Indiana Department of Health
Office of Data & Analytics, Data Analysis Team
May 2021

Adverse Childhood Experiences: Household Member Incarceration and its Association with Adult Health, 2018-2019 Indiana Behavioral Risk Factor Surveillance System Survey

Report prepared by:

Kristen Walker, MPH
& William Felix, MS Candidate

Acknowledgments:

Courtney Lambert, *Data Analysis Team Director*
& the Data Analysis Team

Abstract

Childhood exposure to incarceration of a household member has been associated with a variety of poor health behaviors and outcomes in adulthood; however, when researchers account for exposure to other adverse childhood experiences (ACEs), findings have been inconsistent. This cross-sectional study assessed the prevalence of household member incarceration (HMI) during childhood and its association with health risks and adverse health outcomes in adulthood using combined data from the 2018 and 2019 Indiana Behavioral Risk Factor Surveillance System (BRFSS) surveys. Multivariate logistic regression models were conducted to assess the relationships between HMI exposure and various poor health behaviors and outcomes while adjusting for sex, age, race/ethnicity, and education. An additional set of regression models was conducted to control for other ACE exposures (excluding HMI) while still controlling for the same covariates as the first set. Prevalence estimates reveal that about one-tenth (9.9%) of adult respondents reported exposure to HMI before the age of 18 and that this exposure differed significantly by age, race/ethnicity, income, and education ($p<.001$). Cumulative and individual exposures to other ACEs were also found to differ significantly by HMI exposure ($p<.001$). While the first set of regression models demonstrated that HMI significantly increased the odds of a variety of poor health behaviors and outcomes, further adjustment for other ACE exposures resulted in considerably fewer statistically significant associations with substantially reduced effect sizes. Findings from this study demonstrate that while cumulative ACE exposure confounds the observed relationships between HMI exposure during childhood and various poor health behaviors and outcomes in adulthood, HMI's associations with smoking, COPD, and poor physical health still constitute a significant public health concern.

Introduction

The United States has the highest incarceration rate in the world, with about 1% of its adult population imprisoned.[1] Indiana's incarceration rate of 723 per 100,000 people is particularly concerning, given that a higher percentage of its residents are behind bars compared to many wealthy democratic nations.[2] This represents a significant public health concern, as growing research reveals associations between incarceration and negative health outcomes. The number of studies on family or household member incarceration's effects on children is also increasing;[3-8] however, there is a need for more research on incarceration's long-term collateral damage to the health of impacted children. Thus, this study aims to explore the long-term effects of experiencing household member incarceration (HMI) during childhood in Indiana, while accounting for exposure to other adverse childhood experiences (ACEs), such as child abuse and other forms of household dysfunction.

HMI has been shown to affect children in various ways. While in some cases the removal of a domestic abuser can positively affect child wellbeing, many studies have demonstrated an overall harmful association between HMI exposure and wellness.[3] The researchers of the original CDC-Kaiser ACE study hypothesized that this relationship between childhood trauma and poor health later in life can be attributed to the adoption of health risk behaviors (e.g., smoking, drinking, other substance abuse, etc.) as ways to cope with the psychological impacts of that trauma.[9] For example, findings from two studies using data from many states' Behavioral Risk Factor Surveillance Systems (BRFSS) found harmful associations between HMI exposure during childhood and smoking, heavy drinking, and poor health-related quality of life in adulthood, after controlling for demographics and other ACEs.[3,4] Another study using BRFSS data found that HMI exposure during childhood was associated with myocardial infarction in men, even after adjusting for a variety of risk factors.[5]

Parental incarceration in particular has also been associated with negative outcomes in children. Results from a study using individual- and state-level data from the Pregnancy Risk Assessment Monitoring System (PRAMS) show that parental incarceration is associated with increased risk for early infant mortality in the United States.[6] Another study that used data from the National Longitudinal Study of Adolescent Health found significant, harmful associations between parental incarceration and various self-reported poor health outcomes in adulthood, including depression, anxiety, posttraumatic stress disorder, poor general health, migraines, cholesterol, asthma, and HIV/AIDS.[7] Findings from a study that used data from the National Survey of Children's Health also demonstrated associations between parental incarceration and a variety of adverse health outcomes among children, including poor general health, depression, anxiety, obesity, and asthma; however, these associations were statistically non-significant when other ACEs were controlled for.[8]

The purpose of this study is to determine the prevalence of household member incarceration exposure during childhood and its association with various adverse health outcomes among Indiana adults while taking into account the effects of additional ACEs. It is hypothesized that HMI exposure will have statistically significant, harmful associations with the majority of assessed health outcomes but that the statistical significance and strength of these relationships will be substantially reduced after controlling for additional ACE exposures.

Methods

Data Source

Data for this study were obtained from the 2018 and 2019 Indiana BRFSS surveys. The BRFSS is a state-based telephone survey established by the Centers for Disease Control and Prevention (CDC) in 1984 that collects information from non-institutionalized U.S. adults regarding their health conditions and risks every year.[10] Responses are weighted each year by the CDC to ensure estimates are generalizable to the known state population.[10] In 2008, the CDC also developed an optional BRFSS ACE module with questions adapted from the original CDC-Kaiser ACE Study[9] to collect information on ACEs within each state.[11,12] Indiana began including the ACE module in 2018.[12] Details regarding Indiana's ACE module categorization and scoring methodologies are described elsewhere.[13]

Primary Predictor

The primary predictor for this study was exposure to household member incarceration before the age of 18. Exposure to this ACE was defined as a response of "*yes*" to the question, "*Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?*" Respondents who did not know or refused this question were excluded from analyses.

Primary Outcomes

The health outcomes of this study included a variety of health risk factors, perceived poor health indicators, and chronic health conditions that have been previously analyzed with respect to ACEs in Indiana.[13] Health risk factors included smoking status, drinking behaviors, and obesity status. Current smoking status was assigned to respondents who reported smoking some or every day. Heavy drinking was assigned to female respondents who have more than seven drinks per week and male respondents who have more than 14 drinks per week. Binge drinking was assigned to female respondents who had four or more drinks and male respondents who had five or more drinks on one or more occasions over the past 30 days. Obesity was defined as having a body mass index greater than or equal to 30.

Three perceived poor health indicators were obtained from the surveys: fair or poor health, poor mental health, and poor physical health. Fair or poor health was assigned to respondents who reported their general health was fair or poor. Poor mental health was assigned to respondents who reported having 14 or more days of poor mental health in the past 30 days. Poor physical health was assigned to respondents who reported having 14 or more days of poor physical health in the past 30 days. These 14-day cut-offs, which are in accordance with previous research that use these survey questions, are intended to identify those who experienced significant physical or mental health burden in the past month.[14]

Chronic conditions were assigned to respondents if they reported having ever been diagnosed with that condition by a doctor. Depressive disorder was assigned to respondents who reported having ever been diagnosed with depression, major depression, dysthymia, or minor depression. Chronic obstructive pulmonary disease (COPD) was assigned to respondents who reported that they had ever been diagnosed with COPD, emphysema, or chronic bronchitis. Diabetes was assigned to respondents

who reported having been diagnosed with diabetes at any time other than pregnancy. Other chronic conditions such as kidney disease, coronary heart disease (CHD), asthma, arthritis, and any cancer other than skin were also assigned to respondents who reported having ever been diagnosed with that condition.

Covariates

Covariates included sociodemographic factors and exposure to other ACEs. Sociodemographic variables obtained from the surveys included sex, age, race/ethnicity, annual household income, and education. Sex was measured dichotomously (male/female). Age and income, which were originally collected as continuous variables, were categorized. Race/ethnicity was categorized into five groups: Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Multiracial, Non-Hispanic Other, and Hispanic. Education was categorized into groups based on the highest level of education the respondent received.

The other seven ACEs measured in the Indiana BRFSS ACE Module include emotional abuse, physical abuse, sexual abuse, household mental illness, household domestic violence, household substance abuse, and parental separation/divorce. Since it has been previously shown that ACEs are highly interrelated,[15] it is likely that an individual who was exposed to HMI also experienced one or more other ACEs. Therefore, an adjusted ACE score was calculated to aggregate cumulative exposures to the other seven ACEs (i.e., excluding exposure to HMI) for use in analyses. Respondents who did not know or refused any of the ACE module questions were excluded from analyses.

Statistical Analysis

All analyses were conducted using SAS version 9.4. Since this study combined Indiana BRFSS data from 2018 and 2019, reweighting was necessary. Methodologies for combining and reweighting multiple years of BRFSS data are described elsewhere.[16] Only reweighted percentages and analyses are presented. All missing data were excluded from analyses; however, the number of missing values varied across assessed variables and, accordingly, across each analytic sample.

The overall prevalence of household member incarceration exposure was estimated. Prevalence estimates were also calculated for HMI exposure by sociodemographic characteristics; associations between sociodemographic variables and HMI exposure status were considered statistically significant if chi-square tests produced p-values less than .05. The prevalence of other ACE exposures (including the adjusted, cumulative ACE score and individual ACE categories) and adverse health outcomes were also calculated by HMI exposure status. Chi-square tests were conducted to determine whether the associations between other ACE exposures and HMI and between adverse health outcomes and HMI were statistically significant at the $\alpha=.05$ level.

A set of multivariate logistic regression models (Model I) were conducted to assess the relationships between HMI exposure and health risks, perceived poor health indicators, and chronic health conditions when adjusting for sex, age, race/ethnicity, and education. Since exposure to HMI was significantly associated with exposure to other ACEs (Appendix A; $p<.001$), an additional set of multivariate logistic

regression models (Model II) were developed to control for other ACE exposures (using the adjusted, cumulative ACE score) while still controlling for the same covariates as Model I. The resulting adjusted odds ratio (aOR) estimates were considered statistically significant if their corresponding 95 percent confidence intervals (CIs) did not include 1.00.

Results

Prevalence of Household Member Incarceration Exposure by Sociodemographic Characteristics

The prevalence of HMI exposure during childhood by sociodemographic characteristics is presented in Table 1. About one-tenth (9.9%) of total survey respondents reported having experienced HMI before the age of 18. Exposure to HMI did not differ significantly by sex (p=.188). The percentage of adults who were exposed to HMI was significantly higher among young adults compared to older adults (p<.001); non-Hispanic Black, non-Hispanic multiracial, and Hispanic individuals compared to non-Hispanic White individuals (p<.001); low-income individuals compared to higher-income individuals (p<.001); and less-educated individuals compared to higher-educated individuals, especially those who graduated college (p<.001).

Table 1. Prevalence of Household Member Incarceration Exposure by Sociodemographic Characteristics[†], 2018-19 IN BRFSS

	Sample Size	No Exposure to HMI		Exposure to HMI		p-value
		%	95% CI	%	95% CI	
Sex						
Male	5,846	**89.5**	88.4 – 90.7	**10.5**	9.3 – 11.7	.188
Female	7,729	**90.6**	89.5 – 91.6	**9.4**	8.4 – 10.5	
Age						
18 – 24	633	**79.7**	76.1 – 83.2	**20.3**	16.8 – 23.9	<.001
25 – 34	1,074	**83.4**	80.7 – 86.0	**16.7**	14.1 – 19.3	
35 – 44	1,370	**87.4**	85.4 – 89.5	**12.6**	10.5 – 14.6	
45 – 54	1,196	**92.0**	90.6 – 93.4	**8.0**	6.6 – 9.4	
55 – 64	2,963	**95.2**	94.3 – 96.2	**4.8**	3.9 – 5.7	
65+	5,551	**97.0**	96.4 – 97.6	**3.0**	2.4 – 3.6	
Race/Ethnicity						
White[¤]	11,408	**91.2**	90.3 – 92.0	**8.9**	8.0 – 9.7	<.001
Black[¤]	938	**84.2**	81.0 – 87.4	**15.8**	12.6 – 19.0	
Other race[¤]	327	**91.2**	87.2 – 95.1	**8.9**	4.9 – 12.8	
Multiracial[¤]	225	**76.7**	69.3 – 84.0	**23.4**	16.0 – 30.7	
Hispanic	491	**85.2**	81.1 – 89.4	**14.8**	10.6 – 18.9	
Income						
Less than $10,000	473	**80.4**	75.4 – 85.4	**19.6**	14.6 – 24.6	<.001
$10,000-$14,999	506	**85.7**	81.2 – 90.1	**14.3**	9.9 – 18.8	
$15,000-$19,999	810	**88.1**	84.9 – 91.2	**11.9**	8.8 – 15.1	

$20,000-$24,999	1,102	**84.9**	81.7 – 88.1	**15.1**	11.9 – 18.3	
$25,000-$34,999	1,275	**88.5**	85.9 – 91.1	**11.5**	8.9 – 14.1	
$35,000-$49,999	1,661	**89.9**	87.6 – 92.3	**10.1**	7.7 – 12.4	
$50,000-$74,999	1,832	**91.6**	89.7 – 93.4	**8.4**	6.6 – 10.3	
$75,000+	3,273	**93.9**	92.6 – 95.1	**6.1**	4.9 – 7.4	
Education						
Did not graduate HS	1,037	**80.4**	76.9 – 83.8	**19.6**	16.2 – 23.1	<.001
Graduated HS	4,465	**89.5**	88.2 – 90.8	**10.5**	9.3 – 11.8	
Attended college[€]	3,532	**90.4**	89.1 – 91.8	**9.6**	8.2 – 10.9	
Graduated college[€]	4,507	**95.5**	94.7 – 96.4	**4.5**	3.6 – 5.3	
Overall:	13,587	**90.1**	89.3 – 90.8	**9.9**	9.2 – 10.7	

Abbreviations. HMI: Household member incarceration; HS: High school.
[†] Table displays row percentages; denominator for each percentage is the total number of respondents in each demographic category. Numerator for each percentage is the total number of respondents in each demographic category who were either exposed or not exposed to HMI during childhood. All percentages were reweighted using previously described methodologies.[16]
[¤] Non-Hispanic.
[€] Or technical school.

Prevalence of Adverse Childhood Experiences by Household Member Incarceration Exposure

The prevalence of other ACEs by HMI exposure groups is presented in Appendix A. ACE Score (i.e., the cumulative number of ACEs excluding HMI) differed significantly by exposure to HMI; while only about a fifth of respondents who had no exposure to HMI experienced three or more other ACEs, almost three-fourths of respondents who experienced HMI also experienced three or more additional ACEs. This disparity is also reflected among the individual ACE categories; a significantly greater proportion of those exposed to HMI also experienced emotional abuse (65.2%), physical abuse (46.4%), sexual abuse (33.7%), household mental illness (50.9%), household domestic violence (48.5%), household substance abuse (80.5%), and parental separation or divorce (64.8%), compared to those who were not exposed to HMI. The largest discrepancy was observed for household substance abuse: those exposed to HMI also experienced household substance abuse at almost four times the rate of those who were not exposed to HMI.

Prevalence of Adverse Health Outcomes by Household Member Incarceration Exposure

The prevalence of adverse health outcomes (including health risks, perceived poor health indicators, and chronic health conditions) are presented by HMI exposure groups in Table 2. Among the health risks category, current smoking, heavy drinking, and binge drinking exhibited statistically significant bivariate (i.e., unadjusted) associations with HMI exposure. All three perceived poor health indicators (fair or poor general health, poor mental health, and poor physical health) demonstrated statistically significant bivariate associations with HMI exposure. For the chronic health conditions category, depressive disorder, COPD, current asthma, and cancer (other than skin) exhibited statistically significant bivariate associations with HMI exposure. Among the statistically significant relationships, the largest

differences between exposure groups were observed for current smoking, perceived poor mental health, and depressive disorder; a significantly larger proportion of those who were exposed to HMI were current smokers (40.7%), reported poor mental health (32.1%), and were diagnosed with depressive disorder (39.0%), compared to those who were not exposed to HMI (18.1%, 12.2%, and 19.2%, respectively). There were no significant bivariate associations observed between HMI exposure groups and obesity, arthritis, stroke, CHD, kidney disease, or diabetes.

Table 2. Prevalence of Adverse Health Outcomes by Household Member Incarceration Exposure[†], 2018-19 IN BRFSS

	Sample Size	**No Exposure to HMI (n=12,242)**		**Exposure to HMI (n=1,345)**		**p-value**
		%	95% CI	%	95% CI	
Health Risks						
Current smoker	2,296	**18.1**	17.2 – 19.0	**40.7**	36.6 – 44.9	<.001
Heavy drinking	656	**5.5**	4.9 – 6.1	**8.5**	5.7 – 11.2	.014
Binge drinking	1,512	**14.9**	14.0 – 15.7	**22.3**	18.4 – 26.2	<.001
Obesity	4,497	**35.5**	34.4 – 36.6	**36.9**	32.9 – 41.0	.501
Perceived Poor Health						
14+ days of poor mental health	1,645	**12.2**	11.4 – 12.9	**32.1**	28.2 – 36.0	<.001
Fair or poor general health	3,015	**19.3**	18.5 – 20.2	**27.8**	24.3 – 31.3	<.001
14+ days of poor physical health	2,077	**12.9**	12.2 – 13.6	**20.4**	17.2 – 23.6	<.001
Chronic Health Conditions						
Depressive disorder	2,744	**19.2**	18.3 – 20.1	**39.0**	34.9 – 43.0	<.001
COPD	1,562	**8.9**	8.3 – 9.4	**12.7**	10.2 – 15.1	<.001
Arthritis	5,161	**29.5**	28.6 – 30.5	**26.5**	23.1 – 30.0	.104
Current asthma	1,340	**9.3**	8.7 – 10.0	**16.7**	13.5 – 19.5	<.001
Stroke	757	**4.0**	3.7 – 4.5	**3.8**	2.3 – 5.2	.716
CHD	969	**5.2**	4.7 – 5.6	**4.0**	2.7 – 5.4	.156
Kidney disease	684	**3.7**	3.3 – 4.1	**2.7**	1.6 – 3.8	.129
Diabetes	1,119	**13.2**	12.3 – 14.2	**11.5**	7.7 – 15.4	.423
Cancer (other than skin)	1,492	**7.8**	7.3 – 8.3	**4.5**	2.9 – 6.0	<.001

Abbreviations. HMI: Household member incarceration; COPD: Chronic obstructive pulmonary disease; CHD: Coronary heart disease.

[†] Table displays column percentages; denominator for each percentage is the total number of respondents who were either exposed or not exposed to HMI during childhood. Numerator for each percentage is the total number of respondents who reported each health risk, perceived poor health indicator, or chronic health condition. All percentages were reweighted using previously described methodologies.[16]

Association of Household Member Incarceration Exposure with Adverse Health Outcomes

The results from multivariate logistic regression model sets I and II are presented in Table 3. Model I estimates, which adjusted for sociodemographic factors, demonstrate that exposure to HMI during childhood was statistically significantly associated with current smoking (aOR 2.43 [95% CI 1.99, 2.98]), perceived poor mental health (aOR 2.65 [95% CI 2.15, 3.26]), perceived poor general health (aOR 1.78 [95% CI 1.44, 2.18]), perceived poor physical health (aOR 2.18 [95% CI 1.74, 2.73]), depressive disorder (aOR 2.56 [95% CI 2.10, 3.10]), COPD (aOR 2.31 [95% CI 1.78, 2.98]), arthritis (aOR 1.80 [95% CI 1.46, 2.24]), current asthma (aOR 1.90 [95% CI 1.48, 2.44]), stroke (aOR 1.58 [95% CI 1.05, 2.39]), CHD (aOR 1.63 [95% CI 1.10, 2.41]), and diabetes (aOR 1.51 [95% CI 1.01, 2.25]). However, after also adjusting for exposure to other ACEs (Model II estimates), the majority of these associations were no longer statistically significant; of the remaining statistically significant associations (current smoking, perceived poor physical health, and COPD), the adjusted estimates were substantially reduced after adjusting for exposure to other ACEs (aOR 1.61 [95% CI 1.28, 2.04]), aOR 1.36 [95% CI 1.05, 1.76], and aOR 1.42 [95% CI 1.03, 1.94], respectively).

Table 3. Adjusted Odds Ratios for Adverse Health Outcomes by Household Member Incarceration Exposure, 2018-19 IN BRFSS

	Model I		**Model II**	
	aOR*	95% CI	aOR**	95% CI
Health Risks				
Current smoker	**2.43**	1.99 – 2.98	**1.61**	1.28 – 2.04
Heavy drinking	1.44	0.99 – 2.11	1.10	0.71 – 1.69
Binge drinking	1.24	0.98 – 1.58	0.97	0.76 – 1.31
Obesity	1.09	0.90 – 1.32	0.91	0.74 – 1.13
Perceived Poor Health				
14+ days of poor mental health	**2.65**	2.15 – 3.26	1.25	0.97 – 1.61
Fair or poor general health	**1.78**	1.44 – 2.18	1.01	0.79 – 1.07
14+ days of poor physical health	**2.18**	1.74 – 2.73	**1.36**	1.05 – 1.76
Chronic Health Conditions				
Depressive disorder	**2.56**	2.10 – 3.10	1.04	0.83 – 1.31
COPD	**2.31**	1.78 – 2.98	**1.42**	1.03 – 1.94
Arthritis	**1.80**	1.46 – 2.24	1.11	0.87 – 1.42
Current asthma	**1.90**	1.48 – 2.44	1.27	0.95 – 1.69
Stroke	**1.58**	1.05 – 2.39	1.04	0.67 – 1.63
CHD	**1.63**	1.10 – 2.41	0.92	0.58 – 1.43
Kidney disease	1.26	0.79 – 2.01	0.96	0.57 – 1.61
Diabetes	**1.51**	1.01 – 2.25	1.26	0.82 – 1.94
Cancer (other than skin)	1.10	0.76 – 1.60	0.77	0.50 – 1.19

Abbreviations. aOR: Adjusted odds ratio; COPD: Chronic obstructive pulmonary disease; CHD: Coronary heart disease.
Bold Adjusted Odds Ratios indicate statistical significance.

* Model I Odds Ratios adjusted for sex, age, race/ethnicity, and education with no exposure to household member incarceration during childhood as the referent.
** Model II Odds Ratios adjusted for sex, age, race/ethnicity, education, ***and exposure to other ACEs*** with no exposure to household member incarceration during childhood as the referent.

Discussion

Findings from this study demonstrate that about one-tenth of Indiana adults were exposed to household member incarceration during childhood. The prevalence of this adverse childhood experience in Indiana is higher than the national average (7.9%), which was estimated using 2011-2014 BRFSS data across 23 states.[12] Indiana's prevalence of HMI exposure is also higher than reported in similar studies that have used 2009-2010 BRFSS data across multiple states to assess this ACE (6.5%).[3,4] These differences may indicate a truly higher prevalence rate of this ACE among Hoosiers compared to other states, but it may also be reflective of increases in incarceration rates over time, given that the available comparative statistics rely on outdated data.

HMI exposure also differed significantly by age, race/ethnicity, income, and educational attainment. The much smaller proportion of older adults having been exposed to HMI during childhood could indicate true exposure differences by age, but it could also be attributed to other factors, such as increases in incarceration rates over time or differential ability to recall experiencing this ACE. Differences in HMI exposure by race/ethnicity, income, and educational attainment highlight the systemic racial and socioeconomic disparities of the criminal justice system.

According to data from the 2010 U.S. Census, Black Americans, who represent 13% of the U.S. population, make up 40% of the incarcerated population, while White Americans, who represent 64% of the U.S. population, only make up 39% of the incarcerated population.[17] Another way to interpret this racial/ethnic disparity is that while 450 per 100,000 White Americans are incarcerated, those rates are drastically higher for other racial/ethnic groups; 831 per 100,000 Hispanic Americans, 895 per 100,000 American Indian/Alaska Native Americans, and 2,306 per 100,000 Black Americans are incarcerated.[17] It is evident from these statistics that the racial and ethnic breakdown of incarcerated populations is drastically different from that of the United States as a whole. In addition, using data from the 2015 Bureau of Justice Statistics, incarcerated individuals have a median annual income of less than half (48%) of the median income for nonincarcerated individuals of similar ages.[18] Given these unfortunate disparities in incarceration rates across racial/ethnic and socioeconomic status groups, it is unsurprising that the results from this analysis demonstrate that a substantially larger proportion of non-Hispanic black, non-Hispanic multiracial, Hispanic, low-income, and less-educated adults in Indiana experienced HMI during childhood compared to their counterparts.

Results from the Model I multivariate logistic regression models demonstrate that HMI exposure is associated with various health risks, perceived poor health indicators, and chronic health conditions in adulthood when controlling for sex, age, race/ethnicity, and education. The strongest associations were observed for poor mental health outcomes, poor self-reported physical health, smoking status, and COPD; however, upon further adjustment of these models with exposure to other ACEs (Model II estimates), it is evident that these relationships were confounded by co-occurring ACE exposures. These

findings, which align with the proposed hypothesis, are not surprising, given the observed statistically significant associations between HMI exposure and exposure to other ACEs, along with the substantial literature documenting the high interrelatedness of ACEs.[15] Because adults who report any single ACE are very likely to have experienced other ACEs during childhood, it is highly advisable by the scientific community to control for exposure to other ACEs when assessing the effects of a particular ACE.[15]

Despite the substantial changes in statistical significance and effect sizes of the model estimates that occurred after controlling for other ACEs, HMI exposure is still a significant public health concern. Model II estimates demonstrate that individuals who were exposed to HMI during childhood have significantly higher odds of smoking, reporting poor physical health, and having been diagnosed with COPD in adulthood compared to those who were not exposed to this ACE, even after controlling for sociodemographic factors and other ACE exposures. These findings are consistent with a previous study that assessed HMI exposure using BRFSS data while also adjusting for other ACE exposures.[4] Researchers have proposed that this relationship between ACEs such as HMI and smoking can be attributed to the neurologic effects of nicotine; since nicotine has been shown to regulate the neuropathways involved in the stress response,[19] people may engage in smoking as a way to cope with the mental distress caused by HMI or other ACE exposures.[20]

This study has several limitations. First, due to the cross-sectional design of the data collection methods (via the BRFSS), it cannot be determined whether any of the observed relationships are causal. The use of self-report data is also inherently subject to various biases; for example, survey respondents may not be able to accurately remember personal information or experiences. Respondents may also be inclined to over-report socially desirable factors or under-report socially stigmatized factors. In addition, all missing data were removed from any analyses, which could result in biased estimates if that data were not missing at random. Lastly, it cannot be assessed whether the strength of the significant associations varied depending on the type of incarcerated household member (e.g., parent, sibling, other relative, etc.), the length or frequency of the HMI, or even the type of offense that led to incarceration.

Despite these limitations, the findings from this study demonstrate harmful associations between HMI and smoking, a risky health behavior, along with long-term adverse health outcomes, including poor self-reported physical health and COPD. Further research should explore the relationship between HMI and smoking and into whether this relationship could be exacerbating current racial and SES health disparities, given the unequal proportions of incarcerated individuals along demographic lines. It is also important to consider whether incarceration is always the answer; clearly, some people must be incarcerated to protect society, but minor or nonviolent offenses could be addressed more effectively through programmatic or linkage-to-care alternatives such as community service programs, mental health services, drug treatment/rehabilitation programs, and more.

References

1. United States Profile. Prison Policy Initiative. https://www.prisonpolicy.org/profiles/US.html. Accessed March 1, 2021.
2. Indiana Profile. Prison Policy Initiative. https://www.prisonpolicy.org/profiles/IN.html. Accessed March 1, 2021.
3. Gjelsvik A, Dumont DM, Nunn A, Rosen DL. Adverse childhood events: incarceration of household members and health-related quality of life in adulthood. *J Health Care Poor Underserved*. 2014;25(3):1169-1182. doi:10.1353/hpu.2014.0112
4. Gjelsvik A, Dumont DM, Nunn A. Incarceration of a household member and Hispanic health disparities: childhood exposure and adult chronic disease risk behaviors. *Prev Chronic Dis*. 2013;10:E69. Published 2013 May 2. doi:10.5888/pcd10.120281
5. White BA, Cordie-Garcia L, Fuller-Thomson E. Incarceration of a family member during childhood is associated with later heart attack: Findings from two large, population-based studies. *Journal of Criminal Justice*. 2016;44:89-98. doi:10.1016/j.jcrimjus.2015.12.006
6. Wildeman C. Imprisonment and Infant Mortality. *Social Problems*. 2012;59(2):228-257. doi:10.1525/sp.2012.59.2.228
7. Lee RD, Fang X, Luo F. The impact of parental incarceration on the physical and mental health of young adults. *Pediatrics*. 2013;131(4):e1188-e1195. doi:10.1542/peds.2012-0627
8. Turney K. Stress proliferation across generations? Examining the relationship between parental incarceration and childhood health. *J Health Soc Behav*. 2014;55(3):302-319. doi:10.1177/0022146514544173
9. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *Am J Prev Med*. 1998;14(4):245-258. doi:10.1016/s0749-3797(98)00017-8
10. Behavioral Risk Factor Surveillance System. IN.gov. https://www.in.gov/isdh/25194.htm. Updated July 2020. Accessed March 1, 2021.
11. Anda RF, Butchart A, Felitti VJ, Brown DW. Building a framework for global surveillance of the public health implications of adverse childhood experiences. *Am J Prev Med*. 2010;39(1):93-98. doi:10.1016/j.amepre.2010.03.015
12. Behavioral Risk Factor Surveillance System ACE Data. cdc.gov. https://www.cdc.gov/violenceprevention/aces/ace-brfss.html . Updated April 3, 2020. Accessed March 1, 2021.
13. Walker KW. The Prevalence of Adverse Childhood Experiences and their Association with Adult Health: 2018 Indiana Behavioral Risk Factor Surveillance System Survey. IN.gov. https://www.bit.ly/inace18. Published July 2020. Accessed March 1, 2021.
14. Dwyer-Lindgren L, Mackenbach JP, van Lenthe FJ, Mokdad AH. Self-reported general health, physical distress, mental distress, and activity limitation by US county, 1995-2012. *Popul Health Metr*. 2017;15(1):16. Published 2017 Apr 26. doi:10.1186/s12963-017-0133-5

15. Dong M, Anda RF, Felitti VJ, et al. The interrelatedness of multiple forms of childhood abuse, neglect, and household dysfunction. *Child Abuse Negl*. 2004;28(7):771-784. doi:10.1016/j.chiabu.2004.01.008
16. The Behavioral Risk Factor Surveillance System: Complex Sampling Weights and Preparing 2017 BRFSS Module Data for Analysis. cdc.gov. https://www.cdc.gov/brfss/annual_data/2017/pdf/Complex-Smple-Weights-Prep-Module-Data-Analysis-2017-508.pdf. Published July 2018. Accessed March 1, 2021.
17. Sakala L. Breaking Down Mass Incarceration in the 2010 Census: State-by-State Incarceration Rates by Race/Ethnicity. Prison Policy Initiative. https://www.prisonpolicy.org/reports/rates.html. Published May 28, 2014. Accessed March 1, 2021.
18. Rabuy B & Kopf D. Detaining the Poor: How Money Bail Perpetuates an Endless Cycle of Poverty and Jail Time. Prison Policy Initiative. https://www.prisonpolicy.org/reports/incomejails.html. Published May 10, 2016. Accessed March 1, 2021.
19. Picciotto MR, Brunzell DH, Caldarone BJ. Effect of nicotine and nicotinic receptors on anxiety and depression. *Neuroreport*. 2002;13(9):1097-1106. doi:10.1097/00001756-200207020-00006
20. Anda RF, Croft JB, Felitti VJ, et al. Adverse childhood experiences and smoking during adolescence and adulthood. *JAMA*. 1999;282(17):1652-1658. doi:10.1001/jama.282.17.1652

Appendix

Appendix A. Prevalence of ACEs by Household Member Incarceration Exposure†, 2018-19 IN BRFSS						
	Sample Size	**No Exposure to HMI (n=12,242)**		**Exposure to HMI (n=1,345)**		**p-value**
		%	95% CI	%	95% CI	
ACE Score°						
0	5,557	**41.3**	40.2 – 42.5	**5.0**	3.3 – 6.8	<.001
1	2,875	**25.4**	24.3 – 26.5	**9.0**	6.8 – 11.3	
2	1,561	**13.0**	12.2 – 13.8	**12.3**	9.6 – 14.9	
3-7	974	**20.2**	19.3 – 21.2	**73.7**	70.1 – 77.4	
Other ACE exposure:						
Emotional abuse	3,503	**26.2**	25.1 – 27.2	**65.2**	61.3 – 69.1	<.001
Physical abuse	2,656	**18.7**	17.8 – 19.6	**46.4**	42.2 – 50.6	<.001
Sexual abuse	1,718	**11.2**	10.5 – 11.9	**33.7**	29.7 – 37.7	<.001
Mental illness in household	2,050	**16.1**	15.2 – 17.0	**50.9**	46.8 – 55.1	<.001
Domestic violence in household	1,991	**13.9**	13.1 – 14.8	**48.5**	44.3 – 52.8	<.001
Substance abuse in household	3,273	**22.1**	21.2 – 23.1	**80.5**	77.5 – 83.6	<.001
Parental separation/divorce	3,290	**28.3**	27.2 – 29.4	**64.8**	60.8 – 68.9	<.001

Abbreviations. ACE: Adverse Childhood Experience; HMI: Household member incarceration.

† Table displays column percentages; denominator for each percentage is the total number of respondents who were either exposed or not exposed to HMI during childhood. Numerator for each percentage is the total number of respondents who reported experiencing additional ACEs. All percentages were reweighted using previously described methodologies.[16]

° Adverse Childhood Experience Score ***excluding exposure to household member incarceration.***