# Supplementary materials

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## 1. Supplemental tables

### Table S1. Average age at initiation of alcohol, tobacco, and cannabis use. We used the most recent available report of age at initiation. Adolescents without data on these traits have either not initiated using these substances or have missing data for other reasons.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **N** | **M** | **SD** |
| Age first alcohol | 1,279 | 14.81 | 1.42 |
| Age first time drunk | 1,153 | 15.98 | 1.61 |
| Age first cigarette | 1,033 | 14.81 | 2.05 |
| Age started daily tobacco use | 641 | 15.73 | 2.11 |
| Age first cannabis | 788 | 16.12 | 1.90 |

Table S2.Standardized regression weight (β) with associated 95% confidence intervals (CI\_l lower boundary and CI\_u upper boundary) and p-values (*p*, values <.05 in bold ) for the regression paths in the best fitting SEM per parenting factor and substance use outcome.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| model |  | PGS | parent | GxE | rGE | age | sex\* | PC1 | PC2 | PC3 | PC4 | PC5 | PC6 | PC7 | PC8 | PC9 | PC10 |
| F1 🡪 smoking (model 3 rGE, R2=13%) | β | .19 | .26 | NA | .14  | .10 | -.08 | -.02 | .03 | .04 | -.04 | -.04 | .01 | .03 | -.03 | -.02 | .01 |
| CI\_l | .12 | .17 | NA | .08 | .04 | -.18 | -.09 | -.04 | -.03 | -.10 | -.10 | -.05 | -.03 | -.09 | -.07 | -.05 |
| CI\_u | .25 | .34 | NA | .19 | .16 | .021 | .05 | .09 | .11 | .03 | .01 | .07 | .08 | .03 | .04 | .06 |
| *p* | **<.001** | **<.001** | NA | **<.001** | **.001** | .122 | .540 | .457 | .218 | .230 | .139 | .700 | .373 | .288 | .588 | .834 |
| F2 🡪 smoking (model 4 full, R2=14%) | β | .16 | .33 | .14 | .22 | .08 | .02 | -.02 | .02 | .04 | -.03 | -.04 | .01 | .03 | -.02 | -.01 | <.01 |
| CI\_l | .10 | .21 | .02 | .14 | .02 | -.04 | -.09 | -.04 | -.03 | -.09 | -.09 | -.05 | -.03 | -.08 | -.07 | -.06 |
| CI\_u | .22 | .46 | .26 | .29 | .14 | .08 | .05 | .09 | .10 | .03 | .02 | .07 | .08 | .04 | .04 | .06 |
| *p* | **<.001** | **<.001** | **.019** | **<.001** | **.010** | .509 | .628 | .496 | .287 | .268 | .189 | .754 | .354 | .466 | .661 | .937 |
| F3 🡪 smoking (model 4 full, R2=10%) | β | .18 | .16 | .10 | .10 | .12 | -.03 | -.01 | .03 | .04 | -.03 | -.05 | .02 | .03 | -.03 | -.03 | .01 |
| CI\_l | .12 | .05 | >-.01 | .02 | .06 | -.10 | -.08 | -.04 | -.03 | -.10 | -.10 | -.05 | -.03 | -.09 | -.09 | -.05 |
| CI\_u | .23 | .28 | .19 | .17 | .18 | .04 | .06 | .09 | .11 | .03 | .01 | .08 | .09 | .03 | .03 | .06 |
| *p* | **<.001** | **.004** | .057 | **.009** | **<.001** | .384 | .754 | .453 | .292 | .284 | .106 | .638 | .315 | .343 | .349 | .823 |
| F1 🡪 alcohol (model 1 main, R2=12%) | β | .05 | .01 | NA | NA | .06 | .32 | <.01 | .04 | -.01 | .02 | .01 | -.03 | .03 | -.02 | -.02 | -.02 |
| CI\_l | >-.01 | -.07 | NA | NA | -.04 | .28 | -.09 | -.03 | -.07 | -.04 | -.04 | -.08 | -.03 | -.07 | -.08 | -.08 |
| CI\_u | .10 | .08 | NA | NA | .07 | .38 | .09 | .11 | .06 | .08 | .07 | .03 | .09 | .03 | .04 | .04 |
| *p* | .069 | .850 | NA | NA | .604 | **<.001** | .983 | .274 | .837 | .445 | .641 | .354 | .298 | .478 | .487 | .466 |
| F2 🡪 alcohol (model 4 full, R2=12%) | β | .04 | .04 | -.04 | .06 | .01 | .33 | >.01 | .04 | -.01 | .02 | .01 | -.03 | .03 | -.02 | -.02 | -.02 |
| CI\_l | -.01 | -.06 | -.12 | -.02 | -.05 | .29 | -.09 | -.03 | -.07 | -.04 | -.04 | -.08 | -.03 | -.07 | -.08 | -.08 |
| CI\_u | .10 | .13 | .04 | .13 | .07 | .38 | .09 | .11 | .06 | .08 | .07 | .03 | .09 | .04 | .04 | .04 |
| *p* | .108 | .460 | .338 | .120 | .677 | **<.001** | .955 | .269 | .886 | .447 | .621 | .333 | .303 | .494 | .482 | .466 |
| F3 🡪 alcohol (model 1 main, R2=12%) | β | .05 | -.03 | NA | NA | .02 | .34 | <.01 | .04 | -.01 | .02 | .01 | -.03 | .03 | -.02 | -.02 | -.02 |
| CI\_l | -.01 | -.11 | NA | NA | -.04 | .29 | -.09 | -.03 | -.07 | -.04 | -.04 | -.08 | -.03 | -.07 | -.08 | -.08 |
| CI\_u | .10 | .05 | NA | NA | .07 | .39 | .09 | .11 | .06 | .08 | .07 | .03 | .09 | .04 | .04 | .04 |
| *p* | .075 | .472 | NA | NA | .612 | **<.001** | .991 | .276 | .837 | .435 | .635 | .339 | .314 | .502 | .500 | .469 |
| F1 🡪 cannabis (main, R2=7%) | β | .15 | .08 | NA | NA | .11 | .04 | -.05 | -.04 | .02 | .03 | -.02 | .01 | .07 | -.07 | -.02 | .05 |
| CI\_l | .09 | -.01 | NA | NA | .05 | -.02 | -.13 | -.12 | -.05 | -.03 | -.08 | -.05 | .01 | -.13 | -.08 | -.01 |
| CI\_u | .22 | .17 | NA | NA | .18 | .11 | .03 | .03 | .08 | .10 | .05 | .08 | .13 | -.01 | .05 | .11 |
| *p* | **<.001** | .064 | NA | NA | **<.001** | .202 | .259 | .245 | .607 | .322 | .584 | .712 | .020 | .031 | .620 | .114 |
| F2 🡪 cannabis (model 1 main, R2=10%) | β | .15 | .21 | NA | NA | .10 | .07 | -.05 | -.04 | .02 | .03 | -.01 | .01 | .07 | -.06 | -.02 | .05 |
| CI\_l | .09 | .08 | NA | NA | .04 | .01 | -.13 | -.12 | -.05 | -.03 | -.08 | -.05 | .01 | -.13 | -.08 | -.01 |
| CI\_u | .21 | .34 | NA | NA | .16 | .14 | .03 | .03 | .08 | .10 | .05 | .07 | .13 | >-.01 | .05 | .11 |
| *p* | **<.001** | **.002** | NA | NA | **.001** | **.019** | .230 | .234 | .660 | .311 | .670 | .726 | .025 | .040 | .618 | .116 |
| F3 🡪 cannabis (model 1 main, R2=6%) | β | .15 | -.04 | NA | NA | .12 | .08 | -.05 | -.04 | .02 | .03 | -.02 | .01 | .07 | -.06 | -.02 | .05 |
| CI\_l | .09 | -.13 | NA | NA | .06 | .01 | -.13 | -.11 | -.05 | -.03 | -.08 | -.05 | .01 | -.13 | -.08 | -.01 |
| CI\_u | .22 | .06 | NA | NA | .18 | .14 | .03 | .03 | .08 | .10 | .04 | .07 | .13 | >.01 | -.05 | .11 |
| *p* | **<.001** | .426 | NA | NA | **<.001** | **.020** | .247 | .250 | .666 | .294 | .563 | .739 | .023 | .041 | .628 | .102 |

*Note.* \*reference category for sex was female

PGS=polygenic score for the respective substance use outcome; parent=parenting factor with F1=parental involvement, F2=parental substance use, F3=parent-child relationship; PC=principal component for genetic ancestry; NA = Not available because best fitting model did not contain these effects

Table S3.Correlations between observed variables in the SEM models (before imputation). Correlations significant at *p*<.05 are in bold.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 1 sex\* | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 age | .08 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 parental control | .27 | .12 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 parental sollicitation | .24 | .02 | .51 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 parental knowledge | -.05 | .08 | .23 | .22 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 child disclosure | .19 | .05 | .31 | .46 | .33 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 parental rejection | .14 | .01 | .05 | .16 | .12 | .18 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 parental warmth | .15 | -.01 | .18 | .32 | .23 | .26 | .35 | 1 |  |  |  |  |  |  |  |  |  |  |  |
| 9 parental smoking\* | .00 | .04 | .13 | .15 | .18 | .13 | .06 | .01 | 1 |  |  |  |  |  |  |  |  |  |  |
| 10 parental cannabis\* | -.02 | .04 | .07 | .05 | .15 | .07 | .02 | .03 | .17 | 1 |  |  |  |  |  |  |  |  |  |
| 11 parental addiction\* | .00 | .04 | .08 | .08 | .08 | .02 | .00 | -.02 | .18 | .19 | 1 |  |  |  |  |  |  |  |  |
| 12 PGS smoking | .01 | -.01 | .07 | .09 | .15 | .11 | .08 | .04 | .13 | .04 | .06 | 1 |  |  |  |  |  |  |  |
| 13 PGS alcohol use | .01 | .04 | .01 | -.01 | .07 | .07 | -.02 | -.02 | .03 | .04 | .02 | .24 | 1 |  |  |  |  |  |  |
| 14 PGS cannabis | -.01 | .02 | .01 | .01 | .05 | .05 | -.01 | .01 | .01 | .06 | .06 | .20 | .18 | 1 |  |  |  |  |  |
| 15 daily smoking\* | .01 | .09 | .12 | .09 | .20 | .21 | .04 | .04 | .19 | .08 | .05 | .20 | .09 | .08 | 1 |  |  |  |  |
| 16 cigarettes per day\*# | -.04 | .09 | .10 | .11 | .15 | .14 | .11 | .08 | .22 | .01 | .06 | .21 | .03 | -.03 | .79 | 1 |  |  |  |
| 17 nicotine dependence\*# | .01 | .11 | .14 | .13 | .21 | .22 | .08 | .06 | .18 | .08 | .05 | .16 | .06 | .04 | .83 | .76 | 1 |  |  |
| 18 alcohol per week | .34 | .03 | .09 | .05 | .07 | .13 | .04 | .02 | .06 | .04 | -.01 | .05 | .05 | .13 | .12 | -.01 | .10 | 1 |  |
| 19 cannabis initiation\* | .07 | .11 | .07 | .02 | .15 | .20 | -.02 | -.02 | .06 | .12 | .08 | .10 | .12 | .13 | .32 | .05 | .28 | .32 | 1 |

*Note.* \*For associations with categorical variables Spearman correlation (*ρ*) is reported (for associations containing only continuous variables this was Pearson’s *r*). # The correlations for these variables were computed in the smoking sub sample.

Table S4.Parameters of the associations between age/ sex and the parenting factors in the best fitting models.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **age** | **sex\*** |
| outcome | parental factor | b (se) | *p* | b (se) | *p* |
| **smoking** | F1 involvement | 0.07 (0.03) | **.022** | 0.32 (0.03) | **<.001** |
|  | F2 substance use | 0.20 (0.08) | **.017** | -0.10 (0.16) | .540 |
|  | F3 relationship | -0.01(0.04) | .729 | 0.52 (0.07) | **<.001** |
| **alcohol** | F1 involvement | 0.02 (0.01) | .065 | 0.18 (0.02) | **<.001** |
|  | F2 substance use | 0.02 (0.01) | **.047** | -0.01 (0.02) | .607 |
|  | F3 relationship | -0.02 (0.04) | .597 | 0.53 (0.07) | **<.001** |
| **cannabis** | F1 involvement | 0.02 (0.01) | .057 | 0.18 (0.02) | **<.001** |
|  | F2 substance use | 0.13 (0.06) | **.037** | 0.18 (0.02) | **<.001** |
|  | F3 relationship | -0.02 (0.04) | .601 | 0.52 (0.07) | **<.001** |

*Note.* \*reference category for sex was female

## 2. Script explanation

All scripts for analysis in MPLUS are provided on GitHub (<http://github.com/joellepasman/TRAILS_substanceuse/>).

The script names for the exploratory factor analysis (EFA) follow the format efa\_construct$ with construct being the latent variable that is modeled (either a predictor or outcome construct) and $ representing the modeling step. The script names for the structural equation models (SEM) follow the format outcome\_parentingfactor\_model step. Outcomes included a latent factor for smoking (fsmk), alcohol per week (alc), and cannabis initiation (can). Parenting factors included F1 parental involvement (f1inv), F2 parental substance use (f2sub), and F3 the parent-child relationship (f3rel). The modeling steps were ‘1main’ for the main effects of the PGS and the parenting factor, ‘2interactioneffects’ for the GxE between the PGS and the parenting factor, ‘3rgeeffects’ for the rGE effects, and ‘4full’ for the complete model including main, GxE, and rGE effects.

The following abbreviations are used in the scripts to represent the variables:

C1-C10 Principal components for genetic ancestry

parknow Parental knowledge

pardisc Child disclosure

parcont Parental control

parsol Parental solicitation

rel\_rej Parent-child relationship rejection

rel\_warm Parent-child relationship warmth

parsmk Parental smoking

parcpd Parental cigarettes per day

paralc Parental alcohol use per week

paraddep Parental addiction

parcan Parental cannabis use

prssmcpd Smoking PGS (based on smoking initiation and cigarettes per day)

prsalc Alcohol use PGS

prscan Cannabis initiation PGS

eversmk Ever smoking

dailysmk Daily smoking

cpd Cigarettes per day

ftnd Nicotine dependence

alc Alcohol use per week

alcmonth Any alcohol use in past month (yes/ no)

audit Alcohol Use Disorder Identification Test total score

can Cannabis initiation

cupit1 Cannabis Use Disorder Identification Test subscale 1 (impaired control) score

cupit2 Cannabis Use Disorder Identification Test subscale 2 (cannabis problems) score

Table S5.Explanation of the scripts for the EFA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Construct** | **Filename** | **Content** | **Result** |
| parenting | efa\_parenting1 | EFA of all parenting variables from Table 1 plus parental alcohol use and parental cigarettes per day | Parental alcohol use does not load on any factor. |
|  | efa\_parenting2 | EFA of all parenting variables except parental alcohol use | Separation in the data due to inclusion of parental smoking and cigarettes per day. Also, the inclusion of categorical and continuous variables in this factor led to computational issues. |
|  | efa\_parenting3 | EFA of all parenting variables except parental cigarettes per day and parental alcohol use | Best fit for 3-factor solution. Modification indices indicate that knowledge and disclosure should be correlated. In subsequent SEM models this correlation is added. |
| smoking | efa\_smk1 | EFA of all smoking outcome variables from Table 1 (daily smoking, nicotine dependence, cigarettes per day) plus ever smoking | Poor fit, factor loading of daily smoking exceeds 1.5. Modification indices suggest that daily smoking and ever smoking overlap too strongly. |
|  | efa\_smk2 | EFA of all smoking outcome variables except ever smoking | Good loadings on one smoking factor (just identified so not indications for fit) |
| alcohol | efa\_alc | EFA of all alcohol use outcome variables (AUDIT, binary alcohol use per month, continuous alcohol per week) | Loading of alcohol per month exceeds 1 (just identified so not indications for fit). The SEMs later on will not run due to the inclusion of a categorical variable within this factor, we will not use the factor but only look at alcohol use per week.  |
| cannabis |  | EFA of cannabis use outcome variables (lifetime use, CUPIT subscale 1 and 2) | More than 75% missing data on CUPIT variables lead to computational issues. We will not use factor but only look at lifetime cannabis initiation. |

Table S6.Explanation of the scripts for the structural equation modeling steps (1-4) for the three parenting factors (F1-F3) with **smoking** as outcome. The shaded models are the models that fit the data best and were presented in the main paper.

|  |  |  |  |
| --- | --- | --- | --- |
| **Model** | **Filename** | **Content** | **Result** |
| **F1 - 1a** | fsmk\_f1inv\_1maineffects | Main effects of PGS and parental involvement on smoking | Significant effect of PGS and F1 |
| **F1 - 1b** | fsmk\_f1inv\_1maineffects\_wlsmv | Main effects of PGS and parental involvement on smoking with WLSMV estimator to get model fit | CFI/ TLI indices below acceptance thresholds |
| **F1 - 2** | fsmk\_f1inv\_2interactioneffects | Main and GxE effects of PGS and parental involvement on smoking | Better AIC but worse BIC, no GxE |
| **F1 - 3a** | fsmk\_f1inv\_3rgeeffects | Main and rGE effects of PGS and parental involvement on smoking | Lowest AIC/ BIC, significant rGE |
| **F1 - 3b** | fsmk\_f1inv\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and parental involvement on smoking with WLSMV estimator to get model fit | Acceptable fit, significant rGE |
| **F1 - 4** | fsmk\_f1inv\_4fulleffects | Main, GxE and rGE effects of PGS and parental involvement on smoking | BIC worse than without GxE, significant main and rGE effects |
| **F2 - 1a** | fsmk\_f2sub\_1maineffects | Main effects of PGS and parental substance use on smoking | Main effects of PGS and F2 |
| **F2 - 1b** | fsmk\_f2sub\_1maineffects\_wlsmv | Main effects of PGS and parental substance use on smoking with WLSMV estimator to get model fit | Acceptable fit |
| **F2 - 2** | fsmk\_f2sub\_2interactioneffects | Main and GxE effects of PGS and parental substance use on smoking | Slightly better AIC/ BIC, significant GxE |
| **F2 - 3a** | fsmk\_f2sub\_3rgeeffects | Main and rGE effects of PGS and parental substance use on smoking | Significantly better AIC/ BIC, significant rGE |
| **F2 - 3b** | fsmk\_f2sub\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and parental substance use on smoking with WLSMV estimator to get model fit | Acceptable fit |
| **F2 - 4** | fsmk\_f2sub\_4fulleffects | Main, GxE and rGE effects of PGS and parental substance use on smoking | Lowest AIC/ BIC, significant main, GxE, and rGE effects |
| **F2 – 4** | fsmk\_f2sub\_2interactioneffects\_simpleslopes | As above, plus new parameters for the simple slopes of low (SS\_lopgs), medium (SS\_mepgs) and high (SS\_hipgs) levels of the PGS moderator | All simple slopes are significant but the effect of F2 is larger for high PGS |
| **F3 - 1a** | fsmk\_f3rel\_1maineffects | Main effects of PGS and parental substance use on smoking | Main effects of PGS and F3 |
| **F3 - 1b** | fsmk\_f3rel\_1maineffects\_wlsmv | Main effects of PGS and the parent-child relationship on smoking with WLSMV estimator to get model fit | Acceptable fit |
| **F3 - 2** | fsmk\_f3rel\_2interactioneffects | Main and GxE effects of PGS and the parent-child relationship on smoking | Slightly better AIC but worse BIC, marginal GxE |
| **F3 - 3a** | fsmk\_f3rel\_3rgeeffects | Main and rGE effects of PGS and the parent-child relationship on smoking | Slightly better AIC, significant rGE |
| **F3 - 3b** | fsmk\_f3rel\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and the parent-child relationship on smoking with WLSMV estimator to get model fit | Acceptable fit |
| **F3 - 4** | fsmk\_f3rel\_4fulleffects | Main, GxE and rGE effects of PGS and the parent-child relationship on smoking | Lowest AIC/ BIC, significant main, marginal GxE, and significant rGE effects |

Table S7.Explanation of the scripts for the structural equation modeling steps (1-4) for the three parenting factors (F1-F3) with **alcohol per week** as outcome. The shaded models are the models that fit the data best and were presented in the main paper.

|  |  |  |  |
| --- | --- | --- | --- |
| **Model** | **Filename** | **Content** | **Result** |
| **F1 - 1a** | alc\_f1inv\_1maineffects | Main effects of PGS and parental involvement on alcohol per week  | No main effects |
| **F1 - 1b** | alc\_f1inv\_1maineffects\_wlsmv | Main effects of PGS and parental involvement on alcohol per week with WLSMV estimator to get model fit | TLI below acceptance threshold |
| **F1 - 2** | alc\_f1inv\_2interactioneffects | Main and GxE effects of PGS and parental involvement on alcohol per week | Slightly worse AIC/BIC, no GxE effects |
| **F1 - 3a** | alc\_f1inv\_3rgeeffects | Main and rGE effects of PGS and parental involvement on alcohol per week | Slightly worse AIC/BIC, no rGE effects |
| **F1 - 3b** | alc\_f1inv\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and parental involvement on alcohol per week with WLSMV estimator to get model fit | TLI below acceptance threshold |
| **F1 - 4** | alc\_f1inv\_4fulleffects | Main, GxE and rGE effects of PGS and parental involvement on alcohol per week | Significantly worse BIC, no main, GxE, or rGE effects |
| **F2 - 1a** | alc\_f2sub\_1maineffects | Main effects of PGS and parental substance use on alcohol per week | No main effects |
| **F2 - 1b** | alc\_f2sub\_1maineffects\_wlsmv | Main effects of PGS and parental substance use on alcohol per week with WLSMV estimator to get model fit | Acceptable fit |
| **F2 - 2** | alc\_f2sub\_2interactioneffects | Main and GxE effects of PGS and parental substance use on alcohol per week | Slightly worse AIC/ BIC, no GxE |
| **F2 - 3a** | alc\_f2sub\_3rgeeffects | Main and rGE effects of PGS and parental substance use on alcohol per week | Slightly worse BIC, no rGE |
| **F2 - 3b** | alc\_f2sub\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and parental substance use on alcohol per week with WLSMV estimator to get model fit | Acceptable fit |
| **F2 - 4** | alc\_f2sub\_4fulleffects | Main, GxE and rGE effects of PGS and parental substance use on alcohol per week | Significantly better AIC/ BIC, no main, GxE, or rGE effects |
| **F3 - 1a** | alc\_f3rel\_1maineffects | Main effects of PGS and the parent-child relationship on alcohol per week | No main effects |
| **F3 - 1b** | alc\_f3rel\_1maineffects\_wlsmv | Main effects of PGS and the parent-child relationship on alcohol per week with WLSMV estimator to get model fit | Acceptable fit |
| **F3 - 2** | alc\_f3rel\_2interactioneffects | Main and GxE effects of PGS and the parent-child relationship on alcohol per week | Significantly worse AIC/ BIC, no GxE effects |
| **F3 - 3a** | alc\_f3rel\_3rgeeffects | Main and rGE effects of PGS and the parent-child relationship on alcohol per week | Significantly worse BIC compared to main model, no rGE effects |
| **F3 - 3b** | alc\_f3rel\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and the parent-child relationship on alcohol per week with WLSMV estimator to get model fit | Acceptable fit |
| **F3 - 4** | alc\_f3rel\_4fulleffects | Main, GxE and rGE effects of PGS and the parent-child relationship on alcohol per week | Significantly worse BIC compared to main model, no main, GxE, or rGE effects |

Table S8. Explanation of the scripts for the structural equation modeling steps (1-4) for the three parenting factors (F1-F3) with **cannabis initiation** as outcome. The shaded models are the models that fit the data best and were presented in the main paper.

|  |  |  |  |
| --- | --- | --- | --- |
| **Model** | **Filename** | **Content** | **Result** |
| **F1 - 1a** | can\_f1inv\_1maineffects | Main effects of PGS and parental involvement on cannabis initiation  | Lowest AIC/ BIC, significant effects of PGS and marginal effect of F1 |
| **F1 - 1b** | can\_f1inv\_1maineffects\_wlsmv | Main effects of PGS and parental involvement on cannabis initiation with WLSMV estimator to get model fit | TLI below acceptance threshold |
| **F1 - 2** | can\_f1inv\_2interactioneffects | Main and GxE effects of PGS and parental involvement on cannabis initiation | Slightly worse BIC, no GxE effects |
| **F1 - 3a** | can\_f1inv\_3rgeeffects | Main and rGE effects of PGS and parental involvement on cannabis initiation | Slightly worse AIC/BIC, no rGE effects |
| **F1 - 3b** | can\_f1inv\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and parental involvement on cannabis initiation with WLSMV estimator to get model fit | TLI below acceptance threshold |
| **F1 - 4** | can\_f1inv\_4fulleffects | Main, GxE and rGE effects of PGS and parental involvement on cannabis initiation | Significantly worse BIC, significant effect of PGS and marginal effect of F1 |
| **F2 - 1a** | can\_f2sub\_1maineffects | Main effects of PGS and parental substance use on cannabis initiation | Lowest AIC/ BIC, significant effects of PGS and F2 |
| **F2 - 1b** | can\_f2sub\_1maineffects\_wlsmv | Main effects of PGS and parental substance use on cannabis initiation with WLSMV estimator to get model fit | Acceptable fit |
| **F2 - 2** | can\_f2sub\_2interactioneffects | Main and GxE effects of PGS and parental substance use on cannabis initiation | Slightly worse AIC/ BIC, no GxE |
| **F2 - 3a** | can\_f2sub\_3rgeeffects | Main and rGE effects of PGS and parental substance use on cannabis initiation | Slightly worse BIC, no rGE |
| **F2 - 3b** | can\_f2sub\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and parental substance use on cannabis initiation with WLSMV estimator to get model fit | Acceptable fit |
| **F2 - 4** | can\_f2sub\_4fulleffects | Main, GxE and rGE effects of PGS and parental substance use on cannabis initiation | Significantly worse BIC, significant effect of PGS and F2 |
| **F3 - 1a** | can\_f3rel\_1maineffects | Main effects of PGS and the parent-child relationship on cannabis initiation | Lowest AIC/ BIC, significant effect of PGS |
| **F3 - 1b** | can\_f3rel\_1maineffects\_wlsmv | Main effects of PGS and the parent-child relationship on cannabis initiation with WLSMV estimator to get model fit | Acceptable fit |
| **F3 - 2** | can\_f3rel\_2interactioneffects | Main and GxE effects of PGS and the parent-child relationship on cannabis initiation  | Slightly worse BIC, no GxE effects |
| **F3 - 3a** | can\_f3rel\_3rgeeffects | Main and rGE effects of PGS and the parent-child relationship on cannabis initiation | Slightly worse AIC/BIC, no rGE effects |
| **F3 - 3b** | can\_f3rel\_3rgeeffects\_wlsmv | Main and rGE effects of PGS and the parent-child relationship on cannabis initiation with WLSMV estimator to get model fit | Acceptable fit |
| **F3 - 4** | can\_f3rel\_4fulleffects | Main, GxE and rGE effects of PGS and the parent-child relationship on cannabis initiation | Significantly worse BIC, main effect of PGS, no GxE or rGE effects |