# Trajectories of substance use and substance use problems in adolescents and young adults

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This thesis is submitted for the degree of Doctor of Philosophy.

# Declarations

- This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the Preface and specified in the text. Only one of the four substantive chapters was jointly authored.
- It is not substantially the same as any that I have submitted, or, is being concurrently submitted for a degree or diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. I further state that no substantial part of my dissertation has already been submitted, or, is being concurrently submitted for any such degree, diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text.
- It does not exceed the prescribed word limit for the relevant Degree Committee.

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# Abstract

This thesis examines the determinants of substance use behaviours and substance use problems at several stages in adolescence and adulthood. Analysis is based on a large, representative US-based longitudinal data set, the National Longitudinal Study of Adolescent to Adult Health (Add Health).

The thesis consists of four linked empirical studies. The first investigates the effects of parental beliefs about their adolescent children's smoking and drinking on adolescents' actual engagement in these behaviours. Previous literature has shown a strong association between parental beliefs and adolescent substance use, but has not addressed the issue of causality in this relationship. This chapter attempts to identify causal relationships via propensity score matching techniques.

The second study investigates the effects of parenting styles on substance use problems in adulthood. Previous studies have found a significant association between parenting styles and adolescent substance use; I investigate whether this effect persists into adulthood. Using structural equation modelling, I find that parental warmth has long-term effects on substance use in adulthood. Parental control, while reducing the likelihood of initiation in adolescence, does not reduce the incidence of substance use problems in adulthood.

The third study focuses on the determinants of substance use cessation, among adults who are smokers, drinkers and users of illicit drugs. The effects of parenting behaviours are relatively modest, but I find that the level of religiosity is an important determinant of cessation. In the final study, I examine the effect of religiosity on cessation and find that religious faith and (particularly) participation in church services and activities increase the likelihood of substance use cessation.

Taken together, these studies provide a thorough explanation of the association between parent-adolescent relationships, religiosity, and substance use trajectories. More importantly, the thesis uncovers the underlying mechanisms that explain various stages and levels of substance use at different periods of life.

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# Preface

Chapters 3, 4, and 6 of this thesis (including the abstracts of these three chapters presented in the Executive abstracts subsection) have been published in peer-reviewed journals. The published versions differ slightly from the versions in the thesis in two respects. First, much of the text relating to the data and to the literature has been taken out of the substantive chapters and moved to Chapters 1 and 2, to avoid repetition. Second, some of the material presented in the thesis has been omitted from the published articles due to the journals' limitations on length, number of tables, etc.

The peer-reviewed and edited version of Chapter 3 is published as: Mak, H.W. (2018). Parental beliefs and adolescent smoking and drinking behaviours: A propensity score matching study. *Addictive Behaviors Reports, 8, 11-20.* doi.org/10.1016/j.abrep.2018.04.003. Chapter 4 was carried out in collaboration with my supervisor, Dr Maria Iacovou. I contributed to the original research idea and the data analysis and an original draft. Maria Iacovou contributed to the article structure and the writing. The peer-reviewed and edited version of Chapter 4 is published as: Mak, H.W. & Iacovou, M. (*2019*). Dimensions of the parent-child relationships: Effects on substance use in adolescence and adulthood. *Substance Use and Misuse, 54(5), 724-736.* doi: 10.1080/10826084.2018.1536718. The peer-reviewed and edited version of Chapter 6 is published as: Mak, H.W. (2019). Dimensions of religiosity: The effects of attendance at religious services and religious faith on discontinuity in substance use. *Journal of Studies on Alcohol and Drugs, 80*(3), 358-365*.* doi.org/10.15288/jsad.2019.80.358.

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# List of figures, diagrams, tables and appendix

# Chapter 1

# Introduction

## 1.1 Facts and statistics

The use and abuse of cigarettes, alcohol, marijuana and other illicit drugs (such as cocaine, heroin, crystal meth and LSD) are a major public health concern worldwide.

In the UK, there is evidence that the use of both legal and illegal substances has been declining over the past decade, particularly among younger cohorts. A recent report by NHS Digital (2018a) based on data from the UK's Office for National Statistics shows that around one in five (19.2%) of respondents aged 16 to 24 reported having used an illicit drug in the past 12 months in 2017, a reduction from just over 24 per cent in 2007. A report by the same organisation on alcohol use (NHS Digital, 2018b), based on data from the Opinions and Lifestyle Survey (OPN): Drinking Habits Amongst Adults 2017, shows a similar decrease in alcohol use. The proportion of school students who report having drunk alcohol is declining steadily, and the percentage of people aged 16-24 who report episodes of heavy drinking declined from around 30 per cent to 20 per cent between 2007 and 2017. A similar pattern also holds for cigarette use (NHS Digital, 2018c).

Nevertheless, substance use remains a major concern. In the UK, physical and mental illnesses associated with alcohol alone are estimated to cost the National Health Service (NHS) approximately £3.5 billion annually in England (Alcohol Research UK, 2018). In 2014, the UK National Treatment Agency estimated that the government spent around £15.4 billion annually to cover the cost of drug misuse (Barber, Harker & Pratt, 2017).

Patterns observed in the UK are broadly mirrored in other developed countries. In the US, Schulenburg et al. (2017), using data from the 2016 *Monitoring the Future* study, reported that around 38-43 per cent of young people aged 17-24 had used an illicit drug, more than half of them used alcohol, and approximately one in five young people had smoked in the past year. While the report demonstrates a decrease in cigarette and alcohol use over the past decade, it also reports a 3 to 8 per cent increase in the use of illicit drugs. Data from the District of Columbia show that approximately 16 per cent of the state budget is spent on risky substance use and addiction, with 3 per cent of that amount contributing to prevention and treatment and 96 per cent to the consequences associated with substance use (National

Center on Addiction and Substance Abuse, 2009). According to a report from the National Institute on Drug Abuse (NIDA, 2017), alcohol, cigarette, and illicit drug use are estimated to cost the US around $740 billion each year, with drinking-related illness accounting for almost 33 per cent of healthcare spending. Other social and human costs also contribute to the overall annual expenditure on substance use and misuse: speciality treatment for substance use, crime, mental and physical health issues, unemployment, family conflict, sexually transmitted infections, and premature death (Hall et al., 2016; NIDA, 2017; Sacks et al., 2015; US Department of Health and Human Services, 2016). In recognition of the social and economic burdens associated with substance use, the US government has endeavoured to provide prevention and interventions targeting different users. For example, the US Food and Drug Administration (FDA) recently issued an advance notice of proposed rule-making (ANPRM) with the purpose of reducing the level of nicotine in cigarettes to minimal or non-addictive levels; this may help prevent individuals from becoming regular smokers, make it easier for them to stop smoking, and thus result in fewer tobacco-caused deaths (FDA, 2018).

It is worth asking why substance use in adolescence and early adulthood should continue to be an issue of concern for policymakers or academics. As noted above, repeated cross-sectional studies show that levels of substance use are declining among these young cohorts (NHS Digital, 2018a-c); in addition, longitudinal studies show a tendency for many individuals to stop using substances altogether or to move towards lighter levels of usage as they progress through young adulthood and acquire new roles including entry into marriage, employment, and parenthood (Bachman et al., 2002; Arnett, 2000; Degenhardt et al., 2016).

Longitudinal studies by Chen & Jacobson (2012) and Park et al. (2018), using data from the Add Health survey demonstrate this clearly, noting a decline in usage which commences around age 24-25, with slight variations in trajectory between the different substances. These findings are borne out by other studies including those based on the Monitoring the Future study (Schulenberg et al., 2017) and the National Survey on Drug Use and Health (NSDH) (2017, 2018), which indicate that levels of cigarette, alcohol and drug (mis)use are highest between the ages of 18 and 25. Data from the Center for Behavioral Health Statistics and Quality (2017, 2018) on the substance use among young people aged 12-26 or older in 2015-2017 are presented in Table 1.1.

**Table 1.1 Estimates of substance use among young people aged 12-26 or older, by age category, in 2015-2017**

| | Age: 12-17 | | | Age: 18-25 | | | Age: 26+ | | |
|---|---|---|---|---|---|---|---|---|---|
| | **2015** | **2016** | **2017** | **2015** | **2016** | **2017** | **2015** | **2016** | **2017** |
| **Cigarettes (%)** | | | | | | | | | |
| Lifetime | 17.3 | 15.3 | 14.9 | 61.7 | 59.3 | 57.9 | 69.9 | 69.1 | 69.0 |
| Past year | 11.6 | 10.5 | 9.7 | 43.8 | 40.5 | 39.8 | 28.9 | 28.6 | 27.6 |
| Past month | 6.0 | 5.3 | 4.9 | 33.0 | 30.0 | 29.1 | 24.5 | 24.6 | 23.4 |
| **Alcohol (%)** | | | | | | | | | |
| Lifetime | 28.4 | 27.0 | 27.1 | 82.4 | 81.3 | 81.1 | 87.1 | 86.4 | 87.1 |
| Past year | 22.7 | 21.6 | 21.9 | 75.5 | 74.4 | 74.0 | 69.2 | 68.4 | 69.5 |
| Past month | 9.6 | 9.2 | 9.9 | 58.3 | 57.1 | 56.3 | 55.6 | 54.6 | 55.8 |
| **Binge alcohol use[1,2] (%)** | | | | | | | | | |
| Past month | 5.8 | 4.9 | 5.3 | 39.0 | 38.4 | 36.9 | 24.8 | 24.2 | 24.7 |
| **Marijuana (%)** | | | | | | | | | |
| Lifetime | 15.7 | 14.8 | 15.3 | 52.7 | 51.8 | 52.7 | 46.0 | 46.2 | 47.5 |
| Past year | 12.6 | 12.0 | 12.4 | 32.2 | 33.0 | 34.9 | 10.4 | 11.0 | 12.2 |
| Past month | 7.0 | 6.5 | 6.5 | 19.8 | 20.8 | 22.1 | 6.5 | 7.2 | 7.9 |
| **Any illicit drugs[3] (%)** | | | | | | | | | |
| Lifetime | 25.3 | 23.0 | 23.9 | 57.5 | 56.3 | 57.0 | 50.1 | 50.2 | 51.3 |
| Past year | 17.5 | 15.8 | 16.3 | 37.5 | 37.7 | 39.4 | 14.6 | 15.0 | 16.1 |
| Past month | 8.8 | 7.9 | 7.9 | 22.3 | 23.2 | 24.2 | 8.2 | 8.9 | 9.5 |

Notes: Data from the Center for Behavioral Health Statistics and Quality, 2015-2017 (2017, 2018). [1]Data on binge alcohol use in lifetime and in the past year are not available. [2]Binge alcohol use is defined as drinking 5 or more drinks (for males) or 4 or more drinks (for females) on the same occasion on at least 1 day in the past month. [3]Any illicit drugs include the misuse of prescription psychotherapeutics or the use of marijuana, cocaine, heroin, hallucinogens, inhalants, or methamphetamine.

Thus, given that substance use in youth is widespread, often experimental, subject to spontaneous cessation, and in many cases not associated with particularly problematic outcomes for the individuals concerned (Baumrind, 1991; Shedler & Block, 1990; Steinberg & Morris, 2001), why should we be concerned with the substance use at this stage of the life course? There are three reasons why this remains an issue of concern.

The first is because emerging and young adulthood is the peak age for substance use (see Table 1.1). Young adults are more likely than their older counterparts to use both legal and illegal substances, and to use them problematically (e.g. binge drinking).

The second reason is that substance use in adolescence (particularly protracted or heavy use, or usage among adolescents who are also vulnerable in other ways) has been found to be positively correlated with problematic outcomes: dropout from school (Roche Ahmed &

Blum, 2008; Engberg & Morral, 2006), poor academic performance (King et al., 2006), higher numbers of sexual partners (Roche, Ahmed & Blum, 2008), and early pregnancy (Tapert et al., 2001).

The third reason is that not all young substance users will spontaneously cease or moderate their usage patterns after early adulthood; in fact, substance use in adolescence is one of the most important predictors of substance use and misuse in adulthood (McCambridge, McAlaney & Rowe, 2011; Merline et al, 2004). Substance use among older cohorts is *not* declining over time (NHS Digital, 2018a-c); as well as reflecting a cohort effect, this is likely to also reflect the relative difficulty of cutting down or giving up at older ages. And substance use in adulthood is associated with a wide range of problems including severe mental health problems (Boden & Fergusson, 2010) and premature death (Tomkins et al., 2012). Thus, an understanding of substance use in adolescence and early adulthood is important in developing an understanding of substance use patterns and problems in older adulthood.

### 1.2 Risk and protective factors of substance use

Many studies have identified factors which increase or protect against the risk of substance use in young people; some factors may also explain long-term consumption of substances. These factors can be grouped in multiple ways; here, I have adopted three domains that were used in Hawkins, Catalano, and Miller's (1992) Stone et al.'s (2012) and Degenhardt et al.'s (2016) comprehensive reviews on the risk and protective factors of substance use and substance use problems among young people: fixed markers of risk, contextual risk factors, and individual and interpersonal factors. It is important to note that these three domains are not mutually exclusive and that some factors may be identified as belonging to more than one domain.

First, *fixed markers of risk* are factors that can hardly be changed even through intervention (Hawkins et al., 1992). Factors include markers of socio-demographic background (gender and ethnicity, socio-economic status (SES), family composition and family substance use), parental mental health conditions, a genetic influence and neighbourhood environment (which is also considered as a contextual risk factor, see below). In relation to socio-demographic backgrounds, Chen and Jacobson (2012) found gender and ethnic differences in

substance use. They showed that while females had higher initial levels of substance use in early adolescence than males, males showed greater changes throughout early adolescence to young adulthood. They also found that Hispanic youth tended to start using substances at a younger age, whereas Caucasian youth had higher levels of substance use from mid-adolescence to the early 30s. Huckle, You and Casswell (2009) considered the relationships between SES and drinking patterns and drinking consequences. They revealed that low SES had greater risks for heavy drinking compared to other SES groups in New Zealand. Using a UK data set, Melotti et al. (2010) illustrated that young people from higher-income households consumed more alcohol but those from households where mothers had high levels of education consumed less. They also found an inverse association between SES and smoking behaviour. One possible explanation for the findings provided by the researchers is that a higher income might give rise to greater availability of alcohol, while highly educated mothers might encourage healthier behaviours. There is also evidence for a relationship between family composition and youth substance use. Using data from the Monitoring the Future survey, Hemovich and Crano (2009) found that adolescents from single-parent families were at greater risk of drug use than adolescents from two-parent families. The study also showed that adolescents (particularly girls) from father-only families reported having used more illicit drugs than adolescents from mother-only families or two-parent families. Hayatbakhsh et al. (2006) reported that changes in mothers' marital status from married to separated/divorced/widowed were related to greater risk of first cannabis use before the age of 15 and cannabis use at the age of 21. It has also been shown that parents' substance use (Alati et al., 2005; Buu et al., 2009; Kilpatrick et al., 2000) and their poor mental health (Cortes et al., 2009; Wickham et al., 2015) were associated with adolescents' substance use. Moreover, family, twin, and adoption studies have explicitly demonstrated a connection between a genetic influence and substance (mis)use (Gilvarry, 2000; McGue, Sharma & Benson, 1996; Tsuang et al., 1996; Wang, Kapoor & Goate, 2012). For example, Tsuang et al. (1996) found that monozygotic (MZ) twins had higher concordance rates for DSM-III-R (Diagnostic Interview Schedule Version III Revised) drug abuse or dependence than dizygotic (DZ) twins. The finding suggested that identical twins were more likely than fraternal twins to experience drug problems, and that there might be a potential genetic influence. McGue, Sharma and Benson (1996) also showed that parental alcohol use had a stronger correlation with biological offspring than adopted children. Furthermore, previous research has shown links between neighbourhood environment and youth substance use. For instance, Buu et al.

(2009) found an effect of neighbourhood residential instability on young people's alcohol use disorder, marijuana use disorder, and nicotine dependence. A study by Handley et al. (2015) indicated an association between neighbourhood disadvantage (a scale derived from neighbourhood poverty, safety and drug availability) and adolescent marijuana dependence.

Aside from the fixed risk markers, *contextual risk factors* may influence substance use among young people. Contextual factors refer to broad social and cultural factors (i.e. external to individuals); these include laws (e.g. taxation, laws restrictions on the minimum legal age limits, etc.), social and cultural norms (e.g. social acceptance) (which could also be associated with people's ethnic identity that is considered as a fixed risk marker), the availability of substances, and neighbourhood environment (e.g. physical deterioration, low levels of attachment to neighbourhood, etc.) (Hawkins et al, 1992). For instance, in a well-designed and robust study, Keyes et al. (2012) examined data from 1976 to 2007 to investigate birth cohort effects on alcohol consumption among adolescents. They found that youth who matured in birth cohorts that were characterised by restrictive social norms were less likely to consume alcohol and indulge in binge drinking compared with those who matured in cohorts with a more permissive attitude towards alcohol use. Moreover, Perkins (2007) showed that the perception of peer norm in drinking (respondents' estimate of how many drinks were consumed at parties and bars by students) had a larger predictive power in adolescents' alcohol use than the actual school norm (personal alcohol consumption reported by the specific college/university).

While fixed markers and contextual influences are risk factors for substance use that are hard to change, *individual and interpersonal factors* can potentially reverse unfavourable situations. These factors are associated with individuals' characteristics and their interpersonal environments that are subject to change, such as academic failures, internalising and externalising behaviours, and belief in the moral order (Hawkins et al. 1992; Stone et al., 2012). One factor in this domain that has been studied by many researchers is parenting style, which is instrumental in our understanding of adolescent substance use. Very often, substance use and substance use problems have their origins in early adolescence (Anthony & Petronis, 1995; DeWit et al., 2000; Grant & Dawson, 1998; Grant, Stinson & Harford, 2001; King & Chassin, 2007; McCambridge, McAlaney & Rowe, 2011; McGue et al., 2001), and the early origins of substance use problems usually involve family relations (Fleming et al., 2002; Hill et al., 2005; Garcia & Gracia, 2009; Velleman, Templeton & Copello,

2005). Relationships with parents tend to interact with other important factors, such as youth psychological well-being (Betts, Gullone & Allem, 2009; Ozer et al., 2013) and peer relationships (Adamczyk-Robinette, Fletcher & Wright, 2002; Van Ryzin et al., 2012), to influence adolescents' substance use. The parent-adolescent relationship may also mediate and moderate the effects of fixed risk markers and contextual risk factors on substance use among young people. Brody et al. (2009) indicated that the association between genetic vulnerabilities and adolescents' substance use varied depending on the degree of involved and supportive parenting. They found that the association between a genetic vulnerability factor and the development of substance use was buffered by high levels of involved and supportive parenting. A study by Chuang et al. (2005), using structural equation modelling to estimate the effect of neighbourhood on adolescent cigarette and alcohol use, revealed that the correlation between low SES neighbourhoods and low levels of cigarette and alcohol use were mediated by increased parental monitoring. Similarly, Chassin et al. (1993) showed that a high level of parental monitoring mediated the relationship between parents' high levels of alcohol use and adolescent substance use. Renk et al. (2016) also argued that the association between parental substance use involvement and the risks of substance use among young people was complicated by negative parenting practices, and that the need for parenting interventions might have been more evident. There is a growing body of research that indicates the efficacy of parenting interventions. A comprehensive review by Allen et al. (2016) provided an important insight into the effectiveness of parenting interventions aimed at reducing and preventing adolescents' substance use. The review suggested that interventions involving training of parents may potentially be a cost-effective approach to promoting public health goals for adolescents. The subject of parenting styles and the quality of relationships between parents and children has been recognised as important for health by the American Psychological Association Task Force, the British Medical Association, the National Research Council and Institute of Medicine, and the World Health Organisation (Chu, Farruggia & Sanders, 2012; Eshel et al., 2006; Prinz et al., 2009), and has occupied a prominent place in national and international policy-making. Evidence regarding the significance of parenting with respect to young people's substance use is particularly relevant at this time in the US when positive parenting interventions are becoming the focus of paediatric primary care within the Affordable Care Act (Bultas et al., 2017).

Besides parenting styles, another important and widely researched factor is religiosity. As with parenting styles, religiosity connects more strongly with the individual and interpersonal factors domain set out above (e.g. faith in God or a significant other can be subject to change during adolescence and young adulthood). There is consistent evidence that religiosity is protective against substance use. Existing literature has shown that individuals with higher levels of religiosity are more likely to be abstinent from substances, have lower levels of substance use and have a higher chance of stopping substance use (Brown et al., 2001, 2014; Edlund et al., 2010; Gossop et al., 2008; Kendler et al., 2003; Koenig & Vaillant, 2009; Luczak et al., 2003; Nakash et al., 2016; Whooley et al., 2002; Wills et al., 2003). It has been suggested that the protective effect of religiosity could be due to multiple factors including improving mental health and building social networks with other individuals who do not use substances. In recognition of the beneficial effects religion has on substance users, many substance abuse treatment centres (such as Alcoholics Anonymous) in the US offer religious services (Davis, 2014; Gonzales et al., 2007).

Given the importance of parenting styles and religiosity in substance use and the possibility of these two factors reversing unfavourable situations (e.g. low social class and parents' substance use), this thesis will examine *how* both parenting styles and religiosity are significant factors to substance use. Indeed, drawing upon Bowlby's *attachment theory* (1969), which was further developed by Ainsworth and Bowlby (1991), these two factors share common features that could be translated into an attachment process (Doinita & Maria, 2015; Kirkpatrick, 1992), which in turn may explain their significant influences on substance use. In the next section, a brief overview of attachment theory and how parenting styles and religiosity could be conceptualised as an attachment process are discussed.

## 1.3 Parenting styles and religiosity as attachment processes

### *1.3.1 A brief overview of attachment theory*

The attachment theory was first introduced by Bowlby (1969), and was then revised by Ainsworth and Bowlby (1991), to provide an alternative perspective against the traditional bio-psychological theories that involve merely nutrition and reproduction. Bowlby argues that the infant is designed to maintain proximity with their caregiver through emitting signals (such as crying and clinging to its primary caregiver) in order to protect themselves from dangers

and threats. When the caregiver responds to the infant's signals, the infant develops a secure attachment to the caregiver and considers the caregiver as a source of protection and security. A secure attachment relationship is characterised by two main components- a *secure base* and a *haven of safety* (Ainsworth & Bowlby, 1991; Bowlby, 1969). A 'secure base' is provided through strong affectionate bonding between the infant and their caregiver who is often characterised as caring and responsive. It encourages the infant to safely explore the outside world and offers the infant a safe base to return to when they need to. A 'haven of safety' is created when the infant is comforted and reassured by their caregiver when they feel anxious, distressed or frightened. As a result, the attachment figure serves as a secure base (in the absence of threat) and a safe haven (in the presence of threat) for the infant (Kirkpatrick, 1992). Bowlby stressed that a secure attachment relationship that is often established in infancy or childhood continues to have an influence in adulthood, as he noted "all of us, from the cradle to the grave, are happiest when life is organised as a series of excursions, long or short, from the secure base provided by our attachment figure(s)" (Bowlby, 2005: 69). This suggests that early bonds of child and caregiver could determine the quality of later development.

In contrast to secure attachment, there are two different types of insecure-attachment: anxious-insecure attachment and avoidant-insecure attachment (Bowlby, 1969; Ainsworth & Bowlby, 1991). Anxious-insecure attachment is developed when the infant has ambivalent feelings toward their caregiver (sometimes clinging to the caregiver, sometimes feeling anger towards the caregiver) and appears to be more anxious and less confident when exploring new environments. A caregiver of an infant with this type of attachment tends to have inconsistent and unpredictable behaviours (at times they are caring and nurturing and at other times they are insensitive and emotionally unavailable). Avoidant-insecure attachment is characterised as the infant displaying detachment behaviours toward their caregiver. A caregiver of an infant with avoidant attachment tends to be unresponsive to the infant's needs, and in response, the infant often does not see the caregiver as a source of a secure base or as a safe haven.

As a result, the attachment theory emphasizes the significant impact the attachment figure could have on the infant and the importance of secure attachment. However, this theory should not be restricted to the relationship between caregiver and infant. It is likely that an attachment style can be created and developed in other kinds of relationships, such

as a parent-adolescent relationship and a personal relationship an individual may have with higher forces through religion.

### *1.3.2 Attachment theory and parenting styles*

The theory of parenting styles was originally developed in the 1960s when Diana Baumrind (1966), a clinical and developmental psychologist, began to investigate the relationship between parenting styles and children's outcomes. In Baumrind's early work (1966, 1968, 1971), she distinguished three classic types of parenting style based on varying levels of parental warmth and control: authoritative, authoritarian and permissive parenting. *Authoritative parents* discipline children by means of reason and clear expectations, providing them with a clear framework of rules by which the children are expected to abide, and the reasons for these rules. They are supportive and responsive to their children, respect their children's interests and qualities, value negotiations, and encourage autonomy. As Baumrind noted, "authoritative parent[s] attempt to direct the child[ren]'s activities in a rational, issue-oriented manner" (Baumrind 1966: 891). *Authoritarian parents*, on the other hand, present themselves as authority figures who possess full power and control over their children. They value absolute obedience and restrict children's autonomy, as noted by Baumrind, they "attempt to shape, control, and evaluate the behaviour and attitudes of the child[ren] in accordance with a set standard of conduct" (Baumrind 1966: 890). Lastly, *permissive parents* offer children a high degree of autonomy and seldom establish many strict rules. They do not actively influence their children's' behaviour and usually follow children's desires and wishes. In contrast to authoritarian parents, permissive parents tend to establish a friendship-like relationship with the children.

Baumrind and other researchers have found that children/adolescents with authoritative parents are more likely to develop positively, for example, demonstrating superior school performance (Dornbusch, 1987; Hickman, Bartholomae & McKenry, 2000; Spear, 2005; Steinberg, Elmen, & Mounts, 1989), good mental health (Baumrind, 1971, 1991), high self-esteem (Buri et al., 1988; Chan & Koo, 2011), and healthy relationships with peers (Llorca, Richaud & Malonda, 2017). On the other hand, authoritarian and permissive parenting styles are often associated with negative, undesirable outcomes, including depression, anxiety, substance use problems and conduct disorders (Baumrind, 1991; Bronte-Tinkew, Moore & Carrano, 2006; Calafat et al., 2014; Chan & Koo, 2011).

Maccoby and Martin (1983) and Lamborn et al. (1991) noted that Baumrind's typology was based on two dimensions (parental control and parental warmth) but that her 'permissive' category conflated styles which were low in control and low in warmth, and low in control but high in warmth. They suggested a revised typology which distinguished between these categories, defining an 'indulgent' style (low in control but high in warmth) and a 'neglectful' style low on both dimensions (see Figure 1.1). Although both indulgent and neglectful parenting styles involve low levels of parental control, the motivation for this differs. Indulgent parents impose fewer regulations on the basis of trust, acceptance, and democracy, whereas neglectful parents are disengaged from children and child-rearing responsibility (Lamborn et al., 1991).

Research using this revised typology invariably finds the neglectful style to be associated with poor outcomes, (Calafat et al., 2014; Chan & Koo, 2010; Lamborn et al., 1991; Montgomery, Fisk & Craig, 2008; Steinberg et al., 1994). However, many studies show that an indulgent parenting style is not associated with negative outcomes (Calafat et al., 2014; Lamborn et al., 1991; Maccoby & Martin, 1983, Stafford et al., 2016).

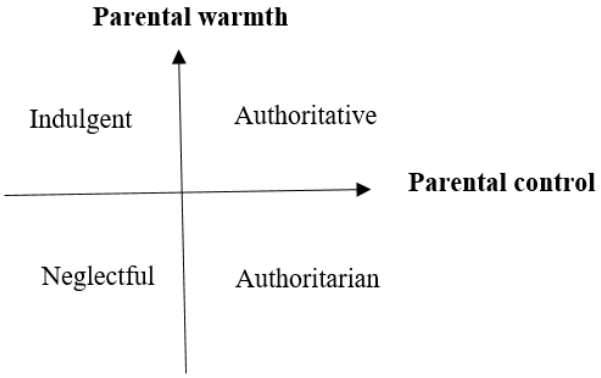



***Figure 1.1 The fourfold schema of parenting styles (Baumrind, 1991; Lamborn et al., 1991; Maccoby & Martin, 1983)***

Many scholars have often found an association between parenting styles and secure/insecure attachment. It has been suggested that positive parenting styles that comprise high levels in both parental warmth/responsiveness and parental control/demandingness (i.e. authoritative parenting) are similar to secure attachment (Cohn et al., 1992; Karavasilis et al., 2003; Doinita & Maria, 2015). Parental availability/presence, another parenting dimension that has received much less attention, has also been shown to be important for children's development, especially when establishing attachment security

with their parents (Karavasilis et al., 2003). These parental practices provide a secure base for children to explore new environments safely and confidently. They also create a safe haven for children in times of need or threat by offering warmth and affection and clear boundaries and rules. This allows children to develop trust with their parents, to face challenges, and to regulate emotions (Mikulincer, Shaver & Pereg, 2003). In contrast, neglectful or authoritarian parenting styles have been found to associate with anxious-insecure or avoidant-insecure attachment (Cohn et al., 1992; Karavasilis et al., 2003), which causes high levels of anxiety and depression in children (McLeod, Wood & Weisz, 2007; Ozer et al., 2011). In substance use research, scholars have invariably shown that positive/authoritative parenting (providing secure attachment) reduces the risk of substance use and misuse, while neglectful or authoritarian parenting (representing insecure attachment) is associated with higher levels of substance use (e.g. Baumrind, 1991; Bronte-Tinkew et al., 2006).

### *1.3.3 Attachment theory and religiosity*

While the attachment process may seem to occur exclusively to relationships between caregivers/parents and infants/children, it has been suggested that the attachment theory set out in the previous section can also be applied to religiosity, i.e. the relationship with higher forces (such as God, Jesus Christ, the Virgin Mary, or other supernatural beings) (Kirkpatrick, 1992) among religious individuals. To conceptualise the relationship between religious individuals and higher forces as the attachment process, the two main components outlined in the attachment theory, a secure base and safe haven, have to be met.

Concerning the aspect of a secure base, religion is a system of beliefs that facilitates closeness to the transcendent (Koenig, King & Carson, 2012), which, in attachment terms, suggests that religious individuals obtain a sense of security from their encounter with God (Kirkpatrick & Shaver, 1990). Previous studies have suggested that having the belief that God/another spiritual figure is present and available helps facilitate resilience, which supports individuals to solve personal problems or difficulties and establishes confidence (Kirkpatrick, 1992; Koenig & Larson, 2001). It has also been shown that holding an image of God is associated with higher levels of self-esteem (Benson & Spike, 1973), which gives a strong sense of empowerment and thus increases motivation to try new things. Furthermore, in parallel with parental control, religion consists of basic moral values, rituals, and conventional authority that set boundaries of religious individuals' behaviours and encourage conformity to these religious norms. For instance, some religious rituals and beliefs regard the use of

substances as a 'sinful behaviour' and prohibit the use of cigarettes, alcohol and drugs (Burkett, 1977; Koenig & Larson, 2001). This may explain at least in part the negative association between religion and substance use found in previous studies (Koenig, 2012; Koenig & Larson, 2001).

With regard to a safe haven, a substantial amount of research in the psychology of religion has found that, in situations of distress, individuals are likely to turn to higher forces (Aydin, Fischer & Frey, 2010; Koenig, George & Siegler, 1988; Williams et al., 1991). As is the case with the distressed infant seeking security from their caregiver, individuals who are experiencing these situations may use religion as a coping strategy and activate their attachment system by praying to higher forces (an analogue to attachment behaviours as suggested by Kirkpatrick, 1999).

As a result, given that both parenting style and religiosity are important individual and/or interpersonal factors linked to substance use that can be changed through interventions (which may have policy implications), and given that their effects on substance use can be conceptualised as the attachment process (secure attachment to parents/higher forces reducing the risk of use; insecure attachment increasing the risk of use), this thesis examines the associations between parenting styles and religiosity and the trajectories of substance use in adolescence and adulthood. Using a US longitudinal, nationally representative data set (Add Health), this research project provides an important and exciting opportunity to advance the understanding of these associations.

The remainder of this thesis is structured as follows. Chapter 2 presents a thorough discussion of the data set which forms the basis of empirical analysis, the construction of variables and measurement scales, the analytical sample that is analysed in each chapter, and the quantitative analytic approaches used in the research.

The main body of the thesis consists of four substantive chapters. Given that parent-adolescent relationships have evidently been shown to be a key predictor of early substance use, which in turn is a critical factor for later substance use problems, the first three chapters (3, 4 and 5) investigate the association between parental behaviours (parental warmth, control and presence) and substance use in adolescence and adulthood, while controlling for cohort members' level of religiosity. More specifically, the first empirical chapter examines the effect of parental beliefs about adolescents' cigarette and alcohol use on adolescents'

actual engagement in these behaviours in the following years (Chapter 3). The thesis will then move on to investigate whether substance use and substance use problems, and cessation in adulthood are attributable to early parent-adolescent relationships in adolescence (Chapters 4 & 5). The results from Chapter 5 indicate a strong effect of the levels of religiosity on cessation, which forms the foundation of the final chapter. In that chapter (Chapter 6), the effects of two widely used dimensions of religiosity on substance use cessation are examined and compared. Each empirical chapter is largely self-contained, with an introduction and sections on methods, results, limitations and conclusions. However, to provide a coherent theoretical background to the study as a whole and to outline a consistent body of research, the findings in each empirical chapter are also discussed in view of the attachment theory set out in Section 1.3.

Chapter 7 draws conclusions from the project as a whole, with a particular emphasis on elaborating on how these findings further develop our understanding of the determinants of substance use trajectories, as well as contributing to policy implications. Chapter 7 also provides a discussion on whether the effects of parental behaviours and religiosity vary on substance use and an overview of how the findings of this thesis that are based on a US data set can be generalised to the UK context. Finally, this chapter reflects on the challenges experienced during the research project and makes suggestions with regard to future directions for research.

Before progressing to a description of the data and methods, a short summary of each empirical chapter is provided for reference. Chapters 3, 4 and 6 have been published in a peer-reviewed academic journal. The published manuscripts are provided in full in the Appendix.

## 1.4 Executive abstracts

*Chapter 3 Parental beliefs and adolescent smoking and drinking behaviours: A propensity score matching study (The edited and peer-reviewed version of this abstract is published as Mak, H.W. (2018). Parental beliefs and adolescent smoking and drinking behaviours: A propensity score matching study. Addictive Behaviors Reports, 8, 11-20. doi.org/10.1016/j.abrep.2018.04.003)*

**Background:** This chapter is formed in response to the existing literature that shows the negative influences of parental beliefs about adolescents' risk behaviours (including

substance use) on adolescents' later engagement in these behaviours. **Objectives:** This research attempts to identify the causal relationships between parental beliefs and adolescents' later smoking and drinking behaviours via propensity score matching (PSM) techniques. **Methods:** Analysis is based on the Add Health data set, Wave 1 and Wave 2, N=3,232, and is conducted using both OLS and PSM (both nearest-neighbour and kernel matching) regressions. **Results:** Results show that adolescents who used cigarettes and alcohol at Wave 1 were more likely to continue the activity if their parents were aware of it. Adolescents were also more likely to use cigarettes if their parents believed they smoked when in fact they did not. Amongst those who did not use alcohol, no significant association is found between parental beliefs and adolescents' later alcohol consumption. When using PSM techniques, the effect of parental beliefs reduces substantially, suggesting that a very large amount of heterogeneity between parental beliefs and adolescents' substance use is captured by the shared factors (e.g. maternal substance use). Nonetheless, some estimates remain statistically significant when using PSM, implying a possibility of a causal relationship. **Conclusions**. Two explanations are proposed to elucidate the results: self-fulfilling prophecy and adolescent concealment. In recognition of the power of self-fulfilling prophecy, family-based programmes and scholars have suggested that parents should have open and informed discussions with adolescents about substance use and the associated problems. It is, however, important to acknowledge that adolescents may conceal their substance use behaviour from their parents, which is considered as a common practice in family dynamics. The association between parental non-beliefs and reduced risk of adolescent involvement with substances may be explained by the motivation behind adolescent concealment (e.g. a concern for parents' feelings). This study suggests that parents may consider allowing adolescents to establish healthy boundaries themselves, understanding their adolescents' unwillingness and discomfort in sharing information regarding risk behaviours. This may help avoid conflicts which may arise when discussing topics about which adolescents feel uncomfortable confiding in their parents.

*Chapter 4 Dimensions of the parent-child relationship: Effects on substance use in adolescence and adulthood (The edited and peer-reviewed version of this abstract is published as Mak, H.W. & Iacovou, M. (2018). Dimensions of the parent-child relationships: Effects on substance use in adolescence and adulthood. Substance Use and Misuse, 54(5), 724-736. doi: 10.1080/10826084.2018.1536718)*

**Background**: Previous research has found a relationship between parenting and young people's substance use; however, very few studies have examined the long-term effect of parenting on adolescents' substance use in adulthood. **Objectives**: This chapter is designed to extend existing research in two ways. First, a longer time frame is considered to investigate the relationship between parenting in adolescence and substance use in adulthood. Second, this study explores the pathways by which this relationship is expressed, in particular the extent to which the relationships in question are mediated by age at first use and depression. **Methods**: The analysis is based on data from Waves 1-4, N=2,954, and is conducted using structural equation modelling (SEM). The study considers warmth and control as distinct dimensions of parenting, as well as a typology of parenting which combined the two dimensions. **Results**: Warmth is associated with reduced risk of problematic substance use in adulthood, via reduced risk of early initiation and a lower risk of depression. Parental control also has a protective effect via reduced risk of early initiation, but this is offset by a detrimental effect on depression, particularly in the case of older adolescents. Indulgent parenting is not associated with extra risk of any kind compared with the authoritative style, whereas authoritarian and neglectful styles are. **Conclusions**: The nexus of relationships which are uncovered in this research has implications for policy aimed at reducing substance use in the longer term, suggesting that initiatives to promote warm and responsive parenting may be most effective in reducing the risks of later substance use problems.

*Chapter 5 The long-term effects of parental behaviours in adolescence on cigarette, alcohol and drug cessation in adulthood*

**Background**: Past longitudinal studies have shown that substance use trajectories are not static and that parenting styles may have some influence on young people's substance use cessation. The aim of Chapter 5 is to uncover the trend and pattern of the

substance use of young people in the US and to investigate whether cigarette, alcohol and drug cessation in adulthood are related to family relationships in adolescence. **Methods**: Data from Waves 1, 3 and 4 are used for analysis. Three parental behaviours are examined: parental warmth, control and parental presence. The sample is restricted to those who reported having used the substance in Wave 3, a time when the prevalence of substance use and misuse is the highest. The number of observations varies depending on the type of substance, N=602-2,392. Logistic regression is applied. **Results**: Results show that the majority of young adults abstained from cigarettes and drugs, and even if they used the substance, they were also likely to quit later in life. For alcohol, many young adults consumed light-to-moderate amount of alcohol. Using logistic regression, results show no long-term effects of parental warmth and control on the rates of cessation in adulthood; however, maternal presence is associated with increased probability of cigarette and drug cessation. All analyses are repeated on a subsample who are classified as the top 20 per cent of heaviest substance users in Wave 3; results are consistent. The effect of maternal presence is also found to be more prominent for females and the younger group of the sample, although the differences between groups are mostly not significant. No correlation between paternal behaviours and cessation is found. This paper also discovers that religiosity is a robust determinant of substance use cessation in adulthood. **Conclusions**: This study concludes that the government should consider promoting the importance of parental presence and collaborate with work organisations to offer flexible and family-friendly employment options for working parents.

*Chapter 6 Dimensions of religiosity: The effects of attendance at religious services and of religious faith on substance use cessation (The peer-reviewed and edited version of Chapter 6 is published as: Mak, H.W. (2019). Dimensions of religiosity: the effects of attendance at religious services and religious faith on discontinuity in substance use. Journal of studies on alcohol and drugs, 80(3), 358-365. doi.org/10.15288/jsad.2019.80.358)*

**Background**: Building upon the results found in Chapter 5, the final research chapter investigates the religion-substance use relationship. Such a relationship has been

investigated in past research, showing that religion plays an important role in health-related behaviours, including substance use. **Objectives**: This chapter examines and compares the effects of the two widely used dimensions of religiosity, *religious behaviour* measured by attendance at religious services and *religious devotion* by the importance of religious faith, on cigarette, alcohol and drug cessation in adulthood. **Methods**: Data from Waves 1, 3 and 4 data are employed for analysis. The sample is restricted to those who reported having used the substance in Wave 3. The number of core sample sizes varies depending on the type of substance, *N*=671-2,113. Logistic regression and PSM methods are used. **Results**: Results show that church attendance frequency is significantly and positively associated with any kind of substance use cessation, whereas religious faith predicted alcohol cessation only. The effects of the dimensions remain significant in two subsamples: (1) a subsample who have low levels of attendance or faith in Wave 3, and (2) another sample who are classified as the top 20 per cent of heaviest users in Wave 3. After controlling for the observables and confounding bias in the PSM models, results in Chapter 6 also show that the statistical significance and the size of odds ratios of the two religious dimensions are reduced, but most of them remain statistically significant. This suggests that the associations between the two religious dimensions and substance use cessation may be causal. The analysis is repeated using alternative definitions of religious behaviour and devotion, attendance at special activities organised by churches and private prayer, respectively. Results are consistent, suggesting that religious behaviour, church attendance in particular, exerts greater effects than religious devotion on substance use cessation. **Conclusions**: This study concludes that health and social services (both social and instrumental supports) offered by churches may be key to substance use cessation. Health professionals should consider establishing partnerships with religious communities to support substance users.

# Chapter 2

# Data and Methods

## 2.1 Data

### *2.1.1 Introducing the Add Health data set*

The main objective of this thesis is to explore the determinants of substance use over adolescence and early adulthood, which requires an appropriate numerical and longitudinal data set. All empirical chapters use US data from the National Longitudinal Study of Adolescent to Adult Health (Add Health). Add Health is a school-based study of a sample of adolescents in grades 7-12 (ages 12-19) from 132 schools in 1994-95. Schools were selected to participate in the study based on region (i.e. North-east, Mid-west, South and West), location (i.e. urban, suburban and rural), school type (i.e. public, private, and parochial), ethnic mix (i.e. percentage of white students), and size (ranging from fewer than 100 students to more than 3,000 students) (Chen & Chantala, 2014). Administrators of these 132 schools were asked to complete a special questionnaire describing the characteristics of the schools (Chen & Chantala, 2014). The original school-sample size was 90,118. A core sample was derived from this administrative process and was randomly selected for in-home interviews by stratifying students in each school by grade and sex. This resulted in a sample size of 20,745, of which 12,105 adolescents were the core in-home sample and the remaining participants were special oversamples, including blacks from well-educated families (with a parent with a college degree; N=1,547), Chinese (N=406), Cuban (N=538), Puerto Rican (N=633), disabled (N=957), twins (N=1,534), full-siblings (N=2,500), half-siblings (N=848), non-related (N=1,314), and pairs (N=2,553). In Wave 1, over 85 per cent of the core sample had parents who completed the parental questionnaire (see Figure 2.1).

All adolescents in Wave 1 were followed up a year later for the second wave (N=14,738). Wave 3 data collection was conducted between 2001 and 2002 when respondents were aged 18-26, the transition period to adulthood (N=15,170). A fourth in-home interview was conducted in 2008 when the Add Health cohort was 24-32 years old and settling into young adulthood (N=15,701). At the time of the interview, the Wave 4 participants were also developing health-related habits and lifestyles that could set pathways for their later health and well-being (Harris, 2013). Response rates across Waves 1 to 4 were 79 per cent, 88.6 per cent, 77.4 per cent, and 80.3 per cent respectively (response rates for

Waves 2, 3 and 4 were calculated as percentages of the original Wave 1 participants who were eligible for subsequent waves). The fifth follow-up wave was conducted in 2016-18; the data were not available at the time of writing. The empirical chapters in this thesis use the public-use data sets, which are randomly generated subsamples of the core data set. The total sample size in the public-use data sets are 6,504 at Wave 1, 4,834 at Wave 2, 4,882 at Wave 3, and 5,114 at Wave 4. The attrition rates are 25.7 per cent, 24.9 per cent, and 21.4 percent, respectively. To enhance the accuracy and quality of self-reporting of sensitive information, audio-CASI technology (audio computer-assisted self-interview) was used at the time of the adolescent in-home interviews (Harris, 2013).

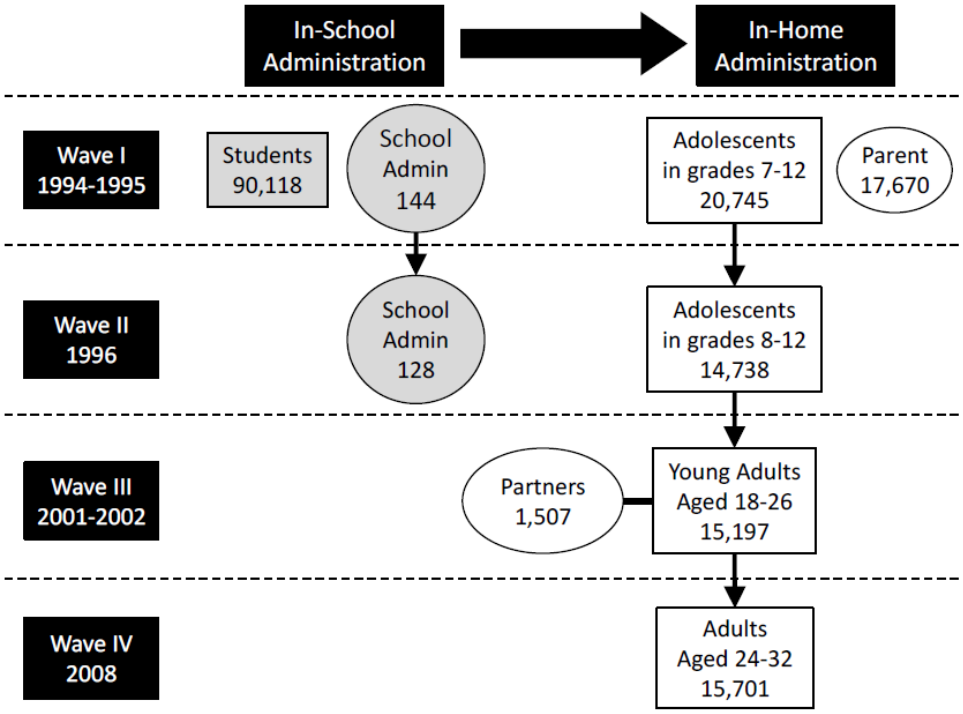



***Figure 2.1 "Add Health Longitudinal Design". Source: Harris, K. M. (2013). The Add Health Study: Design and Accomplishments. Carolina Population Center, University of North Carolina at Chapel Hill.***

Add Health was initially developed in response to the US congressional priority for improving adolescent health, and was designed to explore the causes of health and health-related behaviours of adolescents and the outcomes when they reached adulthood (Harris, 2013). One feature of this data set is that it goes beyond demographic descriptions to identify

the underlying social mechanisms that may explain risk behaviours, like substance use. It captures multiple contexts of adolescent life, including family relationships, educational and social development, psychological well-being, and economic circumstances. The rich survey design has stimulated interdisciplinary research to advance our understanding of adolescent and young adult health development from various perspectives.

Over the last few decades, there has been on-going and considerable investment in developing and maintaining large-scale longitudinal studies in various countries, such as the 1970 British Cohort Study in the UK. However, the feature of Add Health which makes the data set particularly attractive for this research project is the fruitful information on parent-adolescent relationships measured in Waves 1 and 2, and substance use behaviours measured in all waves. Add Health consists of a wide range of variables that measure parenting styles and parent-youth relationships, parental beliefs about their adolescents' substance use, age at first substance use, quantity and frequency of substance use, and problem substance use. The data set also provides important measures that may be associated with substance use, including mental and psychological health conditions, religion and contextual data, such as drug exposure in the neighbourhood. These outside influences could be introduced into regression models in order to examine whether the effects of parental beliefs and parental behaviours on substance use are independent of them. The rich set of measures offered in Add Health, therefore, provides a unique opportunity to investigate the determinants of substance use trajectories.

Another attractive aspect of Add Health is that in the development of the Wave 4 survey, expert advice was sought from the Survey Research Advisory Committee and representatives of National Institutes of Health (NIH). The Wave 4 interview was modified to include questions that reflected the continuity of the earlier waves and updates of important demographic transitions, such as marital status and parenthood (Harris, 2013). This longitudinal data collection starting from adolescence has allowed researchers to map early trajectories of substance use and to analyse how adolescent experiences are associated with later behaviours and health-related outcomes in adulthood when the cohort members begin to develop their expectations and adult roles. More importantly, the inclusion of demographic backgrounds in adulthood has allowed researchers to control for these factors in regression analyses when examining the effects of early family experiences.

However, it is important to note that there are also some challenges to using Add Health for analysis. In common with almost all longitudinal studies, the biggest limitation of

Add Health is attrition (the loss of study participants), especially when there are some long intervals between interviews. In a study investigating Add Health's attrition between Waves 1 and 4, Brownstein et al. (2010) found that the most common type of non-responder was those who refused to participate in the survey; this was followed by those who were not contacted and those who were unable to participate in the survey. The research team also showed that males, non-white, rural respondents, and participants whose parents had low educational levels, were more likely to drop out by Wave 4. These differential attrition patterns are common to many longitudinal cohort studies (Harris et al., 2019). To test the impact of attrition, Brownstein et al. (2010) used sample weights from Wave 1 to calculate the non-response bias and t-tests to determine whether the bias was significantly different from zero. Their results indicated that the non-response bias, including the biases in measurement of variables relating to substance use, was small in magnitude and was not statistically significant. Indeed, it has been suggested that Add Health response rates with multiple year intervals between waves (ranging from 77.4% in Wave 3 to 88.6% in Wave 2) are higher than those achieved by other national studies, including the National Survey of Families and Households (Harris et al., 2019). The design strategy to re-interview the Wave 1 original sample has been felt by the Add Health study team to be successful in minimizing non-response bias so that the samples in the subsequent waves are representative of the original cohort of adolescents in the 7-12$^{th}$ grades (ages 12-19) in the 1994/1995 school year (Harris et al., 2019). In addition to the small effects of attrition, Add Health has excellent data quality with little missing data due to respondents refusing to answer questions and with only minor instrument programming errors (Harris, 2013). Other challenges will be discussed in the Conclusions chapter (Chapter 7).

Despite the limitations, the design of the Add Health is still far outweighed by the unique benefits it provides. Add Health contains a rich volume of variables, particularly with respect to substance use behaviours, with individuals' engagement with substances being tracked as they move through the life course (Harris et al., 2019). In addition, Add Health contains detailed measures of parenting styles and parent-adolescent relationships collected from both adolescents and parents. This wealth of information allows researchers to use advanced statistical techniques to explore the associations; in particular, the data set is well suited for PSM, which is based on the assumption that most important observed variables are controlled. As a result of these advantages, each of the empirical chapters is based on data from Add Health. Given that each chapter addresses its own unique research question and

uses different statistical techniques for analysis, the chapters contain their own brief summary of methodology that is related to the particular piece of work.

## 2.2 Current studies

### *2.2.1 Variables and measurement scales*

This section describes all the variables and the measurement scales used in the analyses; the ranges, means (M), and standard deviations (SD) from the raw data are presented. Latent scales (such as parental warmth and control and depression) are constructed from a set of variables using the standardised values of the individual items. A summative score is computed additively and then divided by the number of items. The internal consistency reliability of this scale is then assessed using Cronbach's alpha (α). All latent scales are standardised to have a mean of zero and a standard deviation of 1. The sets of variables used in each chapter vary in order to match with the theme and the analytical models. Each chapter will indicate the set of variables that are used in the analyses. An overview of all indicators that are used to derive latent scales in each chapter is provided in Table 2.2.

#### *Parental beliefs about adolescents' substance use*

In Wave 1, mothers were asked whether their adolescents used tobacco once a week or more (M=0.12, SD=0.32) and whether the adolescents used alcohol at least once a month (M=0.09, SD=0.29). In the main analysis, the response 'unsure' is included in the 'yes' category as it may implicitly reflect parents' suspicion that their adolescents may be using the substances (Bogenschneider et al., 1998)[1].

#### *Parenting styles in adolescence: warmth and control*

Parenting style is measured via bespoke survey instruments which draw on several existing well-validated instruments (Udry, 2001); data collected in Wave 1 are used. Based on Baumrind's two-dimensional parenting styles, two scales are generated: parental warmth and control. The *warmth* scale reflects parental responsiveness, emotional bonding and trust. The scale in Chapter 4 is based on 11 items, some of which are reported by adolescents and some by mothers (α=0.75). Measurement items include 'How much do you think she cares about you?',

[1] The percentage of parents reporting 'unsure' about their adolescents' substance use is 2 per cent for smoking and 5 per cent for alcohol use.

'Most of the time, your mother is warm and loving', and 'You feel you can really trust your child'. Only responses from mothers are employed for the analysis reported in Chapter 4; the same analysis using responses from fathers gives similar results, but sample sizes are smaller.

In Chapter 5, the warmth measure is similar, except that the responses reported by the parents are not included in the analyses (i.e. it is based on the seven items reported by the adolescents). This is because the sample in that chapter is restricted to those who reported having used substances in Wave 3, therefore any further sample restriction may lead to an insufficient sample size. The maternal warmth scale in Chapter 5 is derived from seven items (α=0.85), and the paternal warmth scale is derived from five items[2] (α=0.89). Higher values indicate greater levels of parental warmth.

The *parental control* scale is based on seven items (α=0.62); all items were reported by adolescents only. The measure is a reversed scale of the degree to which parents (both mothers and fathers) granted autonomy; measurement items include whether adolescents were allowed to decide the time they must be home on weekend nights, people they hanged out with, and television programmes they watched. Higher values indicate higher levels of parental control.

Both parental warmth and control scales are constructed using the standardised value of each individual item and are computed additively and standardised. The internal consistency reliability is assessed by Cronbach's alpha (α). The items used in forming the parental warmth and parental control scales are summarised in Table 2.2. Existing literature consistently shows that parenting styles vary according to adolescent age and gender (Belsky, 1984; Parent et al., 2014). The primary interest of this thesis is the effects of parenting styles inasmuch as they are typical or atypical for adolescents at a particular stage in life; the two parenting dimensions are thus adjusted for age and sex.

***Maternal-adolescent closeness***

The five measurement items indicating mother-adolescent closeness are almost identical to the items that measure parental warmth. Some items are omitted as they do not sufficiently reflect adolescents' perception of their emotional intimacy with their mothers (α=0.84 for the five-item scale, standardised). Items that are considered to measure maternal-adolescent closeness

[2] Two questions measuring paternal warmth are not asked of fathers in the Wave 1 survey: "Your mother encourages you to be independent" and "When you do something wrong that is important, your mother talks about it with you and helps you understand why it is wrong".

include ‘Most of the time, your mother is warm and loving toward you’, ‘You are satisfied with the way your mother and you communicate with each other’, ‘Overall, you are satisfied with your relationship with your mother’, ‘How close do you feel to your [mother]’, and ‘How much do you think she cares about you’. The scale is constructed using the standardised value of each individual item and is computed additively and standardised. The internal consistency reliability is assessed by Cronbach’s alpha (α). Higher values indicate greater levels of mother-adolescent closeness. The five items forming the maternal-adolescent closeness scale are summarised in Table 2.2.

***Maternal trust***

Maternal trust is a five-point item reported by the mothers in Wave 1, which measures how much they felt they could really trust their adolescents (ranging from 1 ‘never’ to 5 ‘always’, M=4.32, SD=0.86).

***Adolescent lying***

Adolescent lying is a four-point item reported by the adolescents in Wave 1, which measures how often adolescents had lied to their parents or guardians about where they had been or whom they had been with (ranging from 0 ‘never’ to 3 ‘5 or more times’, M=0.90, SD=1.04).

***Parental presence***

Parental presence is measured at Wave 1. It is an additive scale of how often parents were present during three time-points of a day; these three time points being before bedtime, before school, and after school. The scale is standardised to have a mean 0 and a standard deviation of 1. Higher scores indicate higher parental presence.

***Parental and peer substance use***

In Wave 1, the definition of parental smoking is based on reports from either the parents or the adolescents (mother: M=0.46, SD=0.50; father: M=0.52, SD=0.50). Parental alcohol consumption was reported by the parents or the parents’ partners (i.e. the mothers or the fathers; adolescents were not asked about parental drinking), which indicates whether the parents use alcohol more than two or three days per month (mother: M=0.23, SD=0.42; father: M=0.40, SD=0.49).

Adolescents were also asked how many of their three best friends use cigarettes, alcohol, and marijuana. Responses range from none to three; the mean varies with age, so (as with the parenting scales) the scales are adjusted for age and sex and are standardised.

Parental and peer drinking are included in the regressions that estimate adolescents' alcohol use, and parental and peer smoking in all other regressions.

***Age at substance use initiation***

Several specifications for the age at first use of each substance are generated (for drinking, and using marijuana and other illicit drugs, this is the age at which the substance is first used; for smoking, it indicates the age at which the respondent first smoked regularly). The main model in Chapter 4 (which looks at the relationship between parenting style in adolescence and substance use problems in adulthood) uses a binary indicator of whether the initiation of each substance had occurred by Wave 1; respondents in Wave 1 (ages 12-19) were asked whether they had used the substance in the past 30 days (cigarettes: M=0.20, SD=0.40; alcohol: M=0.46, SD=0.50; marijuana use: M=0.27, SD=0.44; illicit drug use (excluding marijuana): M=0.31, SD=0.46).

Three alternative specifications of age at substance use initiation (see the robustness checks shown in Table 4.4) are also generated:

- **A binary indicator of initiation by Wave 2**, for those who had not used the substance by Wave 1 (cigarettes: M=0.35, SD=0.48; alcohol: M=0.27, SD=0.45; marijuana use: M=0.12, SD=0.33; illicit drug use (excluding marijuana): M=0.13, SD=0.33);
- **A continuous indicator of age at first use**, in which respondents were asked at which age they first used the substance. This indicator is derived from responses to all four waves of the survey[3] (cigarettes: ranging from age 10 or below to age 31: M=16.3, SD=3.35; alcohol: ranging from age 10 or below to age 30: M=15.9, SD=3.21; marijuana use: ranging from age 10 or below to age 29: M=16.3, SD=3.08;

[3] Some respondents reported different ages at first use in different waves; the age reported in the earlier wave is used, because it is less likely to be subject to recall error. However, individuals might have reported substance use in adulthood which they did not dare report in adolescence. A parallel set of variables is created which prioritised reports in adulthood. The two sets of estimates are almost identical.

illicit drug use (excluding marijuana): ranging from age 10 or below to age 32: M=17.9, SD=4.29); and

- **Use of age 16**, in which a binary variable that is derived from the continuous indicator of age at first use. The threshold chosen is age 16, indicating whether respondents had ever initiated use of each substance by age 16 (cigarettes: M=0.26, SD=0.44; alcohol: M=0.49, SD=0.50; marijuana use: M=0.33, SD=0.47; illicit drug use (excluding marijuana): M=0.14, SD=0.34).

***Substance use in adolescence and adulthood***

The level of cigarette, alcohol, marijuana or any other illicit drug use (including marijuana) in the past 30 days are measured in all waves. These are summarised in turn below.

The variable for the level of cigarette consumption is derived from two measurements: the number of days respondents smoked over the past month, and the average number of cigarettes smoked on each of these days (Wave 1: ranging from 0 to 60 cigarettes in the past 30 days, M=1.47, SD=4.74; Wave 2: ranging from 0 to 60 cigarettes in the past 30 days, M=1.78, SD=5.20; Wave 3: ranging from 0 to 100 cigarettes in the past 30 days, M=3.46, SD=7.53; Wave 4: ranging from 0 to 100 cigarettes in the past 30 days, M=3.50, SD=7.45).

The variable for the levels of alcohol consumed is a combined measurement of the quantity-frequency scale (Poikolainen, Podkletnova & Alho, 2002). The quantity item measures the number of drinks respondents had had each time in the past 12 months. The frequency of alcohol use in the past 12 months is coded in the questionnaire as follows: 0=never/had not had a drink in their lifetime; 1=one or two days; 2=once a month or less (three-12 times in the past 12 months); 3=two or three days a month; 3=one or two days a week; 4=three to five days a week; and 6=every day or almost every day. The two measures are multiplied into a single scale by converting the frequency levels into equivalent occasions per month (i.e. 0=0, 1=0.125 days per month[4], 2=0.625 days per month, 3=2.5 days per month, 4=6 days per month, 5=16 days per month, 6=28 days per month) (Wave 1: ranging from 0 to 50.4 days per month, M=0.35, SD=1.68; Wave 2: ranging from 0 to 50.4 days per month,

[4] For example, using the midpoint of one or two days in the past 12 months (i.e. 1.5), the number of occasions equals 1.5/12 = 0.125 days per month. Similarly, using the midpoint of three to 12 times in the past 12 months (i.e. 7), the number of occasions equals 7/12 = 0.625 days per month.

M=0.38, SD=1.67; Wave 3: ranging from 0 to 16.8 days per month, M=0.62, SD=1.42; Wave 4: ranging from 0 to 16.8 days per month, M=0.56, SD=1.31).

The levels of marijuana use and other illicit drug use are measured by continuous variables, which indicate how often respondents had used marijuana and/or other illicit drug in the past 30 days. The content of the Add Health questionnaires regarding the key substance use measures across waves was revised to be more relevant to different age periods. Questions on any illicit drug use (including marijuana) asked in Waves 1-3 are slightly different from the questions asked in Wave 4. The number of *times* respondents had used the substance in the past 30 days is asked in Waves 1-3, and the number of *days* respondents had used the substance in the past month is asked in Wave 4 (*Marijuana*: Wave 1: ranging from 0 to 666 times in the past 30 days, M=1.79, SD=15.6; Wave 2: ranging from 0 to 222 times in the past 30 days, M=1.80, SD=9.29; Wave 3: ranging from 0 to 500 times in the past 30 days, M=3.62, SD=17.4; Wave 4: ranging from 0 to 6 days in the past month, M=0.60, SD=1.59. *Other illicit drugs (excluding marijuana)*: Wave 1: ranging from 0 to 712 times in the past 30 days, M=2.19, SD=18.1; Wave 2: ranging from 0 to 999 times in the past 30 days, M=2.25, SD=17.7; Wave 3: ranging from 0 to 1485 times in the past 30 days, M=4.22, SD=27.5; Wave 4: ranging from 0 to 6 days in the past month, M=0.72, SD=1.74).

***Depression symptoms in adolescence and adulthood***

Depressive symptoms are measured in the Add Health survey by a modified version of the Center for Epidemiologic Studies Depression Scale (CES-D), an instrument in wide use which has been validated for adolescents and young adults (Radloff, 1991; Roberts et al., 1990). For analyses, Waves 1, 3 and 4 measures are used. The scale in Wave 1 is based on 19 items (α=0.86), Wave 3, on 12 items (α= 0.82), and Wave 4, on 16 items (α= 0.88); most items overlap across waves. Measurement items include 'In the past 12 months, how often have you cried a lot?', 'How satisfied are you with your life as a whole?', 'You were depressed, during the past seven days', and 'You were tired to do things, during the past seven days'. The scales are constructed using the standardised value of each individual item and are computed additively and standardised. The internal consistency reliability is assessed by Cronbach's alpha (α). Higher scores denoting greater levels of depression. A comprehensive list of measurement items at different waves is provided in Table 2.2.

***Substance use problems in young adulthood***

Substance use problems are measured in Wave 4. The instruments for problem use of alcohol, marijuana and other drugs are based on the criteria for the diagnosis of Substance Use Disorder in the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV); these have been extensively validated (Hasin et al., 2006; Van Dulmen et al., 2002). The problem drinking scale is derived from 10 items (α=0.88); the scales for problem marijuana use (α=0.85) and problem use of other drugs (α=0.92) are each based on eight items. The scales are constructed using the standardised value of each individual item and are computed additively and standardised. The internal consistency reliability is assessed by Cronbach's alpha (α). Higher scores denoting greater levels of the problem. No problematic indicator of cigarette use was asked in the study. The items forming the problem use of alcohol, marijuana and other illicit drugs scales are summarised in Table 2.2.

As well as these continuous measures, binary variables are generated, which indicate individuals scoring in the top 5 per cent of heaviest smokers, and individuals scoring in the highest 5 per cent on the substance problem scales.

***Substance non-use in young adulthood***

Four variables indicating the absence of substance use (i.e. cigarette, alcohol, marijuana, or any illicit drugs) at Wave 4 are generated when respondents reported no substance use in the past 30 days (cigarettes: M=0.25, SD=0.43; alcohol: M=0.17, SD=0.38; marijuana: M=0.54, SD=0.50; any illicit drugs (including marijuana): M=0.51, SD=0.50). Given that the analyses in Chapters 5 and 6 (both chapters examine substance use cessation) are restricted to respondents who reported having used the substance in the past month at Wave 3, the 'non-use' category at Wave 4 can be viewed as demonstrating a change in use level from Wave 3 to Wave 4 (i.e. from substance users to substance non-users).

***Demographic backgrounds measured in Wave 1***

*Ethnicity.* Three different ethnic groups are generated: White; African-American; and American-Indian/Asian/Mixed/Others.

*Family composition.* Three household types are created: intact family; step-parent family; and single-parent family.

*Parental educational levels.* Four parental educational levels are generated: less than high-school levels; high-school graduate; some post-school training/college; and bachelor's degree/postgraduate training. The generation of this measure is subject to change to ensure the analysis is performed to the highest standard; this will be specifically indicated in the research chapters.

*Parental employment activities (mother's employment activities if father's activities were missing):* Adolescents were asked to identify their parents' occupation from a list of 14 occupations. Four employment activities are generated: (i) not employed; (ii) elementary/construction/military (craftsperson, e.g. toolmaker, woodworker/construction worker, e.g. carpenter, crane operator/mechanic, e.g. electrician, plumber, machinist/factory worker or labourer, e.g. assembler, janitor/ transportation, e.g. bus driver, taxi driver/military or security e.g. police officer, soldier, fire fighter/farm or fishery worker); (iii) office worker/service/sale (office worker, e.g. bookkeeper, office clerk, secretary/sales worker, e.g. insurance agent, store clerk/restaurant worker or personal service, e.g. waitress, housekeeper); and (iv) manager/technician/teacher/nurse/professional (professional 1, e.g. doctor, lawyer, scientist/professional 2, e.g. teacher, librarian, nurse/manager, e.g. executive, director/technical, e.g. computer specialist, radiologist). This fourfold classification is generated based mainly on the three-category version of the National Statistics Socio-Economic Classification (NS-SEC) (ONS, 2019) that is used in many UK surveys, which consists of routine and manual occupations, intermediate occupations, and higher managerial/professional occupations (with an extra category for people who have never worked or are long-term unemployed).

*Neighbourhood safety.* Substance use in a neighbourhood context is a binary indicator reported by mothers in Wave 1, measuring whether drug dealers and drug users were a big problem in the neighbourhood.

*Religiosity.* The scale indicating levels of religiosity is derived from four items (α=0.85); the scale is constructed using the standardised value of each individual item and is computed additively and standardised. The internal consistency reliability is assessed by Cronbach's alpha (α). Higher values indicate greater levels of religiosity. The items forming the religiosity scale at Wave 1 are summarised in Table 2.2.

*Parental levels of religiosity.* Two variables indicating parents' self-reported church attendance frequency (ranging from 1 'never attended church' to 4 'once a week or more',

M=3.47, SD=0.86) and religious faith (ranging from 1 'not important at all' to 4 'very important'; M=2.79, SD=1.15) are generated.

***Demographic backgrounds measured in Wave 4***

*Educational levels.* Four binary variables are created: less than high-school; high-school graduate; some post-school training/college; and bachelor's degree/postgraduate training. The generation of this measure is subject to change to ensure the analysis is performed to the highest standard; this will be specifically indicated in the research chapters.

*Religiosity.* The religiosity level scale is derived from five items (α=0.83). The scale is constructed using the standardised value of each individual item and is computed additively and standardised. The internal consistency reliability is assessed by Cronbach's alpha (α). Higher values indicate greater levels of religiosity. The items forming the religiosity scale at Wave 4 are summarised in Table 2.2.

Chapter 6 discusses two widely used dimensions extracted for comparison and examination: *religious behaviour* measured by the attendance at religious services and *religious devotion* assessed by individuals' ratings of the importance of religious faith. For church attendance frequency, respondents were asked how often they had attended church, synagogue, temple, mosque, or religious services in the past year. A binary variable is generated in which 1 denotes respondents who attended once a week or more and 0 denotes otherwise (M=0.18, SD=0.38). Religious faith is dichotomised with 'very important' and 'more important than anything else' combined as one category and 'somewhat important' and 'not important' as the other (M=0.57, SD=0.50).

*Employment status.* A dichotomous variable is generated to indicate whether the respondents were employed.

*Marital status.* Three binary variables are generated: married; cohabitation; and single/separated.

*Presence of child(ren).* A binary variable is created, indicating whether respondents had any child(ren).

*Living area.* A dichotomous variable is generated on the basis of whether respondents lived in a rural/suburban area.

### *2.2.2 Analytical sample*

Given that the age of the sample is slightly skewed in the data set, the analytical sample is restricted to respondents aged between 13 and 18[5] at the time of first interview (that is, who were of the usual ages for membership of the relevant school grades) in all analyses throughout the thesis. These respondents were aged between 14 and 19 at Wave 2, 18 and 25 at Wave 3, and 25 and 32 at Wave 4. Since the age range is relatively large and that age is a potential confounder of the associations between parenting styles, religiosity, and substance use, all analyses in the empirical chapters adjust for respondents' age.

Diagrams 2.1-2.4 present the analytical sample size for each of the waves and the resulting longitudinal samples drawn on for the empirical chapters. The sample size for the key variables is also reported.

[5] In the analyses, respondents' age is calculated as the difference between the date of interview (based on month and year) and the date of birth (based on month and year).

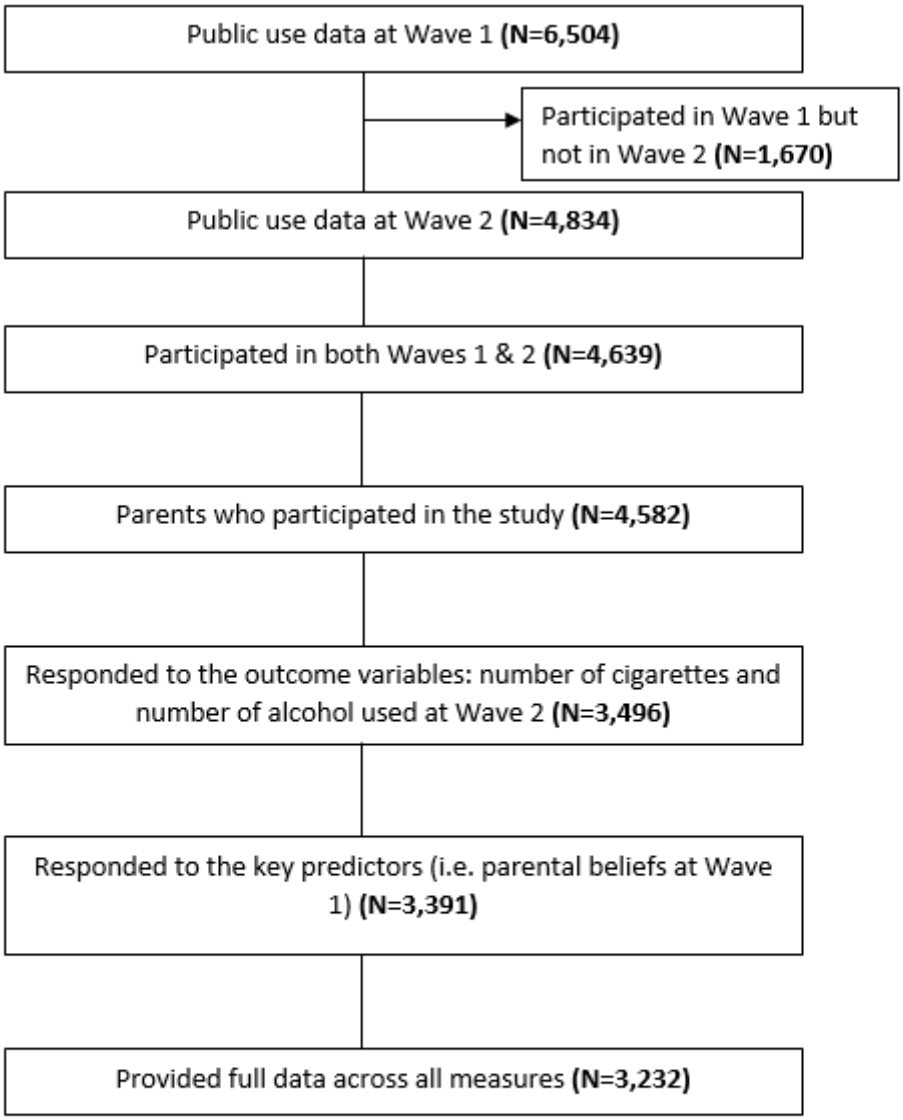



***Diagram 2.1 A flowchart of the analytic sample in Chapter 3. Chapter 3 examines the longitudinal association between parental belief measured at Wave 1 and adolescents' cigarette and alcohol use at Wave 2***

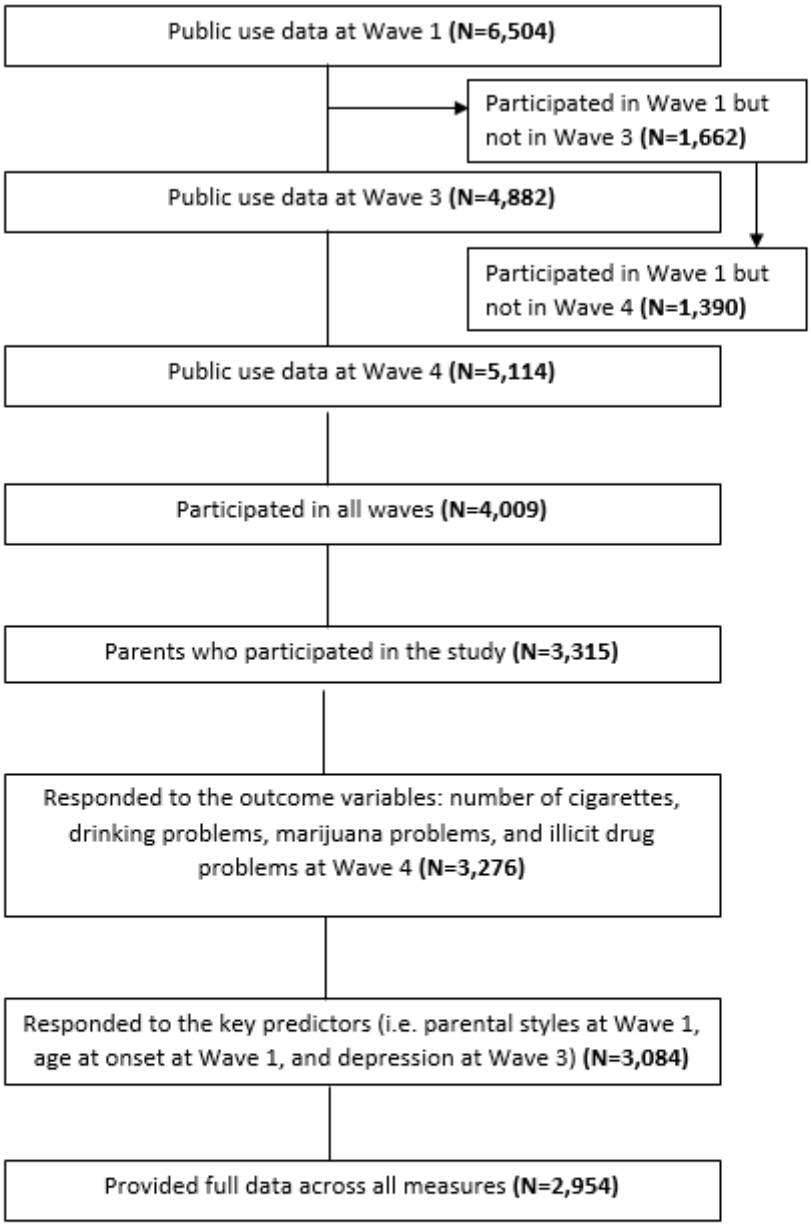
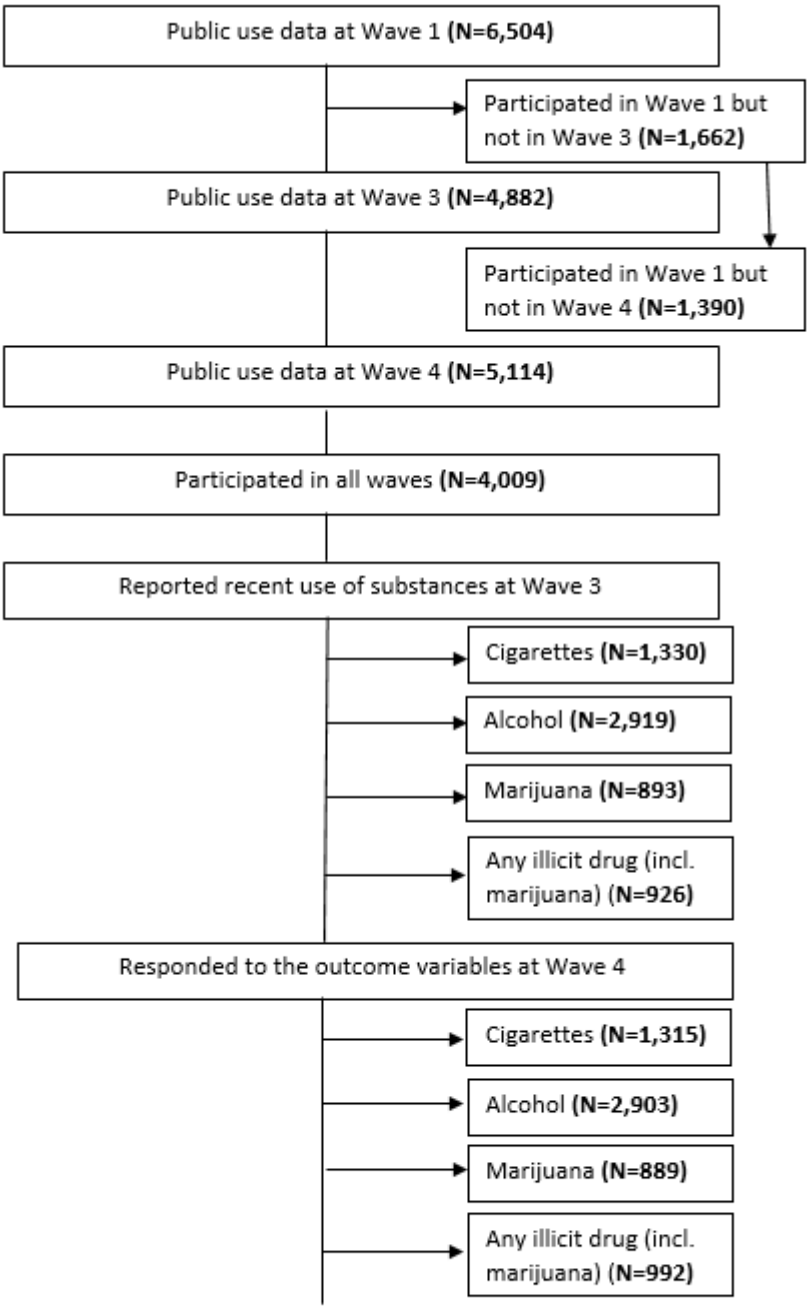



***Diagram 2.2 A flowchart of the analytic sample in Chapter 4. Chapter 4 examines the longitudinal association between parenting styles (the two dimensions-parental warmth and parental control; and the fourfold parenting styles-authoritative, authoritarian, indulgent, and neglectful) measured at Wave 1 and substance use and substance use problems (number of cigarettes, drinking problems, marijuana problems, and illicit drug problems) in adulthood measured at Wave 4***

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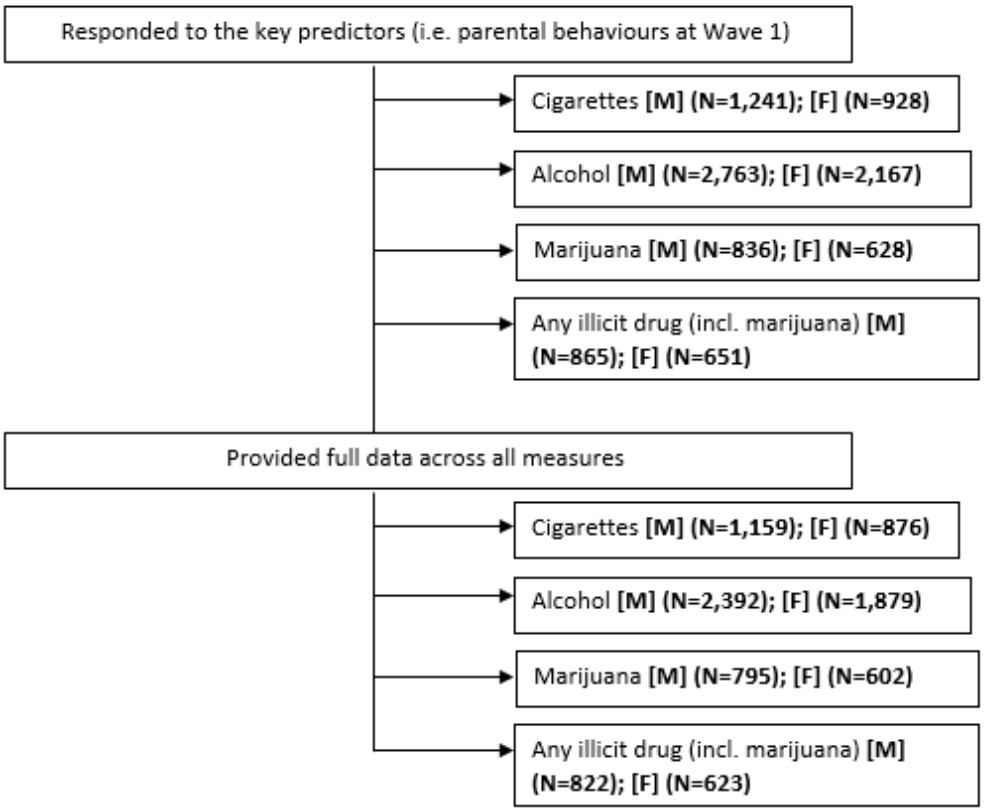
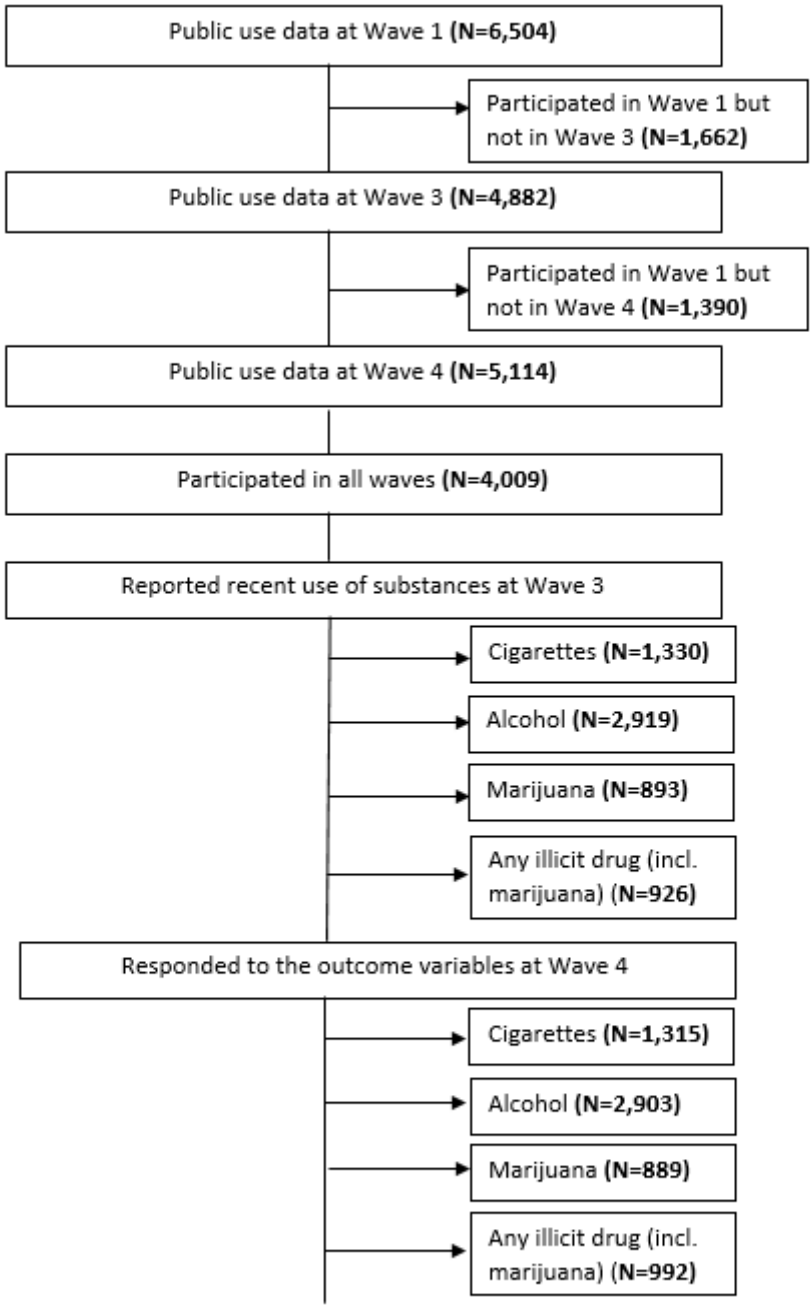



***Diagram 2.3 A flowchart of the analytic sample in Chapter 5. Chapter 5 examines the longitudinal association between parental behaviours (parental warmth, parental control and parental presence) measured at Wave 1 and substance use cessation at Wave 4. The sample is restricted to those who reported of using the substance at Wave 3. [Note: M represents 'mother' models which estimate maternal behaviours towards the cohort member. F represents 'father' models which estimate paternal behaviours towards the cohort member.]***

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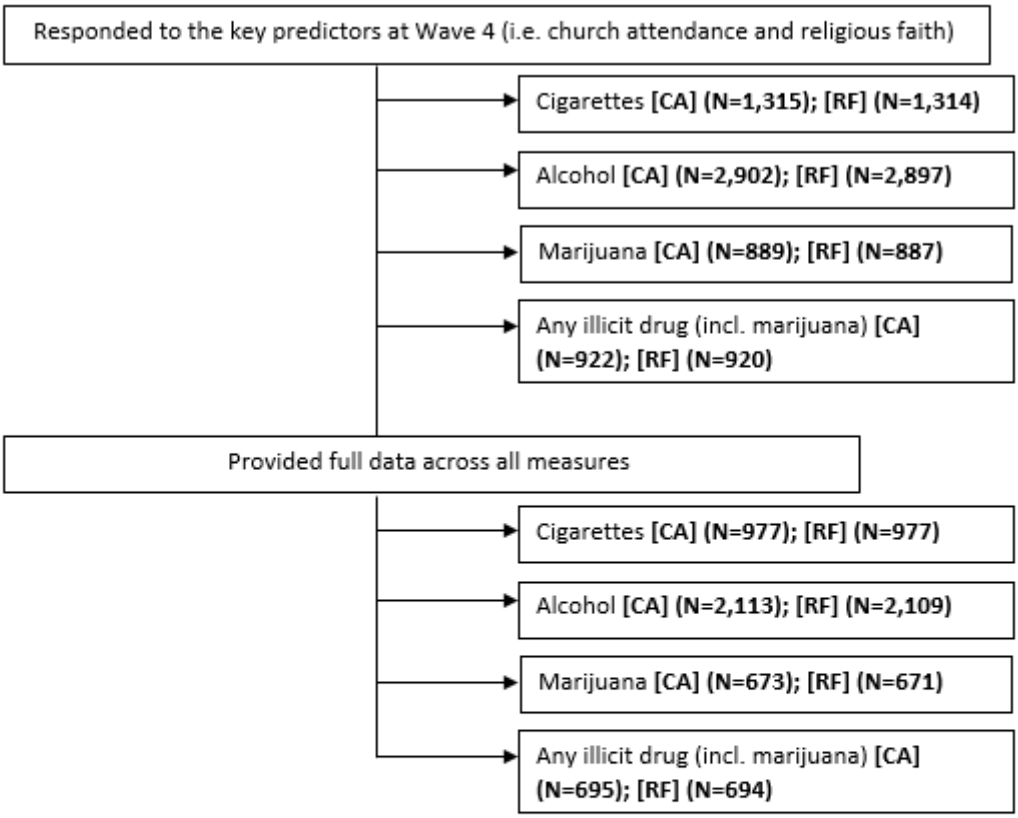


***Diagram 2.4 A flowchart of the analytic sample in Chapter 6. Chapter 6 examines the association between levels of religiosity (church attendance and religious faith) measured at Wave 4 and substance use cessation at Wave 4. The sample is restricted to those who reported of using the substance at Wave 3. [Note: CA represents 'church attendance' models. RF represents 'religious faith' models.]***

These diagrams show that the levels of attrition between waves are relatively low, considering some large intervals between Waves 2 and 3 and between Waves 3 and 4. For instance, Diagram 2.2 shows that nearly 80% of the respondents interviewed in Wave 1 were followed up in the Wave 4 interview (with an interval of approximately 14 years between these two waves). Moreover, the missingness that is attributed by the non-response to the questionnaire items is small. For instance, the percentage of non-response to the substance use items measured at Wave 4 is less than 1%; the nonresponse is mainly due to the respondents who refused to answer the question. With respect to the response bias, the Add Health data team has done a thorough examination to investigate the issue and concluded that the response bias in relation to both attrition and non-response is minimal (see section

2.1.1 on response bias). Additional analyses about the missingness were conducted for this thesis, no systematic differences by age, gender and ethnicity were found.

As a result, the missingness in all empirical analyses in this thesis is handled using listwise deletion (i.e. participants with missing values on any variables are excluded). While multiple imputation is an increasingly popular method to deal with the missing data, some statistical techniques applied in this thesis (such as propensity score matching) cannot currently be estimated using multiple imputation in Stata. In order to be consistent throughout the whole thesis, listwise deletion is therefore used to handle the missing data on the variables.

**Table 2.1 Estimates of substance use (unweighted and weighted) among Add Health cohort members across Waves 1-4 , in 1994-2008**

| | **Wave 1 Age 13-18** | | **Wave 2 Age 14-19** | | **Wave 3 Age 18-25** | | **Wave 4 Age 25-32** | |
|---|---|---|---|---|---|---|---|---|
| | **U** | **W** | **U** | **W** | **U** | **W** | **U** | **W** |
| **Cigarettes (%)** | | | | | | | | |
| Lifetime | 56.2 | 55.6 | 44.8 | 47.1 | 60.1 | 63.8 | 65.5 | 67.4 |
| Past month | 25.3 | 24.4 | 31.9 | 33.1 | 32.7 | 35.5 | 36.4 | 38.3 |
| **Alcohol (%)** | | | | | | | | |
| Lifetime | 56.0 | 53.6 | 48.8 | 50.8 | 77.8 | 78.7 | 80.6 | 82.1 |
| Past month | 46.4 | 43.9 | 45.1 | 47.0 | 72.0 | 73.2 | 72.2 | 74.2 |
| **Marijuana (%)** | | | | | | | | |
| Lifetime | 27.1 | 24.5 | 25.9 | 26.0 | 45.9 | 48.6 | 54.9 | 56.8 |
| Past month | 13.3 | 12.2 | 15.5 | 15.1 | 21.9 | 24.3 | 15.6 | 16.3 |
| **Any illicit drugs (including marijuana) (%)** | | | | | | | | |
| Lifetime | 30.7 | 28.2 | 27.5 | 27.7 | 47.4 | 50.1 | 56.2 | 58.0 |
| Past month | 14.3 | 13.1 | 16.5 | 16.1 | 22.7 | 25.0 | 18.4 | 19.1 |

Notes: U represents unweighted estimates. W represents weighted estimates.

Table 2.1 presents estimates of substance use among the Add Health cohort members across waves (both weighted[6] and unweighted estimates to highlight the magnitude of any non-response bias in the remaining samples). The table shows that the weighted estimates of the respondents who reported using cigarettes, alcohol, marijuana, and any illicit drugs (including marijuana) by Wave 4 (ages 25-32) are 67 per cent, 82 per cent, 57 per cent, and 58 per cent respectively. In line with the estimates of substance use among young people aged

[6] The cross-sectional weight (GSWGT1) used in Table 2.1 is provided in the Add Health public-use data set. The choice of the weighting variable is recommended in the Add Health guidelines for analysing the data (Chen & Chantala, 2014).

12-26 or older in 2015-2017 based on data from the Center for Behavioral Health Statistics and Quality (shown in Table 1.1), there is a sharp increase of alcohol and drug use in the past month between Waves 2 (ages 14-19) and 3 (ages 18-25). While the trend of cigarette and alcohol use in the past month between Waves 3 (ages 18-25) and 4 (ages 25-32) remains relatively stable, the use of any illicit drugs peaks at Wave 3 and then declines at Wave 4. The weighted and unweighted estimates of substance use across Waves 1-4 show no significant differences, which echo with the conclusions of Harris et al. (2019) who stated that the Add Health study sample has maintained its representativeness over time.

## 2.3 Analytical methods

### *2.3.1 Statistical analyses*

Three statistical techniques are employed for the research chapters that address separate, individual research questions; these include propensity score matching (PSM), structural equation modelling (SEM) and logistic regression.

PSM is a technique that attempts to mimic an experimental research setting on an observational data set to reduce a confounding bias and to identify a causal relationship (Rosenbaum & Rubin, 1983, 1984, 1985). It creates two groups from the sample, a treatment group and a control group, and then pairs each sample member in the treatment group with one or more member(s) in the control group. Matches are constructed based on propensity scores that are calculated using the logistic regression on covariates (Becker & Ichino, 2002; Guo & Fraser, 2010; Rosenbaum & Rubin, 1983, 1984, 1985). After matching, the sample distribution of the observed covariates in the treated and control groups should be very similar; the difference between these groups should therefore be due more to the treatment itself.

SEM is a technique that uses a conceptual model and path system to analyse complex relationships (Bartholomew et al., 2008). It allows researchers to include multiple and interrelated outcome variables in a single analytical model. One feature of SEM is that an outcome variable is sometimes an independent variable in other components of the SEM system; this is useful for identifying a mediation relationship and for estimating total, direct and indirect effects. SEM also provides goodness-of-fit statistics to assess the model fit (Bartholomew et al., 2008).

Finally, logistic regressions are applied in some of the chapters which are used to explain the relationship between a binary dependent variable (such as substance use cessation) and one or more independent variables.

Results presented are from unweighted regressions (Solon, Haider & Wooldridge, 2015; Winship & Radbill, 1994); weighted regressions give similar results.

A more detailed discussion of how each method is applied will be provided in the related chapters.

| **Table 2.2 An overview of latent scales used in the chapter(s), including the indicators** | | | | |
|---|---|---|---|---|
| ***Parental Warmth at Wave 1 (all measured on five-point scales)*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| How much do you think [your parental figure] cares about you? | | x | x | |
| How close do you feel to your [parental figure]? | | x | x | |
| Most of the time, your [parent] is warm and loving toward you. | | x | x | |
| Your mother encourages you to be independent[1]. | | x | x | |
| When you do something wrong that is important, your mother talks about it with you and helps you understand why it is wrong[1]. | | x | x | |
| You are satisfied with the way your [parent] and you communicate with each other. | | x | x | |
| Overall, you are satisfied with your relationship with your [parent]. | | x | x | |
| [Asked of parents] How often would it be true for you to make each of the following statement about your child: | | | | |
| You get along well with him/her. | | x | | |
| Your child and you make decisions about his/her life together. | | x | | |
| You just do not understand him or her. | | x | | |
| You feel you can really trust him/her. | | x | | |
| **Alpha α** | | **Mother only= 0.75 (N=6,975)** | **Mother= 0.85 (N=4,845); Father=0.89 (N=3,465)** | |
| ***Mother-adolescent closeness at Wave 1 (all measured on five-point scales)*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| Most of the time, your mother is warm and loving toward you. | x | | | |
| You are satisfied with the way your mother and you communicate with each other. | x | | | |
| Overall, you are satisfied with your relationship with your mother. | x | | | |
| How much do you think she [your maternal figure] cares about you? | x | | | |
| How close do you feel to your [maternal figure]? | x | | | |
| **Alpha α** | **0.84 (N=6,131)** | | | |

| *Parental control at Wave 1 (all measured as yes /no)* | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
|---|---|---|---|---|
| Do your parents let you make your own decisions about: | x | x | x | |
| The time you must be home on weekend nights | x | x | x | |
| The people you hang around with | x | x | x | |
| What you wear | x | x | x | |
| How much television you watch | x | x | x | |
| What time you go to bed on week nights | x | x | x | |
| Which television programs you watch | x | x | x | |
| What you eat | x | x | x | |
| **Alpha α** | **0.62 (N=6,366)** | **0.62 (N=6,366)** | **0.62 ( N=6,366)** | |
| ***Depression symptoms (✈ measured on a 5-point scale; ☼ measured on a 4-point scale)*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| **Wave 1** | | | | |
| ☼You were bothered by things that usually don't bother you. | x | | | |
| ☼You didn't feel like eating, your appetite was poor. | x | | | |
| ☼You felt that you could not shake off the blues, even with help from your family and your friends. | x | | | |
| ☼You felt that you were just as good as other people. | x | | | |
| ☼You had trouble keeping your mind on what you were doing. | x | | | |
| ☼You felt depressed. | x | | | |
| ☼You felt that you were too tired to do things. | x | | | |
| ☼You felt hopeful about the future. | x | | | |
| ☼You thought your life had been a failure. | x | | | |
| ☼You felt fearful. | x | | | |
| ☼You were happy. | x | | | |
| ☼You talked less than usual. | x | | | |
| ☼You felt lonely. | x | | | |
| ☼People were unfriendly to you. | x | | | |
| ☼You enjoyed life. | x | | | |

| | | | | |
|---|---|---|---|---|
| ☼You felt sad. | x | | | |
| **Alpha α** | **0.86 (N=6,491)** | | | |
| ***Wave 3*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| ⅄ In the past 12 months, how often have you laughed a lot? | | x | x | |
| ⅄ In the past 12 months, how often have you cried a lot? | | x | x | |
| ⅄ How satisfied are you with your life as a whole? | | x | x | |
| ☼ In the past 7 days, you were bothered by things that usually don't bother you. | | x | x | |
| ☼ You could not shake off the blues, even with help from your family and your friends, during the past 7 days. | | x | x | |
| ☼ You felt that you were just as good as other people, during the past 7 days. | | x | x | |
| ☼ You had trouble keeping your mind on what you were doing, during the past 7 days. | | x | x | |
| ☼ You were depressed, during the past 7 days. | | x | x | |
| ☼ You were too tired to do things, during the past 7 days. | | x | x | |
| ☼ You enjoyed life, during the past 7 days. | | x | x | |
| ☼ You were sad, during the past 7 days. | | x | x | |
| ☼ You felt that people disliked you, during the past 7 days. | | x | x | |
| **Alpha α** | | **0.82 (N=4,881)** | **0.82 (N=4,881)** | |
| ***Wave 4*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| ⅄In the last 30 days, how often have you felt you were unable to control the important things in your life? | | | | x |
| ⅄In the last 30 days, how often have you felt confident in your ability to handle your personal problems? | | | | x |
| ⅄In the last 30 days, how often have you felt that things were going your way? | | | | x |
| ⅄In the last 30 days, how often have you felt that difficulties were piling up so high that you could not overcome them? | | | | x |
| ☼How often do you feel isolated from others? | | | | x |
| ☼You were bothered by things that usually don't bother you. | | | | x |

| | | | | |
|---|---|---|---|---|
| ☼(During the past 7 days) You could not shake off the blues even with help from your family and your friends. | | | | x |
| ☼(During the past 7 days) You felt you were just as good as other people. | | | | x |
| ☼(During the past 7 days) You had trouble keeping your mind on what you were doing. | | | | x |
| ☼(During the past 7 days) You felt depressed. | | | | x |
| ☼(During the past 7 days) You felt that you were too tired to do things. | | | | x |
| ☼(During the past 7 days) You felt happy. | | | | x |
| ☼(During the past 7 days) You enjoyed life. | | | | x |
| ☼(During the past 7 days) You felt sad. | | | | x |
| ☼(During the past 7 days) You felt that people disliked you. | | | | x |
| ☼ In your day-to-day life, how often do you feel you have been treated with less respect or courtesy than other people? | | | | x |
| **Alpha α** | | | | **0.88 (N=5,113)** |
| ***Substance use problems (❖ responses measured on a 3-point scale; ✞ yes/no responses)*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| ***Drinking problems*** | | | | |
| ❖ How often has your drinking interfered with your responsibilities at work or school? | | x | | |
| ❖ How often have you been under the influence of alcohol when you could have gotten yourself or others hurt, or put yourself or others at risk, including unprotected sex? | | x | | |
| ❖ How often have you had legal problems because of your drinking, like being arrested for disturbing the peace or driving under the influence of alcohol, or anything else? | | x | | |
| ❖ How often have you had problems with your family, friends, or people at work or school because of your drinking? | | x | | |
| ✞ Have you ever found that you had to drink more than you used to in order to get the effect you wanted? | | x | | |
| ✞ Has there ever been a period when you spent a lot of time drinking, planning how you would get alcohol, or recovering from a hangover? | | x | | |

| | | | | |
|---|---|---|---|---|
| ✞ Have you often had more to drink or kept drinking for a longer period of time than you intended? | | x | | |
| ✞ Have you ever tried to quit or cut down on your drinking? | | x | | |
| ✞ Have you ever continued to drink after you realized drinking was causing you any *emotional* problems (such as feeling irritable, depressed, or uninterested in things or having strange ideas) or causing you any *health* problems (such as ulcers, numbness in your hands/feet or memory problems)? | | x | | |
| ✞ Have you ever given up or cut down on important activities that would interfere with drinking like getting together with friends or relatives, going to work or school, participating in sports, or anything else? | | x | | |
| **Alpha α** | | **0.88 (N=5,112)** | | |
| ***Marijuana problems*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| ❖How often has your marijuana use interfered with your responsibilities at work or school? | | x | | |
| ❖How often have you been under the influence of marijuana when you could have gotten yourself or others hurt, or put yourself or others at risk, including unprotected sex? | | x | | |
| ❖How often have you had problems with your family, friends, or people at work or school because of your marijuana use? | | x | | |
| ✞ Have you ever found that you had to use more marijuana than you used to in order to get the effect you wanted? | | x | | |
| ✞ Has there ever been a period when you spent a lot of time using marijuana, getting it, or getting over its effects? | | x | | |
| ✞ Have you often used more marijuana or used marijuana longer than you intended? | | x | | |
| ✞ Have you ever continued to use marijuana after you realized using marijuana was causing you any *emotional* problems (such as feeling depressed or empty, feeling irritable or aggressive, feeling paranoid or confused, feeling anxious or tense, being jumpy or easily startled) or causing you any *health* problems (such as persistent cough, | | x | | |

| | | | | |
|---|---|---|---|---|
| sore throat or sinus problems, heart pounding, headaches or dizziness, or sexual difficulties)? | | | | |
| ✞ Have you ever given up or cut down on important activities that would interfere with your marijuana use like getting together with friends or relatives, going to work or school, participating in sports, or anything else? | | x | | |
| **Alpha α** | | **0.85 (N=5,113)** | | |
| ***Other illicit drug problems*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| ❖How often has your [illicit drug] use interfered with your responsibilities at work or school? | | x | | |
| ❖How often have you been under the influence of [illicit drug] when you could have gotten yourself or others hurt, or put yourself or others at risk, including unprotected sex? | | x | | |
| ❖How often have you had legal problems because of your [illicit drug] use, like being arrested for disturbing the peace of anything else? | | x | | |
| ❖How often have you had problems with your family, friends, or people at work or school because of your [illicit drug] use? | | x | | |
| ✞ Did you continue to use [illicit drug] after you realized using it was causing you problems with family, friends, or people at work or school? | | x | | |
| ✞ Have you ever found that you had to use more [illicit drug] than you used to in order to get the effect you wanted? | | x | | |
| ✞ Has there ever been a period when you spent a lot of time using [illicit drug], getting it, or getting over its effects? | | x | | |
| ✞ Have you often used more [illicit drug] use or used [illicit drug] longer than you intended? | | x | | |
| **Alpha (N)** | | **0.92 (N=5,114)** | | |
| ***Religiosity levels (⅄ measured on a 6-point scale; ✶ measured on a 5-point scale; ☼ measured on a 4-point scale)*** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |

| | | | | |
|---|---|---|---|---|
| **Wave 1** | | | | |
| ☼ In the past 12 months, how often did you attend religious services | x | | | |
| ☼ How important (if at all) is your religious faith to you? | x | | | |
| ✶How often do you pray? | x | | | |
| ⅄ Many churches, synagogues, and other places of worship have special activities for teenagers-such as youth groups, Bible classes, or choir. In the past 12 months, how often did you attend such youth activities | x | | | |
| **Alpha α** | **0.85 (N=6,494)** | | | |
| **Wave 4** | **Chapter 3** | **Chapter 4** | **Chapter 5** | **Chapter 6** |
| ⅄ How often have you attended church, synagogue, temple, mosque, or religious services in the past 12 months? | | x | x | |
| ⅄ Many churches, synagogues, and other places of worship have special activities outside of regular worship services- such as classes, retreats, small groups, or choir. In the past 12 months, how often have you taken part in such activities? | | x | x | |
| ☼ How important (if at all) is your religious faith to you? | | x | x | |
| ⅄ How often do you pray privately, that is, when you're alone in places other than a church, synagogue, temple, mosque, or religious assembly? | | x | x | |
| ✶ How often do you turn to your religious or spiritual beliefs for help when you have personal problems, or problems at school or work? | | x | x | |
| **Alpha α** | | **0.83 (N=5,105)** | **0.83 (N=5,105)** | |

Notes: [1]These two questions measuring paternal warmth are not asked of fathers in the Wave 1 survey. All sub-scales are derived using Cronbach's alpha and are standardised to have a mean 0 and a standard deviation of 1. The alpha coefficients shown here are for all respondents with valid data and not just the subset of respondents who are in the analytical samples.

# Chapter 3
# Parental beliefs and adolescent smoking and drinking behaviours: A propensity score matching study

The peer-reviewed and shorter version of this article is published as: Mak, H.W. (2018). Parental beliefs and adolescent smoking and drinking behaviours: A propensity score matching study. *Addictive Behaviors Reports, 8, 11-20.* doi.org/10.1016/j.abrep.2018.04.003. The full paper is provided in the appendix.

## 3.1 Introduction

Substance use has always been a concern to the adolescent development and public health community. In the US, around one in three students in grades 9 -12 have tried cigarette smoking. More than 60 per cent of them have used alcohol and 17 per cent of them used alcohol before the age of 13 (Frieden et al., 2016). Given that social transition occurs in adolescence, the consequences of substance use during this critical period could hugely affect young people's later life chances, for example, poor academic grades, physical and mental health problems, substance abuse in adulthood, and premature death (Dawson et al., 2008; DeWit et al., 2000; Grant & Dawson, 1998; Hingson, Heeren & Winter, 2006; King & Chassin, 2007; Marshall, 2014; McGue et al., 2001; Merlin et al., 2004; Mikkonen et al., 2008; Tucker et al., 2008; Welch, Carson & Lawrie, 2013). As a result, substance use among young people is a substantial social and health burden to society and remains an important area for investigation.

Parental awareness of adolescents' risk behaviours (including substance use), through the process of attachment to significant others, is one of the key examples of the individual/interpersonal factors that could influence substance use among young people. Previous literature has evidently shown that parents across countries are often unaware of their adolescents' involvement in using substances (Ahern, Kemppainen & Thacker, 2016; Bogenschneider et al., 1998; Bylund, Imes & Baxter, 2005; a Taiwanese study, see Chang et al., 2013; a cross-national study, see Fernandez-Hermida et al., 2013; Fisher et al., 2006; Green et al., 2011; Jones et al., 2017; Langhinrichsen et al., 1990; McGillicuddy et al., 2007; a Canadian study, see Williams et al., 2003; Yang et al., 2006). One may assume that parents

who are aware of their adolescents' deviant behaviours may take appropriate and preventive action to avoid further misbehaving (Beck & Lockhart, 1992; Kerr, Stattin & Burk, 2010). However, empirical evidence suggests otherwise. Parents' accurate beliefs have been found to be associated with an increase in adolescents' later risk behaviours, whereas their non-beliefs or unawareness is related to a decrease in these activities (Lamb & Crano, 2014; Madon et al., 2003, 2004, 2006; Mollborn & Everett, 2010; Yang et al., 2006). The self-fulfilling prophecy (SFP) has often been used to explain this observation. It suggests that adolescent behaviour, and the consequences of that behaviour, are determined by parental beliefs, including *false* beliefs (Merton, 1948). Adolescents start or continue using substances when their parents believe they have started to do so even though they have not and discontinue when the parents believe they have not begun to use them when they have. A possible explanation for this is that when parents think their adolescents are using substances, adolescents may begin to believe that that is what they are expected to do. Existing studies provide evidence in support of the prophecy. For instance, Lamb and Crano (2014) used data from the National Survey of Parents and Youth and found that parental underestimation of adolescent marijuana use at Time 1 was associated with a lower frequency of usage at Time 2. Parents who were correctly aware of their adolescents' marijuana use at Time 1 predicted a higher frequency of usage at Time 2. Similar effects of beliefs have also been found in other areas. For example, Mollborn and Everett (2010) found that parental underestimation of adolescent sexual activity in Wave 1 predicted a lower frequency of sexual activity and STI diagnosis in Wave 2, compared with adolescents whose parents were aware of the behaviour. On the other hand, it is possible that parents who were aware of the risk behaviours such as substance use and sexual activity may adopt a more disciplinary approach towards adolescents, which in turn may increase the probability of adolescents' involvement in risky behaviours (Yang et al., 2006).

However, most research has failed to acknowledge a potential confounding bias that may exist in the relationship between adolescent substance use, parental beliefs and shared factors. Failing to address the bias may over- or underestimate the effect of parental beliefs. An overview of past literature implies that factors responsible for parents' beliefs about their adolescents' involvement in risk behaviours may also be factors that motivate adolescents to engage in those very behaviours (see Diagram 3.1). This may partly explain why parental underestimation is more protective than accurate awareness, given that underestimation

tends to be associated with healthy parent-adolescent relationships, good academic performance and high levels of adolescents' religiosity (Berge et al., 2015; Green et al., 2011; Yang et al., 2006). The studies of Madon et al. (2003, 2004, 2006) are particularly relevant to this subject, being based on the assumption that parental beliefs about adolescents' alcohol use and adolescents' later alcohol consumption shared nearly identical risk and protective factors (e.g. household income and past alcohol use). While the authors suggest that the SFP was responsible for the association between parental beliefs and adolescents' later drinking behaviour, the method applied in the studies might not have successfully removed the confounding bias in the association.

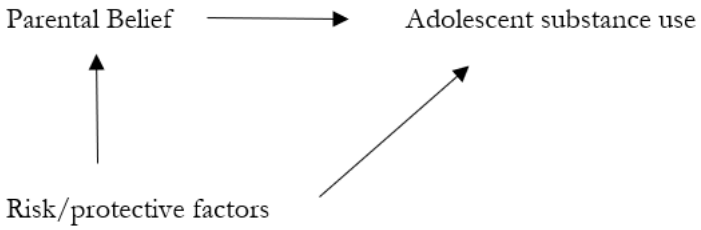


***Diagram 3.1 A model showing a potential confounding bias of the effect of parental beliefs on adolescents' substance use***

In light of this, the current paper is designed to extend the literature by applying propensity score matching (PSM) techniques to (1) address the bias caused by confounders, and more importantly, (2) to identify the possible causal relationship between parental beliefs and adolescents' engagement of substance use. To my best knowledge, this is the first study using PSM to examine the effect of parental beliefs on adolescents' risk behaviours.

## 3.2 The current study

The data analysed in this study are from the Wave 1 and Wave 2 Add Health data set. As shown in Chapter 2, Add Health contains a rich set of variables on adolescents', parents' and peers' substance use, as well as other aspects of adolescents' lives, including parent-adolescent relationships, family composition, mental health conditions, and the levels of religiosity. The very rich data provided by Add Health are particularly well suited for PSM, which is based on the assumption that important factors affecting both parental beliefs and adolescents' substance use or adolescents' substance use only are observable for matching

(Caliendo & Kopeinig, 2008; Brookhart et al., 2006). High-quality matching can significantly reduce the risk of bias caused by unobserved confounders, and estimates derived from the analysis may plausibly be interpreted causally.

In this study, agreement between parental and adolescents' reports of adolescents' smoking and drinking behaviours is first explored. It is hypothesised that agreement between the two reporters would be low (H1). Then adolescent-respondents are partitioned into two groups on the basis of their substance use in Wave 1. OLS and PSM are applied to assess the effect of parental beliefs on adolescents' substance use in Wave 2. It is hypothesised that adolescents would be more likely to use cigarettes and alcohol if their parents believed (rightly or wrongly) that they were engaging in these activities (H2). It is also hypothesised that the effect of parental beliefs may reduce, but not disappear completely, with the PSM techniques that effectively control for confounding covariates (H3).

## 3.3 Methodology

In the analyses, the outcome variables are (a) adolescents' cigarette use and (b) adolescents' alcohol use in Wave 2, and the independent variables are (i) parental beliefs about adolescents' cigarette use and (ii) parental beliefs about adolescents' alcohol use in Wave 1.

Adolescents' levels of cigarette and alcohol use in the past 30 days are measured at Wave 2. The smoking indicator is derived from two measurements: the number of days respondents smoked over the past month, and the average number of cigarettes smoked on each of these days (M=1.78, SD=5.20). The drinking indicator is a combined measurement of the quantity-frequency scale (Poikolainen, Podkletnova & Alho, 2002) (M=0.38, SD=1.67). Further information on the variable measures can be found in Chapter 2.

For parental beliefs, mothers were asked whether their adolescents used tobacco once a week or more (M=0.12, SD=0.32) and whether the adolescents used alcohol at least once a month (M=0.09, SD=0.29) in Wave 1. In the analysis, the response 'unsure' is included in the 'yes' category as it may implicitly reflect parents' suspicion that their adolescents may be using

the substances (Bogenschneider et al., 1998)[7]. More detail on the scales and items of the variable measurements can be found in Chapter 2.

Given that more than 90 per cent of the observations in the parental questionnaires were completed by mothers, who have been found to have more knowledge about their adolescents' risk involvement (DiIOrio et al., 1999; Mollborn & Everett, 2010) and whose beliefs have been shown to have greater effects than paternal beliefs (Madon et al., 2004), the main focus in this study is mothers' beliefs. The core sample is 3,232. The sample includes respondents who provided valid data on substance use in both Waves 1 and 2 and variables used in the PSM, and whose parents had also provided valid data measured at Wave 1 (e.g. parental beliefs). A detailed flowchart showing the derivation of the analytical sample for this empirical analysis is outlined in Diagram 2.1.

### *3.3.1 Analysis*

In this study, the Kappa statistic is first calculated to test the agreement between maternal and adolescents' reports of adolescents' smoking and drinking behaviours. The Kappa statistic is widely used as a measure of reliability between two reporters. It is considered to be less biased than other agreement measurements (e.g. Yule's Y statistics), since it takes into account the amount of the observed agreement occurring by chance (Fleiss, Levin & Paik, 2003). To interpret Kappa statistic results, Fleiss, Levin and Paik (2003)'s guidelines are used to evaluate the agreement between mothers' and adolescents' reports, which coefficients less than .00-.39 (poor), .40-.75 (fair), and .76-1.00 (excellent). Next, to explore the effect of maternal beliefs, adolescents are divided into two groups: those who used substances in Wave 1 and those who did not. Once separated, an OLS regression method is employed for each group.

Although OLS and logistic regression models are applied in most of the previous work, they may produce biased estimations. Firstly, they do not control for the effects of other observed variables on maternal beliefs when estimating the relationship between the beliefs and the outcomes. This potentially increases the bias caused by confounders in the estimations (Zanutto, 2006). Secondly, the average treatment effect for the treated (ATT: the effect of a treatment on individuals who received the treatment) may on average be different from the treatment effect for the untreated (i.e. the effect of a treatment on individuals who

[7] The percentage of parents reporting 'unsure' about their adolescents' substance use is 2 per cent for smoking and 5 per cent for alcohol use.

did not receive the treatment). As a result, the ATT may not be equivalent to the average treatment effect on the total population estimated by either an OLS or logistic regression (Morgan & Harding, 2006). To address these issues, PSM is used as part of the data analysis.

PSM is a technique that attempts to mimic an experimental setting in an observational study to reduce a confounding bias, and to potentially estimate a causal effect. With the implementation of this technique, two groups are created from a sample in this research, a treatment group (i.e. adolescent-respondents whose mothers believed they were using cigarettes or alcohol) and a control group (i.e. adolescent-respondents whose mothers did not believe they were using cigarettes or alcohol). Each adolescent whose mother believed they were using a substance is matched with one or more than one adolescent whose mother did not believe they were using a substance but had similar propensity scores, which have been calculated using the logistic regression on covariates. This method effectively creates an experimental study of an observational data set by allowing the matched adolescent-respondents to be identical in every observed variable (Rosenbaum & Rubin, 1983). Compared to traditional regression models, one attractive aspect of PSM is that it controls for the effects of other observed variables on maternal beliefs when estimating the relationship between the beliefs and later substance use behaviour (Rubin, 2001; Zanutto, 2006). As a result, the difference between the treatment and control groups should more plausibly be attributed to the treatment itself. Furthermore, as mentioned earlier, estimates from PSM models could be interpreted causally. This is particularly true when using a high-quality data set, such as Add Health used in the present study, that allows perfect matching.

Add Health provides a rich set of background variables that allows a high standard PSM implementation. Control variables are selected based on the basis of previous empirical research that may be associated with both maternal beliefs and adolescents' substance use or with adolescents' substance use only (Brookhart et al., 2006; Caliendo & Kopeinig, 2008; Rubin, 2001). These include (1) *basic demographic background*: adolescents' age, gender, ethnicity, family composition, parental education levels, grade point average (GPA), religiosity (4 items, $\alpha$=0.83), and depression (19 items, $\alpha$=0.86); (2) *family relations*: maternal trust, maternal-adolescent closeness (5 items, $\alpha$=0.84), parental control (7 items, $\alpha$=0.62), and the frequency of adolescent lying to parents; (3) *maternal and peer substance use*: maternal and peer cigarette and alcohol use. Two interaction terms between peer substance use and adolescent lying frequency are also generated, given that adolescents might be more likely to

lie to their parents if they had been hanging out with peers who used substances. The interaction term of peer smoking × adolescent lying is included in the regressions that estimate adolescents' cigarette use, and peer drinking × adolescent lying in the regressions that estimate alcohol use; (4) *neighbourhood safety*; and (5) *the levels of substance use in Wave 1:* for adolescents who indicated their cigarette or alcohol use in Wave 1, their amount of use in the past 30 days is also adjusted in the analysis. All control variables are measured in Wave 1. The scales and items of the variable measurements can be found in Chapter 2. Descriptive statistics of adolescents' cigarette and alcohol use, maternal beliefs about their adolescents' substance use, and the control variables are provided in Table 3.1.

**Table 3.1 Descriptive statistics: substance use, maternal beliefs and control variables**

| Variables | Range | | Mean (SD) |
|---|---|---|---|
| | Min | Max | or % |
| **Substance use, W2** | | | |
| Average number of cigarettes per day in the past 30 days | 0 | 24 | 1.50 (4.35) |
| Average number of drinks per day in the past 30 days | 0 | 7 | 0.59 (0.98) |
| **Substance use, W1** | | | |
| Average number of cigarettes per day in the past 30 days | 0 | 20 | 1.02 (3.47) |
| Average number of drinks per day in the past 30 days | 0 | 6.5 | 0.52 (0.84) |
| Used cigarette in the past 30 days | 0 | 1 | 0.22 (0.42) |
| Used alcohol in the past 30 days | 0 | 1 | 0.42 (0.49) |
| **Maternal beliefs, W1** | | | |
| Maternal beliefs about adolescent regular cigarette use (i.e. once a week or more) | 0 | 1 | 0.09 (0.29) |
| Maternal beliefs about adolescent regular alcohol use (i.e. at least once a month) | 0 | 1 | 0.06 (0.24) |
| **Control Variables, W1** | | | |
| ***Demographic factors*** | | | |
| Age | 13 | 18 | 15.1 (1.45) |
| Female | 0 | 1 | 53.5 |
| White (Ref) | 0 | 1 | 67.8 |
| African American | 0 | 1 | 19.1 |
| American-Indian/ Asian/ Mixed/ Others | 0 | 1 | 13.1 |
| Intact family (Ref) | 0 | 1 | 60.2 |
| Step-family | 0 | 1 | 12.2 |
| Single-parent family | 0 | 1 | 27.6 |
| [Parental] Less than high school levels (Ref) | 0 | 1 | 13.2 |
| [Parental] High school graduate | 0 | 1 | 26.8 |
| [Parental] Some post-school training/college | 0 | 1 | 32.6 |
| [Parental] A bachelor's degree/Postgraduate training | 0 | 1 | 27.4 |
| Grade point average (GPA) | 1 | 4 | 2.86 (0.76) |
| Religiosity (standardised) | -1.74 | 1.30 | 0.05 (0.99) |
| Depression (standardised) | -1.45 | 5.18 | -0.06 (0.97) |
| ***Family relations*** | | | |
| Maternal trust (ranging from 1='never' to 5= 'always') | 1 | 5 | 4.37 (0.82) |
| Mother-adolescent closeness[1] (standardised) | -4.97 | 6.59 | 0.01 (0.98) |
| Parental control[2] (standardised) | -1.93 | 4.01 | -0.00 (0.99) |
| Frequency of lying to parents/guardians about whereabouts and people hang out with (ranging from 0= 'never' to 3= '5 or more times') | 0 | 3 | 0.87 (1.03) |
| ***Maternal and peer substance use*** | | | |
| Whether mother smoked | 0 | 1 | 0.49 |
| Mother's high alcohol consumption (i.e. more than 2-3 days per month) | 0 | 1 | 0.23 |
| Number of best friends who smoked (standardised) | -1.06 | 2.41 | -0.01 (0.96) |
| Number of best friends who drank alcohol (standardised) | -1.49 | 2.26 | 0.03 (0.98) |
| ***Neighbourhood safety*** | | | |
| Drug dealers and users is a big problem in the neighbourhood | 0 | 1 | 0.39 |

Notes: N=3,232. [1]The variable measures adolescents' perceived emotional intimacy with mothers.[2]The variable measures parental autonomy-granting (reverse-coded).

Given that variable selection is critical to PSM models (Brookhart et al., 2006), a sensitivity analysis is performed to test different sets of observed variables. Some scholars have suggested that PSM estimations should include all relevant variables that are related to the outcome, even if they are only modestly related to the 'treatment' (Brookhart et al., 2006; Rubin & Thomas, 1996). However, other scholars have shown concern for the degrees of freedom and advised that variable selection should be guided by theories and previous research (Caliendo & Kopeinig, 2008; Dehejia & Wahba, 2002; Guo & Fraser, 2010). With respect to this, a sensitivity analysis is performed to explore how including or excluding different variables would affect the levels of bias. Variables considered included Baumrind's fourfold parenting styles (an interaction between the scales of parent-adolescent closeness and parental control)[8] (Baumrind, 1991), household income, adolescents' conduct disorders (e.g. getting into a serious physical fight), maternal age, and parental employment status. Their exclusion does not substantially affect the results, and also save the degrees of freedom and the number of missing values. In addition to the sensitivity test, Blinder-Oaxaca decomposition analysis is applied to help determine variables that would be included in the final PSM models (shown in Appendix 3A). Blinder-Oaxaca decomposition is a statistical method that shows the output differences (e.g. number of cigarettes smoked by adolescents) between two groups (e.g. parental beliefs vs parental non-beliefs) and how much these differences can be explained by other observed variables (e.g. age and gender). The analysis shows that the average cigarette use and alcohol consumption of adolescents at Wave 2 are higher for those whose mother believed they had used the substance than those whose mother did not believe. As shown in Appendix 3A, these mean differences in average cigarette use and alcohol consumption could be explained by age, ethnicity, GPA, levels of use at Wave 1, frequency of lying to parents/guardians, and maternal and peer substance use.

While there are multiple algorithms for matching participants (Becker & Ichino, 2002; Caliendo & Kopeinig, 2008), the 'nearest-neighbour' algorithm is used with replacement, whereby each participant in the treatment group could be matched with one or more than one participant(s) in the control group whose propensity score(s) is/are closest to him/herself (Becker & Ichino, 2002; Rosenbaum & Rubin, 1983, 1984, 1985). The nearest-neighbour matching technique is commonly used by researchers from various fields and is relatively less biased (Dehejia & Wahba, 2002; Frisco, Muller & Frank, 2007). More importantly, it suits this

[8] The measurement and scales of parental warmth and parental control are shown in Table 2.2.

data set in which there are many potential matches in the control group (i.e. mothers who *did not* believe their children smoked/used alcohol) for each treatment unit (i.e. mothers who *believed* their children smoked/used alcohol) (Bai, 2011). In the analyses, participants in the control group who are unable to be matched with those in the treatment group are excluded from the analyses to reduce the likelihood of bias.

One feature of PSM is that it can determine how well the density distributions between the treatment and control groups overlap, that is, the quality of matching. According to Caliendo and Kopeinig (2008), high quality of matching is defined when the average covariate unbalancing percentage is less than 5 per cent. Unsuccessful matching indicates the region of common support between the treatment and control groups is too small to produce efficient ATT, which is the difference between the average outcome measure for respondents whose mothers believed they used the substance and the average outcome measure for the sample group under the hypothetical situation that their mothers *did not believe* the adolescents were involved in substance use. To ensure the PSM estimation is performed to a high standard, different restrictions (i.e. 'calipers') that ensured all matched pairs would have propensity scores within a particular distance of each other are tested (ranging from 0.001 to 0.9). Furthermore, rather than matching with a single nearest-neighbour, various numbers of neighbours are tested (ranging from 3 to 7). The optimal combination of the calipers and numbers of neighbours, whose estimations have the lowest average covariate unbalancing percentages, is used to calculate the ATT.

For reliability checks, the analyses are replicated using the kernel algorithm, which uses all available cases and constructed a weighted average of counterfactuals for each observation in the treatment group (Guo & Fraser, 2010). Kernel matching takes more information from the matches whose propensity scores are closer to each other and downweights those whose propensity scores are distant from each other (Guo & Fraser, 2010). The common support condition is imposed to help improve the quality of the matches (Caliendo & Kopeinig, 2008). Various bandwidths (ranging from 0.001-0.9) are tested; only the ATT estimates with the most optimal kernel matching (the lowest average covariate unbalancing percentages) are presented in the Results section. All estimations handle missing values with listwise deletion. While multiple imputation is an increasingly popular method to deal with the missing data, PSM cannot currently be estimated in statistical software packages

such as Stata using multiple imputation. 95% confidence intervals are computed by bootstrapping with 1,000 replicates.

## 3.4 Results

### *3.4.1 Parent-adolescent agreement indices*

**Table 3.2a Agreement indices of adolescent and maternal reports of adolescents' cigarette use at Wave 1 (N=3,232)**

| **Adolescents' cigarette use (%)** | **Maternal beliefs of adolescents' cigarette use (%)** | | |
|---|---|---|---|
| | **No** | **Yes** | **Total** |
| **No** | 2,456 (97.97) | 51 (2.03) | 2,504 |
| **Yes** | 478 (65.93) | 247 (34.07) | 725 |
| **Total** | 2,934 (90.78) | 298 (9.22) | 3,232 |
| **Percentage of agreement[1]** | 0.836 | | |
| **Kappa** | 0.405*** | | |

Notes: Statistical significance is denoted by asterisks: *** sig at 0.1%. [1]Percentage of agreement indicates the proportion of the mothers and adolescents who provided the same response.

**Table 3.2b Agreement indices of adolescent and maternal reports of adolescents' alcohol use at Wave 1 (N=3,232)**

| **Adolescents' alcohol use (%)** | **Maternal beliefs of adolescents' alcohol use (%)** | | |
|---|---|---|---|
| | **No** | **Yes** | **Total** |
| **No** | 1,835 (98.66) | 25 (1.34) | 1,860 |
| **Yes** | 1,204 (87.76) | 168 (12.24) | 1,372 |
| **Total** | 3,039 (94.03) | 193 (5.97) | 3,232 |
| **Percentage of agreement[1]** | 0.620 | | |
| **Kappa** | 0.123*** | | |

Notes: Statistical significance is denoted by asterisks: *** sig at 0.1%. [1]Percentage of agreement indicates the proportion of the mothers and adolescents who provided the same response.

Tables 3.2a and 3.2b report the agreement indices of adolescent and maternal reports of adolescents' cigarette and alcohol use in Wave 1. In line with previous studies (as noted above, e.g. Bogenschneider et al., 1998; Williams et al., 2003; Yang et al., 2006), mothers tended to underestimate adolescent substance use, in particular alcohol consumption. For smoking, 65.9 per cent of the mothers underestimated their adolescents' cigarette use, 2 per cent overestimated, and 34.1 per cent made correct assessments. For drinking, 87.8 per cent of the mothers were unaware of their adolescents' alcohol consumption, 1.3 per cent of them

overestimated, and 12.2 per cent of them made correct assessments. In addition, the tables demonstrate a relatively high percentage of agreement, indicating that the proportion of the mothers and adolescents providing the same response is high (although the percentage is lower for adolescents' alcohol use). Higher percentages of agreement are attributed to the majority of the mothers (around 98%) who made correct assessments about their adolescents' abstinence from substance use.

The Kappa statistics confirm the results of the cross-tabulations, showing poor-to-fair agreements on cigarette use (41%) and alcohol use (12%). Furthermore, sensitivity (i.e. the proportion of adolescents and mothers both reporting adolescents' substance use) and specificity (i.e. the proportion of adolescents and mothers both reporting no substance use) tests are carried out. The sensitivity and specificity proportions reporting adolescents' cigarette use are 0.34 and 0.98, and adolescents' alcohol use 0.12 and 0.99 (results not shown). These results are consistent with the Kappa statistics and percentages of agreement.

Tables 3.3a and Table 3.3b present preliminary analyses using logistic regressions to compare the effects of observed variables on maternal beliefs about adolescents' cigarette and alcohol use, and on adolescents' cigarette and alcohol use in Wave 1. Results show that maternal beliefs and adolescents' cigarette and alcohol use could be predicted by adolescents' age, ethnicity, religiosity, maternal trust, and peers' cigarette and alcohol consumption. Moreover, adolescents' GPA is a shared factor between maternal beliefs and adolescents' cigarette use, and maternal high alcohol consumption is a common factor between the beliefs and adolescents' alcohol use. The tables demonstrate that these shared factors are responsible for both maternal beliefs and adolescents' cigarette/alcohol consumption in Wave 1. It is unclear whether adolescents' substance use is attributable to the shared factors or maternal beliefs.

**Table 3.3a Logistic regression models comparing the predictors of maternal beliefs about adolescents' cigarette use and adolescents' cigarette use at Wave 1 (N=3,232)**

| | Estimating maternal beliefs about adolescents' cigarette use | | Estimating adolescents' cigarette use | |
|---|---|---|---|---|
| | **OR** | **95% CI** | **OR** | **95% CI** |
| ***Demographic factors*** | | | | |
| Age | 1.703*** | (1.527 - 1.898) | 1.271*** | (1.181 - 1.369) |
| Female[1] | 0.634** | (0.468 - 0.859) | 0.946 | (0.764 - 1.173) |
| African-American | 0.399*** | (0.245 - 0.649) | 0.509*** | (0.368 - 0.704) |
| American Indian/Asian/Mixed/ Others[2] | 0.696 | (0.432 - 1.120) | 0.836 | (0.607 - 1.152) |
| Step-parent family | 1.204 | (0.768 - 1.889) | 0.924 | (0.665 - 1.285) |
| Single-parent family[3] | 1.796*** | (1.289 - 2.504) | 1.053 | (0.819 - 1.354) |
| [Parental] High school graduate | 0.995 | (0.627 - 1.579) | 1.083 | (0.763 - 1.538) |
| [Parental] Some post-school training/college | 1.142 | (0.725 - 1.796) | 1.277 | (0.909 - 1.794) |
| [Parental] A bachelor's degree or above[4] | 0.866 | (0.512 - 1.467) | 1.489* | (1.033 - 2.148) |
| Grade point average (GPA) | 0.676*** | (0.552 - 0.828) | 0.736*** | (0.634 - 0.854) |
| Religiosity | 0.795** | (0.685 - 0.924) | 0.804*** | (0.721 - 0.895) |
| Depression | 1.031 | (0.885 - 1.201) | 1.177** | (1.049 - 1.320) |
| ***Family relations*** | | | | |
| Maternal trust | 0.473*** | (0.404 - 0.555) | 0.725*** | (0.640 - 0.822) |
| Maternal-adolescent closeness | 0.954 | (0.825 - 1.102) | 1.035 | (0.928 - 1.155) |
| Parental control | 0.932 | (0.803 - 1.082) | 0.864** | (0.773 - 0.965) |
| Frequency of lying to parents/guardians about whereabouts and people hang out with | 0.903 | (0.753 - 1.083) | 1.487*** | (1.340 - 1.649) |
| ***Maternal and peer substance use*** | | | | |
| Mother smokes | 1.923*** | (1.392 - 2.655) | 1.156 | (0.927 - 1.440) |
| Peers' cigarette use | 2.633*** | (2.189 - 3.167) | 3.217*** | (2.778 - 3.724) |
| ***Neighbourhood safety*** | | | | |
| Neighbourhood drug problems | 1.639*** | (1.222 - 2.198) | 0.849 | (0.683 - 1.056) |
| ***Interaction terms*** | | | | |
| Peers' cigarette use × frequency of lying | 0.984 | (0.872 - 1.110) | 0.951 | (0.868 - 1.041) |
| **Constant** | 0.001*** | (0.000 - 0.004) | 0.032*** | (0.008 - 0.121) |
| **Pseudo $R^2$** | **0.359** | | **0.323** | |

Notes: 95% CI in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Reference category: [1]Male; [2]White; [3]Intact family; [4]Less than high school levels.

**Table 3.3b Logistic regression models comparing the predictors of maternal beliefs about adolescents' alcohol use and adolescents' alcohol use at Wave 1 (N=3,232)**

| | Estimating maternal beliefs about adolescents' alcohol use | | Estimating adolescents' alcohol use | |
|---|---|---|---|---|
| | **OR** | **95% CI** | **OR** | **95% CI** |
| ***Demographic factors*** | | | | |
| Age | 2.058*** | (1.798 - 2.355) | 1.466*** | (1.377 - 1.560) |
| Female[1] | 0.728✞ | (0.518 - 1.024) | 0.991 | (0.828 - 1.187) |
| African-American | 0.399** | (0.225 - 0.708) | 0.452*** | (0.351 - 0.583) |
| American Indian/Asian/Mixed/ Others[2] | 0.905 | (0.546 - 1.500) | 0.986 | (0.759 - 1.282) |
| Step-parent family | 1.048 | (0.633 - 1.735) | 1.239 | (0.944 - 1.627) |
| Single-parent family[3] | 1.390✞ | (0.950 - 2.033) | 1.195 | (0.964 - 1.482) |
| [Parental] High school graduate | 0.909 | (0.513 - 1.611) | 1.112 | (0.826 - 1.497) |
| [Parental] Some post-school training/college | 1.022 | (0.587 - 1.778) | 1.204 | (0.903 - 1.604) |
| [Parental] A bachelor's degree or above[4] | 1.382 | (0.781 - 2.443) | 1.109 | (0.818 - 1.504) |
| Grade point average (GPA) | 0.926 | (0.736 - 1.166) | 0.942 | (0.829 - 1.070) |
| Religiosity | 0.674*** | (0.569 - 0.797) | 0.857** | (0.781 - 0.940) |
| Depression | 0.992 | (0.835 - 1.179) | 1.077 | (0.973 - 1.192) |
| ***Family relations*** | | | | |
| Maternal trust | 0.495*** | (0.414 - 0.593) | 0.878* | (0.784 - 0.984) |
| Mother-adolescent closeness | 0.970 | (0.827 - 1.138) | 0.885* | (0.804 - 0.975) |
| Parental control | 0.959 | (0.803 - 1.144) | 0.842*** | (0.769 - 0.922) |
| Frequency of lying to parents/guardians about whereabouts and people hang out with | 0.970 | (0.798 - 1.178) | 1.549*** | (1.413 - 1.698) |
| ***Maternal and peer substance use*** | | | | |
| Mother's high levels of alcohol consumption[5] | 1.488* | (1.044 - 2.120) | 1.500*** | (1.218 - 1.847) |
| Peers' alcohol use | 1.726*** | (1.370 - 2.174) | 2.909*** | (2.553 - 3.314) |
| ***Neighbourhood safety*** | | | | |
| Neighbourhood drug problems | 1.589** | (1.143 - 2.210) | 0.970 | (0.808 - 1.165) |
| ***Interaction terms*** | | | | |
| Peers' alcohol use × frequency of lying | 1.087 | (0.936 - 1.261) | 0.994 | (0.905 - 1.092) |
| **Constant** | 0.000*** | (0.000 - 0.000) | 0.003*** | (0.001 - 0.009) |
| **Pseudo $R^2$** | **0.269** | | **0.293** | |

Notes: 95% CI in parentheses. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. Reference category: [1]Male; [2]White; [3]Intact family; [4]Less than high school levels; [5]Mothers who consumed alcohol more than two to three days per month.

The sample is then split into two groups, adolescents who used the substances in Wave 1 and those who did not, to predict the propensity for maternal beliefs. Propensity scores are estimated from the logistic regression on the covariates and then are used to match cases using the nearest-neighbour and kernel matching algorithms.

### *3.4.2 Parental beliefs and adolescents' substance use: Results from PSM*

Figures 3.1a-3.1d show the PSM distributions and common support areas between the treatment and control groups before and after matching using the nearest-neighbour matching technique. The figures show that most density distributions of the treatment and control groups overlap, indicating good balances of the observed variables between the groups after matching. One exception is the model of the adolescent-sample who reported not using alcohol in the Wave 1 interview, which demonstrates that the density distributions of the propensity scores in the treatment and control groups vary greatly (as shown in Figure 3.1d). The region of common support is thus too small to produce efficient ATT estimates.

**Figures 3.1a-3.1d Propensity score matching distributions and common support areas between the treatment and control groups: Before and after matching using the nearest-neighbour matching method**

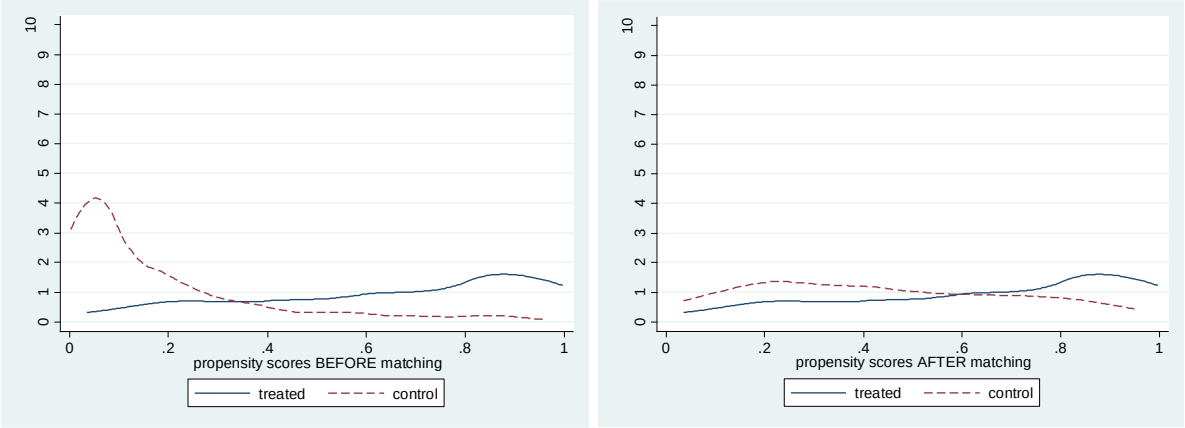


***Figure 3.1a Adolescents who reported having used cigarettes at Wave 1***

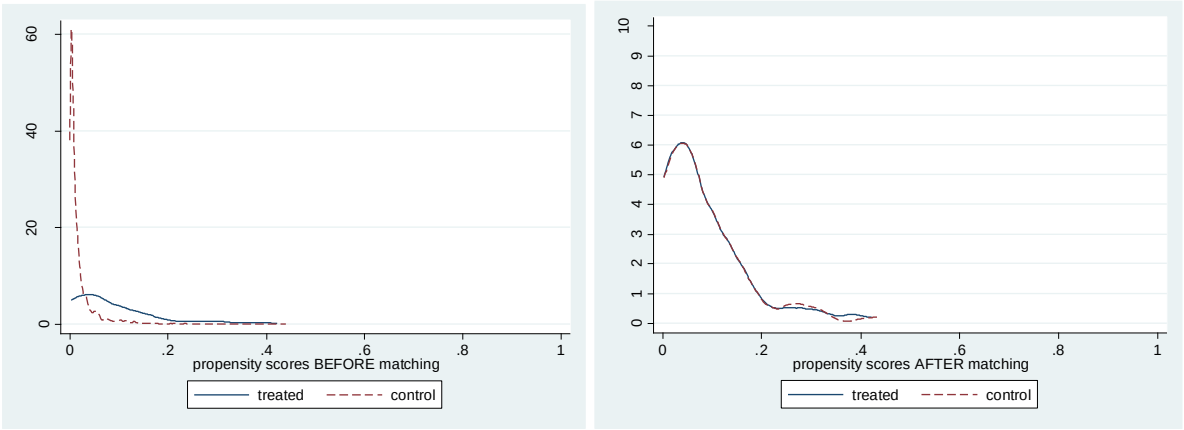


***Figure 3.1b Adolescents who reported not having used cigarettes at Wave 1***

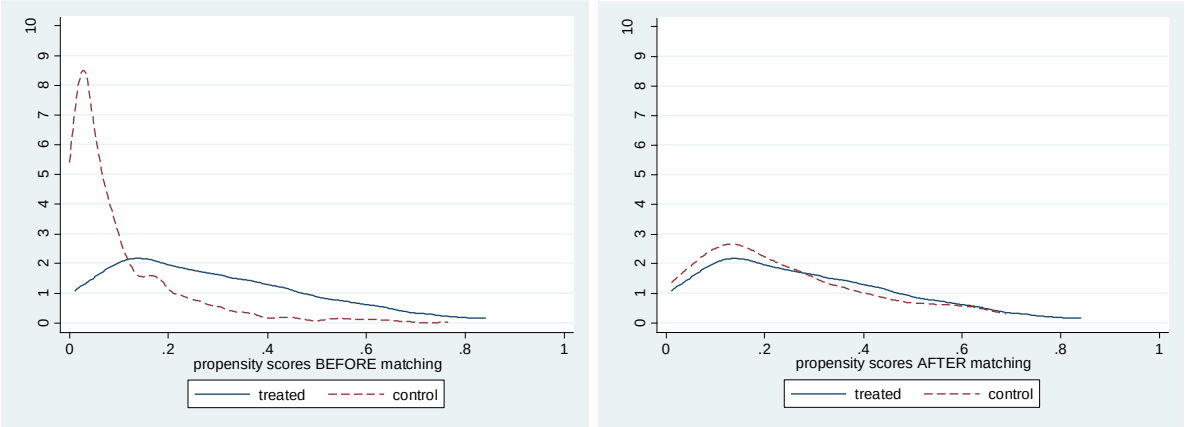


***Figure 3.1c Adolescents who reported having used alcohol at Wave 1***

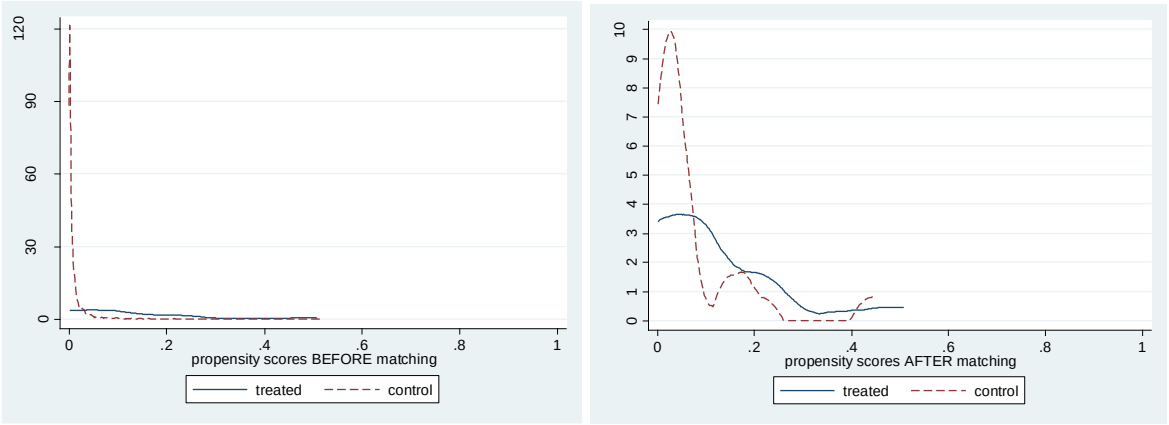


***Figure 3.1d Adolescents who reported not having used alcohol at Wave 1***

Figures 3.2a to 3.2d present the standardised percentage bias across the observed covariates before and after matching using the kernel algorithm. The dots and crosses

represent the percentage bias before and after matching respectively. It is assumed that, after matching, the standardised percentage bias across the observables should be very close to zero (i.e. no significant differences on the covariates between the treatment and control groups). In line with the estimates shown in Figure 3.1d, Figure 3.2d demonstrates that some variables, such as the interaction term of peer alcohol use × frequency of lying, religiosity, and peer alcohol use, are still relatively far away from zero after matching. This suggests that these factors may contribute to the imbalance in matching.

**Figures 3.2a-3.2d Standardised percentage bias across observed covariates: Before and after matching using the kernel matching method**

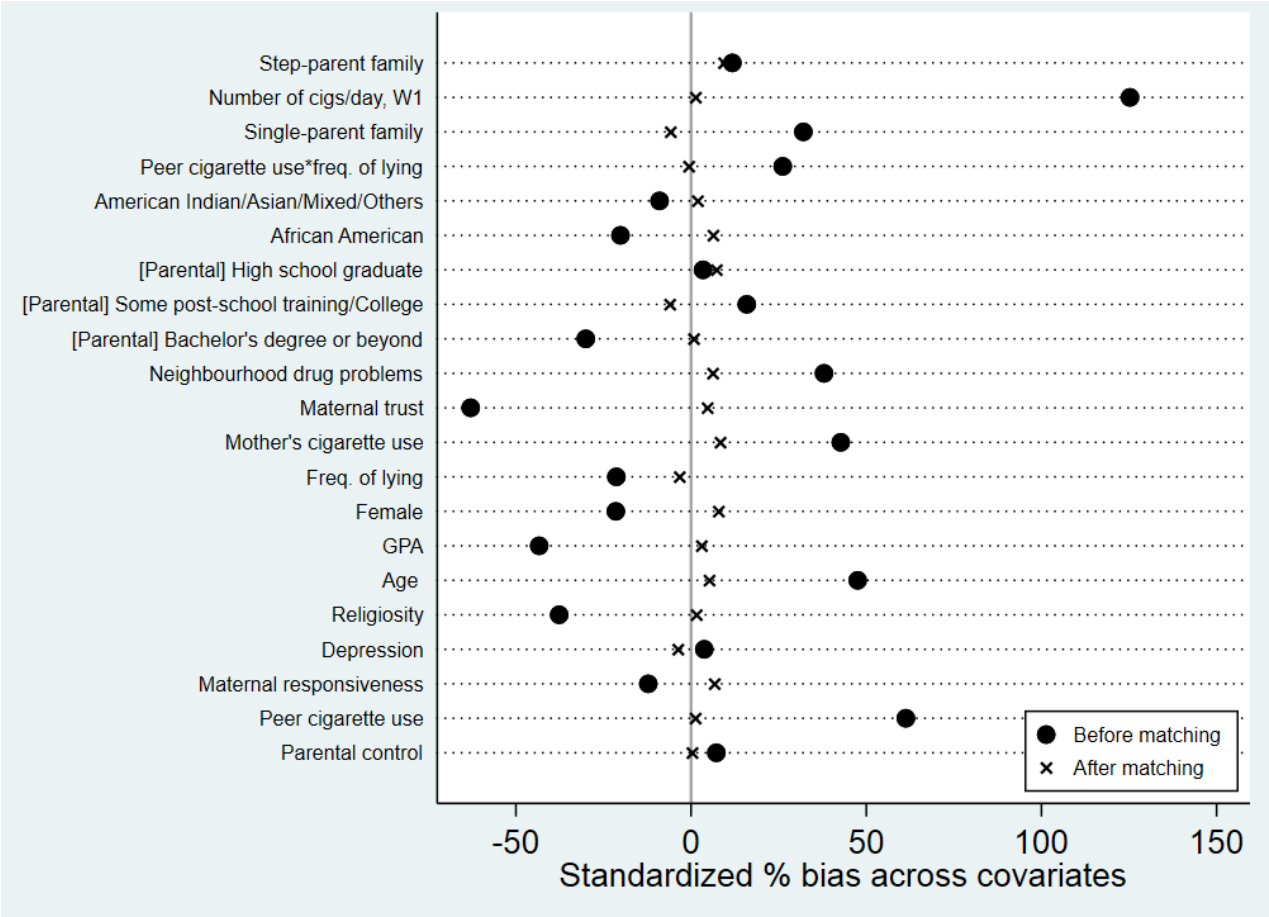


***Figure 3.2a Adolescents who reported having used cigarettes at Wave 1***

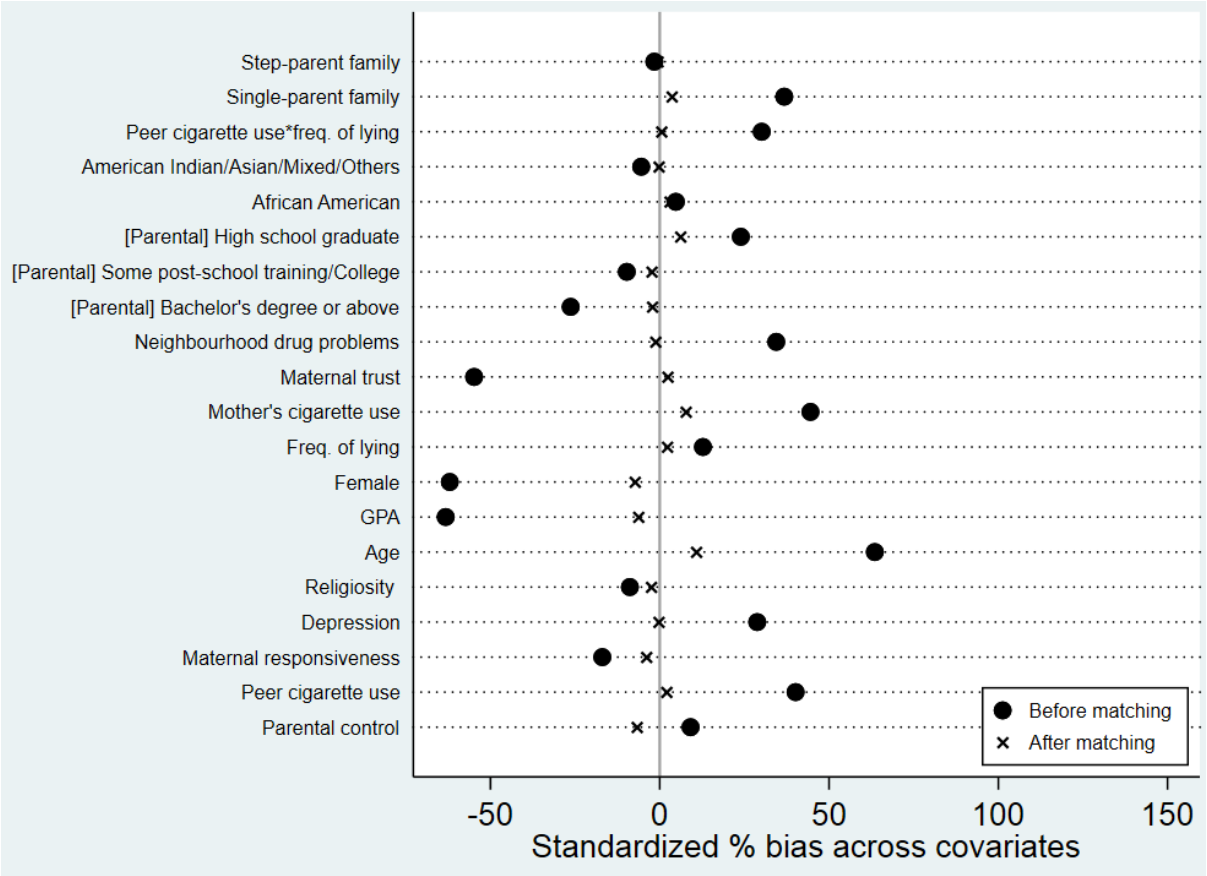


***Figure 3.2b Adolescents who reported not having used cigarettes at Wave 1***

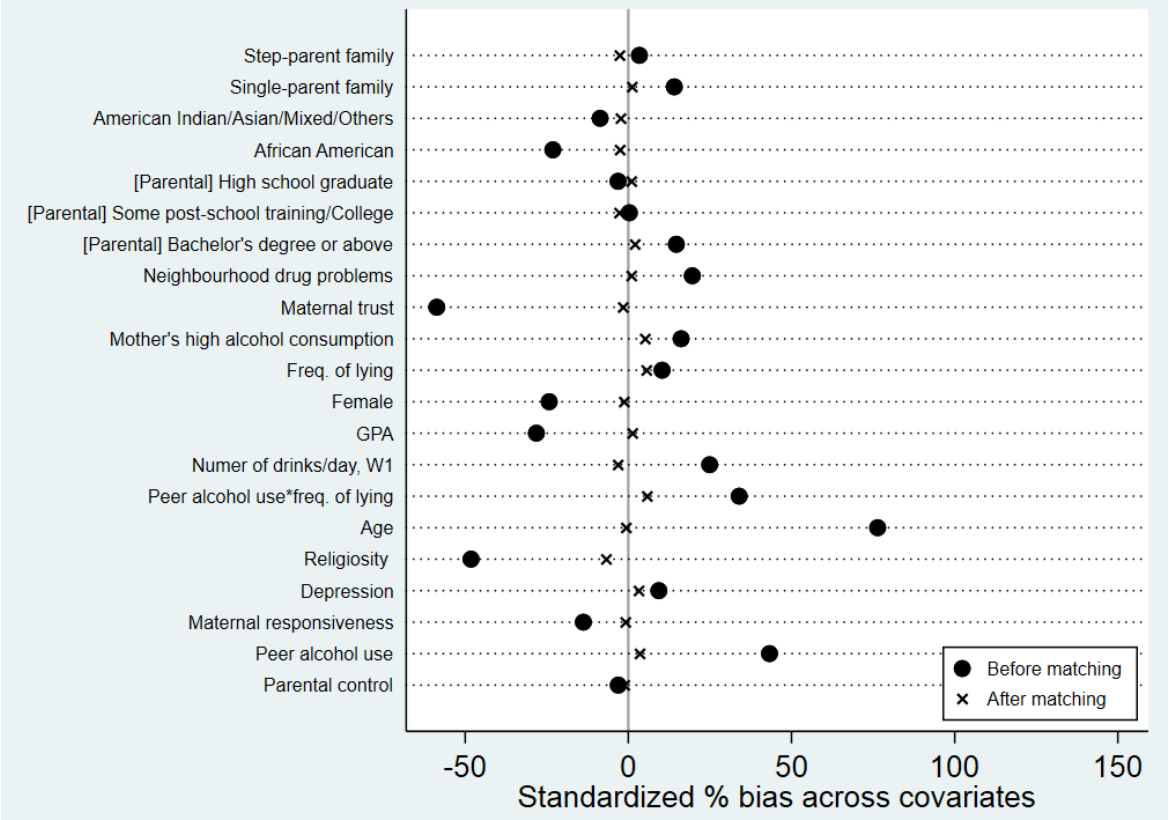


***Figure 3.2c Adolescents who reported having used alcohol at Wave 1***

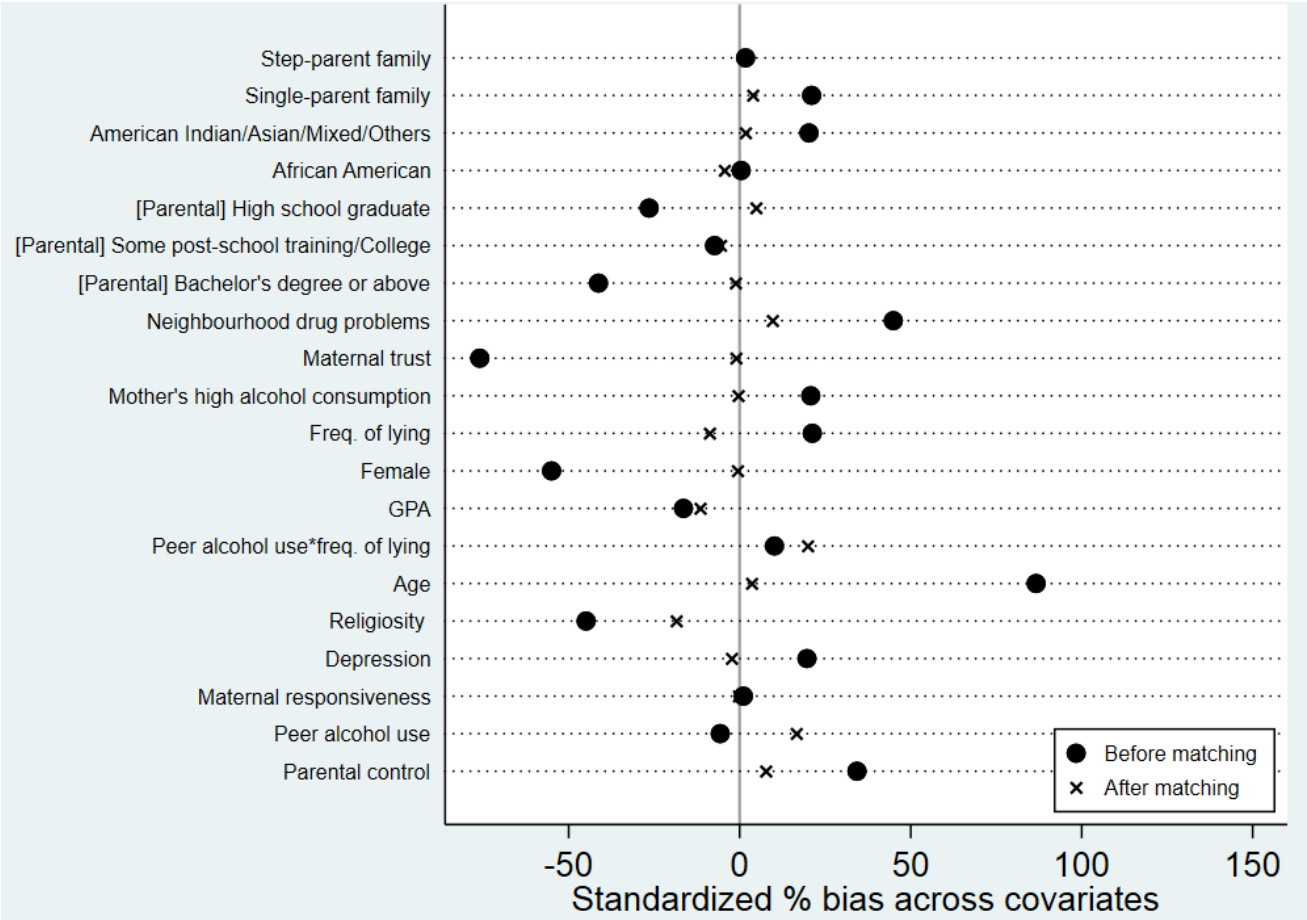


***Figure 3.2d Adolescents who reported not having used alcohol at Wave 1***

Table 3.4 shows the estimated number of cigarettes and drinks per day in Wave 2 and the results from covariate unbalancing tests. The table reports three estimates - coefficients from an OLS regression estimation, the ATTs using nearest-neighbour matching, and the ATTs using kernel matching. Results obtained from the covariate unbalancing tests demonstrate the balance percentages of observed variables between the treatment and control groups, which are demonstrated graphically in Figures 3.1a-3.1d and Figures 3.2a-3.2d. As shown in Figures 3.1d and 3.2d, Table 3.4 indicates that the covariate unbalancing percentage in the model of the adolescent-sample who reported not having used alcohol in Wave 1 exceeds the threshold of 5 per cent (Caliendo & Kopeinig, 2008; 6.7% with the nearest-neighbour matching algorithm and 6.2% with kernel matching algorithm). The estimated ATT value should therefore be interpreted with caution in these models.

**Table 3.4 Comparison of OLS regression estimates and average treatment effect (ATT) of maternal beliefs about adolescents' smoking and drinking behaviours on adolescents' later engagement in these activities**

| | OLS regression | Propensity score matching methods | |
|---|---|---|---|
| | | ATT of experiencing maternal belief about adolescent substance use | |
| | | Nearest-neighbour matching | Kernel matching |
| **Smoke, W1** | | | |
| Number of cigarettes, W2 | 2.616*** (1.529, 3.702) | 2.580* (0.606, 4.554) | 2.425* (0.490, 4.361) |
| Average covariate unbalance | - | 4.6 | 3.9 |
| Treatment observations | 247 | 190 | 190 |
| Control observations | 478 | 181 | 395 |
| **Total N** | **725** | **371** | **585** |
| **No Smoke, W1** | | | |
| Number of cigarettes, W2 | 1.401*** (0.825, 1.976) | 1.570* (0.090, 3.051) | 1.376✞ (-0.077, 2.829) |
| Average covariate unbalance | - | 3.8 | 3.6 |
| Treatment observations | 51 | 51 | 50 |
| Control observations | 2456 | 220 | 2,454 |
| **Total N** | **2,507** | **271** | **2,504** |
| **Alcohol, W1** | | | |
| Number of drinks, W2 | 0.418*** (0.217, 0.619) | 0.258 (-0.096, 0.611) | 0.310✞ (-0.012, 0.631) |
| Average covariate unbalance | - | 4.3 | 4.7 |
| Treatment observations | 168 | 166 | 166 |
| Control observations | 1,204 | 402 | 1,204 |
| **Total N** | **1,372** | **568** | **1,370** |
| **No Alcohol, W1** | | | |
| Number of drinks, W2 | 0.101 (-0.131, 0.334) | 0.102 (-0.248, 0.451) | 0.116 (-0.148, 0.379) |
| Average covariate unbalance | - | 6.7 | 6.2 |
| Treatment observations | 25 | 20 | 20 |
| Control observations | 1835 | 97 | 1,793 |
| **Total N** | **1,860** | **117** | **1,813** |

Notes: The OLS regression models include control variables measured at Wave 1. PSM 95% confidence intervals in parentheses are computed by bootstrapping with 1000 repetitions. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

Overall, the results in Table 3.4 show that adolescents were more likely to continue their cigarette and alcohol consumption if their mothers had been aware of these activities in the previous wave. The probability of smoking initiation is also higher if their mothers believed their adolescents smoked when in fact they did not. Adolescents whose mothers made correct assessments smoked 2.4-2.6 cigarettes more than those whose mothers did not make correct assessments in the following year. Of adolescents who did not smoke in Wave 1, maternal overestimation is positively associated with 1.4-1.6 cigarettes each day in Wave 2. Adolescents whose mothers had made correct assessments about their alcohol use consumed around 0.3 to 0.4 drinks per day in the following year (i.e. about two to three drinks per week), compared with those whose mothers had not made correct assessments. Of adolescents who did not use alcohol in Wave 1, no significant association between maternal beliefs and adolescents' later alcohol use is found. As hypothesised, the effect of maternal beliefs diminishes when using the PSM techniques. In particular, the association between maternal beliefs and adolescents' alcohol use among those who reported having used alcohol in Wave 1 is reduced to the 10% significance level. This suggests that a large amount of the heterogeneity between maternal beliefs and non-beliefs is captured by the observed variables. As a result, simply using traditional regressions could have overestimated the effect of parental beliefs. A fuller discussion of this finding will be presented in the Discussion session.

### *3.4.3 Robustness checks*

Several alternative specifications are estimated as robustness checks[9]. As an initial check, parallel analyses are conducted using binary indicators of the outcome variables in Wave 2 to examine the changing status between waves (shown in Table 3.5). Results show a very similar pattern: logistic regression estimations indicate positive associations between maternal beliefs and adolescents' later cigarette and alcohol use, regardless of whether adolescents had initiated these activities in Wave 1 (the effect of maternal beliefs on adolescents' alcohol use is only significant at the 10% level among adolescents who reported not having used alcohol in Wave 1). The effect of maternal beliefs reduces when using the PSM techniques, except for the cigarette-inexperienced sample in which the coefficients are slightly larger.

[9] For robustness checks, confidence intervals in the PSM models are computed by bootstrapping with 100 repetitions.

**Table 3.5 Robustness checks (I): Binary outcome variables**

| | Logistic regression | Propensity score matching methods | |
|---|---|---|---|
| | | ATT of experiencing maternal belief about adolescent substance use | |
| | | Nearest-neighbour matching | Kernel matching |
| **Smoke, W1** | | | |
| Smoker, W2 | 0.090* | 0.091✞ | 0.089✞ |
| | (0.005, 1.175) | (-0.012, 0.194) | (-0.009, 0.187) |
| Average covariate unbalance | - | 4.7 | 4.5 |
| Treatment observations | 247 | 190 | 190 |
| Control observations | 478 | 181 | 395 |
| **Total N** | **725** | **371** | **585** |
| **No Smoke, W1** | | | |
| Smoker, W2 | 0.274*** | 0.337*** | 0.303*** |
| | (0.170, 0.377) | (0.160, 0.515) | (0.144, 0.462) |
| Average covariate unbalance | - | 3.8 | 3.6 |
| Treatment observations | 51 | 51 | 50 |
| Control observations | 2,456 | 220 | 2,454 |
| **Total N** | **2,507** | **271** | **2,504** |
| **Alcohol, W1** | | | |
| Alcohol user, W2 | 0.484* | 0.068✞ | 0.070* |
| | (0.007, 0.960) | (-0.005, 0.142) | (0.010, 0.131) |
| Average covariate unbalance | - | 3.4 | 2.6 |
| Treatment observations | 168 | 163 | 163 |
| Control observations | 1,204 | 414 | 1,203 |
| **Total N** | **1,372** | **577** | **1,366** |
| **No Alcohol, W1** | | | |
| Alcohol user, W2 | 0.150✞ | 0.133 | 0.163 |
| | (-0.012, 0.311) | (-0.159, 0.426) | (-0.081, 0.406) |
| Average covariate unbalance | - | 6.7 | 6.2 |
| Treatment observations | 25 | 20 | 20 |
| Control observations | 1,835 | 97 | 1,793 |
| **Total N** | **1,860** | **117** | **1,813** |

Notes: The logistic regression models include control variables measured at Wave 1. Coefficients are presented. PSM 95% confidence intervals in parentheses are computed by bootstrapping with 100 repetitions. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

**Table 3.6a Robustness checks (IIa): An alternative definition of maternal beliefs (the 'unsure' response is omitted)**

| | OLS regression | Propensity score matching methods | |
|---|---|---|---|
| | | ATT of experiencing maternal beliefs about adolescent substance use | |
| | | Nearest-neighbour matching | Kernel matching |
| **Smoke, W1** | | | |
| Number of cigarettes, W2 | 2.905*** | 2.570* | 2.518* |
| | (1.695, 4.115) | (0.141, 4.999) | (0.576, 4.459) |
| Average covariate unbalance | - | 7.2 | 6.6 |
| Treatment observations | 203 | 168 | 168 |
| Control observations | 478 | 135 | 478 |
| **Total N** | **681** | **303** | **646** |
| **No Smoke, W1** | | | |
| Number of cigarettes, W2 | 0.844* | 0.605 | 0.550 |
| | (0.196, 1.491) | (-1.024, 2.233) | (-1.008, 2.108) |
| Average covariate unbalance | - | 5.1 | 4.3 |
| Treatment observations | 38 | 38 | 37 |
| Control observations | 2,456 | 181 | 2,446 |
| **Total N** | **2,494** | **219** | **2,483** |
| **Alcohol, W1** | | | |
| Number of drinks, W2 | 0.375** | 0.130 | 0.171 |
| | (0.100, 0.650) | (-0.392, 0.652) | (-0.328, 0.670) |
| Average covariate unbalance | - | 5.4 | 4.4 |
| Treatment observations | 71 | 63 | 60 |
| Control observations | 1,204 | 168 | 1,175 |
| **Total N** | **1,275** | **231** | **1,235** |
| **No Alcohol, W1** | | | |
| Number of drinks, W2 | 0.175 | 0.241 | 0.218 |
| | (-0.188, 0.537) | (-0.158, 0.640) | (-0.161, 0.597) |
| Average covariate unbalance | - | 8.6 | 13.2 |
| Treatment observations | 10 | 10 | 9 |
| Control observations | 1,835 | 63 | 1,286 |
| **Total N** | **1,845** | **73** | **1,325** |

Notes: The OLS regression models include control variables measured at Wave 1. 95% confidence intervals in parentheses are computed by bootstrapping with 100 repetitions. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

**Table 3.6b Robustness checks (IIb): An alternative definition of maternal beliefs (the 'unsure' response is combined with the 'no' category)**

| | OLS regression | Propensity score matching methods | |
|---|---|---|---|
| | | ATT of experiencing maternal belief about adolescent substance use | |
| | | Nearest-neighbour matching | Kernel matching |
| **Smoke, W1** | | | |
| Number of cigarettes, W2 | 2.455*** (1.290, 3.620) | 2.039✞ (-0.138, 4.217) | 2.119✞ (-0.257, 4.495) |
| Average covariate unbalance | - | 4.8 | 6.2 |
| Treatment observations | 203 | 168 | 139 |
| Control observations | 522 | 191 | 314 |
| **Total N** | **725** | **359** | **453** |
| **No Smoke, W1** | | | |
| Number of cigarettes, W2 | 0.791* (0.126, 1.456) | 0.504 (-1.445, 2.452) | 0.647 (-1.126, 2.419) |
| Average covariate unbalance | - | 4 | 4.2 |
| Treatment observations | 38 | 38 | 38 |
| Control observations | 2,469 | 190 | 2,456 |
| **Total N** | **2,507** | **228** | **2,494** |
| **Alcohol, W1** | | | |
| Number of drinks, W2 | 0.283✞ (-0.006, 0.571) | -0.018 (-0.618, 0.582) | 0.010 (-0.547, 0.567) |
| Average covariate unbalance | - | 4.0 | 4.6 |
| Treatment observations | 71 | 70 | 70 |
| Control observations | 1,301 | 226 | 1,300 |
| **Total N** | **1,372** | **296** | **1,370** |
| **No Alcohol, W1** | | | |
| Number of drinks, W2 | 0.177 (-0.185, 0.539) | 0.229 (-0.212, 0.669) | 0.220 (-0.197, 0.637) |
| Average covariate unbalance | - | 6.5 | 8.4 |
| Treatment observations | 10 | 10 | 10 |
| Control observations | 1,850 | 59 | 1,325 |
| **Total N** | **1,860** | **69** | **1,335** |

Notes: The OLS regression models include control variables measured at Wave 1. 95% confidence intervals in parentheses are computed by bootstrapping with 100 repetitions. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

A second check is to explore alternative specifications for the indicator of maternal beliefs. The original indicator records the beliefs when the mothers reported either 'yes' or 'unsure' (due to the possibility of suspicion). A further examination is carried out to investigate how the 'unsure' category relates to the outcome variables. Two complementary sets of analyses are performed: (a) the 'unsure' category is excluded from the model, and (b) the 'unsure' category is combined with the 'no' category. Table 3.6a presents OLS and PSM estimates for the former model and Table 3.6b for the latter model.

Table 3.6a indicates that maternal beliefs are significantly related to a higher number of cigarettes among adolescents who reported having used cigarettes in Wave 1. Of adolescents who *had not used* cigarettes or who *had used* alcohol in Wave 1, the effect of maternal beliefs is only significant in the OLS regressions. As expected, the effect of maternal beliefs diminishes in the PSM models; however, it is important to note that nearly all PSM estimations fail to achieve successful matching. Table 3.6b demonstrates coefficients from models where the 'unsure' category is combined with the 'no' category. Results show that the effect of maternal beliefs is positively related to adolescents' later cigarette use, regardless of their smoking status in Wave 1. Moreover, maternal beliefs are also found to have an effect on later alcohol use among alcohol-experienced adolescents. Results obtained from the OLS regressions are all significant, at least at the 10% level. The statistical significance of the coefficients from the PSM regressions is further reduced and most of them stop being significant.

A third robustness check is to compare the magnitude of the effect of maternal beliefs between the experienced and inexperienced adolescent-samples in Wave 1, and across the smoking and drinking models. Post hoc tests are carried out using the Hausman test and seemingly unrelated estimation (using the Stata *suest* command)[10]. The tests indicate that the effect of maternal beliefs differs in magnitude between the models of alcohol-experienced and -inexperienced adolescents and across the smoking and drinking models (results not shown).

[10] Seemingly unrelated estimation test is only performed after OLS regressions; this is because Stata does not allow standard errors from the previous estimates to be adjusted with a bootstrapping technique.

A final robustness check is to test whether outliers might have affected the results. All analyses are replicated by trimming at the top and bottom first, fifth, and tenth percentiles. Results show no significant differences.

### 3.5 Discussion

By using various statistical methods, this paper builds upon previous studies to investigate the relationship between maternal beliefs and adolescents' substance use. In line with the existing literature (e.g. Bogenschneider et al., 1998; Williams et al., 2003; Yang et al., 2006), findings show that parents generally were not aware of their adolescents' cigarette and alcohol use. This study shows that more than two-thirds of the mothers were unaware of adolescents' substance use in Wave 1. One interesting finding from the agreement indices is that, although there were more adolescents reporting the use of alcohol than those reporting the use of cigarettes, mothers were much less likely to make correct assessments with regard to the former. Low agreement on adolescent drinking may be due to alcohol being a less noticeable substance than cigarettes (e.g. residual odours) if one does not drink excessively (McGillicuddy et al., 2007).

Consistent with the literature (Lamb & Crano, 2014; Madon et al., 2003, 2004, 2006; Mollborn & Everett, 2010; Yang et al., 2006), this study shows that, for adolescents who reported having used cigarettes or alcohol and for adolescents who reported not having used cigarettes in Wave 1, maternal beliefs are related to an increased probability of adolescents' later engagement in these activities. Notably, these findings could not be explained by the differences in socio-demographic backgrounds and family relations between groups (adolescents whose mother believed they used the substance vs those whose mother did not believe) given that the analyses match adolescents on these factors. This suggests that parental beliefs may have a unique contribution to adolescents' substance use. The observed correlations could be explained by the SFP (self-fulfilling prophecy). According to the prophecy, it is possible that maternal knowledge about their adolescents' smoking or drinking behaviour may be perceived as approval, especially when no further preventive actions are taken. This is particularly the case for alcohol consumption, with some parents being more relaxed about underage drinking (Friese et al., 2012). As a result, parents who are less restrictive about substance use may increase adolescents' risks of substance use given that

adolescents may view this as parents' expectations and thus may attempt to live up to those parental expectations (Harris & Rosenthal, 1985; Mollborn & Everett, 2010). Alternatively, parents could have adopted a more coercive and disciplinary parenting practice in response to their adolescents' substance use. Such parenting could ruin the relationship between parents and adolescents and may have a negative impact on adolescents' mental well-being (Baumrind, 1991), which in turn could increase the probability of adolescents' substance use (Yang et al., 2006). Moreover, parents who believe their adolescents are engaging in substance use may actively look for signs. Such actions may demonstrate a lack of trust, making adolescents feel their secrecy, autonomy, and freedom are being breached. Ultimately, this could increase the probability of adolescent substance use engagement (Borawski et al., 2003).

One important feature of this study is the implementation of PSM techniques (nearest-neighbour matching and kernel matching) that effectively control for confounding covariates when exploring the association between maternal beliefs and adolescents' substance use. Coefficients from the PSM regressions are weaker, suggesting that there is a large amount of heterogeneity in the association. This provides evidence for the argument that part of the maternal belief effects could be explained by other observed covariates (e.g. maternal substance use). While PSM controls for confounding covariates that are observable, effects of other unobserved variables related to either or both maternal beliefs and/or adolescents' substance use may not be removed completely. A potential and relevant unobserved variable that may influence the association between maternal beliefs and adolescents' substance use is adolescent concealment. Adolescent concealment is commonly found in parent-adolescent relationships and can have a direct effect on parental awareness of adolescents' substance use. For various reasons, adolescents withhold information from their parents deliberately (Finkenauer et al., 2008). Those reasons may help explain the negative relationship between parental underestimation and adolescents' substance use. For instance, adolescents may conceal their use of cigarettes or alcohol to avoid disappointment and punishment (Darling et al., 2006; Smetana & Metzger, 2008; Smetana et al., 2006). The amount of effort they need to put into hiding their substance use (e.g. brushing teeth to get rid of the smell of smoke or alcohol on the breath, or applying fragrance to cover the residual scent of cigarettes) may discourage them from continuing the behaviour. Furthermore, a sense of guilt or fear of being rejected by parents for engaging in the undesirable behaviour may reduce their use. A study

by Dearing et al. (2005) showed a negative correlation between guilt-proneness (the tendency to feel bad about a specific behaviour) and substance use problems. Lastly, it is possible that adolescents may feel entitled to conceal their substance use information to protect and maintain the relationship with their parents (Finkenauer et al., 2008). This implies that their substance use is mainly for experimental purposes, and that it is unlikely for them to develop chronic use which is often found in high-conflict families (White, Johnson & Buyske, 2000). Taken together, adolescent concealment may play a crucial role in the association between parental unawareness and youth substance use.

Underlying this study is the notion that parental beliefs may protect against – or increase the risk of – substance use in adolescence through the process of attachment to significant others. The protective effect of parental unawareness on substance use may reflect a positive parent-child relationship, which has been found to be associated with the two important components, a secure base and a safe haven, as proposed in the attachment theory (as discussed in the Introduction section; Doinita & Maria, 2015; Karavasilis, Doyle & Markiewicz, 2003). One challenge in considering what contributes to attachment processes during adolescence is the amount of time adolescents spent away from home. Unlike the attachment processes in early childhood, where the infant gives signals to their caregiver and expects to receive developmental needs and emotional support from them, adolescence is a pivotal period for youth to develop their own autonomy (which increases opportunities for them to decide whether or not to conceal their activity in risky behaviours such as substance use) (Smetana & Metzger, 2008). This makes it difficult for parents to respond to adolescents' needs immediately. As a result, different aspects of parent-adolescent interaction (e.g. show trust in adolescents, listen to them, validate their feelings) may come into play that could influence adolescents' sense of security as well as their bonding and attachment with their parents. While adolescent concealment is somewhat the opposite to the attachment processes in early childhood, the underlying motivation may be the same as in earlier childhood, that is adolescents may conceal their use of substances to maintain proximity with their parents (the sort of process that is often seen in a secure attachment relationship).

Despite the use of PSM, the potential causal effect of maternal beliefs on adolescents' later substance use cannot be guaranteed. It is plausible that maternal beliefs and adolescent substance use may change simultaneously during the one-year window between Wave 1 and Wave 2. Moreover, mothers may be more likely to know about their adolescents' smoking or

drinking behaviour if the adolescents are regular smokers or alcohol users. Regular users tend to continue the behaviour in later waves. Nonetheless, findings with respect to the changing behaviours, especially when adolescents changed from being non-smokers to smokers, suggest that maternal beliefs to some extent lead to an increased probability of adolescents' later substance use.

In contrast to earlier findings (as noted above, e.g. Yang et al., 2006), for adolescents who reported not having used alcohol in Wave 1, no effect of maternal beliefs is found on their later alcohol consumption. Two possible reasons may explain this. First, balanced matching is not successfully achieved in this sample; the ATT estimates for the sample are likely to have been biased and may therefore contribute to the insignificant results. The unsuccessful matching may also explain the varying effect size of maternal beliefs between the models of alcohol-experienced and -inexperienced adolescents indicates in the post hoc tests. Second, given that alcohol is the most used substance in the US (Schulenberg et al., 2017), the effect of maternal beliefs may be suppressed by a wide range of factors relating to alcohol initiation, such as the unique drinking culture and norms in society. Different social acceptance of alcohol and cigarette use may also explain the various effect size of maternal beliefs between the smoking and drinking models demonstrated in the post-estimation tests.

### 3.6 Limitations

While this study shows an association between maternal beliefs and adolescents' later substance use, several limitations need to be considered. First, this study is based on the assumption that adolescents and mothers would provide honest answers. However, social desirability and the concern about the legal minimum smoking and drinking age may discourage respondents from reporting truthfully (Latkin et al., 2017). Second, the differences within ethnic groups, gender and age groups are not investigated in the current study, since there are too few cases of mothers reporting adolescents' substance use. It would be interesting for future studies to estimate the effect of parental beliefs separately for these groups. Third, this research only investigates maternal beliefs, the effect of paternal beliefs may be different. Crouter and Head (2002) indicated that mothers tended to have more knowledge about their daughters and fathers about their sons. Fourth, it is noteworthy that the Add Health data set asked parents whether their adolescents used tobacco once a week

or more and alcohol at least once a month. It would be more informative to know if parents were truly aware of adolescents' substance use or whether they made a guess about it. It is also important to note that questions on adolescents' substance use are phrased differently in the adolescent and parental questionnaires. However, these questions should sufficiently reflect adolescents' *monthly* cigarette and alcohol use. Furthermore, given that PSM only reduces the bias caused by observed confounding covariates, it is possible that a 'hidden bias' attributed to the omission of important variables in PSM analysis may produce non-randomised unobserved heterogeneity that could cause inaccurate estimations (Guo & Fraser, 2010; Rosenbaum & Rubin, 1983). However, providing that adolescents' previous substance use frequency is controlled in the analysis, the likelihood of omitted variable bias should have been reduced significantly as it absorbed a great amount of variance in Wave 2 substance use. Finally, the sample size of the adolescents whose mothers overestimated their substance use is relatively small. Future research may wish to consider using a larger sample size to ensure more balanced observations of differences between the treatment and control groups and to help increase the statistical power of the analysis.

## 3.7 Conclusions

This research uses an advanced technique to examine the effect of maternal beliefs about adolescents' substance use on their later engagement in these activities by disentangling the effect of the maternal beliefs from the effects of observed factors. Using both OLS and PSM regressions, this study shows a significant and positive association between maternal beliefs and adolescents' later engagement in substance use. This observation is not new, but one of the implications of this study is that, by using PSM, a large amount of heterogeneity is found in the association. This suggests that the effect of maternal beliefs is likely to be overestimated if the confounding bias is not controlled. While the extent to which the estimated relationships are causal is unclear, the effect of maternal beliefs on adolescents' substance use is evident.

Two explanations have been proposed in this study: the self-fulfilling prophecy (SFP, as widely suggested by previous studies noted above) and adolescent concealment. In recognition of the power of SFP, this study provides evidence for the potential negative impacts of parental beliefs on adolescents' substance use and suggests that it may be worth

considering parental beliefs and the associated behaviour of parents when formulating family-based programmes. For instance, programmes can provide useful and practical information for parents on how to have open and informed discussions with their adolescents about substance use and the consequences of the use in the short-, medium-, and long-term. While communication is central to all kinds of relationships, it is also important to consider that adolescence is a critical period characterised by increased conflict (Finkenauer et al., 2008). This could put pressure on communication between adolescents and parents. The concept of adolescent concealment therefore suggests that parents need to understand adolescents' unwillingness and discomfort in sharing information regarding risk behaviours and to allow adolescents to draw healthy boundaries themselves about things they want to share/discuss or conceal. This may help avoid conflicts that may arise when discussing topics about which adolescents feel uncomfortable when it comes to confiding in their parents.

**Appendix 3A Summary of Blinder-Oaxaca decomposition estimations of adolescents' cigarette and alcohol consumptions at Wave 2 by parental beliefs (N=3,232)**

| **Model estimates** | **Cigarette use** | **Alcohol use** |
|---|---|---|
| Mean consumption without maternal beliefs | 0.760 (0.054)*** | 0.533 (0.016)*** |
| Mean consumption with maternal beliefs | 8.805 (0.463)*** | 1.429 (0.123)*** |
| Mean consumption difference | -8.045 (0.466)*** | -0.896 (0.124)*** |
| Explained | -5.536 (0.431)*** | -0.507 (0.049)*** |
| Unexplained | -2.508 (0.468)*** | -0.389 (0.120)** |
| **Explained contributions** | **Coef. (S.E.)** | |
| ***Demographic factors*** | | |
| Age | -0.063 (0.034)✞ | -0.060 (0.015)*** |
| Female[1] | 0.010 (0.015) | -0.007 (0.005) |
| African-American | -0.081 (0.019)*** | -0.014 (0.005)** |
| American Indian/Asian/Mixed/Others[2] | -0.018 (0.011) | -0.000 (0.001) |
| Step-parent family | -0.001 (0.004) | 0.000 (0.001) |
| Single-parent family[3] | -0.017 (0.023) | -0.000 (0.003) |
| [Parental] High school graduate | -0.019 (0.015) | 0.001 (0.002) |
| [Parental] Some post-school training/college | -0.005 (0.011) | -0.000 (0.001) |
| [Parental] A bachelor's degree or above[4] | 0.020 (0.023) | 0.001 (0.002) |
| Grade point average | -0.177 (0.052)** | -0.004 (0.007) |
| Religiosity | -0.031 (0.032) | -0.007 (0.010) |
| Depression | -0.001 (0.026) | -0.005 (0.006) |
| Number of cigarettes (drinks) at Wave 1 | -4.339 (0.424)*** | -0.210 (0.040)*** |
| ***Family relations*** | | |
| Maternal trust | -0.120 (0.058)* | -0.030 (0.015)* |
| Maternal-adolescent closeness | -0.000 (0.020) | 0.001 (0.005) |
| Parental control | -0.001 (0.003) | -0.002 (0.002) |
| Frequency of lying to parents/guardians | -0.057 (0.024)* | -0.038 (0.011)** |
| ***Maternal and peer substance use*** | | |
| Mother smokes (drinks) | -0.070 (0.029)* | -0.007 (0.005) |
| Peers smoke (drink) | -0.412 (0.140)** | -0.115 (0.025)*** |
| ***Neighbourhood safety*** | | |
| Neighbourhood drug problems | -0.007 (0.018) | 0.004 (0.004) |
| ***Interaction terms*** | | |
| Peers smoke (drink) × frequency of lying | -0.181 (0.103)✞ | -0.013 (0.022) |

Notes: Blinder-Oaxaca decomposition is a statistical method that shows the output differences (e.g. number of cigarettes smoked by adolescents) between two groups (e.g. parental beliefs vs parental non-beliefs) and how much these differences can be explained by other observed variables (e.g. age and gender). Standard errors in parentheses. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. Reference category: [1]Male; [2]White; [3]Intact family; [4] Less than high school levels.

# Chapter 4

# Dimensions of the parent-child relationship: Effects on substance use in adolescence and adulthood

This chapter was carried out in collaboration with my supervisor, Dr Maria Iacovou. I contributed to the original research idea and the data analysis and an original draft. Maria Iacovou contributed to the article structure and the writing. The peer-reviewed and edited version of Chapter 4 is published as: Mak, H.W. & Iacovou, M. (*2018*). Dimensions of the parent-child relationships: Effects on substance use in adolescence and adulthood. *Substance Use and Misuse, 54*(5), 724-736. doi: 10.1080/10826084.2018.1536718. The full paper is provided in the appendix.

## 4.1 Introduction

This chapter examines the long-term influences of early experience, parenting styles in particular, on substance-related problems in adulthood. According to a report from the National Institutes on Alcohol Abuse and Alcoholism (2015) and National Institutes of Health (2015) in the US, 10 per cent of the adults experience drug use problems at least once in their lives, and nearly 1 in 3 adults in the US reported to have an alcohol use disorder at some point in their lives. The figures shown in the report are striking. Substance use exacts heavy personal costs on the individuals involved and their families, in the form of mental and physical health problems, incarceration and crime, lost income, relationship problems and lost years of life (Fazel, Yoon & Hayes, 2017; U.S. Department of Health and Human Services (HHS) & Office of the Surgeon General U.S., 2016; Whiteford et al., 2013). The US government spends considerable expenditure on the health care system to provide various intervention programmes. Recent estimates suggest that excessive drinking costs the US almost $250 billion each year (Sacks et al., 2015), while smoking-related illness accounts for almost 9% of healthcare spending (Xu et al., 2015).

There is evidence that parenting and family relationships influence the propensity for substance use in adolescence, and that interventions promoting effective parenting can reduce adolescent substance use (Allen et al., 2016; Haggerty, McGlynn-Wright & Klima, 2013; Schinke et al., 2011). However, there is also evidence that adolescent substance use is extremely widespread (Young et al., 2002), often experimental and self-limiting, and in itself generally not associated with a significant degree of contemporaneous or future harm (Baumrind, 1991; Englund et al., 2013; Steinberg & Morris, 2001). This is not to say that adolescent substance

use is unproblematic – indeed, it is a significant predictor of later substance use problems (McCambridge, McAlaney & Rowe, 2011) – but given limited resources available for prevention programs, it is arguable that research on substance use should focus on identifying the determinants of problem usage beyond adolescence (Shedler & Block, 1990).

This paper is based on four waves of data from the *Add Health* study, a prospective longitudinal survey that follows a group of respondents (N=2,954) from adolescence into early adulthood. We explore the effects of parenting style in adolescence (when sample members have a mean age of 15.4 years), on problem use of tobacco, alcohol, marijuana and other illicit drugs 13 years later, when sample members had a mean age of 28.2 – by which point most people have jobs, many have families, and substance use is no longer a youthful indiscretion but may potentially have serious effects on life chances.

We use a model of parenting styles originating in the work of Baumrind (1966, 1968, 1971, 1991). It proposes two distinct dimensions of parenting: warmth/responsiveness (the degree to which the parent/child relationship is warm, close and affectionate), and control/demandingness (the degree to which parents have expectations of good behaviour on the part of their children, and the extent to which they encourage or enforce compliance with those expectations). Baumrind's original schema defined three parenting styles: *authoritative* (high in both warmth and control); *authoritarian* (high in control but low in warmth); and *permissive* (low in control). This schema has formed the basis for widely-used survey instruments (Robinson et al., 1995) and for a large body of research, in areas including developmental competence (Baumrind, 1971, 1991); self-esteem (Buri et al., 1988; Chan & Koo, 2011); and educational achievement (Dornbusch, 1987; Steinberg et al., 1989); the authoritative parenting style is almost invariably associated with the best outcomes.

This threefold schema has now been largely superseded by a full orthogonal two-factor model, which divides the permissive group into an *indulgent* group, high in warmth and low in control; and a *neglectful* group, low in both warmth and control (Maccoby & Martin, 1983). This schema decouples low- and high-warmth parents among those exerting lower levels of control; many studies using this schema find that indulgent parenting is associated with outcomes as good as authoritative parenting, while outcomes for the neglectful group are poor; in other words, the major effect is via the warmth rather than the control axis. This pattern is found in several studies examining mental or psychological competence and wellbeing (Stafford et al., 2016; García &

Gracia, 2009; Eun et al., 2018; Schofield et al., 2012; Martinez et al., 2017; Martinez et al., 2019). A number of studies relating specifically to substance use in adolescence also find similar results, including those of Kandel et al. (1978), Bronte-Tinkew et al. (2006), Adalbjarnardottir and Hafsteinsson (2001), Ozer et al. (2011), Martinez et al. (2013), Calafat et al. (2014), and Valente et al. (2017).

Not all studies find warmth to be the more important dimension. Some studies find both dimensions to be of approximately equal importance, either as determinants of competence and adjustment (Lamborn et al., 1991; Steinberg et al., 1994), or as protective factors against substance use (Hill et al., 2005; Piko & Balázs, 2012). Other studies suggest that control is more important than warmth as a protective factor against adolescent substance use (Barnes et al., 2000; Kosterman et al., 2000; Aquilino & Supple, 2001; Choquet et al., 2008).

This paper seeks to extend the state of knowledge in two ways. First, we examine a time frame extending from adolescence into the late twenties. Most studies in this area have focused on adolescence, with longitudinal studies following subjects only into late adolescence or the early adult years (Aquilino & Supple, 2001; Barnes et al., 2000; Mogro-Wilson, 2008; Roche, Ahmed & Blum, 2008; Steinberg et al., 1994; Stone et al., 2012; Van Ryzin, Fosco & Dishion, 2012). Very few studies follow adolescents into adulthood. Dubow, Boxer, and Huesmann (2008) considered a three-item composite of negative family interactions in adolescence, finding it weakly related to drinking behaviour in adulthood. Maggs, Patrick, and Feinstein (2008) found the quality of parent-child relationships at age 16 was associated with alcohol consumption at age 16 and 33, and harmful drinking at age 42. White, Johnson, and Buyske (2000) found that parental warmth and hostility predicted trajectories of smoking behaviour, but predicted drinking only weakly. Clark et al. (2015) found that authoritarian parenting was associated with a lower risk of heavy episodic drinking at age 12 across all racial groups.

The second innovation of this study is that, in addition to assessing the effects of parental warmth and control on substance use problems in adulthood, we seek to investigate the pathways via which these effects are played out. We examine two potential pathways, which have been suggested by different branches of the literature.

The first pathway is via *the age at substance use initiation*. We have already had mentioned research on the relationship between parenting style and substance use; several papers in this area (e.g. Garcia & Gracia, 2009; Velleman, Templeton & Copello, 2005) note specifically a link between parenting style and early initiation. We also expect to find a link between early initiation and the risk that an individual would go on to experience substance use problems. The "critical period" hypothesis, which originated in studies of language acquisition, suggests that there is a developmental period in the early teens during which individuals are particularly sensitive to the effects of substance use; those using substances at this age may be at substantially elevated risk of substance use disorder, or substance-related harm, in later life. The studies of Guttmannova et al. (2011) and Maimaris and McCambridge (2014) focused on alcohol misuse, with the former suggesting evidence for a sensitive period and the latter urging more caution; Jordan and Andersen (2017) considered a wider range of substances and found evidence for a sensitive period in adolescence. Several other studies, while not specifically invoking the sensitive period hypothesis, have also shown that early initiation is related to higher risks of later problems. Anthony and Petronis (1995), Grant and Dawson (1998), McGue et al. (2001), King and Chassin (2007) and Richmond-Rakerd, Slutske and Wood (2017) considered illegal drug use, while DeWit et al. (2000), Grant, Stinson and Harford (2001), Hingson, Heeren and Winter (2006), Dawson et al. (2008) and McCambridge, McAlaney and Rowe (2011) considered alcohol. For example, DeWit et al. (2000) used survival analysis and hazard regression analysis with a Canadian sample and found that respondents who first started at age 11 – 14 were two to three times more likely to develop drinking problems than those who started at age 19 or above. Hingson, Heeren and Winter (2006) indicated that, after controlling for current usage of tobacco and drugs, family history of alcohol consumption, and psychological state, respondents who began drinking before the age of 14 were 2.6 times the odds of experiencing more than a year alcohol dependency compared to those who started drinking at the age of 21 or above.

The second pathway we investigate is via *depression*. As noted above (Stafford et al., 2016 and others), parenting style is associated with many aspects of mental health, with parental warmth exerting a protective effect. For instance, Ozer et al. (2013) showed that parental control predicted adolescent depressive symptoms at 6-month and 1-year follow-ups. Likewise, Betts, Gullone and Allen (2009) indicated that low levels of parental care and nurturance and high levels of affectionless-control were associated with adolescent

depression. Chan and Koo (2011) used British Household Panel Study and found that adolescents with authoritarian or permissive parents were more likely to report feeling sad, losing sleep, having low self-esteem, and were less likely to feel happiness, compared with adolescents with authoritative parents. Aquilino and Supple's longitudinal study (2001) demonstrated that coercive control was positively associated with irritability/hostility and negatively related to self-esteem and life satisfaction, while parental support predicted low levels of depression and irritability/hostility. Poor mental health may in turn increase individuals' susceptibility to substance use problems. A study of von Sydow et al. (2002) showed that mental disorders, an indicator derived from various disorders scales based on DSM-IV (e.g. anxiety disorder and affective disorder), were positively associated with later cannabis use. One theory for this is the "self-medication" hypothesis, which suggests that individuals with mental health problems engage in substance use as a way of alleviating their symptoms. The hypothesis was originally formulated in relation to opiate addiction (Khantzian, Mack & Schatzberg, 1974), and has given rise to research on a range of substances (Bolton, Robinson & Sareen, 2009; Lerman et al., 1996, 1998; Weiss, Griffin & Mirin, 1992). The theory has been critiqued on the grounds that observed associations between mental health problems and substance use may not be causal in the hypothesized direction (Lembke, 2012); however, studies examining the sequencing of onset of mental health problems and substance use suggest that mental health problems are likely to precede substance use disorders (Abraham & Fava, 1999; Deykin, Levy & Wells, 1987). The self-medication hypothesis may relate to many mental health problems; we use depressive symptoms, since detailed information on other mental health problems is not collected in the data set we use.

## 4.2 Methodology

In this study, the relationships between parenting styles (measured at Wave 1) and four different types of substance use and problems (cigarette, alcohol, marijuana, and other illicit drugs) are examined. To test the mediating effects of age at initiation and depression, we use the binary indicator of whether first use had occurred by Wave 1 (respondents were asked whether they were using the substance in the past 30 days in the Wave 1 interview), and the measure in Wave 3 depression (since it post-dates the measurement of parenting

styles and precedes the measurement of the outcome; the measure is derived from 12 items, α=0.82). The scales and items of the variable measurements can be found in Chapter 2.

Aside from the two dimensions (i.e. parental warmth (11 items, α=0.75) and control (7 items, α=0.62), an additional indicator of parenting style is derived based on the fourfold schema (see Figure 4.1). A categorical variable is defined using the scores from the parental warmth and parental control scales derived at Wave 1, denoting four parenting styles: *authoritative* (a score above the median for both warmth and control); *indulgent* (scores above the median in warmth and below the median in control); *authoritarian* (below the median in warmth and above the median in control); and *neglectful* (below the median in both warmth and control). Alternative conceptualisations of control, namely monitoring and demandingness, will also be explored. A fuller discussion is provided in the chapter.

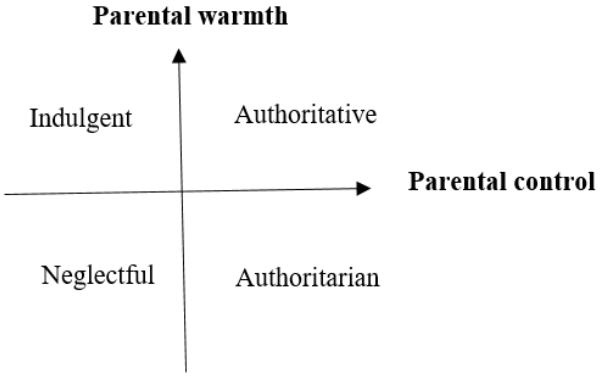


***Figure 4.1 The fourfold schema of parenting styles (Baumrind, 1991; Lamborn et al., 1991; Maccoby & Martin, 1983)***

In the analysis, we control for the following variables in Wave 1: age, gender, ethnicity, parental education, family composition, peers' substance use (Jackson, Dickinson & Levine, 1997; von Sydow et al., 2002) and maternal substance use (Bailey et al., 2016; Baumrind, 1991). Parental employment and neighbourhood safety have been found to be insignificant and are not included in the model. We also control for several variables measured in Wave 4: the highest educational levels, religiosity (5 items, α=0.83), employment, marital status and whether the individual had children. More detail on the scales and items of the variable measurements can be found in Chapter 2.

The core sample size in this study is 2,954; the size may vary slightly between different specifications. A detailed flowchart showing the derivation of the analytical sample is outlined

in Diagram 2.2. The 2,954 respondents included in this analysis took part in Waves 1, 3 and 4 (with valid data on age at onset of substance use at Wave 1, depression at Wave 3 and substance use at Wave 4) and had parents who participated in the study at Wave 1.

Table 4.1 provides descriptive statistics for the variables of interest; other descriptive statistics can be found in Appendix 4A.

**Table 4.1 Descriptive Statistics: substance use and substance use problems, parenting style variables and mediators (N=2,954)**

| Variable | Range of Values | | Mean (SD) or % |
|---|---|---|---|
| | Min | Max | |
| **Outcome Variables, W4** | | | |
| Ave. number of cigarettes per day in the past 30 days | 0 | 20 or more | 3.12 (6.11) |
| Drinking problems (standardised) | -0.61 | 3.58 | 0.01 (0.99) |
| Marijuana problems (standardised) | -0.39 | 5.52 | 0.00 (1.00) |
| Other illicit drug problems (standardised) | -0.27 | 5.92 | -0.01 (0.98) |
| **Variables of Interest, W1** | | | |
| ***Parenting styles in dimensions*** | | | |
| Warmth (standardised) | -4.50 | 2.30 | -0.01 (1.02) |
| Control (standardised) | -1.96 | 4.00 | -0.01 (0.97) |
| ***Fourfold schema of parenting styles, W1[1]*** | | | |
| Authoritative (Ref) | 0 | 1 | 24.6 |
| Indulgent | 0 | 1 | 25.1 |
| Authoritarian | 0 | 1 | 25.4 |
| Neglectful | 0 | 1 | 25.0 |
| ***Mediators*** | | | |
| Cigarette use by W1[2] | 0 | 1 | 0.19 (0.39) |
| Alcohol use by W1[2] | 0 | 1 | 0.45 (0.50) |
| Marijuana use by W1[2] | 0 | 1 | 0.24 (0.43) |
| Illicit drug use by W1[2] | 0 | 1 | 0.27 (0.44) |
| Age first smoked regularly (in years)[3] | 10 or younger | 30 | 16.4 (3.31) |
| Age first used alcohol (in years)[3] | 10 or younger | 30 | 16.2 (3.13) |
| Age first used marijuana (in years)[3] | 10 or younger | 29 | 16.7 (3.02) |
| Age first used illicit drug (in years)[3] | 10 or younger | 31 | 18.3 (4.25) |
| Depression (standardised), W3 | -1.35 | 4.92 | -0.03 (0.96) |

Notes: The scales and measurements of drinking, marijuana and other illicit drug problems, parental warmth, parental control and depression can be found in Table 2.2. [1]Fourfold schema of parenting styles is defined as authoritative (a score above the median for both parental warmth and parental control), indulgent (scores above the median in warmth and below the median in control), authoritarian (below the median in warmth and above the median in control), and neglectful (below the median in both warmth and control). [2]This binary indicator measured in Wave 1 is based on whether respondents had used the substance in the past 30 days. [3]This indicator is derived from responses to Waves 1 to 4.

### *4.2.1 Analysis*

Our analysis is based on structural equation modelling (SEM) in Stata 13. SEM treats all relationships in the model as linear; Hellevik (2009) showed that the inclusion of dichotomous mediators (here, initiation by Wave 1) did not cause problems in this context. One of our robustness checks uses a dichotomous outcome; this is estimated with generalized structural equation modelling (GSEM), described by Rabe-Hesketh, Skrondal and Pickles (2004).

We specify a system of relationships which allows parenting behaviour to exercise a direct effect on the outcome variables, as well as indirect effects via initiation and depression. Of the two mediators, initiation is measured prior to depression; we therefore allow initiation to influence depression. Controls measured in Wave 1 may influence both mediators and outcomes; controls measured in Wave 4 influence only outcomes.

In certain situations, the use of multiple outcome measures may give rise to problems with statistical inference; the larger the number of outcomes, the more likely that a significant result will be found for at least one of them (Shaffer, 1995). One solution involves adjusting confidence intervals. In the analysis, we do not do this, since the same relationships between parenting style and later substance use are observed in relation to every outcome.

Four models are estimated, one relating to problem usage of each of the four substances considered. Full results are available in the Appendix 4B and 4C; Tables 4.2 and 4.3 in the body of the paper, which present results from the two-dimension and fourfold models of parenting respectively, contain only the coefficients on the parenting style variables and the mediating pathways.

Tables 4.2 and 4.3 also contain test statistics for the significance of the mediation pathways; these are from the Sobel procedure (Sobel, 1982), which tests whether the estimated effects of the parenting variables on the outcome variables are significantly attenuated by the inclusion of the mediators. We perform two alternative tests, the Aroian and Goodman tests (MacKinnon et al., 2002); these are not reported but the results are similar.

## 4.3 Results

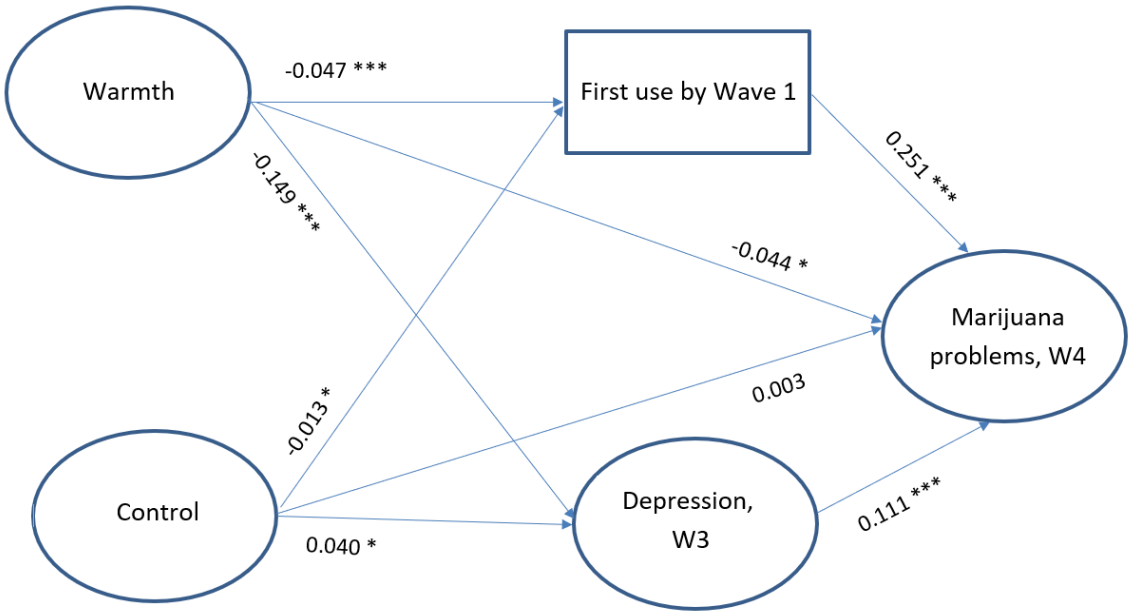


***Figure 4.2 The relationship between parenting in adolescence and marijuana problems in Wave 4; path diagram showing results from SEM analysis***

*Notes: Parental warmth is defined as the degree to which the parent/child relationship is warm, close and affectionate, and parental control is defined as the degree to which parents have expectations of good behaviour on the part of their children (Baumrind, 1966, 1968, 1971, 1991; Maccoby & Martin, 1983). These are latent scales (standardised) derived at Wave 1 from a set of 11 and 7 measurement items respectively (see Table 2.2). For clarity, some relationships have been omitted from the diagram. These are: (1) the determinants of the latent constructs that are not directly observed, such as the parenting dimensions and mental health problems; (2) control variables; (3) the relationship between first use and mental health problems. Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1.*

Figure 4.2 presents estimates from a model estimating the determinants of marijuana problems in Wave 4. This is based on the two-dimensional model of parenting style. Of the two dimensions, only warmth has a direct effect on the outcome. Both mediators, first use by Wave 1 and depression in Wave 3, are positively and significantly associated with marijuana problems in Wave 4. Parental warmth has a significant negative association with both mediators. Parental control is negatively associated with initiation, but is positively related to depression in Wave 3. These results suggest that warm parenting is related to a lower risk of problem marijuana use in adulthood, by three pathways: (1) directly; (2) via a lower risk of early initiation; and (3) via a lower risk of depression. It also suggests that a parenting style

high in control has (1) no significant direct effect on the outcome, (2) a beneficial effect via a lower risk of early initiation; and (3) a negative effect via a higher risk of depression. We return later to a fuller discussion of these findings.

Table 4.2 presents results from the same model, for all four outcomes. The top panel contains estimates of the effects of parenting styles on the outcome variables: direct effects (the effects attributable to all parts of the model except the mediators); indirect effects (effects via the mediating pathways) and total effects (the sum of these). There are significant direct effects from warmth for all outcomes except smoking, and significant indirect effects from warmth for all outcomes. There are no significant effects, direct or indirect, from control.

The second panel shows mediation effects. Both mediators are significantly related to all outcome variables, except that depression in Wave 3 is not significantly related to smoking. Warmth is associated with a lower risk of initiation and with a lower risk of depression. Control is associated with a lower risk of initiation (for drinking and marijuana), but with a higher risk of depression (in all except the smoking model).

The third panel presents tests of significance for the mediating pathways. Both pathways are significant mediators of the effect of parental warmth (except depression in the smoking regression). The evidence is less compelling in relation to the effects of parental control. Initiation is a significant mediator of parental control only in the drinking equation (although in the other three equations, the test statistic is in the same direction, and is associated with a p-value of $p < 0.1$). Similarly, depression is a significant mediator of parental control only in the marijuana problems equation; however, the test statistic is of the same sign in all the other three equations, and associated with a p-value of $p < 0.1$ in two of them.

Results for all models demonstrate good model fit (Bartholomew et al., 2008 defined a good fit as a value <0.05 for RMSEA, a value close to 1 for CFI, and a value < 0.08 for SRMR).

**Table 4.2 Relationships between parenting style in adolescence and substance use problems in adulthood; two dimensions of parenting style, coefficients from SEM analysis (N=2,954)**

| | | | Smoking (cigs/day) | Drinking problems | Marijuana problems | Other illicit drug problems |
|---|---|---|---|---|---|---|
| **Effects of parenting style on Wave 4 outcomes** | **Direct effects** | *Warmth* | 0.016 (0.101) | -0.038 (0.017)* | -0.044 (0.018)* | -0.046 (0.018)** |
| | | *Control* | 0.037 (0.104) | -0.014 (0.018) | 0.003 (0.019) | 0.006 (0.018) |
| | **Indirect effects** | *Warmth* | -0.201 (0.031)*** | -0.023 (0.004)*** | -0.029 (0.005)*** | -0.024 (0.004)*** |
| | | *Control* | -0.031 (0.024) | -0.005 (0.003)✞ | 0.001 (0.003) | -0.001 (0.002) |
| | **Total effects** | *Warmth* | -0.180 (0.101)✞ | -0.060 (0.017)*** | -0.071 (0.018)*** | -0.069 (0.018)*** |
| | | *Control* | 0.002 (0.106) | -0.019 (0.018) | 0.004 (0.019) | -0.008 (0.018) |
| **Mediation effects** | **Via initiation by Wave 1** | *Warmth → initiation* | -0.048 (0.006)*** | -0.052 (0.008)*** | -0.047 (0.006)*** | -0.054 (0.007)*** |
| | | *Control → initiation* | -0.010 (0.006) | -0.025 (0.008)** | -0.013 (0.007)* | -0.014 (0.007)✞ |
| | | *Initiation → outcome* | 3.614 (0.303)*** | 0.295 (0.042)*** | 0.251 (0.052)*** | 0.263 (0.048)*** |
| | **Via depression in Wave 3** | *Warmth → depression* | -0.146 (0.017)*** | -0.156 (0.017)*** | -0.149 (0.017)*** | -0.145 (0.017)*** |
| | | *Control → depression* | 0.040 (0.018)* | 0.039 (0.018)* | 0.040 (0.018)* | 0.041 (0.018)* |
| | | *Depression → outcome* | 0.175 (0.108) | 0.051 (0.019)** | 0.111 (0.019)*** | 0.068 (0.019)*** |
| **Sobel test statistics for significance of mediating pathways** | **Initiation** | *Warmth* | -6.644*** | -4.771*** | -4.109*** | -4.467*** |
| | | *Control* | -1.651✞ | -2.855** | -1.733✞ | -1.879✞ |
| | **Depression** | *Warmth* | -1.592 | -2.576** | -4.861*** | -3.300*** |
| | | *Control* | 1.335 | 1.686✞ | 2.077* | 1.922✞ |
| **Statistics of fit** | | *RMSEA* | 0.040 | 0.041 | 0.040 | 0.040 |
| | | *SRMR* | 0.008 | 0.008 | 0.008 | 0.008 |
| | | *CFI* | 0.964 | 0.957 | 0.960 | 0.957 |
| | | *CD* | 0.434 | 0.437 | 0.443 | 0.409 |

Notes: Age at initiation is measured by the binary indicator of whether the respondent had used the substance in the past 30 days at Wave 1. **Standard errors** in parentheses. **Statistical significance** is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞. **Post-estimation tests on differences between parental warmth and parental control: Direct effects:** Other illicit drugs *; **Indirect effects:** all substances ***; **Total effects:** marijuana ** other illicit drugs *. **Effects on initiation:** all substances ** or better. **Effects on depression:** all substances ***

Table 4.3 presents results from models using the fourfold typology of parenting described above; the baseline group is the 'authoritative' style. Results again demonstrate good model fit (Bartholomew et al., 2008). Few direct effects of parenting style are evident, but strong indirect effects are observed for the authoritarian and neglectful types, yielding significant total effects for all outcomes except smoking. Hardly any difference is evident between the indulgent and authoritative styles.

There is compelling evidence that both mediation pathways are significant. For all outcomes, both the authoritarian and neglectful parenting types are associated with (a) a higher risk of initiation by Wave 1; and (b) a higher risk of depression in Wave 3. The Sobel test statistics show that initiation is a significant mediator of the relationship between the authoritarian and neglectful parenting styles and all four outcomes; depression is a significant mediator for all outcomes except smoking.

### *4.3.1 Robustness checks*

We estimate several alternative specifications as robustness checks; results are presented in Table 4.4. As an initial check (not shown), we test for nonlinearities and interactions in the effects of parental warmth and control. We find no evidence that any of the estimated relationships are significantly nonlinear, and no interaction effects beyond what is evident in the fourfold typology.

Panel 1 of Table 4.4 shows results from a model based on binary outcomes identifying the 5 per cent of heaviest smokers and the 5 per cent of highest scores on the alcohol and drug problem scales. The fact that this specification yields results similar to our previous results indicates that our model successfully predicts severe substance use problems as well as variations across the full range.

**Table 4.3 Relationships between parenting style in adolescence and substance use problems in adulthood; fourfold typology of parenting style, coefficients from SEM analysis (N=2,954)**

| | | | Smoking (cigs/day) | Drinking | Marijuana | Other illicit drug |
|---|---|---|---|---|---|---|
| **Effects of parenting style on Wave 4 outcomes** | **Direct effects** | *Indulgent* | -0.001 (0.283) | 0.017 (0.049) | 0.006 (0.051) | 0.006 (0.050) |
| | | *Authoritarian* | 0.158 (0.284) | 0.062 (0.049) | 0.049 (0.051) | 0.079 (0.050) |
| | | *Neglectful* | 0.002 (0.287) | 0.115 (0.050)* | 0.079 (0.051) | 0.072 (0.051) |
| | **Indirect effects** | *Indulgent* | 0.055 (0.064) | 0.020 (0.008)* | -0.008 (0.008) | -0.003 (0.007) |
| | | *Authoritarian* | 0.261 (0.070)*** | 0.045 (0.009)*** | 0.039 (0.009)*** | 0.031 (0.008)*** |
| | | *Neglectful* | 0.295 (0.069)*** | 0.048 (0.009)*** | 0.039 (0.009)*** | 0.037 (0.008)*** |
| | **Total effects** | *Indulgent* | 0.056 (0.289) | 0.036 (0.049) | -0.001 (0.051) | 0.003 (0.050) |
| | | *Authoritarian* | 0.407 (0.289) | 0.105 (0.049)* | 0.085 (0.051)✞ | 0.108 (0.050)* |
| | | *Neglectful* | 0.292 (0.292) | 0.160 (0.050)** | 0.117 (0.052)* | 0.108 (0.051)* |
| **Mediation effects** | **Via initiation by Wave 1** | *Indulgent → initiation* | 0.019 (0.017) | 0.082 (0.022)*** | 0.008 (0.018) | 0.011 (0.019) |
| | | *Authoritarian → initiation* | 0.061 (0.017)*** | 0.110 (0.021)*** | 0.047 (0.018)** | 0.054 (0.019)** |
| | | *Neglectful → initiation* | 0.075 (0.017)*** | 0.134 (0.022)*** | 0.087 (0.018)*** | 0.098 (0.019)*** |
| | | *Initiation → outcome* | 3.599 (0.302)*** | 0.297 (0.042)*** | 0.264 (0.052)*** | 0.271 (0.048)*** |
| | **Via depression in Wave 3** | *Indulgent → depression* | -0.083 (0.049)✞ | -0.086 (0.049)✞ | -0.089 (0.049)✞ | -0.090 (0.049)✞ |
| | | *Authoritarian → depression* | 0.229 (0.049)*** | 0.240 (0.049)*** | 0.230 (0.049)*** | 0.227 (0.049)*** |
| | | *Neglectful → depression* | 0.140 (0.049)** | 0.157 (0.050)** | 0.141 (0.049)** | 0.134 (0.049)** |
| | | *Depression → outcome* | 0.167 (0.107) | 0.053 (0.018)** | 0.114 (0.019)*** | 0.070 (0.019)*** |
| **Sobel test statistics for significance of mediating pathways** | **Initiation** | *Indulgent* | 1.113 | 3.297*** | 0.443 | 0.576 |
| | | *Authoritarian* | 3.436*** | 4.209*** | 2.322* | 2.539* |
| | | *Neglectful* | 4.137*** | 4.615*** | 3.501*** | 3.808*** |
| | **Depression** | *Indulgent* | -1.148 | -1.508 | -1.738✞ | -1.644 |
| | | *Authoritarian* | 1.480 | 2.524* | 3.697*** | 2.884** |
| | | *Neglectful* | 1.370 | 2.148* | 2.595** | 2.196* |
| **Statistics of fit** | | *RMSEA* | 0.041 | 0.043 | 0.042 | 0.041 |
| | | *SRMR* | 0.008 | 0.009 | 0.008 | 0.008 |
| | | *CFI* | 0.961 | 0.952 | 0.955 | 0.951 |
| | | *CD* | 0.421 | 0.428 | 0.431 | 0.396 |

Notes: **Reference category** for parenting styles is authoritative parenting. Age at initiation is measured by the binary indicator of whether the respondent had used the substance in the past 30 days at Wave 1. **Standard errors** in parentheses. **Statistical significance** is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞. **Post-estimation tests on differences between indulgent, authoritarian and neglectful parenting styles: Direct effects:** None sig; **Indirect effects:** Indulgent v authoritarian and indulgent v neglectful, all substances * or better; **Total effects:** none sig. **Effects on initiation:** Indulgent v neglectful, all except drinking, ** or better; other comparisons n/s. **Effects on depression:** Indulgent v authoritarian and indulgent v neglectful, all substances ** or better; authoritarian v neglectful n/s.

Panel 2 addresses the implicit assumption that adolescents' substance use is influenced by parenting, rather than parenting responding to substance use; it is plausible that effects could run in the opposite direction. We analyse the sample of adolescents who had not initiated substance use by Wave 1, with initiation by Wave 2 as a measure of first use. Parenting in Wave 1 predicts initiation by Wave 1 more strongly than initiation by Wave 2; this may indicate a degree of bidirectional causality, or simply that in the former case, parenting style is a more proximal measure. In any case, the fact that significant relationships remain in the second specification indicates that at least part of the estimated relationship operates in the assumed direction.

We then restrict the sample to those who have had initiated substance use by Wave 4. Results (not reported) are substantially unchanged; this suggests that that parenting style affects not just the probability of initiation, but also the propensity to develop problems following initiation.

We next explore alternative specifications for the indicator of initiation. Panel 3 reports results using a continuous measure of age at initiation (individuals who had never used the substance by Wave 4 were excluded). Results are once again similar: warmth is related to older age at initiation and negatively related to depression, while control is also related to older age at initiation, albeit with smaller coefficients than warmth.

In panels 4 and 5, we use a binary variable indicating whether initiation occurred by age 16. This has the advantage of being a common benchmark for all sample members, but the disadvantage that initiation and parenting are measured at different times. For those aged over 16 in Wave 1, parenting is measured after initiation has (or has not) occurred; for those under 16, parenting is measured before the cut-off point for measuring initiation. We therefore analyse 13-15-year olds and 17-18-year-olds separately. Effects differ substantially between the two age groups, with the main differences being in the determinants of depression. The effect of warmth on depression is about twice as large for the younger group as for the older group; the effect of control on depression is insignificant for the younger group, but large and significant for the older group. This suggests that parental warmth is important for all adolescents, but particularly so at younger ages, while the relationship between control and depression is most pronounced at older ages. We also investigate whether there are differences by gender: greater parental control is associated with depression in Wave 3 for both sexes, but the effect is larger in the case of boys.

**Table 4.4 Robustness checks; results from alternative specification**

| | | | Smoking (cigs/day) | Drinking problems | Marijuana problems | Other illicit drug problems |
|---|---|---|---|---|---|---|
| **1. Discrete outcomes (top 5%). Logistic model using GSEM (*N = 2,954*)** | ***Initiation*** | **Warmth** | -0.400 (0.052)*** | -0.302 (0.045)*** | -0.369 (0.051)*** | -0.368 (0.049)*** |
| | | **Control** | -0.094 (0.062) | -0.145 (0.047)** | -0.136 (0.060)* | -0.115 (0.055)* |
| | ***Depression*** | **Warmth** | -0.146 (0.017)*** | -0.156 (0.017)*** | -0.149 (0.017)*** | -0.145 (0.017)*** |
| | | **Control** | 0.039 (0.018)* | 0.038 (0.018)* | 0.040 (0.018)* | 0.041 (0.018)* |
| **2. Restrict sample to those who had not used by W1; initiation by W2 as mediator (*N = 1,379-1,980*)** | ***Initiation*** | **Warmth** | -0.036 (0.011)** | -0.023 (0.013)✞ | -0.023 (0.008)** | -0.019 (0.008)* |
| | | **Control** | -0.013 (0.011) | -0.006 (0.012) | -0.008 (0.007) | -0.007 (0.008) |
| | ***Depression*** | **Warmth** | -0.159 (0.022)*** | -0.153 (0.027)*** | -0.146 (0.023)*** | -0.138 (0.024)*** |
| | | **Control** | 0.045 (0.021)* | 0.024 (0.024) | 0.051 (0.021)* | 0.054 (0.021)* |
| **3. Continuous age at initiation (restrict sample to ever used by W4) (*N = 1,142-2,676*)** | ***Initiation*** | **Warmth** | 0.387 (0.074)*** | 0.397 (0.053)*** | 0.263 (0.060)*** | 0.390 (0.116)** |
| | | **Control** | 0.147 (0.082)✞ | 0.228 (0.056)*** | 0.091 (0.064) | 0.183 (0.126) |
| | ***Depression*** | **Warmth** | -0.146 (0.025)*** | -0.163 (0.018)*** | -0.177 (0.022)*** | -0.180 (0.029)*** |
| | | **Control** | 0.016 (0.028) | 0.040 (0.019)* | 0.029 (0.024) | 0.065 (0.031)* |
| **4. Initiation by age 16 (sample: those under 16 at W1) (*N = 1,566*)** | ***Initiation*** | **Warmth** | -0.039 (0.008)*** | -0.059 (0.011)*** | -0.030 (0.008)*** | -0.048 (0.009)*** |
| | | **Control** | -0.005 (0.007) | -0.017 (0.010)✞ | -0.012 (0.007) | -0.013 (0.008) |
| | ***Depression*** | **Warmth** | -0.196 (0.026)*** | -0.208 (0.026)*** | -0.200 (0.026)*** | -0.195 (0.026)*** |
| | | **Control** | 0.012 (0.024) | 0.009 (0.024) | 0.010 (0.024) | 0.011 (0.024) |
| **5. Initiation by age 16 (sample: those aged 17-18 at W1) (*N = 861*)** | ***Initiation*** | **Warmth** | -0.056 (0.012)*** | -0.051 (0.013)*** | -0.050 (0.012)*** | -0.040 (0.012)** |
| | | **Control** | -0.001 (0.015) | -0.040 (0.017)* | -0.018 (0.016) | -0.014 (0.016) |
| | ***Depression*** | **Warmth** | -0.096 (0.027)*** | -0.107 (0.027)*** | -0.096 (0.027)*** | -0.095 (0.027)*** |
| | | **Control** | 0.114 (0.034)** | 0.110 (0.035)** | 0.117 (0.034)** | 0.118 (0.034)** |

*Table 4.4 (continue)*

| | | | | | | |
|---|---|---|---|---|---|---|
| **6. Alternative definition of control: monitoring (*N = 2,954*)** | ***Initiation*** | **Warmth** | -0.048 (0.006)*** | -0.051 (0.008)*** | -0.046 (0.006)*** | -0.052 (0.007)*** |
| | | **Monitoring** | -0.004 (0.006) | -0.005 (0.008) | 0.002 (0.007) | 0.002 (0.007) |
| | ***Depression*** | **Warmth** | -0.146 (0.017)*** | -0.157 (0.017)*** | -0.149 (0.017)*** | -0.146 (0.017)*** |
| | | **Monitoring** | 0.030 (0.018)✞ | 0.027 (0.018) | 0.030 (0.018)✞ | 0.030 (0.018)✞ |
| **7. Alternative definition of demandingness: housework duties (*N = 2,954*)** | ***Initiation*** | **Warmth** | -0.052 (0.008)*** | -0.052 (0.008)*** | -0.048 (0.006)*** | -0.054 (0.007)*** |
| | | **Demandingness** | -0.023 (0.008)** | -0.023 (0.008)** | -0.018 (0.007)** | -0.019 (0.007)** |
| | ***Depression*** | **Warmth** | -0.157 (0.017)*** | -0.157 (0.017)*** | -0.150 (0.017)*** | -0.146 (0.017)*** |
| | | **Demandingness** | 0.029 (0.018) | 0.029 (0.018) | 0.031 (0.018)✞ | 0.032 (0.018)✞ |
| **8. Inclusion of parental presence (*N = 2,950*)** | ***Initiation*** | **Warmth** | -0.047 (0.006)*** | -0.050 (0.008)*** | -0.045 (0.006)*** | -0.051 (0.007)*** |
| | | **Control** | -0.010 (0.006) | -0.024 (0.008)** | -0.013 (0.007)✞ | -0.013 (0.007)✞ |
| | | **Parental presence** | -0.012 (0.006)✞ | -0.018 (0.008)* | -0.017 (0.006)** | -0.019 (0.007)** |
| | ***Depression*** | **Warmth** | -0.146 (0.017)*** | -0.155 (0.017)*** | -0.149 (0.017)*** | -0.145 (0.017)*** |
| | | **Control** | 0.040 (0.018)* | 0.039 (0.018)* | 0.040 (0.018)* | 0.041 (0.018)* |
| | | **Parental presence** | -0.002 (0.018) | -0.004 (0.018) | -0.001 (0.018) | 0.000 (0.018) |

Notes: Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

Our next robustness checks explore alternative specifications for the control dimension. Our original variable indicates the control which parents exercise over several domains of their children's lives. However, some other studies have used alternative concepts: monitoring (knowing/controlling children's whereabouts), or a wider concept of "demandingness", which involves expectations of maturity good behaviour, and a degree of enforcement of these standards (Baumrind, 1991). Replacing the indicator of control with an indicator of monitoring based on whether adolescents are allowed to make their own decisions about (a) who they associate with, and (b) what time they come home on weekends yields coefficients of the same sign but reduced magnitude (Panel 6); the effect of monitoring on initiation becomes tiny and insignificant, while its relationship with depression is positive, but significant only at the 10% level. We also test an indicator of demandingness which includes adolescents' frequency of participation in housework. This was not included in our original indicator of control because it reduced the fit of the model. The housework indicator is negatively (albeit insignificantly) related to depression (Panel 7), suggesting that, to the extent that the demandingness dimension is negatively related to depression, this is driven by parental control. Results (not shown) using a composite indicator of demandingness which also includes housework are similar to our initial results.

The final robustness checks examine the effects of parental presence during adolescence, which may allow parents to be emotionally and physically available to adolescents and also serve as a monitoring purpose. The measurement of parental presence is discussed in Chapter 2. Results (Panel 8) show that, parental presence is negatively associated with the initiation measured in Wave 1, but not related to depression in Wave 3. This suggests that parents who are 'simply being there' may provide adolescents a sense of security that helps to prevent early initiation.

### 4.4 Discussion

Prior research has demonstrated that parenting style is associated with the risk of substance use in late adolescence and/or early adulthood (e.g. Aquilino & Supple, 2001; Barnes et al., 2000; Steinberg et al., 1994; Stone et al., 2012). This paper shows that these effects persist into the longer term: warm parenting protects against problem substance use when subjects are well into adulthood. In addition, we have highlight two pathways via which this effect could be shown to work: the age at initiation of substance use, and depression.

We use two specifications for parenting style: one which includes continuous measures of warmth and control, and a fourfold typology based on those two dimensions. In each case, the results are unequivocal: it is parental warmth, and not control, which protects against substance use problems in adulthood. In the fourfold typology, it is the authoritarian and neglectful styles which are associated with an elevated risk of later substance use; the indulgent style is not associated with an extra risk of any kind.

Our analysis of mediating pathways may shed light on heterogeneity between prior studies. Virtually all studies show that warm parenting is protective, and we show the same. However, some studies (Aquilino & Supple, 2001, and others) have found parental control to be protective against substance use in adolescence, while others (Calafat et al., 2014 and others) have not. We find that parental control *does* inhibit the initiation of substance use in adolescence (see Tables 4.2 and 4.4), but that this protective effect does not persist into adulthood; we suggest this may be due to a link between controlling parenting and depression. Thus, the effects of parental control may differ according to the age at which the outcome is measured, and may account for the range of findings in different studies.

This chapter provides important evidence that substance use problems in adulthood could be predicted from parenting styles in adolescence, and most importantly, parental warmth was found to have a greater protective effect on later substance use problems (both directly and indirectly via age at initiation and depression). Whilst previous studies have shown an overlap between a warm, responsive style of parenting style and secure attachment, and between a controlling, harsh disciplinary parenting style and insecure attachment, in childhood and adolescence (Donita & Maria, 2015), this chapter goes beyond and sheds lights into the potential life-long impact of attachment (as Bowlby emphasised- 'from cradle to grave' (Bowlby, 2005:69)). According to the attachment theory, adolescents adopt a strategy to cope with the experiences with their parents, and over time internalise these experiences to allow them to predict and control their environment (Bowlby, 1969). Such internalisation forms a set of expectations and beliefs about the self and the other that could help guide emotional experience and behaviours throughout life. In this view, an adolescent with a controlling parent may develop insecure attachment with the parent and may be at risk of developing a model of the self as unlovable and of others as unsupportive. Alternatively a securely attached adolescent whose parent is usually warm and supportive is likely to develop a positive image of one-self (e.g. self-worth, valued) and others (e.g. trustworthy) (Ainsworth & Bowlby, 1991; Bowlby, 1969). Given the association between parenting styles and

attachment type, the theory of attachment and the process of internalisation may help explain the long-term effect of parenting styles in adolescence on the propensity to depression and to substance use problems in adulthood.

Our study has several strengths. It is based on a nationally representative sample, with a considerably longer follow-up period than is typically used in studies in this area; its findings makes a novel and useful contribution to the state of knowledge. However, our study is not without its limitations. First, our measures of substance use initiation and of parenting style are collected contemporaneously. While it is reasonable to believe that parenting affects substance use, it is also likely that parenting style is itself influenced by adolescents' prior substance use. We have addressed this problem partially in the robustness checks, but we believe there is more scope for disentangling issues of timing and directionality in this relationship. We also believe there is scope for a better understanding of the control/demandingness dimension; our robustness checks suggest that an alternative definition based on adolescents' contributions at home may yield interesting results, but data including an expanded survey instrument are needed to test this. Finally, there has been evidence that individuals self-medicate for a range of mental health conditions, notably for anxiety, which is an extremely common condition (Robinson et al, 2009) but the data allow us to test only for a pathway via depression.

## 4.5 Conclusions

There is already evidence that interventions promoting effective parenting may reduce substance use in adolescence (Haggerty, McGlynn-Wright & Klima, 2013). One justification for interventions in adolescence is that teenage substance use predicts problems in adulthood; our results confirm this, and thus indicate that parenting initiatives may be protective in the longer as well as the shorter term.

However, our finding that over the longer term warmth is of much greater importance than control may have important implications for the formulation of future parenting interventions. This would be true even if substance problems in adulthood were the only outcome of concern; however, if mental health is considered as locus of concern in its own right, rather than solely as a forerunner of substance use problems, the relative importance of a parenting style high in warmth assumes an even higher importance.

The findings of this research provide evidence for prevention programs to effectively tackle adolescent substance use; this could help avoid long-term negative outcomes that often require expensive services from the state, including law enforcement and juvenile justice institutions (Haggerty, McGlynn-Wright & Klima, 2013). Similarly, social and psychiatric services can also be reduced if adolescents develop healthy mental conditions. Moreover, the effects of parenting on substance use have important implications on other aspects of children's lives, for instance, teenage pregnancy, educational achievement and later employment status, and health, which could affect their life trajectories and wellbeing and the society as a whole by lowering the morbidity and mortality rate associated with substance abuse.

**Appendix 4A Descriptive statistics for control variables for the models that estimate the relationship between parenting in adolescence and substance use problems in Wave 4 (N=2,954)**

| Variable | Range | | Mean (SD) |
|---|---|---|---|
| | Min | Max | or % |
| ***Adolescence, W1*** | | | |
| Age | 13 | 18 | 15.4 (1.62) |
| Female | 0 | 1 | 56.8 |
| White (Ref) | 0 | 1 | 67.8 |
| African American | 0 | 1 | 19.1 |
| American-Indian/ Asian/ Mixed/ Others | 0 | 1 | 13.1 |
| Intact family (Ref) | 0 | 1 | 61.9 |
| Step-parent family | 0 | 1 | 11.8 |
| Single-parent family | 0 | 1 | 26.4 |
| [Parental] Less than high school levels (Ref) | 0 | 1 | 14.3 |
| [Parental] High school graduate | 0 | 1 | 24.4 |
| [Parental] Some post-school training/college | 0 | 1 | 31.1 |
| [Parental] A bachelor's degree/Postgraduate training | 0 | 1 | 30.2 |
| Mother smoking | 0 | 1 | 47.6 |
| Mother high alcohol consumption (i.e. more than two to three days per month) | 0 | 1 | 22.4 |
| Peers' smoking behaviour (standardised) | -1.06 | 2.42 | -0.03 (0.98) |
| Peers' drinking behaviour (standardised) | -1.52 | 2.24 | 0.00 (0.99) |
| Peers' marijuana use (standardised) | -0.91 | 2.87 | -0.02 (0.98) |
| ***Adulthood, W4*** | | | |
| Age | 25 | 32 | 28.2 (1.68) |
| Less than high school (Ref) | 0 | 1 | 6.09 |
| High school graduate | 0 | 1 | 13.7 |
| Some post-school training/college | 0 | 1 | 43.1 |
| A bachelor's degree/Postgraduate training | 0 | 1 | 37.1 |
| Married (Ref) | 0 | 1 | 40.8 |
| Cohabitation | 0 | 1 | 18.0 |
| Single/separated | 0 | 1 | 41.2 |
| Presence of child(ren) | 0 | 1 | 44.9 |
| Employment status | 0 | 1 | 66.3 |
| Religiosity (standardised) | -1.73 | 2.19 | 0.00 (1.01) |
| Whether smoked at W4 | 0 | 1 | 43.7 |
| Whether used alcohol at W4 | 0 | 1 | 81.3 |
| Whether used marijuana at W4 | 0 | 1 | 54.6 |
| Whether used other illicit drug at W4 | 0 | 1 | 28.4 |

Note: All variable measurements and scales can be found in Table 2.2.

**Appendix 4B OLS regression of the relationship between the two-dimensional parenting styles in adolescence (Wave 1) and substance use problems in adulthood (Wave 4) (N=2,954)**

| | **Smoking** | | **Drinking problems** | | **Marijuana problems** | | **Illicit drug problems** | |
|---|---|---|---|---|---|---|---|---|
| | Coef | (SE) | Coef | (SE) | Coef | (SE) | Coef | (SE) |
| ***Parenting styles, W1*** | | | | | | | | |
| Maternal warmth | 0.016 | (0.102) | -0.038 | (0.017)* | -0.044 | (0.018)* | -0.046 | (0.018)** |
| Parental control | 0.037 | (0.104) | -0.014 | (0.018) | 0.003 | (0.019) | -0.006 | (0.018) |
| ***Control variables, W1*** | | | | | | | | |
| Age | -0.143 | (0.064)* | -0.047 | (0.011)*** | -0.047 | (0.012)*** | -0.033 | (0.011)** |
| Female | -1.244 | (0.214)*** | -0.229 | (0.037)*** | -0.236 | (0.038)*** | -0.057 | (0.038) |
| African-American[1] | -1.289 | (0.290)*** | -0.388 | (0.049)*** | -0.157 | (0.051)** | -0.295 | (0.050)*** |
| American Indian/Asian/Mixed/Others | -1.754 | (0.307)*** | -0.100 | (0.053)✞ | 0.023 | (0.055) | -0.058 | (0.054) |
| Step-family[2] | -0.062 | (0.322) | -0.065 | (0.055) | 0.005 | (0.058) | -0.037 | (0.057) |
| Single-parent family | -0.042 | (0.246) | -0.001 | (0.042) | 0.022 | (0.044) | -0.038 | (0.043) |
| [Parental] High school graduate[3] | 0.192 | (0.338) | 0.095 | (0.058) | 0.101 | (0.060)✞ | 0.023 | (0.059) |
| [Parental] Some post-school training/college | -0.463 | (0.331) | 0.163 | (0.057)** | 0.156 | (0.059)** | 0.103 | (0.058)✞ |
| [Parental] A bachelor's degree/Postgraduate training | -0.527 | (0.353) | 0.164 | (0.061)** | 0.234 | (0.063)*** | 0.147 | (0.062)* |
| Maternal substance use | 0.512 | (0.209)* | 0.170 | (0.042)*** | 0.040 | (0.037) | 0.067 | (0.037) |
| Peer substance use | 0.591 | (0.120)*** | 0.059 | (0.020)** | 0.063 | (0.022)** | 0.043 | (0.021)* |
| Age at Initiation (defined as whether respondents had used the substance in the past 30 days) | 3.614 | (0.305)*** | 0.295 | (0.042)*** | 0.257 | (0.052)*** | 0.263 | (0.048)*** |
| ***Control variables, W3*** | | | | | | | | |
| Depression | 0.175 | (0.108) | 0.051 | (0.019)** | 0.110 | (0.019)*** | 0.068 | (0.019)*** |
| ***Control variables, W4*** | | | | | | | | |
| High school graduate[4] | -2.883 | (0.490)*** | 0.099 | (0.084) | -0.142 | (0.088) | -0.080 | (0.086) |
| Some post-school training/college | -3.133 | (0.449)*** | 0.199 | (0.077)** | -0.049 | (0.080) | -0.095 | (0.078) |
| A bachelor's degree/Postgraduate training | -4.978 | (0.489)*** | 0.164 | (0.082)* | -0.155 | (0.086)✞ | -0.277 | (0.084)** |
| Employment status | -0.161 | (0.212) | 0.046 | (0.036) | 0.032 | (0.038) | 0.109 | (0.037)** |
| Cohabitation[5] | 0.605 | (0.301)* | 0.120 | (0.052)* | 0.166 | (0.054)** | 0.091 | (0.053)✞ |
| Single/ separated | 0.646 | (0.258)* | 0.130 | (0.044)** | 0.110 | (0.046)* | 0.183 | (0.045)*** |
| Presence of child(ren) | -0.281 | (0.244) | -0.102 | (0.042)* | -0.045 | (0.044) | 0.045 | (0.043) |
| Religiosity | -0.308 | (0.109)** | -0.067 | (0.019)*** | -0.009 | (0.020) | 0.009 | (0.019) |
| **Constant** | **9.333** | **(1.119)*** ** | **0.438** | **(0.193)*** | **0.676** | **(0.202)*** ** | **0.393** | **(0.197)*** |
| **R-squared** | **0.228** | | **0.133** | | **0.082** | | **0.080** | |

Notes: Reference category: [1]White; [2]Intact family; [3][Parental] Less than high school levels; [4]Less than high school levels; [5]Married. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Appendix 4C OLS regression of the relationship between the four-fold parenting styles in adolescence (Wave 1) and substance use problems in adulthood (Wave 4) (N=2,954)**

| | **Smoking** | | **Drinking problems** | | **Marijuana problems** | | **Illicit drug problems** | |
|---|---|---|---|---|---|---|---|---|
| | Coef | (SE) | Coef | (SE) | Coef | (SE) | Coef | (SE) |
| ***Parenting styles, W1*** | | | | | | | | |
| Indulgent[1] | -0.001 | (0.283) | 0.017 | (0.049) | 0.006 | (0.051) | 0.006 | (0.050) |
| Authoritarian | 0.158 | (0.285) | 0.062 | (0.049) | 0.049 | (0.051) | 0.079 | (0.050) |
| Neglectful | 0.002 | (0.288) | 0.115 | (0.050)* | 0.079 | (0.052) | 0.072 | (0.051) |
| ***Control variables, W1*** | | | | | | | | |
| Age | -0.143 | (0.064)* | -0.047 | (0.011)*** | -0.047 | (0.012)*** | -0.033 | (0.011)** |
| Female | -1.241 | (0.214)*** | -0.226 | (0.037)*** | -0.234 | (0.038)*** | -0.054 | (0.038) |
| African-American[2] | -1.285 | (0.290)*** | -0.387 | (0.049)*** | -0.155 | (0.051)** | -0.295 | (0.050)*** |
| American Indian/Asian/Mixed/Others | -1.757 | (0.307)*** | -0.097 | (0.053)✞ | 0.026 | (0.055) | -0.057 | (0.054) |
| Step-family[3] | -0.063 | (0.322) | -0.062 | (0.055) | 0.009 | (0.058) | -0.033 | (0.057) |
| Single-parent family | -0.041 | (0.246) | 0.002 | (0.042) | 0.024 | (0.044) | -0.034 | (0.043) |
| [Parental] High school graduate[4] | 0.187 | (0.338) | 0.095 | (0.058) | 0.100 | (0.060)✞ | 0.022 | (0.059) |
| [Parental] Some post-school training/college | -0.466 | (0.331) | 0.164 | (0.057)** | 0.155 | (0.059)** | 0.103 | (0.058)✞ |
| [Parental] A bachelor's degree/Postgraduate training | -0.526 | (0.353) | 0.165 | (0.061)** | 0.232 | (0.063)*** | 0.147 | (0.062)* |
| Maternal substance use | 0.507 | (0.209)* | 0.167 | (0.042)*** | 0.039 | (0.037) | 0.067 | (0.037)✞ |
| Peer substance use | 0.591 | (0.120)*** | 0.060 | (0.020)** | 0.064 | (0.022)** | 0.045 | (0.021)* |
| Age at Initiation (defined as whether respondents had used the substance in the past 30 days) | 3.599 | (0.303)*** | 0.297 | (0.042)*** | 0.264 | (0.052)*** | 0.271 | (0.048)*** |
| ***Control variables, W3*** | | | | | | | | |
| Depression | 0.167 | (0.108) | 0.053 | (0.019)** | 0.114 | (0.019)*** | 0.070 | (0.019)*** |
| ***Control variables, W4*** | | | | | | | | |
| High school graduate[5] | -2.899 | (0.491)*** | 0.097 | (0.084) | -0.143 | (0.088) | -0.083 | (0.086) |
| Some post-school training/college | -3.141 | (0.449)*** | 0.199 | (0.077)** | -0.050 | (0.080) | -0.094 | (0.078) |
| A bachelor's degree/Postgraduate training | -4.989 | (0.488)*** | 0.163 | (0.082)* | -0.159 | (0.086)✞ | -0.276 | (0.084)** |
| Employment status | -0.161 | (0.212) | 0.048 | (0.036) | 0.033 | (0.038) | 0.111 | (0.037)** |
| Cohabitation[6] | 0.602 | (0.302)* | 0.120 | (0.052)* | 0.165 | (0.054)** | 0.090 | (0.053)✞ |
| Single/ separated | 0.638 | (0.258)* | 0.131 | (0.044)** | 0.112 | (0.046)* | 0.184 | (0.045)*** |
| Presence of child(ren) | -0.284 | (0.244) | -0.103 | (0.042)* | -0.045 | (0.044) | 0.046 | (0.043) |
| Religiosity | -0.303 | (0.109)** | -0.068 | (0.019)*** | -0.009 | (0.019) | 0.008 | (0.019) |
| **Constant** | **9.314** | **(1.126)*** ** | **0.385** | **(0.195)*** | **0.645** | **(0.204)**** | **0.350** | **(0.198)✞** |
| **R-squared** | **0.228** | | **0.133** | | **0.080** | | **0.071** | |

Notes: Reference category: [1]Authoritative; [2]White; [3]Intact family; [4][Parental] Less than high school levels; [5]Less than high school levels; [6]Married. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with p < 0.1 denoted by ✞.

# Chapter 5
# The long-term effects of parental behaviours in adolescence on cigarette, alcohol and drug cessation in adulthood

## 5.1 Introduction

To prevent the adverse effects of substance use and misuse on health and society as a whole, two particular time-points are a key component in public health policy: age at initiation and cessation. Previous studies have provided convincing evidence for the relationship between early initiation and later disorders (Dawson et al., 2008; DeWit et al., 2000; Flory et al., 2004; Grant, Stinson & Harford, 2001; Hingson, Heeren & Winter, 2006; King & Chassin, 2007; McGue et al., 2001; Tucker et al., 2005). For example, Dawson et al. (2008) used data from the National Epidemiologic Survey on Alcohol and Related Conditions in the US and found that, individuals who initiated alcohol consumption under the age of 18 were three times more likely to develop dependency and continue drinking, despite physical or psychological problems. In the literature on the factors of early age at initiation, the relative importance of parent-adolescent relationships has been subject to considerable discussion (Fleming et al., 2002; Hill et al., 2005; Longmore, Manning & Giordano, 2001- for sexual initiation; Roche, Ahmed & Blum, 2008- for sexual initiation).

While delaying age at initiation or never starting to use substances is the optimal option, substance use cessation has been found to result in significant improvement in health when compared with the health of those who continue using substances (Doll, 2004; Holmes et al., 2016; Tillmann & Silcock, 1997; Volkow et al., 2014). For instance, Tillmann and Silcock (1997) compared a group of current smokers to a group of ex-smokers and found that the latter had better respiratory symptoms and health-related quality of life. Doll, Peto and Boreham (2004) found that smokers who quitted tobacco use before the age of 35 had similar life expectancy when compared to individuals who had never smoked. Holmes et al. (2016) showed that alcohol users lost on average one to two years of life if they drank 5.6 units or more per day when compared to non-drinkers. If alcohol users consumed 5.6 units or more across their life course, they would lose approximately 24 years of life. A review by Volkow et al. (2014) suggested that long-term marijuana use was associated with symptoms of chronic bronchitis. Despite evidence showing health improvement with early age of cessation, recent

research suggested that most substance users quitted after age 35; the age when the adverse health consequences may start to become inevitable and irreversible.

There is evidence that parenting and family relationships influence the rates of substance use cessation, although most studies have only focused on adolescence. A cross-sectional study by O'Byrne, Haddock, and Poston (2002) showed that adolescents who were more ready to quit smoking and those who had had at least one successful attempt at quitting for 24 hours had parents with high authoritative parenting style scores (combination scores of family intimacy and autonomy). In a one-year follow-up study, Chassin, Presson and Sherman (1984) found a positive relationship between perceived parental support and cigarette cessation among young adolescents. There is, however, evidence that family relationships have no effect on later cessation in adolescence (Little et al., 2013; Sussman et al., 1998; Sussman & Dent, 2004). A possible explanation is that many adolescents who use substances do so for experimental purposes and are considered as relatively normal (Baumrind, 1991; Englund et al., 2013; Shedler & Block, 1990; Steinberg & Morris, 2001). In most cases, experimental use is harmless; experimenters tend to be more cautious about the substances they take and how much they will take and may self-initiate substance use cessation. Given that substance use during adolescence is transitory in nature, it is reasonable to assume that the effect of family relationships on cessation in adolescence may be fairly modest.

Longitudinal studies on substance use trajectories across adolescence to adulthood have demonstrated that the levels of substance use increase during adolescent years, peak in late adolescence to early/middle 20s (the so-called 'emerging adulthood'), and then decline thereafter (Chen & Jacobson, 2012; Park et al., 2017; Schulenberg et al., 2017). One theory is that the transition to adulthood involves important role changes and responsibilities, such as employment, relationships, and parenthood (Arnett, 2000; Bachman et al., 2002), which naturally motivate many young adults to stop using substances (except for alcohol) (Bachman et al., 2002; Schulenberg et al., 2017). However, not every substance user ceases using substances and dangers may arise when adolescents carry on using them in young adulthood.

In more recent short-panel studies, it has been suggested that family relationships in adolescence may have some influences on the probability of substance use cessation in early adulthood, although results are mixed. Pollard et al. (2014) showed that low parental control was associated with a 43% lower odds of quitting marijuana use six years later. However, they did not find any significant relationships between closeness to mother and the probability of

quitting. Smith, Cleeland and Dennis (2010) investigated the reasons for quitting substances among adolescents and emerging adults and found that emerging adults had less interpersonal motivation to cease using substances, which was partially explained by the number of days in conflict with family. In contrast, Mistry et al. (2015) found no effects of family conflict and parental support on later alcohol, tobacco, and marijuana cessation. Given that parent-adolescent relationships are a key determinant on adolescent substance use and young adult substance use problems (as discussed in Chapter 4), it would be interesting to examine the role of parent-adolescent relationships on cessation when the 'natural' cessation relating to the transition to adulthood did not occur.

This chapter has two main objectives: (1) to identify the trend and pattern of each of the substance amongst young people in the US; and (2) to explore the effect of parent-adolescent relationships on substance use cessation in adulthood in a longer time frame. This investigation will help enhance our understanding of the trajectory (from the peak use to non-use) of each substance and whether and which (if any) parental behaviours affect the probability of substance use cessation later in life. One innovation of this research is that a set of adult socio-demographic variables is considered when estimating the effects of parental behaviours. This means that any of the effects found in regressions would be independent of these important factors. The findings of this study should, therefore, make an interesting contribution to the field of parent-adolescent relationships and substance use trajectories.

In the empirical analysis for this chapter, the term 'cessation' is interchangeable with the terms 'non-use' and 'discontinuity'. All refer to absence of substance use in the past month at Wave 4 among respondents who reported having used the substance in the past month at Wave 3.

## 5.2 Methodology

Add Health Waves 1, 3 and 4 data are used for the analysis. The sample for this analysis consists of individuals who in Wave 3 reported recent use (i.e. use in the past 30 days) of (a) cigarettes, (b) alcohol, (c) marijuana, or (d) any illicit drug (including cocaine, crystal meth, marijuana and other types of illegal drugs). A detailed flowchart showing the derivation of the analytical sample is outlined in Diagram 2.3: respondents are included if they took part at Waves 1, 3 and 4, had reported recent substance use at Wave 3, had data on substance use at Wave 4, and had information on parental behaviours at Wave 1. The sample sizes vary

across the four substances due to the different number of respondents who reported recent use at Wave 3 (being highest for recent use of alcohol and lowest for recent use of marijuana).

Four outcomes variables indicating the absence of substance use (i.e. cigarette, alcohol, marijuana, or any illicit drugs) at Wave 4 are generated when respondents reported no substance use in the past 30 days. Given that the analysis in this chapter is restricted to respondents who reported having used the substance in the past month at Wave 3, the 'non-use' category at Wave 4 can be viewed as demonstrating a change in use level from Wave 3 to Wave 4 (i.e. from substance users to substance non-users).

Two parenting style measures are used as the independent variables of interest: parental warmth (mothers: derived from 7 items, $\alpha$=0.85; fathers: derived from 5 items $\alpha$=0.89[11]) and parental control (7 items, $\alpha$=0.62). Parental presence is also considered since it has been shown to have a long-term, protective effect on substance use problems in adulthood (see the robustness checks in Chapter 4). The scale is computed additively, indicating how often parents (mothers and/or fathers) were at home when adolescents left for school, returned from school, and went to bed. All parent-adolescent relationships scales are standardised to have a mean of 0 and a standard deviation of 1. The correlation between the indicators (all three) is low for both mothers and fathers ($r<0.16$). The correlation of reported warmth between fathers and mothers is moderate ($r= 0.48$), whereas the correlation of paternal and maternal presence is low ($r=0.16$). Parental control is not asked separately for mothers and fathers in the survey.

In the analysis, the following variables measured in Wave 1 are controlled: age, gender, ethnicity, family composition, parental employment activities, and parents' cigarette use and high alcohol consumption. The models also control for a depression index measured in Wave 3 (12 items, $\alpha$=0.82), and other variables measured in Wave 4: educational level, employment status, marital status (married/not married), presence of child(ren) and religiosity (5 items, $\alpha$=0.83). Additionally, a binary variable that indicates whether respondents' initiation of substance use had occurred by age 16 is included in the analysis. All measurement items and scales can be found in Chapter 2.

### *5.2.1 Analysis*

To test the association between parent-adolescent relationships and substance use cessation in adulthood, nested logistic regression models are conducted in Stata15 using the

[11] Some questions that measured paternal warmth are asked of fathers. Details can be found in Chapter 2.

*nestreg* command. One feature of nested models is that they build the regression model one block at a time and compare different blocks of predictors (Acock, 2014). In the analysis, there are five blocks in total. The three parent-adolescent relationships dimensions are included as a first block. A second block consists of a set of control variables measured in Wave 1: adolescent age, sex, ethnicity, household type, parental employment activities and parents' cigarette/alcohol use. A third block includes initial substance use at age 16 or below. A fourth block consists of the depression index measured in Wave 3. A final block includes measures collected in the Wave 4 survey. Each model presents results in odds ratios. An odds ratio that is greater than one indicates that an outcome is likely to occur and an odds ratio that is less than one denotes an outcome is less likely to occur. An odds ratio of one means there is no effect of an independent variable on an outcome (Menard, 2002). Likelihood-ratio tests and Wald tests are used to compare model specifications.

Multiple regression models are run separately for the relationships with mothers and fathers; maternal and paternal cigarette and alcohol use are also included in the models individually. Listwise deletion is applied.

## 5.3 Results

### *5.3.1 Descriptive statistics*

Tables 5.1a-5.1d provide descriptive statistics for respondents who reported recent use of cigarettes, alcohol, marijuana or any illicit drugs (including marijuana) in Wave 3. Please note that these tables only represent the models that estimate the effects of maternal-youth relationships in Wave 1; only mothers' characteristics are demonstrated in the tables.

*Cigarettes*

Amongst respondents who reported of having used cigarette(s) in the past 30 days in the Wave 3 interview, 51 per cent of them are female, 77 per cent are white, 57 per cent come from an intact family, and 31 per cent have parents with managerial or professional employment. On average, 58 per cent of the respondents have mothers who used cigarettes at Wave 1 and 57 per cent of them initiated their first cigarette use at the age of 16 or below. Moreover, in this sample, 23 per cent of them hold a degree-level or above education qualification. Nearly 70% of them are employed and half of the sample are married and have at least one child. Finally, 25% of them stop smoking by the Wave 4 interview.

*Alcohol*

For respondents who reported of recent alcohol use at the Wave 3 interview, the demography of this sample is similar to those who reported of recent cigarette use. However, in this sample, 43 per cent have mothers who used alcohol more than two to three days per month (the proportion is lower than those who reported of having used cigarette(s) at Wave 3 and also having mothers who smoked at Wave 1). Nearly 40 per cent of them hold a degree-level or above educational qualification, which is doubled compared to those who reported of recent cigarette use. Moreover, amongst those who used alcohol, only 17% of them reported non-use at the Wave 4 interview.

*Marijuana and any drug use*

In relation to respondents who reported recent marijuana use or any drug use in the past 30 days, 45 per cent of them are female, 71 per cent are white, 58 per cent come from an intact family, and 48 per cent have parents with managerial or professional employment. Similar to the characteristics of those who reported recent cigarette use, 56 per cent of the respondents have mothers who used cigarettes and 57 per cent of them initiated their first cigarette use at the age of 16 or below. On average, around 32 per cent hold a degree-level or above education qualification. Nearly 70% of them are employed, half of the sample are married, and more than a third of them have at least one child. In comparison to other substance users, more than 50% of the drug users (including marijuana or other illicit drugs) reported non-use at the Wave 4 interview.

These descriptive statistics show that the characteristic and demographical background differ between substance users, in which alcohol and drug users tend to have a higher educational level, parents' employment status is also higher among alcohol/drug users. Drug users are less likely to have children by the Wave 4 interview. Alcohol users at Wave 3 are the least likely to report not having used the substance in the past months in Wave 4, whereas drug users at Wave 3 are the most likely to report having stopped using the substance. The descriptive analysis of the models that estimate the effects of paternal-youth relationships are shown in Appendix 5A.1-5A.4. The statistics are nearly identical across the mother and father models. One exception is that the father models contain more fathers who smoked and fewer respondents who come from single-parent families.

**Table 5.1a Descriptive statistics for respondents who reported recent cigarette use (in the past 30 days) at the Wave 3 interview (N=1,159)**

| Variable | Range of Values Min | Max | Mean (SD) or % |
|---|---|---|---|
| **Outcome variable, Wave 4** | | | |
| Cigarette cessation (absence of use in the past 30 days) | 0 | 1 | 24.8 |
| **Variables of interest, Wave 1** | | | |
| Maternal warmth (standardised) | -4.82 | 1.36 | -0.14 (1.08) |
| Parental control (both parents; standardised) | -2.00 | 4.06 | -0.05 (0.92) |
| Maternal presence (standardised) | -3.85 | 1.20 | -0.10 (1.03) |
| **Control variables, Wave 1** | | | |
| Age | 13 | 18 | 15.4 (1.62) |
| Female | 0 | 1 | 51.3 |
| White | 0 | 1 | 77.0 |
| African-American | 0 | 1 | 11.7 |
| American-Indian/Asian/Mixed/Others | 0 | 1 | 11.4 |
| Intact family | 0 | 1 | 57.2 |
| Step-parent family | 0 | 1 | 14.7 |
| Single-parent family | 0 | 1 | 28.1 |
| [Parent]Not in employment | 0 | 1 | 7.33 |
| [Parent]Elementary/construction/military | 0 | 1 | 48.1 |
| [Parent]Office worker/service/sale | 0 | 1 | 14.0 |
| [Parent]Manager/technician/nurse/professional | 0 | 1 | 30.6 |
| Mother smokes | 0 | 1 | 58.0 |
| First cigarette use at age 16 or below | 0 | 1 | 57.4 |
| **Control variables, Wave 3** | | | |
| Depression (standardised) | -1.35 | 5.32 | 0.11 (1.05) |
| **Control variables, Wave 4** | | | |
| High school graduate or below | 0 | 1 | 29.7 |
| Completed a GED/vocational school | 0 | 1 | 47.7 |
| A bachelor's degree | 0 | 1 | 16.7 |
| Above degree | 0 | 1 | 5.87 |
| Employment status | 0 | 1 | 67.7 |
| Married | 0 | 1 | 56.9 |
| Presence of child(ren) | 0 | 1 | 45.2 |
| Religiosity (standardised) | -1.58 | 2.19 | -0.27 (0.91) |

Notes: This table represents the model estimating the effects of maternal-youth relationships in Wave 1 on cigarette cessation in Wave 4. More detail in variable measurements and scales can be found in Chapter 2.

**Table 5.1b Descriptive statistics for respondents who reported recent alcohol use (in the past 30 days) at the Wave 3 interview (N=2,392)**

| Variable | Range of Values Min | Max | Mean (SD) or % |
|---|---|---|---|
| **Outcome variable, Wave 4** | | | |
| Alcohol cessation (absence of use in the past 30 days) | 0 | 1 | 16.8 |
| **Variables of interest, Wave 1** | | | |
| Maternal warmth (standardised) | -4.97 | 1.38 | -0.02 (1.02) |
| Parental control (both parents; standardised) | -2.02 | 3.84 | -0.07 (0.93) |
| Maternal presence (standardised) | -3.85 | 1.20 | -0.06 (0.99) |
| **Control variables, Wave 1** | | | |
| Age | 13 | 18 | 15.4 (1.61) |
| Female | 0 | 1 | 54.3 |
| White | 0 | 1 | 71.8 |
| African-American | 0 | 1 | 15.6 |
| American-Indian/Asian/Mixed/Others | 0 | 1 | 12.6 |
| Intact family | 0 | 1 | 63.8 |
| Step-parent family | 0 | 1 | 11.8 |
| Single-parent family | 0 | 1 | 24.4 |
| [Parent]Not in employment | 0 | 1 | 5.31 |
| [Parent]Elementary/construction/military | 0 | 1 | 45.3 |
| [Parent]Office worker/service/sale | 0 | 1 | 13.7 |
| [Parent]Manager/technician/nurse/professional | 0 | 1 | 35.7 |
| Mother's high alcohol use (i.e. more than two to three days per month) | 0 | 1 | 42.9 |
| First alcohol use at age 16 or below | 0 | 1 | 55.8 |
| **Control variables, Wave 3** | | | |
| Depression (standardised) | -1.35 | 4.92 | -0.03 (0.95) |
| **Control variables, Wave 4** | | | |
| High school graduate or below | 0 | 1 | 17.3 |
| Completed a GED/vocational school | 0 | 1 | 42.1 |
| A bachelor's degree | 0 | 1 | 24.9 |
| Above degree | 0 | 1 | 15.7 |
| Employment status | 0 | 1 | 68.4 |
| Married | 0 | 1 | 59.4 |
| Presence of child(ren) | 0 | 1 | 42.1 |
| Religiosity (standardised) | -1.73 | 2.19 | -0.12 (0.98) |

Notes: This table represents the model estimating the effects of maternal-youth relationships in Wave 1 on alcohol cessation in Wave 4. More detail in variable measurements and scales can be found in Chapter 2.

**Table 5.1c Descriptive statistics for respondents who reported recent marijuana use (in the past 30 days) at the Wave 3 interview (N=795)**

| Variable | Range of Values Min | Max | Mean (SD) or % |
|---|---|---|---|
| **Outcome variable, Wave 4** | | | |
| Marijuana cessation (absence of use in the past 30 days) | 0 | 1 | 55.2 |
| **Variables of interest, Wave 1** | | | |
| Maternal warmth (standardised) | -4.97 | 1.36 | -0.21 (1.11) |
| Parental control (both parents; standardised) | -1.90 | 4.06 | -0.06 (0.95) |
| Maternal presence (standardised) | -3.85 | 1.20 | -0.12 (1.01) |
| **Control variables, Wave 1** | | | |
| Age | 13 | 18 | 15.2 (1.63) |
| Female | 0 | 1 | 44.9 |
| White | 0 | 1 | 70.7 |
| African-American | 0 | 1 | 17.0 |
| American-Indian/Asian/Mixed/Others | 0 | 1 | 12.3 |
| Intact family | 0 | 1 | 58.2 |
| Step-parent family | 0 | 1 | 13.0 |
| Single-parent family | 0 | 1 | 28.8 |
| [Parent]Not in employment | 0 | 1 | 7.67 |
| [Parent]Elementary/construction/military | 0 | 1 | 44.4 |
| [Parent]Office worker/service/sale | 0 | 1 | 14.0 |
| [Parent]Manager/technician/nurse/professional | 0 | 1 | 34.0 |
| Mother smokes | 0 | 1 | 55.8 |
| First marijuana use at age 16 or below | 0 | 1 | 56.9 |
| **Control variables, Wave 3** | | | |
| Depression (standardised) | -1.35 | 4.92 | 0.13 (1.03) |
| **Control variables, Wave 4** | | | |
| High school graduate or below | 0 | 1 | 25.7 |
| Completed a GED/vocational school | 0 | 1 | 42.6 |
| A bachelor's degree | 0 | 1 | 23.3 |
| Above degree | 0 | 1 | 8.43 |
| Employment status | 0 | 1 | 70.4 |
| Married | 0 | 1 | 51.2 |
| Presence of child(ren) | 0 | 1 | 35.3 |
| Religiosity (standardised) | -1.58 | 2.19 | -0.33 (0.91) |

Notes: This table represents the model estimating the effects of maternal-youth relationships in Wave 1 on marijuana cessation in Wave 4. More detail in variable measurements and scales can be found in Chapter 2.

**Table 5.1d Descriptive statistics for respondents who reported recent use of any illicit drug (including marijuana) (in the past 30 days) at the Wave 3 interview (N=822)**

| Variable | Range of Values Min | Max | Mean (SD) or % |
|---|---|---|---|
| **Outcome variable, Wave 4** | | | |
| Any illicit drug cessation (absence of use in the past 30 days) | 0 | 1 | 52.1 |
| **Variables of interest, Wave 1** | | | |
| Maternal warmth (standardised) | -4.97 | 1.36 | -0.20 (1.11) |
| Parental control (both parents; standardised) | -1.90 | 4.06 | -0.07 (0.95) |
| Maternal presence (standardised) | -3.85 | 1.20 | -0.13 (1.02) |
| **Control variables, Wave 1** | | | |
| Age | 13 | 18 | 15.2 (1.64) |
| Female | 0 | 1 | 45.0 |
| White | 0 | 1 | 71.1 |
| African-American | 0 | 1 | 16.6 |
| American-Indian/Asian/Mixed/Others | 0 | 1 | 12.4 |
| Intact family | 0 | 1 | 57.9 |
| Step-parent family | 0 | 1 | 13.3 |
| Single-parent family | 0 | 1 | 28.8 |
| [Parent]Not in employment | 0 | 1 | 7.54 |
| [Parent]Elementary/construction/military | 0 | 1 | 44.4 |
| [Parent]Office worker/service/sale | 0 | 1 | 13.8 |
| [Parent]Manager/technician/nurse/professional | 0 | 1 | 34.3 |
| Mother smokes | 0 | 1 | 55.1 |
| First any illicit drug use at age 16 or below | 0 | 1 | 60.6 |
| **Control variables, Wave 3** | | | |
| Depression (standardised) | -1.35 | 4.92 | 0.13 (1.02) |
| **Control variables, Wave 4** | | | |
| High school graduate or below | 0 | 1 | 25.6 |
| Completed a GED/vocational school | 0 | 1 | 42.6 |
| A bachelor's degree | 0 | 1 | 23.5 |
| Above degree | 0 | 1 | 8.39 |
| Employment status | 0 | 1 | 70.1 |
| Married | 0 | 1 | 51.3 |
| Presence of child(ren) | 0 | 1 | 35.3 |
| Religiosity (standardised) | -1.58 | 2.19 | -0.34 (0.90) |

Notes: This table represents the model estimating the effects of maternal-youth relationships in Wave 1 on any illicit drug cessation in Wave 4. More detail in variable measurements and scales can be found in Chapter 2.

### *5.3.2 The transition of substance use frequency between Wave 3 and Wave 4 by row percentages*

**Table 5.2a Cross-tabulation of cigarette use in the past 30 days between Wave 3 and Wave 4 (in %; N=3,536)**

| *W3* \ *W4* | Not at all | 1-9 cigs per day | 10-19 cigs per day | 20+ cigs per day |
|---|---|---|---|---|
| **Not at all** | 84.91 | 11.23 | 2.26 | 1.59 |
| **1-9 cigs per day** | 32.19 | 46.82 | 15.49 | 5.51 |
| **10-19 cigs per day** | 21.77 | 27.21 | 35.37 | 15.65 |
| **20+ cigs per day** | 12.36 | 13.45 | 26.91 | 47.27 |
| **All** | **65.36** | **18.58** | **9.11** | **6.96** |

**Table 5.2b Cross-tabulation of alcohol use in the past 30 days between Wave 3 and Wave 4 (in %; N=3,210)**

| *W3* \ *W4* | Not at all | 1-1.5 drinks per day | 1.6-2.6 drinks per day | 2.6+ drinks per day |
|---|---|---|---|---|
| **Not at all** | 56.61 | 39.06 | 1.80 | 2.52 |
| **1-1.5 drinks per day** | 17.93 | 73.77 | 4.87 | 3.43 |
| **1.6-2 drinks per day** | 7.29 | 63.02 | 16.67 | 13.02 |
| **3+ drinks per day** | 14.45 | 47.40 | 14.45 | 23.70 |
| **All** | **27.13** | **62.71** | **5.30** | **4.86** |

**Table 5.2c Cross-tabulation of marijuana use in the past 30 days between Wave 3 and Wave 4 (in %; N=3,600)**

| *W3* \ *W4* | Not at all | 1-2 days per month | 3-5 days per month | Every day/almost every day |
|---|---|---|---|---|
| **Not at all** | 93.90 | 2.82 | 1.82 | 1.46 |
| **1-8 times per month** | 69.56 | 13.82 | 8.67 | 7.96 |
| **9-26 times per month** | 41.71 | 19.25 | 21.93 | 17.11 |
| **27+ times** | 35.36 | 14.92 | 18.23 | 31.49 |
| **All** | **85.36** | **5.58** | **4.50** | **4.56** |

Notes: The content of the Add Health questionnaires regarding the key substance use measures across waves was revised to be more relevant to different age periods. Questions on marijuana use asked in Waves 1-3 are slightly different from the questions asked in Wave 4. The number of *times* respondents had used the substance in the past 30 days is asked in Waves 1-3, and the number of *days* respondents had used the substance in the past month is asked in Wave 4.

Tables 5.2a-5.2c report the cross-tabulation of cigarette, alcohol, marijuana in the past 30 days between Wave 3 and Wave 4[12]; the cross-tabulation of any illicit drug use between the waves is shown in Appendix 5B as it is very similar to the table reporting the transition of marijuana use. The tables show that the majority of the respondents (around 65%-85%) reported no recent use of cigarettes or marijuana. Less than one-third of the respondents reported absence of alcohol use in Wave 4; many participants used light-moderate alcohol (63% had around 1-1.5 drinks per day)[13]. While more than 85 per cent of the respondents did not use cigarettes or drugs in both waves, just over half of the sample abstained from alcohol. The unique alcohol-use pattern is consistent with a national report that used data from the Monitoring the Future data set and showed that alcohol use was the most commonly used substance in the US (Schulenberg et al., 2017). Furthermore, the tables show an inverse correlation between the levels of substance use in the Wave 3 interview and absence of use by Wave 4, except for alcohol. For respondents who reported having smoked 20 or more cigarettes per day, around 12 per cent of them had stopped smoking, compared to 22 per cent of respondents who smoked 10 or more cigarettes per day. For respondents who reported having used marijuana 27 times or above in the past month, 35 per cent of them had ceased using it, compared to 42 per cent of the respondents who used marijuana nine to 26 times per day. Alcohol consumption between Waves 3 and 4 shows a different pattern. While light drinkers are most likely to have stopped using alcohol, moderate users (those who consumed 1.6-2 drinks per day) appear to be less likely than heavy users (those who consumed three or more drinks per day) to have ceased using alcohol by Wave 4. Although it has been suggested that low-risk alcohol consumption may have some health benefits (Saleem & Basha, 2010), more recent studies have found a positive correlation between light drinking (around one drink per day) and an increased risk of cancer and adverse brain outcomes (Bagnardi et al., 2013; Choi, Myung & Lee, 2017; Topiwala et al., 2017). Thus it is important to explore the determinants of substance use cessation, even for the light alcohol users.

[12] Please note that the content of the Add Health questionnaires regarding the key substance use measures between Waves 3 and 4 is revised to be more relevant to different age periods. Questions on marijuana and any illicit drug use asked in Wave 3 are slightly different from questions asked in Wave 4; the number of times in the past 30 days is asked in Wave 3, and the number of days in the past month is asked in Wave 4.

[13] One drink per day for women and two drinks per day for men are considered as moderate drinking. The definition of light and moderate alcohol consumption is based on the Dietary Guidelines 2015-2020 provided by the US Department of Health and Human Services and US Department of Agriculture. 2015-2020 Dietary Guidelines for Americans. 8th Edition. December 2015. Available at https://health.gov/dietaryguidelines/2015/.

### *5.3.3 Parent-adolescent relationships and substance use cessation in adulthood*

Tables 5.3a-5.3d present results from logistic regression models estimating the probability that an individual using a substance in Wave 3 would cease use by Wave 4; these models examine the effects of maternal-adolescent relationships.

In contrast to the previous literature that shows an association between parent-adolescent relationships and later substance use cessation (Pollard et al., 2014; Smith, Cleeland & Dennis, 2010), no effects of maternal warmth and control are found in this study. Interestingly, there is a significant and positive association between maternal presence and the probability of substance use cessation in adulthood (except for alcohol). After controlling for the covariates, the tables show that, for every unit increase in maternal presence, there is about a 16 per cent, 32 per cent, and 27 per cent increase in the odds of cigarette, marijuana and any illicit drug cessation respectively by Wave 4[14]. The effect of maternal presence does not reduce even after including other important variables in the regression models, suggesting that the presence of a mother before school, after school, and before bedtime may have a direct, protective effect on adult cessation. A fuller discussion of this finding is presented in the Discussion section below. The same analyses are performed to investigate the effects of paternal-adolescent relationships. No significant associations are found between the relationships and the rates of cessation in adulthood (shown in Tables 5.4a-5.4d). However, this finding does not necessarily suggest that maternal presence is more important than paternal presence. It is possible that the results are limited due to the small sample size for fathers and the lack of variability in the paternal presence variable. Another possible reason for this is that paternal presence may reflect non-traditional families in which mothers are the breadwinners and fathers are unemployed. This may explain the different effect between maternal and paternal presence found in the analyses.

[14] Percentages reported here and again later are calculated by subtracting odds ratios from 1 (Menard, 2002).

**Table 5.3a Mother: Logistic regression of changes from cigarette users in Wave 3 to non-users in Wave 4 (N=1,159)**

| | Block 1 | | Block 2 | | Block 3 | | Block 4 | | Block 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mother's behaviours** | | | | | | | | | | |
| Maternal warmth | 0.976 | (0.062) | 0.972 | (0.063) | 0.947 | (0.062) | 0.937 | (0.063) | 0.894 | (0.062) |
| Parental control (both parents) | 0.922 | (0.070) | 0.910 | (0.071) | 0.897 | (0.070) | 0.898 | (0.071) | 0.944 | (0.077) |
| Maternal presence | 1.120 | (0.077) | 1.129 | (0.080)✞ | 1.118 | (0.080) | 1.120 | (0.080) | 1.164 | (0.087)* |
| **Wave 1** | | | | | | | | | | |
| Age | | | 1.065 | (0.045) | 1.053 | (0.045) | 1.052 | (0.045) | 1.043 | (0.047) |
| Female[1] | | | 1.181 | (0.164) | 1.207 | (0.169) | 1.230 | (0.175) | 0.995 | (0.154) |
| African-American[2] | | | 1.013 | (0.237) | 0.867 | (0.209) | 0.872 | (0.210) | 1.005 | (0.257) |
| American-Indian/Asian/Mixed/Others | | | 1.222 | (0.260) | 1.159 | (0.248) | 1.174 | (0.253) | 1.206 | (0.268) |
| Step-parents family[3] | | | 0.906 | (0.184) | 0.918 | (0.187) | 0.921 | (0.188) | 1.061 | (0.224) |
| Single-parent family | | | 0.599 | (0.114)** | 0.628 | (0.120)* | 0.633 | (0.121)* | 0.742 | (0.147) |
| [Parent]Elementary/construction/ military[4] | | | 1.834 | (0.618)✞ | 1.762 | (0.595)✞ | 1.761 | (0.595)✞ | 1.593 | (0.549) |
| [Parent]Office worker/service/sale | | | 2.278 | (0.833)* | 2.149 | (0.789)* | 2.156 | (0.792)* | 1.802 | (0.676) |
| [Parent]Manager/technician/teacher/ nurse/ professional | | | 1.720 | (0.593) | 1.600 | (0.554) | 1.603 | (0.556) | 1.025 | (0.370) |
| Mother smokes | | | 0.778 | (0.111)✞ | 0.812 | (0.117) | 0.814 | (0.117) | 0.904 | (0.135) |
| First cigarette use at age 16 or below | | | | | 0.659 | (0.097)** | 0.659 | (0.097)** | 0.753 | (0.115)✞ |
| **Wave 3** | | | | | | | | | | |
| Depression index | | | | | | | 0.948 | (0.066) | 0.990 | (0.072) |
| **Wave 4** | | | | | | | | | | |
| Completed a GED/vocational school[5] | | | | | | | | | 1.434 | (0.267) |
| A bachelor's degree | | | | | | | | | 3.547 | (0.866)*** |
| Above degree | | | | | | | | | 3.756 | (1.196)*** |
| Employment status | | | | | | | | | 1.070 | (0.166) |
| Married | | | | | | | | | 1.960 | (0.325)*** |
| Presence of child(ren) | | | | | | | | | 0.944 | (0.163) |
| Religiosity | | | | | | | | | 1.203 | (0.100)* |
| **Constant** | 0.329 | (0.023)*** | 0.082 | (0.062)** | 0.126 | (0.096)** | 0.126 | (0.096)** | 1.203 | (0.053)** |
| **Log-likelihood** | **-646.8386** | | **-634.4115** | | **-630.3979** | | **-630.1012** | | **-599.8175** | |
| **Wald test** | **3.68** | | **22.82** | | **8.03** | | **0.59** | | **56.45** | |
| **AIC** | **1301.677** | | **1296.823** | | **1290.796** | | **1292.202** | | **1245.635** | |
| **BIC** | **1321.898** | | **1367.597** | | **1366.625** | | **1373.087** | | **1361.907** | |

Notes: Odds ratios are presented. Standard errors in parentheses. [1]Male; [2]White; [3]Intact family; [4]Not employed; [5]High school graduate or below. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.3b Mother: Logistic regression of changes from alcohol users in Wave 3 to non-users in Wave 4 (N=2,392)**

| | Block 1 | | Block 2 | | Block 3 | | Block 4 | | Block 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mother's behaviours** | | | | | | | | | | |
| Maternal warmth | 1.105 | (0.063)✞ | 1.079 | (0.061) | 1.047 | (0.060) | 1.058 | (0.062) | 1.069 | (0.065) |
| Parental control (both parents) | 1.012 | (0.060) | 0.974 | (0.060) | 0.950 | (0.059) | 0.949 | (0.059) | 0.911 | (0.058) |
| Maternal presence | 0.979 | (0.055) | 0.966 | (0.056) | 0.949 | (0.055) | 0.949 | (0.055) | 0.919 | (0.055) |
| **Wave 1** | | | | | | | | | | |
| Age | | | 1.182 | (0.042)*** | 1.177 | (0.042)*** | 1.179 | (0.042)*** | 1.155 | (0.043)*** |
| Female[1] | | | 1.312 | (0.150)* | 1.337 | (0.154)* | 1.310 | (0.153)* | 1.153 | (0.149) |
| African-American[2] | | | 1.993 | (0.286)*** | 1.836 | (0.266)*** | 1.826 | (0.265)*** | 1.464 | (0.234)* |
| American-Indian/Asian/Mixed/Others | | | 1.032 | (0.179) | 1.008 | (0.175) | 0.994 | (0.173) | 0.932 | (0.170) |
| Step-parent family[3] | | | 1.184 | (0.206) | 1.192 | (0.209) | 1.182 | (0.208) | 1.058 | (0.193) |
| Single-parent family | | | 1.221 | (0.174) | 1.253 | (0.179) | 1.242 | (0.178) | 1.015 | (0.155) |
| [Parent]Elementary/construction/military[4] | | | 0.867 | (0.200) | 0.856 | (0.199) | 0.859 | (0.200) | 0.912 | (0.222) |
| [Parent]Office worker/service/sale | | | 0.506 | (0.135)* | 0.503 | (0.135)* | 0.506 | (0.136)* | 0.635 | (0.179) |
| [Parent]Manager/technician/teacher/nurse /professional | | | 0.431 | (0.104)*** | 0.421 | (0.102)*** | 0.424 | (0.103)*** | 0.648 | (0.167)✞ |
| Mother's high-level alcohol use (i.e. 2 to 3+ days per month) | | | 0.745 | (0.087)* | 0.777 | (0.092)* | 0.778 | (0.092)* | 0.838 | (0.103) |
| First alcohol use at age 16 or below | | | | | 0.586 | (0.068)*** | 0.585 | (0.068)*** | 0.593 | (0.071)*** |
| **Wave 3** | | | | | | | | | | |
| Depression index | | | | | | | 1.064 | (0.064) | 1.009 | (0.063) |
| **Wave 4** | | | | | | | | | | |
| Completed a GED/vocational school[5] | | | | | | | | | 0.494 | (0.073)*** |
| A bachelor's degree | | | | | | | | | 0.321 | (0.063)*** |
| Above degree | | | | | | | | | 0.343 | (0.077)*** |
| Employment status | | | | | | | | | 0.690 | (0.084)** |
| Married | | | | | | | | | 0.722 | (0.098)* |
| Presence of child(ren) | | | | | | | | | 2.280 | (0.315)*** |
| Religiosity | | | | | | | | | 1.372 | (0.091)*** |
| **Constant** | 0.202 | (0.011)*** | 0.018 | (0.011)*** | 0.025 | (0.016)*** | 0.025 | (0.015)*** | 0.065 | (0.042)*** |
| **Log-likelihood** | **-1083.084** | | **-1031.511** | | **-1020.788** | | **-1020.252** | | **-952.5464** | |
| **Wald test** | **3.11** | | **97.61** | | **21.29** | | **1.09** | | **124.19** | |
| **AIC** | **2174.168** | | **2091.022** | | **2071.576** | | **2072.505** | | **1951.093** | |
| **BIC** | **2197.288** | | **2171.941** | | **2158.274** | | **2164.983** | | **2084.03** | |

Notes: Odds ratios are presented. Standard errors in parentheses. [1]Male; [2]White; [3]Intact family; [4]Not employed; [5]High school graduate or below. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.3c Mother: Logistic regression of changes from marijuana users in Wave 3 to non-users in Wave 4 (N=795)**

| | Block 1 | | Block 2 | | Block 3 | | Block 4 | | Block 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mother's behaviours** | | | | | | | | | | |
| Maternal warmth | 1.101 | (0.073) | 1.107 | (0.075) | 1.079 | (0.074) | 1.052 | (0.073) | 1.023 | (0.073) |
| Parental control (both parents) | 1.002 | (0.076) | 1.006 | (0.079) | 0.989 | (0.079) | 0.992 | (0.079) | 0.997 | (0.081) |
| Maternal presence | 1.312 | (0.096)*** | 1.358 | (0.104)*** | 1.323 | (0.103)*** | 1.323 | (0.103)*** | 1.329 | (0.105)*** |
| **Wave 1** | | | | | | | | | | |
| Age | | | 1.000 | (0.045) | 0.993 | (0.045) | 0.990 | (0.045) | 0.992 | (0.047) |
| Female[1] | | | 1.608 | (0.242)** | 1.654 | (0.251)*** | 1.762 | (0.274)** | 1.597 | (0.262)** |
| African-American[2] | | | 1.107 | (0.233) | 1.075 | (0.227) | 1.114 | (0.237) | 0.975 | (0.226) |
| American-Indian/Asian/Mixed/Others | | | 1.417 | (0.329) | 1.475 | (0.346) | 1.512 | (0.356)✞ | 1.412 | (0.336) |
| Step-parent family[3] | | | 1.073 | (0.245) | 1.034 | (0.237) | 1.043 | (0.240) | 1.091 | (0.256) |
| Single-parent family | | | 1.039 | (0.195) | 1.028 | (0.194) | 1.049 | (0.199) | 1.091 | (0.211) |
| [Parent]Elementary/construction/military[4] | | | 1.726 | (0.515)✞ | 1.605 | (0.482) | 1.626 | (0.489) | 1.614 | (0.492) |
| [Parent]Office worker/service/sale | | | 1.130 | (0.380) | 1.080 | (0.365) | 1.096 | (0.371) | 1.071 | (0.368) |
| [Parent]Manager/technician/teacher/nurse /professional | | | 1.426 | (0.436) | 1.351 | (0.416) | 1.354 | (0.417) | 1.256 | (0.401) |
| Mother smokes | | | 0.815 | (0.126) | 0.811 | (0.126) | 0.807 | (0.126) | 0.837 | (0.132) |
| First marijuana use at age 16 or below | | | | | 0.639 | (0.098)** | 0.642 | (0.099)** | 0.654 | (0.102)** |
| **Wave 3** | | | | | | | | | | |
| Depression index | | | | | | | 0.858 | (0.065) | 0.855 | (0.066)* |
| **Wave 4** | | | | | | | | | | |
| Completed a GED/vocational school[5] | | | | | | | | | 0.925 | (0.175) |
| A bachelor's degree | | | | | | | | | 1.353 | (0.323) |
| Above degree | | | | | | | | | 1.419 | (0.461) |
| Employment status | | | | | | | | | 0.734 | (0.123)✞ |
| Married | | | | | | | | | 1.153 | (0.185) |
| Presence of child(ren) | | | | | | | | | 1.016 | (0.183) |
| Religiosity | | | | | | | | | 1.205 | (0.109)* |
| **Constant** | 1.303 | (0.097)*** | 0.756 | (0.581) | 1.140 | (0.894) | 1.144 | (0.900) | 1.352 | (1.097) |
| **Log-likelihood** | **-537.3891** | | **-527.5698** | | **-523.3028** | | **-521.2507** | | **-514.3611** | |
| **Wald test** | **18.03** | | **18.98** | | **8.47** | | **4.09** | | **13.40** | |
| **AIC** | **1082.778** | | **1083.14** | | **1076.606** | | **1074.501** | | **1074.722** | |
| **BIC** | **1101.492** | | **1148.636** | | **1146.781** | | **1149.355** | | **1182.324** | |

Notes: Odds ratios are presented. Standard errors in parentheses.[1]Male; [2]White; [3]Intact family; [4]Not employed; [5]High school graduate or below. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.3d Mother: Logistic regression of changes from users of any illicit drug (including marijuana) in Wave 3 to non-users in Wave 4 (N=822)**

| | Block 1 | | Block 2 | | Block 3 | | Block 4 | | Block 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mother's behaviours** | | | | | | | | | | |
| Maternal warmth | 1.075 | (0.070) | 1.070 | (0.071) | 1.035 | (0.070) | 1.010 | (0.069) | 0.980 | (0.069) |
| Parental control (both parents) | 0.956 | (0.071) | 0.952 | (0.073) | 0.938 | (0.073) | 0.943 | (0.073) | 0.949 | (0.075) |
| Maternal presence | 1.257 | (0.090)** | 1.294 | (0.097)*** | 1.261 | (0.095)** | 1.262 | (0.095)** | 1.271 | (0.097)** |
| **Wave 1** | | | | | | | | | | |
| Age | | | 1.019 | (0.045) | 1.007 | (0.045) | 1.004 | (0.045) | 1.012 | (0.047) |
| Female[1] | | | 1.554 | (0.227)** | 1.596 | (0.235)** | 1.694 | (0.257)*** | 1.541 | (0.247)** |
| African-American[2] | | | 1.228 | (0.254) | 1.158 | (0.242) | 1.197 | (0.252) | 1.084 | (0.247) |
| American-Indian/Asian/Mixed/Others | | | 1.393 | (0.312) | 1.448 | (0.328) | 1.479 | (0.336)✞ | 1.381 | (0.318) |
| Step-parent family[3] | | | 0.859 | (0.188) | 0.810 | (0.180) | 0.816 | (0.182) | 0.885 | (0.202) |
| Single-parent family | | | 1.087 | (0.199) | 1.079 | (0.199) | 1.102 | (0.204) | 1.178 | (0.223) |
| [Parent]Elementary/construction/military[4] | | | 1.735 | (0.511)✞ | 1.591 | (0.473) | 1.615 | (0.481) | 1.576 | (0.476) |
| [Parent]Office worker/service/sale | | | 0.992 | (0.331) | 0.914 | (0.308) | 0.927 | (0.313) | 0.873 | (0.300) |
| [Parent]Manager/technician/teacher/nurse /professional | | | 1.493 | (0.451) | 1.387 | (0.423) | 1.394 | (0.425) | 1.177 | (0.373) |
| Mother smokes | | | 0.769 | (0.116)✞ | 0.776 | (0.118)✞ | 0.772 | (0.117)✞ | 0.811 | (0.125) |
| First any illicit drug use at age 16 or below | | | | | 0.591 | (0.091)*** | 0.598 | (0.092)*** | 0.612 | (0.095)** |
| **Wave 3** | | | | | | | | | | |
| Depression index | | | | | | | 0.866 | (0.065)✞ | 0.874 | (0.067)✞ |
| **Wave 4** | | | | | | | | | | |
| Completed a GED/vocational school[5] | | | | | | | | | 0.928 | (0.172) |
| A bachelor's degree | | | | | | | | | 1.630 | (0.380)* |
| Above degree | | | | | | | | | 1.780 | (0.566)✞ |
| Employment status | | | | | | | | | 0.754 | (0.123)✞ |
| Married | | | | | | | | | 1.121 | (0.176) |
| Presence of child(ren) | | | | | | | | | 0.938 | (0.165) |
| Religiosity | | | | | | | | | 1.190 | (0.106)* |
| **Constant** | 1.131 | (0.081)✞ | 0.508 | (0.380) | 0.903 | (0.697) | 0.907 | (0.701) | 0.935 | (0.747) |
| **Log-likelihood** | **-562.2138** | | **-562.2138** | | **-544.8823** | | **-543.0268** | | **-533.3785** | |
| **Wald test** | **13.34** | | **21.93** | | **11.77** | | **3.70** | | **18.65** | |
| **AIC** | **1132.428** | | **1129.657** | | **1119.765** | | **1118.054** | | **1112.757** | |
| **BIC** | **1151.275** | | **1195.621** | | **1190.441** | | **1193.441** | | **1221.127** | |

Notes: Odds ratios are presented. Standard errors in parentheses. [1]Male; [2]White; [3]Intact family; [4]Not employed; [5]High school graduate or below. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.4a Father: Logistic regression of changes from cigarette users in Wave 3 to non-users in Wave 4 (N=876)**

| | Block 1 | | Block 2 | | Block 3 | | Block 4 | | Block 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Father's behaviours** | | | | | | | | | | |
| Paternal warmth | 0.984 | (0.073) | 0.967 | (0.073) | 0.947 | (0.072) | 0.943 | (0.073) | 0.923 | (0.073) |
| Parental control (both parents) | 0.868 | (0.075) | 0.863 | (0.076)✞ | 0.850 | (0.076)✞ | 0.851 | (0.076)✞ | 0.896 | (0.083) |
| Paternal presence | 0.891 | (0.070) | 0.917 | (0.078) | 0.892 | (0.077) | 0.890 | (0.077) | 0.911 | (0.082) |
| **Wave 1** | | | | | | | | | | |
| Age | | | 1.054 | (0.050) | 1.042 | (0.050) | 1.042 | (0.050) | 1.024 | (0.052) |
| Female[1] | | | 1.258 | (0.195) | 1.288 | (0.201) | 1.298 | (0.205) | 1.038 | (0.177) |
| African-American[2] | | | 0.990 | (0.304) | 0.855 | (0.268) | 0.857 | (0.268) | 0.896 | (0.294) |
| American-Indian/Asian/Mixed/Others | | | 1.437 | (0.334) | 1.339 | (0.314) | 1.348 | (0.317) | 1.471 | (0.358) |
| Step-parent family[3] | | | 0.885 | (0.178) | 0.906 | (0.183) | 0.907 | (0.183) | 1.034 | (0.218) |
| Single-parent family | | | 0.700 | (0.276) | 0.736 | (0.291) | 0.747 | (0.297) | 0.839 | (0.341) |
| [Parent]Elementary/construction/military[4] | | | 1.259 | (0.546) | 1.155 | (0.504) | 1.156 | (0.505) | 1.015 | (0.454) |
| [Parent]Office worker/service/sale | | | 1.618 | (0.807) | 1.460 | (0.733) | 1.465 | (0.736) | 1.197 | (0.617) |
| [Parent]Manager/technician/teacher/nurse /professional | | | 1.237 | (0.554) | 1.088 | (0.493) | 1.091 | (0.495) | 0.780 | (0.367) |
| Father smokes | | | 0.654 | (0.108)* | 0.676 | (0.112)* | 0.677 | (0.113)* | 0.780 | (0.136) |
| First cigarette use at age 16 or below | | | | | 0.656 | (0.107)** | 0.655 | (0.107)** | 0.756 | (0.128)✞ |
| **Wave 3** | | | | | | | | | | |
| Depression index | | | | | | | 0.973 | (0.077) | 1.016 | (0.083) |
| **Wave 4** | | | | | | | | | | |
| Completed a GED/vocational school[5] | | | | | | | | | 1.362 | (0.290) |
| A bachelor's degree | | | | | | | | | 3.207 | (0.848)*** |
| Above degree | | | | | | | | | 2.931 | (1.047)** |
| Employment status | | | | | | | | | 1.036 | (0.181) |
| Married | | | | | | | | | 1.946 | (0.359)*** |
| Presence of child(ren) | | | | | | | | | 1.064 | (0.207) |
| Religiosity | | | | | | | | | 1.263 | (0.115)* |
| **Constant** | 0.366 | (0.028)*** | 0.151 | (0.130)* | 0.242 | (0.214) | 0.242 | (0.214) | 0.142 | (0.133)* |
| **Log-likelihood** | **-509.8724** | | **-502.3744** | | **-499.049** | | **-498.987** | | **-475.4208** | |
| **Wald test** | **4.98** | | **14.84** | | **6.64** | | **0.12** | | **43.63** | |
| **AIC** | **1027.745** | | **1032.749** | | **1028.098** | | **1029.974** | | **996.8417** | |
| **BIC** | **1046.846** | | **1099.604** | | **1099.728** | | **1106.38** | | **1106.675** | |

Notes: Odds ratios are presented. Standard errors in parentheses. [1]Male; [2]White; [3]Intact family; [4]Not employed; [5]High school graduate or below. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.4b Father: Logistic regression of changes from alcohol users in Wave 3 to non-users in Wave 4 (N=1,879)**

| | Block 1 | | Block 2 | | Block 3 | | Block 4 | | Block 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Father's behaviours** | | | | | | | | | | |
| Paternal warmth | 0.984 | (0.063) | 0.979 | (0.063) | 0.949 | (0.062) | 0.951 | (0.063) | 0.939 | (0.065) |
| Parental control (both parents) | 1.045 | (0.071) | 1.011 | (0.072) | 0.991 | (0.071) | 0.990 | (0.071) | 0.958 | (0.071) |
| Paternal presence | 1.072 | (0.071) | 1.059 | (0.075) | 1.046 | (0.074) | 1.046 | (0.074) | 1.052 | (0.077) |
| **Wave 1** | | | | | | | | | | |
| Age | | | 1.211 | (0.049)*** | 1.204 | (0.049)*** | 1.205 | (0.049)*** | 1.174 | (0.050)*** |
| Female[1] | | | 1.385 | (0.183)* | 1.390 | (0.184)* | 1.385 | (0.186)* | 1.248 | (0.183) |
| African-American[2] | | | 1.900 | (0.348)*** | 1.752 | (0.325)** | 1.751 | (0.325)** | 1.496 | (0.300)** |
| American-Indian/Asian/Mixed/Others | | | 1.077 | (0.209) | 1.072 | (0.208) | 1.069 | (0.209) | 1.049 | (0.214) |
| Step-parent family[3] | | | 1.149 | (0.202) | 1.145 | (0.203) | 1.144 | (0.203) | 1.034 | (0.190) |
| Single-parent family | | | 0.600 | (0.235) | 0.622 | (0.244) | 0.619 | (0.244) | 0.595 | (0.238) |
| [Parent]Elementary/construction/military[4] | | | 1.179 | (0.398) | 1.101 | (0.374) | 1.101 | (0.374) | 1.182 | (0.412) |
| [Parent]Office worker/service/sale | | | 0.570 | (0.237) | 0.522 | (0.219) | 0.522 | (0.219) | 0.682 | (0.293) |
| [Parent]Manager/technician/teacher/nurse /professional | | | 0.496 | (0.176)* | 0.460 | (0.164)* | 0.460 | (0.164)* | 0.714 | (0.264) |
| Father's high-level alcohol use (i.e. 2 to 3+ days per month) | | | 0.762 | (0.102)* | 0.781 | (0.105)✞ | 0.781 | (0.105)✞ | 0.856 | (0.120) |
| First alcohol use at age 16 or below | | | | | 0.643 | (0.086)*** | 0.642 | (0.086)*** | 0.639 | (0.090)** |
| **Wave 3** | | | | | | | | | | |
| Depression index | | | | | | | 1.012 | (0.072) | 0.956 | (0.072) |
| **Wave 4** | | | | | | | | | | |
| Completed a GED/vocational school[5] | | | | | | | | | 0.486 | (0.084)*** |
| A bachelor's degree | | | | | | | | | 0.365 | (0.079)*** |
| Above degree | | | | | | | | | 0.342 | (0.087)*** |
| Employment status | | | | | | | | | 0.755 | (0.107)* |
| Married | | | | | | | | | 0.775 | (0.124) |
| Presence of child(ren) | | | | | | | | | 2.364 | (0.377)*** |
| Religiosity | | | | | | | | | 1.340 | (0.099)*** |
| **Constant** | 0.189 | (0.012)*** | 0.009 | (0.007)*** | 0.014 | (0.010)*** | 0.014 | (0.010)*** | 0.033 | (0.026)*** |
| **Log-likelihood** | **-820.9526** | | **-777.3445** | | **-771.9079** | | **-771.8941** | | **-722.7408** | |
| **Wald test** | **1.60** | | **80.28** | | **10.83** | | **0.03** | | **91.54** | |
| **AIC** | **1649.905** | | **1582.689** | | **1573.816** | | **1575.788** | | **1491.482** | |
| **BIC** | **1672.059** | | **1660.228** | | **1656.893** | | **1664.404** | | **1618.867** | |

Notes: Odds ratios are presented. Standard errors in parentheses. [1]Male; [2]White; [3]Intact family; [4]Not employed; [5]High school graduate or below. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.4c Father: Logistic regression of changes from marijuana users in Wave 3 to non-users in Wave 4 (N=602)**

| | Block 1 | | Block 2 | | Block 3 | | Block 4 | | Block 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Father's behaviours** | | | | | | | | | | |
| Paternal warmth | 0.966 | (0.078) | 0.965 | (0.080) | 0.951 | (0.080) | 0.913 | (0.079) | 0.897 | (0.079) |
| Parental control (both parents) | 0.974 | (0.082) | 0.972 | (0.084) | 0.956 | (0.084) | 0.972 | (0.085) | 0.987 | (0.089) |
| Paternal presence | 0.970 | (0.082) | 0.989 | (0.091) | 0.978 | (0.091) | 0.993 | (0.093) | 1.006 | (0.095) |
| **Wave 1** | | | | | | | | | | |
| Age | | | 0.957 | (0.049) | 0.949 | (0.049) | 0.951 | (0.049) | 0.935 | (0.050) |
| Female[1] | | | 1.430 | (0.245)* | 1.480 | (0.256)* | 1.604 | (0.285)** | 1.305 | (0.247) |
| African-American[2] | | | 1.206 | (0.334) | 1.178 | (0.328) | 1.211 | (0.339) | 1.016 | (0.309) |
| American-Indian/Asian/Mixed/Others | | | 1.854 | (0.501)* | 1.899 | (0.517)* | 1.971 | (0.539)* | 1.918 | (0.533)* |
| Step-parent family[3] | | | 1.008 | (0.226) | 0.980 | (0.222) | 0.981 | (0.223) | 1.017 | (0.236) |
| Single-parent family | | | 0.975 | (0.357) | 1.059 | (0.391) | 1.095 | (0.407) | 1.161 | (0.441) |
| [Parent]Elementary/construction/military[4] | | | 1.494 | (0.611) | 1.431 | (0.588) | 1.490 | (0.618) | 1.422 | (0.598) |
| [Parent]Office worker/service/sale | | | 1.402 | (0.692) | 1.374 | (0.682) | 1.460 | (0.731) | 1.381 | (0.702) |
| [Parent]Manager/technician/teacher/nurse /professional | | | 1.273 | (0.537) | 1.257 | (0.532) | 1.285 | (0.548) | 1.212 | (0.533) |
| Father smokes | | | 0.820 | (0.149) | 0.813 | (0.148) | 0.822 | (0.150) | 0.868 | (0.164) |
| First marijuana use at age 16 or below | | | | | 0.682 | (0.119)* | 0.701 | (0.123)* | 0.748 | (0.134) |
| **Wave 3** | | | | | | | | | | |
| Depression index | | | | | | | 0.809 | (0.073)* | 0.801 | (0.074)* |
| **Wave 4** | | | | | | | | | | |
| Completed a GED/vocational school[5] | | | | | | | | | 1.011 | (0.226) |
| A bachelor's degree | | | | | | | | | 1.552 | (0.427) |
| Above degree | | | | | | | | | 1.483 | (0.526) |
| Employment status | | | | | | | | | 0.865 | (0.167) |
| Married | | | | | | | | | 1.184 | (0.216) |
| Presence of child(ren) | | | | | | | | | 1.393 | (0.291) |
| Religiosity | | | | | | | | | 1.288 | (0.132)* |
| **Constant** | 1.271 | (0.105)** | 1.612 | (1.446) | 2.328 | (2.133) | 2.083 | 1.921 | 2.509 | 2.412 |
| **Log-likelihood** | **-412.4893** | | **-405.6499** | | **-403.2097** | | **-400.4218** | | **-392.6037** | |
| **Wald test** | **0.45** | | **13.13** | | **4.84** | | **5.52** | | **15.04** | |
| **AIC** | **832.9785** | | **839.2997** | | **836.4194** | | **832.8436** | | **831.2074** | |
| **BIC** | **850.5796** | | **900.9034** | | **902.4232** | | **903.2477** | | **932.4134** | |

Notes: Odds ratios are presented. Standard errors in parentheses. [1]Male; [2]White; [3]Intact family; [4]Not employed; [5]High school graduate or below. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.4d Father: Logistic regression of changes from users of any illicit drug (including marijuana) in Wave 3 to non-users in Wave 4 (N=623)**

| | Block 1 | | Block 2 | | Block 3 | | Block 4 | | Block 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Father's behaviours** | | | | | | | | | | |
| Paternal warmth | 0.944 | (0.075) | 0.927 | (0.075) | 0.907 | (0.074) | 0.878 | (0.074) | 0.860 | (0.074)✞ |
| Parental control (both parents) | 0.904 | (0.076) | 0.904 | (0.078) | 0.889 | (0.077) | 0.902 | (0.079) | 0.915 | (0.082) |
| Paternal presence | 1.003 | (0.083) | 1.031 | (0.092) | 1.018 | (0.092) | 1.030 | (0.093) | 1.050 | (0.097) |
| **Wave 1** | | | | | | | | | | |
| Age | | | 0.983 | (0.049) | 0.970 | (0.049) | 0.971 | (0.049) | 0.964 | (0.050) |
| Female[1] | | | 1.426 | (0.239)* | 1.462 | (0.246)* | 1.562 | (0.270)** | 1.305 | (0.240) |
| African-American[2] | | | 1.301 | (0.353) | 1.245 | (0.340) | 1.270 | (0.349) | 1.078 | (0.321) |
| American-Indian/Asian/Mixed/Others | | | 1.794 | (0.465)* | 1.838 | (0.480)* | 1.888 | (0.495)* | 1.816 | (0.483)* |
| Step-parent family[3] | | | 0.787 | (0.171) | 0.753 | (0.166) | 0.753 | (0.166) | 0.810 | (0.183) |
| Single-parent family | | | 1.051 | (0.375) | 1.137 | (0.408) | 1.174 | (0.424) | 1.304 | (0.481) |
| [Parent]Elementary/construction/military[4] | | | 1.664 | (0.672) | 1.578 | (0.642) | 1.634 | (0.668) | 1.561 | (0.646) |
| [Parent]Office worker/service/sale | | | 1.487 | (0.727) | 1.421 | (0.700) | 1.497 | (0.742) | 1.419 | (0.713) |
| [Parent]Manager/technician/teacher/nurse/ professional | | | 1.438 | (0.600) | 1.415 | (0.595) | 1.446 | (0.609) | 1.271 | (0.552) |
| Father smokes | | | 0.735 | (0.130)✞ | 0.724 | (0.129)✞ | 0.731 | (0.131)✞ | 0.791 | (0.146) |
| First any illicit drug use at age 16 or below | | | | | 0.654 | (0.114)* | 0.671 | (0.118)* | 0.707 | (0.126)✞ |
| **Wave 3** | | | | | | | | | | |
| Depression index | | | | | | | 0.848 | (0.075)✞ | 0.850 | (0.077)✞ |
| **Wave 4** | | | | | | | | | | |
| Completed a GED/vocational school[5] | | | | | | | | | 0.976 | (0.214) |
| A bachelor's degree | | | | | | | | | 1.711 | (0.459)* |
| Above degree | | | | | | | | | 1.837 | (0.639)✞ |
| Employment status | | | | | | | | | 0.852 | (0.160) |
| Married | | | | | | | | | 1.089 | (0.195) |
| Presence of child(ren) | | | | | | | | | 1.262 | (0.256) |
| Religiosity | | | | | | | | | 1.258 | (0.126)* |
| **Constant** | 1.091 | (0.088) | 0.921 | (0.807) | 1.512 | (1.368) | 1.382 | (1.256) | 1.509 | (1.425) |
| **Log-likelihood** | **-430.1032** | | **-421.9728** | | **-418.9665** | | **-417.2341** | | **-409.0757** | |
| **Wald test** | **1.90** | | **15.63** | | **5.95** | | **3.44** | | **15.69** | |
| **AIC** | **868.2063** | | **871.9456** | | **867.933** | | **866.4681** | | **864.1514** | |
| **BIC** | **885.9445** | | **934.0292** | | **934.4512** | | **937.4208** | | **966.1459** | |

Notes: Odds ratios are presented. Standard errors in parentheses. [1]Male; [2]White; [3]Intact family; [4]Not employed; [5]High school graduate or below. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with p < 0.1 denoted by ✞.

Apart from the effect of maternal presence, a number of the demographic variables measured in Wave 1 are also found to affect the probability of cessation in adulthood prior to adjustment for the variables measured at Wave 4. These include respondents' age, gender, ethnicity, family composition, parental employment and parental substance use. The tables show that respondents who are older, female, and from a non-white background are more likely to stop using the substance at Wave 4 (having been a user of the substance at Wave 3). Respondents growing up in a single-parent family are associated with lower odds of cigarette cessation (only in mother's model), whereas those whose parents are in managerial or professional employment are associated with lower odds of alcohol cessation. Furthermore, the analyses show that both mother's and father's alcohol use are negatively related to later drinking cessation, while father's cigarette use is associated with lower odds of cigarette cessation.

However, most of these demographic variables measured at Wave 1 become insignificant once the Wave 4 variables are introduced to the models (e.g. parental employment activities). This suggests that factors that are important determinants of substance use in adolescence, or even in young adulthood, may not necessarily influence the probability of cessation in young adulthood (as also suggested by Haas & Schaefer, 2014; O'Byrne et al., 2002; Pollard et al., 2014; Washburn & Capaldi, 2014). Another possible explanation is that these covariates may be strongly associated with respondents' later educational achievement, employment status, and marital status, which may have absorbed the effects of covariates that are measure in Wave 1. It is also plausible that changes in substance use during young adulthood may be mainly driven by the transition to adulthood (which usually involves employment, marriage, and parenthood) (Arnett, 2000; Bachman et al., 2002). Therefore, entering and maintaining normative adult roles may be a more important factor when it comes to substance use cessation.

Early initiation (captured in this analysis by the binary indicator of whether the respondent had used the substance by age 16), which is a key determinant of substance use problems in adulthood, is also associated with a lower probability of cessation. The effect is stronger in the mother models. This may be attributable to the larger sample size in these models, or plausibly to differences between samples; for example, the father models contain fewer children in single-parent families. Depression in Wave 3 is negatively associated with cessation with respect to marijuana and other illicit drugs, but is not associated with cigarettes

or alcohol. By contrast, the Wave 4 variables strongly predict cessation with respect to cigarettes and alcohol, but not with marijuana or other illicit drugs.

Taken together, Tables 5.3a-5.4d demonstrate that factors affecting the odds of cigarette, alcohol, and drug use cessation vary depending on the type of substance. Therefore, it is crucial to consider each substance on its own right. Nonetheless, current circumstances in young adulthood (such as marriage and being employed) appear to play an important role in affecting the probability of all kinds of substance use cessation. The tables also suggest that factors that are considered as key determinants of substance use in adolescence and young adulthood, such as parental warmth and control, may not have an effect on substance use cessation in young adulthood. Having said that, parental presence is found to be an important early determinant of the probability of substance use cessation.

All analyses are repeated on a sample who are classified as the top 20 per cent of heaviest substance users in the previous waves (shown in Table 5.5). The table shows two columns for each substance use cessation, in which the first column presents odds ratios from unadjusted models (no covariate variables are controlled), and the second column demonstrates odds ratios from adjusted models (all covariate variables are controlled). Results with this sample specification are consistent with the original analysis, showing that maternal presence is significantly related to cigarette and drug cessation for heavy substance users (cigarette: OR=1.25, SE=0.13, $p<0.05$; marijuana: OR=1.34, SE=0.11, $p<0.001$; any illicit drugs: OR=1.23, SE=0.11, $p<0.02$).

**Table 5.5 Top 20% heaviest substance users in Wave 3 transition to non-users in Wave 4**

| | Cigarette | | Alcohol | | Marijuana | | Any illicit drugs (including marijuana) | |
|---|---|---|---|---|---|---|---|---|
| | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** |
| **Mother** | | | | | | | | |
| Warmth | 0.944 | 0.860 | 1.076 | 0.895 | 1.026 | 0.969 | 1.054 | 0.975 |
| | (0.081) | (0.082) | (0.144) | (0.131) | (0.076) | (0.078) | (0.075) | (0.076) |
| Control (both parents) | 1.018 | 1.105 | 0.970 | 0.752 | 1.000 | 0.988 | 0.973 | 0.961 |
| | (0.104) | (0.124) | (0.131) | (0.117)✞ | (0.086) | (0.090) | (0.081) | (0.086) |
| Presence | 1.172 | 1.248 | 0.905 | 0.843 | 1.342 | 1.352 | 1.223 | 1.230 |
| | (0.111)✞ | (0.128)* | (0.111) | (0.114) | (0.112)*** | (0.121)** | (0.097)* | (0.105)* |
| **N** | **755** | | **742** | | **618** | | **663** | |
| **Father** | | | | | | | | |
| Warmth | 0.978 | 0.951 | 1.148 | 0.981 | 0.923 | 0.871 | 0.938 | 0.886 |
| | (0.098) | (0.104) | (0.182) | (0.154) | (0.086) | (0.087) | (0.085) | (0.086) |
| Control (both parents) | 0.976 | 1.045 | 0.987 | 0.789 | 0.984 | 0.998 | 0.920 | 0.928 |
| | (0.111) | (0.132) | (0.150) | (0.135) | (0.094) | (0.101) | (0.086) | (0.093) |
| Presence | 0.852 | 0.900 | 1.059 | 1.115 | 0.982 | 0.977 | 0.988 | 0.988 |
| | (0.091) | (0.109) | (0.151) | (0.179) | (0.094) | (0.105) | (0.091) | (0.102) |
| **N** | **566** | | **614** | | **463** | | **496** | |

Notes: Unadj. refers to the unadjusted model (without any covariate variables controlled). Adj. refers to the adjusted model (with covariate variables controlled). Odds ratios are presented. Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

Two additional sets of analyses are performed to test whether there are any differences between gender (shown in Table 5.6a-5.6b) and two age groups (one group with a sample who are aged 13-15 in Wave 1 and another group aged 16-18) (shown in Table 5.7a-5.7b). Although results demonstrate that maternal presence has a more pronounced effect on marijuana and any illicit drug cessation for female and the younger group, the differences against the opposite group are not significant (tested by seemingly unrelated estimations; estimates not reported). Maternal presence is also shown to have a larger protective effect on cigarette cessation for older adolescents, yet the difference between the younger and older age groups is not significant. An unexpected finding here is the negative correlation between maternal presence and later alcohol cessation for males (OR=0.78, SE=0.07, p<0.01); the difference between female and male is significant. These gender differences may reflect various behavioural expectations from parents and different shared at-home activities during adolescence. It is plausible that adolescents may be more likely to be exposed to maternal alcohol use when their mothers spend more time at home; for instance, some parents may drink light-to-moderate amounts of alcohol with their evening meals and may even

spontaneously decide to let their adolescents drink (Friese et al., 2012). This is perhaps more relevant to male adolescents who tend to perceive lower disapproval of alcohol use from parents than female adolescents (Mrug & McCay, 2013), which may in turn lead to long-term alcohol use. An alternative explanation could be that male respondents may consume alcohol only moderately if their mothers spend more time at home, and that moderate drinkers are less likely than heavy drinkers to cease using alcohol (as reflected in Table 5.2b). However, these are only hypothetical explanations; further work is needed to explore the gender difference in the effect of maternal presence on alcohol cessation.

**Table 5.6a Gender differences in the association between maternal-adolescent relationships and the transition from substance users at Wave 3 to non-users at Wave 4**

| | **Cigarette** | | **Alcohol** | | **Marijuana** | | **Any illicit drugs (including marijuana)** | |
|---|---|---|---|---|---|---|---|---|
| | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** |
| **Female** | | | | | | | | |
| Warmth | 0.935 (0.076) | 0.865 (0.079) | 1.038 (0.070) | 0.996 (0.074) | 1.088 (0.097) | 1.037 (0.103) | 1.077 (0.094) | 1.002 (0.099) |
| Control (both parents) | 0.948 (0.105) | 0.958 (0.114) | 0.983 (0.079) | 0.892 (0.079) | 1.127 (0.144) | 1.113 (0.150) | 1.076 (0.132) | 1.089 (0.141) |
| Presence | 1.106 (0.102) | 1.152 (0.118) | 1.088 (0.081) | 1.030 (0.083) | 1.466 (0.161)** | 1.396 (0.165)** | 1.448 (0.157)** | 1.371 (0.160)** |
| **N** | **595** | | **1,298** | | **357** | | **370** | |
| **Male** | | | | | | | | |
| Warmth | 1.050 (0.109) | 0.961 (0.110) | 1.250 (0.130)* | 1.166 (0.127) | 1.036 (0.113) | 1.135 (0.115) | 1.077 (0.106) | 0.974 (0.104) |
| Control (both parents) | 0.906 (0.095) | 0.905 (0.105) | 1.058 (0.094) | 0.948 (0.091) | 0.965 (0.100) | 0.966 (0.094) | 0.912 (0.087) | 0.897 (0.093) |
| Presence | 1.149 (0.120) | 1.167 (0.135) | 0.846 (0.072)✞ | 0.775 (0.073)** | 1.266 (0.138)* | 1.225 (0.123)* | 1.139 (0.110) | 1.178 (0.124) |
| **N** | **564** | | **1,094** | | **438** | | **452** | |

Notes: Unadj. refers to the unadjusted model (without any covariate variables controlled). Adj. refers to the adjusted model (with covariate variables controlled). Odds ratios are presented. Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.6b Gender differences in the association between paternal-adolescent relationships and the transition from substance users at Wave 3 to non-users at Wave 4**

| | Cigarette | | Alcohol | | Marijuana | | Any illicit drug (including marijuana) | |
|---|---|---|---|---|---|---|---|---|
| | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** |
| **Female** | | | | | | | | |
| Warmth | 0.975 (0.091) | 0.955 (0.098) | 0.927 (0.070) | 0.876 (0.076) | 0.891 (0.108) | 0.816 (0.115) | 0.926 (0.105) | 0.841 (0.111) |
| Control (both parents) | 0.912 (0.113) | 0.954 (0.127) | 1.020 (0.096) | 0.960 (0.100) | 1.145 (0.167) | 1.135 (0.178) | 1.052 (0.146) | 1.072 (0.159) |
| Presence | 0.923 (0.097) | 0.840 (0.104) | 1.074 (0.093) | 1.022 (0.101) | 0.791 (0.105)✞ | 0.793 (0.115) | 0.893 (0.112) | 0.880 (0.122) |
| **N** | **446** | | **990** | | **261** | | **271** | |
| **Male** | | | | | | | | |
| Warmth | 1.004 (0.121) | 0.937 (0.124) | 1.123 (0.131) | 1.064 (0.126) | 1.038 (0.117) | 0.956 (0.116) | 0.968 (0.109) | 0.889 (0.107) |
| Control (both parents) | 0.834 (0.101) | 0.824 (0.114) | 1.097 (0.109) | 0.995 (0.107) | 0.919 (0.098) | 0.937 (0.108) | 0.843 (0.091) | 0.843 (0.098) |
| Presence | 0.863 (0.102) | 0.997 (0.137) | 1.070 (0.110) | 1.093 (0.125) | 1.130 (0.129) | 1.225 (0.166) | 1.106 (0.123) | 1.195 (0.158) |
| **N** | **430** | | **889** | | **341** | | **352** | |

Notes: Unadj. refers to the unadjusted model (without any covariate variables controlled). Adj. refers to the adjusted model (with covariate variables controlled). Odds ratios are presented. Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.7a Age differences in the association between maternal-adolescent relationships and the transition from substance users at Wave 3 to non-users at Wave 4**

| | Cigarette | | Alcohol | | Marijuana | | Any illicit drug (including marijuana) | |
|---|---|---|---|---|---|---|---|---|
| | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** |
| **Age 13 – 15 in Wave 1** | | | | | | | | |
| Warmth | 1.100 (0.114) | 0.955 (0.107) | 1.134 (0.104) | 1.090 (0.110) | 1.188 (0.110)✞ | 1.119 (0.114) | 1.192 (0.108)✞ | 1.090 (0.109) |
| Control (both parents) | 0.961 (0.101) | 0.943 (0.106) | 1.036 (0.085) | 0.932 (0.084) | 1.065 (0.103) | 1.100 (0.116) | 1.015 (0.096) | 1.042 (0.107) |
| Presence | 0.999 (0.098) | 1.002 (0.107) | 1.070 (0.092) | 0.978 (0.092) | 1.422 (0.140)*** | 1.494 (0.161)*** | 1.290 (0.123)** | 1.319 (0.137)** |
| **N** | **606** | | **1242** | | **460** | | **473** | |
| **Age 16 – 18 in Wave 1** | | | | | | | | |
| Warmth | 0.902 (0.074) | 0.848 (0.078)✞ | 1.092 (0.079) | 1.069 (0.084) | 1.012 (0.097) | 0.932 (0.100) | 0.952 (0.090) | 0.877 (0.093) |
| Control (both parents) | 0.859 (0.096) | 0.956 (0.117) | 0.997 (0.088) | 0.888 (0.085) | 0.902 (0.113) | 0.861 (0.121) | 0.845 (0.105) | 0.798 (0.111) |
| Presence | 1.254 (0.123)* | 1.314 (0.143)* | 0.932 (0.070) | 0.880 (0.070) | 1.199 (0.133) | 1.183 (0.142) | 1.241 (0.135)* | 1.245 (0.146)✞ |
| **N** | **553** | | **1150** | | **335** | | **349** | |

Notes: Unadj. refers to the unadjusted model (without any covariate variables controlled). Adj. refers to the adjusted model (with covariate variables controlled). Odds ratios are presented. Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Table 5.7b Age differences in the association between paternal-adolescent relationships and the transition from substance users at Wave 3 to non-users at Wave 4**

| | Cigarette | | Alcohol | | Marijuana | | Any illicit drugs (including marijuana) | |
|---|---|---|---|---|---|---|---|---|
| | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** | **Unadj.** | **Adj.** |
| **Age 13 – 15 in Wave 1** | | | | | | | | |
| Warmth | 1.039 (0.113) | 0.974 (0.117) | 0.957 (0.099) | 0.871 (0.105) | 0.973 (0.107) | 0.912 (0.112) | 0.937 (0.101) | 0.847 (0.103) |
| Control (both parents) | 0.893 (0.105) | 0.867 (0.108) | 1.019 (0.100) | 0.941 (0.100) | 0.997 (0.107) | 0.996 (0.117) | 0.923 (0.098) | 0.927 (0.107) |
| Presence | 0.923 (0.103) | 0.931 (0.122) | 1.118 (0.116) | 1.112 (0.134) | 0.850 (0.099) | 0.853 (0.114) | 0.875 (0.099) | 0.890 (0.115) |
| **N** | **455** | | **962** | | **349** | | **358** | |
| **Age 16 – 18 in Wave 1** | | | | | | | | |
| Warmth | 0.931 (0.094) | 0.876 (0.095) | 0.990 (0.079) | 0.964 (0.082) | 0.969 (0.117) | 0.891 (0.119) | 0.962 (0.114) | 0.870 (0.113) |
| Control (both parents) | 0.835 (0.107) | 0.925 (0.133) | 1.084 (0.105) | 0.986 (0.104) | 0.952 (0.134) | 0.910 (0.145) | 0.893 (0.124) | 0.835 (0.134) |
| Presence | 0.860 (0.095) | 0.877 (0.116) | 1.060 (0.091) | 1.018 (0.097) | 1.113 (0.141) | 1.217 (0.181) | 1.175 (0.145) | 1.293 (0.189)✞ |
| **N** | **421** | | **917** | | **253** | | **265** | |

Notes: Unadj. refers to the unadjusted model (without any covariate variables controlled). Adj. refers to the adjusted model (with covariate variables controlled). Odds ratios are presented. Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

### *5.3.4 Other possible risk and protective factors for substance use cessation in adulthood*

One advantage of using nested models in the main analysis is the comparison of blocks of predictors. Comparison of blocks provides some information regarding the extent to which the association between Wave 1 variables (including the parent-adolescent relationships and demographic backgrounds) and substance use discontinuity in adulthood are confounded by the inclusion of Wave 4 concurrent variables. In Tables 5.3a-5.4d, the likelihood-ratio tests and Wald tests indicate that the subsequent blocks with more predictors fit better with the data, especially when the predictors measured in Wave 4 are included. This is in line with previous studies that suggest adult responsibilities, such as marriage, employment, and parenthood, may change individuals to act in ways that would not affect their ability to perform their roles, which in turn increase the probability of cessation in adulthood (Arnett, 2000; Bachman et al., 2002; Chen & Jacobson, 2012; Chen & Kandel, 1998; Park et al., 2006; Park et al., 2018; Smith, Cleeland & Dennis, 2010; Stone et al., 2012).

While the findings demonstrate factors affecting the chances of cessation vary, the levels of religiosity appear to be a consistent and robust factor across all substance use cessation. The tables indicate that for one standard deviation unit increase in religiosity, there is about a 20-37 per cent increase in the odds of cigarette, alcohol and drug cessation. This finding is consistent with the existing literature that shows high levels of religiosity are inversely associated with substance use and misuse (Edlund et al., 2010; Koenig et al., 1998; Koenig, 2005; Koenig, McCullough & Larson, 2001).

## 5.4 Discussion

There is a growing body of evidence on the longitudinal association between early family experiences and later substance use. These studies are particularly useful for designing cost-effective prevention and intervention programmes to reduce problematic substance use. Previous literature concerning substance use trajectories has indicated that individuals tend to go through an episode of heavy use at the ages of 18-25, then ‘mature out’ of substance abuse to take on adult/family responsibilities in young adulthood (beyond age 25) (Arnett, 2000; Bachman et al., 2002; Chen & Jacobson, 2012;. Park et al., 2006; Park et al., 2018; Smith, Cleeland & Dennis, 2010; Stone et al., 2012). While many individuals successfully reduce or stop using substances, some do not. This chapter is therefore designed to generate

understanding of the determinants of substance use cessation in adulthood; in particular, it explores whether early family relationships in adolescence, a key instrument in substance use trajectories, are associated with later substance use discontinuity.

This study has made several contributions to the current literature. First, this research found no evidence for the association between parental warmth and control and substance use cessation in adulthood. The results are interesting. It is well established from a variety of studies, that parenting styles play a critical role in adolescents' substance use, both in short-term and long-term contexts (e.g. Aquilino & Supple, 2001; Calafat et al., 2014; Fleming et al., 2002; Kandel et al., 1978); yet what this study found here suggests that these two parental behaviours are perhaps less effective when it comes to cessation in adulthood. It is possible that the effects of parental behaviours may be suppressed in a sample of current substance users, implying that they may be only important as a preventer for the onset and severity of substance use, but not as a facilitator for cessation.

The second contribution is that this study has shown positive and significant relationships between maternal presence and cigarette and drug cessation, even if the respondents are the top 20 per cent of heaviest cigarette and drug users in the Wave 3 interview. This suggests that parents who are available to adolescents before school, after school, and in the evening may have a direct and protective effect that encourages adolescents to give up substances in the future. Three possible explanations could elucidate the effect of maternal presence on later cessation. Firstly, maternal presence may reflect the amount of time mothers spend with their adolescents. Parents who are usually at home and available to adolescents may encourage more interactions and participations in shared activities. Furthermore, as proposed in the attachment theory, the availability of the parents may allow parents to respond to adolescents' needs and distress immediately, offering a sense of security for adolescents in that they can turn to their parents in times of need. Indeed, it has been suggested that parental time (e.g. time spent participating in activities with children) may be one of the determinants of adolescent substance use (Coley, Votruba-Drzal & Schindler, 2008; Milkie, Nomaguchi & Denny, 2015), which in turn may influence the probability of later cessation. The second possible explanation is that parents who are not available to adolescents before school, after school, and in the evening may have long working

hours or non-standard employment[15] (Lester et al., 2016). There is evidence showing that parental work-related absence has a negative effect on children's current and later emotional and behavioural problems (Han, 2008; Han & Miller, 2009; Hsueh & Yoshikawa, 2007; Strazdins et al., 2004), which in turn may affect the probability of cessation once they have started using substances. Another plausible explanation is that parental presence may exert a 'monitoring effect' that *practically* helps prevent adolescents from being chronically exposed to substances by (1) delaying or avoiding an early onset of substance use, and (2) reducing the severity and frequency of usage once youth have already begun to use substances (Kingston et al., 2017; Shillington et al., 2005; Stanton et al., 2000; Steinberg et al., 1994). This is perhaps more pertinent during after-school time, when adolescents are more susceptible to peer pressure (Flannery, Williams & Vazsonyi, 1999), and when nearly 70 per cent of delinquent behaviours occur between 2pm and 6pm, hours immediately following the close of school on school days (reported in the Office of Juvenile Justice and Delinquency Prevention (OJJDP) 2010, 2014).

The third contribution of this study is that demographic variables in adolescence are found to be unrelated to the probability of cessation in adulthood. This suggests that factors that are considered to be important with regard to substance use in adolescence, and even in young adulthood, may not be determinants of substance use cessation later in life (in line with the studies of Haas & Schaefer, 2014; O'Byrne et al., 2002; Pollard et al., 2014; and Washburn & Capaldi, 2014). Changes of substance use occurring in young adulthood may be more likely to be driven by the transition to adulthood (such as marriage, employment and parenthood) (Arnett, 2000; Bachman et al., 2002).

This study has also provided important insights into the role of religiosity in substance use cessation (consistent with previous research that shows a negative relationship between religiosity and substance use: Brown et al., 2014; Gossop, Stewart & Marsden, 2008; Kendler et al., 2003; Koenig & Vaillant, 2009). A thorough investigation of the association between religiosity and substance use cessation will be discussed in the next chapter.

[15] A non-standard employment refers to working hours that are mainly outside a typical Monday-Friday daytime schedule (Li et al., 2012).

## 5.5 Limitations

There are several potential limitations to this study. First, this study is limited by the lack of information on whether respondents would return to substances or relapse after reporting no use in the last interview. Although results found in this study may not reflect a stable and long-term cessation, a one-month period of cessation has been found to be associated with health benefits, including a reduction in wound-healing complications (Wong et al., 2012). Second, while a large set of covariate variables is controlled in the analysis, unobserved factors, such as genetic influence and family history of substance use problems, which could be critical determinants, are not included in the models due to information unavailability. Further research should be undertaken using different longitudinal data sets that contain other important factors. Third, substance use measures are based on self-reports; it is possible that some reporters may feel anxious and conceal the behaviour. However, there is evidence that self-reported substance use behaviours, including heavy consumption, are reasonably valid (Brown, Kranzler & Del Boca, 1992; Del Boca & Darkes, 2003). Finally, although the study uses a longitudinal data set and controls for relevant variables, one should be cautious about interpreting the results causally. Nonetheless, the association between maternal presence in adolescence and cessation in adulthood found in this study may offer important insights regarding the possible long-term effect of early family experiences on later substance use behaviour.

## 5.6 Conclusions

This chapter has examined the effects of parent-adolescent relationships on substance use cessation in adulthood and found that maternal presence in adolescence may be an important determinant of substance use cessation in adulthood. This study has also revealed religiosity to be another critical factor with respect to cessation.

These findings suggest some broad ideas for policy and practice. First, for employed mothers, workplace flexibility options could be important in allowing them to be more physically available to their adolescents. Greater efforts are thus needed from the government to encourage home-based or family-friendly work practices and to promote work flexibility both in organisations and for employed parents. This is particular relevant to the current US approach to work-family policy, where social provisions (such as paid family leave, childcare

assistance and schedule flexibility) are limited and are usually accessed by individuals with higher socio-economic status (Collins, 2016). Second, parenting programmes could promote the idea of 'simply being there' to raise an awareness of the importance of parental presence before school, after school, and in the evening, as well as young people's sense of security that could be provided by parental presence and availability.

**Appendix 5A.1 Descriptive statistics for respondents who reported recent cigarette use (in the past 30 days) at the Wave 3 interview (N=876)**

| Variable | Range of Values Min | Max | Mean (SD) or % |
|---|---|---|---|
| **Outcome variable, Wave 4** | | | |
| Cigarette cessation (absence of use in the past 30 days) | 0 | 1 | 27.2 |
| **Variables of interest, Wave 1** | | | |
| Paternal warmth (standardised) | -4.15 | 1.37 | -0.11 (1.04) |
| Parental control (both parents; standardised) | -2.00 | 4.06 | -0.03 (0.91) |
| Paternal presence (standardised) | -2.75 | 1.86 | -0.04 (0.99) |
| **Control variables, Wave 1** | | | |
| Age | 13 | 18 | 15.4 (1.64) |
| Female | 0 | 1 | 50.9 |
| White | 0 | 1 | 81.3 |
| African-American | 0 | 1 | 7.19 |
| American-Indian/Asian/Mixed/Others | 0 | 1 | 11.5 |
| Intact family | 0 | 1 | 75.7 |
| Step-parent family | 0 | 1 | 19.5 |
| Single-parent family | 0 | 1 | 4.79 |
| [Parent]Not in employment | 0 | 1 | 4.57 |
| [Parent]Elementary/construction/military | 0 | 1 | 58.2 |
| [Parent]Office worker/service/sale | 0 | 1 | 7.31 |
| [Parent]Manager/technician/nurse/professional | 0 | 1 | 29.9 |
| Father smokes | 0 | 1 | 69.3 |
| First cigarette use at age 16 or below | 0 | 1 | 55.9 |
| **Control variables, Wave 3** | | | |
| Depression (standardised) | -1.35 | 5.32 | 0.08 (1.01) |
| **Control variables, Wave 4** | | | |
| High school graduate or below | 0 | 1 | 27.1 |
| Completed a GED/vocational school | 0 | 1 | 47.2 |
| A bachelor's degree | 0 | 1 | 19.5 |
| Above degree | 0 | 1 | 6.28 |
| Employment status | 0 | 1 | 68.8 |
| Married | 0 | 1 | 58.0 |
| Presence of child(ren) | 0 | 1 | 44.9 |
| Religiosity (standardised) | -1.58 | 2.19 | -0.32 (0.91) |

Notes: This table represents the model estimating the effects of paternal-youth relationships in Wave 1 on cigarette cessation in Wave 4. More detail in variable measurements and scales can be found in Chapter 2.

**Appendix 5A.2 Descriptive statistics for respondents who reported recent alcohol use (in the past 30 days) at the Wave 3 interview (N=1,879)**

| Variable | Range of Values Min | Max | Mean (SD) or % |
|---|---|---|---|
| **Outcome variable, Wave 4** | | | |
| Alcohol cessation (absence of use in the past 30 days) | 0 | 1 | 15.9 |
| **Variables of interest, Wave 1** | | | |
| Paternal warmth (standardised) | -4.16 | 1.38 | 0.01 (0.99) |
| Parental control (both parents; standardised) | -1.94 | 3.84 | -0.07 (0.92) |
| Paternal presence (standardised) | -2.75 | 1.96 | -0.03 (0.96) |
| **Control variables, Wave 1** | | | |
| Age | 13 | 18 | 15.4 (1.63) |
| Female | 0 | 1 | 52.7 |
| White | 0 | 1 | 76.4 |
| African-American | 0 | 1 | 10.9 |
| American-Indian/Asian/Mixed/Others | 0 | 1 | 12.7 |
| Intact family | 0 | 1 | 81.2 |
| Step-parent family | 0 | 1 | 15.1 |
| Single-parent family | 0 | 1 | 3.73 |
| [Parent]Not in employment | 0 | 1 | 3.57 |
| [Parent]Elementary/construction/military | 0 | 1 | 52.8 |
| [Parent]Office worker/service/sale | 0 | 1 | 8.04 |
| [Parent]Manager/technician/nurse/professional | 0 | 1 | 35.6 |
| Father's high alcohol use ( i.e. more than two to three days per month ) | 0 | 1 | 45.2 |
| First alcohol use at age 16 or below | 0 | 1 | 55.6 |
| **Control variables, Wave 3** | | | |
| Depression (standardised) | -1.35 | 4.92 | -0.05 (0.94) |
| **Control variables, Wave 4** | | | |
| High school graduate or below | 0 | 1 | 16.1 |
| Completed a GED/vocational school | 0 | 1 | 40.2 |
| A bachelor's degree | 0 | 1 | 26.8 |
| Above degree | 0 | 1 | 16.9 |
| Employment status | 0 | 1 | 68.4 |
| Married | 0 | 1 | 61.1 |
| Presence of child(ren) | 0 | 1 | 40.6 |
| Religiosity (standardised) | -1.73 | 2.19 | -0.16 (0.99) |

Notes: This table represents the model estimating the effects of paternal-youth relationships in Wave 1 on alcohol cessation in Wave 4. More detail in variable measurements and scales can be found in Chapter 2.

**Appendix 5A.3 Descriptive statistics for respondents who reported recent marijuana use (in the past 30 days) at the Wave 3 interview (N=602)**

| Variable | Range of Values Min | Max | Mean (SD) or % |
|---|---|---|---|
| **Outcome variable, Wave 4** | | | |
| Marijuana cessation (absence of use in the past 30 days) | 0 | 1 | 56.1 |
| **Variables of interest, Wave 1** | | | |
| Paternal warmth (standardised) | -3.33 | 1.36 | -0.12 (1.03) |
| Parental control (both parents; standardised) | -1.90 | 4.06 | -0.06 (0.97) |
| Paternal presence (standardised) | -2.75 | 1.86 | -0.06 (0.98) |
| **Control variables, Wave 1** | | | |
| Age | 13 | 18 | 15.2 (1.65) |
| Female | 0 | 1 | 43.4 |
| White | 0 | 1 | 77.1 |
| African-American | 0 | 1 | 10.6 |
| American-Indian/Asian/Mixed/Others | 0 | 1 | 12.3 |
| Intact family | 0 | 1 | 76.9 |
| Step-parent family | 0 | 1 | 17.4 |
| Single-parent family | 0 | 1 | 5.65 |
| [Parent]Not in employment | 0 | 1 | 5.15 |
| [Parent]Elementary/construction/military | 0 | 1 | 51.7 |
| [Parent]Office worker/service/sale | 0 | 1 | 7.81 |
| [Parent]Manager/technician/nurse/professional | 0 | 1 | 35.4 |
| Father smokes | 0 | 1 | 66.4 |
| First marijuana use at age 16 or below | 0 | 1 | 57.5 |
| **Control variables, Wave 3** | | | |
| Depression (standardised) | -1.35 | 4.34 | 0.08 (0.98) |
| **Control variables, Wave 4** | | | |
| High school graduate or below | 0 | 1 | 23.9 |
| Completed a GED/vocational school | 0 | 1 | 41.2 |
| A bachelor's degree | 0 | 1 | 25.3 |
| Above degree | 0 | 1 | 9.63 |
| Employment status | 0 | 1 | 70.9 |
| Married | 0 | 1 | 53.5 |
| Presence of child(ren) | 0 | 1 | 34.4 |
| Religiosity (standardised) | -1.73 | 2.19 | -0.42 (0.91) |

Notes: This table represents the model estimating the effects of paternal-youth relationships in Wave 1 on marijuana cessation in Wave 4. More detail in variable measurements and scales can be found in Chapter 2.

**Appendix 5A.4 Descriptive statistics for respondents who reported recent use of any illicit drug (including marijuana) (in the past 30 days) at the Wave 3 interview (N=623)**

| Variable | Range of Values Min | Max | Mean (SD) or % |
|---|---|---|---|
| **Outcome variable, Wave 4** | | | |
| Any illicit drug cessation (absence of use in the past 30 days) | 0 | 1 | 52.5 |
| **Variables of interest, Wave 1** | | | |
| Paternal warmth (standardised) | -3.33 | 1.36 | -0.12 (1.03) |
| Parental control (both parents; standardised) | -1.90 | 4.06 | -0.06 (0.97) |
| Paternal presence (standardised) | -2.75 | 1.86 | -0.06 (0.99) |
| **Control variables, Wave 1** | | | |
| Age | 13 | 18 | 15.2 (1.65) |
| Female | 0 | 1 | 43.5 |
| White | 0 | 1 | 77.1 |
| African-American | 0 | 1 | 10.6 |
| American-Indian/Asian/Mixed/Others | 0 | 1 | 12.4 |
| Intact family | 0 | 1 | 76.4 |
| Step-parent family | 0 | 1 | 17.8 |
| Single-parent family | 0 | 1 | 5.78 |
| [Parent]Not in employment | 0 | 1 | 5.14 |
| [Parent]Elementary/construction/military | 0 | 1 | 52.2 |
| [Parent]Office worker/service/sale | 0 | 1 | 7.54 |
| [Parent]Manager/technician/nurse/professional | 0 | 1 | 35.2 |
| Father smokes | 0 | 1 | 66.3 |
| First any illicit drug use (including marijuana) at age 16 or below | 0 | 1 | 61.2 |
| **Control variables, Wave 3** | | | |
| Depression (standardised) | -1.35 | 4.34 | 0.08 (0.98) |
| **Control variables, Wave 4** | | | |
| High school graduate or below | 0 | 1 | 23.8 |
| Completed a GED/vocational school | 0 | 1 | 41.4 |
| A bachelor's degree | 0 | 1 | 25.2 |
| Above degree | 0 | 1 | 9.63 |
| Employment status | 0 | 1 | 70.6 |
| Married | 0 | 1 | 53.8 |
| Presence of child(ren) | 0 | 1 | 34.7 |
| Religiosity (standardised) | -1.73 | 2.19 | -0.43 (0.90) |

Notes: This table represents the model estimating the effects of paternal-youth relationships in Wave 1 on any illicit drug cessation in Wave 4. More detail in variable measurements and scales can be found in Chapter 2.

**Appendix 5B Cross-tabulation of any illicit drug use (including marijuana) in the past 30 days between Wave 3 and Wave 4 (in %; N=3,611)**

| *W4* / *W3* | Not at all | 1-3 days per month | 4-20 days per month | 21-30 days per month |
|---|---|---|---|---|
| **Not at all** | 91.54 | 3.59 | 2.62 | 2.26 |
| **1-9 times per month** | 66.29 | 15.16 | 8.60 | 9.95 |
| **10-28 times per month** | 38.30 | 18.62 | 20.74 | 22.34 |
| **29+ times per month** | 32.81 | 11.98 | 20.31 | 34.90 |
| **All** | 82.55 | 6.23 | 5.23 | 5.98 |

Notes: The content of the Add Health questionnaires regarding the key substance use measures across waves was revised to be more relevant to different age periods. Questions on other illicit drug use asked in Waves 1-3 are slightly different from the questions asked in Wave 4. The number of *times* respondents had used the substance in the past 30 days is asked in Waves 1-3, and the number of *days* respondents had used the substance in the past month is asked in Wave 4.

# Chapter 6

# Dimensions of religiosity: The effects of attendance at religious services and of religious faith on substance use cessation

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## 6.1 Introduction

There is a well-established association between religiosity and health outcomes. A study of Koenig (2012) provided a comprehensive review of research on religion/spirituality and physical and mental health across various disciplines over the past 15 decades. He found strong evidence for the association between religion/spirituality and a wide range of health-related outcomes, such as happiness, healthy behaviours, suicide attempts, substance abuse and mortality rate. Several possible explanations can explain the association, including the resources provided by religion for coping with stress, a subjective sense of control over events, rules and rituals that help prevent stressful life events like divorce, and a strong discouragement to use drugs and excessive amounts of alcohol (Koenig, 2012). In recognition of the importance of religion in health outcomes, international organisations, such as the World Health Organisation, have encouraged countries to include religion in their health care policies, such as tobacco control interventions (El Awa, 2004).

Previous studies have established that levels of religiosity are protective against substance use. They invariably show that individuals who had higher levels of religiosity are more likely to abstain from substances (Ayers et al., 2009; Hope & Cook, 2001; Koenig et al., 1998; Whooley et al., 2002), and even if they have initiated, they tend to have lower levels of substance use and fewer substance use problems (Ayers et al, 2009; Desmond, Ulmer & Bader, 2013; Edlund et al., 2010; Kendler et al., 2003; Koenig et al., 1998; Koenig, 2012; Koenig & Vaillant, 2009; Luczak et al., 2003; Marsiglia et al., 2005; Nakash et al., 2016; Whooley et al., 2002; Wills, Yaeger & Sandy, 2003). There is, however, a notable paucity of studies investigating the relationship between religiosity and substance use cessation. Brown et al. (2014) and Whooley et al. (2002) found that church attendance was positively associated with cigarette cessation but Koenig et al. (1998) found little evidence for the association. These

studies have only focused on cigarette cessation and have suffered from small sample size. More importantly, they could not address causality or determine the direction of the relationship between religiosity and substance use cessation due to their correlational nature. Therefore the purpose of this study is to explore the effect of religiosity on a range of substance use cessation (cigarette, alcohol, marijuana and any illicit drug) using the national, longitudinal Add Health data set. In particular, this research attempts to identify causality via propensity score matching (PSM) techniques, which will be further discussed below.

One major issue in religion research is the measurement of religiosity. In research, religiosity is a latent construct that cannot be observed or directly measured but can be inferred from other observed variables. It consists of a complex multidimensional construct that the meaning of which cannot be captured by any single measure or dimension (Miller & Thoresen, 2003). Once researchers conceptualise religiosity as containing multiple dimensions and then operationalise these dimensions, the definition of it may then become clearer (Miiller & Thoresen, 2003). Two dimensions of religiosity are often used as proxies for measuring levels of religiosity: *religious behaviour* indicated by the frequency of church attendance and *religious devotion* assessed by individuals' ratings of the importance of religious faith or religious belief to them personally. Studies have found both dimensions to be a protective factor with regard to substance use, though there is disagreement about their relative importance. Mitchell and Weatherly (2000) showed that church attendance was positively related to mental well-being and negatively associated with depression, whereas religious faith did not predict any of the outcome variables. Rasic et al. (2011) and Edlund et al. (2010) demonstrated that both strong religious faith and attendance were related to low alcohol and drug use, although Edlund et al. (2010) found that the odds ratios were larger in relation to church attendance. In contrast, Kulis et al. (2012) showed that there was no effect of attendance at religious services on any substance use outcomes. However, they found that strong religious beliefs, a scale that reflected the importance to respondents of following traditional Indian or Christian beliefs, was associated with lower alcohol and cigarette consumption. This may be explained by the links provided by the Indian and Christian beliefs to cultural heritage, established values systems and traditions, which may, in turn, protect against substance use (Kulis et al., 2012). A parallel study by Miller and Gur (2002) on religiosity and sexual responsibility showed that a high level of personal devotion, which was derived from two measures, namely, the frequency respondents prayed and self-rated religious faith, and a high frequency of church attendance were associated with a lower

number of sexual partners and greater foresight of suffering in the event of contracting HIV or pregnancy from unprotected intercourse. However, their study found that only attendance at religious services was related to responsible birth control use while personal devotion was not. The conflicting results suggest that it remains unclear whether the changes in substance use are a result of religious behaviour or religious devotion. Investigating the various effects of these two dimensions of religiosity is important as this could affect how the collaboration between healthcare services and religious communities should be promoted and delivered.

One problem which arises in considering the relationship between the two dimensions of religiosity and later cessation is the difficulty of identifying whether the relationship is causal. It is likely that, for instance, individuals living in a rural area, whose characteristics include stronger kinship and social networks, greater social control, family cohesion, prosocial peer groups, are more likely to attend religious services or are more devoted to religion and have higher rates of substance use cessation (i.e. a confounding bias). Given that it is not practical or ethical to experimentally manipulate church attendance or religious faith, this study uses propensity score matching (PSM) techniques to control for selection on observables and to identify possible causal effects of church attendance and religious faith on substance use cessation (Rosenbaum & Rubin, 1983, 1984, 1985).

The Add Health data set is well suited for PSM. As discussed in Chapter 2, the data set contains rich information on respondents' religiosity and substance use behaviour, as well as factors influencing these actions. In particular, Add Health provides data on parents' attendance at religious services and ratings of the importance of religious faith. This could help satisfy the assumption of PSM that important factors affecting individuals' religiosity are observable and can be controlled, and thus the likelihood of omitted bias could be minimised.

This paper holds significant implications for designing cost-effective policy tools to advocate health-related behaviour through religion. No known empirical research has used PSM to explore and compare the effects of attendance at religious services (religious *behaviour*) and of religious faith (religious *devotion*) on substance use cessation. The use of PSM and a longitudinal data set could potentially rule out whether the effects are causal.

In the empirical analysis for this chapter, the term 'cessation' refers to absence of substance use in the past month/year at Wave 4 among respondents who reported having used the substance in the past month at Wave 3.

## 6.2 Methodology

This study uses Waves 1, 3, and 4 from the Add Health data set. The sample is restricted to respondents who reported having used (a) cigarettes, (b) alcohol, (c) marijuana, or (d) any illicit drugs (including cocaine, crystal meth, marijuana and other types of illegal drugs) in the past 30 days in the Wave 3 interview. The sample size varies depending on the type of substance (*N*=671-2,113): being highest for alcohol and lowest for marijuana. A detailed flowchart showing the derivation of the analytical sample is outlined in Diagram 2.4.

The outcome variables of the analyses are respondents who reported not having used cigarette, alcohol, marijuana, or any illicit drug (including marijuana) in the past 30 days in Wave 4. Given that the analysis is restricted to respondents who reported having used the substance in the past month at Wave 3, the 'non-use' category at Wave 4 should conclusively demonstrate a change in use level from Wave 3 to Wave 4.

Church attendance frequency and religious faith are measured at Wave 4. For church attendance frequency, respondents were asked how often they had attended church, synagogue, temple, mosque, or religious services in the past year. A binary variable is generated in which 1 denotes respondents who attended once a week or more and 0 denotes otherwise. Religious faith is dichotomised with 'very important' and 'more important than anything else' combined as one category and 'somewhat important' and 'not important' as the other.

A set of variables is controlled in the PSM models based on previous empirical research that may be associated with both the religiosity dimensions and substance use cessation or with the cessation only (Brookhart et al., 2006; Caliendo & Kopeinig, 2008; Rubin, 2001). The control variables measured in Wave 1 include sample members' age, gender, ethnicity, household type, parents' educational level (high school graduates or below, completed a GED/vocational school training, and a bachelor's degree or above), and maternal cigarette and alcohol consumption. Four continuous variables indicating the level of cigarette, alcohol, marijuana or any illicit drug use in the past 30 days measured in Wave 3 are controlled, given that various levels of use may affect the probability of cessation later in life. The analysis also controls for Wave 4 variables: depression (16 items, $\alpha$= 0.88; Lasser et al., 2000), educational level (high school graduates or below, completed a GED/vocational school training, and a bachelor's degree or above), employment status, marital status, presence of child(ren) (Bachman et al., 2002), respondents' living area (Martino, Ellickson & McCaffrey, 2008), and a

continuous indicator of age at first substance use that uses data from Waves 1 to 4 (Breslau & Peterson, 1996).

Additionally and crucially, religiosity in the household in which respondents grew up is also matched on in the PSM models: parents' self-reported church attendance frequency and religious faith[16] (Kliewer & Murrelle, 2007). Both variables are measured in the Wave 1 interview. Together with the other covariates, the balancing property holds for the matched sample. This means that, the treatment group and the control group share the same average value of each of these observed covariates. In other words, there will be no difference in terms of religious upbringing, demographic backgrounds, depression, and previous levels of substance use between the treatment and control groups after matching. The effects of church attendance and religious faith are therefore no longer affected by all of these important factors that may determine individuals' current levels of religiosity.

In this study, both logistic regression and PSM estimation methods are used to estimate the relationship between church attendance frequency and importance of religious and the rate of cessation in Wave 4. Epanechnikov kernel matching with 0.05 bandwidths is applied to calculate the average treatment effect for the treated (ATT). Standard errors are computed using bootstrapping techniques with 100 replications. Missing data are handled with listwise deletion as statistical software such as Stata is not currently able to estimate PSM using the techniques of multiple imputation. A fuller discussion of the implementation of PSM is presented in Chapters 2 and 3.

The analysis is repeated with two sample specifications: (a) respondents who have lower levels of church attendance frequency (i.e. 'less than once a week') or religious faith (i.e. 'somewhat or not important'), and (b) respondents who are classified as the top 20 per cent of heaviest users, in the Wave 3 interview.

## 6.3 Results

Tables 6.1 and 6.2 present the means and standard deviations or percentages for the observed variables by church attendance and religious faith on a sample who reported using alcohol in Wave 3. Descriptive statistics are similar across different samples using various

[16] Parental church attendance frequency is included in the models estimating the effect of respondents' church attendance on cessation, whereas parental religious faith is included in the models estimating the effect of religious faith.

substances (see Appendix 6A.1-6A.3 for church attendance and Appendix 6B.1-6B.3 for religious faith). In general, both tables show that female and non-White respondents are likely to have higher levels of church attendance frequency and religious faith. Frequent attenders tend to come from an intact family, yet the difference between respondents with high and low levels of religious faith is small. Parents of more religious respondents (i.e. high levels of attendance and/or religious faith) consume less alcohol, are more likely to be frequent church attenders, and have higher levels of religious faith. More religious respondents are also likely to have lower levels of daily alcohol intake and depression, be unemployed and married, and have at least one child. Moreover, they tend to postpone the age at which they had their first drink and report not having used alcohol recently in Wave 4. Parents' and respondents' education and whether respondents live in a rural or suburban area are evenly distributed between high and low levels of church attendance and religious faith.

The descriptive statistics indicate that frequent church attenders and respondents with high levels of religious faith tend to possess characteristics (e.g. low levels of maternal alcohol consumption and respondents' depression) that favour more positive outcomes. It then becomes unclear whether it is the religion, either church attendance or religious faith, that is driving substance use cessation or whether it is the shared characteristics that affect cessation.

**Table 6.1 Descriptive statistics for respondents who reported recent alcohol use in the Wave 3 interview by church attendance**

| | High attendance (once a week or more) | Low attendance (less than once a week) |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD) or %** |
| ***Wave 1*** | | |
| Age | 15.6 (1.57) | 15.3 (1.60) |
| Female | 67.0 | 54.5 |
| White | 58.7 | 75.8 |
| African-American | 26.1 | 12.6 |
| American-Indian/Asian/Mixed/Others | 15.2 | 11.7 |
| Intact family | 68.1 | 62.1 |
| Step-parents family | 8.3 | 12.4 |
| Single-parent family | 23.6 | 25.6 |
| Maternal high alcohol use[1] | 13.4 | 27.1 |
| Parental church attendance frequency[2] | 3.34 (0.98) | 2.69 (1.15) |
| [Parental] high school graduates or below | 34.4 | 36.2 |
| [Parental] completed a GED/vocational school training | 31.5 | 32.6 |
| [Parental] a bachelor's degree or above | 34.1 | 31.3 |
| ***Wave 3*** | | |
| Daily alcohol intake in the past 30 days | 0.58 (1.30) | 0.88 (1.59) |
| ***Wave 4*** | | |
| Depression (standardised) | -0.20 (0.85) | -0.06 (0.96) |
| High school graduates or below | 17.3 | 13.4 |
| Completed a GED/vocational school training | 43.3 | 41.3 |
| A bachelor's degree or above | 39.4 | 45.3 |
| Employed | 64.9 | 69.7 |
| Married | 58.0 | 39.3 |
| Cohabitation | 9.78 | 20.6 |
| Single/legally separated | 32.2 | 40.0 |
| Presence of child(ren) | 57.2 | 40.9 |
| Living in rural/suburban | 63.8 | 63.3 |
| Age at first alcohol use | 16.7 (3.08) | 15.9 (2.93) |
| Alcohol cessation (absence of use in the past 30 days) | 29.0 | 14.5 |
| **Total N** | **276** | **1,837** |

Notes: The table presents column percentages and shows, for instance, that of respondents with higher levels of church attendance frequency (once a week or more), 67% are females. Of respondents with lower levels of church attendance frequency (less than once a week), 55% are females.[1]Consumed alcohol more than 2 to 3 days per month. [2]A four-point scale ranging from 'never attended church' to 'once a week or more'.

**Table 6.2 Descriptive statistics for respondents who reported recent alcohol use in the Wave 3 interview by religious faith**

| | Very important/most important | Somewhat important/not important |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD) or %** |
| ***Wave 1*** | | |
| Age | 15.4 (1.61) | 15.4 (1.59) |
| Female | 60.8 | 51.4 |
| White | 64.1 | 83.6 |
| African-American | 23.3 | 4.82 |
| American-Indian/Asian/Mixed/Others | 12.5 | 11.6 |
| Intact family | 62.5 | 63.0 |
| Step-parents family | 11.0 | 12.9 |
| Single-parent family | 26.5 | 24.1 |
| Maternal high alcohol use[1] | 20.7 | 30.1 |
| Parental religious faith[2] | 3.67 (0.71) | 3.16 (0.98) |
| [Parental] high school graduates or below | 35.8 | 36.3 |
| [Parental] completed a GED/vocational school training | 33.3 | 31.4 |
| [Parental] a bachelor's degree or above | 30.9 | 32.3 |
| ***Wave 3*** | | |
| Daily alcohol intake in the past 30 days | 0.71 (1.36) | 1.00 (1.74) |
| ***Wave 4*** | | |
| Depression (standardised) | -0.07 (0.94) | -0.09 (0.96) |
| High school graduates or below | 15.0 | 18.8 |
| Completed a GED/vocational school training | 43.9 | 42.3 |
| A bachelor's degree or above | 41.1 | 38.9 |
| Employed | 66.1 | 71.9 |
| Married | 46.1 | 37.1 |
| Cohabitation | 15.3 | 23.6 |
| Single/legally separated | 38.6 | 39.3 |
| Presence of child(ren) | 48.2 | 37.7 |
| Living in rural/suburban | 63.2 | 63.3 |
| Age at first alcohol use | 16.4 (3.07) | 15.7 (2.79) |
| Alcohol cessation (absence of use in the past 30 days) | 20.1 | 12.4 |
| **Total N** | **1,093** | **1,016** |

Notes: The table presents column percentages and shows, for instance, that of those respondents with higher levels of religious faith (very/most important), 61% are females. Of respondents with lower levels of religious faith (somewhat/not important), 51% are females.[1]Consumed alcohol more than 2 or 3 days per month. [2]The variable measures parental importance of religious faith; a four-point scale ranging from 'not important at all' to 'very important'.

### *6.3.1 Religiosity and substance use cessation: Results from PSM*

To disentangle and compare the effects of church attendance and religious faith on the rate of cessation, they are examined in separate models using logistic regression and PSM methods. In Tables 6.3 and 6.4, three estimates are reported – odds ratios from unadjusted logistic regression models, odds ratios from logistic regression models after controlling for all the observed covariates, and the ATT from the PSM models where the covariates are included. Nearly all PSM estimates achieve successful matching (unless specified in the table notes), meaning that the matching is high-quality.

In Table 6.3, results from both unadjusted and adjusted logistic regressions indicate that church attendance frequency is associated with substance use cessation. The odds ratios in the adjusted logistic regression models for the whole sample range from 2.08 to 3.27. The protective effect of church attendance remains significant in the two specific subsamples: infrequent church attenders and the top 20 per cent of heaviest substance users in Wave 3. Results obtained from the PSM models show that the effects of church attendance drop sharply after controlling for the observed variables and confounding bias. Most notably, for the top 20 per cent of heaviest alcohol users, the odds of frequent church attenders quitting alcohol reduce from 4.57 (shown in the adjusted logistic regression) to 1.22 (indicated in the PSM estimation). Although the association between church attendance and substance use cessation is weaker in the PSM models, all estimates remain statistically significant.

With respect to another dimension of religiosity, Table 6.4 shows that religious faith predicts alcohol cessation. The statistical significance of the odds ratios is reduced substantially after adjusting for the covariates. Of the whole sample and of the sample who reported having low levels of religious faith in the Wave 3 interview, the effect of religious faith stops being statistically significant at the 5% level in the PSM estimations. For the top 20 per cent of heaviest alcohol users, the effect of religious faith remains significant in the PSM regressions. These results suggest that not taking into account the confounding bias may overestimate the effect of religious faith on alcohol cessation. No significant association is found between religious faith and other substance use cessation.

All analyses are replicated using alternative outcome variables that indicate the absence of substance use in the past 12 months[17], a longer cessation period (see Appendix 6C

[17] Cigarette non-use in the past 12 months was not asked in the Wave 4 survey.

& 6D). Results are nearly identical, which further provide a solid evidence base for the protective effect of church attendance on cessation.

**Table 6.3 Church attendance and substance use cessation (absence of use in the past 30 days)**

| | Logit (unadjusted) | | Logit | | ATT | | Total N |
|---|---|---|---|---|---|---|---|
| | OR | (SE) | OR | (SE) | OR | (SE) | |
| ***The whole sample*** | | | | | | | |
| **Cigarette cessation** | 2.526 | (0.576)*** | 2.293 | (0.590)** | 1.203 | (0.071)** | 977 |
| **Alcohol cessation** | 2.411 | (0.358)*** | 2.075 | (0.345)*** | 1.102 | (0.030)*** | 2,113 |
| **Marijuana cessation** | 3.367 | (1.283)** | 3.035 | (1.247)** | 1.203 | (0.078)** | 673 |
| **Any illicit drug cessation (including marijuana)** | 3.544 | (1.293)** | 3.269 | (1.254)** | 1.264 | (0.078)*** | 695 |
| ***Infrequent church attenders in Wave 3*** | | | | | | | |
| **Cigarette cessation** | 2.292 | (0.599)** | 2.156 | (0.638)** | 1.184 | (0.069)* | 897 |
| **Alcohol cessation** | 2.240 | (0.430)*** | 1.860 | (0.395)** | 1.090 | (0.039)* | 1,813 |
| **Marijuana cessation** | 3.149 | (1.361)** | 2.785 | (1.309)* | 1.213 | (0.100)* | 628 |
| **Any illicit drug cessation (including marijuana)** | 3.290 | (1.345)** | 2.943 | (1.265)* | 1.247 | (0.093)** | 649 |
| ***Top 20% substance users in Wave 3*** | | | | | | | |
| **Cigarette cessation** | 2.868 | (0.890)** | 2.332 | (0.836)* | 1.196 | (0.083)* | 652 |
| **Alcohol cessation** | 5.541 | (1.757)*** | 4.569 | (1.700)*** | 1.218 | (0.084)** | 656 |
| **Marijuana cessation** | 2.936 | (1.241)* | 2.736 | (1.229)* | 1.223 | (0.114)* | 520 |
| **Any illicit drug cessation (including marijuana)** | 3.506 | (1.464)** | 3.657 | (1.603)** | 1.272 | (0.116)** | 559 |

Notes: Column Logit (unadjusted) presents unadjusted odds ratios of different substance use cessation on church attendance. Column Logit shows odds ratios adjusting for a set of variables measured in Wave 1: age, female, ethnicity, household type, parental educational level, maternal cigarette/alcohol use, parents' self-reported church attendance frequency; the level of substance use in the past month measured in Wave 3; depression index, educational level, employment status, marital status, presence of child(ren), and rural/suburban living area, measured in Wave 4; and first at onset measured in all waves. Column ATT presents ATT estimates from PSM models using Epanechnikov kernel matching with 0.05 bandwidths; common support condition is imposed. The models control all covariates mentioned above. ATT standard errors in parentheses are computed by bootstrapping with 100 replications. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

**Table 6.4 Religious faith and substance use cessation (absence of use in the past 30 days)**

| | Logit (unadjusted) | | Logit | | ATT | | Total N |
|---|---|---|---|---|---|---|---|
| | OR | (SE) | OR | (SE) | OR | (SE) | |
| ***The whole sample*** | | | | | | | |
| **Cigarette cessation** | 1.142 | (0.172) | 1.168 | (0.199) | 1.028 | (0.032) | 977 |
| **Alcohol cessation** | 1.780 | (0.216)*** | 1.421 | (0.198)* | 1.040 | (0.026) | 2,109 |
| **Marijuana cessation** | 1.194 | (0.190) | 1.148 | (0.209) | 1.006 | (0.048) | 671 |
| **Any illicit drug cessation (including marijuana)** | 1.183 | (0.184) | 1.118 | (0.195) | 1.015 | (0.042) | 694 |
| ***Respondents with low levels of religious faith in Wave 3*** | | | | | | | |
| **Cigarette cessation** | 1.169 | (0.267) | 1.236 | (0.320) | 1.043 | (0.054) | 556 |
| **Alcohol cessation** | 1.857 | (0.350)** | 1.577 | (0.342)* | 1.053 | (0.031)✞ | 1,061 |
| **Marijuana cessation** | 1.258 | (0.307) | 1.276 | (0.350) | 1.037 | (0.070)[1] | 406 |
| **Any illicit drug cessation (including marijuana)** | 1.235 | (0.295) | 1.253 | (0.328) | 1.026 | (0.068) | 420 |
| ***Top 20% substance users in Wave 3*** | | | | | | | |
| **Cigarette cessation** | 1.031 | (0.209) | 1.084 | (0.249) | 1.019 | (0.037) | 652 |
| **Alcohol cessation** | 2.493 | (0.682)** | 2.221 | (0.702)* | 1.068 | (0.029)* | 654 |
| **Marijuana cessation** | 1.119 | (0.201) | 1.073 | (0.221) | 0.997 | (0.058) | 518 |
| **Any illicit drug cessation (including marijuana)** | 1.136 | (0.197) | 1.068 | (0.208) | 1.020 | (0.056) | 558 |

Notes: Column Logit (unadjusted) presents unadjusted odds ratios of different substance use cessation on religious faith. Column Logit shows odds ratios adjusting for a set of variables measured in Wave 1: age, female, ethnicity, household type, parental educational level, maternal cigarette/alcohol use, parents' self-reported religious faith; the level of substance use in the past month measured in Wave 3; depression index, educational level, employment status, marital status, presence of child(ren), and rural/suburban living area, measured in Wave 4; and first at onset measured in all waves. Column ATT presents ATT estimates from PSM models using Epanechnikov kernel matching with 0.05 bandwidths; common support condition is imposed. The models control all covariates mentioned above. ATT standard errors in parentheses are computed by bootstrapping with 100 replications. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. [1]The percentage of average covariate balance is larger than the threshold 5%; the ATT estimate should be interpreted with caution.

Post hoc tests are carried out using the z test to compare the ATT coefficients (log odds) of church attendance and religious faith across models (Clogg, Petkova & Haritou, 1995; Paternoster, Brame & Piquero, 1998). Results (shown in Appendix 6E) demonstrate that the coefficients of the two religiosity dimensions are significantly different (i.e. the z-value is greater than 1.96 or lower than -1.96) in the models for the whole sample, apart from the alcohol-cessation model. Of the sample who reported having low levels of attendance and/or faith in Wave 3, no significant differences are found between the coefficients of church attendance and religious faith, aside from the any illicit-drug-cessation model where the effect of church attendance appears to be more pronounced (the difference between the two religious dimension coefficients is significant at the 10% level in which the z-statistics lay between 1.64-1.96). Of the heavy substance users in Wave 3, the effects of church attendance and religious faith are significantly different (albeit only at the 10% level for the alcohol- and marijuana-cessation models). Different effects of the two religious dimensions suggest that the relationship between religiosity and substance use cessation could vary depending on the dimensions being tested. The post hoc tests indicate that the effect of church attendance is somewhat more salient than religious faith.

In order to take full advantage of the longitudinal data set, an additional analysis is carried out which takes advantage of the fact that the Add Health data set measures religiosity at multiple points in time. No previous study on the religion-cessation relationship has done this, however it is clearly of great potential importance given that there has always been an issue in establishing the causality of the relationship between religiosity and substance use (and other health outcomes; e.g. Edlund et al., 2010; Koenig, 2012; Lim & Putnam, 2010; Rasic et al., 2011).

Given the greater protective effect of church attendance, I explore the interaction effects of Wave 3 and Wave 4 church attendance on substance use cessation in Wave 4. The measurement of church attendance frequency is identical in these two waves. Logistic regression is used for the analysis conducted on the sample who reported recent substance use in the Wave 3 interview. Four categories are generated: (a) respondents who reported having low levels of church attendance in both waves (the reference category); (b) respondents with low levels of church attendance in Wave 3 but high levels in Wave 4; (c) respondents who reported high levels of attendance in Wave 3 but low levels in Wave 4; and (d) respondents who reported high levels in both waves. Table 6.5 indicates that individuals

who have been frequent churchgoers in both waves are two to four times the odds more likely not to use the substance in Wave 4 than those who have low levels of attendance in both waves (although this is only significant for cigarette and alcohol cessation). Respondents who become frequent churchgoers also have a higher probability of substance use cessation in Wave 4. It is important to note that this analysis is unable to identify the causality of the relationship between church attendance and cessation; it is possible that cessation may have happened before respondents become frequent attenders. However, what this table shows here is the change of substance use behaviour when respondents reported having increased the frequency of church attendance.

Furthermore, the table indicates that respondents who reduced their levels of attendance between the Wave 3 and Wave 4 interviews are less likely to stop using marijuana, compared to those who reported having low levels of attendance in both waves. This result is interesting. While it may be logical to assume that religious participation at any point in life would have a protective effect against substance use, this finding indicates that a reduction in participation may have a greater negative effect than low participation at all times. A possible explanation is that those who reduced their attendance, at least from once a week or more to less than once week, may be particularly vulnerable to longer-term substance use. Another alternative explanation could be that outside influences may lead substance users to continue using substances, which in turn reduces their attendance at church. Taken together, results from Table 6.5 suggest that current attendance is critical to the absence of recent use.

**Table 6.5 Interaction effects of Wave 3 and Wave 4 church attendance on substance use cessation (absence of use in the past 30 days)**

| | Cigarette cessation<br><br>OR (SE) | Alcohol cessation<br><br>OR (SE) | Marijuana cessation<br><br>OR (SE) | Any illicit drug cessation (including marijuana)<br>OR (SE) |
|---|---|---|---|---|
| **Low in W3 but high in W4** | 2.224 (0.654)** | 1.895 (0.398)** | 2.759 (1.299)* | 2.913 (1.252)* |
| **High in W3 but low in W4** | 1.125 (0.406) | 1.299 (0.294) | 0.435 (0.176)* | 0.578 (0.227) |
| **High on both waves** | 2.644 (1.256)* | 2.487 (0.600)*** | 2.880 (2.387) | 3.793 (3.123) |
| **Total N** | **974** | **2,103** | **669** | **691** |

Notes: Reference category: low church attendance frequency on both Waves 3 and 4. Logistic regression models show odds ratios adjusting for a set of variables measured in Wave 1: age, female, ethnicity, household type, parental educational level, maternal cigarette/alcohol use, parents' self-reported church attendance frequency; the level of substance use in the past month measured in Wave 3; depression index, educational level, employment status, marital status, presence of child(ren), and rural/suburban living area, measured in Wave 4; and first at onset measured in all waves. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

### *6.3.2 Alternative proxies for religious behaviour and devotion*

To further understand the different effects between religious behaviour and devotion, Add Health provides two other measures that could be considered analogous to church attendance and religious faith: the frequency of respondents' attendance at special activities outside of regular worship services (e.g. classes, retreats, small groups or choirs) that are organised by churches, synagogues, and other places of worship, and the frequency of praying privately when alone in places other than a church or other religious assembly. The positive correlations between the original and substituted variables are fairly high; the correlation between church attendance and special activity attendance is 0.64 and between religious faith and private prayer is 0.73. Two sets of binary variables measured in Waves 3 and 4 are generated: special activity attendance is dichotomised with attendance at least once a month as one category (the treatment group) and less than once a month as the other (the control group). Engagement in private prayer is divided into two categories: praying once a day or more (the treatment group) and less than once a day (the control group). The proportions of respondents attending special activities once a month or more range from 4.7 per cent to 10.1 per cent, and the percentages of those praying privately once a day or more range from 28.7 per cent to 36.7 per cent, depending on the type of substance that respondents are involved,

in Wave 3. In the analysis, parental church attendance frequency is included in the models that estimate the effect of special activities, and parents' praying frequency in the models that estimate the effect of private prayer. All estimations are repeated on the two sample specifications: low levels of the related religious experience and the top 20 per cent of heaviest users in Wave 3.

Table 6.6 reports estimates of the relationship between special activities organised by churches outside regular worship services and substance use cessation. Results show that respondents who attend the activities at least once a month are likely to quit using substances, regardless of whether they are infrequent attenders or are classified as the top 20 per cent of heaviest users in the previous wave. As expected, the effect of special activity attendance diminishes and becomes significant at the 10% level in most outcomes after controlling for other variables. A further reduction resulted when using PSM. The only exception is the marijuana-cessation model of the sample who reported low attendance at special activities in Wave 3, where the effect of attendance is more significant in the PSM regression than in the adjusted logistic regression model. Overall, the odds of frequent special activity attenders quitting substances are around 1.1-1.2 times higher than for respondents with low attendance frequency in Wave 4. Compared to attendance at church services, the effects of special activity attendance appear to be more modest. This finding is interesting. Taking part in special activities outside of regular worship services may indicate higher levels of personal devotion to the religion than attendance at religious services; many atheists and other non-religious individuals may attend churches because of family obligations, whereas attendance at special activities could indicate involvement and attentiveness. What this finding suggests is that frequent church attenders may not be the most religious group, and that some of them may possibly have attended churches to seek support from the clergy to address their substance use, such as counselling and referral services. However, the different effect between these two variables may be attributable to various measurements of frequency of attendance; high levels of church attendance indicate attendance at least once a *week*, whereas high levels of participation in special activities indicate attendance at least once a *month*. It is perhaps also worth noting that the estimated ATT of the relationship between the attendance at special activities and cigarette cessation among the heaviest smokers should be interpreted with caution. This is because the average covariate unbalancing percentage exceeds the threshold of 5%, this means that the matching is not high-quality and that the ATT may contain bias.

Nonetheless, the significant association between special activity attendance and cigarette use shown in the logistic regressions implies the possible protective effect of special activities attendance on cigarette cessation (For the unadjusted model: OR=3.54, SE=1.47, $p<0.01$; for the adjusted model: OR=2.90, SE=1.38, $P<0.05$).

Table 6.7 presents odds ratios for the frequency of engagement in private prayer on substance use cessation. The estimated odds ratios are similar to the results showing the association between religious faith and cessation, although the effect of private prayer appears to be slightly more pronounced. Before introducing controls for the covariates, there is a significant association between private prayer and alcohol cessation and drug cessation (at the 10% level). As expected, controlling for additional factors reduces the estimates, and a further reduction resulted after controlling for the confounding bias using PSM regressions. However, the effect of private prayer on alcohol cessation remains statistically significant in all models. The statistical significance of the odds ratios in alcohol cessation is higher ($p<0.05$) in all model specifications for private prayer than the attendance at special activities organised by churches.

To determine whether the effects of special activity attendance and private prayer engagement are significantly different, post-hoc estimations using z test are performed. No differences are found between the coefficients of these two religiosity dimensions (see Appendix 6F). Please note that, for the heaviest smokers, although the result from the test indicates a significant difference between the effects of special activity and private prayer on cigarette cessation, the former ATT is poorly estimated due to unbalanced matching.

While the effects of special activity attendance and private prayer are not significantly different, the positive association between special activity attendance and cessation is evidently demonstrated in the logistic regressions (albeit mostly significant at the 10% level in the adjusted models). This corresponds to the main analysis that religious behaviour may have greater effects on the rate of cessation than religious devotion.

**Table 6.6 Special activities organised by churches outside regular worship services and substance use cessation (absence of use in the past 30 days)**

| | Logit (unadjusted) | | Logit | | ATT | | Total |
|---|---|---|---|---|---|---|---|
| | OR | (SE) | OR | (SE) | OR | (SE) | N |
| ***The whole sample*** | | | | | | | |
| **Cigarette cessation** | 2.090 | (0.652)* | 1.602 | (0.555) | 1.117 | (0.082) | 977 |
| **Alcohol cessation** | 1.855 | (0.315)*** | 1.537 | (0.289)* | 1.056 | (0.037) | 2,111 |
| **Marijuana cessation** | 2.369 | (0.935)* | 2.110 | (0.860)✞ | 1.178 | (0.103)✞ | 672 |
| **Any illicit drug cessation (including marijuana)** | 2.100 | (0.777)* | 1.998 | (0.768)✞ | 1.175 | (0.108)✞ | 694 |
| ***Infrequent attenders in special activities in Wave 3*** | | | | | | | |
| **Cigarette cessation** | 1.949 | (0.655)* | 1.471 | (0.551) | 1.117 | (0.099) | 932 |
| **Alcohol cessation** | 1.763 | (0.344)** | 1.474 | (0.314)✞ | 1.051 | (0.038) | 1,960 |
| **Marijuana cessation** | 2.359 | (0.932)* | 2.113 | (0.863)✞ | 1.187 | (0.098)* | 649 |
| **Any illicit drug cessation (including marijuana)** | 2.101 | (0.778)* | 2.017 | (0.776)✞ | 1.183 | (0.113)✞ | 671 |
| ***Top 20% substance users in Wave 3*** | | | | | | | |
| **Cigarette cessation** | 3.536 | (1.471)** | 2.896 | (1.384)* | 1.266 | (0.126)*[1] | 652 |
| **Alcohol cessation** | 2.803 | (1.077)** | 2.199 | (0.966)✞ | 1.118 | (0.064)✞ | 656 |
| **Marijuana cessation** | 2.646 | (1.133)* | 2.392 | (1.061)* | 1.213 | (0.145)[2] | 520 |
| **Any illicit drug cessation (including marijuana)** | 2.419 | (1.001)* | 2.544 | (1.104)* | 1.215 | (0.115)* | 558 |

Notes: Column Logit (unadjusted) presents unadjusted odds ratios of different substance use cessation on religious faith. Column Logit shows odds ratios adjusting for a set of variables measured in Wave 1: age, female, ethnicity, household type, parental educational level, maternal cigarette/alcohol use, parents' self-reported church attendance frequency; the level of substance use in the past month measured in Wave 3; depression index, educational level, employment status, marital status, presence of child(ren), and rural/suburban living area, measured in Wave 4; and first at onset measured in all waves. Column ATT presents ATT estimates from PSM models using Epanechnikov kernel matching with 0.05 bandwidths; common support condition is imposed. The models control all covariates mentioned above. ATT standard errors in parentheses are computed by bootstrapping with 100 replications. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. [1]The percentage of average covariate balance is larger than the threshold 5%; the ATT estimate should be interpreted with caution. [2]ATT estimates from PSM models using Epanechnikov kernel matching with 0.03 bandwidths to achieve balanced matching.

**Table 6.7 Frequency of private prayer and substance use cessation (absence of use in the past 30 days)**

| | Logit (unadjusted) OR | (SE) | Logit OR | (SE) | ATT OR | (SE) | Total N |
|---|---|---|---|---|---|---|---|
| ***The whole sample*** | | | | | | | |
| **Cigarette cessation** | 1.109 | (0.176) | 1.123 | (0.204) | 1.032 | (0.030) | 973 |
| **Alcohol cessation** | 1.943 | (0.231)*** | 1.481 | (0.202)** | 1.042 | (0.020)* | 2,107 |
| **Marijuana cessation** | 1.362 | (0.236)✞ | 1.158 | (0.222) | 1.044 | (0.049) | 671 |
| **Any illicit drug cessation (including marijuana)** | 1.288 | (0.218) | 1.116 | (0.207) | 1.031 | (0.045) | 693 |
| ***Infrequent private prayer respondents in Wave 3*** | | | | | | | |
| **Cigarette cessation** | 1.080 | (0.230) | 1.021 | (0.246) | 1.022 | (0.042) | 701 |
| **Alcohol cessation** | 2.327 | (0.389)*** | 1.772 | (0.338)** | 1.082 | (0.078)** | 1,386 |
| **Marijuana cessation** | 1.605 | (0.395)✞ | 1.429 | (0.382) | 1.085 | (0.063) | 498 |
| **Any illicit drug cessation (including marijuana)** | 1.500 | (0.357)✞ | 1.276 | (0.326) | 1.042 | (0.059) | 518 |
| ***Top 20% substance users in Wave 3*** | | | | | | | |
| **Cigarette cessation** | 1.043 | (0.226) | 1.010 | (0.250) | 1.006 | (0.040) | 650 |
| **Alcohol cessation** | 2.960 | (0.791)*** | 2.570 | (0.802)** | 1.087 | (0.033)** | 654 |
| **Marijuana cessation** | 1.464 | (0.286)✞ | 1.235 | (0.264) | 1.074 | (0.063) | 518 |
| **Any illicit drug cessation (including marijuana)** | 1.344 | (0.255) | 1.152 | (0.237) | 1.054 | (0.057) | 557 |

Notes: Column Logit (unadjusted) presents unadjusted odds ratios of different substance use cessation on the religious faith. Column Logit shows odds ratios adjusting for a set of variables measured in Wave 1: age, female, ethnicity, household type, parental educational level, maternal cigarette/alcohol use, parents' self-reported praying frequency; the level of substance use in the past month measured in Wave 3; depression index, educational level, employment status, marital status, presence of child(ren), and rural/suburban living area, measured in Wave 4; and first at onset measured in all waves. Column ATT presents ATT estimates from PSM models using Epanechnikov kernel matching with 0.05 bandwidths; common support condition is imposed. The models control all covariates mentioned above. ATT standard errors in parentheses are computed by bootstrapping with 100 replications. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

## 6.4 Discussion

This chapter examines the effects of church attendance and religious faith (the two dimensions of religiosity - religious behaviour and devotion) on substance use cessation and attempts to disentangle the effects of these two dimensions from other observable factors via the PSM method. The results of the present study have important contributions.

First, church attendance frequency and religious faith had different relationships with substance use cessation, both in the short term (in the past 30 days) and the long term (in the past 12 months). Church attendance have larger and more positive effects for all outcomes, whereas religious faith is only associated with alcohol cessation. These results apply to the two sample specifications, suggesting that i) for respondents with low levels of religious experience, those who later participate in religion (either becoming frequent church attenders or devoted to the faith) are more likely to achieve cessation, and ii) for heavy substance users, church attendance and religious faith are critical for this vulnerable group.

The varying effects of religious behaviour and devotion are further attested by using alternative proxies: attendance at special activities organised by churches and engagement in private prayer. This strengthens the results found in the main analysis that religious behaviour may generally have greater effects in increasing the probability of cessation than religious devotion.

The second contribution is that a large amount of heterogeneity is found in the relationship between the two religious dimensions and substance use cessation. The effects of the two dimensions diminish substantially after controlling for the observables and confounding bias in the PSM models; this suggests, not taking into account the confounding bias, the effects of religious behaviour and devotion are likely to have been overestimated. Nevertheless, the current study finds that church attendance and religious faith remain significant in the PSM models, suggesting that their effects on substance use cessation could be causal. In particular, these findings show that direct exposure to religious institutions and church members could help promote abstention.

Multiple factors can help explain the greater effects of participation in church services. Firstly, high levels of church attendance may lead to less time spent on other risk activities, including substance use. More importantly, some religious communities may organise events to educate participants about the risks and consequences of substance use. They may also provide emotional and instrumental support for those who have already engaged in substance use by offering counselling sessions, educational workshops (e.g. discussions of consequences

of substance use and healthy habits), coping resources and referral services (Koenig, 2012). This would be especially critical for heavy substance users, who may be more likely to suffer withdrawal symptoms (e.g. sleeping difficulties and anxiety) and have a lower success rate in cessation than light or regular users. Secondly, the social support provided by churches may influence the association between religious involvement and the likelihood of using substances (George et al., 2002; Koenig, 2012; Lim & Putnam, 2010; National Center on Addiction Substance abuse at Columbia University, 2011). In particular, religion connects individuals to communities or social networks that have lower rates of substance use (Koenig, 2012). Thirdly, frequent church attenders are found to have better mental health (Koenig, McCullough & Larson, 2001; Koenig, 2005), which is associated with lower levels of substance use (Wills, Yaeger & Sandy, 2003; Gilvarry, 2000; Stone et al., 2012; von Sydow et al., 2002). Furthermore, churches could be an alternative and attractive option for users to quit using substances, especially when many cessation programmes are expensive and are associated with a health-related stigma that may make users reluctant to join (Luoma et al., 2007).

Although this study finds that attendance at church services and activities have larger effects across various types of substance use cessation, both the importance of religious and private prayer are significantly related to alcohol cessation. This result is in line with findings from Edlund et al.'s study (2010), which demonstrated that respondents who reported that religion was important were less likely to consume alcohol and experience alcohol abuse/dependence among those who drank. Unlike cigarette and drug use, light or low-risk alcohol use is more socially accepted; some religions even provide wine during Mass. Previous studies have also shown that it is a common route for heavy drinkers to return to light drinking, instead of complete abstinence (Schulenberg et al., 2017; Sobell, Ellingstad & Sobell, 2000). However, what this study suggests is that respondents who wish to stop drinking may need outside assistance to achieve alcohol cessation, and that both social reinforcement within religious institutions and the commitment to the religion may be key to alcohol users' achievement of abstinence. A good example to demonstrate the significant role of religious devotion is a study by Gossop et al. (2008) that investigated the relationship between the frequency of attending Narcotics Anonymous (NA) and Alcoholics Anonymous (AA) addiction treatment programmes and substance use outcomes after the treatment. NA and AA programmes employ the 12-Step approach to support clients with drug and alcohol problems via an emphasis on religious meaning and righteousness. The researchers found that frequent

attenders were more likely to be abstinent from alcohol use compared to non-attenders and infrequent attenders.

In considering *how* religiosity (regardless of religious behaviour or religious devotion) is protective against substance use, the attachment theory (which has received little attention in research associating with religion and substance use) may provide a useful account for this. Drawing upon the attachment theory, there are two main components, a safe haven and a secure base, that need to be satisfied in order to build a secure attachment relationship with significant others. As discussed in Chapter 1, religion can provide these two important attachment components through an attachment figure (i.e. God or higher forces) (Kirckpatrick, 1992). With respect to a haven of safety, it has been suggested that religious individuals who have faith in higher forces believe they could seek for emotional supports from the forces when they themselves are in need (for example, when they are experiencing substance use problems or other related problems and need help to quit the substance) (Kirckpatrick, 1992). In relation to a secure base, believing that higher forces are present may help facilitate resilience and self-efficacy that support individuals to solve personal problems (Kirkpatrick, 1992; Koenig & Larson, 2001). In addition to offering comfort and security, some religious rituals and values encourage healthy behaviours and well-beings, which in turn help protect against substance use and misuse.

Borrowing the concept from the attachment theory (which should not be confined to parent-child/adolescent relationship) may therefore offer a novel and important insight into the association between religiosity and substance use cessation shown in this chapter.

## 6.5 Limitations

Although the current study has strengths and expands the literature in important ways, there are some limitations that need to be considered. First, this study only considers two widely used dimensions of religiosity (i.e. religious behaviour and religious devotion); future study is needed to identify the effects of other dimensions (e.g. religious exclusivity) of religiosity on cessation. Further work is also required to investigate whether the significance of religious behaviour and devotion with respect to substance use cessation varies across cultures and religious affiliations; different religious institutions may have various attitudes toward substances, especially alcohol. Second, the cut-off point for categorising the sample

into two groups (e.g. frequent and infrequent church attenders) may lead to ambiguity, yet it ensures two things: (i) the sample above the point is relatively more religious, and (ii) a more balanced sample size between the treatment and control groups for the PSM analysis produces efficient estimates. While PSM controls for observed variables, unobserved heterogeneity may not be fully removed. However, a large reduction in confounding bias could be achieved by restricting the samples to more homogenous groups (i.e. the two sample specifications - low engagement in religion and the top 20 per cent of heaviest users in the previous wave) (Dehejia & Wahba, 1999). Another limitation is that respondents were not asked about why they attended churches. The reasons for attending religious services and activities may help explain the relationship between religion and substance use cessation. Furthermore, due to data limitation, the study is unable to estimate whether respondents would return to using substances or relapse after indicating 'non-use' in the last interview; nonetheless, a one-month period of cessation has been found to have had some health benefits (Wong et al., 2012). Moreover, results may involve a self-report bias since some respondents might have underreported their substance use. However, there is evidence showing that self-reported substance use behaviour, including heavy consumption, is reasonably valid (Brown, Kranzler & Del Boca, 1992; Del Boca & Darkes, 2003).

## 6.6 Conclusions

This study provides insights into the relationship between religiosity and substance use cessation. Two dimensions of religiosity are examined, *religious behaviour* indicated by church attendance frequency and *religious devotion* measured by the importance of religious faith. Systematic steps are taken to separately investigate their effects using logistic regressions and the PSM technique. All analysis is repeated with two sample specifications - low levels of the related religious experiences and the top 20 per cent of heaviest substance users in the previous wave. Alternative proxies for religious behaviour and devotion, namely, the frequency of attending special activities organised by churches and engagement in private prayer, are used to provide further evidence for the varying effects of religious behaviour and devotion.

Results show that religious behaviour has a greater effect than religious devotion to protect against the use of substances. Despite the use of PSM techniques, one cannot be certain whether the estimated relationships are causal. However, the relevance of this

research to health programmes, especially substance use preventions and interventions, is clear. Studies have shown successful contributions of churches to improving community health outcomes (Koenig & Vaillant, 2009; El Awa, 2004; Miller & Gur, 2002). For example, a parallel study conducted by Miller and Gur (2002) showed that respondents who were highly involved in religious communities, where safe-sex education was provided, were likely to use birth control. Physicians are also now being encouraged to take the spiritual history of a patient and support the patient's religious practice as that has been found to have health benefits (Koenig, 2000; Lo et al., 1999). On that account, health professionals and treatment programmes should consider collaborating with religious communities to provide preventive health and social services to people with substance use problems. For instance, healthcare providers working with substance users could refer patients to churches or other religious institutions where patients feel comfortable to assist their recovery. Moreover, an increase in governmental funding to churches could allow clergy members to set up quasi-professional support services for individuals with substance use problems. This would be particularly beneficial for individuals who may feel easier about talking to a priest or clergy members, with whom they may or may not have an existing relationship, about substance use. Furthermore, policy-makers involved in substance use interventions should consider providing clergy members with counselling training relevant to substance use problems (National Center on Addiction Substance Abuse at Columbia University, 2011), since such problems are closely associated with issues such as family violence that clergy confront daily with their congregations. By increasing partnerships between religious groups and health professionals, it is likely that a wider population, especially individuals with low incomes, could have access to healthcare. Given that churches are often more familiar to communities in disadvantaged areas (World Bank, 2005), increased collaboration could potentially improve the quality of life for vulnerable groups and reduce health inequality in society.

**Appendix 6A.1 Descriptive statistics for respondents who reported recent cigarette use in the Wave 3 interview by church attendance**

| | High attendance (once a week or more) | Low attendance (less than once a week) |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD) or %** |
| ***Wave 1*** | | |
| Age | 15.4 (1.64) | 15.4 (1.59) |
| Female | 67.8 | 49.9 |
| White | 67.8 | 81.1 |
| African-American | 20.0 | 8.57 |
| American-Indian/Asian/Mixed/Others | 12.2 | 10.4 |
| Intact family | 56.7 | 55.0 |
| Step-parents family | 13.3 | 15.2 |
| Single-parent family | 30.0 | 29.8 |
| Maternal cigarette use | 51.1 | 58.6 |
| Parental church attendance frequency[1] | 3.07 (1.09) | 2.54 (1.16) |
| [Parental] high school graduates or below | 48.9 | 43.6 |
| [Parental] completed a GED/vocational school training | 28.9 | 32.0 |
| [Parental] a bachelor's degree or above | 22.2 | 24.4 |
| ***Wave 3*** | | |
| Daily cigarette intake in the past 30 days | 7.93 (7.35) | 10.7 (9.12) |
| ***Wave 4*** | | |
| Depression (standardised) | -0.09 (1.02) | 0.06 (1.04) |
| High school graduates or below | 32.2 | 28.4 |
| Completed a GED/vocational school | 40.0 | 50.9 |
| A bachelor's degree or above | 27.8 | 20.7 |
| Employed | 60.0 | 70.6 |
| Married | 51.1 | 36.0 |
| Cohabitation | 14.4 | 23.2 |
| Single/legally separated | 34.4 | 40.8 |
| Presence of child(ren) | 62.2 | 45.8 |
| Living in rural/suburban | 60.0 | 65.8 |
| Age at first cigarette use | 16.3 (2.80) | 15.8 (2.65) |
| Cigarette cessation (absence of use in the past 30 days) | 42.2 | 22.4 |
| **Total N** | **90** | **887** |

Notes: The table presents column percentages. [1]A four-point scale ranging from 'never' to 'once a week or more'.

**Appendix 6A.2 Descriptive statistics for respondents who reported recent marijuana use in the Wave 3 interview by church attendance**

| | High attendance (once a week or more) | Low attendance (less than once a week) |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD) or %** |
| ***Wave 1*** | | |
| Age | 15.3 (1.60) | 15.1 (1.60) |
| Female | 48.9 | 45.9 (49.9) |
| White | 53.3 | 76.6 |
| African-American | 28.9 | 12.9 |
| American-Indian/Asian/Mixed/Others | 17.8 | 10.5 |
| Intact family | 61.0 | 55.6 |
| Step-parents family | 6.67 | 12.7 |
| Single-parent family | 33.3 | 31.7 |
| Maternal cigarette use | 51.1 | 57.2 |
| Parental church attendance frequency[1] | 3.16 (1.07) | 2.56 (1.15) |
| [Parental] high school graduates or below | 37.8 | 37.3 |
| [Parental] completed a GED/vocational school training | 28.9 | 32.3 |
| [Parental] a bachelor's degree or above | 33.3 | 30.4 |
| ***Wave 3*** | | |
| Times used marijuana in the past 30 days | 13.2 (18.7) | 16.4 (35.8) |
| ***Wave 4*** | | |
| Depression (standardised) | -0.04 (0.98) | 0.05 (1.00) |
| High school graduates or below | 31.1 | 25.5 |
| Completed a GED/vocational school training | 40.0 | 44.3 |
| A bachelor's degree or above | 28.9 | 30.3 |
| Employed | 55.6 | 74.2 |
| Married | 33.3 | 27.7 |
| Cohabitation | 20.0 | 24.8 |
| Single/legally separated | 46.7 | 47.5 |
| Presence of child(ren) | 51.1 | 35.7 |
| Living in rural/suburban | 68.9 | 60.7 |
| Age at first marijuana use | 16.4 (3.41) | 16.1 (2.53) |
| Marijuana cessation (absence of use in the past 30 days) | 80.0 | 54.3 |
| **Total N** | **45** | **628** |

Notes: The table presents column percentages. [1]A four-point scale ranging from 'never' to 'once a week or more'.

**Appendix 6A.3 Descriptive statistics for respondents who reported recent use of any illicit drug (including marijuana) in the Wave 3 interview by church attendance**

| | High attendance (once a week or more) | Low attendance (less than once a week) |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD) or %** |
| ***Wave 1*** | | |
| Age | 15.3 (1.59) | 15.1 (1.61) |
| Female | 46.8 | 46.1 |
| White | 55.3 | 76.5 |
| African-American | 27.7 | 12.7 |
| American-Indian/Asian/Mixed/Others | 17.0 | 10.8 |
| Intact family | 59.6 | 55.4 |
| Step-parents family | 6.38 | 13.0 |
| Single-parent family | 34.0 | 31.6 |
| Maternal cigarette use | 48.9 | 56.5 |
| Parental church attendance frequency[1] | 3.06 (1.13) | 2.56 (1.15) |
| [Parental] high school graduates or below | 40.4 | 37.0 |
| [Parental] completed a GED/vocational school training | 27.7 | 32.3 |
| [Parental] a bachelor's degree or above | 31.9 | 30.7 |
| ***Wave 3*** | | |
| Times used any kind of drugs (including marijuana) in the past 30 days | 13.9 (19.1) | 19.3 (65.8) |
| ***Wave 4*** | | |
| Depression (standardised) | -0.06 (0.98) | 0.04 (1.00) |
| High school graduates or below | 34.0 | 24.9 |
| Completed a GED/vocational school | 38.3 | 44.3 |
| A bachelor's degree or above | 27.7 | 30.9 |
| Employed | 55.3 | 73.8 |
| Married | 31.9 | 27.9 |
| Cohabitation | 21.3 | 24.7 |
| Single/legally separated | 46.8 | 47.4 |
| Presence of child(ren) | 51.1 | 35.5 |
| Living in rural/suburban | 70.2 | 60.6 |
| Age at first use of any illicit drug (including marijuana) | 15.9 (3.86) | 15.7 (2.69) |
| Any illicit drug cessation (including marijuana) (absence of use in the past 30 days) | 78.7 | 51.1 |
| **Total N** | **47** | **648** |

Notes: The table presents column percentages. [1]A four-point scale ranging from 'never' to 'once a week or more'.

**Appendix 6B.1 Descriptive statistics for respondents who reported recent cigarette use in the Wave 3 interview by religious faith**

| | Very important/most important | Somewhat important/not important |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD) or %** |
| ***Wave 1*** | | |
| Age | 15.3 (1.60) | 15.5 (1.59) |
| Female | 56.8 | 47.7 |
| White | 72.9 | 85.0 |
| African-American | 16.6 | 4.64 |
| American-Indian/Asian/Mixed/Others | 10.6 | 10.4 |
| Intact family | 54.7 | 55.5 |
| Step-parents family | 14.6 | 15.4 |
| Single-parent family | 30.7 | 29.1 |
| Maternal cigarette use | 55.6 | 60.0 |
| Parental religious faith[1] | 3.62 (0.74) | 3.20 (0.97) |
| [Parental] high school graduates or below | 42.9 | 45.2 |
| [Parental] completed a GED/vocational school training | 34.1 | 29.8 |
| [Parental] a bachelor's degree or above | 23.0 | 25.0 |
| ***Wave 3*** | | |
| Daily cigarette intake in the past 30 days | 9.36 (8.33) | 11.3 (9.40) |
| ***Wave 4*** | | |
| Depression (standardised) | 0.06 (1.06) | 0.04 (1.03) |
| High school graduates or below | 25.9 | 30.9 |
| Completed a GED/vocational school training | 53.7 | 47.1 |
| A bachelor's degree or above | 20.4 | 22.0 |
| Employed | 67.6 | 71.1 |
| Married | 38.9 | 36.3 |
| Cohabitation | 19.2 | 24.6 |
| Single/legally separated | 42.0 | 39.1 |
| Presence of child(ren) | 51.1 | 44.6 |
| Living in rural/suburban | 65.7 | 65.0 |
| Age at first cigarette use | 16.0 (2.65) | 15.8 (2.67) |
| Cigarette cessation (absence of use in the past 30 days) | 25.7 | 23.2 |
| **Total N** | **417** | **560** |

Notes: The table presents column percentages. [1]The variable measures parental importance of religious faith; A four-point scale ranging from 'not important at all' to 'very important'.

**Appendix 6B.2 Descriptive statistics for respondents who reported recent marijuana use in the Wave 3 interview by religious faith**

| | Very important/most important | Somewhat important/not important |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD) or %** |
| ***Wave 1*** | | |
| Age | 15.1 (1.57) | 15.2 (1.62) |
| Female | 47.8 | 45.3 |
| White | 61.3 | 84.6 |
| African-American | 27.4 | 5.04 |
| American-Indian/Asian/Mixed/Others | 11.3 | 10.3 |
| Intact family | 51.5 | 58.9 |
| Step-parents family | 11.3 | 13.1 |
| Single-parent family | 37.2 | 28.0 |
| Maternal cigarette use | 54.4 | 58.7 |
| Parental religious faith[1] | 3.59 (0.82) | 3.14 (0.99) |
| [Parental] high school graduates or below | 41.6 | 34.5 |
| [Parental] completed a GED/vocational school training | 29.6 | 33.5 |
| [Parental] a bachelor's degree or above | 28.8 | 32.0 |
| ***Wave 3*** | | |
| Times used marijuana in the past 30 days | 16.2 (33.0) | 15.9 (35.7) |
| ***Wave 4*** | | |
| Depression (standardised) | 0.11 (1.03) | 0.00 (0.98) |
| High school graduates or below | 23.7 | 27.2 |
| Completed a GED/vocational school training | 46.7 | 42.6 |
| A bachelor's degree or above | 29.6 | 30.2 |
| Employed | 69.3 | 75.1 |
| Married | 29.6 | 27.2 |
| Cohabitation | 21.2 | 27.0 |
| Single/legally separated | 49.3 | 45.8 |
| Presence of child(ren) | 42.3 | 33.2 |
| Living in rural/suburban | 59.1 | 62.7 |
| Age at first marijuana use | 16.4 (2.77) | 16.0 (2.47) |
| Marijuana cessation (absence of use in the past 30 days) | 58.8 | 54.4 |
| **Total N** | **274** | **397** |

Notes: The table presents column percentages. [1]The variable measures parental importance of religious faith; A four-point scale ranging from 'not important at all' to 'very important'.

**Appendix 6B.3 Descriptive statistics for respondents who reported recent use of any illicit drug (including marijuana) in the Wave 3 interview by religious faith**

| | Very important/most important | Somewhat important/not important |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD) or %** |
| ***Wave 1*** | | |
| Age | 15.1 (1.57) | 15.2 (1.63) |
| Female | 48.0 | 45.3 |
| White | 61.9 | 84.3 |
| African-American | 26.7 | 5.08 |
| American-Indian/Asian/Mixed/Others | 11.4 | 10.7 |
| Intact family | 51.3 | 58.6 |
| Step-parents family | 11.4 | 13.3 |
| Single-parent family | 37.4 | 28.1 |
| Maternal cigarette use | 53.7 | 57.9 |
| Parental religious faith[1] | 3.58 (0.81) | 3.15 (0.99) |
| [Parental] high school graduates or below | 41.3 | 34.6 |
| [Parental] completed a GED/vocational school training | 29.5 | 33.2 |
| [Parental] a bachelor's degree or above | 29.2 | 32.2 |
| ***Wave 3*** | | |
| Times used any kind of drugs (including marijuana) in the past 30 days | 17.9 (34.4) | 19.3 (77.5) |
| ***Wave 4*** | | |
| Depression (standardised) | 0.12 (1.04) | -0.02 (0.97) |
| High school graduates or below | 24.2 | 26.4 |
| Completed a GED/vocational school training | 46.6 | 42.4 |
| A bachelor's degree or above | 29.2 | 31.2 |
| Employed | 69.4 | 74.3 |
| Married | 28.5 | 28.1 |
| Cohabitation | 21.7 | 26.4 |
| Single/legally separated | 49.8 | 45.5 |
| Presence of child(ren) | 41.6 | 33.4 |
| Living in rural/suburban | 59.4 | 62.7 |
| Age at first use of any illicit drug use (including marijuana) | 16.0 (2.96) | 15.6 (2.65) |
| Any illicit drug cessation (including marijuana) (absence of use in the past 30 days) | 55.5 | 51.3 |
| **Total N** | **281** | **413** |

Notes: The table presents column percentages. [1]The variable measures parental importance of religious faith; A four-point scale ranging from 'not important at all' to 'very important'.

**Appendix 6C Church attendance and substance use cessation (absence of use in the past 12 months)**

| | Logit (unadjusted) | | Logit | | ATT | | Total N |
|---|---|---|---|---|---|---|---|
| | OR | (SE) | OR | (SE) | OR | (SE) | |
| ***The whole sample*** | | | | | | | |
| **Alcohol cessation** | 2.424 | (0.360)*** | 2.092 | (0.347)*** | 1.103 | (0.035)** | 2,122 |
| **Marijuana cessation** | 3.439 | (1.165)*** | 3.033 | (1.108)** | 1.275 | (0.103)** | 673 |
| **Any illicit drug cessation (including marijuana)** | 4.034 | (1.328)*** | 3.464 | (1.251)** | 1.328 | (0.092)*** | 695 |
| ***Infrequent church attenders in Wave 3*** | | | | | | | |
| **Alcohol cessation** | 2.252 | (0.432)*** | 1.878 | (0.399)** | 1.091 | (0.040)* | 1,821 |
| **Marijuana cessation** | 3.325 | (1.282)** | 2.757 | (1.146)* | 1.250 | (0.102)** | 628 |
| **Any illicit drug cessation (including marijuana)** | 3.892 | (1.445)*** | 3.232 | (1.313)** | 1.297 | (1.108)** | 649 |
| ***Top 20% substance users in Wave 3*** | | | | | | | |
| **Alcohol cessation** | 5.581 | (1.770)*** | 4.599 | (1.710)*** | 1.218 | (0.073)** | 660 |
| **Marijuana cessation** | 2.538 | (0.975)* | 2.390 | (0.979)* | 1.224 | (0.126)* | 520 |
| **Any illicit drug cessation (including marijuana)** | 3.470 | (1.307)** | 3.375 | (1.385)** | 1.328 | (0.137)** | 559 |

Notes: Column Logit (unadjusted) presents unadjusted odds ratios of different substance use cessation on church attendance. Column Logit shows odds ratios adjusting for a set of variables measured in Wave 1: age, female, ethnicity, household type, parental educational level, maternal cigarette/alcohol use, parents' self-reported church attendance frequency; the level of substance use in the past month measured in Wave 3; depression index, educational level, employment status, marital status, presence of child(ren), and rural/suburban living area, measured in Wave 4; and first at onset measured in all waves. Column ATT presents ATT estimates from PSM models using Epanechnikov kernel matching with 0.05 bandwidths; common support condition is imposed. The models control all covariates mentioned above. ATT standard errors in parentheses are computed by bootstrapping with 100 replications. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

**Appendix 6D Religious faith and substance use cessation (absence of use in the past 12 months)**

| | Logit (unadjusted) | | Logit | | ATT | | Total |
|---|---|---|---|---|---|---|---|
| | OR | (SE) | OR | (SE) | OR | (SE) | N |
| ***The whole sample*** | | | | | | | |
| **Alcohol cessation** | 1.766 | (0.214)*** | 1.415 | (0.197)* | 1.039 | (0.024)✞ | 2,118 |
| **Marijuana cessation** | 1.454 | (0.230)* | 1.347 | (0.244)✞ | 1.039 | (0.052) | 671 |
| **Any illicit drug cessation (including marijuana)** | 1.487 | (0.235)* | 1.395 | (0.254)✞ | 1.044 | (0.046) | 694 |
| ***Respondents with low levels of religious faith in Wave 3*** | | | | | | | |
| **Alcohol cessation** | 1.848 | (0.348)** | 1.570 | (0.340)* | 1.052 | (0.032)✞ | 1,062 |
| **Marijuana cessation** | 1.253 | (0.304) | 1.155 | (0.312) | 0.021 | (0.076)[1] | 406 |
| **Any illicit drug cessation (including marijuana)** | 1.411 | (0.341) | 1.381 | (0.386) | 1.036 | (0.074) | 420 |
| ***Top 20% substance users in Wave 3*** | | | | | | | |
| **Alcohol cessation** | 2.453 | (0.671)** | 2.208 | (0.699)* | 1.067 | (0.031)* | 658 |
| **Marijuana cessation** | 1.270 | (0.233) | 1.157 | (0.243) | 1.022 | (0.056) | 518 |
| **Any illicit drug cessation (including marijuana)** | 1.362 | (0.247)✞ | 1.234 | (0.258) | 1.036 | (0.056) | 558 |

Notes: Column Logit (unadjusted) presents unadjusted odds ratios of different substance use cessation on religious faith. Column Logit shows odds ratios adjusting for a set of variables measured in Wave 1: age, female, ethnicity, household type, parental educational level, maternal cigarette/alcohol use, parents' self-reported religious faith; the level of substance use in the past month measured in Wave 3; depression index, educational level, employment status, marital status, presence of child(ren), and rural/suburban living area, measured in Wave 4; and first at onset measured in all waves. Column ATT presents ATT estimates from PSM models using Epanechnikov kernel matching with 0.05 bandwidths; common support condition is imposed. The models control all covariates mentioned above. ATT standard errors in parentheses are computed by bootstrapping with 100 replications. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. [1]The percentage of average covariate balance is larger than the threshold 5%; the ATT estimate should be interpreted with caution.

**Appendix 6E Comparison of the ATT coefficients (log odds) of church attendance and religious faith across models that predict substance use cessation (absence of use in the past 30 days)**

| | Cigarette cessation | Alcohol cessation | Marijuana cessation | Any illicit drug cessation (including marijuana) |
|---|---|---|---|---|
| ***Attendance vs religious faith*** | | | | |
| **With the whole sample size** | 2.371 | 1.576 | 2.215 | 2.946 |
| **Low levels of church attendance/religious faith in Wave 3** | 1.470 | 0.748 | 1.474 | 1.929 |
| **Top 20% substance uses in Wave 3** | 2.045 | 1.768 | 1.861 | 2.052 |

Notes: To compare the effects of church attendance and religious faith on the outcomes, I follow Clogg et al. (1995) and Paternoster et al. (2016)'s work and test the significance of the difference between two regression coefficients using z test: $(B1-B2)/\sqrt{(SEB1)^2+(SEB2)^2}$.

**Appendix 6F Comparison of the ATT coefficients (log odds) of attendance at special activities organised by churches outside regularly worship services and frequency of private prayer across models that predict substance use cessation (absence of use in the past 30 days)**

| | Cigarette cessation | Alcohol cessation | Marijuana cessation | Any illicit drug cessation (including marijuana) |
|---|---|---|---|---|
| ***Special activity attendance vs private prayer*** | | | | |
| **With the whole sample size** | 0.994 | 0.347 | 1.224 | 1.290 |
| **Low levels of special activity attendance/private prayer in Wave 3** | 0.898 | -0.606 | 0.843 | 1.143 |
| **Top 20% substance uses in Wave 3** | 2.126 | 0.432 | 0.908 | 1.310 |

Notes: To compare the effects of church attendance and religious faith on the outcomes, I follow Clogg et al. (1995) and Paternoster et al. (2016)'s work and test the significance of the difference between two regression coefficients using z test: $(B1-B2)/\sqrt{(SEB1)^2+(SEB2)^2}$.

# Chapter 7

# Conclusions

## 7.1 Main empirical findings

A large body of research has shown that there are many risk and protective factors associated with substance use and abuse. Many of these are beyond the control of policy-makers or families. This thesis shows, however, that some risk and protective factors are not fixed, but may be amenable to policy and practice on the part of government, local services, and parents.

- In the first research chapter (Chapter 3), I find that parental beliefs about adolescents' cigarette and alcohol use are positively associated with adolescents' later engagement in these behaviours. Both self-fulfilling prophecy and adolescent concealment are proposed as explanations for this effect.
- Chapter 4 explores the longer-term effect of parenting styles on young adults' substance use problems. The chapter reports that parental warmth is associated with later substance use problems in adulthood, both directly and indirectly via lower risk of early age of first use and depression. While parental control could reduce the risk of early initiation, its effect is offset by depression. The chapter also shows no difference between indulgent and authoritative parenting on the prevalence of substance use problems, whereas authoritarian and neglectful styles are associated with extra risk of problems.
- Chapter 5 investigates the long-term effect of parental behaviours on substance use cessation in adulthood, finding that maternal presence is associated with subsequent cessation. The chapter also reveals that the levels of religiosity exert a strong effect on substance use cessation, which has laid the foundation for the final research chapter.
- In Chapter 6, the study compares two different religious dimensions, religious behaviour and religious devotion, and shows that church attendance (in particular) and religious faith may potentially be a key determinant of substance use cessation.

## 7.2 Parenting styles, religiosity, or a combination of both influences substance use?

The empirical chapters in this thesis represent a consistent body of research in the sense that both parenting styles and religiosity can be viewed as providing (1) a haven of safety (e.g. parental warmth and God/high forces offering comfort when one is distressed) and (2) a secure base (e.g. with warm/supportive parents and the presence of God/higher forces one feels confident and secure enough to explore the environment). These are the key functions of the attachment process developed by Bowlby (1969) and Ainsworth and Bowlby (1991).

This thesis has shown that both parenting styles and religiosity are predictors for adolescents' and young adults' substance use, however it is still unclear whether their effects are independent of each other and which of these two factors has a larger protective effect on the specific types and level of substance use. Therefore, in this section I bring together the findings from the relevant empirical chapters (mainly Chapters 4 and 5) to outline whether it is parenting styles, religiosity or a combination of both that most influences substance use among adolescents and young adults.

Apart from the study in Chapter 6 that focuses on the effect of religiosity only on substance use cessation, all empirical analyses in Chapters 3 (substance use in adolescence), 4 (substance use and problems in adolescence and young adulthood), and 5 (substance use cessation in young adulthood) control for parenting styles and religiosity simultaneously in the analytical models. This suggests that the significant effects of parenting styles and/or religiosity on substance use shown in these chapters are independent of each other. In order to explore which of these two factors potentially has a greater effect on the levels of substance use, post-estimation t-tests are carried out for Chapters 4 and 5 (results not shown)[18]. Briefly, this test evaluates the statistical significance of the difference between the parenting and religion variables when both are present in the same statistical model.

In Chapter 4, the study shows that parental warmth in adolescence is associated with lower levels of drinking, marijuana and other illicit drugs problems, parental control is not directly related to any of the substance use problems in adulthood, and the level of religiosity is negatively associated with smoking frequency and drinking problems (Appendix 4b). Results of the post-estimation tests show that the two parenting dimensions (parental warmth and

[18] Given that Chapter 3 uses the propensity score matching technique to examine the association between parental belief and adolescents' substance use, in which respondents are matched on identified observed covariates (including the level of religiosity), it is not applicable to compare the effect of parental belief with the effect of religiosity.

parental control) and religiosity may exert different effects on substance use problems in adulthood. In particular, while religiosity may appear to have a larger effect on smoking frequency than parental warmth and control, parental warmth exerts a greater effect on the level of illicit drug problems than religiosity. The effects of religiosity, parental warmth and parental control on drinking problems and marijuana problems are not significantly different.

In Chapter 5, the study shows that both parental warmth and control have modest effects on later substance use cessation, whereas parental presence and the level of religiosity have stronger effects. The post-estimation t-tests show that there may be differences in effects between religiosity and parental warmth/control, and between religiosity and parental presence (although less well defined), in which the level of religiosity may have a greater protective effect on substance use cessation (especially alcohol cessation) in adulthood than any of the parental behaviours considered.

Overall, these post-estimation tests suggest two important conclusions. First, the effects of parenting styles and religiosity vary depending on the type of substance and on the level of substance use (including severity and cessation). Second, parenting styles appear to have a greater effect on the severity of substance use (in particular, illicit drug problems), whereas religiosity exerts a larger protective effect on smoking frequency and any kind of substance use cessation. In line with previous literature (e.g. Baumrind, 1991), parenting styles may function in a facilitating role for adolescents and young adults to start using a substance or to experience problem use. However, religion (e.g. the perceived presence of higher forces) may play a compensatory role for people who have already started using a substance and/or who may have had a relatively poorer relationship with their parents in their early life. Higher forces may even be viewed as a substitute attachment figure, which could have a profound effect on individuals with substance use problems that are associated with some levels of mental health issues (Kirkpatrick & Shaver, 1990). This may explain at least to some extent why a number of substance use treatment centres highlight religion as a potential means of support for substance users/abusers.

### 7.3 Generalisation of the findings from the US to the UK context

The findings of this research project based on US data may be applicable to the UK context. With respect to the prevalence of substance use, there is evidence that substance

use in the past decade among young people in the US and UK is declining (however as shown in Chapter 1, use of any illicit drug has increased slightly in the US among 17 to 24 year olds).

The levels of substance use in these countries are very similar, although American youths seem to have lower levels of cigarette and alcohol use, and a higher rate of illicit drug use, compared to their English counterparts (Centre for Behavioural Health Statistics and Quality, 2015-2017 (2017, 2018); NHS Digital, 2018a; NHS Digital, 2018b; NHS Digital, 2018c; Schulenburg et al., 2017).

In terms of parenting styles, while to my knowledge no empirical cross-cultural studies have compared parenting styles in the UK and US, it is safely assumed that UK and US parenting styles and values are broadly similar given that both share a culture of individualism that highly values authoritative parenting. Indeed, it has been suggested that authoritative parenting is more effective compared to other types of parenting style in transmitting individualistic values (such as autonomy, personal wishes, individual achievement, and self-assertion) (Markus & Kitayama, 1991).

In relation to religion, the trend of religious polarisation is common to both the US and the UK (Bibby, 2006; Putnam & Campbell, 2010; Wilkins-Laflamme, 2014). The process of religious polarisation refers to people who are more religiously inclined being more likely to interact with like-minded people and become more involved with a religious group, while people who are more secular-inclined tend to move more toward the secular (Bibby, 2006; Putnam & Campbell, 2010). Wilkins-Laflamme (2014) conducted a cross-country study examining religious commitment from 1985 to 2009-2010 in the US, UK, and Canada. She found that, in both the UK and US, the religiously committed group remains small but stable over time, and that populations in these two countries are split between people who are religiously unaffiliated and those who are religiously committed. Despite the religiously committed group being the minority in the US and UK, many studies conducted independently in these countries have shown the positive influence of religion on health (including healthy behaviours and lifestyle, social support, and better psychological state) (e.g. King et al., 2013; Koenig, 2005). This suggests that religion may be an effective coping model for individuals to manage their emotional stress and behavioural problems, including substance (mis)use. Having said that, religion may still have different advantages and disadvantages for people depending on their situations, and personal needs and preferences (Pargament, 1996).

Given the similarities between the US and the UK regarding substance use, parenting styles and religiosity, the findings of this research project, to a large extent, can be generalised

from the US to the UK context. However, it is also important to note that the associations between parenting styles/practices, religiosity, and substance use may still be subject to individual situations, personal and social resources, and personal needs and preferences (e.g. parents' and adolescents' personalities and religious affiliations).

## 7.4 Contribution to the literature and policy implications

By developing our understanding of the determinants of substance use trajectories in adolescence and adulthood, the four empirical studies in this thesis provide theoretical insights into and policy implications for reducing substance use among young people.

### *7.4.1 Contribution to the literature*

This thesis extends the fields of early family experiences and substance use in multiple ways. Firstly, this thesis has investigated the power of parental beliefs about adolescents' cigarette and alcohol use on adolescents' actual engagement with the substances. Traditionally, scholars have often explained the negative effect of parental beliefs with respect to self-fulfilling prophecy, suggesting that parents' beliefs increase the probability that adolescents will go on to engage in risk activities. A number of explanations for the effect of self-fulfilling prophecy have been given, for example, the reactions of parents in response to their beliefs about their adolescents' substance use may encourage adolescents to use substances. However, this thesis goes beyond this to investigate the effect of parental beliefs by using PSM estimations, since factors that are responsible for the beliefs may also affect adolescents' substance use. After effectively controlling for the observables and confounding bias, results in Chapter 3 suggest that adolescent concealment may play an important role in explaining the inverse relationship between parental unawareness/non-beliefs and adolescents' substance use. Adolescence is a critical period characterised by a demand for autonomy and a high level of conflict with family. While youth disclosure may reflect a positive and healthy parent-youth relationship, adolescent concealment is indeed very common in families. Although the concept of adolescent concealment can be somewhat controversial, the underlying motivation for the concealment may indicate adolescents' feelings of guilt, as well as their fear of punishment, for conducting a behaviour that is not approved by their parents. In theory, carrying a sense of guilt with respect to their parents demonstrates adolescents' deep care and concern for their parents' feelings (the sort of process that is often seen in a secure attachment relationship), which may prevent them from becoming regular

users. In practice, constantly putting effort into concealing a behaviour and worrying that the parents may find out could potentially lead adolescents to give up substances. It is important to note that the chapter does not intend to encourage adolescent concealment, rather it is to recognise the complicated dynamics between parents and adolescents. Using the self-fulfilling prophecy to understand the power of parental beliefs may only explain part of the story since the prophecy tends to focus largely upon parents' reactions and behaviours when they believe their adolescents are using substances. However, the prophecy fails to acknowledge that some adolescents also actively hide their undesirable behaviours which in turn contributes to parental (non)beliefs. Even when parents initiate conversations in relation to risk behaviours, some adolescents may feel that this is intrusive and thus be reluctant to have the discussions with them. Results obtained in Chapter 3 therefore suggest that apart from openly and carefully discussing risk behaviours with adolescents, parents could also let adolescents draw healthy boundaries regarding things that they want to disclose or conceal. This may give adolescents a stronger sense of autonomy to make, and to be responsible for, their own decisions. Furthermore, letting adolescents have some amount of privacy may show trust on the part of parents themselves, which could lead to a more positive and healthier relationship.

Second, given the majority of adolescents who try substances do so experimentally (e.g. Baumrind, 1991; Shedler & Block, 1990) , Chapter 4 in this thesis goes beyond the period of adolescence and explores the long-term effect of parenting styles on substance use problems in adulthood. Results in this chapter makes three contributions: (1) the relationship between parenting styles and substance use problems in adulthood can be partly explained by age at initiation and depression; (2) parental warmth exerts a greater effect than control in reducing the probability of later substance use problems, both directly and indirectly via reduced risk of early initiation and later depression; and (3) parental control could substantially reduce the risk of early onset; however, its effect is offset by later depression. The results evidently show a link between parenting styles in adolescence and later outcomes in adulthood, suggesting that the origins of substance use problems involve early family relationships. The exploration of mediating pathways also sheds light on heterogeneity between previous studies which disagreed about the relative importance of parental warmth and control. Moreover, given the overlap between a warm, responsive style of parenting style and secure attachment, and between a controlling, harsh disciplinary parenting style and insecure attachment, the findings of this chapter echo with Bowlby's belief on the potential

life-long impact of parent-child attachment (Bowlby, 1969). In short, this chapter provides insights into how early family experiences could affect children's life trajectories; such work could be of particular importance for future research focusing upon early determinants of later health outcomes.

Third, this thesis further enhances our understanding of the links between family relationships and substance use among young adults by investigating the effect of parental behaviours on cessation in adulthood. Longitudinal studies on substance use trajectories have shown that 'natural' cessation usually occurs beyond the age of 25 (Chen & Jacobson, 2012; Park et al., 2017; Schulenberg et al., 2017), a time when adulthood begins to be established. While many individuals would naturally cease using substances due to assuming adult responsibilities (Bachman et al., 2002), some fail to achieve abstinence and become regular or chronic users. Chapter 5 is therefore designed to develop understanding of whether parental behaviours in adolescence, an important factor involved in adolescent substance use, is associated with the probability of substance use cessation in adulthood. Results in the chapter show that parental warmth and control may only be a key to prevent early initiation and severity of substance use, but not a marker for cessation. Maternal presence, on the other hand, was found to be a determinant of later cigarette and drug cessation; this suggests that adolescents are likely to give up substances once they reach adulthood if their mother is often at home before and after school and before bedtime. One possible explanation for this is that maternal presence may have a 'monitoring effect' that serves both primary and secondary prevention functions by (1) postponing an early onset of substance use, and (2) reducing the amount of usage once initiated. These two functions facilitated by maternal presence *practically* help adolescents to develop a shorter-term relationship with substances, which in turn may increase the successful rates of cessation later in life. An alternative explanation is that the parental presence variable may also indicate the amount of time parents spend with their adolescents (e.g. on shared activities or communication). As proposed in the attachment theory, the availability of the parents may allow parents to respond to adolescents' needs and distress immediately, offering a sense of security for adolescents in that they can turn to their parents in times of need. This in turn may help facilitate resilience in adolescents, leading them to maintain a low, responsible level of substance use which could help increase the probability of cessation later in life (Coley, Votruba-Drzal & Schindler, 2008; Milkie, Nomaguchi & Denny, 2015). Another possible explanation is that parents who are not available to adolescents

before school, after school, and in the evening may reflect their 'non-standard' employment or long working hours (Lester et al., 2016), which have been shown to have a negative effect on children's emotional and behavioural problems (Han, 2008; Han & Miller, 2009; Hsueh & Yoshikawa, 2007; Strazdins et al., 2004).

While maternal presence is positively related to later cessation, no effect of paternal presence is found in the study. This suggests that the presence of the father may not exert the same 'monitoring effect' that facilitates the primary and secondary prevention functions as the presence of mother. It is also plausible that paternal presence may reflect the 'non-traditional' family structure in which the mother is the breadwinner and the father is unemployed, which may explain the different effects of maternal and paternal presence on adolescents' later cessation probability. Another interesting finding reported in this chapter is that none of the parental behaviours is associated with alcohol cessation (apart from the effect of maternal presence on son's alcohol cessation). This may be due to the differences between alcohol and other substances in terms of its social acceptance and parental perceptions of alcohol. Overall, Chapter 5 advances our understanding of the association between parenting styles and substance use trajectories by showing that parent-adolescent relationships may have a modest effect on cessation in adulthood. Importantly, it reveals the critical role religion plays in substance use cessation.

The final empirical chapter in this thesis explores the critical role of religiosity in cessation by comparing the effects of two widely-used dimensions of religiosity- religious behaviours measured by church attendance and religious devotion indicated by self-rated religious importance. Results reveal that participation in church services has a greater effect on cessation than self-rated religious importance. This may be explained by the social and instrumental support (e.g. counselling sessions and educational workshops) offered by churches and the strong supportive ties within the churches (George, Ellison & Larson, 2002; National Center on Addiction Substance Abuse at Columbia University, 2011), which help increase the probability of cessation. Moreover, frequent church attenders are found to have better mental health (Koenig, McCullough & Larson, 2001; Koenig, 2005), which may also help achieve cessation. While church participation has consistent and robust effects on all kinds of cessation, self-rated religious importance is positively associated with alcohol cessation. One possible explanation for this is that alcohol users may need both reinforcement from religious institutions and the commitment to the religion to achieve abstinence, providing that

unproblematic drinking is a norm in most cultures. Chapter 6 also uses the attachment theory that originated in studies of infant-caregiver relationships to explain the association between religiosity (regardless of religious behaviour or religious devotion) and substance use cessation. The chapter suggests that the protective role religion plays in substance use could be explained by the two important attachment components, a safe haven and a secure base, provided by significant others (i.e. God/higher forces in this case). These two components allow religious individuals to build a secure attachment relationship with God or higher forces (i.e. an attachment figure), which in turn protect them from substances. Overall, Chapter 6 provides deeper insights into the relationship between religiosity and substance use and sheds new light on the effectiveness of religious behaviour (particularly) on the probability of cessation. With the implementation of PSM techniques that help estimate a causal effect, the relevance of this research to health programmes, especially for substance use prevention and interventions, is clear.

### *7.4.2 Policy implications*

The findings of this research have a range of implications for policy; this is of potential importance given the scale of substance use problems and the commitment of governments to take action. In the UK, the government sets out Drug Strategy in 2017, aiming to reduce substance demand, restrict supply, and build global action (HM Government, 2017). In the US, changes in healthcare policy and the implementation of the Affordable Care Act have required the majority of the US healthcare providers to offer prevention, interventions and treatment for substance misuse (US Department of Health and Human Services, 2016). However, it should be noted that the Affordable Care Act is being repealed in the US and that the House and Senate have proposed to reduce the expenditures on Medicaid. Medicaid cuts are likely to have negative implications, especially for low-income Americans and individuals who are affected by substance abuse (Wen, Behrle & Tsai, 2017).

The first three empirical chapters highlight the importance of parent-child relationships as one of the important 'life-course' determinants of substance use behaviour in adulthood; these findings have implications for the provision and content of interventions aimed at enhancing parenting. Interventions of this type take many forms. They may be funded by national or local government or by the voluntary sector, or privately, via payment from participants. They may be delivered by a range of service providers, including schools, children's services, religious organisations, charities or private organisations. They are

addressed at many age groups, ranging from courses for the parents of toddlers and pre-schoolers to the parents of older teenagers; for example, the Parent Practice and the National Parenting Initiative in the UK, and the Center for Effective Parenting in the US. They may take a range of forms, from formal and structured courses to informal discussion groups, or groups designed to be primarily social in nature; online and telephone-based resources are now emerging (Allen et al., 2016). Most are general, while some have specific aims (e.g. lowering the risk of substance use). Most courses are open to all parents, but some are designed for particular groups, for example fathers, single parents, or parents of disabled children or children judged to be at risk of poor outcomes. The majority of provision is attended on a voluntary basis but attendance at some courses may be mandatory, especially in cases where families are in the care of social services. Research on the efficacy of parenting programmes is mixed (which is unsurprising given the heterogeneity of provision), though generally favourable. Interventions based on evidence and proven outcomes are more likely to increase parents' confidence in the information with which they are provided in the workshops (Bultas et al., 2017; Chu et al., 2012; Gardner & Leijten, 2017; Haggerty, McGlynn-Wright & Klima, 2013).

Parenting programmes are typically guided by the two main principles which form the basis of Maccoby and Martin's (1983) typology of parenting styles, namely establishing effective discipline, and enabling warm and supportive relationships. The findings of this thesis underline the case for an approach centred first and foremost on warmth and supportiveness. In terms of discipline, the findings of the thesis suggest that the emphasis should move away from a focus on rule-setting, enforcement and monitoring, towards an approach which prioritises the mental health of children and adolescents, which helps parents develop an awareness of their children's emotional needs, and which encourages the granting of autonomy and the setting of age-appropriate boundaries which are not excessively restrictive, especially in the case of older adolescents. In fact most UK-based parenting programmes do take an approach close to this (e.g. the Parenting Skills Course provided by the Parent Practice aims to improve parents' emotional bond with the children and also help parents establish positive discipline), but in the US, it is more common for parenting programmes to focus more heavily on monitoring (e.g. Partnership for Drug-Free Kids notes the importance of knowing where the adolescent is at all times). Effective communication (especially in relation to sensitive topics) is also key; results from Chapter 3 suggest the importance of parents letting

adolescents draw a healthy boundary in relation to what they disclose to their parents and what they conceal.

In Chapter 5, I find that that parental presence (i.e. being present in the home before the adolescent goes to school in the morning, and when he or she returns from school) is associated with the likelihood that as an adult, the adolescent will be able to discontinue substance use. This finding could motivate initiatives on the part of government and employers to develop and support parent-friendly employment practices in workplaces, maximising the opportunities for parents to be physically present while their adolescents are at home. This is particular relevant to the current US approach to work-family policy, where there is no supports for family care on the federal level. While some states (e.g. California) provide social provisions, such as childcare assistance and schedule flexibility, it is usually the parents with higher social class/income who benefit from them. Parents with low income often suffer from the job security, low wages and limited access to these provisions (Collins, 2016). Furthermore, the results from this chapter may also motivate the provision of good-quality extracurricular activities for adolescents after school, although the evidence for this is less clear-cut.

Most of the findings in this thesis relate to maternal practices and behaviour. It is not unusual for social science research to find that mothers' behaviour exerts a more important influence on their offspring than fathers' behaviour (Jones, Forehand & Beach, 2000; Madon et al., 2004; Milevsky et al., 2007); this is to be expected because mothers spend much more time with their children than fathers do and may thus be a more important influence. It is important, however, that findings such as those in this thesis are not used as evidence to support a regressive social agenda with an emphasis on mothers' relationships with their children and (particularly) mothers' presence in the home. Rather, these findings should be understood as reflecting the current situation in which mothers spend more time than fathers with their children, and any translation to policy should be undertaken with a view to safeguarding advances in gender equality and promoting further advances.

The findings in Chapter 6 relate to religious faith and participation; in particular, I find that religious participation is associated with giving up substance use. The protective effect of religious faith and practice has been increasingly recognised; many treatment programmes (e.g. the 12-step programmes of Alcoholics Anonymous and other organisations) already embody a strong spiritual component, which is considered to contribute to positive outcomes

(Davis, 2014; Gossop, Stewart & Marsden, 2008; Kamieneski et al., 2000). Despite this evidence, it may not be considered acceptable in the context of a liberal democracy for publicly-funded treatment programmes to require or even to encourage religious participation. Religion is considered to be a matter for the individual, and even if religious observance were built into treatment programmes there would be obvious problems in ensuring compliance. Clearly, any extension of this in the context of policy would have to be undertaken with full consideration, and a high degree of caution. However, the findings do suggest two lines of approach. Firstly, information packs and treatment programmes for people wanting to give up smoking, drinking, etc. could *mention* that becoming part of a religious congregation could assist with this process, regardless of the individual's level of faith or belief. Secondly, governments could consider routing a proportion of spending on treatment programmes, on an experimental basis, via religious institutions. This could be a particularly useful means of providing more accessible, immediate resources and support for vulnerable groups, given that people from a disadvantaged background are more likely to trust religious institutions, including mosques and churches, than the government to help with their needs (World Bank, 2005).

While the costs of these interventions can be expensive, they are outweighed by future savings in societal costs, such as family dissolution, specialised care for substance abuse, and mental health problems (National Center on Addiction and Substance Abuse at Columbia University, 2009; Sacks et al., 2015; US Department of Health and Human Services, 2016). For example, Sacks et al. (2015) indicate that health care associated with excessive alcohol consumption is estimated to cost the US 28.4 billion dollars, of which 42.4 per cent is for specialised care for alcohol abuse and dependence. A comprehensive report from the US Department of Health and Human Services (2016) states that mental and substance use disorders are the leading causes of individuals living with disability, since these problems tend to occur in early life and can continue for a long time if untreated. The human and financial costs of substance use and substance use problems to society are immeasurable; a multilevel intervention approach is thus needed to provide a practical, comprehensive and efficient way to reduce substance use at the population level.

## 7.5 Thesis challenges and future directions

### *7.5.1 Thesis challenges*

This study is designed to understand the determinants of substance use behaviours and problems at various life stages in adolescence and adulthood. The empirical analyses of this study are based on data from the National Longitudinal Study of Adolescent to Adult Health (Add Health). As discussed in the Data section, there are three main reasons why this data set is suitable for this project. Firstly, Add Health was initially developed with the aim of improving adolescent health and exploring the association between early life experiences in adolescence and later health outcomes in adulthood (Harris, 2013). Therefore Add Health contains a well-developed survey design that helps explore the social determinants of risk behaviours, such as substance use. Secondly, Add Health provides a rich set of variables on parental-adolescent relationships and substance use behaviours. The instruments of these variables are based on well-validated measures from previous studies and expert advice from national institutes (e.g. the Diagnostic and Statistical Manual of Mental Disorder (DSM-IV) criteria are included in the survey to identify the severity of substance use disorders of the respondents). No primary data collection nor any other US secondary data sets could match Add Health in providing data on the determinants of substance use trajectories and comprehensive information on the severity of substance use. Lastly, the development of the Wave 4 survey includes questions that reflect continuity of the earlier waves and updates on important demographic transitions. This enables analysis to link life events from adolescence to adulthood (Harris, 2013).

Despite these advantages, several limitations of this thesis should be acknowledged. In common with most longitudinal studies, participant attrition can pose a threat to the reliability of the results if it is not random; missing not randomly means that the sample is no longer representative of the wider population (Taris, 2000). Despite the attrition in Add Health, researchers have shown that the impact of this is relatively small and insignificant (Brownstein et al., 2010). In addition, only very few respondents refused to answer questions and there are only minor instrument programming errors (Harris, 2013), meaning that the quality of the data set is of a high standard. These suggest that the analyses conducted in this thesis would not have been heavily affected by the attrition and non-response rate. Nonetheless, it is still important to be aware of the effects of attrition when interpreting the findings.

A second challenge imposed by the design of the Add Health data concerned the limited waves and inconsistent spacing between interviews. This has made it more difficult to apply advanced longitudinal statistical techniques, such as fixed effects that could control for all time-invariant variables (both observed and unobserved). Further investigation using different longitudinal data sets that allow an implementation of advanced models is recommended. Moreover, the long intervals between Wave 2, Wave 3 and Wave 4, means that behavioural changes between these waves are not captured in the data set. As substance use trajectories are a constantly changing process, it is impossible to identify respondents who may have gone through multiple stages of substance use within the interval periods. However, it is important to note the difficulty of frequently gathering data about substance use without making respondents feel that this process is intrusive, which may lead them to be less honest about their substance usage. On another note, like most quantitative research that use secondary data sets, analyses in this thesis are based on an assumption that respondents would provide honest responses. Fortunately, evidence concerning this issue has shown that self-reported substance use is comparable with other data collection techniques, such as urinalysis (van den Berg et al., 2018; Kilpatrick et al., 2000).

While Add Health provides a rich set of variables, other critical factors are not captured in the data set. These include early family experiences during childhood, different dimensions of parental control (such as monitoring and demandingness), genetic predisposition to substances, family history of substance use problems, and the motivations underlying substance use and cessation. Nonetheless, as discussed in Chapters 3 and 6, PSM estimation is applied on homogenous groups while controlling for important observables (e.g. the level of substance use in a previous wave); this should have largely reduced the confounding bias. It is also important to note that, even with the implementation of PSM and a longitudinal data set, the extent to which the relationships between the determinants and substance use are causal is still debatable. However, systematic steps have been taken to examine the relationships by disentangling the effects of the determinants from the confounding effects of other observed factors. As a result, the effects of parental beliefs, parenting styles/parental behaviours, and religiosity on various stages of substance use in different periods of life are evident.

A final drawback of the Add Health data set is the insufficient data on paternal participation in the survey. Some research has shed lights on the effect of fathers' parenting

styles on adolescent development (Bronte-Tinkew, Moore & Carrano, 2006). Future research could further extend this area by focusing more on paternal-adolescent relationships that are reported by both the fathers and the adolescents.

### *7.5.2 Future directions*

Despite these constraints, this thesis has enhanced our understanding of the determinants of substance use trajectories in adolescence and adulthood. Together with the insights gained from the thesis, the challenges encountered while conducting the thesis suggest some profitable directions for future research. There are four broad directions for future research work.

Firstly, although there are numerous risk and protective factors associated with substance use, many of them interact with each other. Parenting and parent-adolescent relationships are socially patterned; this suggests that poorer quality of relationships is more common in families living in circumstances of deprivation where family members are more vulnerable to substances. While this thesis has controlled for related variables to examine the independent effect of parent-adolescent relationships on adolescent substance use, the variations within and between social groups could still be large. Future research could investigate the association between early family experiences and substance use with different subgroups.

Secondly, research into the effectiveness of programmes designed to improve parenting skills on adolescents' current and later substance use would be useful. While the importance of parenting and parent-adolescent relationships for adolescent substance use and other risk behaviours (e.g. sexual behaviours and conduct disorders) has been recognised for centuries, evaluation of parenting interventions in reducing substance use among young people is comparatively lacking. It would also be useful for future investigations to identify the best time to deliver the inventions that are sensitive to the needs of parents, and that are most efficient when it comes to preventing the development of regular use in experimental users among young people.

Thirdly, future work could extend this project by assessing the motivations for, and length of, cessation in later adulthood. Qualitative research may be needed to investigate in depth the reasons for users' readiness to quit substances, and whether these reasons are related to early family relationships and levels of religiosity. Such research could help explain

why some users are more likely than others to achieve abstinence. Moreover, examining a longer period of cessation would allow researchers to differentiate previous users who have successfully given up substances from those who have suffered a relapse. At the time of writing, this thesis is unable to address this issue as the data are not yet available. However, Wave 5 follow-up data collected during the period of 2016-2018 (when the cohort members were aged 32-42) and the second parental interviews (Parents Phase 2; parents who were originally interviewed in Wave 1 in 1995) will shortly be released. Future research could use this new data to examine the effect of parenting styles in adolescence on substance use behaviours at a later stage of life.

Fourthly, this thesis uses a US data set to investigate the risk and protective factors associated with substance use behaviours; further research is needed to assess whether these findings are applicable to other ethnic/cultural groups. In particular, it would be interesting to assess the effects of multiple religious dimensions on substance use in various cultural and social settings.

Finally, the status of marijuana has been evolving over the past few years. Some states in the US have legalised marijuana use for both personal and/or medical purposes. The ways marijuana is used are also changing along with the laws – it is used for smoking or mixing with other edible forms like baked goods and candies (US Department of Health and Human Services, 2016). These changes suggest that marijuana has become more socially acceptable, especially a growing body of research showing evidence for the potential medical value of the drug for various health conditions, including pain and nausea (US Department of Health and Human Services, 2016). Given that marijuana is not as addictive as other substances, such as tobacco and alcohol, it would be very interesting to explore whether the legalisation of marijuana changes the dynamics between early family experiences and marijuana use among young people.

## 7.6 Final remarks

In developing our understanding of the key factors associated with substance use and problems at different stages of adolescence and adulthood, a thorough examination of the association between parent-adolescent relationships, religiosity and substance use trajectories is provided in this research project. More importantly, it shows that warm,

responsive and trusting parent-adolescent relationships are protective against early substance use initiation and later substance use problems in adulthood. Adolescents who do not experience such bonding are at increased risk of later misuse. While early family relationships play an instrumental role in substance use, their effects on cessation in adulthood are modest. However, religious faith and (particularly) participation in church services and activities appear to be an important determinant of cessation. This thesis proposes that it may be through secure (or insecure) attachment to significant others (parents/higher forces) that may underlie the influence of various indicators of parenting styles and religiosity on substance use.

Altogether, this study has taken an essential step towards providing comprehensive assessment of the causes of substance use trajectories that remain an important agenda for policy.

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**Appendix A The peer-reviewed and edited version of Chapter 3 is published as: Mak, H.W. (2018). Parental beliefs and adolescent smoking and drinking behaviours: A propensity score matching study. *Addictive Behaviors Reports, 8, 11-20.* doi.org/10.1016/j.abrep.2018.04.003.**

**Abstract**

This research examines the effects of parental belief on adolescent later smoking and drinking behaviors. Previous studies show that parental belief may have detrimental or beneficial influences on adolescents' behaviors. Analysis is based on Wave 1 and 2 data from the National Longitudinal Study of Adolescent Health (Add Health), N = 3232, and is conducted using an OLS regression estimation and propensity score matching (PSM; nearest-neighbor and kernel matching). Results show that, of adolescents who used cigarettes and alcohol at Wave 1, they are more likely to continue the activity if their parents were aware of it. Adolescents are also more likely to use cigarettes if their parents believed they smoked when in fact they did not. Of adolescents who did not use alcohol, no significant association is found between parental belief and their later alcohol use. Selffulfilling prophecy is proposed to explain the effects of parental belief. Results obtained from PSM show weaker effects of parental belief, suggesting that part of the effects is explained by shared factors which are responsible for the belief and adolescent substance use. Adolescent concealment is proposed as an important unobserved confounder that influences the association between parental belief and adolescent substance use. The study suggests that research on parent-adolescent communication affected by the self-fulfilling prophecy needs to consider adolescents' intentional concealment, which may help avoid conflicts elicited by discussing topics that adolescents feel uncomfortable confiding in.

**Introduction**

Substance use has always been a concern to adolescent development and public health community. Currently in the US, around one in three students in grade 9 -12 have tried cigarette smoking. More than 60% of them have used alcohol and 17% of them used alcohol before the age of 13 (Frieden et al., 2016). Adolescent substance use is associated with a range of negative consequences, including poor academic grades, physical and mental health problems, substance abuse in adulthood, and premature death (Dawson et al., 2008; DeWit et al., 2000; Grant & Dawson, 1998; Hingson, Heeren, & Winter, 2006; King & Chassin, 2007; Marshall, 2014; McGue et al., 2001; Merlin et al., 2004; Mikkonen et al., 2008; Tucker et al., 2008; Welch, Carson, & Lawrie, 2013). Understanding substance use in early adolescence can, therefore, offer some insight into early precursors and related factors of adolescent substance use, and provide further knowledge for prevention and intervention.

Previous literature has evidently shown that parents across countries are often unaware of their adolescents' involvement in substances (Ahern, Kemppainen, & Thacker, 2016; Bogenschneider et al., 1998; Bylund, Imes, & Baxter, 2005; a Taiwanese study, see Chang et al., 2013; a cross-national study, see Fernandez-Hermida et al., 2013; Fisher et al., 2006; Green et al., 2011; Jones et al., 2017; Langhinrichsen et al., 1990; McGillicuddy et al., 2007; a Canadian study, see Williams et al., 2003; Yang et al., 2006). One may assume that parents who are aware of their deviant behaviors may take appropriate and preventive actions to avoid further misbehaving (Beck & Lockhart, 1992; Kerr, Stattin, & Burk, 2010). Yet, empirical evidence suggests otherwise. Parents' accurate belief has been found to be associated with an increase in adolescent's later risky behaviors, whereas their non-belief or unawareness is related to a decrease in these activities (Lamb & Crano, 2014; Madon et al., 2003, 2004, 2006; Mollborn & Everett, 2010; Yang et al., 2006). The self-fulling prophecy (SFP) has often been used to explain this observation. It suggests that adolescent behavior, and the consequences of that behavior, are determined by parental belief, including *false* belief (Merton, 1948). Adolescents tend to start or continue using substances when their parents believe they have initiated when they have not, and discontinue when the parents believe they have not initiated when they have. When parents think their adolescents are using substances, adolescents may begin to believe that that is what they are expected to do. Existing studies provide evidence in support of the prophecy. For instance, Lamb and Crano (2014) use data from the National Survey of Parents and Youth and find that parental underestimation of adolescent marijuana use at Time 1 is associated with a lower frequency of usage at Time 2. Parents who are correctly aware of their adolescents' marijuana use at Time 1 predict a higher frequency of usage at Time 2. Similar effects of belief are also found in other areas. For example, Mollborn and Everett (2010) find that parental underestimation of adolescent sexual activity at Wave 1 predicts a lower frequency of sexual activity and STI diagnosis at Wave 2, compared with adolescents whose parents are aware of the behavior.

However, most research has failed to acknowledge a potential confounding bias existed in the relationship between adolescent substance use, parental belief, and shared factors. An overview of the past literature implies that factors responsible for parents' belief about their adolescents' involvement in risky behaviors may also be factors that motivate adolescents to engage in those very behaviors (see Diagram 1). This may partly explain why parental underestimation is more protective than accurate awareness, given that underestimation is often associated with healthy parent-adolescent relationships, good academic performance, and high levels of adolescent religiosity (Berge et al., 2015; Green et al., 2011; Yang et al., 2006). Studies of Madon et al. (2003, 2004, 2006) are particularly relevant to this subject, being based on the assumption that parental belief about adolescents' alcohol use and adolescents' later alcohol consumption share nearly identical risk and protective factors (e.g. household income and past alcohol use). While the authors suggest that the SFP is responsible for the association between parental belief and adolescents' later drinking behavior, they fail to acknowledge potential confounders that may influence the effect of parental belief.

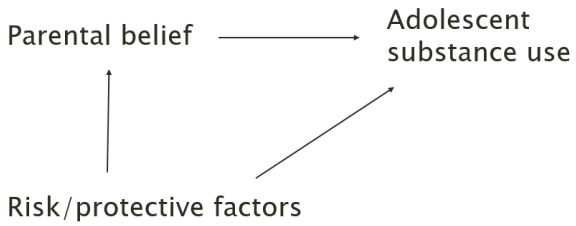


**Diagram 1 A model showing a potential confounding bias of the effect of parental belief on adolescent substance use**

In light of this, this study is designed to contribute to the previous literature by using propensity score matching (PSM) on a representative sample. PSM is a technique that is designed to reduce the bias caused by confounding variables in observational studies (Rosenbaum & Rubin, 1983). A major advantage of PSM is that it accounts for the probability of receiving a treatment when random assignment of the treatment is not available. The treatment effects of parental belief on adolescent later tobacco use and alcohol consumption are examined. To my best knowledge, this is the first study using PSM to examine the effects of parental belief on adolescents' risky behaviors.

**The current study**

This study extends prior research in two important ways. First, the data analyzed in this study is from the National Longitudinal Study of Adolescent to Adult Health (Add Health). The use of a longitudinal dataset and PSM may tell us more about the actual causation. This could give us important information regarding the possible short-term effects of parental belief on adolescent smoking and drinking

behaviors. Second, a large-scale survey enables researchers to explore potential determinants of parental belief, enriching our knowledge in the formation of the belief.

The present study first explores the agreement between parental and adolescent reports of adolescent smoking and drinking behaviors. It is hypothesized that the agreement between the two reporters is low (H1). Secondly, adolescent-respondents are partitioned into two groups on the basis of their previous substance use at Wave 1. OLS and PSM are applied to assess the effects of parental belief on adolescents' later substance use. A set of theoretically and empirically tested explanatory variables used to measure both parental belief and adolescent outcomes is included in the models. It is hypothesized that adolescents are likely to use cigarettes and alcohol if their parents believe (rightly or wrongly) that they engage in these activities (H2). It is also hypothesized that the effects of parental belief may reduce, but not disappear completely, when using PSM which accounts for the covariates that predict the probability of parental belief (H3).

**Data and Methods**

*Data*

The analysis is based on the Add Health dataset from the United States[19]. The survey follows a nationally representative sample of adolescents who were in school grades 7 – 12 in the 1994/95 school year. Over 90,000 students from 132 schools completed an initial questionnaire in school; a subsample was selected for an in-home interview in the same year, which parents were also interviewed. Sample members were re-interviewed for a second time in the following year, a third time in 2001/02, and a fourth time in 2008 when sample members reached young adulthood (aged 24 -32).

The survey covers multiple aspects of respondents' lives, including parent-adolescent relationships, family structure, peer groups, and families' economic situation, with rich data on respondents' usage of tobacco and alcohol. Data have been collected from adolescents, their classmates and friends, teachers, parents, and partners, using computer-assisted self-interview (CAPI) instrument.

The current study uses the first two waves from the public use in-home dataset, which consists of a random selection of the original data (*N* = 6504 and 4834 at Wave 1 and Wave 2, respectively). The response rate of adolescent-sample for Wave 1 is 79% and 88.6%[20] at Wave 2, and approximately 85% have a parent participated in the interview at Wave 1. Given that more than 90% of observations in

[19] Harris, K.M., C.T. Halpern, E. Whitsel, J. Hussey, J. Tabor, P. Entzel, and J.R. Udry. 2009. The National Longitudinal Study of Adolescent to Adult Health: Research Design [WWW document]. URL: http://www.cpc.unc.edu/projects/addhealth/design.

[20] The response rate at Wave 2 is the original sample at Wave 1 who were eligible for Wave 2 interview.

the parent questionnaire were completed by mothers, who have more knowledge about their adolescents' risky involvement (DiIOrio et al., 1999; Mollborn & Everett, 2010) and whose belief are shown to have greater effects than fathers' belief (Madon et al., 2004), this study focuses on maternal belief.

The sample size is restricted to respondents who were aged between 13 and 18 at the time of the first interview. This gives a core sample size of 3232. Table 1 provides descriptive statistics of outcome variables, variables of interest, and control variables. A list of measurement items used to derive scales is provided in the Appendix.

**Table 1 Descriptive statistics of outcome variables, variables of interest, and control variables: National Longitudinal Study of Adolescent Health Wave 1 (1994-1995), and Wave 2 (1995 - 1996) (N = 3232)**

| Variable | Range of Values | | Mean (SD) or % |
|---|---|---|---|
| | Min | Max | |
| **Outcome Variables, W2** | | | |
| Average number of cigarettes per day in the past 30 days | 0 | 24 | 1.50 (4.35) |
| Average number of drinks per day in the past 30 days | 0 | 7 | 0.59 (0.98) |
| **Variables of Interest, W1** | | | |
| Average number of cigarettes per day in the past 30 days | 0 | 20 | 1.02 (3.47) |
| Average number of drinks per day in the past 30 days | 0 | 6.5 | 0.52 (0.84) |
| Any cigarette use [binary] | 0 | 1 | 0.22 (0.42) |
| Any alcohol use [binary] | 0 | 1 | 0.42 (0.49) |
| Maternal belief about adolescent regular cigarette use (i.e. once a week or more) | 0 | 1 | 0.09 (0.29) |
| Maternal belief about adolescent regular alcohol use (i.e. at least once a month) | 0 | 1 | 0.06 (0.24) |
| **Control Variables, W1** | | | |
| ***Demographic factors*** | | | |
| Age | 13 | 18 | 15.1 (1.45) |
| Female | 0 | 1 | 53.5 |
| White (Ref) | 0 | 1 | 67.8 |
| African American | 0 | 1 | 19.1 |
| American-Indian/ Asian/ Mixed/ Others | 0 | 1 | 13.1 |
| Intact family (Ref) | 0 | 1 | 60.2 |
| Step-family | 0 | 1 | 12.2 |
| Single-parent family | 0 | 1 | 27.6 |
| [Parental] Less than high school levels (Ref) | 0 | 1 | 13.2 |
| [Parental] High school graduate | 0 | 1 | 26.8 |
| [Parental] Some post-school training/college | 0 | 1 | 32.6 |
| [Parental] Bachelor's degree/Postgraduate training | 0 | 1 | 27.4 |
| Grade point average (GPA) | 1 | 4 | 2.86 (0.76) |
| Religiosity | -1.74 | 1.30 | 0.05 (0.99) |
| Mental health problems[1] | -1.45 | 5.18 | -0.06 (0.97) |
| ***Family relations*** | | | |
| Maternal trust[2] | 1 | 5 | 4.37 (0.82) |
| Mother-adolescent closeness[3] | -4.97 | 6.59 | 0.01 (0.98) |
| Parental control[4] | -1.93 | 4.01 | -0.00 (0.99) |
| Frequency of lying to parents/guardians about whereabouts and peer hang out with | 0 | 3 | 0.87 (1.03) |
| ***Maternal and peer substance use*** | | | |
| Whether mother smokes | 0 | 1 | 0.49 |
| Mother's high alcohol consumption (i.e. more than three days per week) | 0 | 1 | 0.23 |
| Number of best friends who smoke | -1.06 | 2.41 | -0.01 (0.96) |
| Number of best friends who drink alcohol | -1.49 | 2.26 | 0.03 (0.98) |
| ***Neighborhood environment associated with substance use*** | | | |
| Drug dealers and users is a big problem in the neighborhood | 0 | 1 | 0.39 |

Notes: [1] A higher score indicates worse mental health problems; [2] The variable indicates how much mothers felt they could really trust their adolescent; [3] The variable indicates adolescents' perception of their emotional intimacy with mothers; [4] The variable indicates parental autonomy-granting (reverse coded).

*Measurements*

*Outcome variables: substance use behaviors at Wave 2*

Outcome variables assessed are the average number of cigarettes and drinks each day in the past 30 days at Wave 2. The smoking indicator is derived from two measurements: the number of days respondents smoked over the past month, and the average number of cigarettes smoked on each of these days. The range of the number of cigarettes is 0–24 or more (M=1.50, SD=4.35). The drinking indicator is a combined measurement of the quantity-frequency scale (Poikolainen, Podkletnova, & Alho, 2002). The quantity measures the number of drinks adolescents had each time in the past 12 months. The frequency of alcohol use in the past 12 months was coded in the questionnaire as follows: 0= never/has not had a drink in a lifetime; 1= 1 or 2 days; 2= once a month or less (3-12 times in the past 12 months); 3= 2 or 3 days a month; 3= 1 or 2 days a week; 4= 3 to 5 days a week; and 6= every day or almost every day. The two measures are multiplied into a single scale by converting the frequency levels into equivalent occasions per month (i.e. 0=0, 1=0.125 days per month, 2=0.625 days, 3=2.5 days, 4=6 days, 5=16 days, 6=28 days). Because less than 1% of the respondents consumed more than 7 drinks per day, I replaced the top 1% to be equal to the 99$^{th}$ percentile rank of 7. The average number of drinks per day in the past months is therefore top-coded at 7 (M=0.59, SD=0.98).

*Maternal belief and adolescent substance use behavior at Wave 1*

At Wave 1, mothers were asked whether their adolescents used tobacco and alcohol regularly, namely once a week or more and at least once a month, respectively. In the analysis, the response "unsure" is included in the "yes" category as it implicitly reflects parents' suspicion that the adolescents were engaging in risky behaviors (Bogenschneider et al., 1998)[21]. Adolescents were asked whether they smoked and consumed alcohol in the past 30 days. Three binary indicators are generated. For adolescents who used tobacco or alcohol at Wave 1, they were asked about the number of cigarettes and drinks they consumed per day in the past month. These variables are measured in the same way as Wave 1. The range of cigarette use is 0 to 20 (M=1.02, SD=3.47) and alcohol consumption 0 to 6.5 (M=0.52, SD=0.84).

*Demographic factors, family relations, maternal and peer substance use, and neighborhood environment*

*Demographic factors*. The following variables measured at Wave 1 are controlled: adolescents' age, gender, race, household composition, parental education levels (paternal education levels if maternal education was missing), grade point average (GPA), religiosity (a standardized scale based on 4 items,

[21] The percentage of parents reporting "unsure" about their adolescents' substance use is 2% for smoking and 5% for alcohol use.

α= 0.86), and mental health problem (a standardized scale based on 19 items, α= 0.86). All variables were reported by adolescents.

*Family relations*. Maternal trust, parent-adolescent closeness, parental control, and the frequency of lying to parents in Wave 1 are controlled in the analysis. Maternal trust is an ordinal variable reported by mothers, measuring how much they felt they could really trust their adolescent. The variable ranges from 1-5 (never, seldom, sometimes, often, and always; M=4.37, SD=0.82). Both closeness and control scales were reported by adolescents. The closeness scale measures adolescents' perception of their emotional intimacy with mothers. It is based on 5 items (α=0.84), including "how much do you think [your mother] cares about you?". The control scale is a reverse-coded variable that measures parental autonomy-granting. The scale is derived from 7 items (α=0.62); items include "Do your parents let you make your own decisions about the time you must be home on weekend nights?" (reverse coded). Existing literature has shown that parenting styles vary across adolescent age and gender (Belsky, 1984; Parent et al., 2014). The relevant scales are therefore regressed on age and sex, and are standardized. Adolescents were also asked how often in the past year they lied to their parents about where they had been or whom they were with. The item scale ranges from 0 "never" to 3 "5 or more times" (M=0.87, SD=1.03).

*Maternal and peer substance use.* In Wave 1, maternal smoking is defined based on the reports from either the mothers or the adolescents. Maternal alcohol consumption is defined on the basis of either the mothers or the fathers reporting that the mothers drank alcohol on more than three days per week (adolescents were not asked about parental drinking; M=0.49, SD=0.50 for maternal smoking; M=0.23, SD=0.42 for maternal drinking). Maternal smoking is only included in the model estimating adolescent later cigarette use, and maternal alcohol use in the regression estimating adolescent alcohol consumption. Adolescents were asked how many of their three best friends smoked and drank alcohol. Responses range from 0 to 3 and are adjusted for adolescent age and sex. Both scales are then standardized. The peer-smoking variable is included in the model of adolescent cigarette use, whereas the peer-drinking variable in the model of alcohol use. Since it is possible that adolescents with friends who smoked or used alcohol were likely to lie to their parents about their activities and whom they were with, two interaction terms between peer substance use and the frequency of lying are generated. The interaction term of peer smoking and adolescent lying is included in the regression on cigarette use, and peer drinking and adolescent lying in the regression on alcohol use.

Neighborhood environment associated with substance use. Substance use in a neighborhood context is a binary indicator reported by mothers at Wave 1, measuring whether drug dealers and drug users were a big problem in the neighborhood (M=0.39, SD=0.49).

*Methods*

In this study, I first calculate the kappa statistic to test the agreement between maternal and adolescent reports of adolescent smoking and drinking behaviors. The kappa statistic is widely used as a measure of reliability between two reporters. It is believed to be less biased than other agreement measurements (e.g. Yule's Y statistics) as it takes into account the amount of observed agreement occurring by chance (Fleiss, Levin, & Paik, 2003). To interpret kappa statistic results, Fleiss, Levin, and Paik (2003)'s guidelines are used for evaluating the agreement between maternal and adolescent reports: coefficients less than .00-.39 (poor); .40-.75 (fair); and .76-1.00 (excellent). Second, to explore the effects of maternal belief, adolescents are divided into two groups, those who used substances at Wave 1 and those who did not. Once separated, an OLS regression method is employed for each group.

Although OLS and logistic regression models were applied in most of the previous work, they may produce biased estimations. Firstly, they do not control for the effects of other observed variables on maternal belief when estimating the relationship between the belief and the outcome. This potentially increases the bias caused by confounders in the estimations (Zanutto, 2006). Secondly, the average treatment effect for the treated (ATT; the effect of a treatment for individuals with a high propensity to experience the event) may be on average different from the treatment effect for the untreated (i.e. the effect of a treatment for individuals with a low propensity to experience the event). As a result, simply calculating the average treatment effect for the sample may be inadequate in reflecting the average treatment effect for the total population, especially when the propensity scores vary greatly between individuals (Morgan & Harding, 2006). To address these issues, PSM is thus used as part of the data analysis.

PSM is a technique that attempts to mimic an experimental research setting on an observational data set by creating two groups from the sample, a treatment and a control group, based on whether or not participants had actually received the treatment (i.e., the beliefs) (Becker & Ichino, 2002; Rosenbaum & Rubin, 1983, 1984, 1985). Participants from the treatment unit are matched with those from the control unit who have similar propensity scores obtained from a logistic regression model; the regression model estimates the likelihood of maternal beliefs conditional on a set of pre-treatment variables/covariates. After matching, the sample distribution of the observed covariates in the treated and control groups should be very similar, and the difference between these groups should therefore be more attributed to the treatment itself. This technique may have the potential to estimate the casual effect of the treatment (Rosenbaum & Rubin, 1983). After matching, the sample distribution of the observed covariates in the treated and control groups would be similar; the covariates and treatment itself become unrelated in both groups. In this study, adolescents are divided into two groups: (a) those whose mother believed their use of cigarette or alcohol regularly (i.e., the

"treatment" group); and (b) those whose mother did not believe their use of cigarette or alcohol regularly (i.e., the "control" group).

The PSM estimates presented in this study use nearest neighbor matching with replacement. This approach pairs each adolescent in the "treatment" group with one or more than one adolescents in the "control" group which has the closest propensity score calculated prior. Control cases that are unable to match with treatment cases are dropped from the analysis to reduce the likelihood of bias. This matching method is commonly used by researchers from various fields and is relatively less biased (Dehejia & Wahba, 2002; Frisco, Muller, & Frank, 2007). Most importantly, it suits the dataset where there are many potential matches in the control group (i.e. mothers who *did not* believe their children smoked/used alcohol) for each treatment unit (i.e. mothers who *believed* their children smoked/used alcohol) (Bai, 2011).

For the purpose of reliability check, the analysis is replicated using a kernel matching estimation, which uses all available cases and matches treatment units to a weighted mean of all control units. The analysis is performed with common support imposition to help improve the quality of the matches that would be used for estimating the ATT (Caliendo & Kopeinig, 2008).

Sensitivity analyses are performed, which involve testing different observed variables, number of neighbors, and bandwidths, to determine the final models that have the least mean bias percentage[22,23]. Blinder-Oaxaca decomposition analysis is also used to help determine variables that would be included in the final PSM models. Missing values are handled with listwise deletion, and bootstrapping techniques with 1000 replicates are used to obtain standard errors and 95% confidence intervals (Frisco et al., 2007). Results presented are from unweighted models since the statistical software Stata used in this study does not allow PSM estimations with any weight commands. It has also been reviewed that the procedure of weighting involves arbitrary decisions on weight factors and interactions (Gelman, 2007), which may possibly affect PSM estimations.

[22] While some scholars suggest that PSM estimations should include all relevant variables even if they are only modestly related to the treatment (Rubin & Thomas, 1996), others are concerned about the degrees of freedom and advise that variable selection should be guided by theories and previous research, and that sensitivity analyses are necessary to estimate the level of bias (Caliendo & Kopeinig, 2008; Dehejia & Wahba, 2002; Frisco, Muller, & Frank, 2007; Guo & Fraser, 2010). I, therefore, perform sensitivity analyses to explore how including and excluding different variables would affect the prediction of the likelihood of parental belief (i.e. the propensity scores) and adolescents' later substance use. Variables that are considered include Baumrind's fourfold parenting styles (an interaction between parent-adolescent closeness and control scales; Baumrind, 1991), household income, adolescent conduct disorders (e.g. getting into a serious physical fight), maternal age, and parental employment status. Their exclusion does not substantially affect the results, and also saves degrees of freedom and the number of missing values.

[23] Given that the nearest-neighbor matching estimation relies on the distance with the nearest propensity scores, different calipers (ranging from 0.001 to 0.9) and numbers of neighbors (ranging from 3-7) are tested. For the kernel matching estimation which depends on the density of adjacent propensity scores, various bandwidths (ranging from 0.001-0.9) are tested.

**Results**

*Parent-adolescent agreement indices*

**Table 2a Agreement indices of adolescent and maternal reports of adolescent cigarette use at Wave 1 (N=3232)**

| | Maternal belief of adolescent cigarette use (%) | | |
|---|---|---|---|
| **Adolescent cigarette use (%)** | **No** | **Yes** | **Total** |
| **No** | 2456 (97.97) | 51 (2.03) | 2504 |
| **Yes** | 478 (65.93) | 247 (34.07) | 725 |
| **Total** | 2934 (90.78) | 298 (9.22) | 3232 |
| **Percentage of agreement** | 0.836 | | |
| **Kappa** | 0.405 *** | | |

**Table 2b Agreement indices of adolescent and maternal reports of adolescent alcohol use at Wave 1 (N=3232)**

| | Maternal belief of adolescent alcohol use (%) | | |
|---|---|---|---|
| **Adolescent alcohol use (%)** | **No** | **Yes** | **Total** |
| **No** | 1835 (98.66) | 25 (1.34) | 1860 |
| **Yes** | 1204 (87.76) | 168 (12.24) | 1372 |
| **Total** | 3039 (94.03) | 193 (5.97) | 3232 |
| **Percentage of agreement** | 0.620 | | |
| **Kappa** | 0.123 *** | | |

Tables 2a and 2b report the agreement indices of adolescent and maternal reports of adolescent cigarette and alcohol use at Wave 1. In line with prior work (e.g. Bogenschneider et al., 1998; Williams et al., 2003; Yang et al., 2006), mothers tend to underestimate adolescent substance use, in particular alcohol consumption. For smoking, Table 2a shows that 65.9% of mothers underestimated their children's cigarette use, 2% overestimated, and 34.1% made correct assessments. For drinking, 87.8% of mothers were unaware of their children's alcohol consumption, 1.3% of them overestimated, and 12.2% of them correctly estimated their drinking behavior. Percentages of agreement show the proportion of mothers and adolescents who provided the same response. Around 98% of mothers made correct assessments about their children's abstinence from substance use; this contributes to the high percentage agreement statistics. Agreement on drinking behavior is lower than cigarette use.

The Kappa statistics confirm the results of cross-tabulation, showing poor-to-fair agreement on cigarette use (41%) and alcohol use (12%). Sensitivity (i.e. the proportion of adolescents and mothers both reporting the adolescents' substance use) and specificity (i.e. the proportion of adolescents and mothers both reporting no substance use) tests are performed. The sensitivity and specificity proportions reporting adolescents' cigarette use are 0.34 and 0.98, and adolescents' alcohol use 0.12 and 0.99 (results not shown). The results are consistent with the kappa statistics and percentages of agreement.

Table 3 presents a preliminary analysis using a logistic regression estimation to compare the effects of observed variables on maternal belief about adolescent alcohol use, and on adolescents' alcohol use

at Wave 1. Results demonstrate that maternal belief and adolescent alcohol use can be predicted by adolescent age, ethnicity, religiosity, mother's trust, and maternal and peer alcohol consumption. This suggests that these shared factors are responsible for both maternal belief and adolescent alcohol consumption at Wave 1. Consequently, simply using conventional regression models to estimate the effects of the belief on children's later substance use is likely to produce a biased estimation. The shared factors are similar between models estimating maternal belief of cigarette use and adolescents' actual cigarette use at Wave 1, except adolescent GPA is also a shared factor while mother's cigarette use is not.

The sample is then split into two groups (i.e. adolescents who used the substances at Wave 1 and those who did not) to predict the propensity for maternal belief. Propensity scores output obtained from propensity models is used to match cases using nearest neighbor and kernel matching methods.

**Table 3 Logistic regression models comparing the predictors of maternal belief about adolescent alcohol use and adolescent alcohol use at Wave 1 (N=3232)**

| | Estimating maternal belief about adolescent alcohol use | | Estimating adolescent alcohol use | |
|---|---|---|---|---|
| | **OR** | **95% CI** | **OR** | **95% CI** |
| ***Demographic factors*** | | | | |
| Age | 2.058*** | (1.798 - 2.355) | 1.466*** | (1.377 - 1.560) |
| Female[1] | 0.728 ✞ | (0.518 - 1.024) | 0.991 | (0.828 - 1.187) |
| African-American | 0.399** | (0.225 - 0.708) | 0.452*** | (0.351 - 0.583) |
| American Indian/Asian/Mixed/Others[2] | 0.905 | (0.546 - 1.500) | 0.986 | (0.759 - 1.282) |
| Step-parent family | 1.048 | (0.633 - 1.735) | 1.239 | (0.944 - 1.627) |
| Single-parent family[3] | 1.390 ✞ | (0.950 - 2.033) | 1.195 | (0.964 - 1.482) |
| [Parental] High school graduate | 0.909 | (0.513 - 1.611) | 1.112 | (0.826 - 1.497) |
| [Parental] Some post-school training/College | 1.022 | (0.587 - 1.778) | 1.204 | (0.903 - 1.604) |
| [Parental] Bachelor's degree or beyond[4] | 1.382 | (0.781 - 2.443) | 1.109 | (0.818 - 1.504) |
| Grade point average (GPA) | 0.926 | (0.736 - 1.166) | 0.942 | (0.829 - 1.070) |
| Religiosity | 0.674*** | (0.569 - 0.797) | 0.857** | (0.781 - 0.940) |
| Mental health problems | 0.992 | (0.835 - 1.179) | 1.077 | (0.973 - 1.192) |
| ***Family relations*** | | | | |
| Maternal trust | 0.495*** | (0.414 - 0.593) | 0.878* | (0.784 - 0.984) |
| Mother-adolescent closeness | 0.970 | (0.827 - 1.138) | 0.885* | (0.804 - 0.975) |
| Parental control | 0.959 | (0.803 - 1.144) | 0.842*** | (0.769 - 0.922) |
| Frequency of lying to parents/guardians about whereabouts and people hang out with | 0.970 | (0.798 - 1.178) | 1.549*** | (1.413 - 1.698) |
| ***Maternal and peer substance use*** | | | | |
| Mother's high levels of alcohol consumption | 1.488* | (1.044 - 2.120) | 1.500*** | (1.218 - 1.847) |
| Peers' alcohol use | 1.726*** | (1.370 - 2.174) | 2.909*** | (2.553 - 3.314) |
| ***Neighborhood environment*** | | | | |
| Neighborhood drug problems | 1.589** | (1.143 - 2.210) | 0.970 | (0.808 - 1.165) |
| ***Interaction terms*** | | | | |
| Peers' alcohol use*frequency of lying | 1.087 | (0.936 - 1.261) | 0.994 | (0.905 - 1.092) |
| **Constant** | 0.000*** | (0.000 - 0.000) | 0.003*** | (0.001 - 0.009) |
| **Pseudo $R^2$** | **0.269** | | **0.293** | |

Notes: 95% CI in parentheses. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. Reference category: [1]Male; [2]White; [3]Intact family; [4]Less than high school levels.

*Parental belief and adolescent substance use: Results from PSM and OLS methods*

Table 4 shows the estimated number of cigarettes and drinks per day at Wave 2, and the results from covariate unbalancing tests. The table reports three estimates- the ATT using nearest neighbor matching, the ATT using kernel matching, and coefficients from an OLS regression estimation. Results obtained from the covariate unbalancing tests demonstrate the balance of observed variables between treatment and control groups. They show sufficient density distribution overlaps and

common support areas for calculating efficient estimations of ATT between the groups across models, except for the model of adolescents who did not consume alcohol at Wave 1. The covariate unbalancing percentage in this model exceeds the threshold 5% (Caliendo & Kopeinig, 2008; 6.7% with nearest-neighbor matching and 6.2 % with kernel matching). Failure in matching suggests that, of alcohol-inexperienced adolescents at Wave 1, the density distributions of the propensity scores in the treatment and control groups vary greatly. The region of common support is thus very small to produce efficient ATT. Relevant variables that contribute to the unsuccessful matching estimations include the interaction term of peer alcohol use and frequency of lying, adolescent religiosity, and peer alcohol use. The estimated values should therefore be interpreted with caution.

Overall, the results in Table 4 show that adolescents are more likely to continue their cigarette use and alcohol consumption if their mothers were aware of these activities. The probability of adolescent cigarette initiation is also higher if their mother overestimated their smoking behavior at Wave 1. Adolescents whose mothers made correct assessments smoke 2.4-2.6 cigarettes more than those whose mothers did not make correct assessments. Of adolescents who did not smoke at Wave 1, maternal overestimation is positively associated with 1.4-1.6 cigarettes each day in the following year. Adolescents whose mothers made correct assessments consume around 0.3 to 0.4 drinks per day in the following year (i.e. around 2 to 3 drinks per week), compared with those whose mothers did not make correct assessments. Of adolescents who did not use alcohol at Wave 1, maternal belief of their drinking behavior shows no effects on their later alcohol use. The effects of maternal belief reduce when using PSM where the covariates predicting the belief are accounted for. A fuller discussion of this finding will be presented in the Discussion session.

**Table 4 Comparison of OLS regression estimates and average treatment effects of maternal belief on adolescent smoking and drinking behaviors**

| | OLS Regression | Propensity Score Matching Methods | |
|---|---|---|---|
| | | ATT of Experiencing Maternal Belief about Adolescent Substance Use | |
| | | Nearest Neighbor Matching | Kernel Matching |
| **Smoke, W1** | | | |
| Number of cigarettes, W2 | 2.616 *** | 2.580 * | 2.425 * |
| | (1.529, 3.702) | (0.606, 4.554) | (0.490, 4.361) |
| Average covariate unbalance | - | 4.6 | 3.9 |
| Treatment observations | 247 | 190 | 190 |
| Control observations | 478 | 181 | 395 |
| **Total N** | **725** | **371** | **585** |
| **No Smoke, W1** | | | |
| Number of cigarettes, W2 | 1.401 *** | 1.570 * | 1.376 ✞ |
| | (0.825, 1.976) | (0.090, 3.051) | (-0.077, 2.829) |
| Average covariate unbalance | - | 3.8 | 3.6 |
| Treatment observations | 51 | 51 | 50 |
| Control observations | 2456 | 220 | 2454 |
| **Total N** | **2507** | **271** | **2504** |
| **Alcohol, W1** | | | |
| Number of drinks, W2 | 0.418 *** | 0.258 | 0.310 ✞ |
| | (0.217, 0.619) | (-0.096, 0.611) | (-0.012, 0.631) |
| Average covariate unbalance | - | 4.3 | 4.7 |
| Treatment observations | 168 | 166 | 166 |
| Control observations | 1204 | 402 | 1204 |
| **Total N** | **1372** | **568** | **1370** |
| **No Alcohol, W1** | | | |
| Number of drinks, W2 | 0.101 | 0.102 | 0.116 |
| | (-0.131, 0.334) | (-0.248, 0.451) | (-0.148, 0.379) |
| Average covariate unbalance | - | 6.7 | 6.2 |
| Treatment observations | 25 | 20 | 20 |
| Control observations | 1835 | 97 | 1793 |
| **Total N** | **1860** | **117** | **1813** |

Notes: OLS regression models include control variables measured at Wave 1. PSM 95% confidence intervals in parentheses computed by bootstrapping with 1000 repetitions. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%.

*Robustness checks*

Several alternative specifications are estimated as robustness checks. As an initial check, a parallel analysis is conducted using binary indicators of the outcome variables at Wave 2 to examine the changing status between Wave 1 and 2. Results show a very similar pattern: logistic regression estimations show that there is a positive association between maternal belief and adolescents' later cigarette and alcohol use, regardless whether they had initiated these activities at Wave 1 (the effect of maternal belief on adolescents' alcohol use is only significant at the 10% level among adolescents who did not use alcohol at Wave 1). Results obtained from the PSM models indicate a reduction in the effects of maternal belief.

A second check is to explore alternative specifications for the indicator of maternal belief. The original indicator records the belief which mothers reported either "yes" or "unsure" (due to the possibility of suspiciousness). I then further examine how the "unsure" category relates to the outcome variables. Two complementary sets of analyses are performed; (a) the "unsure" category is excluded from the model, and (b) the "unsure" category is included in the "no" category. In the former model, maternal belief is significantly related to a higher number of cigarettes among adolescents who had already initiated smoking at Wave 1. Of adolescents who *had not used* cigarettes or *had used* alcohol at Wave 1, the effect of maternal belief is significant in the OLS regression model but insignificant in the PSM estimations. In the latter model where the "unsure" category is included in the "no" category, the effects of maternal are positively related to adolescents' later cigarette use, regardless whether they had initiated at Wave 1, and later alcohol use when they had drinking experiences previously. Results are all significant at least at the 10% level with OLS estimations. The effects of maternal belief reduce when using PSM.

A third robustness check is to compare the magnitude of maternal belief effects between experienced and inexperienced adolescents at Wave 1, as well as across smoking and drinking models. Post hoc tests are carried out using Hausman test and seemingly unrelated estimation[24]. The tests indicate that the effects of maternal belief differ in magnitude across smoking and drinking models, and across models of alcohol-experienced and -inexperienced adolescents. A final robustness check is to test if outliers affect the results. All analyses are replicated by trimming at the top and bottom 1$^{st}$, 5$^{th}$, and 10$^{th}$ percentile. Results show no significant differences.

**Discussion**

By using various statistical methods, this paper builds up on previous studies to investigate the relationship between maternal belief and adolescents' substance use. In line with existing literature (e.g. Bogenschneider et al., 1998; Williams et al., 2003; Yang et al., 2006), parents generally are not aware of their adolescents' cigarette and alcohol use. This study shows that more than two-third of mothers were unaware of adolescent substance use at Wave 1. One interesting finding from the agreement indices is that although there were more adolescents reporting their alcohol use than those reporting their cigarette use, mothers were much less likely to make correct assessments on the former. Low agreement on adolescent drinking may be due to the use of alcohol is less noticeable than the use of cigarettes (e.g. residual odors) if one does not drink to excess (McGillicuddy et al., 2007).

[24] Seemingly unrelated estimation test is only performed after OLS regressions; this is because Stata does not allow standard errors from the previous estimates to be adjusted with a bootstrapping technique.

Investigations into the correlates of maternal belief and adolescent substance use using PSM are lacking. This study shows that, of adolescents who used or did not use cigarettes and those who consumed alcohol at Wave 1, maternal belief is related to an increased probability of adolescents' later engagement in these activities. The observed correlations could be explained by the SFP. According to the prophecy, it is possible that maternal knowledge about their adolescents' smoking or drinking behavior may be perceived as an approval when she is aware of the behavior but does not take any preventive actions. Further, in the alternative, parents may adopt a more coercive and disciplinary parenting practice in response to their adolescents' substance use. Such parenting may ruin the parent-adolescent relationship and increase the probability of adolescent substance use (Yang et al., 2006). Moreover, parents who believe their adolescents are involved in risky behaviors may express their belief that is possibly interpreted as an expectation by adolescents. To conform to the expectation, adolescents are encouraged to act what they are expected to. In addition, parents may actively look for signs about adolescent substance use if they believe their adolescents are engaging in the activity. Such parental actions may make adolescents feel their secrecy, autonomy, and freedom are breached; the lack of trust could lead them to initiate or continue using substances.

One of the most important findings in this study is that results obtained from the PSM estimations (nearest-neighbor matching and kernel matching) appear to be weaker than those from the OLS regression estimations. This provides evidence for the argument that part of the maternal belief effects can be explained by the shared factors that are responsible for adolescent substance use. While PSM can control for the observed variables, the effects of other unobserved variables related to maternal belief may not be completely removed. A potential and relevant unobserved variable that influences the association between maternal belief and adolescent substance use could be adolescent concealment. Adolescent concealment is commonly found in a parent-adolescent relationship and can determine parental awareness about adolescents' substance use. For various reasons, adolescents withhold information from their parents deliberately. Those reasons may help explain the negative relationship between parental underestimation and adolescent substance use. Firstly, adolescents may conceal the behaviors to avoid disappointment and punishment (Darling et al., 2006; Smetana & Metzger, 2008; Smetana et al., 2006). The amount of effort they put to hide their cigarette and alcohol use (e.g. brushing teeth to get rid of the smell of smoke or alcohol on the breath or applying fragrance to cover the residual scent of cigarettes) may discourage them from continuing with the substances. Second, a sense of guilt or a fear of being rejected by parents for engaging in undesirable behaviors may reduce their use; a study from Dearing et al. (2005) shows a negative correlation between guilt-proneness (the tendency to feel bad about a specific behavior) and substance use problems. Lastly, it is possible that adolescents feel entitled to conceal their substance use information to protect and maintain the relationship with their parents (Finkenauer et al., 2008). This suggests that their

substance use is mainly for experimental purposes and that it is unlikely for them to develop long-term substance use which is often found in high-conflict families (e.g. White, Johnson, & Buyske, 2000). As a result, it becomes logical to assume that adolescent concealment plays a role in explaining the positive effects of parental underestimation or unawareness found in previous work and the current study.

Despite the use of PSM, it is important to note that one cannot be certain regarding "causal relationships" between maternal belief at Wave 1 and adolescent substance use at Wave 2. Maternal belief and adolescent substance use might change simultaneously during the one-year window between two waves. It is also plausible that adolescents whose mothers know about their smoking or drinking activities are more likely to be regular smokers or alcohol users than those who do not know. Regular users are likely to continue their substance use in later waves. Nonetheless, findings with respect to the changing behaviors, especially adolescents changing from non-smokers to smokers, provide evidence that maternal belief to some extent leads to an increased probability of adolescent substance use.

In contrast to earlier findings, however, no evidence of maternal belief effects is found in a sample of adolescents who did not use alcohol at Wave 1. There are two possible reasons for the inconsistent and insignificant results. First, the sample of adolescents who did not use alcohol fails to achieve balanced matching. The ATT estimations based on the unbalanced matching sample is likely to be biased, and may contribute to the insignificant results, caused by the lack of common support area. This may also explain the different effect sizes of maternal belief between alcohol-experienced and -inexperienced models found in the post hoc tests. Second, alcohol is the most widely used substance in the United States (Schulenberg et al., 2016); the drinking consumption among inexperienced adolescents could be driven by various reasons. The effects of parental belief may thus be minimized by the drinking norms in society. The different social acceptance of alcohol and cigarette use may also help explain the various effect sizes of maternal belief between smoking and drinking models found in the post-estimations.

**Limitations**

A number of important limitations need to be considered. First, this study is based on the assumption that adolescents and mothers would provide honest answers. However, social desirability bias and the legal minimum smoking and drinking age may discourage respondents from reporting truthfully. Second, race/ethnicity, gender, or age groups are not separately estimated in the present study because there are too few cases of mothers reporting adolescent substance use. It would be interesting for future studies to estimate effects of parental belief separately for these groups. Third,

this research only investigates maternal belief, the effects of paternal belief may vary. Crouter and Head (2002) suggest that mothers tend to know more about their daughters and fathers about their sons. Fourth, it is noteworthy that the survey used in this study asked parents whether their adolescents used tobacco and alcohol regularly (i.e. use tobacco once a week or more; use alcohol once a month at least). It would be more informative to know if parents were truly aware of adolescent substance use or whether they made a guess about it. It is also important to note that questions on adolescent substance use were phrased differently in adolescent and parental questionnaires. However, these questions should sufficiently reflect adolescents' *monthly* cigarette and alcohol use. Fifth, although PSM helps reduce unobserved bias, 'hidden bias' created by the omission of important variables in PSM analyses may produce non-randomized unobserved heterogeneity and hence inaccurate estimations (Guo & Fraser, 2010; Rosenbaum & Rubin, 1983). However, earlier research has indicated that PSM is applicable in any conditions as long as the data violates the assumption of random assignment (Caliendo & Kopeinig, 2008; Dehejia & Wahba, 2002). Further, providing that adolescents' previous substance use frequency is controlled in the current study, the likelihood of omitted variables bias should be reduced significantly since it absorbs much variance in Wave 2 substance use. Finally, the sample size of adolescents whose mothers overestimated their substance use is relatively small. Future research may wish to consider using a larger and a more balanced sample size between the treatment and control groups, which may help increase statistical power.

**Conclusions**

Despite the limitations, the findings from this study make several contributions to the current literature. Using both an OLS estimation and PSM, this study shows that adolescents are more likely to smoke and drink if their mothers believe (rightly or wrongly) that they are engaging in these activities. This observation is not new, but one of the implications of this study is that by using PSM, a confounding bias is found in the relationship between maternal belief and adolescent substance use. This finding suggests that part of the parental belief effects is explained by shared factors that are responsible for the belief and adolescent behaviors. No known empirical research has used PSM to explore this association.

By proposing the SFP and adolescent concealment to explain the association between maternal belief and adolescent substance use, this study provides a deeper insight into parent-adolescent relationships. In recognition of the power of SFP, family-based programs and scholars have suggested that parents should have open and informative discussions about substance use and the associated problems with their adolescents. While communication is central in all kinds of relationships, it is also important to consider that adolescence is a critical period characterized by increased conflicts. This

could put pressure on communication between adolescents and parents. The concept of adolescent concealment, therefore, suggests that parents should also understand their adolescents' unwillingness in sharing information regarding risk behaviors. This may help avoid conflicts elicited by discussing topics that adolescents feel uncomfortable confiding in.

**Acknowledgement**

The author would like to thank Dr Maria Iacovou and the anonymous reviewers for valuable comments.

**Conflict of interest statement**

None declared.

## Appendix: Items in measurement scales

**Mental health problems in the past week (all measured on 4-pont scales)**

You were bothered by things that usually don't bother you.

You didn't feel like eating, your appetite was poor.

You felt that you could not shake off the blues, even with help from your family and your friends.

You felt that you were just as good as other people.

You had trouble keeping your mind on what you were doing.

You felt depressed.

You felt that you were too tired to do things.

You felt hopeful about the future.

You thought your life had been a failure.

You felt fearful.

You were happy.

You talked less than usual.

You felt lonely.

People were unfriendly to you.

You enjoyed life.

You felt sad.

**Religiosity (all measured on 4-point scales)**

In the past 12 months, how often did you attend religious services?

How important is religion to you?

How often do you pray?

Many churches, synagogues, and other places of worship have special activities for teenagers—such as youth groups, Bible classes, or choir. In the past 12 months, how often did you attend such youth activities?

**Mother-adolescent closeness (all measured on 5-point scales)**

How much do you think she [your maternal figure] cares about you?

How close do you feel to your [maternal figure]?

Most of the time, your mother is warm and loving toward you.

You are satisfied with the way your mother and you communicate with each other.

Overall, you are satisfied with your relationship with your mother.

**Parental Control (all measured as yes/no)**

Do your parents let you make your own decisions about:

The time you must be home on weekend nights

The people you hang around with

What you wear

How much television you watch

What time you go to bed on week nights

Which television programs you watch

What you eat

**Appendix B The peer-reviewed and edited version of Chapter 4 is published as: Mak, H.W. & Iacovou, M. (*2019*). Dimensions of the parent-child relationships: Effects on substance use in adolescence and adulthood. *Substance Use and Misuse, 54(5), p.724-736.* doi: 10.1080/10826084.2018.1536718.**


**Abstract**

**Background**: Several studies have uncovered a relationship between parenting styles and the likelihood that adolescents use tobacco, alcohol or illegal drugs. **Objectives**: This paper extends existing research in two ways. First, we consider a longer time-frame, investigating the relationship between parenting in adolescence and substance use in adulthood. Second, we explore the pathways by which this relationship is expressed, in particular the extent to which the relationships in question are mediated by age at first use and depression. **Methods**: Our analysis is based on data from the National Longitudinal Study of Adolescent Health (Add Health), N=2954, and is conducted using structural equation modelling (SEM). We consider warmth and control as distinct dimensions of parenting, as well as a typology of parenting which combines the two dimensions. **Results**: Warmth is associated with reduced risks of problem substance use in adulthood, via reduced risks of early initiation and a lower risk of depression. Parental control also has a protective effect via reduced risks of early initiation, but this is offset by a detrimental effect on depression, particularly in the case of older adolescents. We also find that indulgent parenting is not associated with extra risk of any kind compared with the authoritative style, whereas authoritarian and neglectful styles are. **Conclusions/Importance**: The nexus of relationships which we uncover has implications for policy aimed at reducing substance use in the longer term, suggesting that initiatives to promote warm and responsive parenting may be most effective in reducing the risks of later substance use problems.

**Introduction**

The social costs of alcohol, tobacco and illegal drug use are considerable; recent estimates suggest that excessive drinking costs the US almost $250 billion each year (Sacks et al., 2015), while smoking-related illness accounts for almost 9% of healthcare spending (Xu et al., 2015). Substance use also exacts heavy personal costs on the individuals involved and their families, in the form of mental and physical health problems, lost income, relationship problems, and lost years of life (Whiteford et al., 2013; U.S. Department of Health and Human Services (HHS) & Office of the Surgeon General U.S., 2016) .

There is evidence that parenting and family relationships influence the propensity for substance use in adolescence, and that interventions promoting effective parenting can reduce adolescent substance use (Schinke et al., 2011; Haggerty et al., 2013; Allen et al., 2016). However, there is also evidence that adolescent substance use is extremely widespread (Young et al., 2002), often experimental and self-limiting, and in itself generally not associated with a significant degree of contemporaneous or future harm (Baumrind, 1991; Englund et al., 2013). This is not to say that that adolescent substance use is unproblematic – indeed, it is a significant predictor of later substance use problems (McCambridge et al., 2011) – but given limited resources available for prevention programs, it is arguable that research on substance use should focus on identifying the determinants of problem usage beyond adolescence (Shedler & Block, 1990).

This paper is based on four waves of data from the *Add Health* study, a prospective longitudinal survey that follows a group of children (N=2954) from adolescence into early adulthood. We explore the effects of parenting style in adolescence (when sample members have a mean age of 15.4 years), on problem use of tobacco, alcohol, marijuana and other illegal drugs 13 years later, when sample members have a mean age of 28.2 – by which point most people have jobs, many have families, and substance use is no longer a youthful indiscretion but may potentially have serious effects on life chances.

We use a model of parenting styles originating in the work of Baumrind (1966, 1968, 1971, 1991). It proposes two distinct dimensions of parenting: warmth/responsiveness (the degree to which the parent/child relationship is warm, close and affectionate), and control/demandingness (the degree to which parents have expectations of good behavior on the part of their children, and the extent to which they encourage or enforce compliance with those expectations). Baumrind's original schema defined three parenting styles: *authoritative* (high in both warmth and control); *authoritarian* (high in control but low in warmth); and *permissive* (low in control). This schema has formed the basis for widely-used survey instruments (Robinson et al., 1995) and for a large body of research, in areas including developmental competence (Baumrind, 1971, 1991); self-esteem (Buri et al., 1988; Chan & Koo, 2011); and

educational achievement (Dornbusch, 1987; Steinberg et al., 1989); the authoritative parenting style is almost invariably associated with the best outcomes.

This threefold schema has now been largely superseded by a full orthogonal two-factor model, which divides the permissive group into an *indulgent* group, high in warmth and low in control; and a *neglectful* group, low in both warmth and control (Maccoby & Martin, 1983). This schema decouples low- and high-warmth parents among those exerting lower levels of control; many studies using this schema find that indulgent parenting is associated with outcomes as good as authoritative parenting, while outcomes for the neglectful group are poor; in other words, the major effect is via the warmth rather than the control axis. This pattern is found in several studies examining mental or psychological competence and wellbeing (Stafford et al., 2016; García & Gracia, 2009; Eun et al., 2018; Schofield et al., 2012; Martinez et al., 2017; Martinez et al., 2019). A number of studies relating specifically to substance use in adolescence also find similar results, including those of Kandel et al. (1978), Bronte-Tinkew et al. (2006), Adalbjarnardottir and Hafsteinsson (2001), Ozer et al. (2011), Martinez et al. (2013), Calafat et al. (2014), and Valente et al. (2017).

Not all studies find warmth to be the more important dimension. Some studies find both dimensions to be of approximately equal importance, either as determinants of competence and adjustment (Lamborn et al., 1991; Steinberg et al., 1994), or as protective factors against substance use (Hill et al., 2005; Piko & Balázs, 2012). Other studies suggest that control is more important than warmth as a protective factor against adolescent substance use (Barnes et al., 2000; Kosterman et al., 2000; Aquilino & Supple, 2001; Choquet et al., 2008).

This paper seeks to extend the state of knowledge in two ways. First, we examine a time frame extending from adolescence into the late twenties. Most studies in this area have focused on adolescence, with longitudinal studies following subjects only into late adolescence or the early adult years (Steinberg et al., 1994; Barnes et al., 2000; Aquilino & Supple, 2001; Roche et al., 2008; Mogro-Wilson, 2008; Stone et al., 2012, Van Ryzin et al., 2012). Very few studies follow adolescents into adulthood. Dubow et al. (2008) consider a three-item composite of negative family interactions in adolescence, finding it weakly related to drinking behaviour in adulthood. Maggs, Patrick, and Feinstein (2008) find the quality of parent-child relationships at age 16 is associated with alcohol consumption at age 16 and 33, and harmful drinking at age 42. White et al. (2000) find that parental warmth and hostility predict trajectories of smoking behaviour, but predict drinking only weakly. Clark et al. (2015) find that authoritarian parenting is associated with a lower risk of heavy episodic drinking at age 12 across all racial groups.

The second innovation of this study is that, in addition to assessing the effects of parental warmth and control on substance use problems in adulthood, we seek to investigate the pathways via which these effects are played out. We examine two potential pathways, which are suggested by different branches of the literature.

The first pathway is via *the age at substance use initiation*. We have already mentioned research on the relationship between parenting style and substance use; several papers in this area (e.g. Garcia & Gracia, 2009; Velleman et al., 2005) note specifically a link between parenting style and early initiation. We also expect to find a link between early initiation and the risk that an individual will go on to experience substance use problems. The "critical period" hypothesis, which originated in studies of language acquisition, suggests that there is a developmental period in the early teens during which individuals are particularly sensitive to the effects of substance use; those using substances at this age may be at substantially elevated risk of substance use disorder, or substance-related harm, in later life. The studies of Guttmannova (2011) and Maimaris and McCambridge (2014) focus on alcohol misuse, with the former suggesting evidence for a sensitive period and the latter urging more caution; Jordan and Andersen (2017) consider a wider range of substances and find evidence for a sensitive period in adolescence. Several other studies, while not specifically invoking the sensitive period hypothesis, also show that early initiation is related to higher risks of later problems. Anthony and Petronis (1995), Grant and Dawson (1998), McGue et al. (2001), King and Chassin (2007) and Richmond-Rakerd et al. (2017) consider illegal drug use, while DeWit et al. (2000), Grant, Stinson and Harford (2001), Hingson et al. (2006), Dawson et al. (2008) and McCambridge et al. (2011) consider alcohol.

The second pathway we investigate is via *depression*. As noted above (Stafford et al., 2016 and others), parenting style is associated with many aspects of mental health, with parental warmth exerting a protective effect. Poor mental health may in turn increase individuals' susceptibility to substance use problems. The "self-medication" hypothesis suggests that individuals with mental health problems engage in substance use as a way of alleviating their symptoms. The hypothesis was originally formulated in relation to opiate addiction (Khantzian et al., 1974), and has given rise to research on a range of substances (Weiss et al., 1992; Lerman et al., 1996, 1998; Bolton et al., 2009). The theory has been critiqued on the grounds that observed associations between mental health problems and substance use may not be causal in the hypothesized direction (Lembke, 2012); however, studies examining the sequencing of onset of mental health problems and substance use suggest that mental health problems are likely to precede substance use disorders (Deykin et al., 1987; Abraham et al., 1999). The self-medication hypothesis may relate to many mental health problems; we use depressive symptoms, since detailed information on other mental health problems is not collected in the data set we use.

**Data and Methods**

Analysis is based on data from the National Longitudinal Study of Adolescent Health (*Add Health*), a longitudinal study managed from the Carolina Population Center at the University of North Carolina (Harris, 2009).

The survey follows a nationally representative sample of adolescents who were in school grades 7-12 in the 1994/95 school year. Over 90,000 students completed an initial questionnaire in school; a subsample was selected for in-home interview in the same year, with parents also interviewed. Sample members were re-interviewed in 1996, 2001/02 for a third time, and 2008 for a fourth time. At the time of writing, a fifth wave of interviews is under way, but data are not yet available.

Response rates across Waves 1 to 4 are 79%, 88.6%, 77.4% and 80.3% respectively (response rates at Waves 2, 3 and 4 are calculated as percentages of the original Wave 1 participants who were eligible for subsequent waves). In a study of attrition from this survey, Brownstein et al. (2010) found that Wave 1 respondents who were male, non-white, non-native-born, or from families with lower levels of education and socioeconomic status were more likely to drop out; however, attrition bias is relatively small after sample weights are applied. The results presented are from unweighted regressions (see Winship & Radbill, 1994; Solon et al., 2015); weighted regressions give similar results.

Our analysis uses the public use data set, which is a randomly generated subsample of the core data set. We restrict the sample to respondents aged between 13 and 18 at the time of first interview (that is, who were of the usual ages for membership of the relevant school grades); these respondents were aged between 25 and 32 at the time of the fourth interview. This gives a core sample size of 2954, which varies slightly between different specifications. Table 1 provides descriptive statistics for the variables of interest; other descriptive statistics may be found in the Appendix.

**Table 1 Descriptive Statistics: outcome variables, parenting style variables and mediators**

| Variable | Range of Values | | Mean (SD) or % |
|---|---|---|---|
| | Min | Max | |
| Outcome Variables, W4 | | | |
| Ave. number of cigarettes per day in past 30 days | 0 | 20 or more | 3.12 (6.11) |
| Drinking problems | -0.61 | 3.58 | 0.01 (0.99) |
| Marijuana problems | -0.39 | 5.52 | 0.00 (1.00) |
| Other illicit drug problems | -0.27 | 5.92 | -0.01 (0.98) |
| Variables of Interest | | | |
| *Parenting styles in dimensions* | | | |
| Warmth, W1 | -4.50 | 2.30 | -0.01 (1.02) |
| Control, W1 | -1.96 | 4.00 | -0.01 (0.97) |
| *Fourfold schema of parenting styles, W1* | | | |
| Authoritative (Ref) | 0 | 1 | 24.6 |
| Indulgent | 0 | 1 | 25.1 |
| Authoritarian | 0 | 1 | 25.4 |
| Neglectful | 0 | 1 | 25.0 |
| *Mediators* | | | |
| Cigarette use by W1 | 0 | 1 | 0.19 (0.39) |
| Alcohol use by W1 | 0 | 1 | 0.45 (0.50) |
| Marijuana use by W1 | 0 | 1 | 0.24 (0.43) |
| Illegal drug use by W1 | 0 | 1 | 0.27 (0.44) |
| Age first smoked regularly (years) | 10 or younger | 30 | 16.4 (3.31) |
| Age first used alcohol (years) | 10 or younger | 30 | 16.2 (3.13) |
| Age first used marijuana (years) | 10 or younger | 29 | 16.7 (3.02) |
| Age first used illegal drug (years) | 10 or younger | 31 | 18.3 (4.25) |
| Mental health problems, W3 | -1.35 | 4.92 | -0.03 (0.96) |

*Source: National Longitudinal Study of Adolescent Health Waves I (1994-1995), III (2001 - 2002), and IV (2008)*
*N = 2954*

*Outcome variables: substance use problems in adulthood*

Outcomes are measured in Wave 4. The instruments for problem use of alcohol, marijuana and other drugs are based on the criteria for the diagnosis of Substance Use Disorder in the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSIM-IV); these have been extensively validated (Van Dulmen et al., 2002; Hasin et al., 2006). The problem drinking scale is derived from 10 items (α=0.88); the scales for problem marijuana use (α=0.85) and problem use of other drugs (α=0.92) are each based on 8 items. These scales are standardized (mean=0, SD=1). Lists of items used to derive these and other latent scales are provided in the Appendix. The smoking indicator represents average daily cigarette consumption, derived from two questions: the number of days on which respondents smoked over the past month, and the average number of cigarettes smoked on each of these days. The smoking scale is top-coded at 20 and is unstandardized (mean=3.12, SD=6.12). As well as these continuous measures, we also generate binary variables indicating the 5% of heaviest smokers, and individuals scoring the highest 5% on the substance problem scales.

In certain situations, the use of multiple outcome measures may give rise to problems with statistical inference; the larger the number of outcomes, the more likely that a significant result will be found for at least one of them (Shaffer, 1995). One solution involves adjusting confidence intervals. We do not do this, since the same relationships between parenting style and later substance use are observed in relation to every outcome.

*Parenting style*

Parenting style is measured in *Add Health* via bespoke survey instruments which draw on several existing well-validated instruments (Udry, 2001); we use data collected at Wave 1. We generate two scales, as follows. The *warmth* scale reflects maternal responsiveness, emotional bonding, and trust. It is based on 12 items, some of which were reported by adolescents and some by mothers ($\alpha$=0.75). The *control* scale is derived from 7 items ($\alpha$=0.62). The measure we use is a reversed scale of the degree to which parents grant autonomy; in Section 3.1 we explore alternative conceptualisations of control, namely monitoring and demandingness. All questions relating to these scales are asked of both mothers and fathers. We use responses from mothers; the same analysis using responses from fathers gives similar results, but sample sizes are smaller.

Existing literature shows consistently that parenting styles vary according to adolescent age and gender (Belsky, 1984; Parent et al., 2014). We are primarily interested in the effects of parenting styles inasmuch as they are typical or atypical for adolescents at a particular stage in life; we therefore adjust the relevant scales for age and sex. The scales are then standardized.

We also derive an indicator of parenting style based on the fourfold schema described in the Introduction. We define a categorical variable denoting four parenting styles: *authoritative* (a score above the median for both warmth and control); *indulgent* (scores above the median in warmth and below the median in control); *authoritarian* (below the median in warmth and above the median in control); and *neglectful* (below the median in both warmth and control).

*Mediators*

We use several specifications for the age at first use of each substance (for drinking, marijuana and other illegal drugs, this is the age at which the substance was ever used; for smoking, it indicates the age at which the respondent first smoked regularly). Our main model is based on a binary indicator of whether first use had occurred by Wave 1. We also present models based on (a) initiation by Wave 2, for those who had not used the substance by Wave 1; (b) a continuous indicator of age at first use, derived from responses to all four waves of the survey; and (c) a binary variable indicating initiation by age 16.

Depressive symptoms are measured in the *Add Health* survey by a modified version of the Center for Epidemiologic Studies Depression Scale (CES-D), an instrument in wide use which has been validated

for adolescents and young adults (Roberts et al., 1990; Radloff, 1991). This measure is available in each of the four waves; we use the measure at Wave 3 as a mediator, since it post-dates the measurement of parenting styles and precedes the measurement of the outcome. The scale is based on 12 items (α= 0.82), and is standardized, with higher scores denoting more depressed individuals.

*Control variables*

We control for the following variables at Wave 1: age, gender, ethnicity, parental education (in two-parent families, the higher), family composition, peers' substance use (Jackson et al., 1997; von Sydow et al., 2002), and maternal substance use (Baumrind, 1991; Bailey et al., 2016); we include maternal drinking in the alcohol use regressions and maternal smoking in all other regressions. Parental employment and neighborhood safety were found to be insignificant and were not included in the model.

We control for several variables measured at Wave 4: completed years of education, religiosity (a standardized scale based on 5 items, α=0.83), employment; marital status; and whether the individual has children.

**Methods**

Our analysis is based on structural equation modelling (SEM) in Stata 13. SEM treats all relationships in the model as linear; Hellevik (2009) shows that the inclusion of dichotomous mediators (here, initiation by Wave 1) does not cause problems in this context. One of our robustness checks uses a dichotomous outcome; this is estimated with generalized structural equation modelling (GSEM), described by Rabe-Hesketh et al. (2004).

We specify a system of relationships which allows parenting behavior to exercise a direct effect on the outcome variables, as well as indirect effects via initiation and depression. Of the two mediators, initiation is measured prior to depression; we therefore allow initiation to influence depression. Controls measured at Wave 1 may influence both mediators and outcomes; controls measured at Wave 4 influence only outcomes.

Four models were estimated, one relating to problem usage of each of the four substances considered. Full results are available in the Appendix; Tables 2 and 3 in the body of the paper, which present results from the two-dimension and fourfold models of parenting respectively, contain only the coefficients on the parenting style variables and the mediating pathways.

Tables 2 and 3 also contain test statistics for the significance of the mediation pathways; these are from the Sobel procedure (Sobel, 1982), which tests whether the estimated effects of the parenting

variables on the outcome variables are significantly attenuated by the inclusion of the mediators. We performed two alternative tests, the Aroian and Goodman tests (MacKinnon et al., 2002); these are not reported but the results are similar.

**Results**

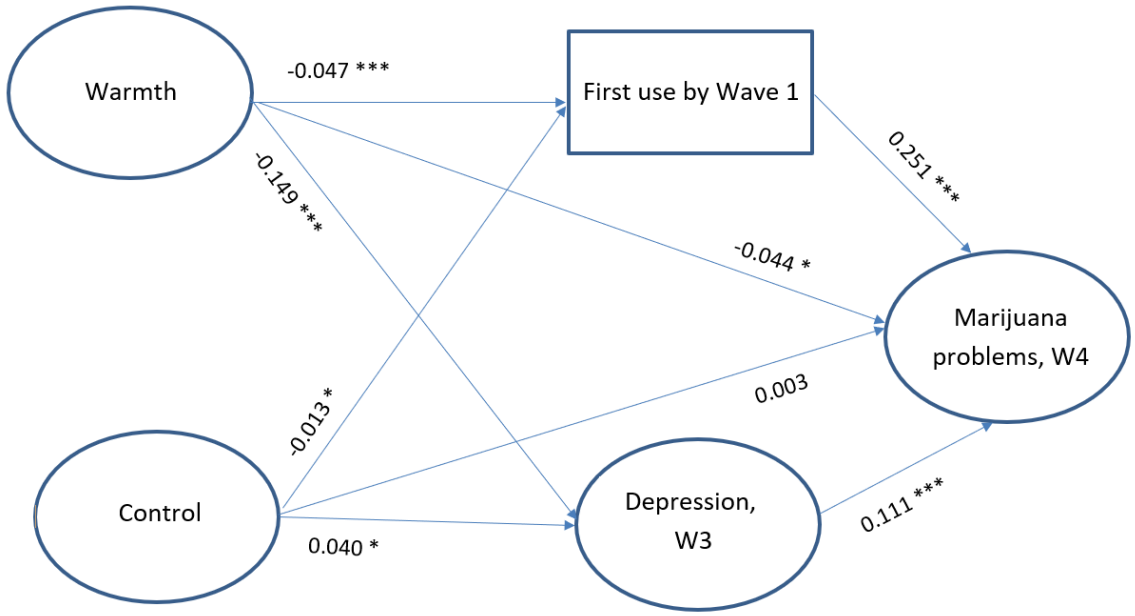


***Figure 1: The relationship between parenting in adolescence and marijuana problems in Wave 4; path diagram showing results from SEM analysis.***

*Notes: For clarity, some relationships have been omitted from the diagram. These are: (1) the determinants of the latent constructs that are not directly observed, such as the parenting dimensions and mental health problems; (2) control variables; (3) the relationship between first use and mental health problems. Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1.*

Figure 1 presents estimates from a model estimating the determinants of marijuana problems at Wave 4. This is based on the two-dimensional model of parenting style. Of the two dimensions, only warmth has a direct effect on the outcome. Both mediators (first use by Wave 1 and depression at Wave 3) are positively and significantly associated with marijuana problems at Wave 4. Parental warmth has a significant negative association with both mediators. Parental control is negatively associated with initiation, but is positively related to depression at Wave 3. These results suggest that warm parenting is related to a lower risk of problem marijuana use in adulthood, by three pathways: (1) directly; (2) via a lower risk of early initiation; and (3) via lower risks of depression. It also suggests that a parenting style high in control has (1) no significant direct effect on the outcome, (2) a beneficial effect via a lowered risk of early initiation; and (3) a negative effect via a higher risk of depression. We return later to a fuller discussion of these findings.

Table 2 presents results from the same model, for all four outcomes. The top panel contains estimates of the effects of parenting styles on the outcome variables: direct effects (the effects attributable to all parts of the model except the mediators); indirect effects (effects via the mediating pathways) and total effects (the sum of these). There are significant direct effects from warmth for all outcomes except smoking, and significant indirect effects from warmth for all outcomes. There are no significant effects, direct or indirect, from control.

The second panel shows mediation effects. Both mediators are significantly related to all outcome variables, except that depression at W3 is not significantly related to smoking. Warmth is associated with lower risks of initiation and with lower risks of depression. Control is associated with lower risks of initiation (for drinking and marijuana), but with higher risks of depression (in all except the smoking model).

The third panel presents tests of significance for the mediating pathways. Both pathways are significant mediators of the effect of parental warmth (except depression in the smoking regression). The evidence is less compelling in relation to the effects of parental control. Initiation is a significant mediator of parental control only in the drinking equation (although in the other three equations, the test statistic is in the same direction, and is associated with a p-value of $p<0.1$). Similarly, depression is a significant mediator of parental control only in the marijuana problems equation; however, the test statistic is of the same sign in all the other three equations, and associated with a p-value of $p<0.1$ in two of them).

Results for all models demonstrate good model fit (Bartholomew et al., 2008 define a good fit as a value <0.05 for RMSEA, a value close to 1 for CFI, and a value < 0.08 for SRMR).

Table 3 presents results from models using the fourfold typology of parenting described above; the baseline group is the 'authoritative' style. Results again demonstrate good model fit (Bartholomew et al., 2008). Few direct effects of parenting style are evident, but strong indirect effects are observed for the authoritarian and neglectful types, yielding significant total effects for all outcomes except smoking. Hardly any difference is evident between the indulgent and authoritative styles.

**Table 2 Relationships between parenting style in adolescence and substance use problems in adulthood; two dimensions of parenting style, coefficients from SEM analysis (N=2954)**

| | | | Smoking (cigs/day) | Drinking problems | Marijuana problems | Other illicit drug problems |
|---|---|---|---|---|---|---|
| **Effects of parenting style on Wave 4 outcomes** | **Direct effects** | *Warmth* | 0.016 (0.101) | -0.038 (0.017)* | -0.044 (0.018)* | -0.046 (0.018)** |
| | | *Control* | 0.037 (0.104) | -0.014 (0.018) | 0.003 (0.019) | 0.006 (0.018) |
| | **Indirect effects** | *Warmth* | -0.201 (0.031)*** | -0.023 (0.004)*** | -0.029 (0.005)*** | -0.024 (0.004)*** |
| | | *Control* | -0.031 (0.024) | -0.005 (0.003)✞ | 0.001 (0.003) | -0.001 (0.002) |
| | **Total effects** | *Warmth* | -0.180 (0.101)✞ | -0.060 (0.017)*** | -0.071 (0.018)*** | -0.069 (0.018)*** |
| | | *Control* | 0.002 (0.106) | -0.019 (0.018) | 0.004 (0.019) | -0.008 (0.018) |
| **Mediation effects** | **Via initiation by Wave 1** | *Warmth → initiation* | -0.048 (0.006)*** | -0.052 (0.008)*** | -0.047 (0.006)*** | -0.054 (0.007)*** |
| | | *Control → initiation* | -0.010 (0.006) | -0.025 (0.008)** | -0.013 (0.007)* | -0.014 (0.007)✞ |
| | | *Initiation → outcome* | 3.614 (0.303)*** | 0.295 (0.042)*** | 0.251 (0.052)*** | 0.263 (0.048)*** |
| | **Via depression at Wave 3** | *Warmth → depression* | -0.146 (0.017)*** | -0.156 (0.017)*** | -0.149 (0.017)*** | -0.145 (0.017)*** |
| | | *Control → depression* | 0.040 (0.018)* | 0.039 (0.018)* | 0.040 (0.018)* | 0.041 (0.018)* |
| | | *Depression → outcome* | 0.175 (0.108) | 0.051 (0.019)** | 0.111 (0.019)*** | 0.068 (0.019)*** |
| **Sobel test statistics for significance of mediating pathways** | **Initiation** | *Warmth* | -6.644*** | -4.771*** | -4.109*** | -4.467*** |
| | | *Control* | -1.651✞ | -2.855** | -1.733✞ | -1.879✞ |
| | **Depression** | *Warmth* | -1.592 | -2.576** | -4.861*** | -3.300*** |
| | | *Control* | 1.335 | 1.686✞ | 2.077* | 1.922✞ |
| **Statistics of fit** | | *RMSEA* | 0.040 | 0.041 | 0.040 | 0.040 |
| | | *SRMR* | 0.008 | 0.008 | 0.008 | 0.008 |
| | | *CFI* | 0.964 | 0.957 | 0.960 | 0.957 |
| | | *CD* | 0.434 | 0.437 | 0.443 | 0.409 |

***Standard errors*** *in parentheses.*

***Statistical significance*** *is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with p < 0.1 denoted by ✞.*

***Post-estimation tests on differences between parental warmth and parental control:***

***Direct effects:*** *Other illicit drugs *;* ***Indirect effects:*** *all substances ***;* ***Total effects:*** *marijuana ** other illicit drugs **

***Effects on initiation:*** *all substances ** or better.* ***Effects on depression:*** *all substances ****

**Table 3 Relationships between parenting style in adolescence and substance use problems in adulthood; fourfold typology of parenting style, coefficients from SEM analysis (N=2954)**

| | | | Smoking (cigs/day) | Drinking problems | Marijuana problems | Other illicit drug problems |
|---|---|---|---|---|---|---|
| **Effects of parenting style on Wave 4 outcomes** | **Direct effects** | *Indulgent* | -0.001 (0.283) | 0.017 (0.049) | 0.006 (0.051) | 0.006 (0.050) |
| | | *Authoritarian* | 0.158 (0.284) | 0.062 (0.049) | 0.049 (0.051) | 0.079 (0.050) |
| | | *Neglectful* | 0.002 (0.287) | 0.115 (0.050)* | 0.079 (0.051) | 0.072 (0.051) |
| | **Indirect effects** | *Indulgent* | 0.055 (0.064) | 0.020 (0.008)* | -0.008 (0.008) | -0.003 (0.007) |
| | | *Authoritarian* | 0.261 (0.070)*** | 0.045 (0.009)*** | 0.039 (0.009)*** | 0.031 (0.008)*** |
| | | *Neglectful* | 0.295 (0.069)*** | 0.048 (0.009)*** | 0.039 (0.009)*** | 0.037 (0.008)*** |
| | **Total effects** | *Indulgent* | 0.056 (0.289) | 0.036 (0.049) | -0.001 (0.051) | 0.003 (0.050) |
| | | *Authoritarian* | 0.407 (0.289) | 0.105 (0.049)* | 0.085 (0.051)✞ | 0.108 (0.050)* |
| | | *Neglectful* | 0.292 (0.292) | 0.160 (0.050)** | 0.117 (0.052)* | 0.108 (0.051)* |
| **Mediation effects** | **Via initiation by Wave 1** | *Indulgent* → *initiation* | 0.019 (0.017) | 0.082 (0.022)*** | 0.008 (0.018) | 0.011 (0.019) |
| | | *Authoritarian* → *initiation* | 0.061 (0.017)*** | 0.110 (0.021)*** | 0.047 (0.018)** | 0.054 (0.019)** |
| | | *Neglectful* → *initiation* | 0.075 (0.017)*** | 0.134 (0.022)*** | 0.087 (0.018)*** | 0.098 (0.019)*** |
| | | *Initiation* → *outcome* | 3.599 (0.302)*** | 0.297 (0.042)*** | 0.264 (0.052)*** | 0.271 (0.048)*** |
| | **Via depression at Wave 3** | *Indulgent* → *depression* | -0.083 (0.049)✞ | -0.086 (0.049)✞ | -0.089 (0.049)✞ | -0.090 (0.049)✞ |
| | | *Authoritarian* → *depression* | 0.229 (0.049)*** | 0.240 (0.049)*** | 0.230 (0.049)*** | 0.227 (0.049)*** |
| | | *Neglectful* → *depression* | 0.140 (0.049)** | 0.157 (0.050)** | 0.141 (0.049)** | 0.134 (0.049)** |
| | | *Depression* → *outcome* | 0.167 (0.107) | 0.053 (0.018)** | 0.114 (0.019)*** | 0.070 (0.019)*** |

***Table 3 (continue)***

| | | | | | | |
|---|---|---|---|---|---|---|
| **Sobel test statistics for significance of mediating pathways** | **Initiation** | *Indulgent* | 1.113 | 3.297*** | 0.443 | 0.576 |
| | | *Authoritarian* | 3.436*** | 4.209*** | 2.322* | 2.539* |
| | | *Neglectful* | 4.137*** | 4.615*** | 3.501*** | 3.808*** |
| | **Depression** | *Indulgent* | -1.148 | -1.508 | -1.738✞ | -1.644 |
| | | *Authoritarian* | 1.480 | 2.524* | 3.697*** | 2.884** |
| | | *Neglectful* | 1.370 | 2.148* | 2.595** | 2.196* |
| **Statistics of fit** | | *RMSEA* | 0.041 | 0.043 | 0.042 | 0.041 |
| | | *SRMR* | 0.008 | 0.009 | 0.008 | 0.008 |
| | | *CFI* | 0.961 | 0.952 | 0.955 | 0.951 |
| | | *CD* | 0.421 | 0.428 | 0.431 | 0.396 |

***Standard errors*** *in parentheses.*

***Statistical significance*** *is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with p < 0.1 denoted by ✞.*

***Post-estimation tests on differences between indulgent, authoritarian and neglectful parenting styles:***

***Direct effects:*** *None sig;* ***Indirect effects:*** *Indulgent v authoritarian and indulgent v neglectful, all substances * or better;*

***Total effects:*** *none sig.;* ***Effects on initiation:*** *Indulgent v neglectful, all except drinking, ** or better; other comparisons n/s;*

***Effects on depression:*** *Indulgent v authoritarian and indulgent v neglectful, all substances ** or better; authoritarian v neglectful n/s.*

There is compelling evidence that both mediation pathways are significant. For all outcomes, both the authoritarian and neglectful parenting types are associated with (a) a higher risk of initiation by Wave 1; and (b) a higher risk of depression at Wave 3. The Sobel test statistics show that initiation is a significant mediator of the relationship between the authoritarian and neglectful parenting styles and all four outcomes; depression is a significant mediator for all outcomes except smoking.

*Robustness checks*

We estimated several alternative specifications as robustness checks; results are presented in Table 4. As an initial check (not shown), we tested for nonlinearities and interactions in the effects of parental warmth and control. We found no evidence that any of the estimated relationships were significantly nonlinear, and no interaction effects beyond what is evident in the fourfold typology.

Panel 1 of Table 4 shows results from a model based on binary outcomes identifying the 5% of heaviest smokers and the 5% of highest scores on the alcohol and drug problem scales. The fact that this specification yields results similar to our previous results indicates that our model successfully predicts severe substance use problems as well as variations across the full range.

Panel 2 addresses the implicit assumption that adolescents' substance use is influenced by parenting, rather than parenting responding to substance use; it is plausible that effects could run in the opposite direction. We analyze the sample of adolescents who had not initiated substance use by Wave 1, with initiation by Wave 2 as a measure of first use. Parenting at Wave 1 predicts initiation by Wave 1 more strongly than initiation by Wave 2; this may indicate a degree of bidirectional causality, or simply that in the former case, parenting style is a more proximal measure. In any case, the fact that significant relationships remain in the second specification indicates that at least part of the estimated relationship operates in the assumed direction.

We then restrict the sample to those who have initiated substance use by Wave 4. Results (not reported) are substantially unchanged; this suggests that that parenting style affects not just the probability of initiation, but also the propensity to develop problems following initiation.

We next explore alternative specifications for the indicator of initiation. Panel 3 reports results using a continuous measure of age at initiation (individuals who had never used the substance by Wave 4 are excluded). Results are once again similar: warmth is related to older age at initiation and negatively related to depression, while control is also related to older age at initiation, albeit with smaller coefficients than warmth.

In panels 4 and 5, we use a binary variable indicating whether initiation occurred by age 16. This has the advantage of being a common benchmark for all sample members, but the disadvantage that

initiation and parenting are measured at different times. For those aged over 16 at Wave 1, parenting is measured after initiation has (or has not) occurred; for those under 16, parenting is measured before the cut-off point for measuring initiation. We therefore analyze 13-15-year olds and 17-18-year-olds separately. Effects differ substantially between the two age groups, with the main differences being in the determinants of depression. The effect of warmth on depression is about twice as large for the younger group as for the older group; the effect of control on depression is insignificant for the younger group, but large and significant for the older group. This suggests that parental warmth is important for all adolescents, but particularly so at younger ages, while the relationship between control and depression is most pronounced at older ages. We also investigated whether there are differences by gender: greater parental control is associated with depression at Wave 3 for both sexes, but the effect is larger in the case of boys.

Our final robustness checks explore alternative specifications for the control dimension. Our original variable indicates the control which parents exercise over several domains of their children's lives. However, some other studies have used alternative concepts: monitoring (knowing/controlling children's whereabouts), or a wider concept of "demandingness", which involves expectations of maturity good behavior, and a degree of enforcement of these standards (Baumrind, 1991). Replacing the indicator of control with an indicator of monitoring based on whether adolescents are allowed to make their own decisions about (a) who they associate with, and (b) what time they come home on weekends yields coefficients of the same sign but reduced magnitude (Panel 6); the effect of monitoring on initiation becomes tiny and insignificant, while its relationship with depression is positive, but significant only at the 10% level. We also test an indicator of demandingness which includes adolescents' frequency of participation in housework. This was not included in our original indicator of control because it reduced the fit of the model. The housework indicator is negatively (albeit insignificantly) related to depression (Panel 7), suggesting that, to the extent that the control/demandingness dimension is negatively related to depression, this is driven by parental control. Results (not shown) using a composite indicator of demandingness which also includes housework are similar to our initial results.

**Table 4 Robustness checks; results from alternative specification**

| | | | Smoking (cigs/day) | Drinking problems | Marijuana problems | Other illicit drug problems |
|---|---|---|---|---|---|---|
| **1. Discrete outcomes (top 5%). Logistic model using GSEM (*N = 2954*)** | ***Initiation*** | **Warmth** | -0.400 (0.052)*** | -0.302 (0.045)*** | -0.369 (0.051)*** | -0.368 (0.049)*** |
| | | **Control** | -0.094 (0.062) | -0.145 (0.047)** | -0.136 (0.060)* | -0.115 (0.055)* |
| | ***Depression*** | **Warmth** | -0.146 (0.017)*** | -0.156 (0.017)*** | -0.149 (0.017)*** | -0.145 (0.017)*** |
| | | **Control** | 0.039 (0.018)* | 0.038 (0.018)* | 0.040 (0.018)* | 0.041 (0.018)* |
| **2. Restrict sample to those who had not used by W1; initiation by W2 as mediator (*N = 1379-1980*)** | ***Initiation*** | **Warmth** | -0.036 (0.011)** | -0.023 (0.013)✞ | -0.023 (0.008)** | -0.019 (0.008)* |
| | | **Control** | -0.013 (0.011) | -0.006 (0.012) | -0.008 (0.007) | -0.007 (0.008) |
| | ***Depression*** | **Warmth** | -0.159 (0.022)*** | -0.153 (0.027)*** | -0.146 (0.023)*** | -0.138 (0.024)*** |
| | | **Control** | 0.045 (0.021)* | 0.024 (0.024) | 0.051 (0.021)* | 0.054 (0.021)* |
| **3. Continuous age at initiation (restrict sample to ever used by W4) (*N = 1142-2676*)** | ***Initiation*** | **Warmth** | 0.387 (0.074)*** | 0.397 (0.053)*** | 0.263 (0.060)*** | 0.390 (0.116)** |
| | | **Control** | 0.147 (0.082)✞ | 0.228 (0.056)*** | 0.091 (0.064) | 0.183 (0.126) |
| | ***Depression*** | **Warmth** | -0.146 (0.025)*** | -0.163 (0.018)*** | -0.177 (0.022)*** | -0.180 (0.029)*** |
| | | **Control** | 0.016 (0.028) | 0.040 (0.019)* | 0.029 (0.024) | 0.065 (0.031)* |
| **4. Initiation by age 16 (sample: those under 16 at W1) (*N = 1566*)** | ***Initiation*** | **Warmth** | -0.039 (0.008)*** | -0.059 (0.011)*** | -0.030 (0.008)*** | -0.048 (0.009)*** |
| | | **Control** | -0.005 (0.007) | -0.017 (0.010)✞ | -0.012 (0.007) | -0.013 (0.008) |
| | ***Depression*** | **Warmth** | -0.196 (0.026)*** | -0.208 (0.026)*** | -0.200 (0.026)*** | -0.195 (0.026)*** |
| | | **Control** | 0.012 (0.024) | 0.009 (0.024) | 0.010 (0.024) | 0.011 (0.024) |
| **5. Initiation by age 16 (sample: those aged 17-18 at W1) (*N = 861*)** | ***Initiation*** | **Warmth** | -0.056 (0.012)*** | -0.051 (0.013)*** | -0.050 (0.012)*** | -0.040 (0.012)** |
| | | **Control** | -0.001 (0.015) | -0.040 (0.017)* | -0.018 (0.016) | -0.014 (0.016) |
| | ***Depression*** | **Warmth** | -0.096 (0.027)*** | -0.107 (0.027)*** | -0.096 (0.027)*** | -0.095 (0.027)*** |
| | | **Control** | 0.114 (0.034)** | 0.110 (0.035)** | 0.117 (0.034)** | 0.118 (0.034)** |
| **6. Alternative definition of control: monitoring (*N = 2954*)** | ***Initiation*** | **Warmth** | -0.048 (0.006)*** | -0.051 (0.008)*** | -0.046 (0.006)*** | -0.052 (0.007)*** |
| | | **Monitoring** | -0.004 (0.006) | -0.005 (0.008) | 0.002 (0.007) | 0.002 (0.007) |
| | ***Depression*** | **Warmth** | -0.146 (0.017)*** | -0.157 (0.017)*** | -0.149 (0.017)*** | -0.146 (0.017)*** |
| | | **Monitoring** | 0.030 (0.018)✞ | 0.027 (0.018) | 0.030 (0.018)✞ | 0.030 (0.018)✞ |
| **7. Alternative definition of demandingness: housework duties (*N = 2954*)** | ***Initiation*** | **Warmth** | -0.052 (0.008)*** | -0.052 (0.008)*** | -0.048 (0.006)*** | -0.054 (0.007)*** |
| | | **Demandingness** | -0.023 (0.008)** | -0.023 (0.008)** | -0.018 (0.007)** | -0.019 (0.007)** |
| | ***Depression*** | **Warmth** | -0.157 (0.017)*** | -0.157 (0.017)*** | -0.150 (0.017)*** | -0.146 (0.017)*** |
| | | **Demandingness** | 0.029 (0.018) | 0.029 (0.018) | 0.031 (0.018)✞ | 0.032 (0.018)✞ |

Notes: Standard errors in parentheses. Statistical significance is denoted by asterisks: * sig at 5%, ** sig at 1%, *** sig at 0.1%. Insignificant results with $p < 0.1$ denoted by ✞.

**Discussion**

Prior research has demonstrated that parenting style is associated with the risk of substance use in late adolescence and/or early adulthood (e.g. Steinberg et al., 1994; Barnes et al., 2000; Aquilino & Supple, 2001; Stone et al., 2012). This paper shows that these effects persist into the longer term: warm parenting protects against problem substance use when subjects are well into adulthood. In addition, we have highlighted two pathways via which this effect can be shown to work: the age at initiation of substance use, and depression.

We used two specifications for parenting style: one which includes continuous measures of warmth and control, and a fourfold typology based on those two dimensions. In each case, the results are unequivocal: it is parental warmth, and not control, which protects against substance use problems in adulthood. In the fourfold typology, it is the authoritarian and neglectful styles which are associated with elevated risks of later substance use; the indulgent style is not associated with extra risks of any kind.

Our analysis of mediating pathways may shed light on heterogeneity between prior studies. Virtually all studies show that warm parenting is protective, and we show the same. However, some studies (Aquilino & Supple, 2001, and others) have found parental control to be protective against substance use in adolescence, while others (Calafat et al., 2014 and others) have not. We have found that parental control *does* inhibit the initiation of substance use in adolescence (see Tables 2 and 4), but that this protective effect does not persist into adulthood; we suggest this may be due to a link between controlling parenting and depression. Thus, the effects of parental control may differ according to the age at which the outcome is measured, and may account for the range of findings in different studies.

Our study has several strengths. It is based on a nationally representative sample, with a considerably longer follow-up period than is typically used in studies in this area; its findings make a novel and useful contribution to the state of knowledge. However, our study is not without its limitations. First, our measures of substance use initiation and of parenting style were collected contemporaneously. While it is reasonable to believe that parenting affects substance use, it is also likely that parenting style is itself influenced by adolescents' prior substance use. We have addressed this problem partially in the robustness checks, but we believe there is more scope for disentangling issues of timing and directionality in this relationship. We also believe there is scope for a better understanding of the control/demandingness dimension; our robustness checks suggest that an alternative definition based on adolescents' contributions at home may yield interesting results, but data including an expanded survey instrument would be needed to test this. Finally, there is evidence that individuals self-medicate for a range of mental health conditions, notably for anxiety, which is an extremely common condition (Robinson et al, 2009) but the data allowed us to test only for a pathway via depression.

**Conclusions and implications for policy**

There is already evidence that interventions promoting effective parenting may reduce substance use in adolescence (Haggerty et al., 2013). One justification for interventions in adolescence is that teenage substance use predicts problems in adulthood; our results confirm this, and thus indicate that parenting initiatives may be protective in the longer as well as the shorter term.

However, our finding that over the longer term warmth is of much greater importance than control may have important implications for the formulation of future parenting interventions. This would be true even if substance problems in adulthood were the only outcome of concern; however, if mental health is considered as locus of concern in its own right, rather than solely as a forerunner of substance use problems, the relative importance of a parenting style high in warmth assumes an even higher importance.

**Declaration of Interest**

The authors report no conflicts of interest.

**Appendix C The peer-reviewed and edited version of Chapter 6 is published as: Mak, H.W. (2019). Dimensions of religiosity: The effects of attendance at religious services and religious faith on discontinuity in substance use. *Journal of Studies on Alcohol and Drugs, 80*(3), 358-365. doi.org/10.15288/jsad.2019.80.358.**


**Abstract**

**Objective:** Previous studies have shown that religion plays an important role in substance misuse. This study examines the effects of the two widely used dimensions of religiosity—*religious behavior* measured by attendance at religious services and *religious faith* measured by the importance of religious faith—on cigarette, alcohol, and drug non-use in adulthood. **Method:** The analysis was based on data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), Waves 1, 3, and 4. The sample was restricted to those who reported having used the substance in Wave 3 (ages 18–25). Four outcome variables (cigarette, alcohol, marijuana, and any illicit drugs) were generated indicating respondents' substance non-use in the past 30 days in Wave 4 (ages 25–32). The number of core sample sizes varied depending on the type of substance (*N* = 666–1,045). Logistic regression and propensity score matching (PSM) methods (the kernel matching and nearest-neighbor matching methods) were used. **Results:** Church attendance frequency was significantly and positively associated with any kind of substance non-use in the past 30 days, whereas religious faith was related to the discontinuation of alcohol use only. After we controlled for the observables and confounding bias in the PSM models, results became weaker but remained statistically significant. **Conclusions:** Social and instrumental support offered by churches may help people abstain from substance use. Health professionals could consider establishing partnerships with religious communities to support substance users.

**Introduction**

Alcohol, tobacco, and illegal drug use are estimated to cost the United States around $740 billion each year, in which drinking-related illness accounts for almost 33% of health care spending (National Institute on Drug Abuse [NIDA], 2017). Substance use cessation has been found to have significant improvement in health in comparison to people who continue using substances, including better respiratory symptoms and health-related quality of life (Doll, 2004; Holmes et al., 2016; Tillmann & Silcock, 1997; Volkow et al., 2014).

There is consistent evidence that religiosity is protective against substance use. Existing literature has shown that individuals with higher levels of religiosity are more likely to be abstinent from substances, reduce the amount of usage, and have higher rates of cessation and are less likely to experience relapse following a period of cessation (Brown et al., 2001, 2014; Edlund et al., 2010; Gossop et al., 2008; Kendler et al., 2003; Koenig & Vaillant, 2009; Luczak et al., 2003; Nakash et al., 2016; Whooley et al., 2002; Wills et al., 2003). The association between religion and substance use has been increasingly recognized; some substance abuse treatment programs in the United States offer religious services (Davis, 2014; Gonzales et al., 2007). Most worldwide addiction centers, such as Alcoholics Anonymous, provide the 12-Step spiritually based program to support people to achieve and maintain abstinence from substance abuse.

One major issue in religion research is the measurement of religiosity. In research, religiosity is a latent construct that cannot be observed or directly measured but can be inferred from other observed variables (Miller & Thoresen, 2003). Two dimensions of religiosity are often used as proxies for measuring levels of religiosity: *religious behaviors* indicated by the frequency of church attendance and *religious faith* assessed by individuals' ratings of the importance of religious faith or religious belief to them personally. Studies have found both dimensions to be a protective factor with regard to substance use, although there is disagreement about their relative importance. Rasic et al. (2011) and Edlund et al. (2010) demonstrated that both strong religious faith and frequent church attendance were related to low alcohol and drug use, although Edlund et al. (2010) found that the odds ratios were larger in relation to church attendance. In contrast, Kulis et al. (2012) showed that there was no effect of attendance at religious services on any substance use outcomes.

However, they found that strong religious beliefs, a scale that reflected the importance to respondents of following traditional Indian or Christian beliefs, was associated with lower alcohol and cigarette consumption. This may be explained by the links provided by the Indian and Christian beliefs to cultural heritage, established values systems, and traditions, which may, in turn, protect against substance use (Kulis et al., 2012). The conflicting results suggest that it remains unclear whether the changes in substance use behaviors are a result of religious behavior or religious faith. Investigating the various

effects of these two dimensions of religiosity is important because they affect how the collaboration between health care services and religious communities should be promoted and delivered.

A challenge when researching the effects of the two dimensions of religiosity is that religiosity is socially patterned. Demographic differences in the levels of religiosity may lead to over- or underestimation of the potential effect religiosity may have on the discontinuity in substance use. Therefore, this study used propensity score matching (PSM) techniques to control for selection on observables and to remove the effects of any potential factors that might possibly influence individuals' levels of religiosity and/or the probability of the discontinuity in substance use (Rosenbaum & Rubin, 1983, 1984, 1985).

## Method

### *Data*

The National Longitudinal Study of Adolescent to Adult Health (Add Health) is a U.S. longitudinal data set that follows a nationally representative sample of adolescents in Grades 7–12 in 1994/1995 to adulthood (Harris et al., 2009). Within the sample, around 85% had a parent who completed the questionnaire in Wave 1. Data were collected at four points through adolescence to the transition to adulthood; the subsequent interviews were conducted in 1996, 2001/2002, and 2008 when sample members were ages 25–32. The data cover a wide range of adolescent health and health behaviors, and multiple contexts of adolescent life such as religiosity, parents' self-reported substance use, and socioeconomic background.

The main analyses used Waves 1, 3, and 4 from the public-use in-house data sets, which consist of a random selection of the original data. All follow-up interviews were with original Wave 1 respondents who were eligible for the interviews. The attrition rate was approximately 12% between waves; respondents who were non-White, started using substances at earlier ages, and whose parents had low educational levels were more likely to drop out by Wave 4.

The sample was restricted to respondents who were between ages 13 and 18 at the time of the first interview and those who reported having (a) used at least one cigarette per day, (b) consumed at least one alcoholic drink per day or consumed three or more drinks on one occasion at least two times a month (based on the definitions of "moderate alcohol consumption" and "drinking at low risk" provided by the National Institute on Alcohol Abuse and Alcoholism [NIAAA], 2019), (c) used marijuana at least once, or (d) used any illicit drugs (including cocaine, crystal meth, marijuana, and other types of illegal drugs) at least once since 1995 and in the past 30 days in the Wave 3 interview (ages 18–25). The number of core sample size varied depending on the type of substance ($N$ = 666–1,045).

*Measures*

*Substance non-use in the past 30 days.* Four variables indicating the absence of substance use (i.e., cigarette, alcohol, marijuana, or any illicit drugs) at Wave 4 were generated when respondents reported no substance use in the past 30 days. Given that the analysis was restricted to respondents who reported having used the substance in the past month at Wave 3 and given that these respondents had also reported using the substance since 1995, the "non-use" category at Wave 4 should conclusively demonstrate a change in use level from Wave 3 to Wave 4.

*Church attendance and religious faith.* Church attendance frequency and the importance of religion were measured at Wave 4. For church attendance frequency, respondents were asked how often they had attended church, synagogue, temple, mosque, or religious services in the past year. A binary variable was generated in which 1 denotes respondents who attended once a week or more and 0 denotes otherwise. Religious faith was assessed by individuals' ratings of the importance of religious faith. It was dichotomized with "very important" and "more important than anything else" combined as one category and "somewhat important" and "not important" combined as the other category.

*Control variables.* PSM models incorporated possible confounding variables based on previous empirical research that might be associated with both the religiosity dimensions and the absence of substance use or with the absence of substance use only (Brookhart et al., 2006; Caliendo & Kopeinig, 2008; Rubin, 2001). The control variables measured in Wave 1 included sample members' age, gender, ethnicity, household type, levels of substance use in the past 30 days (cigarette, alcohol, marijuana, or any illicit drugs), parents' educational level, maternal cigarette and/or alcohol consumption, parents' self-reported church attendance frequency (included only in the model estimating the effect of church attendance frequency), and religious faith (only in the model estimating the effect of religious faith) (Kliewer & Murrelle, 2007).

Four continuous variables indicating the levels of substance use in the past 30 days measured in Wave 3 were controlled, since various levels of use might affect the probability of non-use later in life. The analysis also controlled for Wave 4 variables: educational level, marital status, presence of children (Bachman et al., 2002), respondents' living area (Martino et al., 2008), and a continuous indicator of age at first substance use that was derived from responses to all four waves of the survey (Breslau & Peterson, 1996).

*Statistics*

In this study, both logistic regression and PSM estimation methods were used to estimate the relationships between church attendance frequency and religious faith and the rates of substance non-use in the past 30 days at Wave 4.

PSM created two groups from a sample: a treatment group (i.e., respondents who had high levels of church attendance frequency or religious faith) and a control group (i.e., respondents who had low levels of church attendance frequency or religious faith). It then matched each respondent with high levels of attendance or religious faith with one or more than one respondent who had low levels of attendance or religious faith based on propensity scores. This method effectively creates an experimental study of an observational data set by allowing the matched respondents to be identical in every observed variable (Rosenbaum & Rubin, 1983). Epanechnikov kernel matching with 0.05 bandwidths was applied to calculate the average treatment effect on the treated (ATT). ATT is the difference between the average outcome measure for respondents who had high levels of church attendance/religious faith and the average outcome measure for the sample group under the hypothetic situation that they had low levels of attendance/religious faith. Therefore, the difference between the treatment and control groups should not be influenced by the observed covariates.

PSM is also able to determine how well the density distributions between the treatment and control groups overlap, that is, the quality of matching. High quality of matching is defined when the average covariate unbalancing percentage is less than 10% (Morgan, 2018). Standard errors were computed by bootstrapping with 1,000 replications. Missing data were handled with listwise deletion. To check the robustness of the results, all analyses were replicated using another PSM technique that involved matching one treatment unit with two control units that had the closest propensity score (i.e., nearest-neighbor matching); standard errors were computed using Abadie-Imbens formulas.

Results for all PSM models demonstrated high standard matching. The quality of matching was higher with the kernel matching method.

## Results

### *Demographic backgrounds*

In the sample, female and non-White respondents were likely to have higher levels of church attendance frequency and religious faith. Religious respondents (those who had high levels of attendance or religious faith) tended to have parents who consumed fewer cigarettes or less alcohol, and who were more likely to be frequent church attendees and/or had higher levels of religious faith. They were also likely to postpone the age at which they had their first substance use, to be married, to have children, and to report not having used substances in the past month in Wave 4. Demographic statistics of alcohol use by the two religious dimensions are shown in Supplementary Tables S1 and S2; statistics were similar across different samples using various substances (not shown).

The descriptive statistics indicate that respondents with high levels of church attendance frequency or religious faith tended to possess characteristics (e.g., low levels of maternal alcohol consumption) that favored more positive outcomes. It then became unclear whether it was the religion, either church attendance or religious faith, that was driving substance use discontinuity or whether it was the shared characteristics that affected the discontinuity (i.e., a confounding bias).

*Church attendance and religious faith and substance non-use using PSM*

Tables 1 and 2 present results from four different models: (a) unadjusted coefficients (log-odds) from logistic regression models, (b) adjusted coefficients from logistic regression models, (c) ATTs from PSM models using the kernel matching method, and (d) ATTs from PSM models using the nearest-neighbor matching method. Any differences found between the logistic regression and PSM results would give an indication of the magnitude of the confounding effects.

Table 1 shows that church attendance frequency was significantly associated with all types of substance non-use, suggesting that respondents with a high level of church attendance frequency were more likely to have been abstinent from the substance for at least a month. In adjusted logistic models, the log-odds for cigarette, alcohol, marijuana, and any illicit drug non-use were 0.94 ($p < .01$), 1.43 ($p < .001$), 1.28 ($p < .01$), and 1.40 ($p < .01$), respectively. Results obtained from the PSM models indicate that the effect of church attendance dropped sharply after controlling for the observed variables and confounding bias. In kernel matching models, the ATTs for cigarette, alcohol, marijuana, and any illicit drug non-use were 0.20 ($p < .001$), 0.17 ($p < .01$), 0.23 ($p < .01$), and 0.25 ($p < .001$); this indicates that a higher level of church attendance frequency was associated with an increase of 19%–29% (i.e., exponentiating the log-odds and subtracting it from 1) in the likelihood of non-use in the past 30 days.

Although the associations between church attendance and substance non-use were weaker in the PSM models, all estimates remained statistically significant. Importantly, these findings could not be explained by the differences in terms of demographic backgrounds, religious upbringing, or previous levels of substance use between groups given that the analyses matched participants on these factors. These findings provide a solid evidence base for the association between church attendance and any kind of substance non-use.

**Table 1 Church attendance and substance non-use in the past 30 days**

| | Cigarette | Alcohol | Marijuana | Any illicit drugs (including marijuana) |
|---|---|---|---|---|
| Unadjusted coefficient | 1.048 (0.251)*** | 1.516 (0.242)*** | 1.361 (0.398)** | 1.495 (0.397)*** |
| Adjusted coefficient | 0.943 (0.280)** | 1.426 (0.275)*** | 1.277 (0.423)** | 1.398 (0.410)** |
| ATT (kernel) | 0.203 (0.058)*** | 0.174 (0.051)** | 0.228 (0.067)** | 0.251 (0.065)*** |
| Mean bias | 2.5 | 2.9 | 4.3 | 2.9 |
| ATT (nearest-neighbour) | 0.158 (0.066)* | 0.191 (0.056)*** | 0.200 (0.081)* | 0.239 (0.085)** |
| Mean bias | 7.6 | 8.6 | 8.1 | 6.1 |
| **N** | **837** | **1045** | **668** | **684** |

Notes: Unadjusted coefficients were obtained from logistic regression models that did not control for any covariates. Adjusted coefficients were obtained from logistic regression models that controlled for the covariates. ATT (kernel) presents ATT estimates from PSM models using Epanechnikov kernel matching with 0.05 bandwidths; the standard errors computed by bootstrapping with 1000 replications. ATT (nearest-neighbour) presents ATT estimates from PSM models matching with two neighbours; standard errors were computed using Abadie-Imbens formulas. Both PSM models controlled all covariates mentioned above, and common support condition was imposed. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. Success of the propensity score matching was assessed using a percentage bias of <10% for each covariate.

**Table 2 Religious faith and substance non-use in the past 30 days**

| | Cigarette | Alcohol | Marijuana | Any illicit drugs (including marijuana) |
|---|---|---|---|---|
| Unadjusted coefficient | 0.110 (0.171) | 0.649 (0.200)** | 0.152 (0.160) | 0.175 (0.157) |
| Adjusted coefficient | 0.149 (0.189) | 0.480 (0.232)* | 0.104 (0.182) | 0.102 (0.175) |
| ATT (kernel) | -0.005 (0.036) | 0.055 (0.023)* | -0.006 (0.049) | 0.003 (0.046) |
| Mean bias | 4.0 | 2.9 | 3.4 | 2.6 |
| ATT (nearest-neighbour) | -0.044 (0.043) | 0.038 (0.030) | 0.006 (0.052) | -0.004 (0.053) |
| Mean bias | 4.3 | 3.8 | 5.3 | 3.7 |
| **N** | **836** | **1042** | **666** | **682** |

Notes: Unadjusted coefficients were obtained from logistic regression models that did not control for any covariates. Adjusted coefficients were obtained from logistic regression models that controlled for the covariates. ATT (kernel) presents ATT estimates from PSM models using Epanechnikov kernel matching with 0.05 bandwidths; the standard errors computed by bootstrapping with 1000 replications. ATT (nearest-neighbour) presents ATT estimates from PSM models matching with two neighbours; standard errors were computed using Abadie-Imbens formulas. Both PSM models controlled all covariates mentioned above, and common support condition was imposed. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. Success of the propensity score matching was assessed using a percentage bias of <10% for each covariate.

With respect to another dimension of religiosity, Table 2 shows that alcohol non-use in the past 30 days was positively related to religious faith. In the adjusted logistic model, the log-odds for alcohol non-use was 0.48 ($p < .05$), meaning that a higher level of religious faith was related to an increase of 62% in the rate of absence of alcohol consumption. Again, the effect of religious faith reduced substantially after adjusting for the covariates and confounding bias. In the kernel model, the ATT for alcohol non-use was 0.06 ($p < .05$), indicating that a higher level of religious faith was associated with a 6% increase in the likelihood of alcohol non-use. This suggests that not taking into account the confounding bias might have overestimated the effect of religious faith on alcohol non-use. No significant association was found between religious faith and cigarette or drug non-use in the past 30 days.

Post hoc tests were carried out using the *z* statistics to compare the ATTs of church attendance and religious faith across models (Clogg et al., 1995; Paternoster et al., 1998). Results demonstrate that the ATTs of the two religiosity dimensions were significantly different across models (i.e., when the *z* value is greater than 1.96 or lower than -1.96); the *z* values were 3.05, 2.13, 2.82, and 3.11 for cigarette, alcohol, marijuana, and any illicit drug, respectively. These post hoc tests imply that the effect of church attendance might be somewhat more pronounced than religious faith.

*Sensitivity analysis*

All analyses were repeated with various alternative specifications as sensitivity checks; results are presented in Table 3. Panel 1 shows ATT estimates from analyses where the sample was restricted to those who indicated problematic substance use at Wave 3. Problematic substance users were defined as the top 20% of cigarette, marijuana, or any illicit drug users, or respondents who consumed 5 or more alcoholic drinks on the same occasion more than 2 times in a month (based on the "binge drinking" definition provided by the NIAAA, 2019). Results show that the positive association between church attendance frequency and substance non-use in the past month remained, although the effect of church attendance on the discontinuities of cigarette, alcohol, and marijuana use was reduced to at least the 10% significance level and some PSM matching models failed to achieve successful matching. No significant relationship was found between religious faith and substance non-use among respondents with previous problematic use.

Panel 2 partially addresses the implicit assumption that substance non-use was influenced by the level of religiosity (either church attendance or religious faith) rather than by the level of religiosity responding to the non-use; it is possible that the relationship was bidirectional. In the second sensitivity checks, the analyses were based on a sample of those who had low levels of religiosity previously. Results show that respondents who became frequent church attendees or who increased their level of religious faith also had a higher probability of substance non-use in Wave 4. However, it

is important to note that this analysis was unable to identify the causality of the relationship between religiosity and substance non-use; it is possible that the absence of use might have happened before respondents became frequent attendees or increased their faith in religious belief. However, what this table shows is the change of substance use behavior when respondents reported having increased the frequency of church attendance or the level of religious faith.

The final sensitivity check explored whether the effects of the two religious dimensions extended to a longer period of absence of use. Similar to the main analyses, the level of church attendance frequency was positively correlated with alcohol and drug non-use, whereas religious faith was associated with alcohol non-use. (*Note:* Cigarette use in the past 12 months was not asked about in the Wave 4 interview.) These findings confirm the results found in the main analyses that church attendance, and possibly religious faith, may help support substance users to achieve abstinence.

**Table 3 Sensitivity analysis; PSM results from alternative specification**

| | | | Cigarette | Alcohol | Marijuana | Any illicit drugs (including marijuana) |
|---|---|---|---|---|---|---|
| 1. Respondents with problematic use at Wave 3 | *Church attendance* | Kernel | 0.138 (0.078)✞ | 0.154 (0.072)* ᵅ | 0.234 (0.091)* | 0.314 (0.083)*** |
| | | Nearest-neighbour | 0.130 (0.076)✞ | 0.154 (0.088)✞ ᵅ | 0.190 (0.111)✞ ᵅ | 0.400 (0.107)*** |
| | **N** | | **649** | **584** | **515** | **549** |
| | *Religious faith* | Kernel | 0.020 (0.036) | 0.047 (0.033) | 0.005 (0.059) | 0.025 (0.052) |
| | | Nearest-neighbour | 0.040 (0.044) | 0.027 (0.041) | 0.002 (0.062) | -0.009 (0.062) |
| | **N** | | **648** | **582** | **513** | **547** |
| 2. Low levels of attendance/religious faith at Wave 3 | *Church attendance* | Kernel | 0.191 (0.070)** | 0.210 (0.060)*** | 0.226 (0.074)** | 0.247 (0.073)** |
| | | Nearest-neighbour | 0.175 (0.071)* | 0.246 (0.064)*** | 0.258 (0.100)* | 0.309 (0.102)** |
| | **N** | | **773** | **947** | **623** | **639** |
| | *Religious faith* | Kernel | 0.016 (0.052) | 0.071 (0.035)* | 0.012 (0.067) | 0.031 (0.070) |
| | | Nearest-neighbour | 0.041 (0.067) | 0.058 (0.041) | 0.000 (0.070) | -0.017 (0.081) |
| | **N** | | **477** | **586** | **403** | **414** |
| 3. Substance non-use in the past 12 months | *Church attendance* | Kernel | - | 0.174 (0.050)** | 0.256 (0.077)** | 0.282 (0.075)*** |
| | | Nearest-neighbour | - | 0.216 (0.056)*** | 0.020 (0.085)* | 0.272 (0.093)** |
| | **N** | | | **1050** | **668** | **684** |
| | *Religious faith* | Kernel | - | 0.054 (0.023)* | 0.031 (0.048) | 0.034 (0.047) |
| | | Nearest-neighbour | - | 0.052 (0.029)✞ | 0.039 (0.055) | 0.044 (0.053) |
| | **N** | | - | **1047** | **666** | **682** |

Notes: Information on cigarette use in the past 12 months was not available. Statistical significance is denoted by asterisks: ✞ sig at 10%, * sig at 5%, ** sig at 1%, *** sig at 0.1%. Success of the propensity score matching was assessed using a percentage bias of <10% for each covariate. Values marked with a ᵅ signify models where these thresholds were exceeded, meaning the common support area was too small to produce efficient ATTs due to a lower sample size for these supplementary analyses, so results should be interpreted with caution.

**Discussion**

This article compares the effects of two different religious dimensions, religious behavior which was measured by attendance at religious services and religious faith, on substance non-use, and attempts to disentangle the effects of these two dimensions from other observable factors via the PSM methods. The results of the present study have two important contributions.

First, church attendance frequency and religious faith have different relationships with substance non-use. Church attendance has a larger and greater effect for all outcomes compared with religious faith.

This finding remained for respondents who had a history of problematic use or those who had low levels of religiosity previously, suggesting that church attendance may be effective in guarding against further development of substance use among respondents who were already experiencing such behaviors, and that substance use behavior changes with the change of religiosity levels, particularly church attendance. Although this finding may be at odds with the study of Longest and Vaisey (2008), who found that religious salience was more protective against adolescent marijuana use than religious involvement, both the present study and the Longest and Vaisey study suggest that religious dimensions may have various effects on different types of behavior

It is possible that, for example, religious faith is more effective in preventing initiation, whereas religious participation that involves direct exposure to religious institutions and church members might help promote abstention. Miller and Gur's (2002) parallel study supports this by demonstrating that religious faith was more effective in reducing the risk of lifetime sexual activity outside of a relationship, whereas a high level of church attendance frequency was positively associated with the use of birth control.

The second contribution is that a large amount of heterogeneity was found in the relationship between the two religious dimensions and substance non-use. The effects of the two dimensions diminished substantially after controlling for the observables and confounding bias in the PSM models; this suggests, not taking into account the confounding bias, the effects of religious behavior and faith were likely to have been overestimated. Nevertheless, the current study found that church attendance and religious faith remained significant in the PSM models.

Multiple factors can help explain the beneficial effect of church attendance. First, a high level of church attendance may lead to less time spent on other risk activities, including substance use. More importantly, some religious communities may organize events to educate participants about the risks and consequences of substance use. They may also provide emotional and instrumental supports for those who have already engaged in substance use by offering counseling sessions, educational workshops (e.g., discussions of consequences of substance use), coping resources, and referral services

(Koenig, 2012). This would be especially crucial for heavy substance users, who may be more likely to suffer withdrawal symptoms (e.g., sleeping difficulties and anxiety) and thus have lower success rates of abstinence from substances than light or regular users.

Second, the social support provided by churches may influence the association between religious involvement and the likelihood of using substances (CASA, 2011; Koenig, 2012). In particular, religion connects individuals to communities or social networks that have lower rates of substance use. Third, frequent church attendees are found to have better mental health (Koenig, 2005; Koenig et al., 2007), which is associated with lower levels of substance use (Gilvarry, 2000; Stone et al., 2012; von Sydow et al., 2002; Wills et al., 2003). Furthermore, churches could be an alternative and attractive option for users to achieve abstinence, especially when many cessation programs are expensive and are associated with a health-related stigma that might make users reluctant to join (Luoma et al., 2007).

Although this study found that church attendance has a larger effect across various types of substance non-use, religious faith is significantly related to alcohol non-use. This result is in line with the study by Edlund et al. (2010), which demonstrated that respondents who reported religion was important were less likely to consume alcohol and experience alcohol abuse/dependence among those who drank. Unlike cigarette and drug use, light and low-risk alcohol use is more socially accepted; some religions even provide wine during Mass. Previous studies have also suggested that it is a common route for heavy drinkers to return to light drinking, instead of complete abstinence (Schulenberg et al., 2017; Sobell et al., 2000)

However, what this study found suggests that respondents who wished to stop drinking might need outside assistance to achieve alcohol non-use and that both social reinforcement within religious institutions and the commitment to the religion might be important to alcohol users' achievement of abstinence. A good example to demonstrate the significant role of religious faith is a study conducted by Gossop et al. (2008). They found that frequent attendees in treatment centers, which use the 12-step approach to support clients with drug and alcohol problems via an emphasis on religious meaning and righteousness, were more likely to be abstinent from alcohol use compared with non-attendees and infrequent attendees.

Although the current study has strengths and expands the literature in important ways, there are some limitations that need to be considered. First, this study only considered two widely used dimensions of religiosity; future study is needed to identify the effects of other dimensions (e.g., religious exclusivity) of religiosity on substance non-use. Further work is also required to investigate whether the significance of religious behavior and faith with respect to substance non-use varies across cultures and religious affiliations; different religious institutions may have various attitudes toward substances, especially alcohol.

Second, the cut-off point for dividing the sample into the "treatment" and the "control" groups (e.g., frequent and infrequent church attendees) may be arbitrary. Further studies might like to consider in more detail the thresholds for religious dimensions.

Third, although PSM controls for observed factors, the unobserved heterogeneity might remain an issue (e.g., the motivation to quit using substances and the reasons for attending churches). However, the richness of the data set had allowed matching to a high standard, meaning that any remaining unobserved heterogeneity should have been minimized. Furthermore, because of data limitation, the study was unable to estimate whether respondents would return to substances or relapse after reporting no use in the last interview. Nonetheless, a 1-month period of non-use was found to have had some health benefits, including a reduction in wound-healing complications (Wong et al., 2012).

Another limitation was that results might involve a self-report bias since some respondents might have underreported their substance use. However, there is evidence showing that self-reported substance use behaviors, including heavy consumption, was reasonably valid (Brown et al., 1992; Del Boca & Darkes, 2003). Finally, this study handled missing data with listwise deletion, and it is plausible that there might be potential attrition bias in the sample. Future studies might like to consider using advanced techniques (e.g., multiple imputations) to handle missing data.

**Conclusion**

This study provided insights into the relationship between religiosity and substance non-use. Two dimensions of religiosity were examined, religious behavior indicated by church attendance frequency and religious faith measured by the importance of religious faith. Systematic steps were taken to separately investigate their effects using logistic regressions and the PSM technique. Results showed that religious behavior had a greater effect than religious faith to protect against the use of substances. Therefore, it may be beneficial for health professionals and substance use treatment programs to consider collaborating with religious communities to provide preventive health and social services to people with substance use problems. By increasing partnerships between religious groups and health professionals, it is likely that a wider population, especially individuals with low incomes, could have access to health care and thus potentially reduce health inequality in society.

**Supplementary Table S1 Descriptive statistics for respondents who reported recent alcohol use in the Wave 3 interview by church attendance**

| | High attendance (once a week or more) | Low attendance (less than once a week) |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD)** |
| ***Wave 1*** | | |
| Age | 15.5 (1.60) | 15.3 (1.57) |
| Female | 54.9 | 42.0 |
| White | 68.6 | 79.8 |
| African-American | 20.6 | 9.33 |
| American-Indian/Asian/Mixed/Others | 10.8 | 10.9 |
| Intact family | 65.7 | 64.4 |
| Step-parents family | 9.80 | 12.8 |
| Single-parent family | 24.5 | 22.8 |
| Maternal high alcohol use[1] | 17.7 | 30.3 |
| Parental church attendance frequency[2] | 3.25 (0.97) | 2.69 (1.14) |
| [Parental] High school graduates or below | 33.3 | 33.1 |
| [Parental] completed a GED/vocational school training | 32.4 | 32.7 |
| [Parental] bachelor's degree or above | 34.3 | 34.3 |
| Days of using alcohol in the past year[3] | 2.30 (2.55) | 2.62 (2.51) |
| Number of drinks each time in the past year | 2.46 (3.84); max=20 | 3.01 (5.17); max=54 |
| ***Wave 3*** | | |
| Days of using alcohol in the past year | 3.85 (0.80) | 3.95 (0.85) |
| Number of drinks each time in the past year | 5.95 (3.98); max=18 | 5.97 (3.52); max=18 |
| ***Wave 4*** | | |
| High school graduates or below | 16.7 | 16.4 |
| Completed a GED/vocational school training | 42.2 | 43.1 |
| Bachelor's degree or above | 41.2 | 40.5 |
| Married | 55.9 | 34.9 |
| Cohabitation | 10.8 | 23.4 |
| Single/legally separated | 33.3 | 41.7 |
| Presence of child(ren) | 35.2 | 35.2 |
| Living in rural/suburban | 63.3 | 69.6 |
| Age at first drink[4] | 16.1 (2.95) | 15.4 (2.67) |
| Alcohol non-use in the past 30 days | 31.4 | 9.12 |
| **Total N** | **102** | **943** |

Notes: [1]Consumed more than 2 or 3 alcoholic drinks per month. [2]A four-point scale, ranging from "never", "less than once a month", "less than once a week, but at least once a month", to "once a week or more". [3]A seven-point scale, ranging from "none", "1 or 2 days in the past 12 months", "once a month or less", "2 or 3 days a month", "1 or 2 days a week", "3-5 days a week", to "every day/almost every day". [4]A continuous indicator derived from responses to all waves; the age reported at the earlier wave was used to reduce recall error.

**Supplementary Table S2 Descriptive statistics for respondents who reported recent alcohol use in the Wave 3 interview by religious faith**

| | Very important/most important | Somewhat important/not important |
|---|---|---|
| | **Mean (SD) or %** | **Mean (SD)** |
| ***Wave 1*** | | |
| Age | 15.3 (1.61) | 15.3 (1.55) |
| Female | 46.5 | 40.7 |
| White | 71.3 | 85.1 |
| African-American | 18.0 | 3.94 |
| American-Indian/Asian/Mixed/Others | 10.7 | 10.9 |
| Intact family | 63.4 | 65.4 |
| Step-parents family | 12.8 | 12.4 |
| Single-parent family | 23.8 | 22.2 |
| Maternal high alcohol use[1] | 23.3 | 34.1 |
| Parental religions importance[2] | 3.66 (0.68) | 3.18 (0.96) |
| [Parental] High school graduates or below | 33.1 | 33.2 |
| [Parental] completed a GED/vocational school training | 35.3 | 30.3 |
| [Parental] bachelor's degree or above | 31.6 | 36.6 |
| Days of using alcohol in the past year[3] | 2.37 (2.55) | 2.78 (2.46) |
| Number of drinks each time in the past year | 2.73 (5.58); max=54 | 3.15 (4.57); max=40 |
| ***Wave 3*** | | |
| Days of using alcohol in the past year | 3.85 (0.82) | 4.01 (0.86) |
| Number of drinks each time in the past year | 6.09 (3.88); max=18 | 5.87 (3.27); max=18 |
| ***Wave 4*** | | |
| High school graduates or below | 15.7 | 17.2 |
| Completed a GED/vocational school training | 44.6 | 41.6 |
| Bachelor's degree or above | 39.7 | 41.2 |
| Married | 42.2 | 32.6 |
| Cohabitation | 16.7 | 27.1 |
| Single/legally separated | 41.1 | 40.3 |
| Presence of child(ren) | 43.2 | 32.1 |
| Living in rural/suburban | 64.9 | 63.1 |
| Age at first drink[4] | 15.7 (2.75) | 15.3 (2.66) |
| Alcohol non-use in the past 30 days | 14.7 | 8.24 |
| **Total N** | **484** | **558** |

Notes: [1]Consumed more than 2 or 3 alcoholic drinks per month. [2]A four-point scale, ranging from "not important at all", fairly unimportance", "fairly important", to "very important". [3]A seven-point scale, ranging from "none", "1 or 2 days in the past 12 months", "once a month or less", "2 or 3 days a month", "1 or 2 days a week", "3-5 days a week", to "every day/almost every day". [4]A continuous indicator derived from responses to all waves; the age reported at the earlier wave was used to reduce recall error.