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The Impact of Initial Age of Methamphetamine Use on Social Integration

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Abstract

Background: Prevalence of methamphetamine use is rising in North America. Peers and social relationships are known to influence substance use patterns, but fewer studies have examined the role of early initiation on later social integration. We aimed to understand the relationship between age of first use and social integration.

Methods: Bivariate analyses were performed to assess the relationship between age of first use and social integration before performing a sex-based analysis. Multivariable linear regressions were used to help to understand this relationship.

Results: There was no significant association between age of first use and social integration scores for the sample. Sex, age of first use, and the interaction between the two were not significantly associated with social integration scores.

Conclusions: Researchers and those working with current or past methamphetamine users should perform larger population-based studies to better address the gap in the literature between social integration and age of first methamphetamine use.

Keywords

Methamphetamine; substance use; age of first use; initiation; age of onset; integration; social integration; community integration; social roles; sex-based analysis

Summary for Lay Audience

Methamphetamine, also referred to as ‘speed’ or ‘ice’, is a stimulant; a type of drug that allows people to feel more awake and alert. Methamphetamine is a growing public health concern, as its use is becoming more common in North America. Use of methamphetamine can lead to a wide range of physical and mental health complications. These complications can be short-term or long-term, depending on the dosage and duration of use. Researchers have noted that the average age of first use occurs between the ages of 19 to 21, during the transition period between late adolescence and early adulthood. It is important to understand factors associated with methamphetamine use because early drug use is associated with more health-related problems.

Traditional social roles (e.g., being an employee, spouse, parent etc.) can influence an individual to start using substances. Adolescents in particular, are often influenced by their peers. Drug use disorders are impacted by social roles and social integration. Poor social integration and fewer social roles increase the risk of developing drug use disorders compared to those with better social integration and more social roles.

This study analyzed data from the Methamphetamine Harm Reduction study, which is aimed at introducing harm reduction strategies in hospitals for people who use methamphetamine. We used quantitative methods to assess the potential relationship between age of first methamphetamine use and social integration. The literature aided us in choosing additional factors associated with methamphetamine use including sex, ethnicity, education level, quality of life and other scales of community integration.

We found no evidence of a relationship between social integration and age of first methamphetamine use. Both high school and college/university/trade school education were associated with greater social integration scores compared to those whose highest level of education was grade school. Upon performing a sex-based analysis, we found no evidence of a relationship between age of first use and social integration scores. Our study is one of the first to look at how age of first use affects social integration. Larger population-based studies should be conducted to better address this gap in the literature.

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Chapter 1

1 Introduction

The following section will outline the rationale for this study, along with the overall aim and research objectives.

1.1 Study Rationale

Methamphetamine use is a growing public health concern, with an estimated 35 million users worldwide in the past year (Stuart et al., 2020). The prevalence of methamphetamine in the Canadian population is approximately 0.2%, however prevalence is increasing (Canadian Centre on Substance Use and Addiction, 2018; Hamel et al., 2020). In the United States, between 2015 and 2019, there has been an increase in methamphetamine use without injection among those aged 18 to 23 (Han et al., 2021). This time period is a critical period for brain development (Han et al., 2021). Methamphetamine can cause a wide range of mental and physical health complications for users that may start off as acute, and become chronic with increased dosage and use (Casey 2019; Kwon & Han, 2018; Ramin Radfar & Rawson, 2014).

Recent studies have identified particular groups that are more likely to begin using methamphetamine, including street-involved youth, those identifying as 2SLGBTQ+, women, individuals with unstable housing, and those who have been incarcerated (Canadian Centre on Substance Use and Addiction, 2020). Majority of people start using methamphetamines between the ages of 19-21 (Brecht et al., 2007; Guerin & Kim, 2021). This young average age poses a concern as an individual's brain is still developing during this time period. The transition period between adolescence and early adulthood is considered to be a critical developmental period for social, educational, and career milestones in an individual's life. During this period, individuals face changes in both their social environment and role responsibility (Newcomb & Mcgee, 1991). Some of these changes include, finding employment, getting married, moving out of a parental home, and attending post-secondary education. This time of transition is important for the development of both personal and interpersonal competence, including responsible

decision making, self-awareness, and the ability to maintain healthy relationships (Newcomb & Bentler, 1989). Therefore, initiation of methamphetamine during this critical developmental period may have an impact on one's trajectories into adulthood.

An individual's physical, social, economic and mental health can be impacted by the initiation of methamphetamine, and a wide range of factors have been identified for the initiation of its use, including sex, ethnicity, education, childhood adverse events, economic status, and community environment. Social roles (e.g., being an employee, spouse, student, son/daughter, parent etc.) influence the onset, continuation, escalation and cessation of substance use (Green et al., 2010). There is a relationship between substance use and social variables, whereby adolescents are influenced to initiate substance use through their peers. Peer influences, including the modelling and encouragement of substance use, have been found to be the strongest of all factors for initiation (Newcomb & Bentler, 1989). Previous research has demonstrated that fewer social roles and poor social integration lead to an increased risk of developing a drug use disorder compared to those with more social roles and better social integration (Green et al., 2010). Further research is needed to get a better understanding of how the age of first methamphetamine use influences an individual's social integration.

1.2 Study Purpose and Research Objectives

The initial hypothesis of this study was that methamphetamine users who began using methamphetamine at a younger age will have poorer current social integration than users who started at an older age. We hypothesized that starting methamphetamine at a younger age may be associated with poor social skills and development, as adolescence is a critical time period where social relationships and developmental tasks are key.

Following initial analyses between social integration and age of first methamphetamine use, we investigated which factors known to be associated with methamphetamine impact social integration scores. Finally, we performed a sex-based analysis, as the literature suggests evidence of potential sex differences in methamphetamine initiation.

There were two overall objectives for this thesis.

1. To estimate the association between participant's age of first methamphetamine use and social integration using their baseline Social Integration subscale scores from the Community Integration Questionnaire-Revised (CIQ-R).
 - a. To estimate the association between participant's age of first methamphetamine use and the three remaining subscales of the CIQ-R (Home Integration, Productivity, Electronic Social Networking) and for the total CIQ-R scale.
 - b. To assess how social integration scores are affected by other factors associated with methamphetamine use, including sex, education, and ethnicity, as well as overall quality of life as assessed by the overall life satisfaction scores on the Lehman's Quality of Life Questionnaire.
2. To explore whether the association between participant's age of first methamphetamine use and social integration is modified by sex.

Chapter 2

2 Literature Review

This chapter will discuss what is currently known in the literature about methamphetamine use, including its history, prevalence, health effects, and risk factors. It will also discuss how the age of first use impacts initiation of substances, factors associated with methamphetamine use, as well as the relationship between social integration and substance use.

2.1 Methamphetamine

2.1.1 History of Methamphetamine

Amphetamines are a class of synthetic drugs that act as powerful central nervous system stimulants. These stimulants allow for a greater amount of dopamine to be released in the brain, creating feelings of euphoria or wakefulness (Casey, 2019). Methamphetamine is the most frequently used type of amphetamine, and is the second most commonly used substance after cannabis worldwide (Sarani et al., 2020). It is known by various street names including speed, crystal, and ice (Stoneberg et al., 2018). Methamphetamine was originally developed in 1893 by Japanese researcher Nagai Nagayoshi, and was later used in World War II to allow soldiers to enhance their performance and reduce fatigue (Lewis et al., 2021). Use of the injectable form of methamphetamine grew in popularity in Japan, once released to the market after the war (Hunt et al., 2006). It was used as a prescription drug to treat various medical conditions including asthma, epilepsy, obesity, schizophrenia and ADHD (Casey, 2019; McCormick et al., 2007). Due to its addictive nature, methamphetamine for prescription use was discontinued in the 1960s and 1970s, and has since been classified as a Schedule II stimulant by the U.S. Drug Enforcement Administration (McCormick et al., 2007; Pennell et al., 1999). In Canada, under the Controlled Drugs and Substances Act (CDSA), methamphetamine production, possession, trafficking and importation/exportation is illegal (Casey, 2019). Methamphetamine is now listed under Schedule I of the CDSA in Canada (Casey, 2019).

2.1.2 Health Effects of Methamphetamine Use

Methamphetamine is a white, odorless substance that comes in a variety of forms including as a powder, tablet or as crystals. Depending on the form, it can be smoked, injected, inhaled or ingested. Methamphetamine works to increase the levels of dopamine, serotonin and norepinephrine in the brain by releasing and inhibiting the reabsorption of these neurotransmitters (Sarani et al., 2020). Excess dopamine levels result in stronger, more prolonged effects (Canadian Centre on Substance Use and Addiction, 2018). It is metabolized slower than other substances such as cocaine, and can therefore lead to a high that lasts for hours (Oetting et al., 2000).

The spectrum of effects is dependent on both the dose and route of administration, with effects lasting up to 12 hours (Ramin Radfar & Rawson, 2014; Scott et al., 2007). Smoking and injection methods provide more rapid and intense effects compared to other methods of use (Ramin Radfar & Rawson, 2014). Acute effects of methamphetamine include increased blood pressure, body temperature, heart rate and breathing rate (Ramin Radfar & Rawson, 2014). People may use methamphetamine for personal enjoyment, enhanced sociability, or increased concentration (Casey, 2019). There is a high potential for addiction due to its rewarding effects, including reduced fatigue, increased self-esteem, reduced hunger, euphoria, and increased libido (Kwon & Han, 2018). Chronic methamphetamine use may lead to psychiatric symptoms such as heightened anxiety, depression, feelings of paranoia, hallucinations, and sleep disturbance (Kwon & Han, 2018).

2.1.3 Epidemiology

Methamphetamine use is a growing public health concern, as prevalence is rising in North America, particularly on the West Coast in both Canada and the United States (Casey, 2019; Hamel et al., 2020). In the United States, the prevalence of use in Western states is approximately twice that found in Eastern states (Oetting et al., 2000). It has been characterized as a 'rural drug' as its prevalence is greatest in rural areas (Grant et al., 2007). This is thought to be due to limited resources available for prevention, treatment and recovery in these areas, as well as a lack of access to health care providers

with specialized training (Moody et al., 2017). Casey (2019), report a 104% increase in methamphetamine use in Manitoba among adults in one year. They also report provincially, 48% of youth seeking treatment for addiction, use methamphetamine as their primary substance (Casey, 2019). As of 2015, it was estimated that 35 million people worldwide had used methamphetamine in the past year (Stuart et al., 2020). This is greater than heroin (fewer than 10 million) or cocaine (15 million) (Grant et al., 2007). The estimated prevalence of methamphetamine use in the Canadian population is 0.2% or approximately 59,000 people (Canadian Centre on Substance Use and Addiction, 2018). In a 2020 National Survey on Drug Use and Health, the Substance Abuse and Mental Health Services Administration (2021), reported that among individuals aged 12 and older, 153,000 people initiated methamphetamine use in the past year in the United States.

The prevalence of methamphetamine is increasing due to a variety of factors including its ease of manufacture and availability, as well as its low cost (Scott et al., 2007). Change in substance use over time at the individual level may in part be a reflection of trends in the drug popularity, availability and composition (Burns et al., 2017). Purity levels of the illicit methamphetamine produced are approaching 100%, as the knowledge required to manufacture this substance is readily available on the internet, and requires chemicals that are easily accessible (McCormick et al., 2007).

A recent development that increases public health concerns about methamphetamine use is contamination, particularly with fentanyl. Fentanyl is approximately 50 times more potent than heroin (CDC, 2021). It is commonly being mixed into heroin, cocaine, and methamphetamine (CDC, 2021). Contamination with fentanyl can lead to serious adverse effects including overdose deaths. According to the Centers for Disease Control and Prevention [CDC] (2021), overdose deaths from psychostimulants, including methamphetamine, have been increasing since 2010. A study conducted by the National Institute on Drug Abuse (NIDA) found that in the United States, overdose deaths involving methamphetamine have nearly tripled from 2015 to 2019 among individuals aged 18-64 (Han et al., 2021). Methamphetamine laced with fentanyl exposes users to

opioids who may not have a tolerance to opioids, which could contribute to this increase in overdose deaths (Han et al., 2021).

Different social groups are disproportionately affected by the growing methamphetamine problem in Canada (Canadian Centre on Substance Use and Addiction, 2020). The groups that are impacted most include street-involved youth, those identifying as 2SLGBTQ+, women, individuals with unstable housing, and those who have been incarcerated (Canadian Centre on Substance Use and Addiction, 2020). The prevalence of methamphetamine use is rising most commonly among youth, particularly among street-involved youth who are also involved in the party scene (McCormick et al., 2007). In a non-random sample of street-involved youth and young adults (aged 14-30) in Vancouver, 71% of those aged 14 to 30 reported using methamphetamines (Health Canada, 2008). According to the 2017 Canadian Tobacco, Alcohol and Drugs Survey (CTADS), 3.7% of Canadians aged 15 and older have used methamphetamine at least once in their lifetime (Canadian Centre on Substance Use and Addiction, 2018). Among those 15 and older, lifetime prevalence of methamphetamine use among males (5.4%) was significantly higher compared to females (2.2%) (Canadian Centre on Substance Use and Addiction, 2018). This increase in prevalence amongst youth is a concern due to the multitude of health and social consequences that have been linked to its use.

2.2 Age of First Use

2.2.1 Age of First Substance Use

Earlier age of onset for substances such as tobacco, alcohol and cannabis have been linked to mental, physical, and social health consequences. It has been reported that of Ontarians between the ages of 18-29, 45% reported past-year cannabis use in 2019, compared to 15% among those aged 50 and older (Ali et al., 2022). Initiating substances at an earlier age increases the length of adolescent exposure and risk for dependence (Ali et al., 2022; Johnson & Mott, 2001). Substance use trajectories are influenced by both age and birth cohort. Burns et al. (2017) suggested that compared to older adolescents who may already have an established attitude towards substances, as well as an established pattern of use, younger adolescents are more vulnerable to emerging trends in substance

use. Younger age at initiation is linked to three possible addiction use trajectories including (1) early onset and severe substance use disorder symptoms persisting into adulthood, (2) early onset of substance use disorder symptoms in adolescence that improve into adulthood, and (3) substance use disorders symptoms emerging later, with varying degrees of severity and persistence (Harerimana et al., 2021).

An earlier age of first use is associated with subsequent substance use, physical injury, depression, and high-risk sexual behaviours (Johnson & Mott, 2001). When looking at a substance like cannabis, research has found that an earlier age of first use is associated with an increase in the likelihood of polysubstance use, engagement in risky sexual behaviour, and fewer years of education (Degenhardt et al., 2000). Previous research has demonstrated that substance use during early adolescence (prior to age 18) impacts adolescent development, and increases the likelihood of developing a substance use disorder in adulthood (Alcover, 2020; Ali et al., 2022; Gallegos et al., 2021; Johnson & Mott, 2001). For example, a Canadian study compared those who began drinking at the legal age of 19, to those who began consuming alcohol between the ages of 11 and 14. They found that those who consumed alcohol at a younger age were at an increased risk for developing an alcohol disorder later in life (Harerimana et al., 2021).

2.2.2 Age of First Methamphetamine Use

Youth are the most vulnerable population for engaging in methamphetamine use (Chomchoei et al., 2019). According to the United Nations, the term youth refers to individuals between the ages of 15-24 (Chomchoei et al., 2019). Youths are influenced to begin using methamphetamine due to a variety of physical and social contexts. Some of these contexts include being at parties, being on the street or in a park, or being in homes or hotel rooms where methamphetamine is available, as well as being with a sex partner, dealer, family member or friend who uses methamphetamine (Bowen et al., 2012).

Research has shown that the average age of first methamphetamine use typically occurs between 19-21, as this is the transition period between late adolescence and early adulthood (Brecht et al., 2007; Guerin & Kim, 2021). This early age of first use poses a concern, as the brain does not fully develop until one's mid to late 20s (Guerin & Kim,

2021). During this crucial developmental time, adolescents experience increased vulnerability to stress and risk-seeking behaviours (Whitesell et al., 2013). Familial and social factors can create stressful circumstances in adolescents, leading to an increased reactivity to addictive substances, and potential for future substance use disorders (Whitesell et al., 2013). Substances such as nicotine and alcohol increase the release of dopamine in the brain. This can result in addiction, as the presence of high amounts of dopamine causes adjustments in the brain (Whitesell et al., 2013). The brain begins to decrease its natural production of this neurotransmitter, and becomes dependent on the substance for its supply (Whitesell et al., 2013). In comparison to other substances, age of first methamphetamine use is often later than for nicotine and alcohol, although it is comparable to that of cannabis (Yimsaard et al., 2018). This is thought to be because of legislation, as substances, such as alcohol and nicotine are legal and more readily accessible in most parts of the world (Yimsaard et al., 2018).

Initiation of methamphetamine for recreational use is often associated with a younger age of first use, whereas initiation to cope with stressful life events is associated with an older age of first use (Yimsaard et al., 2018). This younger age of first use may in part be due to youths being more impressionable, and easily influenced by their peers.

Methamphetamine initiation during adolescence is also associated with an increase in prevalence of methamphetamine dependence in adulthood (Ali et al., 2022; Johnson et al., 2010). Therefore, it is important to understand the impact of the age of first use as well as the potential factors that affect methamphetamine use.

2.3 Factors that Affect Methamphetamine Use

There are a variety of socio-demographic factors that impact methamphetamine use. Some of these factors include sex, ethnicity, education, marital status, childhood adverse events, quality of life, economic status, and community environment. Although all of these factors are of importance, this thesis will take a further look into sex, ethnicity, education, quality of life and community environment. We opted to only look at these variables due to limitations in our data, including availability and lack of variability in response.

2.3.1 Sex and Gender

Sex and gender are important determinants of health that are related to the development of substance use and addiction (Casey, 2019). Though often used interchangeably, sex and gender are two different concepts. Sex is a biological construct. It refers to the biological characteristics of an individual, including their genetic makeup and hormone profile (Phillips, 2005). Sex is most commonly reported as a binary term; male or female (Canadian Institutes of Health Research, 2020). However, it can also include those who identify as intersex; those who are born with characteristics that do not fit exclusively into the binary categories of male or female (Health Canada, 2019). Gender is a social construct, as it is a product of society. It refers to characteristics of an individual including norms, behaviours, roles, and expectations attributed to men and women in society, which can change over time (Phillips, 2005). Gender is not a binary term; but rather exists on a continuum that can change over time. (Canadian Institutes of Health Research, 2020). The term encompasses those who identify as a man, woman, non-binary or two spirited (Health Canada, 2019). This thesis will analyze sex-based data.

Sex and gender are two factors that impact methamphetamine use. There is evidence of unique sex and psychosocial differences associated with methamphetamine use in the population of adult substance users, however there is a gap in the literature within the adolescent population (Rawson et al., 2005). Reasons for methamphetamine initiation can differ across user groups. For example, women are more likely to begin using to cope with emotional or family problems, or to lose weight (Casey, 2019; Mayo et al., 2019; Saw et al., 2017). Men are more likely to use out of curiosity or to improve sexual performance (Buxton & Dove, 2008; Mayo et al., 2019). Recent reports demonstrate that men are more likely than women to use almost all types of illicit substances; however, with methamphetamine women are more likely to develop a substance use disorder (Bach et al., 2020; Franke et al., 2022; Saw et al., 2017). In Manitoba in 2017, it was found that methamphetamine use was more common among women than men (Casey, 2019). Methamphetamine use among women is associated with rapid escalation of patterns of use, as they transition from recreational use to dependence more often than their male counterparts (Bach et al., 2020; Saw et al., 2017). This is thought to be partially due to

the fact that the age of first use tends to be younger for females compared to males (Casey, 2019; Dluzen & Liu, 2008; He et al., 2013). However, some studies show age of first use to be similar between males and females (Simpson et al., 2016). Health consequences of methamphetamine use disproportionately affect women more than men. For example, women face more pressure to engage in risky sexual behaviours, as there is pressure to obtain substances through the sex trade (Casey, 2019). Women are also more likely to experience a higher incidence of psychiatric comorbid conditions, as well as negative psychosocial conditions including intimate partner violence, and low economic status/unemployment (Bach et al., 2020; Franke et al., 2022).

2.3.2 Ethnicity

According to the United Nations, ethnicity can be broadly defined as a “shared understanding of the history and territorial origins of a community, as well as on particular cultural characteristics such as language, religion or specific customs/ways of life” (Statistics Canada, 2021). Use of methamphetamine has increased among a variety of ethnic groups in the United States including Hispanics, African Americans and Asian Americans (Semple et al., 2009). In a large study Oetting et al. (2000), examined ethnic differences in methamphetamine use of 629,722 high school students in the United States. They concluded that highest prevalence of methamphetamine use was found among Indigenous populations and Mexican Americans, however they noted that this finding may be confounded with geography (Oetting et al. 2000). For example, they found rates of methamphetamine use in the Western states to be twice those of the Eastern states, and it is believed there is a greater proportion of these two ethnic minority groups living in Western states (Oetting et al., 2000). The demographics of methamphetamine use are changing, indicating a need for culturally appropriate outreach and treatment facilities (Herbeck et al., 2013). Ethnic-minority populations may be at an increased risk of adverse methamphetamine related health consequences, related to use and dependence (Herbeck et al., 2013). Initiation can be impacted by perceived risk group. A systematic review looking at the risk factors for methamphetamine use determined that in high-risk youth (those with previous drug abuse of substances other than methamphetamine, or recruited from a juvenile detention center), Caucasian youth

were more likely to use methamphetamine compared to African American and Asian youth, but there were no significant differences in use between Caucasian and Hispanic youth (Russell et al., 2008). However, in low-risk youth (those with no previous reported drug abuse), Caucasian youth were more likely to use methamphetamine compared to African American and Asian youth, but were also significantly less likely to use compared to Hispanic youth (Russell et al., 2008). In the United States, age of first methamphetamine use has been associated with ethnicity (Saw et al., 2017). Lynch et al. (2021) found Hispanic/Latino adolescents had an earlier age of first use compared to those who identified as Caucasian, and both Brecht et al. (2007) and Semple et al. (2009) found that African American ethnicity was associated with an older age of first use.

2.3.3 Education

Lower educational attainment is a risk factor for methamphetamine use, methamphetamine use disorder, and methamphetamine use with injection (Han et al., 2021). Methamphetamine use tends to begin during late adolescence and early adulthood; a time when it is common for individuals to still be attending school. It can result in cognitive impairment, including deficits in memory, attention and executive functioning. These are various negative side effects that impact school-aged youth (Henry et al., 2010; Plüddemann et al., 2010). Initiation during adolescence impacts both the quantity and quality of education received. Dean et al. (2012) found that in regards to quantity, a younger age of first use is associated with fewer years of education. Sarani et al. (2020) found an older age of first use was associated with higher levels of education.

Researchers have reported that age of first use was negatively related to years of education attainment, as methamphetamine users had fewer years of education (Dean et al., 2012; Russell et al., 2008). It has been reported that methamphetamine initiation in high school predicts school dropout one year later (Dean et al., 2012). The relationship between age of first use and education level is an important factor to consider, as younger age of first use and lower education levels may have carry-over effects on an individual throughout adulthood, including lower income, unemployment and lower life satisfaction (Plüddemann et al., 2010).

2.3.4 Quality of Life

Quality of life is a subjective perception of an individuals' own life status. It involves several domains including physical health, psychological state, social relations and living conditions (Wang et al., 2020). Quality of life can be influenced by a variety of factors including patterns of methamphetamine use (injecting vs non-injecting), and contextual factors such as polysubstance use, unemployment and comorbid psychiatric conditions (McKetin et al., 2019). Adolescents who begin using substances during their formative years are at an increased risk of developing both mental and physical health issues (Sommers & Baskin, 2006). This can interfere with their educational and occupational pursuits, and therefore affect their long-term quality of life (Sommers & Baskin, 2006). Impairments in communication, work and recreation have all been linked to methamphetamine use (Henry et al., 2010). Individuals who use methamphetamine, on average, have a poorer quality of life, including poorer social functioning and mental health than the general population (Henry et al., 2010; McKetin et al., 2019). Henry et al. (2010) found that earlier age of first use, combined with an increased frequency of use, was significantly associated with greater impairment in functional performance, demonstrating that chronic methamphetamine use is associated with a decreased ability to perform common everyday tasks. Severity of methamphetamine use disorder acts as a stable predictor of overall quality of life, whereby increased severity predicts poorer quality of life (Wang et al., 2020).

2.4 What is Social Integration?

Social integration is a multidimensional concept that can be defined as the degree to which an individual is linked to a set of social relationships/networks. It includes active engagement in social activities outside the home, interpersonal relations, and a sense of communality with one's social roles (Holt-Lunstad, 2015). It is a bond that allows people to feel attached to a larger society, and can be measured by the strength of ties people have to their social groups (Green et al., 2010). Involvement in major social institutions such as family, school, church and economy contribute a great deal to shaping the behaviours of an individual, as they allow an individual to expand and restructure their social networks (Hatch, 2007). Fewer and poorer social relationships are associated with

poorer physical health as well as an increase in risk for early mortality (Holt-Lunstad, 2015). The opposite is true for those who have more healthy social relationships, as these individuals typically have greater physical health and greater odds for survival (Holt-Lunstad, 2015).

2.4.1 Social Integration and Substance Use

A bidirectional association exists between social integration and substance use. Social integration is a factor associated with early substance use initiation (i.e., poor social integration can occur before early substance use initiation) (Green et al., 2010). However, social integration can also be the consequence of early substance use (i.e., poor social integration occurs after early substance use initiation). Several studies have examined the role of social integration as a factor in the initiation, continuation and cessation of substance use. Research has suggested that there is an inverse relationship between social integration and risk-seeking behaviour (Leslie et al., 2013). Poorer social integration is reflective of a weaker connection to social groups, as well as participating in fewer social roles, and an increase in these behaviours (Leslie et al., 2013). Social integration has been found to be a protective factor against substance use (Brand et al., 2018). It is important to note that the social role itself is not necessarily the critical factor in protecting against substance use, but rather it is the amount of social integration that matters (Green et al., 2010). Green et al. (2010) found that having lower overall social integration predicted the initiation of cocaine and heroin.

Failure to meet developmentally appropriate social activities is thought to be related to substance use. Adolescents are particularly at risk, as problems at school, home or with their peers can increase the risk of initiation (Green et al., 2010). Susceptibility to peer pressure, and the influence of peers can lead to initiation during adolescence, as there is a strong link between use and social variables (Gallegos et al., 2021; Degenhardt et al., 2018). The onset, continuation, escalation and cessation of substance use is influenced by social roles (Green et al., 2010). Researchers have found that those with fewer social roles (poorer social integration) have more than three times the risk for developing a drug use disorder compared to those with more social roles (Green et al., 2010). Jones-Johnson et al. (2013) analyzed data from the Americans' Changing Lives Survey, a large

nationally representative study in the United States. They aimed to understand the relationship between social integration and substance use, mainly alcohol and tobacco. Findings demonstrated social integration impacts the number of drinks and cigarettes smoked per day among adults (Jones-Johnson et al., 2013). Social integration is a component of community integration, along with physical integration and psychological integration. Physical integration refers to how an individual participates in activities in the community and uses community goods and services (Baumgartner & Herman, 2012). Psychological integration refers to the extent an individual feels a part of the community (Baumgartner & Herman, 2012). Community factors play a role in exposing, and normalizing substance use patterns at a younger age (Maina et al., 2021). However, various community-level factors also work to decrease the risk of substance initiation during adolescence. Some of these factors include having a positive school climate, feeling safe at school or in the community, and having a connection to school or other adults in the neighborhood (Trujillo et al., 2019).

2.4.2 Social Integration and Methamphetamine Use

Although commonly associated with the party scene, consumption of methamphetamine occurs throughout various social groups, including family, friends and coworkers. First-time users often do not seek out the drug themselves, but rather are introduced to it through their social networks (Boshears et al., 2011; Hobkirk et al., 2016; McCormick et al., 2007). In the United States, among high school youth, the most commonly used substance is cannabis. Oetting et al. (2000) suggests that high school youths may have increased access to methamphetamine through cannabis distribution networks. Substance use amongst women is often influenced by power dynamics in their relationships with men, as many women initiate substances if their partner is using drugs (Casey, 2019). Women have reported that their significant other was the first person to introduce them to methamphetamine (Hobkirk et al., 2016). As use continues to increase amongst adolescents, so does the social pressure from their friends. Hobkirk et al. (2016) suggests friends are the most common social network to introduce people to methamphetamine.

Researchers have also examined the effects of methamphetamine use on social integration. Substance use, including methamphetamine, can impact an individual's

physical, social, economic and mental health. It can lead to social impairment as users gradually become more socially vulnerable over time (Chomchoei et al., 2019; Huang et al., 2021; Kwon & Han, 2018). Methamphetamine use leads to social isolation, and can result in anti-social behaviours and the dissolution of relationships (Government of Canada Department of Justice, 2019; Watt et al., 2014). Research looking at injection drug use found that those who inject methamphetamine have more isolated social networks, and therefore poorer social support systems compared to other injection drug users (Marshall et al., 2011).

Most of the literature to date has focused on the general relationship between methamphetamine and social integration. Fewer studies have been done to assess the relationship between age of first methamphetamine use and social integration. We were unable to examine social integration scores as a factor of early methamphetamine use as we do not have information on social integration scores prior to initiation. Therefore, this thesis will aim to examine social integration scores as a consequence of early methamphetamine use, determining if a potential relationship exists between age of first use and later social integration scores, while controlling for known confounding factors.

Chapter 3

3 Methods

This chapter is a description of the data source, methods of recruitment, main variables used in the present study and methods of statistical analysis.

3.1 Data Source

This thesis utilizes data from the Methamphetamine Harm Reduction Study, (Forchuk et al., 2020), a prospective cohort study with the aim of creating, evaluating, and introducing harm reduction strategies into the hospitals for people who use methamphetamine. This study examined the data collected at baseline. Data were collected between October 2020 and September 2021, using a mixed-methods one-to-one interview approach. Interviews lasted approximately 60 minutes, and were conducted in person at a convenient location arranged with the researchers, or via telephone. Participants were allowed to skip any questions they did not feel comfortable answering. After completing the interview, participants were given a small monetary token (\$20) to thank them for their participation.

3.2 Recruitment

Participants were residents of London, Ontario and the surrounding area recruited from hospitals, homeless agencies, and community outreach programs. Purposive sampling techniques were used, as specific locations were targeted. Posters were placed at hospitals and community services describing a study being conducted in current or previous methamphetamine users, inviting potential participants to volunteer and enroll in the study. Interested participants were able to contact the Principal Investigator themselves, or have a health care/service provider contact the research team on their behalf.

3.3 Study Sample

To be eligible, participants had to have prior or current lived experience using methamphetamine, and had to have received services from a hospital, including but not limited to inpatient, outpatient and emergency room services at any point in their life.

Participants also had to be able to communicate in English and provide informed consent. Participants were excluded from the study if they were younger than 16, older than 85, and had not used methamphetamine or received hospital services. A total of 120 individuals between the ages of 16-85 were enrolled. We chose to analyze individuals starting at age 16, as we do not have ethical approval for those younger than 16. Ethics were approved by the Health Sciences Research Ethics Board (HSREB) at Western University.

3.4 Measures

Seven quantitative instruments were used during the individual interviews to collect data on demographics, community integration, health and health service use, quality of life, and substance use. In addition, qualitative information was collected using open-ended interview questions. For the present study, three of the quantitative instruments were used, including the demographics form, Community Integration Questionnaire-Revised, and the Lehman's Quality of Life Interview Questionnaire.

3.4.1 Demographic Variables

Sociodemographic information was collected from participants using an in-house demographics form. We collected information on participants sex, ethnicity and level of education. There were three categories for sex including male, female and those who do not identify as either male or female. We opted to exclude those who identified as neither male nor female due to small sample size ($n=3$). The present study grouped ethnicity into three categories including Caucasian, Indigenous, and Other/Mixed. Ethnicity was collapsed into three categories in order to maintain minimum cell sizes for analysis. Education was collapsed into three categories including grade school, high school, and college/university/trade school for the same reasons.

3.4.1.1 Age of First Methamphetamine Use

Our demographics form included a subsection with questions pertaining to mental health, addiction, and physical health. In this section, participants were asked a series of questions related to their methamphetamine use. Our main variable of interest from this

section was the open-ended question “How old were you when you first used methamphetamine?”. Interviewers recorded participants age of first methamphetamine use in a text-box format. Age of first use was then used as our main exposure variable in our analysis.

3.4.2 Community Integration Questionnaire Revised (CIQ-R)

The Community Integration Questionnaire (CIQ) is a tool used by researchers to obtain information about how connected an individual is to their community (Callaway et al., 2014). It is used to assess a person’s control over their home environment, integration into their social support network, as well as productive use of their daytime activities and financial circumstances (Callaway et al., 2014). The questionnaire is composed of 15 items across three overall subscales including: Home Integration (housework, meal preparation etc.), Social Integration (socialization, leisure activities), and Productivity, where Productivity refers to work, school or volunteer activities. The Community Integration Questionnaire was revised in 2014, and the present study uses the revised version of this tool. The revision involved the addition of a new subscale, Electronic Social Networking, which is used to provide insight on technology-enabled participation and its impact on integration (Callaway et al., 2014). In total, there are 18 items across these four subscales. Each subscale is scored to give an overall assessment of integration in each domain (Dijkers, 2000). The sum of the subscales forms the overall community integration score.

3.4.2.1 Psychometric Properties of Community Integration Questionnaire Revised (CIQ-R)

The CIQ was originally designed to assess integration in those who have had a traumatic brain injury. Test-retest reliability analyses were conducted with 78 respondents in order to assess the reliability of the CIQ-R (Callaway et al., 2014). Pearson correlation scores were collected at two time periods, 10 weeks apart. (Callaway et al., 2014). Paired sample t-tests demonstrated little change in absolute scores over time (Callaway et al., 2014).

In order to assess the extent to which the addition of the electronic social networking subscale contributed to community integration, total CIQ scores (excluding items from the electronic social networking scale) were correlated with scores from the electronic social networking subscale (Callaway et al., 2014). A moderate, positive correlation was found between the two scores, demonstrating that although the scores were related, they were able to capture different aspects of integration (Callaway et al., 2014). This further suggested that the addition of this new subscale added additional information (Callaway et al., 2014). It has therefore been recommended that this revised version of the CIQ be used in future analyses (Callaway et al., 2014).

To date, most research of the psychometric properties of the CIQ-R tool have been assessed in populations with physical disabilities including traumatic brain and spinal cord injuries. For example, results of a study conducted in an Italian population showed, that in a sample of 80 individuals with spinal cord injuries, the CIQ-R proved to be a valid and reliable tool to assess community integration (Panuccio et al., 2022). Intraclass correlation coefficient values ranged from 0.94 to 1, demonstrating excellent test-retest reliability (Panuccio et al., 2022). Though this tool has been validated in populations of traumatic brain and spinal cord injuries, psychometrics properties have yet to be tested in populations of substance users.

3.4.2.2 Home Integration

Home integration refers to active participation of a person in the operation of the home. This subscale is made up of 6 questions including: 1. “Who usually does the shopping for groceries or other necessities in your household?”, 2. “Who usually prepares meals in your household?”, 3. “In your home who usually does the normal everyday housework?”, 4. “Who usually cares for the children in your home?”, 5. “Who usually plans social arrangements such as get-togethers with family and friends?” and 6. “Who usually looks after your personal finances, such as banking or paying bills?” Responses to each question are scored between 0 and 2, where 0 indicates the respondent answered ‘someone else’, 1 indicates the respondent answered ‘yourself and someone else’ and 2 represents an answer of ‘yourself alone’. These scores are summed together to provide an

overall domain score between 0 and 12, with higher scores indicating higher levels of home integration.

3.4.2.3 Social Integration

Social integration refers to interpersonal relations and participation in a variety of activities outside of the home. This subscale is made up of 5 questions including: 7. “Approximately how many times a month do you usually participate in shopping outside your home?”, 8. “Approximately how many times a month do you usually participate in leisure activities such as movies, sports, restaurants etc.?”, 9. “Approximately how many times a month do you usually visit your friends or relatives?”, 10. “When you participate in leisure activities do you usually do this alone or with others?”, and 11. “Do you have a best friend in whom you confide?”. Similar to the home integration score, each question is scored between 0 and 2. For questions 7 through 9, a score of 0 represents an answer of ‘seldom/never’, a score of 1 represents an answer of ‘1-4 times’, and a score of 2 represents an answer of ‘5 or more times.’ For question 10, a score of 0 represents an answer of ‘mostly alone’, a score of 1 represents an answer of “mostly with family members, or mostly with friends who have a disability”, and a score of 2 represents an answer of ‘mostly with friends who do not have a disability, or with a combination of family and friends.’ For question 11, a score of 0 represents the respondent answered ‘no’, and a score of 2 indicates the respondent answered ‘yes.’ These scores are then summed together to provide an overall score between 0 and 10, with higher scores indicating higher levels of social integration.

3.4.2.4 Productivity

Productivity refers to the involvement in employment, education and volunteer activities. This subscale includes 4 questions, with scores ranging from 0 to 7, and higher scores indicating higher levels of productivity. These questions include: 12. “How often do you travel outside the home?”, 13. “Please check the answer that best corresponds to your current (during the past month) work situation”, 14. “Please check the answer that best corresponds to your current (during the past month) school or training program situation”, and 15. “In the past month, how often did you engage in volunteer activities?”

A score of 0 for question 12 represents an answer of ‘seldom/never (less than once per week)’, 1 represents an answer of ‘almost every week’, and 2 represents an answer of ‘almost every day’. Answers for questions 13-15 are combined to form one variable named ‘Jobschool’. This variable is scored between 0 and 5, where 0 represents ‘not working, not looking for work, not going to school, and no volunteer activities’, 1 represents ‘volunteers 1 to 4 times per month and not working, not looking for work, not in school’, 2 represents ‘actively looking for work and/or volunteers 5 or more times per month’, 3 represents ‘attends school part-time or working part-time (less than 20 hours per week)’, 4 represents ‘attends school full-time or works full-time’, and 5 represents ‘works full-time and attends school part-time or attends school full-time and works part-time (less than 20 hours per week)’. If the individual is retired due to their age, this ‘Jobschool’ variable becomes based on the response to question 15 only. The overall productivity score is the sum of the score of question 12 and the score of the ‘Jobschool’ variable.

3.4.2.5 Electronic Social Networking

Electronic social networking refers to use of electronic devices to connect with people. This subscale is made up of 3 questions. Questions include: 16. “How often do you write to people for social contact using the Internet (e.g., email, social networking sites such as Facebook)?”, 17. “How often do you talk to people for social contact using an online video link (e.g., Skype, FaceTime)?”, 18. “How often do you make social contact with people by talking or text messaging using your phone?” Each question is scored between 0 and 2, where 0 represents ‘seldom/never’, 1 represents ‘almost every week’, and 2 represents ‘every day or most days.’ These scores are summed together to provide an overall score between 0 and 6, with higher scores indicating higher levels of electronic social integration.

3.4.2.6 Total Score

The total CIQ-R score is the sum of the Home Integration score, Social Integration score, Productivity score and Electronic Social Networking score summed together. This score provides an overall assessment of community integration, and can range from 0 to 35.

Higher scores are indicative of greater integration, whereas lower scores are reflective of poorer integration.

3.4.3 Lehman's Quality of Life Interview Questionnaire

The Lehman's Quality of Life Interview Questionnaire was developed in 1980 to assess the life circumstances of those living with severe mental illness (Lehman et al., 1995). The present study uses the brief version of this questionnaire, developed in 1994. This questionnaire is a 74-item instrument that assesses quality of life in both objective (experiences), and subjective terms (feelings about the experiences). There are 8 life domains including 1. living situation, 2. daily activities and functioning, 3. family relations, 4. social relations, 5. finances, 6. work and school, 7. legal and safety issues and 8. health (Lehman et al., 1995).

Each domain starts with the respondent's objective quality of life and then looks at subjective quality of life, asking about the respondent's overall life satisfaction in that domain (Lehman et al., 1995). For example, for social relations the respondent is asked an objective question such as "How often do you do things with a close friend?", where their response options are "at least once a day, at least once a week, at least once a month, less than once a month, or not at all" (Lehman et al., 1995). After being asked the objective question, they are then asked a subjective question such as "Looking at the delighted/terrible scale, how do you feel about the things you do with other people?" (Lehman et al., 1995). Respondents provide their answer as a number between 1 and 7. The pairing of both objective and subjective questions is central to this instrument (Lançon et al., 2000).

At the beginning and the end of the instrument, respondents are asked about how they perceive their global life satisfaction using a delighted/terrible scale which ranges from 1 to 7, where 1 is terrible and 7 is delighted. For the purpose of the present study, only the global life satisfaction scales were used to gauge an overall understanding of how participants perceive their overall quality of life. In order to get an average global life satisfaction score for each participant, the responses from these two scales were summed

together and divided by 2. The global life satisfaction score was used as a covariate in the regression model for Objective 1.

3.4.3.1 Psychometric Properties of the Lehman's Quality of Life Interview

Most literature looking at the psychometric properties of the Lehman's Quality of Life Interview Questionnaire (QOLI) have been conducted in populations of individuals with chronic psychiatric disorders. For example, in a population of individuals with severe and persistent mental illnesses, Lehman et al. (1993) examined the convergent validity of the Lehman's Quality of Life Interview and the Heinrichs-Carpenter Quality of Life Scale (QLS) using correlations. When measured at the same time point, subjective quality of life measures (i.e., general life satisfaction score) from the QOLI demonstrated significant convergence, as well as test-retest correlation with a related construct from the QLS (Lehman et al., 1993). Similar results were seen when looking at the objective quality of life measures (i.e., frequency of family contacts, social relations and daily activities), as results showed moderate and significant correlations with similar measures on the QLS (Lehman et al., 1993). This demonstrated good convergent validity in a population with severe and persistent mental illnesses.

To the best of our knowledge, no literature has examined the psychometric properties of the Lehman's Quality of Life Interview Questionnaire in a population of methamphetamine users specifically. However, Wasserman et al. (2006) evaluated the psychometric properties of this tool in a population of 126 opioid injection drug users. They assessed internal consistency, as well as convergent validity with the SF-36 and Beck Depression Inventory as reference. Results demonstrated acceptable internal consistency (Wasserman et al., 2006). Convergent validity was also demonstrated by moderately high correlations between subscales on the QOLI and the SF-36 and Beck Depression Inventory (Wasserman et al., 2006). Therefore, there is evidence to support that the QOLI is an acceptable quality of life measure in a population of opioid injection users (Wasserman et al., 2006).

3.5 Statistical Analyses

We conducted descriptive analyses of the sample and reported frequencies for categorical data, as well as means and standard deviations for continuous data. Bivariate analyses were performed to examine the relationship between age of first use (independent variable) and social integration (dependent variable). All statistical analyses were conducted using IBM SPSS v. 27 (IBM Corp, 2020).

To address objective 1, Pearson correlations were performed using age of first use as the independent variable, and social integration score as the dependent variable. We then used Pearson correlations to look at other subscale scores of community integration. We kept the independent variable the same, but switched the dependent variable from social integration score to home integration score, productivity score, electronic social networking score, and total CIQ-R score for the sample. To address objective 2, participants were divided and analyzed based on sex (male/female). We opted to exclude those who identified as neither male nor female when sex was used in the analysis, as only three individuals identified as being a part of this group. Since the expected cell count was less than 5, these values were suppressed (Matthews et al., 2016). Mean social integration and total CIQ-R scores were descriptively analyzed for each sex by ethnicity and education level in order to get a better understanding of the makeup of our sample.

Linear regression analyses were used to address both objectives 1 and 2, and assumptions for multicollinearity were assessed among covariates using tolerance (Menard, 2002). As expected, multicollinearity was detected among our covariate of total CIQ-R score, as this variable is the sum of four subscales included in the model (Menard, 2002). Total CIQ-R score was therefore removed from the model as it was perfectly predicted by the subscales included (Menard, 2002). To address objective 1, social integration score was used as our dependent variable. Covariates assessed in the model included age of first methamphetamine use, education level, ethnicity, sex, and overall life satisfaction scores. To address objective 2, we used a linear regression model to perform a sex-based analysis. In this model, social integration score remained the dependent variable, and age of first methamphetamine use, sex, and the interaction term between age of first use and sex were included as the independent variables. For both sets of regressions, dummy

variables were created for binary and categorical predictors, and the lowest coded value for each was used as the reference category. All variables were assessed in the model to obtain the models' overall R-squared value.

3.6 Missing Data

For our main independent variable of age of first methamphetamine use, 0.9% of the sample had missing data. Since there were low levels of missingness for this independent variable, it was not necessary to use imputation methods for our model. The primary dependent variable of social integration scores, had 5.1% missingness among the data. We also decided to look at a variety of other covariates in our analysis. There was no missing data for our demographic factors of sex, ethnicity and education level. We had 0.9% missing data for our variable of overall quality of life. Looking at CIQ-R subscale scores, we had 15.4% missing data for home integration scores, 5.1% missing for productivity scores, 0.9% missing for electronic social networking scores, and 20.5% missing for total CIQ-R scores. The high percentage of missing responses for the total CIQ-R scores is reflective of the missing data in the subscales. Those who had missing data on one of the four integration subscales were considered missing from the total CIQ-R score, as the total score is made up from the sum of the subscale scores. This high percentage of missing data was the main statistical reason why total CIQ-R scores were not analyzed as the primary dependent variable.

Chapter 4

4 Results

This chapter presents the main results for this thesis. The first section contains descriptive statistics of our sample, and the following sections contain the analytical findings related to each of our research objectives.

4.1 Sample Characteristics

Descriptive statistics for the analytic sample ($n=117$) are presented in Table 1. In total, there were 117 participants enrolled in this study. Participants were between the ages of 17 and 66 years, and the average age of participants at time of enrollment was 35.9 years ($SD=12.5$). The sample consisted of 79 (67.5%) males, and 38 (32.5%) females. A majority of the sample (61.5%) identified as being Caucasian, 22.2% identified as being Indigenous, and 16.2% identified as being mixed or from other visible minority groups. A total of 38.5% of participants reported their highest education level as elementary school, 43.6% completed high school, and 17.9% had completed college, university or trade school. The minimum age of first use for the sample was 12 years and the maximum age was 59 years. The average age of first use was 25.6 years ($SD=11.4$). On average, participants began using methamphetamine during 2010. The earliest year participants began using was 1968, and the most recent year was 2020.

A total of 111 participants had a completed social integration score. The average social integration score of these participants was 6.5 ($SD=2.4$). Approximately 85% of the sample had a completed home integration score, with the average score being 6.4 ($SD=3.1$). The average productivity score of those with a completed score ($n=111$) was 2.1 ($SD=1.3$), and the average electronic social networking score ($n=116$) was 2.3 ($SD=1.9$). Using these four subscales, we were able to obtain a total CIQ-R score for 93 participants, with the average score being 17.6 ($SD=5.2$). For the sample, participants had an average life satisfaction score of 3.8 ($SD=1.6$) out of a possible score of 7.

Table 1: Descriptive Statistics of the Sample (n=117)

	n (%)	Mean (SD)
Sex		
Male	79 (67.5)	
Female	38 (32.5)	
Current Age	117 (100.0)	35.9 (12.5)
Age of First Methamphetamine Use	116 (99.1)	25.6 (11.4)
Year of First Methamphetamine Use	116 (99.1)	2010.4 (8.3)
Highest Education Level		
Elementary School	45 (38.5)	
High School	51 (43.6)	
College/University/Trade School	21 (17.9)	
Ethnicity		
Caucasian	72 (61.5)	
Indigenous	26 (22.2)	
Other/Mixed	19 (16.2)	
Social Integration Score	111 (94.9)	6.5 (2.4)
Home Integration Score	99 (84.6)	6.4 (3.1)
Productivity Score	111 (94.9)	2.1 (1.3)
Electronic Social Networking Score	116 (99.1)	2.3 (1.9)
Total CIQ Score	93 (79.5)	17.6 (5.2)
Overall Life Satisfaction Score	116 (99.1)	3.8 (1.6)

4.2 Objective 1: Relationship Between Age of First Use and Social Integration

Presented here are the results from objective 1; to assess the relationship between age of first use and social integration, as well as factors that affect methamphetamine use.

First using social integration as the dependent variable, we found no statistically significant associations between social integration scores and age of first methamphetamine use ($r=-0.150$, $p=0.118$), 95% CI [-0.328, 0.038]. We then decided to see if a relationship exists between other various subscales of overall community integration. Using integration subscale scores as the dependent variable, we also found no statistically significant associations between home integration ($r=0.102$, $p=0.317$), 95% CI [-0.098, 0.295], productivity ($r=-0.017$, $p=0.861$), 95% CI [-0.203, 0.171], electronic social networking score ($r=-0.114$, $p=0.223$), 95% CI [-0.291, 0.070], or total CIQ-R scores ($r=-0.028$, $p=0.789$), 95% CI [-0.232, 0.178].

Table 2: Correlation Coefficients (r) Between Age of First Use and CIQ-R Subscale Scores, Total Sample (n = 117; see Table 1 for n for each scale.)

Dependent Variable	Independent Variable	r	p-value	95% Confidence Interval
Social Integration Score	Age of first use	-0.150	0.118	(-0.328, 0.038)
Home Integration Score	Age of first use	0.102	0.317	(-0.098, 0.295)
Productivity Score	Age of first use	-0.017	0.861	(-0.203, 0.171)
Electronic Social Networking Score	Age of first use	-0.114	0.223	(-0.291, 0.070)
Total CIQ Score	Age of first use	-0.028	0.789	(-0.232, 0.178)

4.2.1 Linear Regression

A linear regression was performed for the entire sample (n=117) to investigate whether age of first methamphetamine use was significantly associated with the participant's social integration scores. Social integration scores were used as the dependent variable and age of first use was used as the independent variable.

Table 3: Linear Regression of Social Integration Scores and Age of First Use for the Sample (n=117)

	β Coefficients	p-values	F-value	R ² values
Model		0.118	2.483	0.022
Constant	7.283	<0.001		
Age of First Methamphetamine Use	-0.031	0.118		

The results of the regression for the sample (n=117) indicated that the model explained 2.2% of the variance ($R^2=0.022$), and that the model was not a significant predictor of social integration ($F=2.483$, $p=0.118$). Age of first methamphetamine use did not significantly contribute to the model ($\beta=-0.031$, $p=0.118$).

4.2.2 Multivariable Linear Regression

A multivariable linear regression was performed for the entire sample (n=117), to include other factors associated with methamphetamine use. It was used to investigate whether age of first methamphetamine use, ethnicity, education level, sex, and overall quality of life scores could significantly predict the participants social integration score. Social integration scores were used as the dependent variable, and the other covariates were used as the various independent variables.

Table 4: Multivariable Linear Regression for the Sample (n=117)

	β Coefficients	p-values	F-value	R ² values
Model		0.019*	2.537	0.148
Constant	5.480	<0.001		
Age of First Use	-0.026	0.179		
Indigenous Ethnicity (ref=Caucasian)	0.145	0.792		
Mixed/Other Ethnicity (ref=Caucasian)	0.882	0.158		
Male (ref=Female)	-0.333	0.480		
Overall Life Satisfaction	0.258	0.064		
High School Education (ref=Grade school education)	0.996	0.041*		
College/University/Trade School Education (ref=Grade school education)	1.758	0.006*		

The results of the regression for the sample (n=117) indicated that the model explained 14.8% of the variance ($R^2=0.148$), and that the model was a significant predictor of social integration ($F=2.537$, $p=0.019$). High school education ($\beta=0.996$, $p=0.041$), and college/university/trade school education ($\beta=1.758$, $p=0.006$) both significantly contributed to the model. Our main covariate of interest of age of first use did not significantly contribute to the model ($\beta=-0.026$, $p=0.179$). All other factors including Indigenous or mixed ethnicity, being a male, and overall life satisfaction scores did not significantly contribute to the model. The final predictive model was as follows:

$$\text{Social Integration} = 5.480 + (0.996 * \text{High School Education}) \\ + (1.758 * \text{College/University/Trade School Education})$$

Social integration scores of those with a high school education increase by 0.996 points compared to those whose highest level of education is grade school. Social integration scores of those with a college, university or trade school education increase by 1.758 points compared to those whose highest level of education is grade school.

4.3 Objective 2: Sex-Based Analysis

Presented here are the results from objective 2; to explore whether the association between participant's age of first methamphetamine use and social integration is modified by sex.

4.3.1 Sample Characteristics by Sex

Descriptive statistics for the sample ($n=117$) are displayed in Table 5 by sex. We decided to exclude those who identified as neither male nor female for the purpose of this analysis as sample size was small ($n=3$).

Males

Our sample had a total of 79 males enrolled in this study, and the average age of participants was 36.1 years old ($SD=12.4$). Majority of males (67.1%) identified as Caucasian, 19.0% identified as being Indigenous, and 13.9% identified as being mixed or from other visible minority groups. When looking at level of education, 43.0% reported their highest education level as high school, 38.0% completed elementary school, and 19.0% had completed college, university or trade school. The average age of first methamphetamine use for males was 25.9 years old ($SD=11.4$), and on average, males began using methamphetamines in the year 2010.

A total of 74 male participants had a completed social integration score. The average social integration score of these participants was 6.3 ($SD=2.5$). In regards to home integration score, 79.7% had a completed score, and the average score was 6.5 ($SD=3.1$). Approximately 94% of the sample had a completed productivity score, with the average being 2.0 ($SD=1.1$). Majority of the sample (98.7%) had a completed electronic social networking score, and the average score was 2.1 ($SD=1.9$). Using these four subscales, we were able to obtain a total CIQ-R score for 59 participants (75.0%), with the average score being 17.1 ($SD=5.1$). For this sample, participants had an average life satisfaction score of 3.7 ($SD=1.7$) out of a possible score of 7.

Females

Our sample had a total of 38 females enrolled in this study, and the average age of participants was 35.6 years old (SD=12.8). Half of the females (50.0%) identified as Caucasian, 28.9% identified as being Indigenous, and 21.1% identified as being mixed or from other visible minority groups. When looking at level of education, 44.7% reported their highest education level as high school, 39.5% completed elementary school, and 16.0% had completed college, university or trade school. The average age of first methamphetamine use for females was 25.1 years old (SD=11.3), and on average, participants began using methamphetamines in the year 2010.

A total of 37 female participants had a completed social integration score. The average social integration score of these participants was 6.7 (SD=2.1). In regards to home integration score, 94.7% had a completed score, with the average being 6.4 (SD=3.1). Thirty-six participants (94%) had a completed productivity score, with an average score of 2.3 (SD=1.7). The entire sample (100%) had a completed electronic social networking score, and the average score was 2.8 (SD=2.0). Using these four subscales, we were able to obtain a total CIQ-R score for 34 participants (89.5%), with the average score being 18.5 (SD=5.5). Participants had an average life satisfaction score of 4.1 (SD=1.5) out of a possible score of 7.

Table 5: Descriptive Statistics of the Sample by Sex (n=117)

	Males n=79		Females n=38	
	n (%)	Mean (SD)	n (%)	Mean (SD)
Current Age	79 (100.0)	36.1 (12.4)	38 (100.0)	35.6 (12.8)
Age of First Use of Methamphetamine	79 (100.0)	25.9 (11.4)	37 (97.4)	25.1 (11.3)
Year of First Use of Methamphetamine	79 (100.0)	2010.4 (7.2)	37 (97.4)	2010.3 (10.3)
Highest Education Level				
Elementary School	30 (38.0)		15 (39.5)	
High School	34 (43.0)		17 (44.7)	
College/University/Trade School	15 (19.0)		6 (16.0)	
Ethnicity	53 (67.1)		19 (50.0)	
Caucasian	15 (19.0)		11 (28.9)	
Indigenous	11 (13.9)		8 (21.1)	
Other/Mixed				
Social Integration Score	74 (94.0)	6.3 (2.5)	37 (97.4)	6.7 (2.1)
Home Integration Score	63 (79.7)	6.5 (3.1)	36 (94.7)	6.4 (3.1)
Productivity Score	74 (94.0)	2.0 (1.1)	36 (94.7)	2.3 (1.7)
Electronic Social Networking Score	78 (98.7)	2.1 (1.9)	38 (100.0)	2.8 (2.0)
Total CIQ Score	59 (75.0)	17.1 (5.1)	34 (89.5)	18.5 (5.5)
General Life Satisfaction Score	78 (98.7)	3.7 (1.7)	38 (100.0)	4.1 (1.5)

4.3.2 Sex-Based Analysis of Social Integration and Total CIQ-R Scores by Ethnicity and Education Level

Males

Males identifying as being mixed or from other visible minority groups have the highest social integration score, with the average being 7.3 (SD=2.2). Those who identify as being Indigenous have the lowest, with an average of 5.6 (SD=2.7) out of a possible 10. Caucasian males have an average social integration score of 6.3 (SD=2.5). Similar trends are seen in regards to total CIQ-R scores. Those who identify as being mixed or from other visible minority groups have the highest average total CIQ-R score (16.1, SD=4.5), and those who identify as being Indigenous have the lowest (15.0, SD=5.3). Males identifying as Caucasian have a total CIQ-R score of 15.0 (SD=5.3).

In regards to education level, males who have completed college, university or trade school have the highest social integration score (7.4, SD=2.6), and highest total CIQ-R score (16.4, SD=4.7). Those who have completed grade school have the lowest social integration score (5.6, SD=2.3) and total CIQ-R score (14.7, SD=5.3). Males whose highest level of education was high school have an average social integration score of 6.4 (SD=2.5), and an average total CIQ-R score of 16.3 (SD=4.2).

Table 6: Social Integration and Total CIQ-R Scores of Males (n=74) by Ethnicity and Education Level

	Social Integration Score		Total CIQ-R Score	
	n	Mean (SD)	n	Mean (SD)
Ethnicity				
Caucasian	50	6.3 (2.5)	38	15.9 (4.7)
Indigenous	14	5.6 (2.7)	12	15.0 (5.3)
Other/Mixed	10	7.3 (2.2)	9	16.1 (4.5)
Education Level				
Grade School	28	5.6 (2.3)	22	14.7 (5.3)
High School	32	6.4 (2.5)	25	16.3 (4.2)
College/University/Trade School	14	7.4 (2.6)	12	16.4 (4.7)

Females

Females identifying as being Indigenous have the highest social integration score, with the average being 7.5 (SD=2.1). Those identifying as being Caucasian have the lowest score, with an average score of 6.1 (SD=1.9). Females identifying as being mixed or of other visible minority groups have an average score of 7.5 (SD=2.1). Similar trends are seen in regards to total CIQ-R scores. Indigenous females have the highest average total score (17.9, SD=4.9), and Caucasian females have the lowest (16.0, SD=4.6). Those females who identify as being mixed or of other visible minority groups have an average total CIQ-R score of 17.6 (SD=5.8).

Similar to the male participants, females whose highest level of education was college, university or trade school had the highest average social integration score (7.3, SD=2.2)

and average total CIQ-R score (22.0, SD=4.3). Females who completed grade school had the lowest average social integration score (6.0, SD=2.2), and average total CIQ-R score (15.0, SD=4.4). Females whose highest level of education was high school have an average social integration score of 7.1 (SD=2.0), and an average total CIQ-R score of 16.9 (SD=4.5).

Table 7: Social Integration and Total CIQ-R Scores of Females (n=37) by Ethnicity and Education Level

	Social Integration Score		Total CIQ Score	
	n	Mean (SD)	n	Mean (SD)
Ethnicity				
Caucasian	19	6.1 (1.9)	17	16.0 (4.6)
Indigenous	10	7.5 (2.1)	10	17.9 (4.9)
Other/Mixed	8	7.4 (2.3)	7	17.6 (5.8)
Education				
Grade School	14	6.0 (2.2)	14	15.0 (4.4)
High School	17	7.1 (2.0)	15	16.9 (4.5)
College/University/Trade School	6	7.3 (2.2)	5	22.0 (4.3)

Males who identified as being Caucasian had greater social integration scores compared to females who identified as being Caucasian. However, females who identified as being Indigenous or mixed/of another visible minority had greater social integration scores compared to men of the same ethnicity. In regards to total CIQ-R scores, females of all ethnicities (Caucasian, Indigenous, mixed), consistently had greater total CIQ-R scores compared to males of the same ethnicity. On average, females whose highest level of education was grade school or high school, had greater social integration scores compared to males with the same level of education. Males whose highest education level was college, university or trade school had higher social integration scores compared to females with the same level of education. Females had greater total CIQ-R scores compared to males for all levels of education.

4.3.3 Regression Model of Social Integration and Sex

A simple linear regression was performed to investigate whether sex was significantly associated with social integration scores. We used social integration scores as the dependent variable and sex as the independent variable. Females were coded as 0, and males were coded as 1. Results showed that the model explained 0.7% of the variance in social integration scores ($R^2=0.007$). The model was not a statistically significant predictor of social integration scores ($F=0.755$, $p=0.387$). Sex as our covariate ($\beta=-0.419$, $p=0.387$) did not significantly contribute to the model.

Table 8: Linear Regression Model for Social Integration Scores Using Sex as a Covariate

	β Coefficients	p-values	F-value	R^2 values
Model		0.387	0.755	0.007
Constant	6.730	<0.001		
Sex (ref=Female)	-0.419	0.387		

4.3.4 Regression Model of Social Integration, Sex, and Age of First Use

A second linear regression was performed using social integration as the dependent variable and sex, and age of first methamphetamine use as the covariates. Results showed that the model explained 3.3% of the variance in social integration scores ($R^2=0.033$). Adding the variable of age of first methamphetamine use slightly improved the model as the R-squared value increased from 0.7% to 3.3%. The model was not a statistically significant predictor of social integration scores ($F=1.825$, $p=0.166$). Our covariates of sex ($\beta=-0.515$, $p=0.283$), and age of first methamphetamine use ($\beta=-0.030$, $p=0.131$) were not statistically significant.

Table 9: Linear Regression Model for Social Integration Scores Using Sex, and Age of First Methamphetamine Use as Covariates

	β Coefficients	p-values	F-value	R ² values
Model		0.166	1.825	0.033
Constant	7.603	<0.001		
Sex (ref=Female)	-0.515	0.283		
Age of First Methamphetamine Use	-0.030	0.131		

4.3.5 Regression Model of Social Integration, Sex, Age of First Use and the Interaction Term

For our final linear regression, we kept social integration as the dependent variable, and sex and age of first methamphetamine use as the covariates, however we added in an interaction term between sex and age of first use. Results showed that the model explained 3.5% of the variation in social integration scores ($R^2=0.035$). Therefore, adding the interaction term to the model slightly improved the model. However, the model was not found to be statistically significant ($F=1.277$, $p=0.286$). Our covariates of sex ($\beta=-1.001$, $p=0.395$), age of first methamphetamine use ($\beta=-0.043$, $p=0.222$), and the interaction term of sex*age of first use ($\beta=0.019$, $p=0.651$), were all found not to be statistically significant.

Table 10: Linear Regression Model for Social Integration Scores Using Sex, Age of First Methamphetamine Use and the Interaction Term as Covariates

	β Coefficients	p-values	F-value	R ² values
Model		0.286	1.277	0.035
Constant	7.931	<0.001		
Sex (ref=Female)	-1.001	0.395		
Age of First Methamphetamine Use	-0.043	0.222		
Sex*Age of First Methamphetamine Use (interaction term)	0.019	0.651		

Chapter 5

5 Discussion

This chapter will discuss the study's research objectives in relation to the existing literature. It will also discuss the strengths and limitations of the study, as well as directions for future research and implications.

5.1 Summary of Findings

5.1.1 Social Integration and Age of First Methamphetamine Use

The main objective of this study was to determine if a relationship exists between social integration and age of first methamphetamine use, hypothesizing that lower social integration scores are associated with having a younger age of first methamphetamine use. In the present study we found the average age of first use to be 25.6 years old. This finding differs from what has been commonly reported in the literature, as our finding of age of first use is higher. Previous research has found the average age of first methamphetamine use to consistently be between 19 to 21 years old (Brecht et al., 2007; Darvishzadeh et al., 2019; Guerin & Kim, 2021; Hobkirk et al., 2016; Reid et al., 2007; Yimsaard et al., 2018). Our finding may differ from previous findings due to the nature of our sample. The current age of our participants at the time of the interview ranged from 17 to 66 years old, a span of 49 years. Since our sample had a wide age range, we had high variability in age at first use in our sample. The majority of the current literature analyzes methamphetamine users over a much narrower range of ages. For example, Darvishzadeh et al. (2019) looked at a sample of participants between the ages of 19 to 29; a span of 10 years, whereas Reid et al. (2007) looked at a sample between the ages of 18 to 25, a span of 8 years.

In regards to social integration, we found the average social integration score to be 6.5 out of a possible score of 10. After analyzing the sample as a whole, we did not find a statistically significant association between age of first use and social integration scores. Though not statistically significant in any of our analyses, it is interesting to note the direction associated with age of first use in our regression models, as the direction is

always negative. As age of first use increases by 1-year, social integration scores decrease. This is the opposite of what was hypothesized, as it would imply that older age of first use is associated with lower social integration scores, however these findings were consistently not statistically significant. Social integration was measured through scoring a series of questions related to social and leisure activities. Age of first methamphetamine use and its impact on social integration scores do not have a direct comparison in the literature, as no previous studies have examined social integration scores using the Community Integration Questionnaire-Revised in this type of study population.

5.1.1.1 Factors that Affect Methamphetamine Use

Prior literature has identified many individual, social and community level factors known to be associated with methamphetamine use. Some of these factors include sex, ethnicity, sexual orientation, marital status, income, rural location, education level, family relationships, childhood adverse events/maltreatment, and psychiatric conditions (Casey, 2019; Chomchoei et al., 2019; Darvishzadeh et al., 2019; Guerin & Kim, 2021; Huang et al., 2021). For the present study, the following factors were taken into consideration: sex, ethnicity, education level, and overall life satisfaction/quality of life. Due to limitations in our data, including lack of variability in response and small cell sizes, we were unable to include all factors of interest mentioned in previous research.

Upon performing our multivariable linear regression for the sample, we found having a high school education ($\beta = 0.996$, $p = 0.041$) and college/university/trade school education ($\beta = 1.758$, $p = 0.006$) to be significantly associated with social integration scores. These results demonstrate that social integration scores increase with higher levels of education. None of our other covariates met the threshold for statistical significance ($\alpha = 0.05$), and therefore were not included in our model. Previous literature has found education level to be positively associated with social integration scores (Dibello et al., 2020). This may be because higher levels of education promote better social wellbeing through helping to establish stronger, and larger social networks, as it increases both the probability of social support, as well as the number of support providers in one's network (Brandt & Hagge, 2020; Dibello et al., 2020).

5.1.2 Sex-Based Analysis of the Sample

In our sample, we had a small number ($n = 3$) of participants who identified as being neither male nor female. For this reason, we were unable to analyze the data of these participants in our sex-based analysis, and therefore only included those who identified as being male or female. Very few studies looking at the age of first methamphetamine use have accounted for gender diverse individuals in their analysis (Barger et al., 2021; Watson et al., 2020). Bach et al. (2020) discuss how a similar issue occurred, where the percentage of respondents who identified as being transgender, two-spirited, or other non-binary persons was too small (1%) to gather any information on their age of first use and relationship with methamphetamine, leading to their exclusion from their analysis.

Our present study found the average age of first use to be similar between males and females (25.9 years old vs. 25.1 years old), though females started using at a slightly younger age. Current research demonstrates a lack of sex differences in regards to the age of first methamphetamine use, citing that both males and females use around the same age (Simpson et al., 2016). However, there have been reports of women initiating use at an earlier age, though these findings are not always statistically significant (Bach et al., 2020; Casey, 2019; Dluzen & Liu, 2008).

We analyzed a series of sociodemographic factors by sex identity, and performed quantitative methods to determine how these factors influence social integration and total community integration scores. Looking at descriptive statistics, compared to males, females had higher scores for both social integration and total community integration. The overall descriptive finding of sex differences in regards to social integration is similar to what has been found in literature, as it has been discovered that persistent sex differences exist in both the degree and pattern of people's integration into society (European Bank for Reconstruction, 2011). Umberson et al. (1996) have found clear differences between men and women in regards to the number and quality of social relationships they both have. Results demonstrated greater social integration for women compared to men, as there is evidence to support greater social connectedness among women, particularly in times of stress (Turner & Turner, 2013). However, further

regression analyses showed that sex, age of first use, and the interaction between sex and age of first use were not significantly associated with social integration scores.

5.2 Strengths

There are many strengths to our study. Firstly, the way participants were recruited to participate can be considered a strength. Recruitment occurred at numerous locations throughout London, Ontario and the surrounding areas. Participants and research staff were flexible when conducting interviews, as they were able to be interviewed in person at a convenient location or over the phone. Allowing participants to have a choice over how they were interviewed may have made participants feel more comfortable and open to participating in the study.

Our study utilized a series of self-report questionnaires. The use of self-report questionnaires is a strength as overall, self-report measures of amphetamine use have demonstrated moderately high validity (Napper et al., 2010). Another strength of our study is we had high completion rates for our main variables of interest including age of first use and social integration scores. There was little data missing, as nearly everyone in the sample (99.1%) provided us with information regarding their age of first use, and 94.9% provided us with complete social integration scores. Though social integration was our main variable of interest, another strength was that we were able to descriptively examine other integration scales that contribute to overall integration in the community, including home integration, productivity and electronic social networking. This allowed us to get a more in-depth look at various components of integration.

There is a current gap in the literature looking at how age of first methamphetamine use impacts social integration. The final strength of our study was we aimed to address this gap as we performed a series of analyses to see if a relationship exists between the two. The prevalence of methamphetamine is on the rise. However, previous research has not considered how the age of methamphetamine initiation impacts social integration, but rather the focus seems to be on a variety of other substances including alcohol, tobacco, inhalants and hallucinogens (Burns et al., 2017).

5.3 Limitations

Though this study has many strengths, it is not without limitations. We performed a secondary analysis using cross-sectional data. Performing a secondary analysis is a limitation as we could only use the instruments that were available for use through the parent study. Because social integration was measured concurrently, and age of first methamphetamine use occurred in the past, we cannot make inferences about poor social integration as a risk factor for early age of first methamphetamine use. For the same reasons, we were unable to identify if social integration changed since the onset of or as a result of methamphetamine use. Causal relationships cannot be drawn; therefore, it is important to note that any significant association identified may not be causal in nature.

Participants of this study had to be current or previous methamphetamine users. However, majority of our sample were polysubstance users (i.e., using methamphetamine as well as other substances). A total of 90 people were current users, and 26 were previous users of methamphetamine, as well as other substances. Results of our study may have been affected by unmeasured confounding, and polysubstance use. We were unable to stratify our participants based on user status and account for this polysubstance use due to the small sample size of current or previous users of methamphetamine only. A total of 5 individuals were current, and 4 were previous users of methamphetamine alone.

We used data collected from our parent study that used purposive sampling techniques, as specific locations were targeted. Since the main goal of our parent study was to create, evaluate and introduce harm reduction strategies into the hospitals for people who use methamphetamine, all participants had to be current or previous users of methamphetamine and had to have received hospital services. Restricting the eligibility criteria to include only those who had received services may limit the generalizability of our findings, as our results may not be generalizable to current or past users who have not received hospital services.

Additionally, there are limitations in the use of the CIQ-R instrument in our study sample, due to the nature of the some of the questions asked in this tool. For example,

when looking at home integration, majority of our study sample were experiencing homelessness, therefore questions related to home integration were not applicable to everyone in our sample. In terms of social integration, participants were asked about various activities such as shopping outside the home, leisurely activities such as going to the movies, sporting events and restaurants, and how often they visit with friends and family. However, there are limitations in use of this subscale due to the time at which participants were recruited into the study. Our data was collected between October 2020 and September 2021, during the time of the COVID-19 pandemic. Public health restrictions surrounding the pandemic made it difficult for individuals to socially integrate with one another, as lockdown measures were put into place, and individuals were encouraged to practice social distancing.

The study was conducted using self-reported sex identity. We were only able to include two sex identities; males and females in our analysis. Non-binary individuals, (i.e., those who identified as neither male nor female) were excluded from this study due to insufficient sample size. Previous literature shows that gender minority adolescents are affected by substance use related problems disproportionately more than their cisgender peers (Bach et al., 2020; Barger et al., 2021; Watson et al., 2020), which we were unable to capture in this study due to the size of that sub-sample. Additionally, our lack of statistically significant findings between social integration and our main independent variable of age of first use does not mean that a relationship does not exist. It is possible we were unable to detect effects due to the small size of our sample ($n=117$), as small sample size increases the probability of Type II error.

Lastly, the utilization of self-report questionnaires is both a strength and a limitation of our study. Though research has shown them to demonstrate high validity, self-reported substance use is also dependent on the study population, and therefore may not be generalizable to the entire population. Our measures may be influenced by factors such as social desirability/social stigma and recall bias. Some of our reports contained questions that were more sensitive in nature. Social desirability bias refers to the tendency to underreport social undesirable behaviours or over report more desirable behaviours. It is possible that social desirability bias occurred in our sample as participants may have

underreported their substance use, since methamphetamine is often stigmatized in society. Social stigma is associated with methamphetamine use, and therefore out of fear of judgement or possible legal repercussions, participants may feel as if they can be less forthcoming about their substance use. It is possible that recall bias may have occurred in our sample, as participants were asked to think back and report the age at which they first began using methamphetamine.

5.4 Future Research and Implications

To the best of our knowledge, this study is one of the firsts to assess the relationship between social integration and age of first methamphetamine use. Though we did not find significant evidence of a relationship between social integration and age of first use, there are still implications for future research. Larger, longitudinal population-based studies should be conducted in order better address the gap in the literature between social integration and age of first methamphetamine use. They would help to ascertain the direction of associations between social integration scores and age of first use within the population, as well as to address this notion of younger age of first use and see how social integration scores are impacted. Composition of the population is likely to change over time, as variability can be the result of births, deaths and migration. Therefore, substance use should be monitored periodically.

Our study was heavily reliant on literature from the United States. Future Canadian based studies should be conducted in order to expand the pool of literature and get a better understanding of the growing methamphetamine problem in Canada. Additionally, our study was open to those aged 16 and older. The youngest participant at the time of the interview included in our analysis was 17 years old, however the youngest age of first use was 12 years old. Therefore, future research can be done to include individuals who are younger than 16 years old.

As previously discussed, gender minority adolescents are understudied in this area of research, but are disproportionately affected more by substance use related problems than their cisgender peers. It is recommended that future studies go beyond the use of gender binary, and make an effort to increase representation of these individuals (e.g., through

oversampling). This would allow researchers to gauge a better understanding of how age of first methamphetamine use impacts those with diverse gender identities. Knowledge of substance use differences across multiple identities can help stakeholders to identify specific subgroups that are particularly affected.

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