) flourishing was then added and main effects tested, and 3) the addition of 2-way and 3-way interactions were included as the last step for the final model. Using a stepwise modeling approach, I was able to demonstrate and evaluate any changes in significance after adding variables and interactions, as well as supplement the interpretation of my results. A total of 12 logistic models were run. Models 1-3 explored the association between cannabis ever use and dichotomized mental health variables, and models 4-6 considered the same association using continuous mental health variables. Models 7-9 explored the association between the frequency of cannabis use and dichotomized mental health variables, and models 10-12 considered the same association using continuous mental health variables. Models 3, 6, 9 and 12 represented the comprehensive model to include the 2-way and 3-way interactions. Concordance statistics (c-statistic) will be recorded to evaluate the goodness of fit for each model. High c-statistic values are

indicative of meaningful results and predictive value for the variables included (151). As the c-statistic increases or approaches 1.0, and the more likely models and variance within the analyses are explained not by random/chance and by the appropriate application of variables (151).

4.5.1 Cannabis ever use and binary mental health variables

For models 1-3, three binomial logistic regression models were conducted to assess if depression and/or anxiety was significantly associated with cannabis *ever use*. As well, I explored whether flourishing moderates cannabis use in students who indicate clinically relevant levels of depression and/or anxiety. I examined flourishing as a potential moderator within this association via 2-way and 3-way interactions. Independent and dependent variables were collapsed as dichotomous. All models controlled for student-level covariates (sex, grade, ethnicity, spending money, binge drinking and smoking).

4.5.1.1 Model 1

Model 1 explored how depression and anxiety (versus not) are associated with cannabis *ever use,* using a binomial logistic regression. This model analyzed depression and anxiety as dichotomous variables (0,1).

4.5.1.2 Model 2

Model 2 explored depression, anxiety and flourishing as the independent variables of interest and how they are associated with cannabis *ever use,* using a binomial logistic regression. Model 2 analyzed depression and anxiety as dichotomous variables.

4.5.1.3 Model 3

Model 3 explored 2-way and 3-way interactions (a total of 4 interaction terms) between depression, anxiety and flourishing, and how they are associated with cannabis *ever use,* using a binomial logistic regression. Model 3 analyzed depression and anxiety as dichotomous variables.

4.5.2 Cannabis ever use and continuous mental health variables

For models 4-6, three binomial logistic regression models were conducted to assess if depression and/or anxiety was significantly associated with cannabis *ever use*. As well, I explored flourishing as a potential moderator within this association via 2-way and 3-way interactions. Depression and anxiety was coded as continuous variables and cannabis *ever* use remained dichotomous. All models controlled for student-level covariates.

4.5.2.1 Model 4

Model 4 explored how subtle differences in the level of depression and anxiety will impact cannabis *ever use,* using a binomial logistic regression where depression (0-30) and anxiety (0-21) were continuous variables.

4.5.2.2 Model 5

Model 5 explored how subtle differences in students' level of depression, anxiety and flourishing will impact cannabis *ever use,* using a binomial logistic regression where depression and anxiety are continuous variables.

4.5.2.3 Model 6

Model 6 explored 2-way and 3-way interactions (a total of 4 interaction terms) between depression, anxiety and flourishing and how they are associated with cannabis *ever use,* using a binomial logistic regression. I fit depression and anxiety as both continuous variables.

4.5.3 Frequency of cannabis use and binary mental health variables

For models 7-9, three ordinal logistic regression models were conducted to assess if depression and/or anxiety was significantly associated with the frequency of cannabis use. Depression and anxiety were collapsed into dichotomous variables (0,1) and cannabis use frequency was coded as an ordinal variable (0,1,2,3,4). Models controlled for student-level covariates (sex, grade, ethnicity, spending money, binge drinking and smoking).

4.5.3.1 Model 7

An ordinal regression was fit for model 7, exploring the association between depression and anxiety, and cannabis use frequency. Model 7 analyzed depression and anxiety as a dichotomous variables.

4.5.3.2 Model 8

Model 8 explored depression, anxiety and flourishing as the independent variables of interest and how they were associated with the frequency of cannabis use, using an ordinal logistic regression. Model 8 analyzed depression and anxiety as dichotomous variables.

4.5.3.3 Model 9

Model 9 explored 2-way and 3-way interactions (a total of 4 interaction terms) between depression, anxiety and flourishing and how they were associated with the frequency of cannabis use, using a binomial logistic regression. Model 9 analyzed depression and anxiety as dichotomous variables.

4.5.4 Frequency of cannabis use and continuous mental health variables

For models 10-12, three ordinal logistic regression models were conducted to assess if depression and/or anxiety was significantly associated with the frequency of cannabis use. Depression and anxiety were coded as continuous variables and cannabis use frequency as an ordinal variable (0,1,2,3,4). Models controlled for student-level covariates.

4.5.4.1 Model 10

Model 10 explored how subtle differences in the level of depression and anxiety will impact cannabis *ever use,* using a binomial logistic regression where depression (0-30) and anxiety (0-21) are continuous variables

4.5.4.2 Model 11

Model 11 explored how subtle differences in students' level of depression, anxiety and flourishing will impact cannabis use frequency, using a binomial logistic regression where depression and anxiety are continuous variables.

4.5.4.3 Model 12

Model 12 explored 2-way and 3-way interactions (a total of 4 interaction terms) between depression, anxiety and flourishing and how they are associated with cannabis use frequency, using an ordinal logistic regression. I fit both depression and anxiety as continuous variables.

SECTION 5: Results

5.1 Demographic Characteristics

In the large sample of youth, I identified that among grade 9-12 students, 33% of students reported ever using cannabis, and 7% were daily users. Clinically relevant symptoms of depression and anxiety (scores >/= 10) were reported by 51% and 38% of students, respectively, and showed increased prevalence in older grades. Co-occurring mental illness was common, as 86% of students who reported depression also reported having anxiety. The mean flourishing score was 16.6 (SD 5.87) and declined with grade level, suggesting that languishing may increase by grade. The majority of the sample reported their ethnicity as White (71.0%), and 50.8% of the sample reported their sex as female.

5.1.1 Descriptive statistics by sex difference

As shown in Table 1, females cannabis users were more likely to report sporadic use (18.0% versus 14.9%) and monthly use (7.7% versus 6.7%), while male cannabis users were more likely to report being weekly (4.2% versus 3.0%), habitual (2.6% versus 4.4%) or daily (4.3% versus 2.6%) cannabis users. Additionally, females more commonly reported depression (58.9%), anxiety (47.7%) and lower flourishing levels (mean 17.02) compared to males. Although still considerably high, males were less likely to report symptoms of depression (42.9%) and anxiety (28.1%), and indicated a better flourishing score average (mean 16.0 (SD 5.7)) compared to their female counterparts (mean 17.2 (SD 5.97)). Females were more likely to report higher levels of truancy (having skipped 1 or more classes in the last 4 weeks) (41.7%) compared to males (38.8%). Males more commonly indicated a weekly spending allowance of either $0 or >$100 per week. There was no significant difference between males and females in cannabis ever use, smoking status, or binge drinking.

5.1.2 Descriptive statistics by Depression

As shown in table 2, females more commonly reported symptoms of depression (58.6%) compared to males (41.4%). Depression was more common in all grade levels other than grade 9 (25.7% reported depression versus 30.2% reported no depression). Grade 10 students reported highest levels of depression (29.9%) and decreased in grade 11 (25.9%) and grade 12 (18.8%). Of the students who indicated having depression, majority reported being White (69.7%), skipping one or more classes a week (47.0%), smoking (14.5%), binge drinking (41.4%) and having anxiety (63.8%). Compared to those who reported no depression, students with depression also had lower flourishing (mean 19.14 [SD 6.09] versus mean 14.19 [SD 4.46]). Depression was significantly associated with cannabis ever use and all levels of cannabis use frequency. Students who met the criteria for depression were more likely to be cannabis ever

users (38.9% versus 25.9%) and report daily use (4.9% versus 1.9%), habitual use (2.5% versus 1.1%), weekly use (4.5% versus 2.7%), monthly use (8.8% versus 5.6%) and sporadic use (18.3% versus 14.6%).

5.1.3 Descriptive statistics by Anxiety

As shown in table 3, clinically relevant symptoms of anxiety (referred to as anxiety) was more prevalent in females (63.7%) compared to males (36.3%). Anxiety was more common in all grade levels other than grade 9 (25.7% reported anxiety versus 30.2% reported no anxiety), whereby grade 10 students reported highest levels of anxiety (29.7%) and decreased in grade 11 (25.7%) and grade 12 (18.9%). Of the students who indicated having anxiety, majority reported being White (70.7%), skipping one or more classes (46.4%), smoking (15.1%), binge drinking (41.6%) and having depression (85.6%). Students who reported anxiety had lower flourishing (mean 19.53 [SD 6.38]) compared to students who did not met the criteria for anxiety (mean 14.99 [SD 4.84]). Students who met the criteria for anxiety were more commonly cannabis ever users (39.4% versus 28.3%) as well as, daily users (5.4% versus 2.2%), habitual users (2.4% versus 1.5%), weekly users (4.4% versus 3.2%), monthly users (9.1% versus 6.1%) and sporadic users (18.2% versus 15.4%).

5.1.4 Descriptive statistics by Cannabis Ever Use

As shown in Table 4, prevalence of cannabis ever use increased with grade. Reported cannabis ever use was lowest among grade 9 students (14.4%), and the prevalence nearly doubled in grade 10 students. Significantly large differences in smoking status, binge drinking, depression, and anxiety were reported between never users and ever users of cannabis. Compared to students who indicated never using cannabis, cannabis ever users were more likely to report smoking (29.4% versus 1.8%), binge drinking (75.5% versus 18.1%), symptoms of depression (61.0% versus 46.2%) and anxiety (46.1% versus 34.1%), as well as lower flourishing (mean 17.9 [SD 6.29] versus mean 16.0 [SD 5.55]). Moreover, cannabis users typically had higher weekly spending allowances and were more likely to report having skipped 1 or more classes a week (68.66% versus 26.59%). There were no significant differences by sex and provinces for cannabis ever use.

5.1.5 Descriptive statistics by Frequency of Cannabis Use

As shown in Table 5, frequency of reported cannabis use was found to typically increase with grade. Across cannabis use frequencies, the greatest jump in reported use occurred in grade 10 students with prevalence rates nearly doubled for all frequencies between grade 9 and 10. Prevalence of more frequent use continued to increase in grade 11 students and plateaued in grade 12. As frequency of reported cannabis use increased, students were at a greater risk for smoking and binge drinking, as well as

having poorer mental health outcomes. Compared to sporadic cannabis users, habitual users more commonly reported smoking (15.0% versus 58.2%), binge drinking (67.5% versus 85.7%), being depressed (56.5% versus 69.4%) and anxious (42.0% versus 49.0%) and lower flourishing (mean (17.2) versus mean (19.4)). Daily users of cannabis were the most likely to smoke (65.9%), binge drink (87.3%), report feelings of depression (72.9%) and anxiety (60.44%) and have the lowest mean flourishing score (20.8). I used an AVONA to measure significant differences between flourishing means for each level of cannabis use frequency. The normalcy of distribution was unclear, and therefore, both parametric and nonparametric tests were fit for further exploration. Both the ANOVA and Kruskal-Wallis test demonstrated statically significant differences in the means; ANOVA results were reported due to the test being more conventional in comparison (see Appendix E for additional analysis). As frequency of reported cannabis use increased, students were more likely to report being male, truancy and have greater spending allowances.

5.2 Main effects and interactions

The main effects and interactions were modeled using a stepwise approach. Models 1, 4, 7 and 10 demonstrate the main effects of depression and anxiety, while models 2, 5, 8 and 11 were the same models inclusive of flourishing. Models 3, 6, 9 and 12 were the comprehensive models that included all interaction terms (i.e., the results of the main objectives). For all comprehensive models, flourishing was the only variable associated with cannabis ever use and frequency of use. After removing the 3-way interaction from the binary model, there were no changes in significance for the 2-way interactions. However, after removing flourishing as a main effect, I observed many changes in significance, whereby majority of the interactions had a significant effect confirming the expectation of flourishing as a third variable of interest (see Appendix E for additional analysis).

5.2.1 Cannabis Ever Use with Binary Mental Health Outcomes (Models 1-3)

The results of the stepwise models exploring cannabis ever use with binary mental health outcomes are presented in Table 6. The results for model 3 (comprehensive model) identified that for every one-unit increase on the flourishing scale (recall that higher scores reflect languishing), the likelihood of cannabis ever use significantly increases (B=0.040, SE=0.012). Although depression was found to be significant associated with cannabis ever use (B=0.281, SE=0.078) in model 1, after including flourishing in model 2 and 3, neither depression nor anxiety was significantly associated with cannabis ever use. This result was also observed for all 2-way and 3-way interactions included in model 3. Of the covariates included in model 3, absenteeism (OR=2.61), smoking (OR=9.83) and binge drinking

(OR=7.34) were found to be strong risk factors for cannabis ever use. Model 3 yielded a strong c-statistic (0.881), suggesting this is a good model.

5.2.2 Cannabis Ever use with Continuous Mental Health Outcomes (Models 4-6)

Table 7 presents the results of the stepwise models exploring cannabis ever use with continuous mental health outcomes. The results for model 6 (comprehensive model) demonstrates that for every unit increase on the flourishing scale, the likelihood of cannabis ever use significantly increases (B=0.048, SE=0.009). Depression and anxiety were not found to significantly predicted cannabis ever use. This was also observed for all 2-way and 3-way interactions included in model 6. Of the covariates included in model 6, absenteeism (OR=2.64), smoking (OR=10.07) and binge drinking (OR=7.33) were found to be strong risk factors for cannabis ever use. The c-statistic for model 6 was 0.881, demonstrating that the model is a good fit.

5.2.3 Frequency of Cannabis Use with Binary Mental Health Outcomes (Models 7-9)

Results for the stepwise models examining the frequency of cannabis use with binary mental health outcomes are shown in Table 8. The results of model 9 (comprehensive model) identified that every one-unit increase in languishing was significantly associated with an increase in the frequency of cannabis use (B=0.042, SE=0.010). While depression (B=0.286, SE=0.068) and anxiety (B=0.239, SE=0.068) were found to be significantly associated with the frequency of cannabis use in model 7, neither significantly predicted cannabis use after including flourishing in models 8 and 9. This was also observed for all 2-way and 3-way interactions included in model 9. Of the covariates included in model 9, absenteeism (OR=2.44), smoking (OR=7.32) and binge drinking (OR=6.94) were found to be strong risk factors for the frequency of cannabis use. Model 9 yielded a strong c-statistic (0.854), indicating much of the variance is explained and that the model was a good fit.

5.2.4 Frequency of Cannabis Use with Continuous Mental Health Outcomes (Models 10-12)

Table 9 presents the results of the stepwise models exploring the frequency of cannabis use with continuous mental health outcomes. The results for model 12 (comprehensive model) demonstrates that for every unit increase on the Flourishing Scale, the likelihood of cannabis ever use significantly increases (B=0.0513, SE=0.008). Similar to results from previous models, depression (B=0.002, SE=0.004) and anxiety (B=-0.001, SE=0.0061) was not associated with the frequency of cannabis use after including flourishing in the model and this was also observed for all 2-way and 3-way interactions included in model 12. Absenteeism (OR=2.46), smoking (OR=7.43) and binge drinking (OR=6.98) were found to be

strong risk factors for cannabis use frequency in model 12. The c-statistic for model 12 was 0.853, demonstrating that the model is a good fit.

SECTION 6: DISCUSSION

The legalization of recreational cannabis use in Canada is expected to be implemented in late 2018. Given these new regulations, there is a demand for research to identify at-risk populations and implement effective prevention programs to mitigate possible health consequences that may accompany the new legislation as mentioned previously. This study examined the association between mental health problems and cannabis use within high school students in Ontario and British Columbia, Canada. To the best of my knowledge, this thesis is the first study of its kind to evaluate indicators of mental wellbeing, such as flourishing, as a protective measure against cannabis use in youth with mental health problems. Overall, both cannabis use and mental health problems were found to be very common among youth in this thesis. Furthermore, these results suggest that higher flourishing is associated with lower cannabis use regardless of the presence or absence of mental health problems. The results of this study fill a knowledge gap within research, practice, and clinical domains, and may also present significant implications for innovative and universal prevention approaches to youth substance use.

6.1 Cannabis use and mental health problems in Canadian youth

Youth mental health problems and cannabis use are both highly prevalent and multifaceted public health issues. Half of the students in this pilot study scored above the accepted clinical threshold for symptoms of depression, and over one third for anxiety. Results indicated that depression, anxiety, and languishing all increased with grade level. As expected and consistent with previous research, students indicating symptoms of depression and anxiety were less likely to flourish, and females were more likely to experience symptoms of depression and anxiety than males (84). Additionally, this study identified that females tend to have lower levels of flourishing than males (84). Also consistent with previous research, this study found that males used cannabis at higher frequencies (e.g., weekly and daily) than females (152–156). Co-occurring depression and anxiety are highly prevalent in adolescent substance users, whereby use is typically more severe and problematic (157–160). Research shows that young drug users with mental health problems typically have greater morbidity related to mental illness and substance use as well as poorer quality of life compared to individuals with substance use problems exclusively (157). These findings demonstrate similar results, as the majority of youth (over three quarters) with depression also reported co-occurring anxiety. Moreover, cannabis use frequency was greater in individuals with co-occurring depression and anxiety. Interestingly, sex or provincial differences for cannabis ever use were not observed.

One third of the students in this sample had tried cannabis at least once and nearly 10% indicated using cannabis at least once a week. These findings align with other research (54,161) that suggests adolescence is the peak age for cannabis uptake, there was a significant increase in cannabis ever use observed between grade 9 and grade 12, and that older students used cannabis at higher frequencies. Depression and anxiety were also found to increase with grade. More specifically, this research identified the largest increase in depression, anxiety and cannabis use within grade 10 students. These high risk periods are important to take into account when developing prevention or intervention programs as individuals are impressionable and receptive to their environment (162). The findings presented in this thesis are consistent with other studies that have identified approximately one third of youth initiate cannabis use during adolescence (163), and further research shows that these individuals are at higher risk for developing a substance dependence than those initiating cannabis use later in life (164–166). The initiation of substance use early in life has been shown commonly to increase later in life and is associated with negative health, social and behavioural consequences (167). This suggests that the critical period for development of health behaviours and targeted interventions and prevention strategies might consider targeting students before grade 10, prior to initial cannabis uptake, to maximize resistance (168).

6.2 Correlates of cannabis use in Canadian youth

Consistent with both cross sectional and longitudinal research, this thesis found that youth who use cannabis were substantially more likely to engage in alcohol and tobacco use (169–171). On average, cannabis users were approximately 10 times more likely to smoke and 7 times more likely to binge drink. The frequency of cannabis use was directly related to tobacco smoking and binge drinking, with daily cannabis users being most likely to smoke and/or binge drink than all other cannabis users. My findings demonstrate a very strong correlation between these behaviours and suggest that risk-seeking behaviours might cluster. The strongest association of risky health behaviour clustering has been demonstrated in adolescent substance use literature (172), highlighting that these behaviours typically serve the same social and psychological function such as achieving adult status and acceptance from peers (173). Further, research has shown that risk behaviours cluster due to being from the same manifestation of related factors and is commonly a result of exposure to, and perception of various biological, individual, and environmental domains (173,174). A greater propensity for risk-seeking behaviours has been more commonly identified in males than in females (2,27,77,114), and it is therefore notable that no sex differences were found for binge drinking or smoking.

6.3 Flourishing as a significant third variable

This research found that mental wellbeing was strongly associated with mental health problems and cannabis use. These findings are particularly novel, as they demonstrate that flourishing might mitigate potential negative associations between mental health problems and youth cannabis use. Results from this study demonstrate that students with high flourishing, regardless of mental health problems were less likely to use cannabis. Accordingly, languishing was found to be the strongest risk factor for cannabis use, outweighing even the influence of depression and anxiety. While most evidence suggests that there is a link between depression, anxiety, and cannabis use (5,33,51,129), the connection with flourishing/languishing has not been previously been established in the literature. And while mental health problems were found to be significantly correlated with cannabis use in some of my analyses, the stepwise modeling approach illustrated that these associations were no longer significant after including flourishing in the models. This suggests that flourishing may attenuate the effects of depression and anxiety on cannabis use, as previously demonstrated in the literature. Moreover, these results suggest that higher flourishing may result in lower cannabis use regardless of symptoms of depression or anxiety.

6.4 Implications for Research

Results suggest that flourishing may act as a dominant confounding variable in the association between depression, anxiety, and cannabis use. I am unaware of any research that has controlled for mental wellbeing when exploring this association, and therefore, available evidence may not represent accurate findings between cannabis use and depression and anxiety. Lastly, future longitudinal research is required to inform the temporal sequence and the direction of effect between mental health and cannabis use.

6.4.1 Differential Susceptibility Framework

The differential susceptibility model was used to assess how individuals differ in their response or sensitivity to exposed environments (175,176). This framework was used as a theoretical framework to help guide my study design, examining both positive and negative affect in cannabis use patterns. Using depression and anxiety as measures of vulnerability and flourishing as a stress factor, my data did not support the differential susceptibility framework as there were no interactions (2-way or 3-way) observed between mental health problems, flourishing and cannabis use.

6.4.2 Confounding effects of flourishing

There were no associations or interactions found between mental health problems and cannabis use, contrary to previous research. I hypothesized there would be an association between mental health problems and cannabis use and for this to be moderated by flourishing. However, since there were no significant interactions identified in the analyses, my hypotheses were not supported. A moderator is a third variable that affects the association between the dependent and independent variables (150), and is typically observed as an interaction between the variables included within the analysis (150). As there were no significant interactions identified in my analysis, I concluded that flourishing is not a moderator. In support of this finding, flourishing was found to have a significant effect on both depression and anxiety (independent variables) as well as cannabis use (dependent variable), which is typical of a confounding variable. As such, flourishing would not be considered a moderator in this study, rather a major confounder given its influence on both the exposure and outcome variables and not solely the correlation between them (see appendix B for a pathway illustration of both moderating and confounding variables).

Although this study was the first to explore the association between mental health and substance use while controlling for flourishing, positive wellbeing has been identified as an important variable in the prevention of substance use. For example, flourishing and other constructs of positive mental health have been recognized by global research centers, such as the Centre for Addiction and Mental Health (177) and the Mental Health Commission of Canada (178) as important individual protective factors against youth substance use. Current research on cannabis use and mental health may not represent accurate findings as flourishing or other indicators have not been previously controlled for, and as such, should consider replicating previous studies within this domain if measures are available. Future research and large scale epidemiological studies should aim to measure and control for indicators of positive mental health and test for confounding effects in other substance use research including alcohol and tobacco given its highly influential effects observed in the results of this thesis.

6.4.3 Longitudinal analysis

While this study identified a cross-sectional association, future studies should explore the casual relationship between mental health problems and cannabis use, as well as the role of flourishing over time. As demonstrated in this study and by other research, co-occurring mental health problems and

substance use disorders are highly prevalent (157,158), however, the direction of effect is not well understood. There would be great value in having a clear understanding of the causal relationship between cannabis use and mental health problems and future longitudinal work may want to consider using path analyses, such as a cross-lag panel modeling, to identify the sequential relationship if one exists as well as the possible direction of effect. This is now possible with COMPASS, which has incorporated the MH-M in all wave 6 (Y_6[2017-2018]) data collections. Future longitudinal research might also explore the effect of flourishing on other substance use domains including tobacco and alcohol. As cannabis use has been found to increase with age (2,114), following youth into young adulthood would also provide valuable insight for prevention and intervention programs that are targeted at an older population, such as university and college students.

The gateway hypothesis describes the theory that adolescents initial engagement with tobacco, alcohol, and cannabis, could lead to experimentation with more addictive illicit drugs over time (179). Studies exploring this theory have demonstrated mixed and inconclusive results (7,180–182). COMPASS provides an ideal platform to evaluate the gateway hypothesis, and identify potential gateway substances or individual constructs (e.g., socio-emotional skills, self-regulation, and impulse control) that may be related to the proposed gateway effect. On account of the impending legalization of cannabis, Canada is currently undergoing a natural experiment at the national level, and as such, there is a demand for research focused on youth cannabis use. Evidence within this domain is currently limited and research platforms that have collected longitudinal data pre- and post-legalization of cannabis will be paramount in evaluating the resulting advantages and consequences. In addition to this nation-wide experiment, provinces have adopted their own set of guidelines to supplement federal requirements allowing for evaluation of cross-provincial and national comparisons of cannabis prevalence and effective laws and policies. This research will be important to assess various approaches and make decisions on best practice and public health safety standards by evaluating lowest risk use.

6.5 Implications for Practice and Prevention

Flourishing was found to be protective against substance use for all youth regardless of depression or anxiety symptoms. Findings relating to flourishing are novel as overall wellbeing had a ubiquitous effect on preventing cannabis use regardless of mental health problems. These results compliment recent literature that highlights the importance of a universal approach for reducing cannabis use in a youth population (183–185). Research has demonstrated that traditional interventions promoting

abstinence from substance use are not effective (186,187). Instead, research should focus on prevention programs that do not inherently target substance use, rather upstream protective factors such as flourishing and resilience, that contribute to overall wellbeing. Researchers expect cannabis uptake in Canadian youth to initially increase, following a similar trajectory to what has been observed in other jurisdictions (e.g. Colorado, Washington State) that have legalized cannabis (2–4), and as such, further examination of how flourishing is related to substance use trajectories will produce valuable prevention planning insight moving forward.

6.5.1 Universal programs and school-based prevention strategies

Universal prevention strategies are designed to be implemented at the population-level, providing the necessary knowledge and skills to prevent negative health behaviours, instead of targeting individual risk factors. These findings suggest that a universal approach to fostering mental wellbeing and building resilience among all youth should be a leading priority, and may be more effective at reducing substance use than intervention strategies targeting individuals with mental illness. This is consistent with other research domains showing that population-level programs supporting the development of life skills and psychosocial attributes, have been found to be highly effective at reducing substance use (186,188,189). Elementary and secondary schools might be one such environment to support the development of these skills and have the potential to reach majority of youth, as this is where more than half of their waking hours are spent. These strategies have the potential to reach the majority of youth and alter the school environment, which has previously been identified as an important setting to modify substance use behaviours (190) and promote overall wellbeing among youth (191). Positive school experiences including rewarding relationships with teachers and academic engagement have been linked to better mental health outcomes (191). Positive school experiences have even been found to improve mental health among students exposed to maltreatment in childhood (191).

A systematic review of universal, school-based substance use interventions demonstrated that intervention type, approach, and setting, are important for long-term results (188). Interventions were most effective when addressing resilient-protective factors as part of a multidimensional intervention approach that targeted broader individual resilience factors such as, social, emotional and cognitive competencies, self-efficacy and regulation, academic achievement. This study also identified environmental resilience factors (e.g., school connectedness, community participation and support, parent support and involvement) to be very effective at reducing substance use (188). The same long-term

effects were seen in universal-only approaches as well as interventions that were implemented within a school setting, illustrating the importance of using the school environment as a platform for these programs (188). One study assigned a community-based, universal drug prevention strategy to randomly selected public schools in Iowa and Pennsylvania, U.S.A (192). The study implemented family-focused interventions within grade 6 and 7 classrooms that focused on developing peer-resistance, self-management, and social skills, preventing social influence and strengthening family dynamics. The community-based intervention demonstrated long-term effects on both the initiation and past –year use of cannabis and intervention effects were stronger for high risk students (192). COMPASS has the unique ability to identify naturally occurring student health behaviours and environmental changes over time, and allows for the implementation of school-based intervention programs targeting these issues. This research system provides the capacity to implement evidence-based universal programs at the school-level with the opportunity to evaluate.

6.5.2 Clinical-based implications

These results demonstrate the importance of fostering good mental wellbeing to mitigate the use and misuse of cannabis in secondary school students. There would be great value in replicating this study on other substance use outcomes, and using clinical-based data that uses true diagnostic criteria for mental disorders. This type of research could help inform clinical approaches that may be effective when considering individual and personality targeted interventions. Personality-targeted interventions that include a personality assessment to determine substance use risk factors, allow for tailored intervention strategies that correspond to specific traits and have been effective at reducing cannabis use within high-risk adolescents (193). A study conducted in UK secondary schools found that targeted-interventions that provide personality-specific coping skills resulted in significant reductions of cannabis use among high-risk youth after a 2-year follow-up (193). Prevention-intervention approaches used within this study included sessions that promoted positive coping behaviours and goal-setting, as well as evaluating cognitive-behavioural components. Because of the resources and training that were required for school staff, this approach may be more appropriately implemented at the clinical level. Research should continue to reference previous studies that have explored domains similar to flourishing such as resilience, coping, and other domains of psychosocial wellbeing to inform future substance use prevention strategies.

SECTION 7: STRENGTHS AND LIMITATIONS

It is important to note that this study is not without limitations. First, my results were cross-sectional, and as such, causality and temporality cannot be inferred. However, given the nature of the pilot study, an initial cross-sectional analysis was necessary to understand the prevalence of mental health problems and provide direction for future longitudinal studies using data from the COMPASS MH-M. COMPASS uses a convenience sample and was therefore not designed to be nationally representative. While the collected data may not be generalizable to all youth, sufficient sample size and power was provided to detect a correlation.

All measures included in the analyses were self-reported and are subject to social desirability bias and recall bias. It is possible that students will be erroneous when recalling past-year cannabis use frequency and may under-or over-report their cannabis use as accuracy depends on their ability to remember past use (194). Additionally, evidence suggests that self-reported depressive symptoms, mental health problems and substance use behaviours can be underreported if participants are influenced by stigma and social desirability (195). These biases mentioned could lead to potential misclassification of both the exposure and outcome, therefore underestimating the association between depression, anxiety, flourishing and cannabis use in youth. Another limitation is that of missing data, which might be due to students' discomfort reporting mental health problems or cannabis use. By employing a complete-case analysis, the results could underestimate the true association, as unreported or missing data may be more likely among students with mental health problems and those who use cannabis. To account for biases that accompany self-reported measures, COMPASS ensures confidentiality of data through anonymized student surveys and utilizes a passive consent protocol to reduce the effects of information bias (social desirability and recall bias) and missing data.

While self-reported data does come with limitations, mental health (146,147) and cannabis use measures included in the analyses are consistent with previously validated self-reported measure among youth and measures used in national survey systems such as the Youth Smoking Survey (YSS) (136). It is important to note that mental health data were measured using scales and not diagnostic criteria. It is expected that the scales used to measure symptoms of mental health problems (CES-D-10 and GAD-7) will yield higher results than what exists within the general population. Despite this, research has

demonstrated that the mode of data collection is important for collecting reliable and unbiased data; self-administered surveys or checklists typically produce valuable and truthful results when compared to telephone surveys or face-to-face interviews where participant may account for social norms and responses reflect more socially desirable answers (196). Moreover, self-administered surveys are necessary for large school-based studies and research platforms such as COMPASS as diagnostic interviews are not feasible at this scale.

SECTION 8: CONCLUSIONS

Youth mental health and cannabis use are leading public health concerns in Canada, especially given the impending legalization of cannabis. Researchers expect cannabis uptake in Canadian youth to increase, following a similar trend to what has been observed in other countries and states that have legalized cannabis use. This study supplements what is known about cannabis use in adolescents, as it was found to be highly prevalent and increased with age, consistent with previous research. Despite existing evidence that has demonstrated a relationship between mental health problems and cannabis use, there were no significant correlations between depression, anxiety and cannabis use found within this large sample of youth. Indicators of mental wellbeing, such as flourishing, appear to be associated with a lower likelihood of cannabis use, even after controlling for depression and anxiety. A greater understanding of the context in which cannabis uptake develops will help inform future research, policies and programs that can effectively reduce or prevent substance use in youth. Prevention strategies for youth cannabis use should aim to foster mental wellbeing among all youth, rather than exclusively targeting those experiencing mental health problems, and the school environment offers an important setting with large breadth to intervene. If available, future analyses might consider including additional measures such as parental factors (e.g., parent education, support and involvement), other risk seeking behaviours (e.g., gambling) and sexual health, as well as exploring this relationship over time. Future longitudinal studies should test the sequential relationship between cannabis use and mental health and explore how flourishing is related to different substance use trajectories, in order to better inform future policy and prevention programs. The relationship between mental health problems and cannabis use is not well understood and employing methods such as a cross-lag analysis may provide more context to the direction of causality. The COMPASS System provides an ideal platform to examine this relationship over time and allows researchers to evaluate the effectiveness of universal school-based substance use interventions within a Canadian context.

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APPENDIX A: COMPASS Student Questionnaire

About You

1. What grade are you in?

- ○ Grade 9
- ○ Grade 10
- ○ Grade 11
- ○ Grade 12

2. How old are you today?

- ○ 13 years or younger
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years or older

3. Are you female or male?

- ○ Female
- ○ Male

4. How would you describe yourself? *(Mark all that apply)*

- ○ White
- ○ Black
- ○ Asian
- ○ Aboriginal (First Nations, Métis, Inuit)
- ○ Latin American/Hispanic
- ○ Other _____

5. About how much money do you usually get each week to spend on yourself or to save?
(Remember to include all money from allowances and jobs like baby-sitting, delivering papers, etc.)

- ○ Zero
- ○ $1 to $5
- ○ $6 to $10
- ○ $11 to $20
- ○ $21 to $40
- ○ $41 to $100
- ○ More than $100
- ○ I do not know how much money I get each week

6. How do you usually travel to and from school? *(If you use two or more modes of travel, choose the one that you spend most time doing)*

To school	From school
○ By car (as a passenger)	○ By car (as a passenger)
○ By car (as a driver)	○ By car (as a driver)
○ By school bus	○ By school bus
○ By public bus, subway, or streetcar	○ By public bus, subway, or streetcar
○ By walking	○ By walking
○ By bicycling	○ By bicycling
○ Other_____	○ Other_____

7. Did you attend this school last year?

- ○ Yes, I attended the same school last year
- ○ No, I was at another school last year

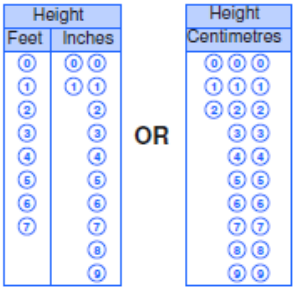
8. How tall are you without your shoes on? (Please write your height in feet and inches **OR** in centimetres, and then fill in the appropriate numbers for your height.)

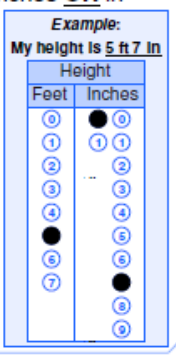
○ I do not know how tall I am

"My height is ____feet, _____inches"

OR

"My height is _____ centimetres"





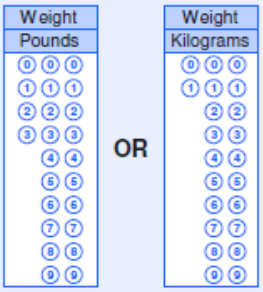
9. How much do you weigh without your shoes on? (Please write your weight in pounds **OR** in kilograms, and then fill in the appropriate numbers for your weight.)

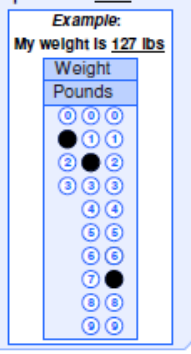
○ I do not know how much I weigh

"My weight is _____ pounds"

OR

"My weight is _____ kilograms"





10. How much time per day do you *usually* spend doing the following activities?

For example: If you spend about 3 hours watching TV each day, you will need to fill in the 3 hour circle, and the 0 minute circle as shown below:

a) Watching/streaming TV shows or movies — Hours ● Minutes ●

	Hours	Minutes
a) Watching/streaming TV shows or movies		
b) Playing video/computer games		
c) Doing homework		
d) Talking on the phone		
e) Surfing the internet		
f) Texting, messaging, emailing **(note: 50 texts = 30 minutes)**		
g) Sleeping		

○○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

Physical Activity

HARD physical activities include jogging, team sports, fast dancing, jump-rope, and any other physical activities that increase your heart rate and make you breathe hard and sweat.

MODERATE physical activities include lower intensity activities such as walking, biking to school, and recreational swimming.

11. Mark how many minutes of HARD physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time.

	Hours					Minutes			
	0	1	2	3	4	0	15	30	45
Monday	○	○	○	○	○	○	○	○	○
Tuesday	○	○	○	○	○	○	○	○	○
Wednesday	○	○	○	○	○	○	○	○	○
Thursday	○	○	○	○	○	○	○	○	○
Friday	○	○	○	○	○	○	○	○	○
Saturday	○	○	○	○	○	○	○	○	○
Sunday	○	○	○	○	○	○	○	○	○

For example: If you did 45 minutes of hard physical activity on Monday, you will need to fill in the 0 hour circle and the 45 minute circle, as shown below:

	Hours					Minutes			
	0	1	2	3	4	0	15	30	45
Monday	●	○	○	○	○	○	○	○	●

12. Mark how many minutes of MODERATE physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time. Do not include time spent doing hard physical activities.

	Hours					Minutes			
	0	1	2	3	4	0	15	30	45
Monday	○	○	○	○	○	○	○	○	○
Tuesday	○	○	○	○	○	○	○	○	○
Wednesday	○	○	○	○	○	○	○	○	○
Thursday	○	○	○	○	○	○	○	○	○
Friday	○	○	○	○	○	○	○	○	○
Saturday	○	○	○	○	○	○	○	○	○
Sunday	○	○	○	○	○	○	○	○	○

For example: If you did 1 hour and 30 minutes of moderate physical activity on Monday, you will need to fill in the 1 hour circle and the 30 minute circle, as shown below:

	Hours					Minutes			
	0	1	2	3	4	0	15	30	45
Monday	○	●	○	○	○	○	○	●	○

13. Were the last 7 days a typical week in terms of the amount of physical activity that you usually do?

- ○ Yes
- ○ No, I was *more* active in the last 7 days
- ○ No, I was *less* active in the last 7 days

14. Your closest friends are the friends you like to spend the most time with. How many of your closest friends are physically active?

- ○ None
- ○ 1 friend
- ○ 2 friends
- ○ 3 friends
- ○ 4 friends
- ○ 5 or more friends

15. Are you taking a physical education class at school this year?

- ○ **Yes**, I am taking one **this term**
- ○ **Yes**, I will be taking one or have taken one this school year, **but not this term**.
- ○ **No**, I am not taking a physical education class at school this year

16. Do you participate in before-school, noon hour, or after-school physical activities organized by your school? *(e.g., intramurals, non-competitive clubs)*

- ○ Yes
- ○ No
- ○ None offered at my school

17. Do you participate in competitive school sports teams that compete against other schools? *(e.g., junior varsity or varsity sports)*

- ○ Yes
- ○ No
- ○ None offered at my school

18. Do you participate in league or team sports outside of school?

- ○ Yes
- ○ No
- ○ There are none available where I live

19. On how many days in the last 7 days did you do exercises to strengthen or tone your muscles? *(e.g., push-ups, sit-ups, or weight-training)*

- ○ 0 days
- ○ 1 day
- ○ 2 days
- ○ 3 days
- ○ 4 days
- ○ 5 days
- ○ 6 days
- ○ 7 days

20. How do you describe your weight?

- ○ Very underweight
- ○ Slightly underweight
- ○ About the right weight
- ○ Slightly overweight
- ○ Very overweight

21. Which of the following are you trying to do about your weight?

- ○ **Lose** weight
- ○ **Gain** weight
- ○ **Stay** the same weight
- ○ I am **not trying to do anything** about my weight

22. How much do your parents, step-parents, or guardians encourage you to be physically active?

- ○ Strongly encourage
- ○ Encourage
- ○ Do not encourage or discourage
- ○ Discourage
- ○ Strongly discourage

23. How much do your parents, step-parents, or guardians support you in being physically active? *(e.g., driving you to team games, buying you sporting equipment)*

- ○ Very supportive
- ○ Supportive
- ○ Unsupportive
- ○ Very unsupportive

○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

Healthy Eating

24. If you do not eat breakfast every day, why do you skip breakfast? *(Mark all that apply)*

- ○ I eat breakfast every day
- ○ I don't have time for breakfast
- ○ The bus comes too early
- ○ I sleep in
- ○ I'm not hungry in the morning
- ○ I feel sick when I eat breakfast
- ○ I'm trying to lose weight
- ○ There is nothing to eat at home
- ○ Other _____

25. In a *usual* school week *(Monday to Friday)*, on how many days do you do the following?	None	1 day	2 days	3 days	4 days	5 days
a) Eat breakfast	○	○	○	○	○	○
b) Eat breakfast provided to you **as part of a school program**	○	○	○	○	○	○
c) Eat lunch at school - lunch packed and brought from home	○	○	○	○	○	○
d) Eat lunch at school - lunch purchased in the cafeteria	○	○	○	○	○	○
e) Eat lunch purchased at a fast food place or restaurant	○	○	○	○	○	○
f) Eat snacks purchased from a vending machine **in your school**	○	○	○	○	○	○
g) Eat snacks purchased from a vending machine, corner store, snack bar, or canteen **off school property**	○	○	○	○	○	○
h) Drink sugar-sweetened beverages (soda pop, Kool-Aid, Gatorade, etc.) Do not include diet/sugar-free drinks	○	○	○	○	○	○
i) Drink high-energy drinks (Red Bull, Monster, Rock Star, etc.)	○	○	○	○	○	○
j) Drink coffee or tea **with sugar** (include cappuccino, frappuccino, iced-tea, iced-coffees, etc.)	○	○	○	○	○	○
k) Drink coffee or tea **without sugar**	○	○	○	○	○	○

26. On a *usual* weekend *(Saturday and Sunday)*, on how many days do you do the following?	None	1 day	2 days
a) Eat breakfast	○	○	○
b) Eat lunch	○	○	○
c) Eat foods purchased at a fast food place or restaurant	○	○	○
d) Eat snacks purchased from a vending machine, corner store, snack bar, or canteen	○	○	○
e) Drink sugar-sweetened beverages (soda pop, Kool-Aid, Gatorade, etc.) Do not include diet/sugar-free drinks	○	○	○
f) Drink high energy drinks (Red Bull, Monster, Rock Star, etc.)	○	○	○
g) Drink coffee or tea **with sugar** (include cappuccino, frappuccino, iced-tea, iced-coffees, etc.)	○	○	○
h) Drink coffee or tea **without sugar**	○	○	○

27. YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of meats and alternatives did you have? *One 'Food Guide' serving of meat and alternatives includes cooked fish, chicken, beef, pork, or game meat, eggs, nuts or seeds, peanut butter or nut butters, legumes (beans), and tofu.*

- ○ None
- ○ 1 serving
- ○ 2 servings
- ○ 3 servings
- ○ 4 servings
- ○ 5 or more servings

***Canada's Food Guide* Serving Sizes of Meats and Alternatives**

28. YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of vegetables and fruits did you have? *One 'Food Guide' serving of vegetables and fruit includes pieces of fresh vegetable or fruit, salad or raw leafy greens, cooked leafy green vegetables, dried or canned or frozen fruit, and 100% fruit or vegetable juice.*

- ○ None
- ○ 1 serving
- ○ 2 servings
- ○ 3 servings
- ○ 4 servings
- ○ 5 servings
- ○ 6 servings
- ○ 7 servings
- ○ 8 servings
- ○ 9 or more servings

***Canada's Food Guide* Serving Sizes of Vegetables and Fruits**

29. YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of milk and alternatives did you have? *One 'Food Guide' serving of milk or milk alternatives includes milk, fortified soy beverage, reconstituted powdered milk, canned (evaporated) milk, yogurt or kefir (another type of cultured milk product), and cheese.*

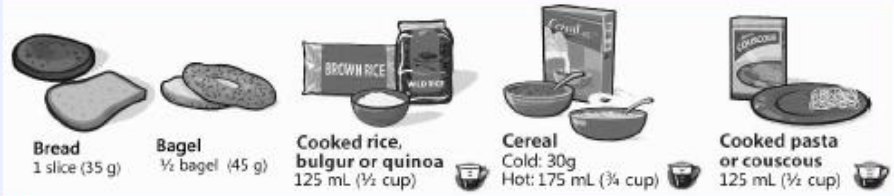
- ○ None
- ○ 1 serving
- ○ 2 servings
- ○ 3 servings
- ○ 4 servings
- ○ 5 servings
- ○ 6 or more servings

***Canada's Food Guide* Serving Sizes of Milk and Alternatives**

30. YESTERDAY, *from the time you woke up until the time you went to bed*, how many servings of grain products did you have? *One 'Food Guide' serving of grain products includes bread, bagels, flatbread such as tortilla, pita, cooked rice or pasta, and cold cereal.*

- ○ None
- ○ 1 serving
- ○ 2 servings
- ○ 3 servings
- ○ 4 servings
- ○ 5 servings
- ○ 6 servings
- ○ 7 servings
- ○ 8 servings
- ○ 9 or more servings

***Canada's Food Guide* Serving Sizes of Grain Products**



Food photos source: Canada's Food Guide, Health Canada, 2011. Reproduced with the permission of the Minister of Health, 2011.

Your Experience with Smoking

31. Have you ever tried cigarette smoking, even just a few puffs?

- ○ Yes
- ○ No

32. How old were you when you first tried smoking cigarettes, even just a few puffs?

- ○ I have never done this
- ○ I do not know

- ○ 8 years or younger
- ○ 9 years
- ○ 10 years
- ○ 11 years
- ○ 12 years
- ○ 13 years
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years or older

33. Do you think in the future you might try smoking cigarettes?

- ○ Definitely yes
- ○ Probably yes
- ○ Probably not
- ○ Definitely not

34. If one of your best friends were to offer you a cigarette, would you smoke it?

- ○ Definitely yes
- ○ Probably yes
- ○ Probably not
- ○ Definitely not

35. At any time during the next year do you think you will smoke a cigarette?

- ○ Definitely yes
- ○ Probably yes
- ○ Probably not
- ○ Definitely not

36. Do you think it would be difficult or easy for you to get cigarettes if you wanted to smoke?

- ○ Difficult
- ○ Easy
- ○ I do not know

37. Have you ever smoked a whole cigarette?

- ○ Yes
- ○ No

38. Have you ever smoked 100 or more whole cigarettes in your life?

- ○ Yes
- ○ No

○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

39. Have you ever smoked every day for at least 7 days in a row?

- ○ Yes
- ○ No

40. On how many of the last 30 days did you smoke one or more cigarettes?

- ○ None
- ○ 1 day
- ○ 2 to 3 days
- ○ 4 to 5 days
- ○ 6 to 10 days
- ○ 11 to 20 days
- ○ 21 to 29 days
- ○ 30 days *(every day)*

41. Thinking back over the last 30 days, on the days that you smoked, how many cigarettes did you usually smoke each day?

- ○ None
- ○ A few puffs to one whole cigarette
- ○ 2 to 3 cigarettes
- ○ 4 to 5 cigarettes
- ○ 6 to 10 cigarettes
- ○ 11 to 20 cigarettes
- ○ 21 to 29 cigarettes
- ○ 30 or more cigarettes

42. Your closest friends are the friends you like to spend the most time with. How many of your closest friends smoke cigarettes?

- ○ None
- ○ 1 friend
- ○ 2 friends
- ○ 3 friends
- ○ 4 friends
- ○ 5 or more friends

43. Have you ever tried to quit smoking cigarettes?

- ○ I have never smoked
- ○ I have only smoked a few times
- ○ I have never tried to quit
- ○ I have tried to quit once
- ○ I have tried to quit 2 or 3 times
- ○ I have tried to quit 4 or 5 times
- ○ I have tried to quit 6 or more times

44. In the last 30 days, did you use any of the following? *(Mark all that apply)*

- ○ Pipe tobacco
- ○ Cigarillos or little cigars (*plain or flavoured*)
- ○ Cigars (not including cigarillos or little cigars, *plain or flavoured*)
- ○ Roll-your-own cigarettes (tobacco only)
- ○ Loose tobacco mixed with marijuana
- ○ E-cigarettes (electronic cigarettes that look like cigarettes/cigars, but produce vapour instead of smoke)
- ○ Smokeless tobacco (chewing tobacco, pinch, snuff, or snus)
- ○ Nicotine patches, nicotine gum, nicotine lozenges, or nicotine inhalers
- ○ Hookah (water-pipe) to smoke tobacco
- ○ Hookah (water-pipe) to smoke herbal sheesha/shisha
- ○ Blunt wraps (a sheet or tube made of tobacco used to roll cigarette tobacco)
- ○ I have not used any of these things in the last 30 days

Alcohol and Marijuana Use

*Please remember that we will keep your answers **completely confidential**.*

A DRINK means: 1 regular sized bottle, can, or draft of beer; 1 glass of wine; 1 bottle of cooler; 1 shot of liquor (rum, whiskey, etc); or 1 mixed drink (1 shot of liquor with pop, juice, energy drink).

45. In the last 12 months, how often did you have a drink of alcohol that was more than just a sip?

- ○ I have never drunk alcohol
- ○ I did not drink alcohol in the last 12 months
- ○ I have only had a sip of alcohol
- ○ Less than once a month
- ○ Once a month
- ○ 2 or 3 times a month
- ○ Once a week
- ○ 2 or 3 times a week
- ○ 4 to 6 times a week
- ○ Every day

46. How old were you when you first had a drink of alcohol that was more than just a sip?

- ○ I have never drunk alcohol
- ○ I have only had a sip of alcohol
- ○ I do not know

- ○ 8 years or younger
- ○ 9 years
- ○ 10 years
- ○ 11 years
- ○ 12 years
- ○ 13 years
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years or older

47. In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?

- ○ I have never done this
- ○ I did not have 5 or more drinks on one occasion in the last 12 months
- ○ Less than once a month
- ○ Once a month
- ○ 2 to 3 times a month
- ○ Once a week
- ○ 2 to 5 times a week
- ○ Daily or almost daily

48. In the last 12 months, have you had alcohol mixed or pre-mixed with an energy drink (such as Red Bull, Rock Star, Monster, or another brand)?

- ○ I have never done this
- ○ I did not do this in the last 12 months
- ○ Yes
- ○ I do not know

49. In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash)

- ○ I have never used marijuana
- ○ I have used marijuana but not in the last 12 months
- ○ Less than once a month
- ○ Once a month
- ○ 2 or 3 times a month
- ○ Once a week
- ○ 2 or 3 times a week
- ○ 4 to 6 times a week
- ○ Every day

50. How old were you when you first used marijuana or cannabis?

- ○ I have never used marijuana
- ○ I do not know

- ○ 8 years or younger
- ○ 9 years
- ○ 10 years
- ○ 11 years
- ○ 12 years
- ○ 13 years
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years or older

51. Do you think it would be difficult or easy for you to get marijuana if you wanted some?

- ○ Difficult
- ○ Easy
- ○ I do not know

○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

Your School and You

52. How strongly do you agree or disagree with each of the following statements?

	Strongly Agree	Agree	Disagree	Strongly Disagree
a) I feel close to people at my school.	○	○	○	○
b) I feel I am part of my school.	○	○	○	○
c) I am happy to be at my school.	○	○	○	○
d) I feel the teachers at my school treat me fairly.	○	○	○	○
e) I feel safe in my school.	○	○	○	○
f) Getting good grades is important to me.	○	○	○	○

53. In the last 30 days, in what ways were you bullied by other students? *(Mark all that apply)*

- ○ I have not been bullied in the last 30 days
- ○ Physical attacks (e.g., getting beaten up, pushed, or kicked)
- ○ Verbal attacks (e.g., getting teased, threatened, or having rumours spread about you)
- ○ Cyber-attacks (e.g., being sent mean text messages or having rumours spread about you on the internet)
- ○ Had someone steal from you or damage your things

54. In the last 30 days, how often have you been bullied by other students?

- ○ I have not been bullied by other students in the last 30 days
- ○ Less than once a week
- ○ About once a week
- ○ 2 or 3 times a week
- ○ Daily or almost daily

55. In the last 30 days, in what ways did you bully other students? *(Mark all that apply)*

- ○ I did not bully other students in the last 30 days
- ○ Physical attacks (e.g., beat up, pushed, or kicked them)
- ○ Verbal attacks (e.g., teased, threatened, or spread rumours about them)
- ○ Cyber-attacks (e.g., sent mean text messages or spread rumours about them on the internet)
- ○ Stole from them or damaged their things

56. In the last 30 days, how often have you taken part in bullying other students?

- ○ I did not bully other students in the last 30 days
- ○ Less than once a week
- ○ About once a week
- ○ 2 or 3 times a week
- ○ Daily or almost daily

57. How supportive is your school of the following?

	Very supportive	Supportive	Unsupportive	Very unsupportive
a) Making sure there are opportunities for students to be physically active	○	○	○	○
b) Making sure students have access to healthy foods and drinks	○	○	○	○
c) Making sure no one is bullied at school	○	○	○	○
d) Giving students the support they need to resist or quit tobacco	○	○	○	○
e) Giving students the support they need to resist or quit drugs and/or alcohol	○	○	○	○

58. What academic level was your current or most recent Math course?

- ○ Applied
- ○ Academic
- ○ Other _____

59. In your current or most recent Math course, what is your approximate overall mark?
(Think about last year if you have not taken math this year)

- ○ 90% - 100%
- ○ 80% - 89%
- ○ 70% - 79%
- ○ 60% - 69%
- ○ 55% - 59%
- ○ 50% - 54%
- ○ Less than 50%

60. In your current or most recent English course, what is your approximate overall mark?
(Think about last year if you have not taken English this year)

- ○ 90% - 100%
- ○ 80% - 89%
- ○ 70% - 79%
- ○ 60% - 69%
- ○ 55% - 59%
- ○ 50% - 54%
- ○ Less than 50%

61. What is the highest level of education you would like to get? *(Choose only one)*

- ○ Some high school or less
- ○ High school diploma or graduation equivalency
- ○ College/trade/vocational certificate
- ○ University Bachelor's degree
- ○ University Master's / PhD / law school / medical school / teachers' college degree
- ○ I don't know

62. What is the highest level of education you think you will get? *(Choose only one)*

- ○ Some high school or less
- ○ High school diploma or graduation equivalency
- ○ College/trade/vocational certificate
- ○ University Bachelor's degree
- ○ University Master's / PhD / law school / medical school / teachers' college degree
- ○ I don't know

63. In the last 4 weeks, how many days of school did you miss because of your health?

- ○ 0 days
- ○ 1 or 2 days
- ○ 3 to 5 days
- ○ 6 to 10 days
- ○ 11 or more days

64. In the last 4 weeks, how many classes did you skip when you were not supposed to?

- ○ 0 classes
- ○ 1 or 2 classes
- ○ 3 to 5 classes
- ○ 6 to 10 classes
- ○ 11 to 20 classes
- ○ More than 20 classes

65. How often do you go to class without your homework complete?

- ○ Never
- ○ Seldom
- ○ Often
- ○ Usually

○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

66. How would you rate your mental or emotional health?

- ○ Excellent
- ○ Very good
- ○ Good
- ○ Fair
- ○ Poor

67. How much do you agree or disagree with the following statements?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) I have a happy home life	○	○	○	○	○
b) My parents/guardians expect too much of me	○	○	○	○	○
c) I can talk about my problems with my family	○	○	○	○	○
d) I can talk about my problems with my friends	○	○	○	○	○

68. How much do you agree with the following statements?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) I lead a purposeful and meaningful life	○	○	○	○	○
b) My social relationships are supportive and rewarding	○	○	○	○	○
c) I am engaged and interested in my daily activities	○	○	○	○	○
d) I actively contribute to the happiness and well-being of others	○	○	○	○	○
e) I am competent and capable in the activities that are important to me	○	○	○	○	○
f) I am a good person and live a good life	○	○	○	○	○
g) I am optimistic about my future	○	○	○	○	○
h) People respect me	○	○	○	○	○

69. Choose the answer that best describes how you feel.	True	Mostly true	Sometimes true, sometimes false	Mostly false	False
a) In general, I like the way I am	○	○	○	○	○
b) Overall, I have a lot to be proud of	○	○	○	○	○
c) A lot of things about me are good	○	○	○	○	○
d) When I do something, I do it well	○	○	○	○	○
e) I like the way I look	○	○	○	○	○

70. If you had concerns regarding your mental health, are there any reasons why you wouldn't talk to an adult at school (e.g., a school social worker, child and youth worker, counsellor, psychologist, nurse, teacher, or other staff person)? *(Mark all that apply)*

- ○ I would have no problem talking to an adult at school about my mental health

- ○ Worried about what others would think of me (e.g., I'd be too embarrassed)
- ○ Lack of trust in these people - word would get out
- ○ Prefer to handle problems myself
- ○ Don't think these people would be able to help
- ○ Wouldn't know who to approach
- ○ There is no one to talk to

71. Over the last 2 weeks, how often have you been bothered by the following problems?	Not at all	Several days	Over half the days	Nearly every day
a) Feeling nervous, anxious, or on edge	○	○	○	○
b) Not being able to stop or control worrying	○	○	○	○
c) Worrying too much about different things	○	○	○	○
d) Trouble relaxing	○	○	○	○
e) Being so restless that it's hard to sit still	○	○	○	○
f) Becoming easily annoyed or irritable	○	○	○	○
g) Feeling afraid as if something awful might happen	○	○	○	○

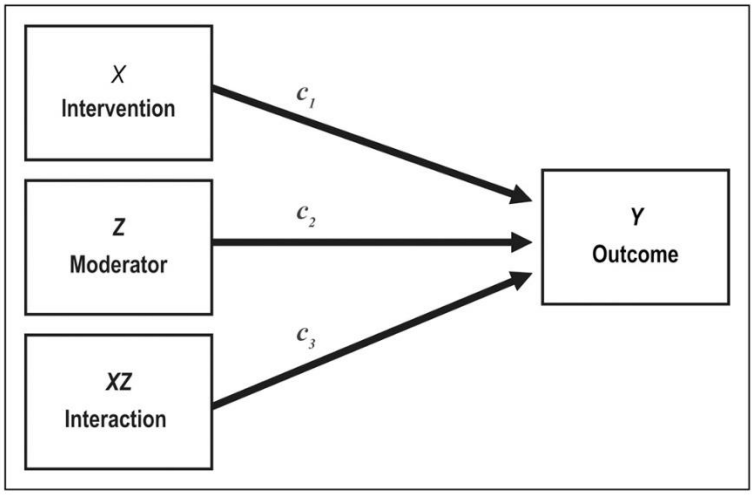
72. Please indicate how often the following statements apply to you:	Almost never	Sometimes	About half the time	Most of the time	Almost always
a) I have difficulty making sense out of my feelings	○	○	○	○	○
b) I pay attention to how I feel	○	○	○	○	○
c) When I'm upset, I have difficulty concentrating	○	○	○	○	○
d) When I'm upset, I believe there is nothing I can do to make myself feel better	○	○	○	○	○
e) When I'm upset, I lose control over my behaviour	○	○	○	○	○
f) When I'm upset, I feel ashamed for feeling that way	○	○	○	○	○

73. On how many of the last 7 days did you feel the following ways?	None or less than 1 day	1-2 days	3-4 days	5-7 days
a) I was bothered by things that usually don't bother me	○	○	○	○
b) I had trouble keeping my mind on what I was doing	○	○	○	○
c) I felt depressed	○	○	○	○
d) I felt that everything I did was an effort	○	○	○	○
e) I felt hopeful about the future	○	○	○	○
f) I felt fearful	○	○	○	○
g) My sleep was restless	○	○	○	○
h) I was happy	○	○	○	○
i) I felt lonely	○	○	○	○
j) I could not get "going"	○	○	○	○

APPENDIX B: Diagrams
Mental illness and health continuum

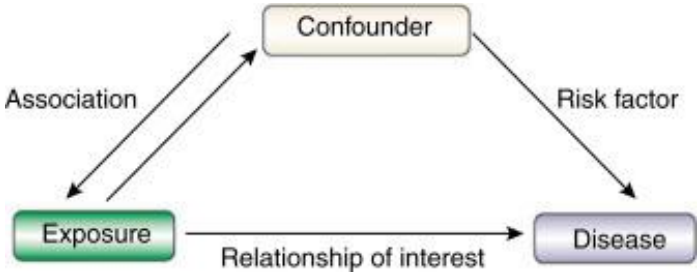
The mental illness continua runs from severe mental illness to no mental illness and intersects with the mental health continua that runs from good mental health to poor mental health. This therefore shows that a person with without mental illness is not necessary mentally healthy (languishing) due to environmental factors such as stress for an example. Moreover, a person with mental illness can still have good mental health (flourishing) and can exhibit a high emotional, psychological and social wellbeing with the right therapy plan.

Pathway of moderating and confounding variables



Y= dependent variable (cannabis use)
X=independent variable (depression and/or anxiety)
Z=moderator (flourishing)
XZ=product of independent variable and the moderator

The pathway of a moderating variable is demonstrated in the diagram above. *C*1 is the effect of depression and/or anxiety on cannabis use (when Z= 0); *C*2 is the effect of flourishing on cannabis use (when X = 0), *C3* is the effect of the product of depression and/or anxiety and flourishing on cannabis use, *i*5 is the intercept and *e*5 is the residual in the equation. The regression coefficient, *C3*, provides an estimate of the effect flourishing via an interaction; if *β3* is found to be statistically different from zero, flourishing will significantly moderate the association between mental health and cannabis use (150). A logistic regression analysis is used to test flourishing as an interaction (moderating) variable (150).



The image above illustrates the pathway of a confounding variable. Confounding is classified as a variable that influences both the exposure and outcome variables and not solely the correlation between them. For a variable to be considered a confounder, it must be associated with the exposure (unequally distributed between exposed and nonexposed) and outcome of interest (usually as a risk factor) and it must not be and effect of the exposure or interact with the causal pathway (197).

APPENDIX C: Tables

Table 1. Sample Descriptive by Sex *

*Complete case analysis only. Students with missing data for sex, grade and cannabis use were removed from analysis

		Female (n=4083)	Male (n=3957)	
		% (n)	% (n)	Test Statistic, P-value
Grade	9 10 11 12	27.6 (1127) 30.4 (1240) 23.4 (957) 18.6 (759)	29.4 (1163) 28.6 (1131) 24.9 (985) 17.1 (678)	8.57, 0.036
Ethnicity	White Black Asian Indigenous Latin American/Hispanic Latin American/Hispanic Mixed/Other	70.5 (2742) 2.0 (79) 10.8 (421) 2.0 (77) 2.4 (95) 12.3 (476)	71.4 (2680) 3.3 (122) 9.8 (367) 2.3 (86) 3.4 (129) 9.8 (368)	30.60, <0.001
Province	Ontario British Columbia	55.8 (2279) 44.2 (1804)	57.5 (2277) 42.5 (1680)	2.44, , 0.12
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	13.2 (537) 28.0 (1138) 26.8 (1091) 17.9 (726) 14.1 (571)	17.1 (692) 26.4 (1038) 23.3 (917) 21.6 (847) 11.1 (437)	64.18, <0.001
Truancy	No skipped class 1 or more	58.3 (2349) 41.7 (1682)	61.2 (2377) 38.8 (1504)	7.27, 0.007
Smoking Status	Non-smoker Smoker	89.7 (3648) 10.3 (420)	88.7 (3498) 11.3 (445)	1.92, 0.17
Binge Drinking	Non-binge drinker Binge drinker	62.7 (2554) 37.3 (1518)	63.9 (2520) 36.1 (1425)	1.16, 0.28
Depression (CES-D-10)	No Depression Depression (≥0)	41.1 (1679) 58.9 (2404)	57.1 (2261) 42.9 (1696)	206.31, <0.001
Anxiety (GAD-7)	No Anxiety Anxiety (≥ 10)	52.3 (2137) 47.7 (1946)	71.9 (2846) 28.1 (1111)	327.06, <0.001
Flourishing (FS) (8-40)	Mean Score (SD)	17.2 (5.97)	16.0 (5.70)	8.70, <0.001
Cannabis Ever Use	Never Use Ever Used	67.5 (2758) 32.5 (1325)	67.3 (2664) 32.7 (1293)	0.05, 0.83
Cannabis Use **	Never Use Sporadic/Rare Use Monthly Use Weekly Use Habitual use Daily use	67.6 (2578) 18.0 (736) 7.7 (315) 3.0 (124) 1.1 (45) 2.6 (105)	67.3 (2664) 14.9 (589) 6.7 (267) 4.2 (167) 2.6 (102) 4.3 (168)	62.93, <0.001

**Numbers may not add to total sample due to missing data

Table 2. Sample Descriptive by Symptoms of Depression (Binary Outcomes)

*Numbers may not add to total sample due to missing data

		No Depression (N=3940)	Depression (N=4100)	
		% (n)	% (n)	Chi-Square
Sex	Female Male	42.6 (1679) 57.4 (2261)	58.6 (2404) 41.4 (1696)	X^2 =206.31, *df*= 1, p< 0.0001
Grade	9 10 11 12	31.6 (1246) 29.1 (1147) 22.4 (882) 16.9 (665)	25.5 (1044) 29.9 (1224) 25.9 (1060) 18.8 (772)	X^2 =41.43, *df*= 3, p< 0.0001
Ethnicity	White Black Asian Indigenous Latin American/Hispanic Mixed/Other	72.3 (2714) 2.7 (102) 10.4 (389) 1.8 (68) 3.0 (111) 9.9 (371)	69.7 (2708) 2.6 (99) 10.3 (399) 2.4 (95) 2.9 (113) 12.2 (473)	X^2 =14.72, *df*= 5, P=0.0116
Province	Ontario British Columbia	57.1 (2251) 42.9 (1689)	56.2 (2305) 43.8 (1795)	X^2 =0.681, *df*= 1, p=0.409
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	15.1 (591) 27.6 (1081) 25.4 (998) 19.1 (748) 12.9 (505)	15.7 (638) 26.9 (1095) 24.8 (1010) 20.3 (825) 12.4 (503)	X^2 =2.993, *df*= 1, P=0.559
Truancy	No skipped class 1 or more	66.7 (2606) 33.4 (1304)	53.0 (2120) 47.0 (1882)	X^2 =153.79, *df*= 1, p< 0.0001
Smoking Status	Non-smoker Smoker	93.1 (3654) 6.9 (273)	85.5 (3492) 14.5 (592)	X^2 =118.29, *df*= 1, p< 0.0001
Binge Drinking	Non-binge drinker Binge drinker	68.2 (2684) 31.8 (1252)	58.6 (2390) 41.4 (1691)	X^2 =79.92, *df*= 1, p< 0.0001
Anxiety	No Anxiety Anxiety	88.8 (3499) 11.2 (441)	36.2 (1484) 63.8 (2616)	X^2 =2360.04, *df*= 1, p< 0.0001
Flourishing (8-40)	Mean Score (SD)	14.19 (4.46)	19.14 (6.09)	t= -40.38, df=7570, p<0.0001
Cannabis Ever Use	Never Use Ever Used	74.1 (2919) 25.9 (1021)	61.1 (2503) 38.9(1597)	X^2 =155.52, *df*= 1, p< 0.0001
Cannabis Use *	Never Use Sporadic/Rare Use Monthly Use Weekly Use Habitual use Daily use	74.1 (2919) 14.6 (575) 5.6 (220) 2.7 (107) 1.1 (45) 1.9 (74)	61.1(2503) 18.3 (750) 8.8 (362) 4.5 (184) 2.5 (102) 4.9 (199)	X^2 =186.28, *df*= 5, p< 0.0001

Table 3. Sample Descriptive by Symptoms of Anxiety (Binary Outcomes)

		No Anxiety (N=4983)	Anxiety (N=3057)	
		% (n)	% (n)	Chi-Square
Sex	Female Male	42.9 (2137) 57.1 (2846)	63.7 (1946) 36.3 (1111)	X^2 =327.06, *df*= 1, p< 0.0001
Grade	9 10 11 12	30.2 (1503) 29.4 (1464) 23.2(1158) 17.2 (858)	25.7 (787) 29.7(907) 25.7(784) 18.9(579)	X^2 =20.73, *df*= 3, p< 0.0001
Ethnicity	White Black Asian Indigenous Latin American/Hispanic Mixed/Other	71.2 (3373) 2.6 (122) 10.9 (516) 2.2 (102) 2.9 (139) 10.3 (486)	70.7 (2049) 2.7 (79) 9.4 (272) 2.1 (61) 2.9 (85) 12.3 (358)	X^2 =11.31, *df*= 5, p< 0.0455
Province	Ontario British Columbia	55.6(2769) 44.4 (2214)	58.5 (1787) 41.5 (1270)	X^2 =6.43, *df*= 1, p< 0.0112
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	15.8 (781) 27.3 (1354) 25.3 (1256) 18.9 (939) 12.7 (629)	14.8 (448) 27.1 (822) 24.8 (752) 20.9 (634) 12.5 (379)	X^2 =5.17, *df*= 4, p< 0.2705
Truancy	No skipped class 1 or more	63.4 (3131) 36.6 (1808)	53.7 (1595) 46.4 (1378)	X^2 =73.26, *df*= 1, p< 0.0001
Smoking Status	Non-smoker Smoker	91.8 (4562) 8.2 (407)	84.9 (2584) 15.1 (458)	X^2 =92.33, *df*= 1, p< 0.0001
Binge Drinking	Non-binge drinker Binge drinker	66.3 (3298) 33.7 (1677)	58.38 (1776) 41.6 (1266)	X^2 =50.82, *df*= 1, p< 0.0001
Depression	No Depression Depression	70.2 (3499) 29.8 (1484)	14.4 (441) 85.6 (2616)	X^2 =2360.04, *df*= 1, p< 0.0001
Flourishing (8-40)	Mean Score (SD)	14.99 (4.84)	19.53 (6.38)	*T=-34.90*, *df*= 7570, p< 0.0001
Cannabis Ever Use	Never Use Ever Used	71.7 (3571) 28.3 (1412)	60.6 (1851) 39.4 (1203)	X^2 =106.58, *df*= 1, p< 0.0001
Cannabis Use *	Never Use Sporadic/Rare Use Monthly Use Weekly Use Habitual use Daily use	71.7 (3571) 15.4 (768) 6.1 (303) 3.2 (158) 1.5 (75) 2.2 (108)	60.6 (1851) 18.2 (557) 9.1 (279) 4.4 (133) 2.4 (72) 5.4 (165)	X^2 =141.05, *df*= 5, p< 0.0001

*Numbers may not add to total sample due to missing data

Table 4. Sample Descriptive by Cannabis Ever Use

		Full sample (N=8040)	Never Users (N=5422)	Ever Users (N=2618)	
		% (n)	% (n)	% (n)	Test Statistic, P-value
Sex	Female Male	50.8 (4083) 49.2 (3957)	50.8 (2758) 49.2 (2664)	50.6 (1325) 49.4 (1293)	0.05, 0.83
Grade	9 10 11 12	28.5 (2290) 29.5 (2371) 24.1 (1942) 17.9 (1437)	35.3 (1913) 30.3 (1642) 20.8 (1130) 13.6 (737)	14.4 (377) 27.9 (729) 31.0 (812) 26.7(700)	520.22, <0.001
Ethnicity	White Black Asian Indigenous Latin American/Hispanic Mixed/Other	71.0 (5422) 2.6 (201) 10.3 (788) 2.1 (163) 2.9 (224) 11.1 (844)	69.3 (3562) 2.1 (111) 13.4 (688) 1.4 (71) 3.0 (155) 10.8 (553)	74.3 (1860) 3.6 (90) 4.0 (100) 3.7 (92) 2.8 (69) 11.6 (291)	206.22, <0.001
Province	Ontario British Columbia	56.7 (4556) 43.3 (3484)	56.5 (3062) 43.5 (2360)	57.1 (1494) 42.9 (1124)	0.25, 0.62
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	15.3 (1229) 27.2 (2176) 25.1 (2008) 19.8 (1573) 12.6 (1008)	18.8 (1012) 30.5 (1642) 22.9 (1237) 14.0 (756) 13.8 (743)	8.3 (217) 20.5 (534) 29.6 (771) 31.4 (817) 10.2 (265)	506.15, <0.001
Truancy	No skipped class 1 or more	59.7 (4726) 40.3 (3186)	73.4 (3920) 26.6 (1420)	31.3 (806) 68.7 (1766)	1277.38, <0.001
Smoking Status	Non-smoker Smoker	89.2 (7146) 10.8 (865)	98.2 (5307) 1.8 (99)	70.6 (1839) 29.4 (766)	1387.65, <0.001
Binge Drinking	Non-binge drinker Binge drinker	63.3 (5074) 36.7 (2943)	81.9 (4436) 18.1 (978)	24.5 (638) 75.5 (1965)	2495.02, <0.001
Depression (CES-D-10)	No Depression Depression (≥10)	49.0 (3940) 51.0 (4100)	53.8 (2919) 46.2 (2503)	39.0 (1021) 61.0 (1597)	155.52, <0.001
Anxiety (GAD-7)	No Anxiety Anxiety (≥ 10)	62.0 (4983) 38.0 (3057)	65.9 (3571) 34.1 (1851)	53.9 (1412) 46.1 (1206)	106.58, <0.001
Flourishing (FS) (8-40)	Mean Score (SD)	16.6 (5.87)	16.0 (5.55)	17.9 (6.29)	-13.57, <0.001

Table 5. Sample Descriptive by Frequency of Cannabis Use

		Never (N=5422)	Sporadic (N=1325)	Monthly (N=582)	Weekly (N=291)	Habitual (N=147)	Daily (N=273)	
		% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	Test Statistic, P-value
Sex	Female Male	50.9(2758) 49.1(2664)	55.6(736) 44.4(589)	54.1(315) 45.9(267)	42.6(124) 57.4(167)	30.6(45) 69.4(102)	38.5(105) 61.5(168)	62.93, <0.001
Grade	9 10 11 12	35.3(1913) 30.3(1642) 20.8(1130) 13.6(737)	14.6(193) 27.7(367) 29.4(390) 28.3(375)	14.4(84) 24.6(143) 36.1(210) 24.9(145)	15.1(44) 31.6(92) 29.2(85) 24.1(70)	12.9(19) 34.7(51) 31.3(46) 21.1(31)	13.6(37) 27.8(76) 29.7(81) 28.9(79)	541.92, <0.001
Ethnicity	White Black Asian Indigenous Hispanic Mixed/Other	69.3(3562) 2.2(111) 13.4(688) 1.4(71) 3.0(155) 10.7(553)	76.0(965) 2.0(25) 4.4(54) 3.4(43) 2.5(36) 11.7(147)	77.4(435) 3.6(20) 3.9(22) 2.9(16) 3.0(17) 9.2(52)	68.9(191) 4.0(11) 2.9(8) 5.0(14) 2.2(6) 17.0(47)	75.7(109) 7.6(11) 2.1(3) 6.9(10) 0.0 (0.0) 7.7(11)	64.3(160) 9.2(23) 5.2(13) 3.6(9) 4.0(10) 13.7(34)	296.08, <0.001
Province	Ontario British Columbia	56.5(3062) 43.5(2360)	54.4(721) 45.6(604)	60.0(349) 40.0(233)	59.5(173) 40.5(118)	59.9(88) 40.1(59)	59.7(163) 40.3(110)	7.96, 0.16
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	18.8(1012) 30.4(1642) 23.0(1237) 14.0(756) 13.8(743)	8.6(114) 23.1(305) 28.4(375) 29.4(388) 10.5(138)	8.1(47) 18.2(105) 33.8(195) 31.1(180) 8.8(51)	7.9(23) 18.3(27) 31.0(90) 32.1(93) 10.7(31)	4.9(7) 18.6(27) 26.9(39) 37.9(55) 11.7(17)	9.6(26) 16.2(44) 26.6(72) 37.3(101) 10.3(28)	532.96, <0.001
Truancy	No skipped class 1 or more	73.4(3920) 26.6(1420)	37.5(492) 62.5(819)	29.3(169) 70.7(408)	23.1(66) 76.9(220)	17.4(24) 82.6(114)	21.2(55) 78.8(205)	1329.76, <0.001
Smoking Status	Non-smoker Smoker	98.2(5307) 1.8(99)	85.0(1124) 15.0(199)	69.6(403) 30.4(176)	55.2(160) 44.8(130)	41.8(61) 58.2(85)	34.1(91) 65.9(176)	2238.66, <0.001
Binge Drinking	Non-binge drinker Binge drinker	81.9(4436) 18.1(978)	32.5(429) 67.5(892)	18.9(109) 81.1(468)	15.5(45) 84.5(245)	14.3(21) 85.7(126)	12.7(34) 87.3(234)	2571.77, <0.001
Depression (CES-D-10)	No Depression Depress (≥10)	53.8(2919) 46.2(2503)	43.3(575) 56.5(750)	37.8(220) 62.2(362)	36.8(107) 63.2(184)	30.6(45) 69.4(102)	27.1(74) 72.9(199)	186.28, <0.001
Anxiety (GAD-7)	No Anxiety Anxiety (≥ 10)	65.9(3571) 34.1(1851)	58.0(768) 42.0(557)	52.1(303) 47.9(279)	54.3(158) 45.7(133)	51.0(75) 49.0(72)	39.6(108) 60.4(165)	141.05, <0.001
Flourishing (FS) (8-40)	ANOVA Mean (SD)	16.0 (5.55)	17.2 (5.75)	17.6 (5.75)	18.7 (6.20)	19.4 (7.20)	20.8 (8.46)	56.43, <0.001

Table 6. Cannabis Ever Use for grade 9-12 students in year 5 of the mental health pilot of COMPASS (using depression and anxiety threshold measures)

		Model 1 Depression and Anxiety	Model 2 Depression, Anxiety and Flourishing	Model 3 2-way and 3-way interactions (final model)
		OR (95%CI)	OR (95%CI)	OR (95%CI)
Sex	Female Male	 1.12 (0.98-1.28)	 1.13 (0.99-1.30)	 1.12 (0.98-1.29)
Grade	9 10 11 12	 0.65 (0.54-0.79)** 0.53 (0.44-0.65)** 0.52 (0.42-0.64)**	 0.63 (0.52-0.76)** 0.52 (0.43-0.64)** 0.50 (0.41-0.62)**	 0.63 (0.52-0.76)** 0.52 (0.43-0.64)** 0.50 (0.41-0.62)**
Ethnicity	White Black Asian Indigenous Latin American/Hispanic Mixed/Other	 1.78 (1.20-2.65)* 0.33 (0.25-0.43)** 2.04 (1.34-3.12)* 0.88 (0.59-1.30) 1.01 (0.82-1.24)	 1.89 (1.26-2.85)* 0.34 (0.25-0.45)** 2.03 (1.29-3.18)* 0.91 (0.61-1.36) 1.03 (0.83-1.27)	 1.90 (1.26-2.86)* 0.33 (0.25-0.44)** 2.02 (1.29-3.16)* 0.91 (0.61-1.36) 1.03 (0.84-1.27)
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	 1.25 (0.99-1.57) 1.44 (1.15-1.81)* 1.77 (1.40-2.24)** 1.22 (0.94-1.59)	 1.30 (1.03-1.65) 1.54 (1.22-1.94)* 1.79 (1.41-2.29)** 1.23 (0.93-1.62)	 1.30 (1.03-1.65) 1.54 (1.22-1.95)* 1.79 (1.41-2.29)** 1.23 (0.94-1.62)
Truancy	No skipped class 1 or more	 2.71 (2.38-3.10)**	 2.61 (2.28-2.99)**	 2.61 (2.28-2.99)**
Smoking Status	Non-smoker Smoker	 9.61(7.43-12.42)**	 9.82 (7.48-12.88)**	 9.83 (7.49-12.91)**
Binge Drinking	Non-binge drinker Binge drinker	 7.29 (6.38-8.32)**	 7.28 (6.35-8.35)**	 7.34 (6.40-8.42)**
Main Effects		**B(SE)**	**B(SE)**	**B(SE)**
Depression (Dep)	No Depression Depression (≥10)	 0.281 (0.078)*	 0.181 (0.083)	 -0.050 (0.322)
Anxiety (Anx)	No Anxiety Anxiety (≥ 10)	 0.167 (0.080)	 0.074 (0.084)	 -0.533 (0.529)
Flourishing (Flourish)			0.033 (0.007)**	0.040 (0.012)*
Interactions				**B(SE)**
Dep*Anx				1.297 (0.628)
Dep*Flourish				0.009 (0.019)
Anx*Flourish				0.031 (0.033)
Dep*Anx*Flourish				-0.065 (0.038)
	Concordance statistic	0.881	0.880	0.881

* p≤0.01, **p<0.001

Table 7. Cannabis Ever Use for grade 9-12 students in year 5 of the mental health pilot of COMPASS (using mental health continuous scores)

		Model 4 Depression and Anxiety	Model 5 Depression, Anxiety and Flourishing	Model 6 2-way and 3-way interactions (final model)
		OR (95%CI)	OR (95%CI)	OR (95%CI)
Sex	Female Male	 1.02 (0.90-1.16)	 1.08 (0.95-1.24)	 1.09 (0.95-1.25)
Grade	9 10 11 12	 0.65 (0.54-0.78)** 0.52 (0.43-0.64)** 0.52 (0.42-0.64)**	 0.63 (0.52-0.76)** 0.52 (0.43-0.64)** 0.50 (0.41-0.62)**	 0.62 (0.51-0.76)** 0.517 (0.42-0.63)** 0.50 (0.40-0.62)**
Ethnicity	White Black Asian Indigenous Latin American/Hispanic Mixed/Other	 1.77 (1.20-2.62)* 0.33 (0.25-0.44)** 2.06 (1.35-3.15)* 0.87 (0.59-1.29) 1.03 (0.84-1.27)	 1.90 (1.27-2.86)* 0.34 (0.25-0.45)** 2.05 (1.30-3.21)* 0.91 (0.61-1.36) 1.04 (0.84-1.28)	 1.90 (1.26-2.85)* 0.33 (0.25-0.44)** 2.04 (1.30-3.21)* 0.91 (0.61-1.37) 1.04 (0.84-1.28)
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	 1.23 (0.98-1.54) 1.39 (1.11-1.74)* 1.73 (1.37-2.18)** 1.20 (0.92-1.56)	 1.31 (1.03-1.66) 1.54 (1.22-1.94)* 1.79 (1.41-2.29)** 1.23 (0.94-1.62)	 1.30 (1.03-1.65) 1.54 (1.22-1.94)* 1.79 (1.41-2.29)** 1.23 (0.93-1.62)
Truancy	No skipped class 1 or more	 2.80 (2.46-3.19)**	 2.63 (2.30-3.02)**	 2.64 (2.31-3.02)**
Smoking Status	Non-smoker Smoker	 10.06(7.79-12.99)**	 9.98 (7.61-1310)**	 10.07(7.67-13.21)**
Binge Drinking	Non-binge drinker Binge drinker	 7.30 (6.40-8.33)**	 7.31 (6.38-8.38)**	 7.33 (6.39-8.40)**
Main Effects		**B(SE)**	**B(SE)**	**B(SE)**
Depression (Dep)		0.001 (0.001)	0.00004 (0.001)	0.006 (0.004)
Anxiety (Anx)		0.002 (0.001)	0.001 (0.002)	0.0001 (0.007)
Flourishing (Flourish)			0.041 (0.006)**	0.048 (0.009)**
Interactions				**B(SE)**
Dep*Anx				0.00004 (0.0001)
Dep*Flourish				-0.0003 (0.0003)
Anx*Flourish				0.0001 (0.0004)
Dep*Anx*Flourish				-3.77E-6 (5.92E-6)
	Concordance statistic	0.879	0.880	0.853

* p≤0.01, **p<0.001

Table 8. Frequency of Cannabis Use for grade 9-12 students in year 5 of the mental health pilot of COMPASS (using depressive and anxiety threshold measures)

		Model 7 Depression and Anxiety	Model 8 Depression, Anxiety and Flourishing	Model 9 2-way and 3-way interactions (final model)
		OR (95%CI)	OR (95%CI)	OR (95%CI)
Sex	Female Male	 1.33 (1.19-1.49)**	 1.33 (1.18-1.50)**	 1.35 (1.18-1.49)**
Grade	9 10 11 12	 0.67 (0.57-0.79)** 0.63 (0.53-0.75)** 0.61 (0.51-0.73)**	 0.64 (0.54-0.76)** 0.61 (0.51-0.73)** 0.58 (0.48-0.70)**	 0.64 (0.54-0.76)** 0.61 (0.51-0.73)** 0.58 (0.48-0.70)**
Ethnicity	White Black Asian Indigenous Latin American/Hispanic Mixed/Other	 2.41 (1.78-3.26)** 0.39 (0.31-0.51)** 1.59 (1.15-2.21)* 0.90 (0.642-1.26) 1.05 (0.88-1.25)	 2.53 (1.84-3.47)** 0.41 (0.31-0.52)** 1.52 (1.07-2.14)* 0.85 (0.60-1.22) 1.05 (0.88-1.25)	 2.53 (1.85-3.48)** 0.40 (0.31-0.52)** 1.51 (1.07-2.13) 0.86 (0.60-1.22) 1.05 (0.88-1.25)
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	 1.12 (0.91-1.37) 1.29 (1.06-1.57)* 1.51 (1.23-1.85)** 1.17 (0.93-1.48)	 1.18 (0.95-1.45) 1.41 (1.15-1.73)* 1.55 (1.26-1.92)** 1.19 ()0.94-1.52	 1.18 (0.95-1.45) 1.41 (1.15-1.74)* 1.56 (1.26-1.92)** 1.20 (0.94-1.52)
Truancy	No skipped class 1 or more	 2.55 (2.27-2.88)**	 2.45 (2.16-2.76)**	 2.44 (2.16-2.76)**
Smoking Status	Non-smoker Smoker	 7.39 (6.32-8.64)**	 7.32 (6.22-9.61)**	 7.32 (6.22-8.62)**
Binge Drinking	Non-binge drinker Binge drinker	 6.88 (6.07-7.79)**	 6.93 (6.10-7.89)**	 6.94 (6.11-7.90)**
Main Effects		**B(SE)**	**B(SE)**	**B(SE)**
Depression (Dep)	No Depression Depression (≥10)	 0.287(0.068)**	 0.155 (0.072)	 0.181 (0.278)
Anxiety (Anx)	No Anxiety Anxiety (≥10)	 0.239(0.068)*	 0.130 (0.072)	 -0.401 (0.455)
Flourishing (Flourish)			0.039 (0.005)**	0.042 (0.010)**
Interactions				**B(SE)**
Dep*Anx				0.649 (0.536)
Dep*Flourish				-0.004 (0.016)
Anx*Flourish				0.028 (0.028)
Dep*Anx*Flourish				-0.032 (0.032)
	Concordance statistic	0.852	0.853	0.854

* p≤0.01, **p<0.001

Table 9. Frequency of Cannabis Use for grade 9-12 students in year 5 of the mental health pilot of COMPASS (using mental health continuous scores)

		Model 10 Depression and Anxiety	Model 11 Depression, Anxiety and Flourishing	Model 12 2-way and 3-way interactions (final model)
		OR (95%CI)	OR (95%CI)	OR (95%CI)
Sex	Female Male	 1.19 (1.07-1.33)*	 1.26 (1.13-1.42)**	 1.27 (1.13-1.43)**
Grade	9 10 11 12	 0.67 (0.57-0.79)** 0.62 (0.52-0.73)** 0.61(0.51-0.73)**	 0.64 (0.54-0.76)** 0.61 (0.51-0.72)** 0.58 (0.48-0.70)**	 0.64 (0.54-0.76)** 0.61(0.51-0.72)** 0.58 (0.48-0.70)**
Ethnicity	White Black Asian Indigenous Latin American/Hispanic Mixed/Other	 2.36 (1.74-3.20)** 0.40 (0.31-0.51)** 1.59 (1.15-2.20)* 0.89 (0.64-1.25) 1.07 (0.90-1.27)	 2.15 (1.83-3.45)** 0.40 (0.31-0.52)** 1.52 (1.08-2.14) 0.85 (0.60-1.22) 1.06 (0.88-1.26)	 2.52(1.83-3.46)** 0.40 (0.31-0.52)** 1.52 (1.07-2.14) 0.85 (0.60-1.22) 1.05 (0.88-1.26)
Weekly spending money	$0 $1-$20 $21-$100 >$100 I don't know	 1.10 (0.90-1.34) 1.23 (1.01-1.50) 1.47 (1.20-1.80)* 1.14 (0.91-1.44)	 1.18 (0.96-1.46) 1.41 (1.15-1.73)* 1.56 (1.26-1.93)** 1.20 (0.94-1.53)	 1.17 (0.95-1.45) 1.40 (1.14-1.73)* 1.55 (1.26-1.92)** 1.19 (0.93-1.52)
Truancy	No skipped class 1 or more	 2.63 (2.34-2.96)**	 2.46 (2.17-2.77)**	 2.46 (2.18-2.78)**
Smoking Status	Non-smoker Smoker	 7.73 (6.61-9.03)**	 7.40 (6.29-8.71)**	 7.43 (6.32-8.74)**
Binge Drinking	Non-binge drinker Binge drinker	 6.87 (6.07-7.78)**	 6.96 (6.12-7.92)**	 6.98 (6.13-7.93)**
Main Effects		**B(SE)**	**B(SE)**	**B(SE)**
Depression (Dep)		0.001 (0.001)	0.001 (0.001)	0.002 (0.004)
Anxiety (Anx)		0.002 (0.001)	0.0002 (0.001)	-0.001 (0.006)
Flourishing (Flourish)			0.047 (0.005)**	0.0513 (0.008)**
Interactions				**B(SE)**
Dep*Anx				0.001(0.001)
Dep*Flourish				-0.0001(0.0002)
Anx*Flourish				0.0001(0.0003)
Dep*Anx*Flourish				-4.9E-6 (4.8E-6)
	Concordance statistic	0.849	0.853	0.853

* p≤0.01, **p<0.001

APPENDIX D: Figures

Figure 1: Depression scores for Grade

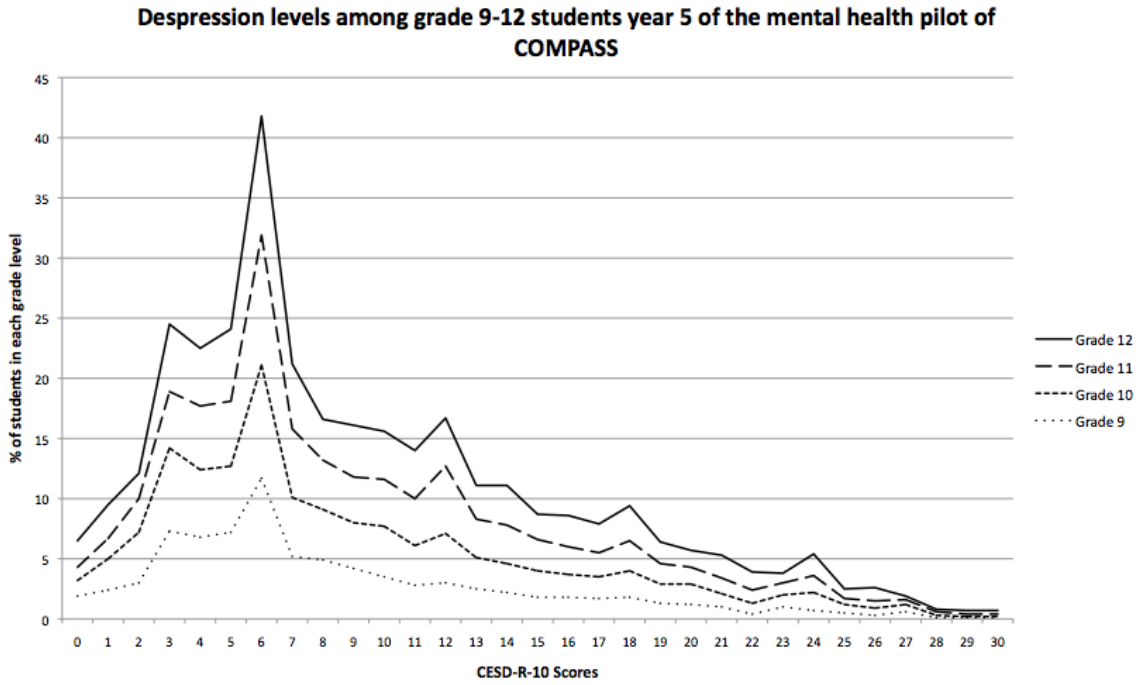


Figure 2: Anxiety scores for Grade

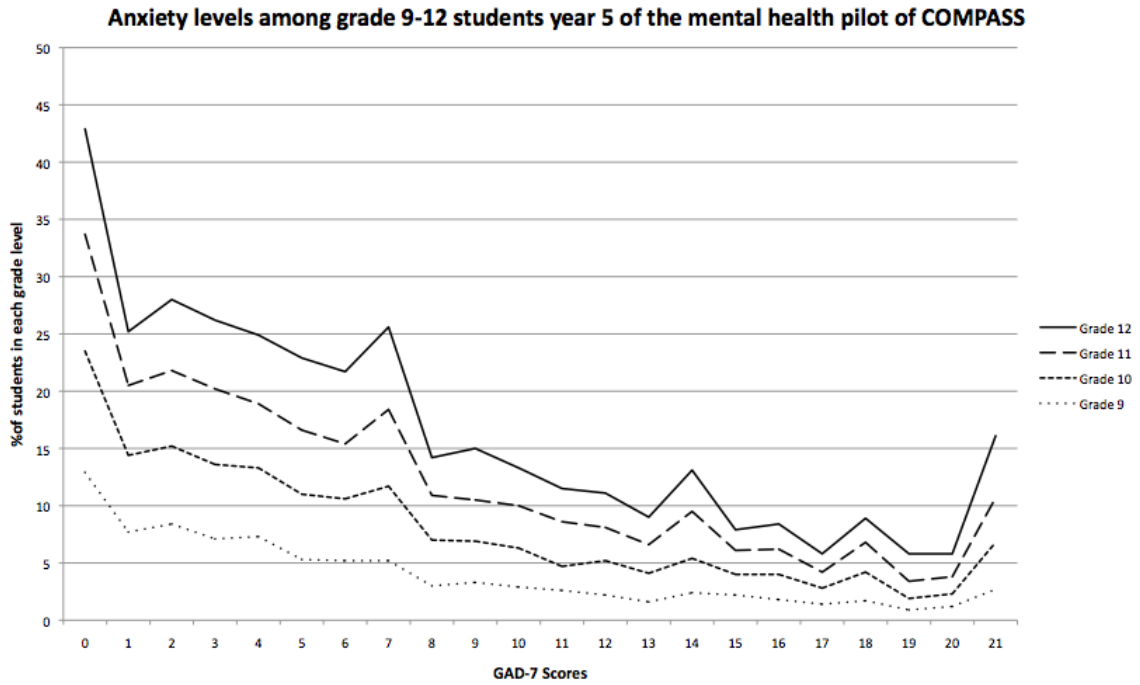
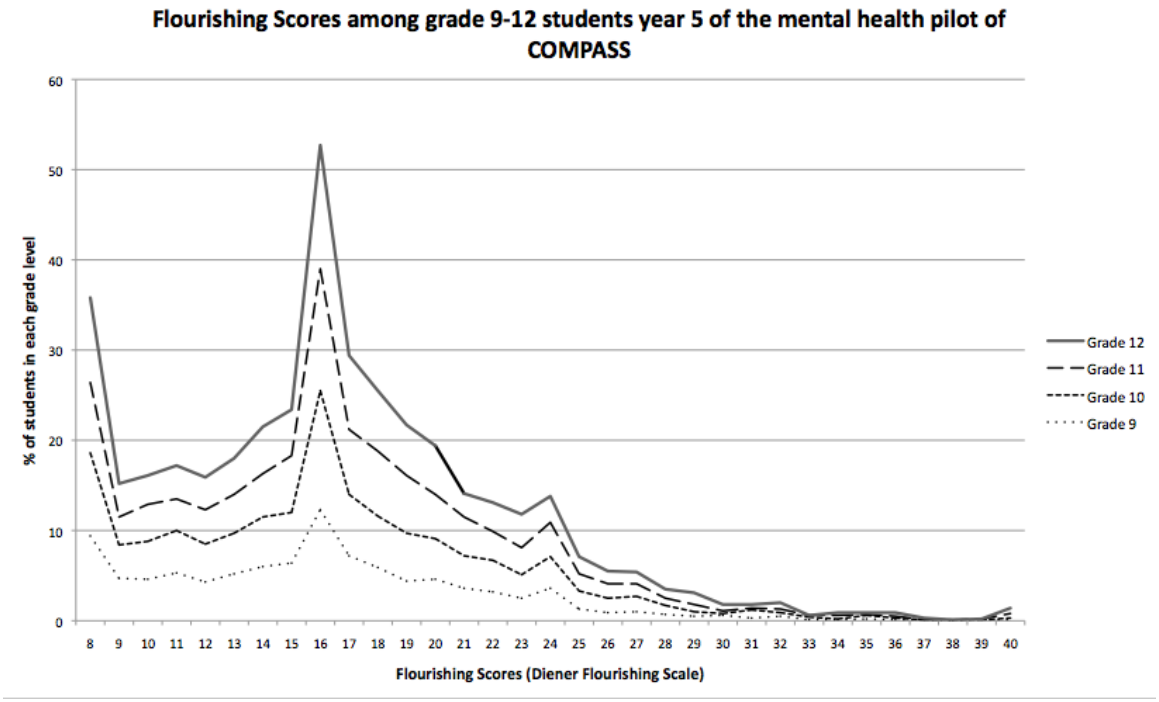


Figure 3: Flourishing scores for Grade



APPENDIX E: Additional Analyses

Kruskal-Wallis Test

Kruskal-Wallis Test	
Chi-Square	208.5029
DF	5
Pr > Chi-Square	<.0001

Median Scores (Number of Points Above Median) for Variable FLOURISH Classified by Variable CAN_ORD					
CAN_ORD	**N**	**Sum of Scores**	**Expected Under H0**	**Std Dev Under H0**	**Mean Score**
1	5113	2344.71630	2556.50	19.164259	0.458579
2	1273	702.08652	636.50	15.304702	0.551521
4	267	170.03823	133.50	7.548152	0.636847
5	134	89.25956	67.00	5.395794	0.666116
6	238	164.80080	119.00	7.140585	0.692440
3	547	315.09859	273.50	10.594774	0.576049
Average scores were used for ties.					

Median One-Way Analysis	
Chi-Square	148.4107
DF	5
Pr > Chi-Square	<.0001

ANOVA Test

Class Level Information		
Class	**Levels**	**Values**
CAN_ORD	6	1 2 3 4 5 6

Number of Observations Read	8040				
Number of Observations Used	7572				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	5	9374.4689	1874.8938	56.43	<.0001
Error	7566	251394.5268	33.2269		
Corrected Total	7571	260768.9956			

R-Square	Coeff Var	Root MSE	FLOURISH Mean
0.035949	34.66614	5.764276	16.62797

Source	DF	Anova SS	Mean Square	F Value	Pr > F
CAN_ORD	5	9374.468883	1874.893777	56.43	<.0001

		FLOURISH	
Level of CAN_ORD	**N**	**Mean**	**Std Dev**
1	5113	16.0007823	5.54530347
2	1273	17.2065986	5.75062647
3	547	17.6234004	5.75068406
4	267	18.6816479	6.19602713
5	134	19.4328358	7.19591338
6	238	20.8361345	8.46402395

Binary Model without 3-way interaction

Analysis of Maximum Likelihood Estimates							
Parameter			**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > Chi Sq**
Intercept			1	-2.3270	0.2938	62.7504	<.0001
CESD_BIN	**Depression**		1	0.2194	0.2808	0.6105	0.4346
FLOURISH			1	0.0466	0.0112	17.4086	<.0001
GAD7_BIN	**Anxiety**		1	0.2300	0.2810	0.6700	0.4131
GAD7_BIN*CESD_BIN	**Anxiety**	**Depression**	1	0.2682	0.1891	2.0120	0.1561
FLOURISH*CESD_BIN	**Depression**		1	-0.00729	0.0164	0.1984	0.6560
FLOURISH*GAD7_BIN	**Anxiety**		1	-0.0194	0.0157	1.5377	0.2150
MALE	**male**		1	0.1174	0.0703	2.7948	0.0946
GRADE10	**0**		1	-0.4669	0.0993	22.0955	<.0001
GRADE11	**0**		1	-0.6466	0.1023	39.9766	<.0001
GRADE12	**0**		1	-0.6863	0.1094	39.3584	<.0001
TRU	**At elast 1 skipped day**		1	0.9585	0.0692	192.0338	<.0001
PROV	**BC**		1	0.3672	0.0704	27.2242	<.0001
WKLY_SPEND	**1-20$**		1	0.2591	0.1207	4.6067	0.0318

WKLY_SPEND	**21-100$**		1	0.4309	0.1193	13.0452	0.0003
WKLY_SPEND	**>100$**		1	0.5821	0.1240	22.0465	<.0001
WKLY_SPEND	**IDK**		1	0.2056	0.1399	2.1595	0.1417
ETHNIC	**Aboriginal**		1	0.7014	0.2298	9.3183	0.0023
ETHNIC	**Asian**		1	-1.1011	0.1456	57.1837	<.0001
ETHNIC	**Black**		1	0.6338	0.2083	9.2622	0.0023
ETHNIC	**Latin American**		1	-0.0948	0.2059	0.2120	0.6452
ETHNIC	**Other/Mixed**		1	0.0272	0.1077	0.0636	0.8009
SMOKE_BIN	**Smoker**		1	2.2874	0.1387	271.9133	<.0001
BINGE_BIN	**Binge Drinking**		1	1.9919	0.0698	814.6048	<.0001

Binary Model without Flourishing as a Main Effect

Analysis of Maximum Likelihood Estimates							
Parameter			**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > Chi Sq**
Intercept			1	-1.6553	0.2424	46.6232	<.0001
CESD_BIN	**Depression**		1	-0.6159	0.2766	4.9597	0.0259
GAD7_BIN	**Anxiety**		1	-1.0929	0.5031	4.7200	0.0298
FLOURI*GAD7_B*CESD_B	**Anxiety**	**Depression**	1	-0.1046	0.0360	8.4313	0.0037
GAD7_BIN*CESD_BIN	**Anxiety**	**Depression**	1	1.8530	0.6066	9.3303	0.0023
FLOURISH*CESD_BIN	**Depression**		1	0.0493	0.0151	10.6254	0.0011
FLOURISH*GAD7_BIN	**Anxiety**		1	0.0708	0.0313	5.1264	0.0236
MALE	**male**		1	0.1195	0.0701	2.9033	0.0884
GRADE10	**0**		1	-0.4607	0.0991	21.6093	<.0001
GRADE11	**0**		1	-0.6501	0.1021	40.5436	<.0001
GRADE12	**0**		1	-0.6859	0.1092	39.4340	<.0001
TRU	**At elast 1 skipped day**		1	0.9729	0.0690	198.6229	<.0001

PROV	**BC**		1	0.3632	0.0703	26.6956	<.0001
WKLY_SPEND	**1-20$**		1	0.2513	0.1206	4.3430	0.0372
WKLY_SPEND	**21-100$**		1	0.4039	0.1188	11.5477	0.0007
WKLY_SPEND	**>100$**		1	0.5606	0.1236	20.5594	<.0001
WKLY_SPEND	**IDK**		1	0.1901	0.1397	1.8504	0.1737
ETHNIC	**Aboriginal**		1	0.7001	0.2291	9.3380	0.0022
ETHNIC	**Asian**		1	-1.0845	0.1459	55.2568	<.0001
ETHNIC	**Black**		1	0.6482	0.2080	9.7107	0.0018
ETHNIC	**Latin American**		1	-0.0874	0.2051	0.1817	0.6699
ETHNIC	**Other/Mixed**		1	0.0303	0.1079	0.0788	0.7789
SMOKE_BIN	**Smoker**		1	2.2952	0.1387	273.9986	<.0001
BINGE_BIN	**Binge Drinking**		1	1.9842	0.0696	812.1189	<.0001