



Health Policy Brief

Adverse Childhood Experiences (ACEs) Economic Impact of ACEs in Ohio

Appendix

This appendix provides additional information about the analysis that informed the Health Policy Institute of Ohio (HPIO) policy brief, **Adverse Childhood Experiences (ACEs): Economic Impact of ACEs in Ohio**.

Data sources

The **Economic Impact of ACEs in Ohio** brief builds on HPIO's analysis of the Behavioral Risk Factor Surveillance System (BRFSS) ACEs module data discussed in the **Health Impact of ACEs in Ohio** brief. In that analysis, HPIO estimated population attributable risk (PAR) for ACEs exposure for three health outcomes (asthma, chronic obstructive pulmonary disorder [COPD] and depression), two health behaviors (smoking and heavy drinking) and inability to afford health care.¹ Inability to afford health care is excluded from this analysis due to a lack of reliable data to attribute costs to this outcome.

HPIO's analysis for this brief uses data from the following sources to estimate annual healthcare costs associated with ACEs exposure, as well as lost wages due to missed work:

- **Medical Expenditure Panel Survey (MEPS)**, Agency for Healthcare Research and Quality (AHRQ)
- **Smoking-Attributable Morbidity, Mortality, and Economic Costs (SAMMEC) - Smoking-Attributable Expenditures (SAE) dataset**, Centers for Disease Control and Prevention (CDC)
- A **CDC study of the economic costs attributable to excessive drinking** published in the *American Journal of Preventive Medicine*
- **State Occupational Employment and Wage Estimates**, U.S. Bureau of Labor Statistics (BLS)

Medical Expenditure Panel Survey (MEPS)

MEPS is a set of large-scale surveys of families and individuals, medical providers

and employers that is administered by the Agency for Healthcare Research and Quality (AHRQ). According to AHRQ, MEPS is "the most complete source of data on the cost and use of health care and health insurance coverage."² The survey includes a household component, an insurance and employer component and a medical provider component. MEPS cost data includes office-based, outpatient, home health, inpatient hospital stays, emergency room visits and prescriptions. Healthcare costs are paid by individuals; local, state and federal governments; employers and insurance companies.

MEPS data is weighted to be nationally representative and includes variables that can be used to produce regional estimates of healthcare costs and utilization. There are four MEPS regions; Ohio is one of 12 states in the Midwest region. Because MEPS does not allow for state-level estimates, HPIO's analysis uses estimates for the Midwest region to calculate annual healthcare costs for Ohio.

Data used in HPIO's analysis is from 2018 and most estimates discussed in **Economic Impact of ACEs in Ohio** were adjusted for inflation to 2020 dollars using the Consumer Price Index Urban All Items (CPI-U) deflator. MEPS data is accessed using **files released periodically by AHRQ**. HPIO used the 2018 Full Year Consolidated File and the 2018 Medical Conditions File.

Smoking-Attributable Morbidity, Mortality, and Economic Costs (SAMMEC) - Smoking-Attributable Expenditures (SAE) dataset

The CDC SAE dataset is one component of the SAMMEC. SAMMEC is a large-scale CDC project that periodically estimates the impact of cigarette smoking on disease morbidity and mortality, as well as the economic costs of these outcomes.

Estimates from the most-recently published SAE dataset are for 2005-2009. HPIO used 2009 estimates adjusted for inflation to 2020 dollars using the CPI-U deflator.

SAMMEC datasets are based on calculations of the smoking attributable fraction (SAF) for smoking-related diseases for adults and children. SAF is an estimate of the percentage of disease prevalence in the total population that is attributable to smoking. Examples of smoking-related diseases include lip and lung cancers, coronary heart disease, respiratory diseases and sudden infant death syndrome (SIDS).

The SAE dataset includes estimates of healthcare costs attributable to smoking for current and former smokers, as well as healthcare costs attributable to secondhand smoke. To estimate the healthcare expenditures in the SAE dataset, SAMMEC applies SAFs to estimates of healthcare costs for treating smoking-related diseases generated through analysis of MEPS data.

Estimates of costs attributable to excessive drinking

HPIO obtained annual costs attributable to excessive drinking from a CDC study³ published in the *American Journal of Preventive Medicine*. Unlike MEPS and SAMMEC-SAE, estimates from this source include costs outside the healthcare system, including lost productivity due to premature death, criminal justice costs and property damage.

In the CDC study, excessive drinking is defined to include heavy drinking (more than two drinks per day for men or more than one drink per day for women), binge drinking (more than four (women) or five (men) drinks on a single occasion), any drinking during pregnancy and any underage drinking. This definition is broader than the alcohol use variable in [Health Impact of ACEs in Ohio](#), which was limited to heavy drinking. However, according to BRFSS data, heavy drinking and other types of excessive drinking are often reported by the same individuals. For example, in 2018, 83.7% of adults ages 18 and older who reported binge drinking also reported heavy drinking.

The CDC study provides state-level estimates

for 2010. HPIO adjusted these figures for inflation to 2020 dollars using the CPI-U deflator.

U.S. Bureau of Labor Statistics, State Occupational Employment and Wage Estimates

The Bureau of Labor Statistics collects data from employers in Ohio to produce estimates of hourly and annual wages.

Because 2018 data from MEPS was used to calculate the number of missed work days for the brief's analysis, HPIO also used 2018 wage data and adjusted to 2020 dollars using the CPI-U deflator.

Methodology for analysis of MEPS data

HPIO used 2018 MEPS data to estimate the incremental costs for medical treatment and missed work days for three health conditions associated with ACEs: asthma, COPD and depression. In addition to describing the methodology for this analysis, this section provides data and information that was not included in the [Economic Impact of ACEs in Ohio](#) policy brief.

Identification of individuals with medical conditions in MEPS data files

HPIO identified all individuals (children and adults) with asthma, COPD and depression in the MEPS 2018 Medical Condition File using the ICD-10 diagnosis codes in figure 1.

Figure 1. ICD-10 diagnosis codes used

Medical condition	Diagnosis code(s)
Asthma	J45
COPD	J40, J42, J43, J44
Depression	F32

HPIO obtained data on the socioeconomic characteristics of individuals with asthma, COPD and depression from the MEPS 2018 Full Consolidated file. HPIO also calculated the Charlson Comorbidity Index for these individuals. The Charlson Comorbidity Index is a method for categorizing comorbidities of individuals and is often used in research about increased risk for mortality or resource use.⁴

Annual per-person medical costs and missed work day estimates

To estimate annual per-person medical costs for treating asthma, COPD and depression and missed work days due to these conditions, HPIO ran a series of weighted regressions where the dependent variable was either total expenditures or missed work days. Variables, MEPS variable names and summary statistics for the dependent variables and covariates used in regressions are shown in figures 2 and 3.

Figure 2. **Variables, MEPS variable names and summary statistics for analysis of total expenditures**

MEPS variable	MEPS variable name	Number of observations	Mean	Standard deviation	Minimum	Maximum
Dependent variable						
Total expenditures	TOTEXP	29,415	\$6,063	\$17,185	0	\$807,611
Covariates						
Asthma	See ICD-10 codes	29,415	0.0597	0.2370	0	1
COPD	See ICD-10 codes	29,415	0.0322	0.1766	0	1
Depression	See ICD-10 codes	29,415	0.0615	0.2403	0	1
Charlson Comorbidity Index	N/A	29,415	0.1070	0.4040	0	2
Midwest	REGION18	29,415	0.21	0.41	0	1
Female	SEX	29,415	0.5105	0.4999	0	1
Age	AGELAST	29,415	39	23	0	85
Age squared	AGELAST	29,415	2,067	1,951	0	7,225
Married	MARRY18X	29,415	0.3979	0.4895	0	1
College degree	HIDEG	29,415	0.2531	0.4348	0	1
White	RACETHX	29,415	0.5968	0.4905	0	1
Black	RACETHX	29,415	0.1229	0.3283	0	1
Hispanic	RACETHX	29,415	0.1846	0.3880	0	1
Other	RACETHX	29,415	0.0957	0.2942	0	1
Under \$30,000	FAMINC18	29,415	0.2122	0.4088	0	1
Between \$30,000 and \$85,000	FAMINC18	29,415	0.3894	0.4876	0	1
\$85,000 or more	FAMINC18	29,415	0.3985	0.4896	0	1
Private	INSCOV18	29,415	0.6757	0.4681	0	1
Public	INSCOV18	29,415	0.2592	0.4382	0	1
Uninsured	INSCOV18	29,415	0.0651	0.2467	0	1

Source: Analysis of 2018 MEPS

Figure 3. Variables, MEPS variable names and summary statistics for analysis of missed work days

MEPS variable	MEPS variable name	Number of observations	Mean	Standard deviation	Minimum	Maximum
Dependent variable						
Missed work days	DDNWRK18	12,612	3	9	0	63
Covariates						
Asthma	See ICD-10 codes	12,612	0.0481	0.2139	0	1
COPD	See ICD-10 codes	12,612	0.0215	0.1452	0	1
Depression	See ICD-10 codes	12,612	0.0668	0.3238	0	2
Charlson Comorbidity Index	N/A	12,612	0.0577	0.2331	0	1
Midwest	REGION18	12,612	0.2199	0.4142	0	1
Female	SEX	12,612	0.4716	0.4992	0	1
Age	AGELAST	12,612	43	14	15	85
Age squared	AGELAST	12,612	2020	1287	225	7,225
Married	MARRY18X	12,612	0.5337	0.4989	0	1
College degree	HIDEG	12,612	0.3800	0.4854	0	1
White	RACETHX	12,612	0.6207	0.4852	0	1
Black	RACETHX	12,612	0.1152	0.3193	0	1
Hispanic	RACETHX	12,612	0.1730	0.3783	0	1
Other	RACETHX	12,612	0.0911	0.2877	0	1

Source: Analysis of 2018 MEPS

The results of the weighted regressions for total expenditures are shown in figure 4. All estimates are adjusted for inflation to 2020 dollars using the CPI-U deflator. For example, the estimated annual per-person cost for treating asthma in the Midwest was \$4,222 after adjusting the 2018 estimate to 2020 dollars. The confidence intervals in figure 4 are upper and lower bounds of the estimate. Because these confidence intervals do not include \$0, these estimates are statistically significant. Throughout this Appendix and the [Economic Impact of ACEs in Ohio](#) policy brief, HPIO only displays and discusses statistically significant estimates.

Figure 4. **Annual per-person medical cost in the Midwest by condition (in 2020 dollars)**

Asthma		COPD		Depression	
\$4,222	95% confidence interval	\$4,827	95% confidence interval	\$7,096	95% confidence interval
	\$1,781-\$6,663		\$1,642-\$8,013		\$4,769-\$9,421

Source: Analysis of 2018 MEPS

The results of the weighted regressions for missed work days are shown in figure 5.

Figure 5. **Annual per person missed work days in the Midwest by condition**

Asthma		COPD		Depression	
*	95% confidence interval	2.9	95% confidence interval	4	95% confidence interval
	*		0.1-5.7		2.1-5.9

*Estimate is not statistically significant

Source: Analysis of 2018 MEPS

Annual statewide medical cost estimates

To calculate annual statewide medical costs for asthma, COPD and depression, HPIO estimated the number of people in Ohio with these conditions by multiplying the proportion of Ohio adults estimated to have each condition based on 2015 BRFSS data with the estimated 2015 population of Ohioans, ages 18 or older (8,986,544).⁵

In 2015, 10% of adult Ohioans reported asthma, 7.2% reported COPD and 19.6% reported depression. See figure 6 for the estimated number of people with each condition in Ohio and the annual cost in Ohio adjusted to 2020 dollars.

Figure 6. **Estimated number of Ohioans with medical conditions (2015) and annual cost by condition (in 2020 dollars)**

Condition	Annual per person medical cost	Number with condition in Ohio	Annual cost in Ohio
Asthma	\$4,222	898,654	\$3,794,117,188
COPD	\$4,827	647,031	\$3,123,218,637
Depression	\$7,096	1,761,363	\$12,498,631,848
Total	N/A	3,307,048	\$19,415,967,673

Source: Analysis of 2018 MEPS and 2015 BRFSS

Annual per-person lost wage estimates

To estimate annual, per-person lost wages, HPIO multiplied the annual number of missed work days by the number of hours in a typical work day (8) and the median hourly wage for Ohio workers in 2018 as estimated by the U.S. Bureau of Labor Statistics, \$17.96 (\$18.42 in 2020 dollars). Results of this analysis are shown in figure 7.

Figure 7. **Annual per-person lost wages due to missed work days in the Midwest by condition (in 2020 dollars)**

Condition	Annual number of missed days	Annual lost wages due to missed work days
Asthma	*	*
COPD	2.9	\$423
Depression	4	\$590

*Estimate is not statistically significant

Source: Analysis of 2018 MEPS and 2018 U.S. Bureau of Labor Statistics

Annual statewide lost wage estimates

To estimate annual, statewide lost wages, HPIO multiplied the annual per-person lost wages for each condition by the estimated number of workers with each condition in Ohio based on 2015 BRFSS data (see figure 8).

Figure 8. **Lost wages by condition, Midwest and Ohio (in 2020 dollars)**

Condition	Annual per-person cost of missed work days due to condition (Midwest)	Number of Ohio workers with condition	Total annual cost of missed work days in Ohio
COPD	\$423	251,623	\$106,463,529
Depression	\$590	1,401,901	\$827,121,590
Total	N/A	N/A	\$933,558,119

Methodology for estimating costs attributable to experiencing multiple ACEs and specific types of ACEs

To estimate annual costs attributable to experiencing multiple ACEs (two or more) and specific types of ACEs for medical conditions and health behaviors, HPIO multiplied the PAR for each medical condition and health behavior by the estimated total annual cost for each health condition or behavior. For more information about PARs, see [Health Impact of ACEs in Ohio](#) and its [Appendix](#).

Below, figure 9 includes PARs, estimated total annual healthcare cost to Ohio and costs attributable to experiencing multiple ACEs.

Figure 9. PARs, total annual healthcare cost to Ohio* and costs attributable to experiencing multiple ACEs (in 2020 dollars)

Condition	PAR	Total annual healthcare cost to Ohio**	Healthcare cost attributable to experiencing multiple ACEs
Depression	36%	\$12,498,631,848	\$4,499,507,465
Smoking	33%	\$6,779,720,000	\$2,237,307,600
Asthma	24%	\$3,794,117,188	\$910,588,125
COPD	20%	\$3,123,218,637	\$624,643,727
Drinking	19%	\$10,063,170,000	\$1,912,002,300

*Amounts for asthma, COPD and depression are based on cost estimates for the Midwest region, which includes Ohio and 11 other states.

**The dataset used to estimate annual costs related to excessive drinking includes costs other than healthcare costs, such as lost productivity at home and work, criminal justice costs and property damage.

Source: Analysis of 2018 MEPS, 2018 U.S. Bureau of Labor Statistics, 2009 SAMMEC-SAE, 2010 CDC and 2015 BRFSS

Figure 10 includes estimated total annual cost to Ohio and costs attributable to experiencing specific ACEs. Not all of the costs shown in figure 9 can be fully attributed to experiencing the specific ACE alone. Some costs may be attributed to experiencing that ACE in combination with other ACEs.

Figure 10. PARs, estimated total annual cost in Ohio and costs attributable to experiencing specific ACEs

Emotional abuse			
Outcome	PAR	Annual cost	Cost attributable to ACE
Depression	16%	\$12,498,631,848	\$1,999,781,096
Current smoking	12%	\$6,779,720,000	\$813,566,400
Substance use in the household			
Outcome	PAR	Annual cost	Cost attributable to ACE
Current smoking	14%	\$6,779,720,000	\$949,160,800
Mental illness in the household			
Outcome	PAR	Annual cost	Cost attributable to ACE
Depression	20%	\$12,498,631,848	\$2,499,726,370
Asthma	13%	\$3,794,117,188	\$493,235,234
Sexual abuse			
Outcome	PAR	Annual cost	Cost attributable to ACE
Depression	15%	\$12,498,631,848	\$1,874,794,777
Incarcerated member of the household			
Outcome	PAR	Annual cost	Cost attributable to ACE
Current smoking	7%	\$6,779,720,000	\$474,580,400

Source: Analysis of 2018 MEPS, 2018 U.S. Bureau of Labor Statistics, 2009 SAMMEC-SAE, 2010 CDC and 2015 BRFSS

HPIO contracted with Anirudh Ruhil from Ohio University, Voinovich School of Leadership and Public Affairs and Christelle Khalaf from University of Wyoming, Center for Business and Economic Analysis to analyze data for this brief.

Notes

1. HPIO's analysis of 2015 BRFSS data includes 14 variables associated with ACEs exposure through other research. These six variables (asthma, COPD, depression, smoking, heavy drinking and inability to afford care) had statistically significant PARs for experiencing multiple ACEs (2 or more). For a list of variables included in HPIO's analysis of 2015 BRFSS data, see the [Health Impacts of ACEs in Ohio Appendix: Methodology and technical report](#).
1. "Medical Expenditure Panel Survey." Agency for Healthcare Research and Quality. Accessed Dec. 4, 2020. <https://www.meps.ahrq.gov/mepsweb/>
1. Sacks JJ, Gonzales KR, Bouchery EE, Tomedi LE, Brewer RD. 2010 national and state costs of excessive alcohol consumption. *Am J Prev Med*. 2015;49(5):e73–e79. <https://www.ncbi.nlm.nih.gov/pubmed/26477807>
1. For more information, see <http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?printer=Y&conceptID=1098#:~:text=The%20Charlson%20Comorbidity%20Index%20is,such%20as%20hospital%20abstracts%20data>.
2. 2015 data was used because that is the same data that was used to calculate the PARs in HPIO's first ACEs Impact Project brief. Those PARs were used in this analysis to calculate costs attributable to ACEs exposure.



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