What family, individual, and social factors predict casual methamphetamine use (and regular use) over the life span from age 16 to age 40?

Christchurch Health and Development Study (University of Otago Christchurch) – Methamphetamine in New Zealand Research Programme

Professor Joseph M. Boden

31 May 2021

University of Otago

Project report

Contracting body name: Evidence-Based Policing Centre, New Zealand Police

Contract title: Christchurch Health and Development Study (University of Otago Christchurch) – Methamphetamine in New Zealand Research Programme

Notes: This is the report submitted to the EBPC for 31 May 2021 concerning Deliverable/Milestone 2

What family, individual, and social factors predict casual methamphetamine use (and regular use) over the life span from age 16 to age 40?

The purpose of this report is to examine a series of explanatory variables, drawn from the Christchurch Health and Development Study database, which predict methamphetamine use over the life span from age 16 to age 40.

Summary

This report describes a series of analyses using data from the Christchurch Health and Development Study, a cohort of approximately 1000 people born in Christchurch in mid-1977 and followed to age 40 in 2017. The analyses examine a series of factors, measured over the life course, that may be associated with casual and regular use of methamphetamine over the period from age 16 to age 40 years. An estimated 29% of cohort members reported trying methamphetamine on at least one occasion, while less than 7% reported using methamphetamine regularly (weekly or more often) at any time. The data show that there are several factors from childhood and adolescence that are related to a higher likelihood of using methamphetamine or using methamphetamine regularly. Using a "competing variable" model in which several explanatory factors are modelled simultaneously, relatively few factors were found to be important in explaining methamphetamine use in late adolescence and early adulthood. These factors included: male gender; paternal overprotectiveness; early symptoms of anxiety; novelty-seeking personality; affiliation with deviant peers; conduct problems in childhood; and having a parental history of illicit drug use. In addition, factors that also increased the likelihood of methamphetamine use, which were measured at the same time as methamphetamine use included: alcohol use disorder; nicotine dependence; cannabis use disorder; unemployment; and life stress. The results of these analyses differed somewhat for casual methamphetamine use and regular use. The findings suggest that, in the sample considered, now in their 40s, methamphetamine use is predicted by being male, having behaviour problems in childhood and adolescence; poor role modelling and peer influence; personality tendencies toward drug use; and other substance use and stressful life events across adulthood. This knowledge may allow us to design interventions to reduce the transition to methamphetamine use in young people, and may also inform treatment pathways for adults who use methamphetamine.

Contents

1. Measures

1.1. Methamphetamine use (ages 16-40 years)

At each assessment from age 18 to age 40, cohort members were queried about their use of a range of illicit drugs. One aspect of this questioning concerned methamphetamine. The question stem was worded "Since you turned (age) have you used the following, and how often?". The second part of the question listed a series of substances, with methamphetamine use described as "Methamphetamine, speed, P, ice, etc."[1] Overall, approximately 29% of cohort members reported trying methamphetamine on at least one occasion, while less than 7% reported using methamphetamine regularly (weekly or more often) at any of the assessments between age 16 and 40.

Table 1 shows the cohort classified into methamphetamine users (casual use) and regular (at least weekly, or more often) use for each assessment period, ages 16-18, 18-21, 21-25, 25-30, 30-35, and 35-40 years.

Table 1: Percentage of the cohort using methamphetamine

Assessment period	% of the cohort reporting for each category	
	Casual methamphetamine use	Regular methamphetamine use
16-18 years	2.5	0.8
18-21 years	5.0	0.6
21-25 years	19.7	2.7
25-30 years	12.3	2.1
30-35 years	6.7	1.1
35-40 years	6.4	1.0

Table 1 shows that rates of methamphetamine use were very low prior to age 21. From that point, for the next two assessments, self-reported casual use of methamphetamine was considerably higher than in prior assessments, peaking at 19.7% between the ages of 21 and 25 (3.9 times higher than during the period 18-21 years). Correspondingly, rates of regular use also increased, although there were many fewer regular users than casual users. Rates of regular use during the period 21-25, for example, were 2.7%, and this was 4.5 times higher than rates of regular use during the period 18-21.

[1] The reference to "P" and "ice" first appeared in the age 30 (2007) assessment due to their common use as slang terms from that time.

Table 1 also shows that rates of casual use declined after age 25, remaining relatively high during the 25-30 age period but dropping considerably after that time (about a 50% reduction to age 40). These trends were also reflected in the data for regular use of methamphetamine. In general, substance use in the CHDS cohort tended to decline after age 30 as more cohort members became parents, or had young children in the home.

1.2. Childhood/ adolescent predictors of methamphetamine use in adulthood (ages 0-16 years)

We examined the database of the study to determine the variables that would be the most important and useful in examining the childhood/ adolescent predictors of methamphetamine use over the lifespan.

The rationale for choosing particular variables from the database was as follows. The CHDS has a long history of examining substance use in the cohort, and in particular has been active in researching the life course factors that are associated with alcohol and illicit substance use, and alcohol and illicit substance use disorder. Variables were identified and chosen as to their likelihood of their being associated with illicit drug use and drug use disorder, on the basis of several previous CHDS publications examining alcohol use, cannabis use, and illicit drug use [1-8]. In general, these variables can be described according to several categories:

Childhood socio-economic factors and demographic background. The variables representing "childhood socio-economic factors and demographic background" were chosen primarily from the first decade of life (many of these were measured at birth). These variables represent the socio-economic positioning of the family that the child was born into in 1977, which has been shown to be an important indicator of outcomes across the life course of the cohort [9]. In cases where children were adopted, the data were drawn from the adoptive family rather than the birth family.

Family functioning. The variables chosen to represent "family functioning" pertain to several aspects of family life, including stability of parental figures, parental maladaptive behaviour, and the quality of the relationship between adolescents and parents. Previous CHDS research has shown that family functioning in middle childhood is an important predictor of either positive or negative child outcomes (e.g. [10]), and more recent research suggests that relationships with parents can provide protection over the life course from the effects of childhood maladaptive behaviour [11], and problems with alcohol use [12].

Individual, personality and behavioural factors. The variables representing individual, personality and behavioural factors were chosen on the basis that there are clear differences in outcomes over the life course for individuals depending upon their personal identity, gender, and early behaviour. Early behaviour, and in particular maladaptive behaviour, has been shown to be related to adverse psychosocial outcomes over the life course in CHDS data [9]. Gender has been shown to be related to mental health outcomes, with males more likely to develop externalizing problems such as conduct disorder and substance use disorder [13], and females more likely to develop internalizing problems such as depression and anxiety [14]. We have

also shown that personality factors including neuroticism and novelty-seeking are also related to a number of life outcomes, particularly with respect to depression and substance use [15, 16]. Finally, cognitive ability and school performance have also been shown to be associated with more positive outcomes, particularly with regard to educational pursuits [17, 18].

Abuse exposure. Exposure to abuse in childhood, whether directed at the child themselves (sexual or physical abuse), or exposure to parental intimate partner violence, has been shown in CHDS data to be a significant predictor of later psychosocial functioning [19-22]. In fact, it is important to note that exposure to sexual abuse in childhood is one of the strongest and most consistent predictors of mental ill health over the life course [23, 24].

Adolescent problem behaviour. Adolescence is a period marked by behavioural and emotional changes, and for many adolescents these changes result in poor psychological functioning and/or mental disorder. In the CHDS, adolescent mental health, including internalizing disorders (depression, anxiety) [25-27] and externalizing disorders (conduct disorder, oppositional/defiant disorder, attention deficit hyperactivity disorder) [28] have been shown to have consequences for psychosocial functioning over the life course. Furthermore, peer influence has also been shown to play an important role in the development and maintenance of maladaptive behaviour over the life course, but beginning primarily in adolescence [29-33].

1.2.1. Measures of family socio-economic and demographic background

Maternal age. Assessed at the time of the survey child's birth.

Family living standards (0-10 years). At each year, a global assessment of the material living standards of the family was obtained by means of an interviewer rating. These were averaged over the period 0-10 years.

Maternal and paternal education (at birth). Parental education level was assessed at the time of the survey child's birth reflecting the highest level of educational achievement attained, using a three-level scale. These levels were: no secondary school qualifications; at least one secondary school qualification; tertiary qualification.

Family socio-economic status (SES, at birth). Family SES was assessed at the time of the survey child's birth using the Elley-Irving [34] scale of socio-economic status for New Zealand.

Single parenthood (at birth). Family structure was assessed at the time of the survey child's birth.

Averaged family income (0–10 years). At each year, estimates of the family's gross annual income were obtained from parental report and were recoded into decile [2] categories.

[2] Decile categories are obtained by ranking income estimates from highest to lowest, and dividing these into groups representing 10% of the overall distribution. Because income is a highly skewed measure, the decile score serves as the income measure.

1.2.2. Measures of family functioning

Parental illicit drug use (11 years). At age 11, parents were questioned regarding their history of illicit drug use. The cohort member was classified as having a parent history of illicit drug use if one of his/her parents was reported to have a history of illicit drug use.

Parental alcohol problems (15 years). This was assessed at age 15 years via parental report. These reports were used to form a dichotomous measure of whether or not the young person's parents reported experiencing problems with alcohol.

Parental criminality (15 years). At age 15 years, parents were questioned as to whether any parent had a history of criminal offending. The cohort member was classified as having a parent history of criminality if one of his/her parents was reported to have a history of offending.

Changes of parents (0-15 years). At each assessment from birth to 15 years, information was gathered on changes in the cohort member's family situation since the previous assessment. Using this information an overall measure of family instability was constructed up to age 15, representing the number of changes in parental figures (due to separation, divorce, death, or re-partnering) in the home during the life of the cohort member to age 15.

Parental Bonding (Maternal and Paternal Care and Protection; 16 years). To measure parental bonding, the maternal care and protection scales of the Parental Bonding Instrument (PBI) [35] were administered to the cohort members at the age of 16 years. The young person was asked to rate their mother on the PBI items describing the quality of maternal care and protection throughout their childhood. The care scale measures the extent to which the parents provide support, affection and nurturing with a high score indicating high levels of care. The protection scale measures the extent to which parents exhibit tendencies to over protection or over control with a high score indicating tendencies to over control. The reliabilities of the resulting scale scores were assessed using coefficient alpha and found to be good: maternal care $\alpha = .89$; paternal care $\alpha = .91$; maternal over protection $\alpha = .85$; paternal over protection $\alpha = .87$.

1.2.3. Individual, personality and behavioural factors

Gender. Recorded at birth.

Child conduct and attention problems, and anxious/withdrawn behaviour (7–9 years). When sample members were aged 7–9 years, information on child behaviour problems was obtained from parental and teacher reports using a behaviour questionnaire combining items from the Rutter et al. [36] and Conners [37] parental questionnaires. ($\alpha = .97$; .93; and .92, respectively).

Neuroticism (14 years). This was assessed using a short form version of the Neuroticism scale of the Eysenck Personality Inventory [38] at age 14. ($\alpha = .80$).

Novelty-seeking (16 years). Novelty-seeking was assessed at age 16 using the novelty seeking items from the Tridimensional Personality Questionnaire [39] ($\alpha = .76$).

Childhood IQ (8-9 years). At ages 8 and 9 years, cohort members were assessed using the revised version of the Wechsler Intelligence Scale for Children (WISC-R [40]) modified for New Zealand conditions. At each age, total IQ scores were computed using the method described in

the test manual. The reliabilities of these measures assessed by using split half methods ranged from .93 to .95. The IQ measure used in the present analyses was based on an average of the total IQ score at the two ages.

GPA (11-13 years). School performance was assessed via teachers' ratings in each of five areas of the curriculum (reading, handwriting, written expression, spelling, mathematics) using a 5-point scale ranging from very good to very poor. To provide a global measure of the child's educational achievement over the interval from 11-13 years, the teacher ratings were summed across years and curriculum areas and then averaged to provide a teacher rating grade point average for each child.

1.2.4. Abuse exposure

Childhood sexual abuse (0-16 years). At ages 18 and 21 years, sample members were questioned about their experience of sexual abuse during childhood (<16 years) [20]. Questioning spanned an array of abusive experiences from episodes involving non-contact abuse (e.g. indecent exposure) to episodes involving attempted or completed intercourse. A four-level scale was devised reflecting the most extreme form of sexual abuse reported by the young person at either age. The levels were: no sexual abuse; non-contact sexual abuse; sexual abuse involving physical contact but not penetration; penetrative sexual abuse.

Childhood physical abuse (0-16 years). At ages 18 and 21 years, sample members were questioned about their experience of physical punishment during childhood (<16 years) [41]. Questioning spanned an array of experiences with physical punishment and the frequency with which these occurred during childhood. A four-level scale was devised reflecting the most extreme form of physical punishment reported by the young person at either age. These levels were: no physical punishment; occasional physical punishment; regular physical punishment; harsh and abusive physical punishment.

Exposure to parental intimate partner violence (0-16 years). At the age of 18, sample members were questioned concerning their experience of violence between parental figures during their childhood (prior to age 16 years), with questions derived from the Conflict Tactics Scale [CTS: 42]. The items were chosen on the basis that the behaviours could have been readily observed and reported on by the participant, and also to span the potential range of violent behaviour from verbal abuse to physical assault. Separate questioning was conducted for violence initiated by the father against the mother and for violence initiated by the mother against the father, and combined into a single scale score representing overall exposure across both parents.

1.2.5. Adolescent problem behaviour

Information concerning disruptive childhood behaviour was obtained at two assessments taking place when the sample members were aged 15 and 16 years. At each age, sample members were interviewed on a comprehensive mental health interview that examined aspects of mental health and adjustment over the previous 12 months. A parallel interview was also conducted with the child's mother at each assessment stage.

Conduct disorder, oppositional defiant disorder, attention deficit hyperactivity disorder (14-16 years). As part of the assessments at each age, information was obtained on DSM-III-R [43] symptom criteria for disruptive childhood behaviours, including conduct disorder (CD), oppositional defiant disorder (ODD), and attention deficit hyperactivity disorder (ADHD) [44]. For child self-report, the assessment of ODD and ADHD was based on the relevant sections of the Diagnostic Interview Schedule for Children (DISC) [45], whereas CD was assessed using the Self-Report Early Delinquency (SRED) scale [46]. For parental reports, ODD and ADHD were assessed using items from the Revised Behaviour Problems Checklist (RBPC) [47], and CD was assessed using a parent version of the SRED. The combined symptom data thus comprised information on DSM-III-R symptom criteria for two separate 12-month periods (ages 14-15 and 15-16 years) from two sources (parent, self-report).

Alcohol use disorders (15-16 years). At each interview at ages 15 and 16, cohort members were asked a series of questions concerning whether the individual experienced any problems relating to their drinking. This measure was based on the Diagnostic Interview Schedule for Children (DISC) [48], in order to obtain information pertaining to DSM-III-R [43] symptoms of alcohol abuse/alcohol dependence (alcohol use disorder). These data allowed classification of participants as to whether they meet DSM criteria for an alcohol use disorder during the period following the previous assessment.

Internalizing disorders (14-16 years). Parallel to the assessment of disruptive behaviour disorders, ages 15 and 16 years cohort members and their parents were questioned about symptoms of major depression and anxiety disorders (generalized anxiety disorder; over-anxious disorder; social phobia; simple phobia) occurring in the previous 12 months using the relevant sections of the Diagnostic Interview Schedule for Children [DISC: 45]. These items were used to classify participants according to DSM-III-R [43] symptom criteria for major depression and anxiety disorders. Participants were classified as having major depression or an anxiety disorder during the period 14-16 years if they met criteria for the disorder on the basis of either self or parental report over the period 14-16 years.

Deviant peer affiliation (15 years). At the assessment at age 15, cohort members and their parents were asked to indicate how many of the child's friends were "deviant", defined as smoking cigarettes, drinking alcohol, using illicit drugs, or who committed crimes. The larger of the two answers (child; parent) was used as the measure.

1.3. Contemporaneous predictors of methamphetamine use in adulthood (ages 16-40 years)

Several potential covariate [3] factors, measured contemporaneously with methamphetamine use, will also be employed as predictors of methamphetamine use. Previous CHDS analyses have shown that substance use in adulthood tends to "cluster" particularly in early adulthood, and specifically for illicit drugs in early and later adulthood [1, 3]. In addition, mental health disorders such as depression and anxiety [49, 50], as well as life stress [51] and unemployment [52, 53] have also been shown to be associated with substance use outcomes in analyses of CHDS data. The variables assessed include:

Alcohol use disorders (16-40 years). At each interview from age 18 years, cohort members were asked a series of questions concerning whether the individual experienced any problems relating to their drinking. This measure was based on the Composite International Diagnostic Interview (CIDI) [54] at ages 18 , 21, 25, 30, 35 and 40 years, in order to obtain information pertaining to DSM-IV (age 18 and above) [55] symptoms of alcohol abuse/alcohol dependence (alcohol use disorder). These data allow classification of participants as to whether they meet DSM criteria for an alcohol use disorder during the period following the previous assessment.

Mental health disorders (15-40 years). Cohort members completed the CIDI at ages 18, 21, 25, 30, 35, and 40 years. These data were used to classify individuals as to whether they met DSM-IV criteria for major depression and anxiety disorder over the intervals 15-18 years, 18-21 years, 21-25 years, 25-30 years, 30-35 years, and 35-40 years.

Other substance use disorders (15-40 years). Also at ages 18, 21, 25, 30, 35 and 40 years, cohort members were questioned about their substance use behaviours and problems associated with substance use since the previous assessment (tobacco, cannabis) based on the CIDI (items for cigarette smoking were custom written). Using this information, cohort members were classified as meeting DSM-IV criteria for nicotine dependence and cannabis dependence over the intervals 15-18 years, 18-21 years, 21-25 years, 25-30 years, 30-35 years, and 35-40 years (for nicotine dependence, the measure refers to current ND at ages 18, 21, 25, 30, 35 and 40 years).

Unemployment (18-40 years). At each assessment, starting at age 21, cohort members were asked whether they had been unemployed and looking for work for three or more months during any calendar year since the previous assessment (ages 18–21, 21–25, 25–30, 30–35, and 35-40 years).

Stressful life events other than unemployment (18-40 years). Life events were assessed for each 12-month period during ages 18-40 years using a 30-item inventory based on the Social Readjustment Rating Scale [56] supplemented by custom-written survey items. These items spanned several domains, including, for example, death and illness, relationship problems and difficulties, and crime victimization. All items were scored on a 0 to 4 scale (0 = *no event*, 1 = *not upset or distressed*, 2 = *a little upset or distressed*, 3 = *moderately upset or distressed*, and 4 = *very distressed*). Using this information, a measure of exposure to stressful life events was

[3] In this context, "covariate" refers to time-dynamic covariate factors that may influence the likelihood that an individual uses methamphetamine during any particular time period.

created, computed by summing the scores for each item for each 12-month period, and then summing over each assessment period, resulting in a total life events distress score for the periods 18–21, 21–25, 25–30, 30–35, and 35-40 years.

2. Preliminary findings

2.1. Association between childhood/ adolescent predictors and lifetime methamphetamine use

Below are illustrated the associations between each of the childhood/ adolescent predictors detailed previously, and lifetime methamphetamine use (ages 16-40). Spearman's *r* was used as the measure of association as lifetime methamphetamine use was a dichotomous variable, and many of the measures reported are also categorical in nature (Spearman's *r* is a non-parametric statistic, which therefore does not require an underlying assumption of a normal distribution of the two variables for which a correlation is being estimated).

For social research data such as that reported below, a correlation with an absolute value of 0 to 0.9 is considered "weak" in magnitude, 0.10 to 0.19 is considered "moderate", and 0.20 or higher is considered "strong". Significant associations are presented in the table below in bold (p-value). P-values refer to "probability values", which refers to the likelihood of error in conclusions drawn using the analysed data. Our maximum acceptable likelihood of error is set at 5% as a matter of convention. P-values larger than this are referred to as "non-significant", while p-values smaller than this are referred to as "significant" with significance level noted at the foot of Table 2.

Table 2: Associations between childhood/ adolescent predictors and lifetime methamphetamine use

Measure	Casual methamphetamine use	Regular methamphetamine use
Measures of family socio-economic and demographic background		
Maternal age (at birth)	-.03	**-.07***
Family living standards (0-10 years)	-.06	-.05
Maternal education (at birth)	.00	.05
Paternal education (at birth)	-.06	-.00
Family socio-economic status (at birth)	-.01	**-.09****
Single parenthood (at birth)	.02	.03
Averaged family income (0-10 years)	-.04	-.02
Measures of family functioning		
Parental illicit drug use (11 years)	.06	**.12*****
Parental alcohol problems (15 years)	.02	.06

Parental criminality (15 years)	.05	**.10*** **
Changes of parents (15 years)	**.07***	**.12*** **
Maternal care (16 years)	-.04	-.03
Paternal care (16 years)	**-.09***	**-.08***
Maternal over-protection (16 years)	**.07***	.02
Paternal over-protection (16 years)	**.10****	.05
Individual, personality and behavioural factors		
Gender (at birth)	**-.14*** **	-.06
Child conduct problems (7-9 years)	**.09****	**.13*** **
Child attention problems (7-9 years)	**.07***	**.11****
Anxious/withdrawn behaviour (7-9 years)	**-.09****	**.10****
Neuroticism (14 years)	-.06	**-.07***
Novelty-seeking (16 years)	**.22*** **	**.16*** **
Childhood IQ (8-9 years)	.06	-.01
GPA (11-13 years)	-.00	.03
Abuse exposure		
Exposure to childhood sexual abuse (0-16 years)	-.02	.04
Exposure to childhood physical punishment (0-16 years)	.04	**.09****
Exposure to parental IPV (0-16 years)	.03	.04
Adolescent problem behaviour and mental health		
Conduct disorder (14-16 years)	**.19*** **	**.16*** **
Oppositional defiant disorder (14-16 years)	**.17*** **	**.12*** **
Attention deficit hyperactivity disorder (14-16 years)	**.11*** **	**.07***
Alcohol use disorder (15-16 years)	**.10****	**.14*** **
Major depression (14-16 years)	-.06	-.01
Anxiety disorder (14-16 years)	-.05	.02
Deviant peer affiliation (15 years)	**.16*** **	**.15*** **

* $p < .05$; ** $p < .01$; *** $p < .001$

As can be seen from the Table, childhood, family functioning and abuse exposure variables were for the most part weakly associated with later methamphetamine use. On the other hand, behaviour problems (externalizing) in childhood and adolescence (and association with deviant peers) were moderately associated with later methamphetamine use. In terms of personality, novelty seeking was strongly associated with casual methamphetamine use (and moderately with regular use). The focus of prediction models will be the statistically significant ($p < .05$) variables noted above, although variables with a non-significant association will be used in

analyses as these are often found to be associated with the exposure (methamphetamine use) when used in a set of multiple predictors.

It is also worth noting that the profile of predictors differs with respect to whether a person used methamphetamine casually, or used methamphetamine regularly (at least weekly) at some point. Predictors varied both in their strength of association with the methamphetamine variable, and whether they reached statistical significance. This implies that prediction models will need to be customized according to the dependent variable being modelled.

2.2. Association between contemporaneous predictors and lifetime methamphetamine use

The associations between contemporaneous predictors and lifetime methamphetamine use are shown in Table 3. As can be seen, Spearman's *r* and P-values show that the contemporaneous measures are associated with casual methamphetamine use (with the exception of anxiety disorder), and also with regular use, although the magnitude of association was smaller. Therefore each of these will be considered in the analyses.

Table 3: Associations between contemporaneous predictors and lifetime methamphetamine use

Measure	Casual methamphetamine use	Regular methamphetamine use
Alcohol use disorder (16-40 years)	**.18*** **	**.09** **
Major depression (15-40 years)	**.07***	**.07***
Anxiety disorder (15-40 years)	.00	.00
Nicotine dependence (15-40 years)	**.24*** **	**.13*** **
Cannabis use disorder (15-40 years)	**.26*** **	**.15*** **
Unemployment (18-40 years)	**.18*** **	**.08***
Life stress (18-40 years)	**.22*** **	**.10** **

* p < .05; ** p < .01; *** p < .001

3. Main findings

To analyse the repeated measures data for casual methamphetamine use and regular methamphetamine use, logistic generalized estimating equation (GEE) models were fitted to each predictor variable [57] in which the log odds of either: (a) casual methamphetamine use; or (b) regular methamphetamine use in a given year was modelled as a linear function of the

predictor and age. Random effects models provide a single estimate of the regression coefficients pooled over the repeated measures of the outcome variable.

In the next step of the modelling, the base models were extended, in order to fit two multivariate logistic GEE models of the linkages between the factors listed in Table 1 and the risks of methamphetamine use and regular methamphetamine use over the period 16-40 years. These models were fitted in steps, as follows:

- In the second model, the fixed predictors (childhood/ adolescent predictors) presented in Table 2 were entered in blocks, with forward and backward elimination of variables to identify a stable and parsimonious set of predictors of methamphetamine use and regular methamphetamine use.

- The third model extended the second model by including the time-dynamic factors (contemporaneous predictors) listed in Table 3, with the factors being entered into the models simultaneously. In addition, to take into account potential age-related changes in the strength of association between the predictors and outcome measures, tests of age x predictor interaction terms were entered into the models in forward and backward stepwise fashion, with only statistically significant interactions retained in the final models.

All models were fitted using Stata 16 [58].

3.1. First model: Casual methamphetamine use and regular use over time

Table 4 shows the parameter estimates, standard errors of estimate and probability values for the base models of casual methamphetamine use and regular methamphetamine use. Table 4 shows that, relative to the period 16-18 years (the reference wave), rates of casual methamphetamine use were significantly ($p < .05$) higher at each subsequent assessment wave. However, for regular methamphetamine use, Table 4 shows that rates of use at ages 21-25 and ages 25-30 years were significantly ($p < .01$) higher than the reference wave, whereas rates of regular use were no longer significantly ($p < .05$) higher than the reference wave during the periods 30-35 and 35-40 years.

Additionally, rates of regular use at ages 18-21 were not significantly different from rates of regular use for the reference wave. Also of note is that, because standard errors were higher for regular methamphetamine use as compared with casual use (due to smaller numbers of regular users), it was more difficult to identify stable predictors for the regular use model (see below; significant values are presented in bold).

Table 4: Parameter estimates for wave-related predictors of casual methamphetamine use/regular methamphetamine use assessment periods, ages 16-40

Assessment wave	Casual methamphetamine use			Regular methamphetamine use		
	B	S.E.	p	B	S.E.	p
16-18 (wave 1)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
18-21 (wave 2)	**.73**	**.26**	**.004**	-0.21	.45	.64
21-25 (wave 3)	**3.19**	**.24**	**<.0001**	**1.26**	**.37**	**.001**
25-30 (wave 4)	**2.27**	**.24**	**<.0001**	**1.01**	**.39**	**.009**
30-35 (wave 5)	**1.24**	**.25**	**<.0001**	0.42	.46	.37
35-40 (wave 6)	**1.18**	**.25**	**<.0001**	0.24	.49	.62

3.2. Second model: Childhood and adolescent predictors of casual methamphetamine use and regular use

Table 5 shows the parameter estimates, standard errors of estimate and probability values for the fitted models of methamphetamine use and regular methamphetamine use, using predictors drawn from childhood and adolescence (detailed in Table 2). An inspection of Table 2 shows that there were five statistically significant predictors each for casual methamphetamine use and regular use [4], with the pattern of predictors being somewhat different. For example, paternal overprotectiveness predicted casual use, which may reflect parental worries about early drug use, whereas regular use was significantly predicted by having had at least one parent who had a history of illicit drug use (possibly reflecting genetic or familial processes).

In addition, while lower levels of anxious/withdrawn behaviour predicted casual use, conduct problems in childhood, known to be a predictor of substance use in general in the CHDS cohort, predicted regular methamphetamine use. The other three predictors, gender, novelty-seeking, and deviant peer affiliation, were common across both categorizations of methamphetamine use. Males, those higher in novelty seeking, and those reporting a greater number of friends who use illicit substances and break the law were significantly more likely to both use methamphetamine, and to use methamphetamine regularly at some point during the period from 16-40 years.

[4] In multivariate modelling, the analyses begin with those predictors that were statistically significant in bivariate modelling, and these are reduced in number due to the inclusion of multiple predictors in the multivariate model, which "compete" for explanatory power.

Table 5: Parameter estimates for childhood and adolescent predictors of casual methamphetamine use/regular methamphetamine use, ages 16-40

Casual methamphetamine use				Regular methamphetamine use			
Predictor	**B**	**S.E.**	**p**	**Predictor**	**B**	**S.E.**	**p**
Paternal overprotectiveness	**.04**	**.01**	**<.0001**	Parental history of illicit drug use	**.85**	**.28**	**.003**
Gender	**-.62**	**.31**	**.043**	Gender	**-.72**	**.31**	**.02**
Anxious/withdrawn behaviour	**-.05**	**.21**	**.022**	Conduct problems	**.04**	**.01**	**.004**
Novelty-seeking	**.12**	**.03**	**<.0001**	Novelty-seeking	**.12**	**.03**	**<.0001**
Deviant peer affiliation	**.04**	**.01**	**.001**	Deviant peer affiliation	**.04**	**.01**	**.003**

3.3. Third model: Extension of the prediction models to include contemporaneous predictors of casual methamphetamine use and regular use

Table 6 shows the parameter estimates, standard errors of estimate and probability values for the fitted models of casual methamphetamine use and regular methamphetamine use, extended from the models shown in Table 5 to include the contemporaneous factors observed during the period 16 to 40 years, as shown in Table 3 . Table 6 shows that, after extending the models, each of the childhood and adolescent predictors remained statistically significant.

In addition, for casual methamphetamine use, five measures were found to be significant predictors of methamphetamine use. These included: alcohol use disorder, nicotine dependence, cannabis use disorder, unemployment, and life stress. Those cohort members who reported using methamphetamine on at least one occasion were more likely than participants who reported no use of methamphetamine to meet criteria for an alcohol use disorder, nicotine dependence, and cannabis use disorder. These cohort members were also more likely to report at least one period of unemployment for three or more months and higher levels of life stress.

The pattern of associations between the contemporaneous factors and regular methamphetamine use were largely similar to those for casual use, with the exception that alcohol use disorder was not a significant predictor of regular methamphetamine use. The relative sparseness of the data for regular use may have influenced this particular pattern of association.

Table 6: Parameter estimates for life course predictors of casual methamphetamine use/regular methamphetamine use, ages 16-40

Casual methamphetamine use				Regular methamphetamine use			
Childhood/ adolescent factors (to age 16)							
Predictor	**B**	**S.E.**	**p**	**Predictor**	**B**	**S.E.**	**p**
Paternal overprotectiveness	**.03**	**.01**	**.01**	Parental history of illicit drug use	**.96**	**.29**	**.001**
Gender	**-.56**	**.15**	**<.0001**	Gender	**-.69**	**.32**	**.031**
Anxious/withdrawn behaviour	**-.05**	**.21**	**.022**	Conduct problems	**.03**	**.01**	**.049**
Novelty-seeking	**.08**	**.02**	**<.0001**	Novelty-seeking	**.10**	**.03**	**<.004**
Deviant peer affiliation	**.02**	**.01**	**.001**	Deviant peer affiliation	**.03**	**.01**	**.024**
Contemporaneous factors (ages 16-40)							
Predictor	**B**	**S.E.**	**p**	**Predictor**	**B**	**S.E.**	**p**
Alcohol use disorder	**.51**	**.10**	**<.0001**	-	-	-	-
Nicotine dependence	**.40**	**.12**	**.001**	Nicotine dependence	**.83**	**.28**	**.003**
Cannabis use disorder	**.89**	**.14**	**<.0001**	Cannabis use disorder	**.84**	**.30**	**.005**
Unemployment	**.21**	**.06**	**.001**	Unemployment	**.39**	**.14**	**.006**
Life stress	**.04**	**.01**	**<.0001**	Life stress	**.07**	**.02**	**.001**

4. Discussion

One of the key issues in tackling methamphetamine use from a population perspective is understanding the factors that are associated with an increased likelihood of using methamphetamine or transitioning to regular use of methamphetamine. The analyses featured in this report show that there are robust associations between a series of predictors (from both childhood/adolescence and adulthood) and methamphetamine use/regular methamphetamine use. A critical step in this process was the use of multivariate models that were able to show which predictors are the strongest among those identified in the present report.

In the analyses of the “fixed” (time-invariant) predictors from childhood and adolescence, we have seen that the factors associated with childhood demographics that were associated with methamphetamine use at the bivariate level were no longer statistically significant in the context of multivariate modelling. There are two possible reasons for this: one is that, because these factors were measured early in the lives of cohort members, it is possible that the passage of time meant that the predictive power of these measures was superseded by more recent measures. Alternatively, it may be the case that childhood economic and related measures may not be strongly predictive of methamphetamine and related substance use outcomes in the

sample. One reason for these findings may be the relatively narrow gap between those at the lower end of the socio-economic scale and those at the high end in this cohort born in the late 1970s, as compared with cohorts born later, particularly following the economic reforms in New Zealand in the 1980s that increased socio-economic inequality.

On the other hand, variables associated with familial relationships and family functioning did remain statistically significant following multivariate modelling, indicating their strength in predicting methamphetamine use in late adolescence and early adulthood. In particular, paternal overprotectiveness (which often occurs in the context of adolescent problem behaviour) and parental history of illicit drug use both feature as predictors of methamphetamine use/regular use. These findings suggest that parental modelling of behaviour has an influence on methamphetamine use, while overprotective behaviour may be an indicator of early problem behaviour on the part of the cohort member.

Individual factors such as male gender, personality (novelty-seeking), conduct problems in childhood, and less anxious behaviour in childhood were also significantly associated with methamphetamine use in late adolescence and early adulthood. These findings suggest that the profile of those members of the cohort who were likely to use methamphetamine were that they were male, had early evidence of problem behaviour, were less likely to display anxious behaviour in childhood, and were temperamentally disposed to seeking out new experiences. These factors suggest that there may be ways of identifying young people who may be at particular risk of initiating methamphetamine use, which may aid in screening and preventing activities to reduce the risk of methamphetamine use in adolescents generally.

Deviant peer affiliation also remained significantly associated with methamphetamine use in the multivariate model. This finding suggests that the influence of peers plays a vital role in scaffolding young people into substance use generally, and methamphetamine use more specifically. As with the individual factors identified above, this finding suggests that strategies to reduce the influence of peer pressure in the initiation of substance use may help to reduce the likelihood that a young person will use methamphetamine.

It is worth noting that in our original analytic plan, we intended to measure the association between Māori ethnicity and methamphetamine use. Early analyses suggested that Māori were more likely than non-Māori to report using methamphetamine (which is reflected in official statistics for arrests and convictions for methamphetamine offences). However, we found no evidence that the magnitude of association with methamphetamine use differed according to ethnicity. For these reasons, and for the purposes of avoiding stigmatization of Māori, we have opted to omit reporting of the main effect finding.

Analyses of the time-dynamic factors during the period 16-40 years (measured contemporaneously with methamphetamine use) suggest that there were several factors that increased the likelihood of a cohort member using methamphetamine. These included meeting criteria for an alcohol use disorder, nicotine dependence or cannabis dependence, and having higher levels of life stress and exposure to unemployment. These findings suggest that cohort members who have problems with substance use and are under higher levels of general stress (and specific stress due to unemployment) are more likely to transition to methamphetamine use or regular use. Again, these findings suggest potential avenues for treatment or intervention

to reduce the likelihood that a young person will begin to use, or continue to use methamphetamine.

5. References

1. Boden, J.M., D.M. Fergusson, and L.J. Horwood, *Illicit drug use and dependence in a New Zealand birth cohort.* Australian and New Zealand Journal of Psychiatry, 2006. **40**: p. 156-163.
2. Fergusson, D.M., J.M. Boden, and L.J. Horwood, *Cannabis use and other illicit drug use: Testing the cannabis gateway hypothesis.* Addiction, 2006. **101**: p. 556-569.
3. Fergusson, D.M., J.M. Boden, and L.J. Horwood, *The developmental antecedents of illicit drug use: Evidence from a 25-year longitudinal study.* Drug and Alcohol Dependence, 2008. **96**: p. 165-177.
4. Lynskey, M.T. and D.M. Fergusson, *Childhood conduct problems, attention deficit behaviors, and adolescent alcohol, tobacco, and illicit drug use.* Journal of Abnormal Child Psychology, 1995. **23**(3): p. 281-302.
5. Lynskey, M.T., D.M. Fergusson, and L.J. Horwood, *The origins of the correlations between tobacco, alcohol, and cannabis use during adolescence.* Journal of Child Psychology and Psychiatry and Allied Disciplines, 1998. **39**(7): p. 995-1005.
6. Fergusson, D.M. and J.M. Boden, *Alcohol use in adolescence*, in *Improving the Transition: Reducing Social and Psychological Morbidity During Adolescence*, P. Gluckman and H. Hayne, Editors. 2011, Office of the Prime Minister's Science Advisory Committee. p. 235-255.
7. Fergusson, D.M., L.J. Horwood, and M.T. Lynskey, *The prevalence and risk factors associated with abusive or hazardous alcohol consumption in 16-year-olds.* Addiction, 1995. **90**(7): p. 935-946.
8. Fergusson, D.M., M.T. Lynskey, and L.J. Horwood, *Childhood exposure to alcohol and adolescent drinking patterns.* Addiction, 1994. **89**(8): p. 1007-1016.
9. Fergusson, D.M., L.J. Horwood, and E. Ridder, *Show me the child at seven: The consequences of conduct problems in childhood for psychosocial functioning in adulthood.* Journal of Child Psychology and Psychiatry, 2005. **46**(8): p. 837-849.
10. Fergusson, D.M., L.J. Horwood, and M.T. Lynskey, *The childhoods of multiple problem adolescents: A 15-year longitudinal study.* Journal of Child Psychology and Psychiatry, 1994. **35**(6): p. 1123-1140.
11. Jakobsen, I.S., L.J. Horwood, and D.M. Fergusson, *Childhood anxiety/withdrawal, adolescent parent-child attachment and later risk of depression and anxiety disorder.* Journal of Child and Family Studies, 2012. **21**(2): p. 303-310.
12. Boden, J.M., et al., *Parenting and home environment in childhood and adolescence and alcohol use disorder in adulthood.* Journal of Adolescent Health, 2021: p. S1054-139X(21)00006-9.
13. Fergusson, D.M., L.J. Horwood, and M.T. Lynskey, *The prevalence and comorbidity of DSM-III-R diagnoses in a birth cohort of 15 year olds.* Journal of the American Academy of Child and Adolescent Psychiatry, 1993. **32**(6): p. 1127-1134.
14. Gillies, W.M., et al., *Ethnic differences in adolescent mental health problems: Examining early risk factors and deviant peer affiliation.* Journal of Child and Family Studies, 2017.
15. Foulds, J.A., et al., *High novelty seeking as a predictor of antisocial behaviour in early adulthood.* Personality and Mental Health, 2017.

16. Fergusson, D.M., L.J. Horwood, and J.M. Lawton, *The relationships between neuroticism and depressive symptoms.* Social Psychiatry and Psychiatric Epidemiology, 1989. **24**(6): p. 275-281.
17. Fergusson, D.M., L.J. Horwood, and E.M. Ridder, *Show me the child at seven II: Childhood intelligence and later outcomes in adolescence and young adulthood.* Journal of Child Psychology and Psychiatry, 2005. **46**(8): p. 850-858.
18. Fergusson, D.M., L.J. Horwood, and J.M. Boden, *The transmission of social inequality: Examination of the linkages between family socioeconomic status in childhood and educational achievement in young adulthood.* Research in Social Stratification and Mobility, 2008. **26**: p. 277-295.
19. Fergusson, D.M., L.J. Horwood, and M.T. Lynskey, *Childhood sexual abuse and psychiatric disorder in young adulthood: II. Psychiatric outcomes of childhood sexual abuse.* Journal of the American Academy of Child and Adolescent Psychiatry, 1996. **35**(10): p. 1365-1374.
20. Fergusson, D.M., M.T. Lynskey, and L.J. Horwood, *Childhood sexual abuse and psychiatric disorder in young adulthood: I. Prevalence of sexual abuse and factors associated with sexual abuse.* Journal of the American Academy of Child and Adolescent Psychiatry, 1996. **35**(10): p. 1355-1364.
21. Mulder, R., T., et al., *The relationship between dissociation, sexual abuse, physical abuse and mental illness in a general population sample.* American Journal of Psychiatry, 1998. **155**: p. 806-811.
22. Fergusson, D.M., J.M. Boden, and L.J. Horwood, *Examining the intergenerational transmission of violence in a New Zealand birth cohort.* Child Abuse and Neglect, 2006. **30**: p. 89-108.
23. Boden, J.M., L.J. Horwood, and D.M. Fergusson, *Exposure to childhood sexual and physical abuse and subsequent educational achievement outcomes.* Child Abuse and Neglect, 2007. **31**: p. 1101-1114.
24. Fergusson, D.M., G.F.H. McLeod, and L.J. Horwood, *Childhood sexual abuse and adult developmental outcomes: Findings from a 30-year longitudinal study in New Zealand.* Child Abuse and Neglect, 2013. **37**(9): p. 664-674.
25. McLeod, G.F.H., L.J. Horwood, and D.M. Fergusson, *Adolescent depression, adult mental health and psychosocial outcomes at 30 and 35 years.* Psychological Medicine, 2016. **46**(7): p. 1401-12.
26. Fergusson, D.M., M.T. Lynskey, and L.J. Horwood, *Comorbidity between depressive disorders and nicotine dependence in a cohort of 16-year-olds.* Archives of General Psychiatry, 1996. **53**: p. 1043-1047.
27. Fergusson, D.M. and L.J. Woodward, *Mental health, educational and social role outcomes of adolescents with depression.* Archives of General Psychiatry, 2002. **59**: p. 225-231.
28. Fergusson, D.M., J.M. Boden, and L.J. Horwood, *Classification of behavior disorders in adolescence: Scaling methods, predictive validity and gender differences.* Journal of Abnormal Psychology, 2010. **119**(4): p. 699-712.
29. Fergusson, D.M. and L.J. Horwood, *The role of adolescent peer affiliations in the continuity between childhood behavioral adjustment and juvenile offending.* Journal of Abnormal Child Psychology, 1996. **24**(2): p. 205-221.
30. Fergusson, D.M. and L.J. Horwood, *Prospective childhood predictors of deviant peer affiliations in adolescence.* Journal of Child Psychology and Psychiatry, 1999. **40**(4): p. 581-592.
31. Fergusson, D.M., M.T. Lynskey, and L.J. Horwood, *The role of peer affiliations, social, family and individual factors in continuities in cigarette smoking between childhood and adolescence.* Addiction, 1995. **90**(5): p. 647-660.

32. Fergusson, D.M., N.R. Swain-Campbell, and L.J. Horwood, *Deviant peer affiliations, crime and substance use: A fixed effects regression analysis.* Journal of Abnormal Psychology, 2002. **30**(4): p. 419-430.
33. Fergusson, D.M., et al., *Deviant peer affiliations and depression: Confounding or causation?* Journal of Abnormal Psychology, 2003. **31**: p. 605-618.
34. Elley, W.B. and J.C. Irving, *Revised socio-economic index for New Zealand.* New Zealand Journal of Educational Studies, 1976. **11**(1): p. 25-36.
35. Parker, G., H. Tupling, and L.B. Brown, *A parental bonding instrument.* British Journal of Medical Psychology, 1979. **52**: p. 1-10.
36. Rutter, M., J. Tizard, and K. Whitmore, *Education, Health and Behaviour*. 1970, London: Longmans.
37. Conners, C.K., *Symptom patterns in hyperkinetic, neurotic and normal children.* Child Development, 1970. **41**(3): p. 667-682.
38. Eysenck, H.M. and S.B.G. Eysenck, *Manual of the Eysenck Personality Inventory*. 1964, London: London University Press.
39. Cloninger, C.R., *A systematic method for clinical description and classification of personality variants: A proposal.* Archives of General Psychiatry, 1987. **44**(6): p. 573-588.
40. Wechsler, D., *Wechsler Intelligence Scale for Children: Revised*. 1974, New York: The Psychological Corporation.
41. Fergusson, D.M. and M.T. Lynskey, *Physical punishment/maltreatment during childhood and adjustment in young adulthood.* Child Abuse and Neglect, 1997. **21**(7): p. 617-630.
42. Straus, M., *Measuring intrafamily conflict and violence: The conflict tactics (CT) scale.* Journal of Marriage & the Family, 1979. **41**: p. 75-88.
43. American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders (3rd ed. - rev)*. 1987, Washington, DC: American Psychiatric Association.
44. Fergusson, D.M., L.J. Horwood, and M.T. Lynskey, *The prevalence and comorbidity of DSM-III-R diagnoses in a birth cohort of 15 year olds.* Journal of the American Academy of Child & Adolescent Psychiatry, 1993. **32**(6): p. 1127-1134.
45. Costello, A., et al., *Diagnostic Interview Schedule for Children (DISC)*. 1982, National Institute of Mental Health: Bethesda, MD.
46. Moffitt, T.R. and P.A. Silva, *Self-reported delinquency: Results from an instrument for New Zealand.* Australian and New Zealand Journal of Criminology, 1988. **21**: p. 227-240.
47. Quay, H.C. and D.R. Peterson, *Manual for the Revised Behaviour Problem Checklist*. 1987, Miami: H.C. Quay & D.R. Peterson.
48. Costello, A., et al., *Diagnostic Interview Schedule for Children (DISC)*. 1984, National Institute of Mental Health: Bethesda, MD.
49. Fergusson, D.M., J.M. Boden, and L.J. Horwood, *Tests of causal linkages between alcohol abuse or dependence and major depression.* Archives of General Psychiatry, 2009. **66**(3): p. 260-266.
50. Fergusson, D.M., J.M. Boden, and L.J. Horwood, *Structural models of the comorbidity of internalizing disorders and substance use disorders in a longitudinal birth cohort.* Social Psychiatry and Psychiatric Epidemiology, 2011. **46**(10): p. 933-942.
51. Boden, J.M., D.M. Fergusson, and L.J. Horwood, *Associations between exposure to life stress and alcohol use disorder in a longitudinal birth cohort studied to age 30.* Drug and Alcohol Dependence, 2014. **142**: p. 154-160.
52. Boden, J.M., et al., *Modelling possible causality in the associations between unemployment, cannabis use, and alcohol misuse.* Social Science and Medicine, 2017. **175**: p. 127–134.
53. Lee, J.O., et al., *Social causation, social selection, or common liability? Testing possible causality in the link between young adult unemployment and nicotine dependence disorder.* Nicotine and Tobacco Research, 2019.

54. Robins, L.N., et al., *Diagnostic Interview Schedule for DSM-IV*. 1995, St Louis, MO: Washington University Press.
55. American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders (4th ed.)*. 1994, Washington DC: American Psychiatric Association.
56. Holmes, T.H. and R. Rahe, *The Social Readjustment Rating Scale.* Journal of Psychosomatic Research, 1967. **11**: p. 213-218.
57. Gibbons RD, Hedeker D, Waternaux C, Davis JM. Random effects regression models: A comprehensive approach to the analysis of longitudinal psychiatric data. Psychopharmacological Bulletin. 1988;24:438-43.
58. StataCorp. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC; 2019.