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Assessing the Association Between Internalizing Behaviors, Externalizing Behaviors and Early
Substance Use Initiation

A Thesis submitted in partial satisfaction of the requirements for the Master's degree

in

Public Health

by

Lauren Redfern

Committee in charge:

Professor Gretchen Bandoli, Chair

Professor Christina Chambers

Professor Richard Garfein

2022

This thesis of Lauren Redfern is approved, and it is acceptable
in quality and form for publication on microfilm and electronically:

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TABLE OF CONTENTS

THESIS APPROVAL PAGE	iii
TABLE OF CONTENTS.....	iv
LIST OF FIGURES	v
LIST OF TABLES	vi
ACKNOWLEDGEMENTS.....	vii
ABSTRACT OF THESIS.....	viii
CHAPTER 1: INTRODUCTION.....	1
1.1 Background & Significance.....	1
1.2 Literature Review.....	1
1.3 Study Objectives	7
CHAPTER 2: METHODS.....	9
2.1 Data Source & Study Design	9
2.2 Measures	9
2.3 Sample.....	11
2.4 Statistical Methods.....	13
CHAPTER 3: RESULTS.....	14
3.1 Internalizing Behaviors.....	15
3.2 Externalizing Behaviors.....	16
CHAPTER 4: DISCUSSION.....	20
4.1 Summary of Findings.....	20
4.2 Comparison to the Literature	20
4.3 Internalizing Behaviors.....	21
4.4 Externalizing Behaviors.....	21
4.5 Strengths	22
4.6 Limitations	22
4.7 Conclusions.....	23
APPENDIX.....	25

LIST OF FIGURES

Figure 1: Directed acyclic graph (DAG) of the proposed pathway between internalizing behaviors and externalizing behaviors.....	7
Figure 2: Study Sample Flowchart.....	12
Figure 3a: Boxplot of internalizing score by focal child sex at birth.....	26
Figure 3b: Boxplot of externalizing score by focal child sex at birth.....	27

LIST OF TABLES

Table 1: Demographic variables of the focal child by internalizing and externalizing behavior level at age 9 years, Fragile Families and Child Wellbeing Study.....17

Table 2a: Unadjusted and Adjusted Risk Ratios of Substance Use Initiation by Internalizing Categorization.....18

Table 2b: Unadjusted and Adjusted Risk Ratios of Substance Use Initiation by Externalizing Categorization.....18

Table 3: Risk of Substance Use Initiation Stratified by Sex.....19

Table 4: Correlation Between Internalizing Score & Externalizing Score.....25

Table 5: Unadjusted Risk Ratios by High/Low Internalizing/Externalizing Categorization.....25

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ABSTRACT OF THESIS

Assessing the Association Between Internalizing Behaviors, Externalizing Behaviors and Early Substance Use Initiation

by

Lauren Redfern

Master of Public Health

University of California San Diego, 2022

Professor Gretchen Bandoli, Chair

Objective: The purpose of this study is to assess whether childhood externalizing and internalizing behaviors predict substance use initiation during adolescence. Additionally, we examined whether there was effect measure modification by sex of the child on this association.

Methods: This study is a secondary analysis using data from a prospective cohort study, the Fragile Families and Child Wellbeing Study. A multivariable log link regression analysis was used to estimate the risk of initiation of marijuana, cigarettes, and alcohol at age 15, based on internalizing and externalizing behaviors measured at age 9. Models were adjusted for child race/ethnicity, maternal age, maternal substance use during pregnancy, poverty level, and ACEs.

Results: Out of 2935 children at age 9, 6.5% met the criteria for high externalizing score, and 3.6% met the criteria for high internalizing score. High externalizing score was a risk factor for marijuana (ARR= 1.57, CI= 1.10, 2.20) and cigarette use (ARR= 2.38, CI= 1.31, 4.17) initiation. High internalizing score decreased the risk of alcohol use initiation, after controlling for all confounding variables. There was no evidence of effect modification by child sex.

Conclusion: These findings are of public health importance, as they add to the paucity of information on known risk factors for substance use initiation among adolescents. Additionally, these results can be used to help identify youth who may benefit from interventions designed to prevent adolescent substance use initiation.

CHAPTER 1: INTRODUCTION

1.1 Background & Significance

Understanding potential risk factors for substance initiation is of great public health importance, as rates of substance use and abuse among teens have been rising and teen/young adult drug overdose deaths have increased over 3-fold from 1999 to 2019.¹ It is important to study predictors of substance use initiation (SUI) because early substance initiation has been linked to the development of more serious substance use disorders in adulthood.¹ Additionally, early alcohol dependence is associated with serious, adverse health outcomes such as heart disease, high blood pressure, and sleep disorders.¹ Early-onset substance use is associated with a larger number of adverse health outcomes than late-onset substance use.¹ Childhood psychopathology, including internalizing behaviors (IB) and externalizing behaviors (EB), may increase the risk of early substance initiation. Internalizing behaviors reflect a child's emotional and physiological state and typically are characterized by anxiety and depressive disorders.² Externalizing behaviors are displayed outwardly and may be characterized by aggression and violence.³ Research has shown that internalizing and externalizing behaviors tend to co-occur.² Further inquiry of risk factors of early substance initiation, including internalizing and externalizing behaviors, is of great public health importance.

1.2 Literature Review

Internalizing and Externalizing Behaviors

Internalizing and externalizing behaviors in childhood have been linked to negative mental health outcomes later in life. Childhood depression often accompanies childhood anxiety,

both of which are internalizing disorders.⁴ Studies have found an association between childhood depression and anxiety and adulthood major depressive disorder, anxiety disorder, suicidal behavior, and psychiatric hospitalization.⁴ Internalizing and externalizing behaviors have also been associated with poor academic performance. A study by Eisenberg et al. reported that children who display externalizing behaviors have lower rates of high school completion.⁵ The same study found that children who display both internalizing and externalizing behaviors are more likely to be incarcerated and end up in the criminal justice system later in life.⁵ A 1998 study by Pines et al., found that most anxiety and depressive disorders in young adults are preceded by internalizing behaviors of depression and anxiety in adolescence.⁶ A study by Winters et al., reported that among those seeking treatment for a substance use disorder, individuals who presented with externalizing behaviors in childhood tended to have poorer outcomes and worsened treatment retention.⁷

A Potential Link Between Internalizing Behaviors, Externalizing Behaviors & Substance Initiation

While more data on the link between externalizing and internalizing behaviors and substance initiation is needed, the rise in substance use disorders nationally has prompted the emergence of research on this topic. A study by King et al. used data from the Minnesota Twin Family Study to examine the relationships between childhood internalizing and externalizing disorders and substance use in early adolescence.⁸ Internalizing and externalizing behaviors were assessed at age 11, and substance use and abuse were assessed at age 11 and 14.⁹ This study found that externalizing behaviors at age 11 were linked to having tried alcohol, nicotine, and cannabis by age 14.⁹ An additional study by Elkins et al., “Prospective Effects of Attention-

Deficit/Hyperactivity Disorder, Conduct Disorder, and Sex on Adolescent Substance Use and Abuse,” also used data from the Minnesota Twin Family Study.³ Researchers found that hyperactivity and impulsivity predicted initiation of all types of substance use, nicotine dependence, and cannabis abuse/dependence, even after controlling for conduct disorder.³ Additionally, this study reported that a diagnosis of attention deficit hyperactivity disorder (ADHD) significantly predicted tobacco and illicit drug use.³

A 2006 study by Sartor et al., found that conduct disorder was a strong predictor of early alcohol initiation.¹⁰ This is significant because conduct disorder is classified as an externalizing behavioral disorder. A 1998 study, by Clark and Bukstein, found that adolescents who abuse alcohol are more likely to have a coexisting mental health disorder, such as depression or anxiety.¹¹ A limitation of this study is that they did not assess if the development of a mental health disorder preceded the development of substance abuse. However, it is significant to note the finding that depression and anxiety, which are internalizing behavior disorders, often co-occur with alcohol abuse.

A study by Lillehoj et al., “Externalizing behaviors as predictors of substance initiation trajectories among rural adolescents,” analyzed data from 198 rural adolescents and found that having a higher number of externalizing behaviors at age 12 was associated with a great number of substances initiated over time.² This paper supports the findings of King et al. and Elkins et al., who also found externalizing behaviors to be a predictor of substance use initiation later in life.^{3,9} An additional study by Colder et al., “Prospective Associations of Internalizing and Externalizing Problems and Their Co-Occurrence with Early Adolescent Substance Use,” found a strong positive association between externalizing behaviors and alcohol, cigarette, and marijuana use.¹² Interestingly, this study found that internalizing behaviors, in the absence of

externalizing behaviors, decreased the risk of cigarette and marijuana use.¹² This study also highlighted the need for more research to be done on the co-occurrence of internalizing and externalizing behaviors and pathways to substance initiation.

A recent study by Das et al, “Externalizing psychopathology and cognitive functions in patients with early and late-onset alcohol dependence,” reported that early-onset alcohol dependence is associated with displaying a higher number of externalizing behaviors and cognitive dysfunction compared to late-onset alcohol dependence.¹³ This finding is significant because early-onset alcohol dependence is associated with greater adverse health effects than late-onset alcohol dependence.¹⁴

Other Predictors of Internalizing Behaviors, Externalizing Behaviors & Substance

Initiation

Understanding well-established risk factors for both internalizing behaviors, externalizing behaviors and substance use is necessary for identifying possible confounding or mediating variables. A 2018 study by Chatterjee et al., found that abuse and household dysfunction were associated with early initiation of marijuana and alcohol use.¹⁵ A 2017 study reported that children who have been abused are more likely to use substances at an earlier age and develop substance use disorders later in life.⁶ The same study found that externalizing behaviors mediated the link between child maltreatment and alcohol and marijuana use initiation.⁶ Additionally, a recent study, by Guarino et al., found that an increasing number of childhood traumas was associated with increased odds of multiple opioid use behaviors.¹⁶

Parent involvement, as well as parental substance use and abuse, are also important predictors for childhood substance initiation. A study by Cohen et al., found that children whose

parents spent more time with them and communicated with them more frequently had lower rates of substance initiation, thus parental monitoring was found to be a protective factor against early-onset substance use.¹⁷ A 2018 study by Rusby et al. supported these findings and found that a poor parent-youth relationship was associated with alcohol use, binge drinking, and marijuana use.¹⁴ This study also found that parent binge drinking was a predictor of alcohol initiation.¹⁴ Not only does parental support predict a child's risk of substance initiation, but school support does as well. A 2012 study by McCarty et al., found that children with higher levels of perceived teacher support in grade 6 had lower rates of substance initiation in grade 8.¹⁸ The same study also found that experiencing a recent stressful life event in grade 6 was associated with a greater risk of substance initiation by grade 8.¹⁸

A child's home environment and level of parental support have also been found to be strong predictors of the development of internalizing and externalizing behaviors. A study by Muniz et al., found that emotional abuse was a strong predictor of children developing externalizing problem behaviors.¹⁹ This study also found that household member incarceration, physical abuse, emotional neglect, and household violence or substance abuse also predicted externalizing outcomes.¹⁹ Additionally, sexual abuse was found to be the only predictor of the development of internalizing behaviors. An additional study found that child maltreatment was linked to internalizing and externalizing disorders, as well as decreasing problem-focused coping.²⁰ A 2020 study, "Pathways from Parental Substance Use to Child Internalizing and Externalizing Behaviors in a Child Protective Services Sample," used data from the National Survey of Child and Adolescent Well-Being II to examine the role of mediation in the pathway from parental substance use to children developing internalizing and externalizing behaviors.²¹

This study found that emotional maltreatment mediated the relationship between parental substance use and the development of internalizing and externalizing behaviors.²¹

Childhood abuse, neglect, and household dysfunction, such as having a parent with a substance use disorder, all fall under the category of Adverse Childhood Experiences (ACES).²² ACEs are traumatic or potentially traumatic events that occur from the ages of 0-17.²² The original study on ACEs was conducted from 1995-1997 and assessed 10 Adverse Childhood Experiences: emotional abuse, physical abuse, sexual abuse, mother treated violently, substance abuse in the household, mental illness in the household, parental separation or divorce, incarcerated household member, emotional neglect, and physical neglect.²² We suspect that ACEs are a confounding variable in the relationship between internalizing and externalizing behaviors and age of substance initiation. Although, it is also probable that ACEs cause internalizing and externalizing behaviors, which in turn lead to early substance use initiation. For the purpose of this study, we were interested in looking at the potential pathway from internalizing and externalizing behaviors to substance use initiation, so we considered ACEs to be a potential confounding variable in that pathway (Figure 1). Based on the current literature, we also predicted that socioeconomic status, sex, and substance use during pregnancy would be confounding variables in this pathway (Figure1).

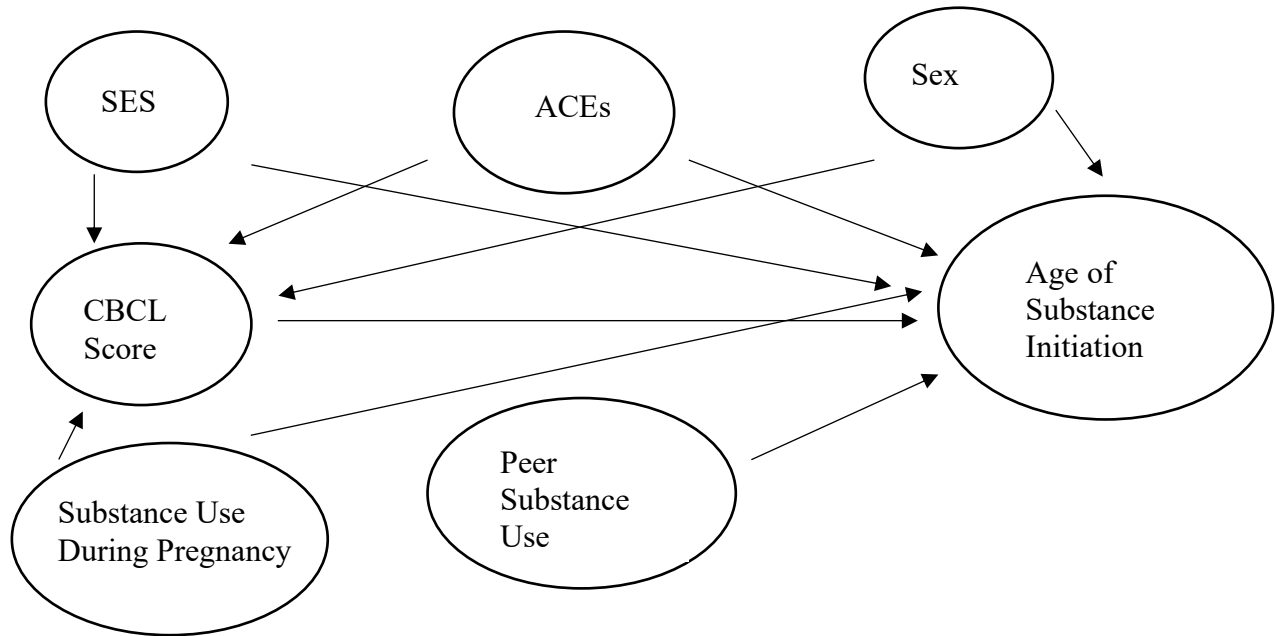


Figure 1: Directed acyclic graph (DAG) of the proposed pathway between internalizing behaviors and externalizing behaviors (Measured by CBCL score) and substance initiation.

SES= Socioeconomic status

ACEs= Adverse Childhood Experiences (physical abuse, emotional abuse & neglect)

CBCL Score= Child Behavioral Checklist Score (measure of internalizing and externalizing behaviors)

1.3 Study Objectives

Although research has been conducted to assess a potential link between internalizing and externalizing behaviors, the current literature on the topic remains limited and somewhat inconsistent. Specifically, there is limited research on the relationship between internalizing behaviors alone and substance initiation. Additionally, more research needs to be conducted on the effect that gender has on the relationship between internalizing and externalizing behaviors

and substance initiation. In this study, we assessed the association between childhood externalizing and internalizing behaviors and early substance use using data from the Fragile Families and Child Wellbeing Study. We further assessed whether associations between internalizing and externalizing behaviors were modified by child sex at birth.

CHAPTER 2: METHODS

2.1 Data Source & Study Design

We conducted a secondary analysis of data from the Fragile Families and Child Wellbeing Study (FFCWS). FFCWS is a prospective cohort study consisting of 4898 children born in U.S. cities with a population over 200,000 between 1998 and 2000.²³ Twenty total cities were selected using stratified random sampling.²³ Hospitals in selected cities were rank-ordered from highest number of non-married births to lowest (using data from 1996-1997).²³ Recruitment began at hospitals with the highest number of non-married births.²³ Mothers were screened and interviewed at hospitals shortly after giving birth.²³ Exclusion criteria for mothers included giving their baby up for adoption, reporting that the baby's father was deceased, and being a minor at the time of giving birth.²³ Unmarried mothers were oversampled by a ratio of 3 to 1.²³ This study consists of data from surveys with mothers, fathers, primary caregivers(PCG), in-home teachers, and the focal child.²³ Interviews were conducted at birth(mother and father), year 1(mother and father), year 3(mother, father, and PCG), year 5(mother, father, and PCG), year 9(mother, father, PCG, in-home teacher, and focal child), year 15(PCG, focal child, and in-home teacher) and year 22(PCG and focal child).²³ To address the objectives of this analysis, we used data from surveys at child age 9(wave 5) and child age 15(wave 6).

2.2 Measures

Exposure

Internalizing and Externalizing behaviors were measured using the Child Behavioral Checklist (CBCL). The school-age CBCL is a validated scale completed by a child's

parent/primary caregiver and is used to assess internalizing and externalizing behaviors among children ages 6-18.²⁴ The CBCL is a 113 item questionnaire that assesses internalizing behaviors such as anxiety, depression, and social withdraw, as well as externalizing behaviors such as rule-breaking behaviors, aggressive behaviors, and conflict with others.²⁴ Each question on the CBCL is answered on a scale from 0-2, where 0= not true, 1= somewhat/sometimes true, 2= very true/often true. The CBCL has an internalizing score out of 66, and an externalizing score out of 70. Clinically significant scores for internalizing are 17 and 18 for boys and girls respectively, and clinically significant scores for externalizing are 18 and 17 for boys and girls respectively.²⁴ We looked at CBCL score at child age 9 (wave 5). The CBCL was filled out by the focal child's mother/primary caregiver. We dichotomously classified children's internalizing and externalizing scores as high or low based on recommendations from the CBCL school-age manual.²⁴

Covariates

Demographic information on the mother and baby, as well as data on self-reported maternal substance use (marijuana, cigarettes, and alcohol) during pregnancy, were reported by the mother and collected at baseline shortly after the birth of the child in the hospital.²³ Data on adverse childhood experiences (physical abuse, emotional abuse, and neglect) were collected at wave 4 (child age 5).²³ The specific ACEs we incorporated into our adjusted analyses are physical abuse, emotional abuse, and neglect. Data on poverty level was collected at wave 5 (child age 9). Poverty level was measured as a ratio of maternal income to poverty level (<1= income below poverty, >1=income above poverty level). The year 15 (wave 6) follow-up survey collected information on peer substance use.²³

Outcomes

Substance use initiation was our main outcome of interest. Specifically, the three outcomes we looked at were: ever smoked a cigarette, ever drank alcohol more than two times without parents, and ever tried marijuana. Data on substance use initiation was self-reported by the focal child and collected at wave 6 (age 15).

2.3 Sample

From the full dataset of 4898 participants, 1561 had no data on the Child Behavioral Checklist (CBCL) at age 9, and 113 were missing more than 2 items on the CBCL so they were not included in our analysis. Additionally, 278 did not complete the wave 6 interview (age 15) and 11 had no outcome information on our 3 outcomes of interest (ever drank more than twice without parents, ever smoked a cigarette, and ever tried marijuana) so these participants were also removed from our final analytic sample (Figure 2). Our final sample consisted of 2935 participants (Figure 2). Participants who had drunk, smoked a cigarette, or used marijuana before the age of 9 were excluded from the individual analyses for each substance. Six individuals had tried alcohol by age 9 (n=2929), 29 had used cigarettes (n=2906) and 13 had tried marijuana (n=2922).

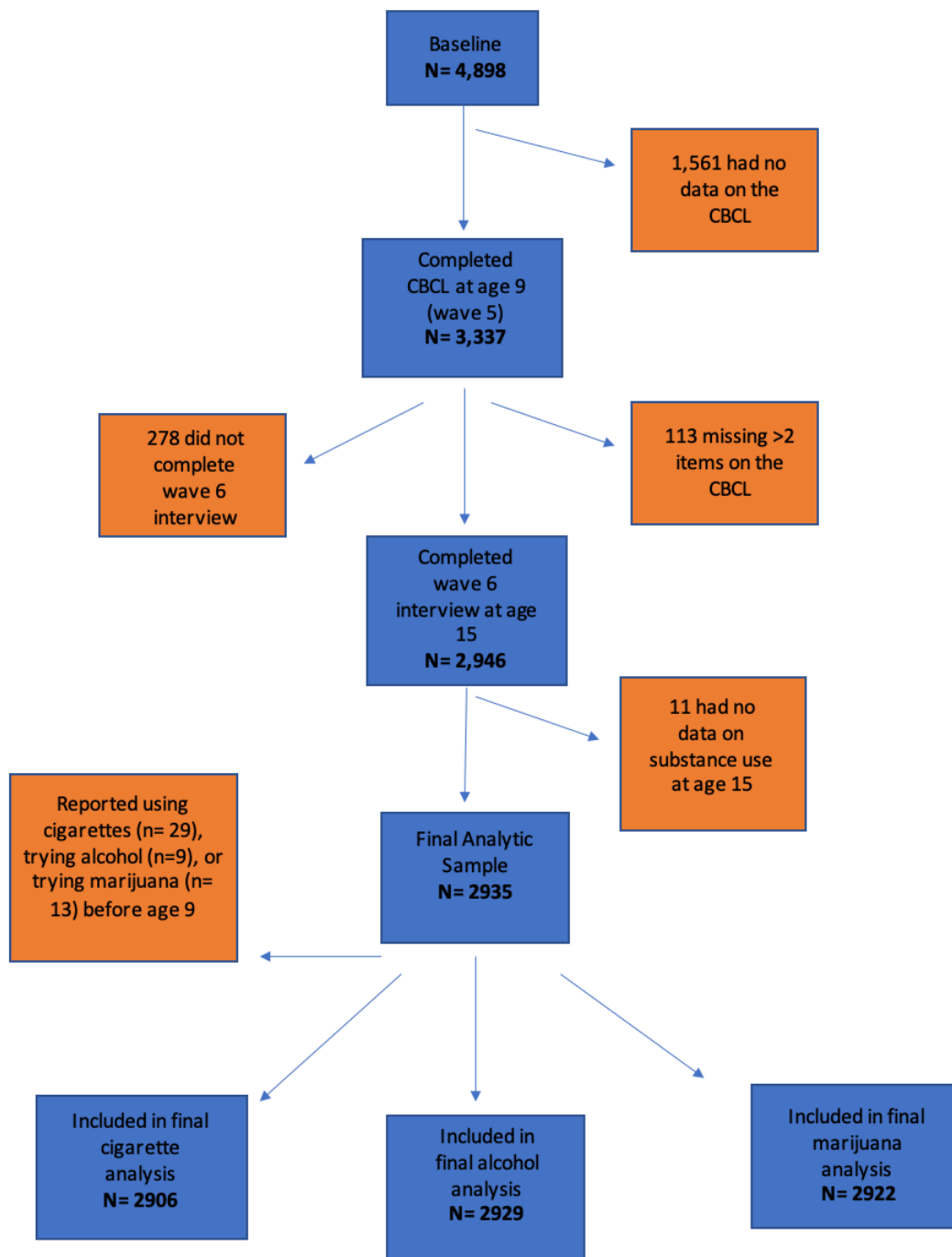


Figure 2: Study sample flowchart indicating the final analytic sample used in our analyses.

2.4 Statistical Methods

We performed a log link regression, using the Poisson distribution, to calculate the risk of substance initiation based on internalizing and externalizing classification. We then conducted adjusted analyses to address possible confounding. Model 1 adjusted for maternal age and child-reported race/ethnicity. Model 2 adjusted for Model 1 and maternal substance use during pregnancy, poverty level, and ACEs (physical abuse, emotional abuse, and neglect). Model 3 adjusted for the covariates in Model 2 as well as externalizing score (in the internalizing model) and internalizing score (in the externalizing model). Having multiple adjusted models allows us to assess how potential confounding variables impact the relationship between internalizing and externalizing behaviors and substance use initiation.

We conducted a Pearson's correlation test to assess if there was any evidence of collinearity between internalizing and externalizing behaviors. Due to the collinearity of internalizing behaviors and externalizing behaviors we recoded these variables into 4 mutually exclusive groups (low externalizing behaviors and low internalizing behaviors, low externalizing behaviors and high internalizing behaviors, high externalizing behaviors and low internalizing behaviors, and high externalizing behaviors and high internalizing behaviors). We ran an unadjusted log link regression using the Poisson distribution to calculate the risk of substance initiation based on high/low internalizing/externalizing categorization. Lastly, we conducted a stratified analysis to assess if there was any evidence of effect modification by child sex at birth. All statistical analyses were conducted using R statistical software.²⁵

CHAPTER 3: RESULTS

Overall, our study sample (N=2935) consisted of 47.3% Non-Hispanic Black, 23.4% White, 16.8% Hispanic, and 12.5% Other/Multi-Race/Don't Know. Almost half (48.7%) of the study population was assigned female sex at birth, and 36.2% of the study population lived below the poverty line. Among the study sample, the mean internalizing behavior score was 4.9 (SD=5.8) for males (4.3% with scores > 17) and 4.9 (SD= 5.5) for females (3.0% with scores > 18) (Figure 2a). The mean externalizing score was 6.8 (SD= 7.0) for males (6.6% with scores > 18) and 5.6 (SD= 6.6) for females (6.5% with scores > 17) (Figure 2b). Demographic characteristics by internalizing and externalizing score are presented in Table 1. Children who scored higher on the internalizing behavior scale were more likely to live below the poverty level and have mothers who used substances during their pregnancy (marijuana, alcohol, and/or cigarettes), compared to those with low internalizing behavior scores. Children who scored higher on the externalizing behavior scale were also more likely to live below the poverty level, have mothers who used substances during their pregnancy (marijuana, alcohol, and/or cigarettes), and have peers who used marijuana, alcohol, and/or cigarettes, compared to those with lower externalizing behavior scores. Among children with a high internalizing behavior score, over half experienced physical abuse (52%) or emotional abuse (64.1%). Among children with a high externalizing behavior score, 51.8% experienced physical abuse, and 65.9% experienced emotional abuse.

Table 2 shows the unadjusted risk ratios (RR) and adjusted risk ratios (ARR) of early substance initiation of marijuana, alcohol, and marijuana by internalizing (2a) and externalizing (2b) categorization. We conducted three adjusted models to have a more complete understanding

of how the covariates in our model affected the relationship between our main exposure (internalizing and externalizing behaviors) and our outcome of interest (substance use initiation).

3.1 Internalizing Behaviors

Among those with higher internalizing behaviors, 8.7% had used cigarettes, 13.2% drank alcohol more than two times without their parents, and 20.4% had tried marijuana by age 15. The risk of alcohol use initiation was lower among the high internalizing group, compared to the low internalizing group (ARR= 0.406, CI=0.16, 0.85). Among those with higher internalizing behaviors, 68.6% reported that their friends never drank, and 93.6% reported that their parents never offered them alcohol. After adjusting for child externalizing score in our final model for internalizing behaviors and cigarette use, the ARR decreased from being a risk factor, ARR= 1.5 (CI=0.6, 3.1), to being a protective factor, ARR= 0.65 (CI=0.2, 1.6). This suggests that externalizing behaviors may be a confounding variable in the relationship between internalizing behaviors and cigarette use initiation and the effect previously observed was due to externalizing score. This may also suggest that internalizing behaviors and externalizing behaviors are collinear.

We conducted a Pearson's Correlation test between internalizing score and externalizing score and found that continuous internalizing score and continuous externalizing score have a correlation coefficient of 0.68 ($p < 0.001$), and internalizing behaviors and externalizing behaviors as binary variables have a correlation coefficient of 0.36 ($p < 0.001$) (Appendix: Table 4). This statistically significant correlation suggests that internalizing behaviors and externalizing behaviors are moderately collinear (Appendix: Table 4). The results of our final analysis to address collinearity can be found in Appendix: Table 5. Our analyses found that those in the

High Externalizing/Low Internalizing category had an increased risk of initiating cigarette use (RR=3.05, CI= 1.80, 4.88) and marijuana use (RR= 1.79, CI=1.32, 2.37) compared to those in the Low Externalizing/Low Internalizing group. We also found that those in the High Externalizing/High Internalizing group had a greater risk of initiating cigarette use (RR=2.82, CI= 1.19, 5.59) compared to those in the Low Externalizing/Low Internalizing Group.

3.2 Externalizing Behaviors

Among those with higher externalizing behaviors, 13.7% had used a cigarette, 17.5% drank alcohol more than two times without their parents, and 30.7% had used marijuana by age 15. Among study participants with higher externalizing behaviors, risk of cigarette use initiation was significantly greater than among study participants with lower externalizing behaviors (ARR= 2.38, CI=1.31, 4.17). Among those with higher externalizing behaviors, who also reported using a cigarette by age 15, 28% smoked half of a pack a day, and 36% had a primary caregiver that smoked 6-7 days per week. Among those with higher externalizing behaviors, risk of marijuana initiation was greater than among those with lower externalizing behaviors (ARR=1.57, CI=1.10, 2.20). Among those with higher externalizing behaviors, who also reported trying marijuana by age 15, 43% used marijuana more than once a month, 19% used marijuana 3 or more times a week, and 24% had friends who had given or sold marijuana to them. The results of our stratified analysis to assess effect measure modification by focal child sex at birth can be found in Table 3.

Table 1: Demographic variables of focal child by internalizing and externalizing behavior level at age 9 years, Fragile Families and Child Wellbeing Study

	Internalizing				Externalizing			
	High (n= 107)		Low (n=2828)		High (n=192)		Low (n=2743)	
Race/Ethnicity	n	%	n	%	n	%	n	%
White	17	14.5	477	16.9	31	13.7	463	16.9
Black	41	35.0	1348	47.7	88	38.9	1301	47.4
Hispanic	32	27.4	643	22.7	43	19.0	643	23.5
Other/Multi-Race/Don't Know	17	14.5	360	12.7	30	13.3	336	12.3
Sex								
Female	43	36.8	1386	49.0	93	46.5	1336	48.7
ACEs								
Physical Abuse	61	52.1	1337	47.3	117	51.8	1281	46.7
Emotional Abuse	75	64.1	1863	65.9	149	65.9	1789	65.2
Neglect	10	8.5	82	2.9	9	4.0	83	3.0
Pregnancy Substance Use	30	25.6	570	20.2	67	29.6	533	19.4
Live Below Poverty Line	57	48.7	1005	35.5	95	42.0	967	35.3
Peer Substance Use	22	18.8	473	16.7	61	27.0	434	15.8
Maternal Age, y (Mean, SD)	25.3	5.8	25.1	6.0	23.8	5.12	25.2	6.04

Table 2a: Unadjusted and Adjusted Risk Ratios of Substance Use Initiation by Internalizing Categorization

Substance Used at Age 15	High Externalizing Score (N=107)*	Low Internalizing Score (N=2828)**	Crude RR (95% CI)	ARR Model 1 (95% CI)	ARR Model 2 (95%CI)	ARR Model 3 (95% CI)
Cigarette	9 (8.7%)	141 (5.0%)	1.71 (0.81, 3.18)	1.63 (0.77, 3.02)	1.54 (0.62, 3.14)	0.649 (0.23, 1.56)
Alcohol	14 (13.2%)	454 (16.1%)	0.82 (0.46, 1.34)	0.79 (0.44, 1.28)	0.52 (0.22, 1.02)	0.406 (0.16, 0.85)
Marijuana	21 (20.4%)	593 (21.1%)	0.97 (0.61, 1.45)	0.98 (0.62, 1.48)	0.98 (0.56, 1.58)	0.587 (0.31, 1.04)

RR= Risk Ratio

CI= Confidence Interval

Model 1 adjusted for maternal age and race/ethnicity

Model 2 adjusted for Model 1 + maternal substance use during pregnancy, poverty level and ACEs

Model 3 adjusted for Model 2 + externalizing score

* N= 104, 106, 103 (cigarette, alcohol, marijuana)

**N= 2801 ,2821, 2814 (cigarette, alcohol, marijuana)

Table 2b: Unadjusted and Adjusted Risk Ratios of Substance Use Initiation by Externalizing Categorization

Substance Used at Age 15	High Externalizing Score (N=192)*	Low Externalizing Score (N=2743)**	Crude RR (95% CI)	ARR Model 1 (95% CI)	ARR Model 2 (95%CI)	ARR Model 3 (95% CI)
Cigarette	25 (13.7%)	125 (4.6%)	2.99 (1.90, 4.51)	2.89 (1.83,4.36)	2.63 (1.57, 4.23)	2.38 (1.31, 4.17)
Alcohol	33 (17.5%)	435 (15.9%)	1.10 (0.76, 1.54)	1.09 (0.75,1.53)	0.97 (0.62,1.45)	1.17 (0.72, 1.83)
Marijuana	58 (30.7%)	556 (20.4%)	1.51(1.14, 1.95)	1.47 (1.11, 1.91)	1.49 (1.08, 2.00)	1.57 (1.10, 2.20)

RR= Risk Ratio

CI= Confidence Interval

Model 1 adjusted for maternal age and race/ethnicity

Model 2 adjusted for Model 1 + maternal substance use during pregnancy, poverty level and ACEs

Model 3 adjusted for Model 2 + internalizing score

*N= 182, 189,189 (cigarette, alcohol, marijuana)

Table 3: Risk of Substance Use Initiation Stratified by Sex

Substance Use at Age 15	Internalizing Behaviors		
	Adjusted RR Males (95% CI)	Adjusted RR Females (95% CI)	P-value of Interaction*
Cigarette	1.03 (0.25, 2.87)	1.97 (0.582, 5.05)	0.20
Alcohol	0.38 (0.09, 1.00)	0.710 (0.22, 1.70)	0.35
Marijuana	0.90 (0.41, 1.73)	1.07 (0.45, 2.14)	0.54
Externalizing Behaviors			
Substance Use at Age 15	Adjusted RR Males (95% CI)	Adjusted RR Females (95% CI)	P-value of Interaction*
Cigarette	2.53 (1.23, 4.78)	2.46 (1.13, 4.94)	0.58
Alcohol	0.83 (0.42, 1.48)	1.06 (0.57, 1.83)	0.52
Marijuana	1.48 (0.95, 2.21)	1.49 (0.92, 2.30)	0.72

RR= Risk Ratio

CI= Confidence Interval

Adjusted RR is adjusted for maternal age, race/ethnicity, maternal substance use during pregnancy, poverty level and ACEs

*P-value of the interaction between sex and internalizing/externalizing behaviors

CHAPTER 4: DISCUSSION

4.1 Summary of Findings

Although it has been well-established in the literature that early substance use initiation is a risk factor for later substance use disorders in adulthood, research on risk factors of early substance use initiation remains limited. Thus, this analysis aimed to add to the limited research in this field and assess risk factors for early substance use initiation in adolescence. Specifically, these analyses aimed to assess the relationship between internalizing and externalizing behaviors in childhood, and early substance use initiation, of marijuana, cigarettes, and alcohol, in adolescence. Overall, our analysis found that externalizing behaviors were a significant predictor of early cigarette use initiation and marijuana use initiation. Interestingly, internalizing behaviors decreased the risk of early alcohol use initiation after controlling for all confounding variables.

4.2 Comparison to the Literature

Although other studies have assessed the potential link between internalizing and externalizing behaviors and substance use initiation, our analysis is unique in that it assessed the combined effect of internalizing and externalizing behaviors and assessed effect modification by child sex at birth. Additionally, our study used prospective data which provides much stronger evidence to support a causal association compared to previous studies that used a cross-sectional or case-control design. Our analysis supports the findings of other studies, such as Iacono et al. and King et al., that externalizing behaviors in childhood are a predictor of cigarette initiation later in adolescence.^{9,26} Interestingly, we did not find a significant relationship between externalizing behaviors and alcohol initiation. Previous research by Sartor et al. and Colder et al.

did find a significant relationship between childhood externalizing behaviors and alcohol use initiation.^{10, 12} However, our findings did support the findings from Colder et al. that externalizing behaviors were a significant predictor of marijuana use initiation.¹²

4.3 Internalizing Behaviors

After adjusting for all confounders, we observed that internalizing behaviors decreased the risk of early alcohol use initiation. Multiple studies that have assessed the link between internalizing behaviors and substance use initiation have found internalizing behaviors to decrease the risk of early substance use initiation.^{9,11,12} Our findings are in line with previous research, as we also found internalizing behaviors to decrease the risk of early substance use initiation. There has been limited research on the mechanism behind this observed decreased risk. Interestingly, depression and anxiety, both of which are internalizing disorders, have been widely linked to a greater risk of developing substance use disorders in adulthood. Additionally, a 2010 study by O'Neill et al., asserted that internalizing disorders often preceded substance use disorders because individuals may use substances as a coping mechanism for internalizing disorders, such as depression and anxiety.²⁹ It is possible that in adolescence alcohol, cigarette, and marijuana use are more social/group activities, and thus the social withdrawal and the isolation associated with internalizing behaviors may partially explain the decreased risk of substance use initiation among those with internalizing behaviors. However, more research on these seemingly opposing findings should be conducted to elucidate the pathway between internalizing disorders and substance initiation.

4.4 Externalizing Behaviors

After adjusting for all confounding variables, we found externalizing behaviors to be a significant predictor of early cigarette and marijuana use initiation. Various mechanisms behind the pathway between externalizing behaviors and early substance initiation have been proposed. A 2004 study by Liu, suggests that increased rule-breaking behaviors associated with externalizing behaviors may make individuals more likely to participate in the use of substances that are illegal or illicit.³⁰ Additionally, it was proposed by Kozak et al. that the increase in impulsivity associated with externalizing behaviors puts an individual at a greater risk of using illegal or illicit substances, or may make them more willing to try illicit substances at an earlier age.⁸

4.5 Strengths

One of the major strengths of this analysis is that the data used came from a large, prospective cohort study. A cohort study allows one to establish temporality from exposure to outcome which is helpful in mapping causal pathways. Additionally, a strength of the Fragile Families and Child Wellbeing (FFCW) study is that unmarried mothers were oversampled resulting in the inclusion of many Black, Hispanic, and low-income families. Participants were recruited in large metropolitan cities across the entire United States allowing for increased generalizability of these findings.

4.6 Limitations

One of the limitations of this analysis is that it is a secondary analysis, therefore we were limited in what variables we could control for in our analyses since we had no control over the survey or study design. For example, categories for child race/ethnicity were very limited. Additionally, child sex at birth was assessed but child gender identity was not. Due to the nature

of the self-reported surveys used in the FFCW study, there is likely response bias, specifically social desirability bias. There is likely underreporting of substance use by mothers during pregnancy, and by the focal child at age 15, because of the stigma surrounding substance use. Responses to surveys were confidential, which may have helped to decrease this potential social desirability reporting. Additionally, the focal child did not complete any surveys until age 9, so we must rely on information solely from the mother/father/primary caregiver for all assessments done before age 9. Similarly, the mother/PCG was responsible for filling out the CBCL to assess IB and EB, and there was likely bias when filling out this survey. It would have been useful to also have the focal child's teacher fill out the CBCL to get a more objective, third-party perspective on the child's emotional state.

Due to the nature of a long-term prospective cohort study, there is likely a significant amount of loss to follow-up of study participants. This loss to follow-up may be a potential source of bias and weakens the internal validity of our findings. Lastly, although the Fragile Families and Child Wellbeing Study is large, strata within individual categories were very small in some of our final analyses, resulting in a decrease in statistical power.

4.7 Conclusions

To our knowledge, very few studies have assessed the link between internalizing and externalizing behaviors and early substance use initiation. Our findings provide more evidence to support a potential causal link between internalizing behaviors, externalizing behaviors and substance use initiation. These findings are of public health importance because understanding potential risk factors for early substance use initiation can allow researchers to develop targeted

interventions and outreach programs to decrease rates of teen substance use and later substance abuse.

Further research on the mechanism behind why internalizing behaviors decrease the risk of early substance use initiation, as well as why externalizing behaviors increase a child's risk of early cigarette and marijuana use initiation, would be beneficial. Additionally, continuing to follow the long-term health outcomes from the Fragile Families and Child-Wellbeing Study would allow us to assess if internalizing and externalizing behaviors are a predictor of later substance abuse in adulthood.

It is possible that we did not observe a strong connection between externalizing behaviors and alcohol use because alcohol use is more normalized than cigarette and marijuana use. Thus, if more adolescents are using alcohol overall, we would not see as strong of an association between externalizing behaviors and alcohol use, compared to marijuana or cigarettes, which may be harder to obtain, are used less frequently in early adolescence or are viewed as riskier.

It would be interesting to collect new data on marijuana initiation among adolescents in states that have legalized marijuana in recent years, to assess if the legalization of marijuana has had any effect on the relationship we observed between externalizing behaviors and early marijuana use initiation. Lastly, future research should focus on applying these findings to develop specific interventions to prevent early substance use initiation among children who present with externalizing behaviors in childhood.

APPENDIX

Table 4: Correlation Between Internalizing Score & Externalizing Score

	Pearson's Correlation Coefficient (95% CI)	P-Value
Internalizing & Externalizing Score (continuous)	0.68 (0.66, 0.70)	<0.001
Internalizing & Externalizing Categorization (binary)	0.36 (0.33,0.39)	<0.001

Table 5: Unadjusted Risk Ratios by High/Low Internalizing/Externalizing Categorization

	Low Internalizing & High Externalizing RR	High Internalizing & Low Externalizing RR	High Internalizing & High Externalizing RR
Cigarette Initiation	3.05 (1.80, 4.88)	0.87 (0.14, 2.73)	2.82 (1.19, 5.59)
Alcohol Initiation	1.22 (0.80, 1.77)	0.86 (0.37, 1.68)	0.80 (0.34, 1.56)
Marijuana Initiation	1.79 (1.32, 2.37)	1.21 (0.64, 2.04)	0.82 (0.39, 1.49)

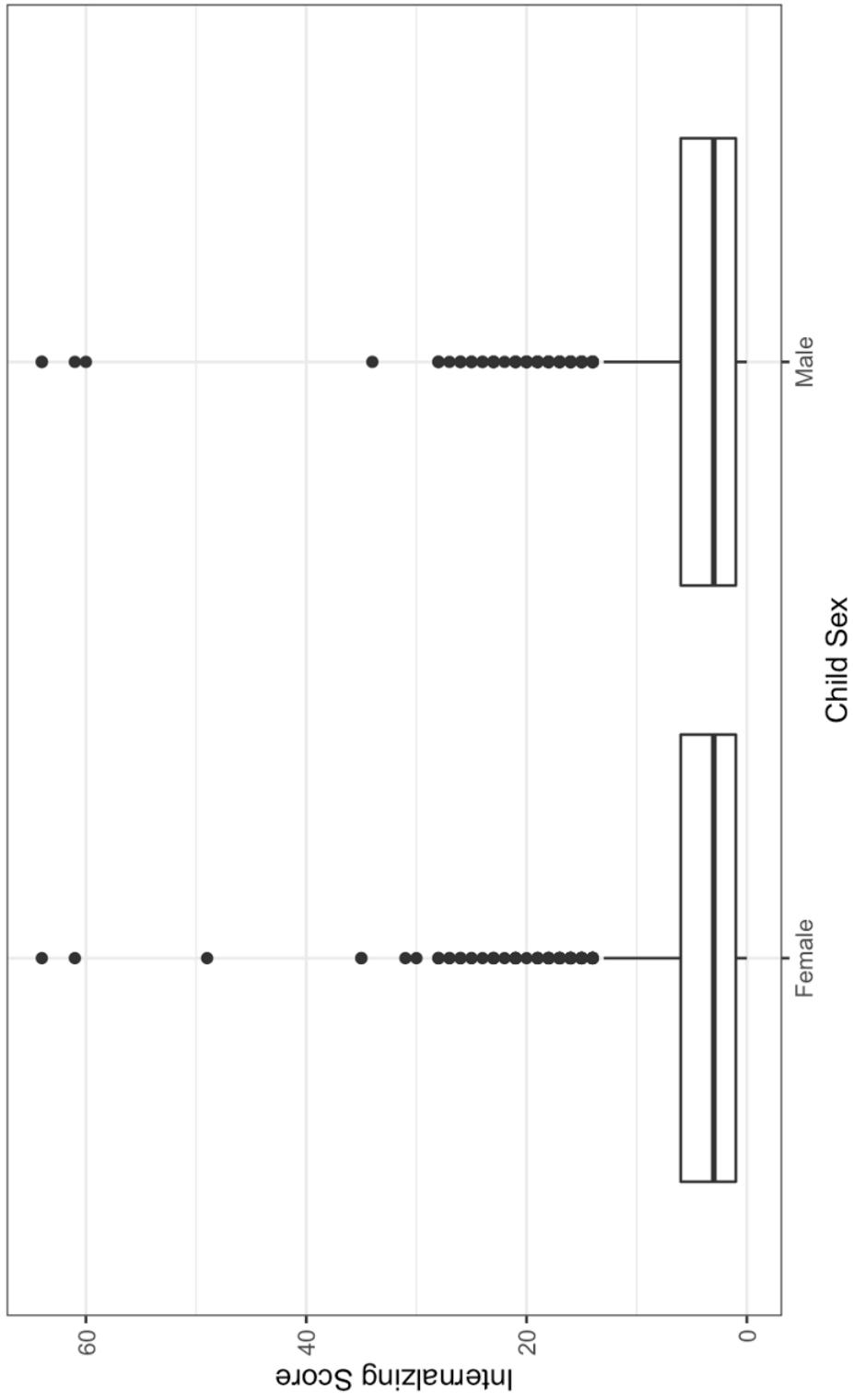


Figure 3a: Boxplot of internalizing score by focal child sex at birth

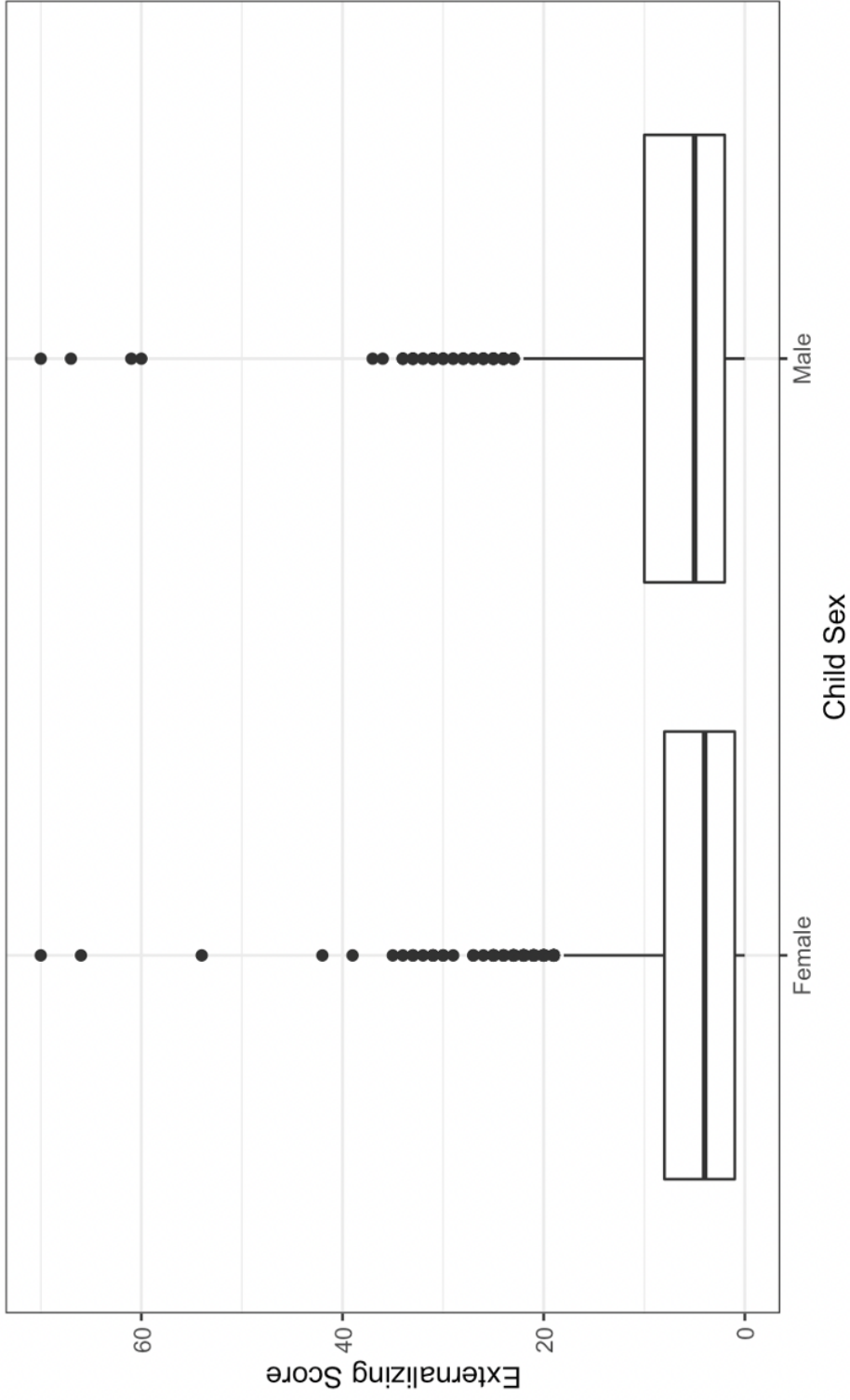


Figure 3b: Boxplot of externalizing score by focal child sex at birth

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