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# Health Issues in Ohio

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I am very happy to introduce myself as the next editor of the *Ohio Journal of Public Health (OJPH)*. I am very grateful for the opportunity given to me by the Ohio Public Health Association. I am also very appreciative of the work Sheryl Chatfield has put into the journal and in establishing it within the [Directory of Open Access Journals](). I am excited about the future of the journal and to build upon the foundation laid by Dr. Chatfield. I envision the journal providing important insight into the health and well-being of the people in Ohio and providing guidance for public health practitioners in their work to improve people's lives. Coming off the height of the COVID-19 pandemic, many issues are likely to impact the health of Ohioans.

While it seems that COVID-19 is no longer on the minds of many Ohioans, the disease is still present within the state. Since the beginning of 2024 there have been 91 786 cases of COVID-19 within the state, with 3365 being hospitalized and 598 deaths.[1] While this is a fraction of what was seen during the first year of the pandemic, it still highlights the presence of the disease and that it is the fourth leading cause of death in the state.[2] Additionally, long COVID (the continuation or development of new symptoms 3 months after the initial SARS-CoV-2 infection, with these symptoms lasting for at least 2 months with no other explanation) is a problem that many Ohioans are reporting. Data from the US Census Bureau found that approximately 30% of Ohio people report long COVID symptoms.[3] Nationally, race/ethnic minorities, along with sexual and gender minorities, have reported suffering from long COVID.[4] COVID-19 is not finished with Ohio, and with only 12% of Ohio having updated vaccines, COVID-19 will continue to be a problem within the state.

The election in November 2023 led to the passage of Ohio Issue 2, which led to the legalization of recreational marijuana in the state, making Ohio the 24th state to do so. This change can potentially lead to public health issues within the state. Examples include increased risk for accidents due to cannabis use as well as accidental ingestion of cannabis edibles. Studies examining motor vehicle accidents found some evidence of harm due to driving while high; these effects were inconsistent.[5-7] One aspect that should be of concern is the rise of accidental poisoning by adults, children, and pets ingesting cannabis edibles. A systemic review found that acute cannabis poisonings increased after the legalization of cannabis.[8] Overall, the legalization of recreational cannabis has led to an increase in the use by adults but not that of adolescents.[9] Additional questions exist regarding recreational cannabis' impact on other substances (tobacco, alcohol, and other drugs). Given Ohio's history with opiate usage and outcomes, attention to the impact of recreational cannabis is warranted.

Ohio continues to experience problems related to opiate use and overdose.[10] Ohio is not alone in the opiate epidemic, and the amount of fentanyl available is impacting overdose rates across the country.[11] The opiate problem is but one problem in what is referred to as "Disorders of Despair," as drug overdose, suicides, and alcohol-related liver diseases are related to people's poor economic and social conditions. In the past, discussions about disorders of despair were focused on the lives of White men and women; however, recent research shows no difference between White and Black Ohioans in the rate of deaths from Diseases of Despair.[12] African-American Ohioans are at more risk for overdose as

fentanyl is being laced with other drugs; at the same time, they lack access to important resources that can prevent overdose.[13] Preventing overdose among all Ohioans is an important goal, equally important is examining the social determinants that can impact the health and health behaviors of Ohioans.

Public Health itself has been under attack even before the COVID-19 pandemic. Ohio ranks 37th in Public Health funding by the United Health Foundation.[14] This can be seen in the high rates of smoking and cardiovascular diseases in the state.[14] Since the pandemic, we have been seeing attacks on the very concept of public health.  Governmental bodies are seeking to limit collective efforts to improve the health of communities in favor of individualistic strategies where vaccines and mask-wearing are seen as a personal choice. In this way, the government and other organizations can then paint morbidity and mortality because of people's personal choices and not social and economic factors, just like smoking.  Public Health policies and other collective forms of action to improve people's health are not popular among many policymakers, which led to the passing of legislation limiting public health activities.[15]

As *OJPH* editor, I see the *Ohio Journal of Public Health* as an important tool to highlight the health issues facing Ohioans and an important tool for advocates looking for evidence-based material. While there are many health issues in the state, there are also dedicated public health workers, academics, and other professionals across the state working to improve the health of communities. I look forward to helping authors share their work with others and aiding students in becoming academic writers.

**REFERENCES**

1. Ohio Department of Health. COVID-19 Reporting. Ohio Department of Health. Updated June 13, 2024. Accessed June 17, 2024, 2024.
   https://data.ohio.gov/wps/portal/gov/data/view/covid-19-reporting

2. Wiselogel N, Chirakos L. Data snapshot: updated death trends among working-age Ohioans (2023). 2023. October 6, 2023.
   https://www.healthpolicyohio.org/our-work/publications/updated-death-trends-among-working-age-ohioans-2023

3. US Census Bureau. US Census Bureau, Household Pulse Survey. Accessed June 17, 2024, 2024.
   https://www.census.gov/data-tools/demo/hhp/#/?
   s_state=00001,00002,00004,00005,00006,00008,00009,00010,00011,00012,00013,00015,00016,00017,
   00018,00019,00020,00021,00022,00023,00024,00025,00026,00027,00028,00029,00030,00031,00032,00033,00034,00035,0003
   6,00037,00038,00039,00040,00041,00042,00044,00045,00046,00047,00048,00049,00050,00051,00053,00054,00055,00056&p
   eriodSelector=5&periodFilter=5&measures=LONGCOVID_1

4. Glassman B. Household pulse survey shows 31.1% reported symptoms three months or longer after they had COVID-19. US Census Bureau. Updated May 01, 2023. Accessed June 17, 2024, 2024.
   https://www.census.gov/library/stories/2023/05/long-covid-19-symptoms-reported.html

5. Windle SB, Eisenberg MJ, Reynier P, et al. Association between legalization of recreational cannabis and fatal motor vehicle collisions in the United States: an ecologic study. *CMAJ Open*. Jan-Mar 2021;9(1):E233-e241.
   https://doi.org/10.9778/cmajo.20200155

6. Windle SB, Socha P, Nazif-Munoz JI, Harper S, Nandi A. The impact of cannabis decriminalization and legalization on road safety outcomes: a systematic review. *Am J Prev Med*. Dec 2022;63(6):1037-1052.
   https://doi.org/10.1016/j.amepre.2022.07.012

7. Voy A. Collisions and cannabis: Measuring the effect of recreational marijuana legalization on traffic crashes in Washington state. *Traffic Inj Prev*. 2023;24(7):527-535.
   https://doi.org/10.1080/15389588.2023.2220853

8. Allaf S, Lim JS, Buckley NA, Cairns R. The impact of cannabis legalization and decriminalization on acute poisoning: a systematic review. *Addiction*. 2023;118(12):2252-2274.
   https://doi.org/10.1111/add.16280

9. Athanassiou M, Dumais A, Zouaoui I, Potvin S. The clouded debate: a systematic review of comparative longitudinal studies examining the impact of recreational cannabis legalization on key public health outcomes. *Frontiers in Psychiatry*. 2023;13
   https://doi.org/10.3389/fpsyt.2022.1060656

10. Ohio Department of Health. State of Ohio Integrated Behavioral Health Dashboard. Ohio Department of Health,. Accessed June 17, 2024.
    https://data.ohio.gov/wps/portal/gov/data/view/ohio-ibhd

11. The HEALing Communities Study Consortium. Community-Based Cluster-Randomized Trial to Reduce Opioid Overdose Deaths. *N Engl J Med.* 2024;0(0)
    https://doi.org/10.1056/NEJMoa2401177

12. Leite R, Hall O, Gay J, Ruhil A, Hodges R. Ohio Deaths of Despair: 2010-2019. 2020.
    https://www.ohio.edu/chsp/sites/ohio.edu.chsp/files/sites/alliance/Ohio%20Deaths%20of%20Despair%202010-19.pdf

13. Beausir A, King KA. Reducing overdoses among African American individuals in Ohio: an emerging public health crisis. *Ohio J Public Health.* 2023;6(1):1-7.
    https://doi.org/10.18061/ojph.v6i1.9410

14. United Health Foundation. America's Health Rankings analysis of CDC, HRSA and Trust for America's Health. United Health Foundation. Accessed June 20, 2024, 2024.
    https://www.americashealthrankings.org/explore/measures

15. The Network for Public Health Law. Proposed Limits on Public Health Authority: Dangerous for Public Health. 2021. May, 2021.
    https://www.networkforphl.org/resources/proposed-limits-on-public-health-authority-dangerous-for-public-health-3/

**RESEARCH ARTICLE**

# Availability and Characteristics of Hemp-Derived Psychoactive Cannabis Products: A Pilot Study in Cleveland, Ohio

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**ABSTRACT**

**Background:** Hemp-derived psychoactive cannabis products (HDPCPs), such as delta-8 tetrahydrocannabinol (THC), emerged onto the market as an alternative to cannabis following the 2018 US Farm Bill which legalized hemp. Research on HDPCPs remains limited. The purpose of this research was to evaluate the availability, placement, and consumption modality of HDPCPs as well as to identify potential defining characteristics of consumers.

**Methods:** Between October 2022 and January 2023, researchers visited a random sample of 82 tobacco retailers in Cleveland, Ohio, to evaluate the availability of HDPCPs marketed as delta THC (eg, delta-8 or delta-10). Information was captured on where the HDPCPs were placed (eg, behind the counter, on the counter, by candy, or elsewhere) as well as the consumption modality (eg, edible or inhaled). Among retailers who stocked these products, clerks were asked who typically buys these products and how often they are purchased.

**Results:** Over two-fifths (41.5%) of retailers carried HDPCPs. Most retailers (97.1%) carried delta THC products behind the counter and carried products as inhaled (82.4%), edible (70.6%). More than half of retailers (55.9%) carried both inhaled and edible forms of HDPCP. Retail clerks reported on a range of ages of consumers from younger to older or "everyone."

**Conclusion:** Hemp-derived psychoactive cannabis products are prevalent in this pilot study sample. These findings necessitate additional research to better quantify the population health impact of these products to determine if regulatory action may be necessary to protect public health.

**Keywords:** Hemp-derived psychoactive cannabis products; Delta-8; Market research; Substance use

## INTRODUCTION

Hemp-derived psychoactive cannabis products (HDPCPs) emerged onto the market in the United States (US) following the 2018 Farm Bill, which removed hemp from the list of federally controlled substances.[1] This legislation allowed for the proliferation of industry seeking to use hemp-derived cannabidiol (CBD) to synthesize psychoactive cannabis products,[2] which contain the same psychoactive constituent of federally illicit cannabis, tetrahydrocannabinol

(THC).[3-5] These products are more commonly referred to as delta-8, delta-10, THC-O, or TCH-P.

While several states restricted or banned the sale of HDPCPs, these products are still largely available to populations of all ages in the majority of US states,[2,6] thus making them an attractive option to individuals who use THC, particularly in places where adult or medicinal cannabis use remains restricted. Public interest in HDPCPs has grown tremendously,[7] with the number of online

search queries for delta-8 THC hitting 35% of the "marijuana" query in 2021.[8] To cater to a growing consumer base, HDPCPs have become particularly prevalent online as well as in brick-and-mortar retailers such as convenience stores, gas stations, and bodegas, where CBD and other hemp products are also commonly sold.[9]

The production and sale of HDPCPs may present several risks to broader public health. First, there is no regulatory oversight of the production of these cannabinoids. Manufacturers may use strong reactants which have not been thoroughly evaluated for their impact or safety, nor are they required to be disclosed to consumers.[2,10] Second, there is limited information about how to treat individuals who experience adverse effects. Currently, many medical facilities do not have toxicology screening assays readily available to assess for potential exposure to or intoxication with HDPCPs.[6] Further, many manufacturers have mislabeled products with incorrect THC concentrations, posing a hazard to consumers who may not know exactly how much of this psychoactive substance they are consuming.[11,12] As a result, poison control centers and emergency departments are seeing pediatric patients unconscious and unresponsive because of high-dose exposure to THC,[9] highlighting a consequence of a lack of product oversight. Additionally, new isomers are being synthesized rapidly, with the recently emerging THC-P being reported to be 33 times stronger than the naturally occurring delta-9 isomer.[13] In line with industry innovation and as HDPCPs continue to become more potent, there is growing imperative to thoroughly evaluate the potential risk to public health.

Research on availability and prevalence of use of these products is limited. Among adults who used cannabis in the past 30 days, 16.7% report use of delta-8 THC.[14] There is evidence that these products are disproportionately available in socioeconomically deprived communities,[15] which would exacerbate existing inequities if these products are found to contribute to poorer health outcomes particularly within the scope of substance use disorders and their subsequent health outcomes. While the state of Ohio implemented legislation in December 2023 which allows for retail sales of cannabis and possession of up to 2.5 ounces of cannabis by residents over the age of 21 years,[16] there is no current legislation regulating or restricting sales or marketing of hemp-derived psychoactive cannabinoids. However, in January 2024, Ohio legislators have begun discussions regarding restrictions or regulation of these products across the state.[17] One notable gap, however, is that little is known regarding the general availability of these products to potential consumers particularly in brick-and-mortar locations. To date, there are fewer than 5 publications describing the availability of HDPCPs in a physical retail space, none of which are set in Ohio. In order to begin laying a strong scientific foundation to assess public health impact, this research sought to determine if the availability of HDPCPs could be captured using measures adapted from the field of tobacco.

## METHODS

### Setting

In the city of Cleveland, prior to statewide implementation of adult use cannabis laws in 2023, cannabis retail sales were restricted to medical use with a limited number of available licensed dispensaries in the city.[18] Cleveland is a highly segregated city due primarily to historic redlining practices which have contributed to one of the most substantial poverty rates in the US with an estimated 31.2% of Cleveland residents living under the federal poverty line compared to Ohio (13.4%) and the US (11.5%).[19,20] In hand with the current legislative context, these factors may represent a vulnerable context for individuals who are susceptible to these products thus necessitating research to assess their availability in their first steps toward broader evaluation of the impact of HDPCPs.

### Retail Sample

The sample used in this pilot study was drawn from the Cleveland Food and Tobacco Retail Database (CIFTR). Collected since 2015, CIFTR includes an annual assessment of all food and tobacco retailers in Cleveland. Tobacco retailers were chosen for data collection for this study because HDPCPs have been found to be commonly available in these stores.[21] Additionally, cannabis and tobacco products often are used concurrently or in a substitutive manner, that is switching one product for another.[22] Therefore, a high prevalence of HDPCPs in tobacco retailers may have implications for tobacco smoking cessation.

A stratified random sample of 20% of the 422 tobacco retailers was identified from CIFTR in summer 2022 (n=85). Sampling was stratified by the east and west sides of Cleveland due to broad sociodemographic differences, which are linked to the historic redlining practices of the mid-20th century and contribute to higher rates of area deprivation on the east side of the Cuyahoga River compared to the west side[19] as well as a greater number of tobacco retailers (229 on the east side and 193 on the west side) based on the 2022 CIFTR data collection. Thus, random sampling was conducted with 20% of retailers within each geographic stratum.

### Data Collection

The data collection tool used items adapted from the Standardized Tobacco Assessment for Retail Settings (STARS) surveillance developed by the State and Community Tobacco Control Research as well as the tobacco-related Assurance of Voluntary Compliance Field Inspection Form which are both published by Counter Tools to capture availability and placement of tobacco products.[23,24] The adaptation of these items asked specifically about the availability of products marketed as "delta" or "Δ" THC (eg, delta-8, delta-10) and the placement of these products (eg, behind the counter, on the counter, within 1 foot of candy, or elsewhere) to evaluate the potential accessibility of these products to adolescents or children with products that were behind the counter being considered not accessible and those on the counter, by candy, or elsewhere being

considered accessible. Two items were developed to better understand the availability of these products across consumption modality to gain a broader sense of how products may appeal to individuals who use or co-use tobacco or cannabis (eg, inhaled vape or combustible) or to youth (eg, edible candies). To capture this, the data collection tool included options to indicate whether the products available were intended to be inhaled (eg, as a vape or vaping concentrate, prerolled joint, or "flower") or eaten (eg, as a candy, beverage, or other edible). Lastly, to capture any information about potential consumers, an open-ended question, "Who buys [HDPCPs]?" was developed to help guide the development of future surveillance items. The data collection tool used in this research is shown in the Appendix.

Two research assistants received training in the audit tool and protocol before conducting any audits. Prior to conducting the pilot study, the tool was tested in 3 retailers and modifications to the tool or protocol were made based on the feedback received by the research assistants. Once the tool and protocol were finalized, both research assistants visited each of the 85 retailers between October 2022 and January 2023. Three retailers were excluded from data collection and analysis because they were closed or declined to participate, yielding a final sample of 82 retailers.

### Analysis

Data on the availability, placement, and consumption modality of HDPCPs in tobacco retailers are provided descriptively. Bivariate analyses using chi-square and Fisher exact tests were used to evaluate differences, if any, between HDPCP availability, placement, and consumption modality on the east and west sides of Cleveland. In addition to the quantitative data, qualitative summaries regarding potential consumer characteristics were summarized to generate recommendations for future data collection.

### RESULTS

Across the random sample of tobacco retailers visited in this pilot study (n = 82), 41.5% (n = 34) carried HDPCPs (Table 1). The HDPCPs were predominantly located behind the counter (97.1%) in places that were not accessible to consumers without the assistance of a retail clerk. Only one store placed these products on a counter, and no stores placed them near candy or elsewhere in the store. Products were available in both consumption modalities, inhaled (82.4%) and edible (70.6%). No differences were observed between retailers on the east side or west side of Cleveland with respect to availability, placement, or modality with one exception. West side retailers were more likely to carry both inhaled and edible forms of HDPCPs than retailers on the east side (76.5% compared to 37.5%, respectively).

Qualitative responses were captured from HDPCP retailers (n = 33). Clerks responding to the question regarding who is purchasing these products consistently mentioned age in their responses while others discussed other demographic characteristics including race and gender. When discussing age, there was substantial variability among responses particularly with no clear age group emerging as the primary consumer. Several clerks reported that younger populations typically purchase HDPCPs, while others reported middle aged or older consumers. Finally, some clerks reported that "everyone" bought these products or that ages were "varied" with a "mix of old and young."

### DISCUSSION

Results from this pilot study demonstrate that HDPCPs are prevalent in tobacco retailers in Cleveland, with 41.5% of retailers in this pilot study offering some form of these products (eg, inhaled, edible), which may necessitate broader epidemiological surveillance and investigation in Cleveland as well as the state of Ohio.

The high prevalence of HDPCPs in this Cleveland sample, along with a lack of regulation or restriction on these products in Ohio, necessitates regulatory oversight. While Ohio legalized adult can-

**Table 1. Availability, Placement, and Consumption Modality of Hemp-Derived Psychoactive Cannabis Products[a] Cleveland, Ohio, 2022-2023**

| | Full sample n=82 | | East side n=43 | | West side n=39 | | |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | p value[b] |
| **Availability** | | | | | | | |
| | 34 | 41.5% | 16 | 37.2% | 18 | 46.2% | 0.4116 |
| **Placement[c,d]** | | | | | | | |
| Not accessible | 33 | 97.1% | 15 | 93.8% | 18 | 100% | 0.2817 |
| Accessible | 1 | 2.9% | 1 | 6.3% | 0 | 0% | - |
| **Consumption modality[d,e]** | | | | | | | |
| Inhaled[f] | 28 | 82.4% | 12 | 75.0% | 16 | 94.1% | 0.1304 |
| Edible[g] | 24 | 70.6% | 10 | 62.5% | 14 | 82.4% | 0.1412 |
| Both inhaled and edible | 19 | 55.9% | 6 | 37.5% | 13 | 76.5% | 0.0366 |

[a] Includes products marketed as "delta" or "Δ" tetrahydrocannabinol (THC) excluding delta-9 THC which is naturally occurring.
[b] Calculated based on chi-square or Fisher exact test.
[c] Placement was measured to evaluate the potential accessibility of these products to youth. Products located behind the counter were considered not accessible while products located on the counter or by candy were determined to be accessible. Notably, only 1 retailer had products on the counter and no retailers placed these products near candy or elsewhere in the store.
[d] The proportion calculated here represents the number of retailers carrying hemp-derived psychoactive cannabis products.
[e] Retailers could carry multiple modalities of products which means that totals will not add up to 100%.
[f] As a vape or vaping concentrate, prerolled joint, or "flower."
[g] As a candy, beverage, or other edible.

nabis use in 2023, HDPCPs are expected to remain a prevalent public health issue, as they produce similar psychoactive effects to THC[3] but are much more accessible than legal cannabis products. Adult use cannabis sales are restricted to licensed dispensaries, and, while the state of Ohio has a limited number of dispensaries currently, a preponderance of tobacco retailers selling HDPCPs have already been identified as highlight in this research, demonstrating the high accessibility of these products in Cleveland and likely throughout Ohio.

The availability of inhaled products may pose similar health risks to combusted cannabis as well as cannabis that is in a concentrate or vaping liquid. Combusted HDPCPs present with respiratory symptoms resembling those from smoking delta-9 THC cannabis, including cough, respiratory tract irritation, and throat tightness.[25] Combusted cannabis has been shown to carry similar health risks as tobacco smoke. For example, Graves et al identified 110 different compounds in combusted cannabis smoke that are known to have a carcinogenic effect—69 of which are shared with tobacco smoke.[26] Vaping concentrates may similarly pose health risks. An analysis of vaping liquids obtained from patients diagnosed with e-cigarette or vaping product use-associated lung injury (EVALI) indicates a high prevalence of unnatural THC isomers including delta-8 and delta-10.[27,28] Preliminary evidence shows that 41.5% of adults who use delta-8 primarily consume it as a vaping concentration, increasing the potential public health risks posed by these products.[14]

This research highlights substantial availability of HDPCPs in the form of edibles and candies in Cleveland. Livne et al found these modalities to be popular, with 30.9% and 25.0% of past 30-day delta-8 users using edibles and candies, respectively.[14] The availability of edible products present concerns specific to adolescents, particularly with respect to those products available as gummies that resemble popular name-brand candies both in package design and flavors.[29] Not only do these products appeal to youth, but there is also the added risk of accidental intoxication of adolescents. Forty-one percent of adverse events reported to the National Poison Data System in 2021 were for delta-8 THC involved unintentional exposure, and most of these reports (77%) were for children under the age of 18 years.[30] The ongoing development of even stronger HDPCPs (such as THC-P with physiological affinity 33 times that of naturally occurring delta-9) poses even higher risk for accidental intoxication and adverse events.[13] Risks to health are specifically high for adolescents, whose brains are still developing. A review by Fisher et al highlights that adolescent cannabis exposure contributes to both psychiatric symptoms and daily function and may alter neurobiological pathways of reward and stress.[31] There may be a need for additional considerations regarding age restrictions of these products to reduce the risks posed to adolescents. Currently, there is no federal mandate or policy in the US stipulating a minimum legal purchasing age. Even if product packaging itself indicates an age restriction, there is no

legal obligation for HDPCP retailers currently to abide by these restrictions. Additionally, the widespread availability of these products may pose a risk to adults with substance use disorders. Given the psychoactive similarities between HDPCPs and cannabis, HDPCPs may be used as a substitute to cannabis, and a lack of information and education surrounding these products may cause accidental propagation of substance use disorders.[3,32]

The prevalence of HDPCPs in Cleveland, Ohio, was much greater among tobacco retailers compared to the prevalence documented in Fort Worth, Texas, where 11% of alcohol, tobacco, and cannabis retailers carried specifically delta-8 THC products.[15] However, this research may have captured a broader swath of HDPCPs available beyond delta-8 THC products. While the sample size of this study was limited to a subset of tobacco retailers in Cleveland, additional retail types may need to be examined such as cannabis dispensaries or alcohol retailers (although Livne et al suggests that the most common way of obtaining delta-8 THC is through stores that were not cannabis dispensaries[14]). Regardless, the prevalence of these products in these 2 municipalities in differing regions necessitates further investigation of this broader national phenomenon. Additionally, given the prevalence of HDPCPs in retailers that also sell commercial tobacco products, which are known to be marketed specifically toward marginalized populations,[33] further research should investigate whether these products are being marketed in the same way as commercial tobacco products.

While these results shed light on the emergence and prevalence of these products, there are several methodological improvements that may improve future surveillance. First, there was limited variability in the placement of these products highlighting several potential scenarios including that these products are less accessible in the retail setting to adolescents or products are higher value and require mechanisms of theft prevention. An improvement for capturing accessibility to adolescents could be capturing if retailers themselves have set a minimum purchasing age requirement. Second, results from Rossheim et al in Fort Worth, Texas, suggest that HDPCP item costs are variable across consumption modality with edibles (predominantly gummies) costing an average of $8.58 less than inhaled forms.[15] Specific formulations of HDPCPs were not captured in this research nor was a more in-depth measure of the consumption modality (ie, vaping concentrates, "flower," and prerolled joints were combined into a single category). As an alternate means of capturing accessibility of products, individual products and their respective prices and marketing may provide further depth for consideration. Lastly, retailers describe the consumers consistently by age group with responses ranging across the lifespan yet the open-ended measure used to capture this among clerks and owners is subjective and limited in its interpretability. Consumer behavior and perceptions of these products may be better quantified through a more rigorous human subjects research design or through qualitative research

which would allow us to more effectively assess the broader population-level health impacts of these products.

## PUBLIC HEALTH IMPLICATIONS

Hemp-derived psychoactive cannabis products are an emerging product presenting pressing threats to public health and potential harms to consumers. Data suggests that these products are quite prevalent in the city of Cleveland, Ohio, with 41.5% of tobacco retailers in this pilot study offering them in some form. The high availability of HDPCPs highlights a need for additional research into these products to better assess the public health impact to determine if regulatory oversight is a necessary public health measure.

**Data Availability Statement**

Data can be made available upon reasonable request to the corresponding author.

**REFERENCES**

1.  Agriculture Improvement Act 2018 (US) Pub L No. 115-334, 132 Stat 4490. Accessed May 5, 2024.
    https://www.congress.gov/115/plaws/publ334/PLAW-115publ334.pdf

2.  Erickson BE. Delta-8-THC craze concerns chemists. *Chem Eng News*. 2021;99:25-28. Accessed May 5, 2024.
    https://doi.org/10.1021/cen-09931-cover

3.  Hollister LE, Gillespie HK. Delta-8- and delta-9-tetrahydrocannabinol comparison in man by oral and intravenous administration. *Clin Pharmacol Ther*. 1973;14(3):353-357.
    https://doi.org/10.1002/cpt1973143353

4.  PubChem compound summary for CID 2977, delta-8-tetrahydrocannabinol. National Center for Biotechnology Information. Updated May 3, 2024. Accessed May 5, 2024.
    https://pubchem.ncbi.nlm.nih.gov/compound/delta-8-Tetrahydrocannabinol

5.  The unregulated distribution and sale of consumer products marketed as delta-8 THC. United States Cannabis Council. 2021. Accessed May 5, 2024.
    https://irp.cdn-website.com/6531d7ca/files/uploaded/USCC%20Delta-8%20Kit.pdf

6.  Johnson-Arbor K, Smolinske S. The current state of delta-8 THC. *Am J Emerg Med*. 2022;56:259-261.
    https://doi.org/10.1016/j.ajem.2021.06.066

7.  Leas EC, Nobles AL, Shi Y, Hendrickson E. Public interest in $\Delta^8$-tetrahydrocannabinol (delta-8-THC) increased in US states that restricted $\Delta^9$-tetrahydrocannabinol (delta-9-THC) use. *Int J Drug Policy*. 2022;101:103557.
    https://doi.org/10.1016/j.drugpo.2021.103557

8.  Livingston MD, Walker A, Cannell MB, Rossheim ME. Popularity of delta-8 THC on the internet across US states, 2021. *Am J Public Health*. 2022;112(2):296-299.
    https://doi.org/10.2105/AJPH.2021.306586

9.  Babalonis S, Raup-Konsavage WM, Akpunonu PD, Balla A, Vrana KE. $\Delta^8$-THC: legal status, widespread availability, and safety concerns. *Cannabis Cannabinoid Res*. 2021;6(5):362-365.
    https://pubmed.ncbi.nlm.nih.gov/34662224/

10. Webster GRB, Sarna LP, Mechoulam R, inventors; Full Spectrum Laboratories Ltd, assignee. Conversion of CBD to delta8-THC and delta9-THC. U.S. Patent No. 0,143,126. July 22, 2004.

11. Dubrow GA, Pawar RS, Srigley C, et al. A survey of cannabinoids and toxic elements in hemp-derived products from the United States marketplace. *J Food Compost Anal*. 2021;97:103800.
    https://doi.org/10.1016/j.jfca.2020.103800

12. Spindle TR, Sholler DJ, Cone EJ, et al. Cannabinoid content and label accuracy of hemp-derived topical products available online and at national retail stores. *JAMA Netw Open*. 2022;5(7):e2223019.
    https://doi.org/10.1001/jamanetworkopen.2022.23019

13. Citti C, Linciano P, Russo F, et al. A novel phytocannabinoid isolated from Cannabis sativa L. with an in vivo cannabimimetic activity higher than $\Delta9$-tetrahydrocannabinol: $\Delta9$-tetrahydrocannabiphorol. *Sci Rep*. 2019;9(1):1-13.
    https://doi.org/10.1038/s41598-019-56785-1

14. Livne O, Budney A, Borodovsky J, et al. Delta-8 THC use in US adults: sociodemographic characteristics and correlates. *Addict Behav*. 2022;133:107374.
    https://doi.org/10.1016/j.addbeh.2022.107374

15. Rossheim ME, LoParco CR, Walker A, et al. Delta-8 THC retail availability, price, and minimum purchase age. *Cannabis Cannabinoid Res*. 2024;9(1):363-70.
    https://doi.org/10.1089/can.2022.0079

16. Ohio legalizes adult use of recreational marijuana: what does this mean for employers?. Taft Law. November 21, 2023. Accessed May 5, 2024.
    https://www.taftlaw.com/news-events/law-bulletins/ohio-legalizes-adult-use-of-recreational-marijuana-what-does-this-mean-for-employers/

17. Donaldson S. Ohio lawmaker drafting standalone bill to regulate hemp products. Ideastream Public Media. January 5, 2024. Accessed May 5, 2024.
    https://www.ideastream.org/2024-01-05/ohio-lawmaker-drafting-standalone-bill-to-regulate-hemp-products

18. Ohio laws and penalties. NORML. Updated May 12, 2023. Accessed May 5, 2024.
    https://norml.org/laws/ohio-penalties-2/

19. Perzynski A, Berg KA, Thomas C, et al. Racial discrimination and economic factors in redlining of Ohio neighborhoods. *Du Bois Review: Social Science Research on Race*. 2022;1-17.
    https://doi.org/10.1017/S1742058X22000236

20. QuickFacts. United States Census Bureau. Accessed May 5, 2024.
    https://www.census.gov/quickfacts/fact/table/OH,clevelandcityohio,US/IPE120222

21. Bernhard W, Heeb T, Tytgat J. Delta-8-tetrahydrocannabinol, an emerging NPS and other structurally related cannabinoids. *Toxicol Anal Clin*. 2022;34(3): S174.
    https://doi.org/10.1016/j.toxac.2022.06.300

22. Akre C, Michaud PA, Berchtold A, Suris JC. Cannabis and tobacco use: where are the boundaries? A qualitative study on cannabis consumption modes among adolescents. *Health Educ Res*. 2010;25(1):74-82.
    https://doi.org/10.1093/her/cyp027

23. STARS. Counter Tobacco. Accessed May 20, 2024.
https://countertobacco.org/resources-tools/store-assessment-tools/stars/

24. Assurances of Voluntary Compliance. Counter Tobacco. Accessed May 20, 2024.
https://countertobacco.org/resources-tools/store-assessment-tools/assurances-of-voluntary-compliance/

25. Leas EC, Harati RM, Satybaldiyeva N, et al. Self-reported adverse events associated with Δ8-tetrahydrocannabinol (delta-8-THC) use. *J Cannabis Res.* 2023;5(1):15.
https://doi.org/10.1186/s42238-023-00191-y

26. Graves BM, Johnson TJ, Nishida RT, et al. Comprehensive characterization of mainstream marijuana and tobacco smoke. *Sci Rep.* 2020;10(1):7160.
https://doi.org/10.1038/s41598-020-63120-6

27. Ciolino LA, Ranieri TL, Brueggemeyer JL, Taylor AM, Mohrhaus AS. EVALI vaping liquids part 1: GC-MS cannabinoids profiles and identification of unnatural THC isomers. *Front Chem.* 2021;9:746479.
https://doi.org/10.3389/fchem.2021.746479

28. Duffy B, Li L, Lu S, et al. Analysis of cannabinoid-containing fluids in illicit vaping cartridges recovered from pulmonary injury patients: identification of vitamin E acetate as a major diluent. *Toxics.* 2020;8(1):8.
https://doi.org/10.3390/toxics8010008

29. LoParco CR, Rossheim ME, Walters ST, Zhou Z, Olsson S, Sussman SY. Delta-8 tetrahydrocannabinol: a scoping review and commentary. *Addiction.* 2023;118(6):1011-1028.
https://doi.org/10.1111/add.16142

30. Korioth T. Accidental exposure risks reported in children from delta-8 THC in cannabidiol products. AAP News. November 1, 2021. Accessed May 5, 2024.
https://publications.aap.org/aapnews/news/17433/Accidental-exposure-risks-reported-in-children?autologincheck=redirected

31. Fischer AS, Tapert SF, Louie DL, Schatzberg AF, Singh MK. Cannabis and the developing adolescent brain. *Curr Treat Options Psychiatry.* 2020;7(2):144-161.
https://doi.org/10.1007/s40501-020-00202-2

32. Kruger DJ, Kruger JS. Consumer experiences with delta-8-THC: medical use, pharmaceutical substitution, and comparisons with delta-9-THC. *Cannabis Cannabinoid Res.* 2023;8(1):166-173.
https://doi.org/10.1089/can.2021.0124

33. Cruz TB, Rose SW, Lienemann BA, et al. Pro-tobacco marketing and anti-tobacco campaigns aimed at vulnerable populations: a review of the literature. *Tob Induc Dis.* 2019;17:68.
https://doi.org/10.18332/tid/111397

**APPENDIX—Data Collection Tool**

| Tobacco, THC, Other: Product Placement & Advertising *check all that apply* | | | | | | | |
|---|---|---|---|---|---|---|---|
| **a. Product Available** | **NONE** | **BEHIND COUNTER** | **ON COUNTER/ KIOSK** | **BY CANDY (within 1 ft)** | **ELSEWHERE IN STORE** | **FLAVOR** CHARACTERIZING | **FLAVOR** CONCEPT |
| Cigarettes | | | | | | | |
| Menthol Cigarette | | | | | | n/a | n/a |
| LCCs | | | | | | | |
| ENDS | | | | | | | |
| NRT | | | | | | n/a | n/a |
| **a.1. New Products of Interest** | **NONE** | **BEHIND COUNTER** | **ON COUNTER/ KIOSK** | **BY CANDY (within 1 ft)** | **ELSEWHERE IN STORE** | **INHALED PRODUCT** List types | **EDIBLE PRODUCT** List Types |
| CBD | | | | | | | |
| Delta THC | | | | | | | |
| Kratom | | | | | | | |
| Other: | | | | | | | |

| **b. Interior Advertising** | **INSIDE** | | | | |
|---|---|---|---|---|---|
| | **NONE** | **BELOW 3 ft.** | **3+ ft.** | **FLAVOR CHARACTERIZING** | **FLAVOR CONCEPT** |
| Cigarettes | | | | | |
| LCCs | | | | | |
| ENDS | | | | | |
| NRT | | | | | n/a | n/a |
| Hemp | | | | | n/a | n/a |

| **c. Outdoor Advertising** | **# ON BUILDING** | | | | **# ON PROPERTY** | | | |
|---|---|---|---|---|---|---|---|---|
| | **NONE** | **#** | **FLAVOR CHARACTERIZ-ING** | **FLAVOR CONCEPT** | **NONE** | **#** | **FLAVOR CHARACTERIZING** | **FLAVOR CONCEPT** |
| Cigarettes | | | | | | | | |
| LCCs | | | | | | | | |
| ENDS | | | | | | | | |
| NRT | | | n/a | n/a | | | n/a | n/a |
| Hemp | | | n/a | n/a | | | n/a | n/a |
| **d. Is there local, state or federal t21 signage posted?** | YES    NO | | | | | | | |
| **e. Did you purchase a product?** | YES    NO | | | | Did they check your ID?  YES   NO ___ | | | |

**RESEARCH ARTICLE**

# Racial Disparities in Obstetrical Outcomes: A Single Institution Study

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**ABSTRACT**

**Background:** Maternal and neonatal morbidity and mortality is a prevalent and pressing issue in our health care system that is disproportionately affecting minority populations at increasing rates. This study's objective is to analyze data from a single institution in southwest Ohio to determine if racial disparities are present and to what extent different measures of labor outcomes are influenced.

**Methods:** We analyzed retrospective data utilizing the electronic medical records system from a multicenter hospital system in southwest Ohio, dating January 2019 to July 2021. The dataset included demographic, obstetrical, and labor outcomes of patients who gave birth to singleton pregnancies at 37 weeks gestation or greater during the time period. Using the patients' self-identified race, chi-square tests and Student t tests were used to identify disparities in obstetrical outcomes.

**Results:** Of the 13 666 patients in the cohort, non-Caucasian patients experienced higher rates of cesarean delivery than Caucasian patients and were more likely to have higher maternal composite scores, indicating a higher rate of adverse effects during and after labor. The nulliparous, term, singleton, vertex (NTSV) rate was 5% higher among non-Caucasian patients than Caucasian patients. Significant differences in the length of time between induction and delivery were also found between race groups.

**Conclusion:** Our findings suggest the presence of unmeasured clinical and nonclinical factors that are affecting the care of minority patients, similar to the findings of current and past literature. This data can be utilized as a baseline for future interventions aimed at reducing the disparities in Ohio and across the country.

**Keywords:** Racial disparities; Labor outcomes; Maternal morbidity; Women's health

## INTRODUCTION

The United States has the highest infant and maternal mortality rates among high-income countries, despite spending more per capita on health care than other high-income countries.[1] Within these high morbidity and mortality rates, there exists a pronounced disparity between White and minority patients. Black pregnant patients are up to 3 times more likely to die from pregnancy-related complications than White pregnant patients and are more likely to die from a preventable cause.[2,3] There have been observed disparities in cesarean delivery rates and indications among racial groups, with minority populations having significant-ly higher odds of having a cesarean delivery compared to White patients.[4]

There has been a rapid rise in the rates of cesarean delivery, up over 4% from 2019 to 2021, but without an associated decrease in the rates of maternal and neonatal mortality.[5] This increase was driven predominantly by primary cesarean deliveries (ie, patients who have not had a prior cesarean delivery).[6,7] Cesarean delivery is often a lifesaving procedure for both the mother and baby, but it is not without higher risks of maternal morbidity and mortality and adverse neonatal outcomes compared to vaginal deliveries.[8] These findings have led to the rate of cesarean deliveries among

patients with nulliparous, term, singleton, vertex pregnancies (NTSV) becoming the central metric used by health care systems for tracking interventions aimed at reducing cesarean delivery rates.[5,9] Regardless of race, NTSV rates are higher among patients with multiple comorbidities compared to patients with no comorbidities. However, among patients with no comorbidities, non-Hispanic Black patients have the highest NTSV rate among all race groups.[10]

As the growing cesarean rates become more apparent, induction of labor (IOL) has become an increasingly common procedure as it can reduce the risk of cesarean delivery and provide benefits for the baby.[11,12] About 1 in 5 pregnant patients in the United States will undergo IOL, but the process varies by patient, providers, and institution making the outcomes and levels of maternal birth satisfaction, assessed by the Birth Satisfaction Scale–Revised, also vary widely.[13,14] Historically, systemic racism both outside and within the health care system, as well as reports of mistreatment by minority patients, have been well-documented in literature to affect the trust and relationships between patients and their provider.[15,17] Specific to IOL, Black patients are more likely to describe lower levels of birth satisfaction, hypothesized to be associated with the higher rates of inductions resulting in cesarean delivery and longer laboring times also reported in this group.[14,18]

The current gaps in the research lie in how to best create and implement solutions that will reduce the racial disparities in maternal and neonatal morbidity. Limited research has shown that applying standardized protocols to common obstetrical procedures has successfully reduced the overall maternal mortality rate as well as the differing rates of cesarean deliveries and neonatal morbidities between racial groups.[19] There are many factors that can contribute to the disparities seen in patient morbidity, but statistically significant risks may vary between providers, hospitals, and communities. Understanding how the patients within Ohio and our community are affected by these factors has significant implications for public health in Ohio and can be utilized to improve care for all patients. The purpose of our study is to analyze the data from a single institution in southwest Ohio to determine if racial disparities are present and to what extent different measures of labor outcomes are disproportionately affected. This data will allow us to better understand the disparities present in our community and in Ohio and will serve as a baseline for comparing the effectiveness of interventions on patient outcomes in the future.

## METHODS

### Data and Participants

Retrospective data were extracted from the electronic medical record at a large hospital system in southwestern Ohio. Patient identifiers were removed from the dataset prior to analysis. All pregnant patients at 37 weeks of gestational age or greater who were admitted to 1 of the 5 maternity locations within a single health system from January 2019 to July 2021 were eligible for inclusion. Individuals were excluded if they were carrying more than 1 baby to ensure the study population did not include those at increased risk for poor maternal or fetal outcomes due to multiple gestation. In total, 13 666 patients met criteria to be included in the study. The data included demographic information such as gestational age at delivery, self-identified race, zip code of residence, primary language spoken, type of insurance, and the presence of diabetes and/or hypertension. It also included measures of obstetrical outcomes such as date and time of admission and delivery, maternal morbidity and maternal outcome composite scores, neonatal morbidity and neonatal outcome composite scores, mode of delivery, birth weight, and induction of labor rates. This study was approved by the Wright State University Institutional Review Board (#07272).

### Measures

Maternal outcome composite scores were calculated as a yes or no that at least 1 adverse effect occurred for the mother during labor and delivery or up to 4 weeks postpartum, effects included third- or fourth-degree perineal laceration, blood transfusion, endometritis, wound separation or infection, venous thromboembolism, hysterectomy, intensive care unit admission, eclampsia, cardiac arrest, or death. Neonatal outcome composite scores were calculated as a yes or no that at least 1 adverse effect occurred for the neonate during or after delivery, effects included severe respiratory distress, need for resuscitation, sepsis, and/or admission to the neonatal intensive care unit (NICU). If an adverse outcome was present, the patient received a score of 1, if no adverse outcome occurred, they received a 0. The average birth weight of the babies born to the whole cohort and to each race group was defined, as well as the percentage of babies that qualified as small for gestational age (SGA). Small for gestational age was defined as a weight less than the 10th percentile for the gestational age and sex of baby as set by the American Academy of Pediatrics.[20] A vaginal birth after cesarean delivery (VBAC) is a term used for patients who undergo vaginal delivery following a previous cesarean delivery in a prior pregnancy. The data included whether the patient attempted a VBAC and, if so, whether it was successful or failed. Using these data, we could calculate a successful VBAC rate by determining the ratio of successful VBACs to all attempted VBACs.

### Statistical Analysis

Descriptive statistics of the data from each of the 4 sites within the hospital system were first completed to identify if there were significant differences in the patient populations between the sites. The demographics were not found to be significantly different between the sites, so the remaining analysis was done with data from all sites together. Patients were grouped by their self-identified race as recorded in the medical record. In this study the largest racial groups were Caucasian (73.2%) and Black or African American (21.7%). All patients who did not identify as Caucasian were also grouped into a secondary non-Caucasian category to allow for a comparison of Caucasian patients versus all other

races. Descriptive statistics were used to characterize the demographic and clinical data of the entire cohort and of each race group. The associations between the groups were compared using chi-square tests for categorical variables and Student t tests for the continuous variables. Statistical significance was defined as $P < 0.05$. All statistical analysis was performed on SPSS version 29.0 software (IBM, Armonk NY).

## RESULTS

### Cohort Demographics

Demographic and health history of the cohort grouped by race are reported in Table 1. Overall, 73% of the patients identified as Caucasian and 21.7% as Black or African American. In the period studied, there were no cases of maternal death and 8 cases of neonatal death, 5 Caucasian babies and 3 Black or African American babies, which each accounted for 0.1% of babies born to the respective groups. English was identified as the primary language spoken of 95% of the cohort. A prior parity was experienced by 64.5% of the cohort; this rate was similar across Caucasian and non-Caucasian patients. There were statistically significant differences for age, body mass index (BMI), maternal comorbidities, and insurance type between Caucasian and non-Caucasian patients. Caucasian patients tended to be older, have lower BMIs, and have diabetes at the time of labor while non-Caucasian patients were more likely to

have hypertension and have Medicaid insurance. Over 77% of Black or African American patients utilized Medicaid compared to 34.7% of Caucasian patients.

### Labor Outcomes

In total, 3 953 patients (28.9%) underwent a cesarean delivery. Non-Caucasian patients underwent a cesarean delivery at a significantly higher rate than Caucasian patients (30.0% vs 28.5%; $P < 0.01$). Of the patients who received cesarean delivery, 47.2% were experiencing cesareans for the first time, and this rate was similar across race groups. The rate of attempted VBAC was higher in non-Caucasian individuals than Caucasian individuals but was more often successful in Caucasian patients (78.6% vs 68.5%; $P < 0.01$). Examination of NTSV data showed a significantly higher rate in non-Caucasian patients when compared to Caucasian patients, a difference of 5%. Table 2 describes the labor outcomes for the entire cohort and group breakdowns.

### Neonatal Outcomes

Neonatal outcomes included birth weight, the rate of NICU admission, the proportion of babies that were small for gestational age (SGA), and neonatal composite score (Table 3). Caucasian babies had an average neonatal composite score of 0.05 while non-Caucasian babies had an average neonatal composite score of 0.07. There was a statistically significant difference in the

### Table 1. Demographic and Health History for Full Cohort and by Racial Groups

| | Entire Cohort (n = 13666) | Caucasian (n = 9999) | Black or African American (n = 2965) | All non-Caucasian (n = 3667) | P value (Caucasian vs Black/African American) | P value (Caucasian vs non-Caucasian) |
|---|---|---|---|---|---|---|
| **Age at Delivery** [years (mean ± SD)] | 28.1 ± 5.6 | 28.5 ± 5.4 | 26.5 ± 5.8 | 27.0 ± 5.9 | <.001 | <.001 |
| **BMI** (mean ± SD) | 33.4 ± 6.9 | 33.3 ± 6.7 | 34.1 ± 7.5 | 33.6 ± 7.3 | <.001 | .008 |
| **Gestational Age at Delivery** [weeks (mean ± SD)] | 38.9 ± 1.1 | 39.0 ± 1.1 | 38.8 ± 1.1 | 38.9 ± 1.1 | <.001 | <.001 |
| **Diabetes** [n (%)] | 1306 (9.6%) | 994 (9.9%) | 218 (7.3%) | 312 (8.5%) | <.001 | .005 |
| **Hypertension** [n (%)] | 2481 (18.2%) | 1674 (16.7%) | 712 (24.0%) | 807 (22.19%) | <.001 | <.001 |
| **Prior Parity** [n (%)] | 8690 (64.5%) | 6348 (64.3%) | 1915 (65.9%) | 2337 (65.2%) | .159 | .324 |
| **Medicaid Insurance** [n (%)] | 6090 (44.6%) | 3465 (34.7%) | 2290 (77.2%) | 2634 (71.8%) | <.001 | <.001 |

### Table 2. Labor Outcomes for Full Cohort and by Racial Groups

| | Entire Cohort (n = 13666) | Caucasian (n = 9999) | Black or African American (n = 2965) | All non-Caucasian (n = 3667) | P value (Caucasian vs Black/ African American) | P value (Caucasian vs non-Caucasian) |
|---|---|---|---|---|---|---|
| **Cesarean Delivery** [n (%)] | 3954 (28.9%) | 2855 (28.5%) | 900 (30.3%) | 1098 (30.0%) | .061 | .028 |
| **Repeat Cesarean** [n (%)] | 1980 (52.8%) | 1519 (53.4%) | 461 (51.2%) | 562 (51.2%) | .236 | .126 |
| **Attempted VBAC** [n (%)] | 624 (4.6%) | 384 (3.8%) | 197 (6.6%) | 240 (6.6%) | <.001 | <.001 |
| **Successful VBAC Rate** [n (%)] | 469 (75.2%) | 302 (78.6%) | 92 (68.5%) | 167 (69.6%) | <.001 | <.001 |
| **NTSV Rate** [n (%)] | 1086 (27.5%) | 774 (24.7%) | 273 (29.8%) | 312 (29.5%) | .006 | .007 |

VBAC: vaginal birth after cesarean delivery; NTSV: nulliparous, term, singleton, vertex; Successful VBAC rate: The ratio of successful VBACs to attempted VBACs.

proportion of Caucasian babies admitted to the NICU versus the proportion of non-Caucasian babies admitted (4.9% vs 6.7%; P < 0.001). Non-Caucasian babies were more likely to be SGA than Caucasian babies (13.1% vs 6.4%, respectively). Black or African American babies qualified as SGA at a rate of 13.7%, while only 6.4% of Caucasian babies qualified as SGA.

## Maternal Outcomes

During the period studied, there were no cases of maternal death. The average maternal composite score for Caucasian patients was 0.04 while the average maternal composite score for non-Caucasian patients was significantly higher at 0.05 (P < 0.01). The average length of stay (LOS) for patients giving birth was 2.2 days which was similar across the different racial groups (Table 4).

## Inductions and Laboring Length of Time

Overall, 30% of the patients in the cohort were induced into labor. Patients in labor less than 2 hours or greater than 100 hours were excluded from this analysis. Patients who were induced showed a similar length of time between time of induction and time of eventual delivery, about 23 hours. For the patients who were induced

into labor and delivered via cesarean delivery, non-Caucasian patients spent a significantly shorter length of time in labor than Caucasian patients (29.0 hours vs 33.3 hours, P < 0.01). When induced patients delivered vaginally, there was no significant difference in the length of laboring time between racial groups. For all patients presenting to any maternity site (all comers) who eventually had a vaginal delivery, the average length of laboring time was 14.8 hours and was significantly different between racial groups. For all comers who delivered via cesarean delivery, non-Caucasian patients spent a significantly longer length of time in labor when compared to Caucasian patients (13.5 vs 12.0, P < 0.01) (Table 5).

## DISCUSSION

We found that patients of different racial groups experienced delivery outcomes, maternal complications, and neonatal complications at significantly different rates. Of the cohort, 28.9% of patients received a cesarean delivery and 27.5% of those patients qualified as NTSV. We found a significantly higher overall rate of cesarean delivery and a higher NTSV rate among the non-Caucasian patients when compared to the Caucasian patients. Our

### Table 3. Neonatal Outcomes for Full Cohort and by Racial Groups

|  | Entire Cohort (n = 13666) | Caucasian ( n = 9999) | Black or African American (n = 2965) | All non-Caucasian (n = 3667) | P value (Caucasian vs Black/ African American) | P value (Caucasian vs non-Caucasian) |
|---|---|---|---|---|---|---|
| NICU Admission [n (%)] | 737 (5.4%) | 491 (4.9%) | 208 (7.0%) | 246 (6.7%) | <.001 | <.001 |
| Neonatal Composite Score (mean ± SD) | 0.06 ± 0.3 | 0.05 ± 0.24 | 0.08 ± 0 .29 | 0.07 ± 0.29 | <.001 | <.001 |
| Small for Gestational Age (SGA) [n (%)] | 1123 (8.2%) | 642 (6.4%) | 406 (13.7%) | 479 (13.1%) | <.001 | <.001 |
| Neonatal Death [n (%)] | 8 (0.06%) | 5 (0.05%) | 3 (0.1%) | 3 (0.08%) | .395 | .426 |

### Table 4. Maternal Outcomes for Full Cohort and by Racial Groups

|  | Entire Cohort (n = 13666) | Caucasian (n = 9999) | Black or African American (n = 2965) | All non-Caucasian (n = 3667) | P value (Caucasian vs Black/ African American) | P value (Caucasian vs non-Caucasian) |
|---|---|---|---|---|---|---|
| Composite Score (mean ± SD) | 0.04 ± 0.21) | 0.04 ± 0.20) | 0.04 ± 0.23 | 0.05 ± 0.24 | .017 | <.001 |
| Length of Stay (LOS) (mean ± SD) | 2.2 ± 2.5 | 2.1 ± 2.7 | 2.2 ± 2.0 | 2.2 ± 1.9 | <.001 | <.001 |

### Table 5. Inductions and Laboring Length of Time for Full Cohort and by Racial Groups

|  | Entire Cohort (n = 13666) | Caucasian (n = 9999) | Black or African American (n = 2965) | All non-Caucasian (n = 3667) | P value (Caucasian vs Black/ African American) | P value (Caucasian vs non-Caucasian |
|---|---|---|---|---|---|---|
| Induction Rate [n (%)] | 4105 (30.7%) | 3109 (31%) | 878 (29.5%) | 996 (27%) | .099 | .067 |
| Time to Delivery (All comers – Cesarean) [hours (mean ± SD)] | 12.4 ± 14.8 | 12.0 ± 15.0 | 13.4 ± 13.9 | 13.5 ± 14.1 | .012 | .007 |
| Time to Delivery (All Comers – Vaginal) [hours (mean ± SD)] | 14.8 ±11.1 | 15.0 ± 11.2 | 14.3 ± 10.7 | 14.2 ± 10.6 | .017 | .006 |
| Time to Delivery (Inductions – Cesarean) [hours (mean ± SD)] | 32.1 ± 16.1 | 33.3 ± 16.6 | 28.8 ±13.9 | 29.0 ± 14.2 | <.001 | <.001 |
| Time to Delivery (Inductions – Vaginal) [hours (mean ± SD) | 21.1 ± 12.6 | 21.2 ± 12.7 | 20.8 ± 11.8 | 20.6 ± 11.8 | .492 | .241 |

findings also showed more negative health outcomes, such as small for gestational age, NICU admissions, and higher composite scores, to be experienced by non-Caucasian babies at a higher rate than Caucasian babies. These adverse experiences as a neonate can increase the risk for chronic diseases, obesity, psychosocial barriers, and more.[21,22] The results suggest that unmeasured clinical and nonclinical factors may be affecting providers' judgments on the progression of labor or whether a cesarean delivery is warranted.

Our findings are consistent with current and past literature reporting that racial disparities are present in a wide range of labor outcomes and measures of maternal and neonatal morbidity. These patterns have persisted both across the United States and in many single-institution or state-specific studies.[23,24] Many providers in the field have turned toward the goal of creating and implementing efforts to narrow or eliminate racial and ethnic disparities, yet a specific path that solves this problem has yet to be agreed upon. Howell et al provides a framework and resources for those hoping to address the etiologies of these disparities and highlight the essential idea that each health care system requires modified interventions specific to their patients, community, and resources.[25]

Our data, showing that non-Caucasian patients experience labor outcomes at different rates than Caucasian patients, highlight a specific area in which modifiable factors may be affecting patient care. These include gaps in patient-provider communication, bias, stereotyping, and variations in provider experience.[4] With the discordance between cesarean rates and outcomes, in combination with the rising rates of maternal and neonatal morbidity, we can utilize our data to suggest that nondifferential treatment by providers is contributing in some capacity. A survey given to members of the Society of Maternal Fetal Medicine found that 83% of respondents agreed that disparities influence their practice, but only 29% believed their personal biases affected the care of their patients.[26] Although this shows a delay for some providers to acknowledge their own biases, the racial disparities found in the health care field today are products of the entire system, not any one individual.

**Strength and Limitations**

A key strength of this study was the large cohort from a hospital system that is racially diverse and representative of the geographic area it serves. There were a large number of variables included in the dataset that allowed us to explore many different associations between race groups and labor, maternal, and neonatal outcomes. The data originate from a multicenter hospital system that is capable of providing any level of care necessary before, during, and after labor. Data were included from all 4 maternity sites in the hospital system, ensuring we captured patients from diverse race groups, socioeconomic statuses, ages, and obstetrical history.

One major limitation of this study is that we utilized a retrospective dataset. There were multiple instances in which we had to exclude patients from analysis due to missing, incomplete, or inconsistencies in the data. Variables such as indications for cesarean delivery, ethnicity, and fetal heart tones, were not included in the dataset and may have provided greater insight for our analysis and future interventions. However, this retrospective dataset provided a large amount of data that was readily available for our use and allowed us to identify many disparities in obstetrical outcomes.

## PUBLIC HEALTH IMPLICATIONS

This study highlights the ongoing racial disparities that are prevalent in health care systems, both across the country and in Ohio. The state of Ohio has implemented programs such as the Ohio Pregnancy-Associated Mortality Review Program to monitor maternal mortality in Ohio and use data to implement informed activities and programs to reduce these rates, but it is clear that there is still work to be done. The pregnancy-related mortality rate has increased in Ohio from 2008 to 2018, with a disproportionately high rate among non-Hispanic Black patients.[27]

Our data specifically suggest that patients in Ohio of different racial groups are experiencing poorer labor outcomes at differing rates. Future steps include utilizing these results to target specific labor outcomes and create standardized protocols aimed at reducing the disparities we report. By removing the opportunity for unconscious bias of providers to affect the care of minority populations, we hope to see the disappearance of disparities in adverse labor outcomes and achieve lower rates of these outcomes for all patients.

**REFERENCES**

1. Gunja MZ, Gumas ED, Williams RD II. US health care from a global perspective, 2022: accelerating spending, worsening outcomes. The Commonwealth Fund. Published January 31, 2023. https://www.commonwealthfund.org/publications/issue-briefs/2023/jan/us-health-care-global-perspective-2022

2. Admon LK, Winkelman TNA, Zivin K, Terplan M, Mhyre JM, Dalton VK. Racial and ethnic disparities in the incidence of severe maternal morbidity in the United States, 2012–2015. *Obstet Gynecol.* 2018;132 (5):1158-1166. https://doi.org/10.1097/aog.0000000000002937

3.  Jain JA, Temming LA, D'Alton ME, et al. SMFM special report: putting the "M" back in MFM: reducing racial and ethnic disparities in maternal morbidity and mortality: a call to action. *Am J Obstet Gynecol*. 2018;218(2):B9-B17.
    https://doi.org/10.1016/j.ajog.2017.11.591

4.  Okwandu IC, Anderson M, Postlethwaite D, Shirazi A, Torrente S. Racial and ethnic disparities in cesarean delivery and indications among nulliparous, term, singleton, vertex women. *J Racial Ethn Health Disparities*. Published online July 12, 2021.
    https://doi.org/10.1007/s40615-021-01057-w

5.  CDC. Infant Mortality. Published May 14, 2024.
    https://www.cdc.gov/maternal-infant-health/infant-mortality/index.html

6.  Osterman MJK. Changes in primary and repeat cesarean delivery: United States, 2016–2021. Vital Statistics Rapid Release; no 21. Hyattsville, MD: National Center for Health Statistics. July 2022.
    https://doi.org/10.15620/cdc:117432

7.  Barber EL, Lundsberg LS, Belanger K, Pettker CM, Funai EF, Illuzzi JL. Indications contributing to the increasing cesarean delivery rate. *Obstet Gynecol*. 2011;118(1):29-38.
    https://doi.org/10.1097/aog.0b013e31821e5f65

8.  Caughey AB, Cahill AG, Guise JM, Rouse DJ. Safe prevention of the primary cesarean delivery. *Am J Obstet Gynecol*. 2014;210(3):179-193.
    https://doi.org/10.1016/j.ajog.2014.01.026

9.  Main EK, Chang SC, Cape V, Sakowski C, Smith H, Vasher J. Safety assessment of a large-scale improvement collaborative to reduce nulliparous cesarean delivery rates. *Obstet Gynecol*. 2019;133(4):613-623.
    https://doi.org/10.1097/aog.0000000000003109

10. Wetcher CS, Kirshenbaum RL, Alvarez A, et al. Association of Maternal Comorbidity Burden With cesarean Birth Rate Among Nulliparous, Term, Singleton, Vertex Pregnancies. *JAMA Netw Open*. 2023;6 (10):e2338604.
    https://doi.org/10.1001/jamanetworkopen.2023.38604

11. Mishanina E, Rogozinska E, Thatthi T, Uddin-Khan R, Khan KS, Meads C. Use of labour induction and risk of cesarean delivery: a systematic review and meta-analysis. *CMAJ*. 2014;186(9):665-673.
    https://doi.org/10.1503/cmaj.130925

12. Wood R, Freret TS, Clapp MA, Little S. Rates of induction of labor at 39 weeks and cesarean delivery following publication of the ARRIVE trial. *JAMA Netw Open*. 2023;6(8):e2328274-e2328274.
    https://doi.org/10.1001/jamanetworkopen.2023.28274

13. American College of Obstetricians and Gynecologists. Induction of Labor. Published 2020.
    https://www.acog.org/clinical/clinical-guidance/practice-bulletin/articles/2009/08/induction-of-labor

14. Hamm RF, Srinivas SK, Levine LD. Risk factors and racial disparities related to low maternal birth satisfaction with labor induction: a prospective, cohort study. *BMC Pregnancy Childbirth*. 2019;19(1).
    https://doi.org/10.1186/s12884-019-2658-z

15. OjiNjideka Hemphill N, Crooks N, Zhang W, et al. Obstetric experiences of young black mothers: an intersectional perspective. *Soc Sci Med*. 2022;317:115604.
    https://doi.org/10.1016/j.socscimed.2022.115604

16. Bailey ZD, Krieger N, Agénor M, Graves J, Linos N, Bassett MT. Structural racism and health inequities in the USA: evidence and interventions. *Lancet*. 2017;389(10077):1453-1463.
    https://doi.org/10.1016/s0140-6736(17)30569-x

17. Bower KM, Geller RJ, Perrin NA, Alhusen J. Experiences of racism and preterm birth: findings from a pregnancy risk assessment monitoring system, 2004 through 2012. *Womens Health Issues*. 2018;28(6):495-501.
    https://doi.org/10.1016/j.whi.2018.06.002

18. Wang X, Walsh D, Allsworth JE. The role of labor induction in racial disparities in cesarean delivery. *Mo Med*. 2021;118(3):246-252.
    https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8210985/

19. Hamm RF, Srinivas SK, Levine LD. A standardized labor induction protocol: impact on racial disparities in obstetrical outcomes. *Am J Obstet Gynecol MFM*. 2020;2(3):100148.
    https://doi.org/10.1016/j.ajogmf.2020.100148

20. Aris IM, Kleinman KP, Belfort MB, Kaimal A, Oken E. A 2017 US reference for singleton birth weight percentiles using obstetric estimates of gestation. *Pediatrics*. 2019;144(1).
    https://doi.org/10.1542/peds.2019-0076

21. Martín-Calvo N, Goni L, Tur JA, Martínez JA. Low birth weight and small for gestational age are associated with complications of childhood and adolescence obesity: systematic review and meta-analysis. *Obes Rev*. Published online November 16, 2021.
    https://doi.org/10.1111/obr.13380

22. Lean RE, Rogers CE, Paul RA, Gerstein ED. NICU hospitalization: long-term implications on parenting and child behaviors. *Curr Treat Options Pediatr*. 2018;4(1):49-69.
    https://doi.org/10.1007/s40746-018-0112-5

23. Sastow DL, Jiang SY, Tangel VE, et al. Patient race and racial composition of delivery unit associated with disparities in severe maternal morbidity: a multistate analysis 2007–2014. *Int J Obstet Anesth*. 2021;47:103160.
    https://doi.org/10.1016/j.ijoa.2021.103160

24. Huang RS, Spence AR, Abenhaim HA. Racial disparities in national maternal mortality trends in the United States from 2000 to 2019: a population-based study on 80 million live births. *Archives of Gynecology and Obstetrics*. 2023;309.
    https://doi.org/10.1007/s00404-023-06999-6

25. Howell EA, Brown H, Brumley J, et al. Reduction of peripartum racial and ethnic disparities: a conceptual framework and maternal safety consensus bundle. *J Obstet Gynecol Neonatal Nurs*. 2018;47(3):275-289.
    https://doi.org/10.1016/j.jogn.2018.03.004

26. Jain J, Moroz L. Strategies to reduce disparities in maternal morbidity and mortality: patient and provider education. *Semin Perinatol*. 2017;41(5):323-328.
    https://doi.org/10.1053/j.semperi.2017.04.010

27. Ohio Department of Health. Ohio Maternal Health Data and Reports. Published 2021.
    https://odh.ohio.gov/know-our-programs/pregnancy-associated-mortality-review/Reports

# The Prevalence of Adverse Childhood Experiences in Ohio: Changes from 2015 to 2019

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## ABSTRACT

**Background:** Adverse childhood experiences (ACEs) are associated with long-term negative health outcomes including substance use and mental health disorders. Little is known about how exposure to ACEs impacts health care access in adulthood.

**Methods:** We examined the prevalence of ACEs in 2015 and 2019 in Ohio. We analyzed relationships between ACEs and self-reported health outcomes, with a focus on health care access and utilization. We examined the 2015 and 2019 Behavioral Risk Factor Surveillance System (BRFSS) data from 14 247 persons who resided in Ohio. We stratified participants by ACE prevalence and assessed demographic differences between groups. Multivariable and multinomial logistic regression models were used to analyze health-related outcomes of interest.

**Results:** The prevalence of experiencing any ACE increased from 2015 to 2019, from approximately 62% to 68%. Exposure to ACEs was associated with smoking (OR = 3.167), binge drinking (OR = 3.259), and heavy drinking (OR = 4.455). Persons with any ACEs had increased odds of no health insurance (OR = 1.435) and increased odds of not having a doctor for any reason (OR = 1.722). Persons with 3 ACEs had 4.307 times the odds of depression, and this increased to 8.250 among persons with 5 or more ACEs. There was no association between ACEs and hypertension, cancer, heart attacks, stroke, and diabetes.

**Conclusion:** These findings support the hypothesis that ACEs have a long-term effect on health and access to health care. Findings from this study may inform interventions to reduce the incidence and long-term sequelae of ACEs.

**Keywords:** ACEs; Mental health; Health care utilization; Health care access; Epidemiology

## INTRODUCTION

Adverse childhood experiences (ACEs) have long-term effects on health across the lifespan.[1] Adverse childhood experiences include events such as direct experiences of childhood physical and emotional abuse, sexual abuse, witnessing domestic violence, and indirect effects through their home environment such as having a family member with mental illness, a family member in prison, or a family member with substance abuse.[2] Consequences linked to ACEs are varied. Persons who experience ACEs have a propensity for increased physical or mental health problems as adults.[3] Elevated risk of substance use and mental health disorders are linked to ACEs.[4,5] Research has tied ACEs to physical health conditions including cardiovascular diseases and cancers.[6–8] Exposure to ACEs may also result in an elevated risk of detrimental health behaviors and chronic health conditions later in life.[4,9]

A life course perspective offers a plausible relationship between exposure to ACEs and the development of these adverse consequences later in life.[10,11] Through this lens, exposure to harmful events during sensitive periods in development has a long-term impact and impacts the trajectory of a person's life, including socioeconomic status, educational attainment, and health outcomes.[12–15] Closely related to the life course perspective is the

concept of stress proliferation, where stressors such as ACEs give rise to additional stressors later in life.[16-18] Taken together, these perspectives posit that ACEs trigger an initial stress response that predisposes an individual to stressors later in life. As such, ACEs may have a profound impact on health-related outcomes across the lifespan.

Exposure to ACEs in the United States (US) is not uncommon. An estimated 57.8% of US adults experienced at least 1 ACE, and greater than 20% experienced more than 3 ACEs.[19] A separate analysis found that approximately 16% reported 4 or more ACEs.[20] The average number of cumulative ACEs is estimated to be higher among women and young adults.[21] A higher number of cumulative ACEs was reported among those with lower education levels, lower income levels, and among those identifying as a sexual minority.[19,21] Adverse childhood experiences can be framed as preventable risk factors for disease.[22,23] Preventing ACEs is of unique importance to improve the health and safety of children as they develop and mature into adulthood.

Despite the robust literature on the impact of ACEs on health outcomes, substantially less research has focused on the connection between ACEs and both health care utilization and health care access. Evidence suggests that ACEs are associated with increased use and higher health care costs.[24,25] Emerging data indicate that exposure to ACEs is linked to more missed medical appointments and higher unmet care needs.[26,27] Greater exposure to ACEs is also associated with being uninsured later in life.[20,26,28] Early work on this topic has been limited by a focus on highly specialized populations.[29] Previous studies of ACEs assessing outcomes related to health care utilization in large representative surveys of the US are limited by challenges related to the implementation of the Affordable Care Act or the use of a single period.[20,26]

Other limitations to ACEs research include methodological challenges in operationalizing ACEs. While a substantial body of research uses a cumulative risk approach to ACEs, where each additional ACE increases the risk of adverse outcomes, alternative approaches have been developed.[30,31] Individual-risk and latent class approaches include assessments of how each category of ACEs contributes to risk. Findings from these studies highlight that different combinations and types of ACEs may contribute uniquely to health outcomes.[26,30,31] Understanding not only the distribution of cumulative ACEs in the population but also the prevalence of each type is critical to developing effective interventions to mitigate the lifelong harms of ACEs.

In this study, we expand on previous research using representative survey data and report an analysis of ACEs among Ohioans. We describe the prevalence of ACEs by sociodemographic characteristics to highlight the distribution and patterning of ACEs in Ohio. We build off previous literature by assessing the relationship between ACEs, health behaviors, and health care utilization and access within the same population using multiple years of representative survey data. Further, we expand the current litera-

ture through assessments of whether insurance modifies the relationship between ACEs and health care utilization for chronic conditions. Identifying at-risk groups can inform prevention efforts and policy. Findings from the Behavioral Risk Factor Surveillance System (BRFSS) ACEs module may assist in identifying those at increased risk of negative health outcomes. From this, effective screening and interventions can be developed to mitigate the long-term sequelae of ACEs.

## METHODS

### Study Design and Data Source

This cross-sectional study used publicly available data from the BRFSS from 2015 and 2019. The BRFSS is a nationwide population-based computer-assisted telephone interview survey conducted by the Centers for Disease Control and Prevention (CDC) on noninstitutionalized adults aged 18 years or over.[32] The BRFSS is implemented in each state separately. The Ohio BRFSS consists of a core questionnaire, optional modules, and state-added questions. Data were sourced from the Ohio BRFSS, which included an ACE module in both 2015 and 2019. The psychometric properties of the BRFSS have been tested numerous times and demonstrate high levels of reliability.[33]

We included respondents who completed the core component questions and the ACE module in both 2015 and 2019. In 2019, both the core module and the optional ACE module were completed by 7523 persons, resulting in a weighted sample of 7 434 373. In 2015, both the core module and the optional ACE module were completed by 6724 persons, resulting in a weighted sample of 7 350 673.

### Ethical Considerations

This research is a secondary data analysis of the BRFSS, which is a publicly available dataset containing deidentified survey data. As no members of the research team were involved in data collection nor can access participant identifiers linked to the data, this study does not meet the criteria of human subjects research as defined by the National Institute of Health and was not subject to institutional review board (IRB) review.

### Measures

The core questions from the Ohio BRFSS used for this analysis included: self-rated health status, health care access, asthma, diabetes, cardiovascular disease, tobacco, and alcohol use. Additional demographic variables such as age, gender, race, marital status, household income, employment status, and education level were included. The age of adults was categorized into 3 groups: 18-49 years, 50-64 years, 65 years and over. Responses to employment items were used to create 2 dichotomous 'employed' and 'unemployed' variables. Employment was defined by responses of 'employed for wages' or 'self-employed'; unemployed was defined by responses of 'out of work' for either less than or more than a year.

Health care access items were sourced from the health care access module. Health care utilization variables included HIV testing, taking blood pressure medication, and having cholesterol checked. Responses were dichotomized such that any affirmative response to having cholesterol checked within the past 5 years was coded as having had cholesterol checked. The BRFSS questions regarding blood pressure medications reflect not taking blood pressure medications for any reason, such as not being prescribed them, and do not reflect adherence to prescribed medications.

Questions about chronic medical conditions (including asthma, diabetes, chronic obstructive pulmonary disease (COPD), and cardiovascular disease) were asked using a standard format "(ever told) you had…?" Cardiovascular conditions included coronary artery disease, stroke, and heart attack or myocardial infarction. Cancer diagnoses were determined using responses to 2 items: "(ever told) you had skin cancer?" and "(ever told) you had any other types of cancer?" An affirmative response to either question was coded as having a cancer diagnosis.

Heavy drinking was defined as male respondents reporting 15 drinks per week or more, and female respondents who reported having 8 drinks per week or more. Binge drinking was defined as respondents who reported having a drink in the past 30 days and having had 5 or more drinks on one or more occasions in the past month. Definitions of heavy drinking and binge drinking are based on US Government guidelines on alcohol consumption and are shown to correlate with risk of alcohol use disorder (AUD).[34-36] Current tobacco use was operationalized as those who reported smoking at least 100 cigarettes in their lifetime and currently smoked either every day or some days.

Poor mental health was operationalized as a dichotomous indicator of 14 days or more of the past 30 days of self-reported poor mental health. Similarly, poor physical health was operationalized as 14 or more days of the past 30 days of self-reported poor physical health. These metrics are part of the 4-item health-related quality of life measure employed by the CDC and have been demonstrated to have high reliability and validity in the population. The 14-day threshold was originally used in the literature to define frequent mental distress but has also been applied to physical health.[37-42] Depression was included as a separate self-reported health condition.

The ACE questionnaire was included in both the 2015 and 2019 BRFSS. The ACE module was originally developed in 1985 and consists of 11 questions assessing events experienced during childhood.[2] Abuse-oriented questions asked for frequency of occurrence including "never," "once," or "more than once." Questions from the ACE module related to child sexual abuse were collapsed from 3 questions into 1 sexual abuse variable, and questions related to alcohol and drug use were collapsed from 2 questions into 1 substance abuse variable. The ACE items asking for frequency of occurrence were collapsed into "at least once" or "never," creating a dichotomous exposure variable. For the total number of ACEs, or

cumulative score, the individual indicators were summed to represent a score bounded by 0 and 8. Due to low counts at the higher ACE scores, those with 5 or more ACEs were collapsed into 1 category. Assessments of the BRFSS ACE module suggest strong reliability and validity.[43-45]

### Data Analysis

Participants were stratified by the prevalence of ACEs. We estimated the proportion of demographic variables, including sex, age, race, education level, income level, employment status, and insurance coverage, within each group of ACE prevalence.

Multivariable logistic regressions were used to assess the association between ACEs and the odds of 8 health conditions (ie, high blood pressure, cancer, heart attack, stroke, COPD, diabetes, asthma, and depression), 3 health behaviors (ie, current smoking, heavy drinking, and binge drinking), and 2 indicators of subjective well-being (ie, poor physical health and poor mental health) by number of ACEs. Further, we used multivariable logistic regression models to quantify the relationship between number of ACEs and indicators of health care access and health care utilization. We hypothesized that insurance status may impact an individual's decisions to utilize care, and thus conducted analyses for health care utilization variables both with insurance status as a covariate, and without. No additional covariates were included in these models.

Due to the strong relationship between ACEs and depression, we separately assessed the odds of current poor mental health and lifetime depression among those exposed to each ACE category. This was performed using a multivariable logistic regression model controlling for each category of ACE and respondents' gender. Further, a multinomial logistic regression model was used to assess the odds of days in poor mental health by number of ACEs. No additional control variable was used in this model. All analyses incorporated the use of survey-weights, in accordance with guidelines provided by the CDC and software-specific survey documentation.[46,47] All analyses were completed using Stata (version 17).

### RESULTS

#### Demographic Characteristics

A total of 7523 persons completed the 2019 Ohio Core BRFSS and ACE module, resulting in a weighted sample of 7 434 373 persons. Of the weighted sample, 48.9% were male and 51.1% were female (Table 1). Approximately 81% of the sample self-identified as White/Caucasian. The modal category of education was a high school education or GED, and the modal income category was below $35 000 per year. Nearly 50% of persons were between the ages of 18 and 49 years.

#### Prevalence of ACEs

Demographic characteristics of Ohioans in 2019 (Table 1) and 2015 (Appendix) are presented both stratified by ACEs and overall. The portion of the sample reported having at least 1 ACE in

**Table 1. Demographic Characteristics of Weighted 2019 BRFSS Sample by Prevalence of ACEs**

| | | Overall % (95% CI) | No ACEs % (95% CI) | At least 1 ACE % (95% CI) | Number of ACEs Mean (95% CI) |
|---|---|---|---|---|---|
| Total | | 100% | 31.3 (29.7, 32.9) | 68.7 (67.1, 70.3) | 1.87 (1.80, 1.95) |
| **Biological sex** | | | | | |
| | Male | 48.9 (47.1, 50.7) | 48.0 (45.1, 50.9) | 49.3 (47.0, 51.6) | 1.76 (1.66, 1.87) |
| | Female | 51.1 (49.3, 52.9) | 52.0 (49.1, 54.9) | 50.7 (48.4, 53.0) | 1.98 (1.87, 2.08) |
| **Age group** | | | | | |
| | 18-49 years | 49.9 (48.2, 51.7) | 38.1 (35.1, 41.3) | 55.3 (53.2, 57.5) | 2.29 (2.16, 2.43) |
| | 50-64 years | 26.2 (24.8, 27.7) | 28.1 (25.8, 30.5) | 25.4 (23.7, 27.2) | 1.70 (1.60, 1.81) |
| | 65 years or older | 23.0 (22.0, 24.2) | 32.5 (30.3, 34.8) | 18.7 (17.5, 20.0) | 1.18 (1.10, 1.25) |
| | Missing | 0.8 (0.5, 1.1) | 1.3 (0.8, 2.0) | 0.6 (0.3, 1.0) | |
| **Race** | | | | | |
| | White/Caucasian | 80.7 (79.0, 82.2) | 84.5 (81.9, 86.7) | 79.0 (76.8, 81.0) | 1.79 (1.71, 1.87) |
| | Black/African American | 10.2 (9.0, 11.6) | 8.5 (5.8, 9.5) | 11.5 (9.8, 13.3) | 2.26 (1.98, 2.53) |
| | Asian | 2.3 (1.8, 2.9) | 2.9 (2.0, 4.2) | 2.0 (1.4, 2.8) | 1.84 (1.25, 2.43) |
| | Other | 5.4 (4.6, 6.4) | 3.6 (2.5, 5.2) | 6.2 (5.2, 7.6) | 2.39 (2.01, 2.78) |
| | Missing | 1.4 (1.1, 1.9) | 1.6 (1.0, 2.3) | 1.4 (1.0, 2.3) | |
| **Highest level of education** | | | | | |
| | Elementary school | 9.8 (8.5, 11.4) | 7.1 (5.4, 9.3) | 11.1 (9.3, 13.1) | 2.54 (2.16, 2.92) |
| | Completed high school/GED | 32.7 (31.0, 34.4) | 31.1 (28.7, 33.7) | 33.4 (31.2, 35.6) | 1.98 (1.85, 2.10) |
| | Some college | 30.6 (28.9, 32.3) | 28.3 (25.7, 31.1) | 31.6 (29.5, 33.8) | 1.94 (1.81, 2.07) |
| | College degree or higher | 26.8 (25.3, 28.3) | 33.2 (30.6, 35.8) | 23.9 (22.2, 25.7) | 1.43 (1.33, 1.53) |
| | Missing | 0.2 (0.1, 0.4) | 0.3 (0.1, 0.9) | 0.2 (0.0, 0.3) | |
| **Employment status[a]** | | | | | |
| | Employed | 57.9 (56.1, 59.6) | 53.0 (50.1, 55.8) | 60.1 (57.9, 62.2) | 1.92 (1.81, 2.02) |
| | Unemployed | 4.4 (3.6, 5.4) | 2.5 (1.6, 3.9) | 5.3 (4.3, 6.6) | 2.88 (2.39, 3.36) |
| | Other | 37.4 (35.8, 39.0) | 43.9 (41.2, 46.7) | 34.4 (32.4, 36.4) | 1.69 (1.59, 1.80) |
| | Missing | 0.4 (0.2, 0.6) | 0.6 (0.3, 1.3) | 0.2 (0.1, 0.5) | |
| **Annual household income** | | | | | |
| | < $35,000 | 31.1 (29.4, 32.8) | 26.1 (23.6, 28.6) | 33.4 (31.3, 35.6) | 2.26 (2.11, 2.40) |
| | $35 000 - $74 999 | 27.2 (25.5, 28.9) | 26.3 (23.8, 29.0) | 27.5 (25.4, 29.7) | 1.84 (1.69, 1.99) |
| | ≥ $75 000 | 28.2 (26.6, 29.9) | 31.3 (28.6, 34.0) | 26.8 (24.8, 28.9) | 1.57 (1.46, 1.69) |
| | Missing | 13.6 (12.4, 14.8) | 16.3 (14.5, 18.4) | 12.3 (10.9, 13.9) | |
| **Health care coverage** | | | | | |
| | No | 8.6 (7.5, 9.9) | 6.8 (5.2, 8.9) | 9.5 (8.0, 11.2) | 2.58 (2.23, 2.93) |
| | Yes | 91.0 (89.7, 92.2) | 92.9 (90.8, 94.5) | 90.2 (88.5, 91.6) | 1.81 (1.73, 1.88) |
| | Missing | 0.4 (0.2, 0.6) | 0.4 (0.1, 0.9) | 0.4 (0.2, 0.6) | |
| **Marital status** | | | | | |
| | Married | 50.5 (48.7, 52.3) | 59.4 (56.6, 62.2) | 46.4 (44.2, 48.7) | 1.58 (1.48, 1.67) |
| | Divorced/separated | 13.0 (12.0, 14.2) | 11.5 (9.9, 13.3) | 13.7 (12.4, 15.2) | 2.11 (1.92, 2.29) |
| | Widowed | 7.9 (7.2, 8.7) | 10.0 (8.8, 11.4) | 6.9 (6.1, 7.9) | 1.53 (1.27, 1.79) |
| | Never married | 27.7 (26.0, 29.6) | 18.0 (15.6, 20.6) | 32.2 (29.9, 34.6) | 2.41 (2.24, 2.58) |
| | Missing | 0.8 (0.6, 1.2) | 1.1 (0.7, 1.9) | 0.7 (0.4, 1.2) | |

[a] Self-reported employment status. An employment status of other included responses of either "a homemaker," "a student," "retired," or "unable to work."

2019 was 68.7% compared to 62.2% in 2015. The mean ACE score increased from 1.58 in 2015 to 1.87 in 2019. There were no observable changes in the proportion of those with at least 1 ACE when stratified by race, sex, education level, employment status, household income, health care coverage, or marital status from 2015 to 2019.

Men had fewer ACEs on average compared to women, though there was an increase in both from 2015 to 2019. Of those with at least 1 ACE in 2019, 49.3% were male and 50.7% were female. In both 2015 and 2019, older persons tended to have fewer ACEs on average. Among those with at least 1 ACE in 2019, 55.3% were between the ages of 18 and 49 years, which remains consistent from 2015. Since 2015, the mean number of ACEs increased among all age groups. Higher levels of education were associated with a lower number of ACEs in both years.

Notably, higher income levels were also associated with lower average ACE scores. In 2019, those with an income of $35 000 or less annually had a mean ACE score of 2.26 compared to those with an annual income of $75 000 or more who had a mean ACE score of 1.57. Those who were unemployed had an average of 2.88 ACEs in 2019. These results are consistent with those reported in 2015.

In 2019, the prevalence of sexual abuse was twice as high for women compared to men (17.7% compared to 8.1%, Table 2) and the prevalence of having a family member with mental illness was also higher for women (23.9% compared to 16.4%). The prevalence of other ACE categories was similar between men and women. Those between the ages of 18 and 49 years also had a higher prevalence of experiencing family with mental illness, family in prison, parental separation, and verbal abuse. Compared to White Ohioans, Black Ohioans had a 2 times higher prevalence of having family in prison (19.1% compared to 9.1%) in 2019. In the same year, Black Ohioans also had a higher prevalence of experiencing parental separation, witnessing domestic violence, and

**Table 2. Demographic Characteristics of Weighted 2019 BRFSS Populations by Categorized ACEs**

| | Family with mental illness | Family with substance abuse | Family in prison | Parental separation or divorce | Domestic violence | Physical abuse | Verbal abuse | Sexual abuse |
|---|---|---|---|---|---|---|---|---|
| | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) |
| Total | 20.3 (18.7, 21.9) | 28.0 (26.4, 29.7) | 10.8 (9.5, 12.3) | 31.7 (29.9, 33.6) | 18.8 (17.4, 20.3) | 25.7 (24.1, 27.3) | 39.0 (37.2, 40.8) | 13.0 (11.8, 14.3) |
| **Biological sex** | | | | | | | | |
| Male | 16.4 (14.3, 18.7) | 26.2 (23.8, 28.7) | 11.4 (9.5, 13.7) | 32.2 (29.4, 35.0) | 17.5 (15.4, 19.7) | 25.0 (22.7, 27.4) | 39.8 (37.1, 42.5) | 8.1 (6.7, 9.8) |
| Female | 23.9 (21.8, 26.2) | 29.8 (27.6, 32.1) | 10.2 (8.5, 12.2) | 31.3 (29.0, 33.8) | 20.1 (18.1, 22.2) | 26.3 (24.2, 28.6) | 38.2 (35.8, 40.6) | 17.7 (15.9, 19.8) |
| **Age group** | | | | | | | | |
| 18-49 years | 28.8 (26.0, 31.6) | 31.7 (28.9, 34.6) | 17.6 (15.2, 20.3) | 44.0 (40.9, 47.1) | 20.5 (18.1, 23.2) | 26.3 (23.6, 29.1) | 46.1 (43.0, 49.2) | 14.5 (12.5, 16.9) |
| 50-64 years | 14.0 (12.1, 16.1) | 26.6 (24.1, 29.4) | 5.6 (4.3, 7.3) | 23.5 (21.0, 26.2) | 20.0 (17.7, 22.5) | 28.3 (25.7, 31.1) | 37.9 (35.1, 40.8) | 14.3 (12.3, 16.5) |
| 65 years or older | 9.1 (7.8, 10.7) | 22.1 (20.1, 24.3) | 2.3 (1.7, 3.1) | 14.9 (13.1, 16.9) | 14.0 (12.2, 15.9) | 21.6 (19.6, 23.8) | 25.1 (22.9, 27.3) | 8.4 (7.2, 9.8) |
| **Race** | | | | | | | | |
| White/Caucasian | 20.3 (18.6, 22.0) | 27.7 (26.0, 29.5) | 9.1 (7.8, 10.6) | 29.1 (27.2, 31.0) | 17.7 (16.2, 19.3) | 24.0 (22.4, 25.7) | 39.2 (37.2, 41.1) | 11.6 (10.4, 12.9) |
| Black/African American | 14.4 (10.1, 20.2) | 28.4 (22.6, 35.1) | 19.1 (13.7, 26.0) | 49.7 (42.8, 56.7) | 25.4 (19.8, 31.9) | 31.9 (25.8, 38.8) | 35.9 (29.2, 43.1) | 20.9 (15.6, 27.4) |
| Asian | 22.1 (12.9, 35.30) | 24.2 (14.3, 37.9) | 6.7 (1.8, 21.6) | 29.6 (19.5, 42.2) | 16.6 (9.2, 28.0) | 27.1 (16.8, 40.7) | 38.7 (27.4, 51.3) | 18.6 (10.5, 30.9) |
| Other | 29.9 (22.6, 38.4) | 32.1 (24.8, 40.5) | 19.4 (13.5, 27.2) | 38.0 (29.7, 47.0) | 23.2 (16.7, 31.3) | 36.3 (28.1, 45.3) | 42.3 (33.9, 51.0) | 17.6 (12.3, 24.6) |
| **Highest level of education** | | | | | | | | |
| Elementary school | 24.1 (17.7, 32.0) | 34.4 (27.5, 42.0) | 21.5 (14.8, 30.0) | 46.5 (38.7, 54.5) | 30.6 (23.6, 38.5) | 36.3 (29.0, 44.3) | 41.7 (34.1, 49.8) | 19.0 (13.2, 26.5) |
| Completed high school/GED | 20.1 (17.5, 23.0) | 30.8 (28.0, 33.9) | 13.3 (11.0, 16.1) | 35.6 (32.5, 38.9) | 19.7 (17.3, 22.3) | 27.4 (24.7, 30.4) | 38.4 (35.3, 41.5) | 12.4 (10.5, 14.7) |
| Some college | 21.8 (19.2, 24.7) | 28.7 (25.8, 31.8) | 10.5 (8.4, 12.9) | 32.7 (29.5, 36.1) | 19.9 (17.3, 22.7) | 26.0 (23.3, 29.0) | 40.4 (37.2, 43.8) | 14.1 (12.0, 16.5) |
| College degree or higher | 17.3 (15.1, 19.9) | 21.7 (19.3, 24.3) | 4.3 (3.2, 5.8) | 20.5 (18.1, 23.2) | 12.2 (10.4, 14.3) | 19.3 (17.1, 21.7) | 37.1 (34.2, 40.1) | 10.2 (8.6, 12.2) |
| **Employment** | | | | | | | | |
| Employed | 21.8 (19.6, 24.1) | 28.6 (26.3, 31.0) | 12.2 (10.4, 14.3) | 35.0 (32.4, 37.6) | 17.7 (15.8, 19.8) | 23.7 (21.6, 26.0) | 40.9 (38.3, 43.4) | 11.8 (10.2, 13.5) |
| Not employed | 18.1 (16.1, 20.3) | 27.4 (24.2, 29.7) | 8.9 (7.2, 11.0) | 27.3 (24.9, 29.8) | 20.4 (18.3, 22.7) | 28.5 (26.1, 31.0) | 36.5 (34.0, 39.1) | 14.8 (12.9, 16.9) |
| **Household income** | | | | | | | | |
| <$35 000 | 23.3 (20.6, 26.3) | 34.0 (31.0, 37.2) | 15.1 (12.6, 18.1) | 38.1 (34.8, 41.4) | 24.5 (21.8, 27.4) | 31.9 (28.9, 35.0) | 41.9 (38.7, 45.1) | 17.0 (14.7, 19.6) |
| $35 000-$74 999 | 20.7 (17.6, 24.2) | 28.1 (24.9, 31.6) | 11.0 (8.2, 14.5) | 30.8 (27.2, 34.6) | 18.0 (15.1, 21.4) | 24.4 (21.2, 27.9) | 38.4 (34.8, 42.1) | 12.7 (10.1, 15.7) |
| ≥$75 000 | 17.6 (15.1, 20.4) | 24.2 (21.4, 27.2) | 6.1 (4.6, 8.0) | 27.6 (24.4, 31.0) | 13.7 (11.5, 16.2) | 20.4 (17.9, 23.2) | 38.2 (34.9, 41.6) | 9.6 (7.9, 11.8) |
| **Health care coverage** | | | | | | | | |
| Yes | 19.8 (18.3, 21.5) | 27.5 (25.8, 29.2) | 9.6 (8.3, 11.0) | 30.1 (28.2, 32.0) | 18.3 (16.8, 19.8) | 24.9 (23.3, 26.6) | 38.0 (36.2, 39.9) | 12.5 (11.2, 13.8) |
| No | 24.1 (18.0, 31.6) | 34.7 (28.0, 42.1) | 23.5 (17.5, 30.9) | 48.8 (41.4, 56.3) | 14.9 (19.1, 31.8) | 33.3 (26.6, 40.7) | 49.7 (42.3, 57.1) | 19.1 (13.7, 25.9) |
| **Marital status** | | | | | | | | |
| Married | 15.3 (13.6, 17.2) | 25.1 (23.0, 27.2) | 6.7 (5.3, 8.4) | 25.4 (23.2, 27.8) | 16.6 (14.7, 18.6) | 22.9 (20.8, 25.0) | 35.1 (32.8, 37.5) | 10.5 (9.0, 12.3) |
| Divorced/separated | 22.3 (18.7, 26.4) | 32.6 (28.6, 37.0) | 8.9 (6.6, 12.0) | 34.5 (30.3, 39.0) | 23.1 (19.5, 27.2) | 30.4 (26.5, 34.7) | 39.5 (35.3, 43.9) | 19.2 (15.9, 22.8) |
| Widowed | 12.7 (9.2, 17.4) | 27.4 (22.9, 32.4) | 6.8 (3.8, 12.0) | 20.0 (16.0, 24.8) | 17.5 (13.8, 22.1) | 27.5 (23.0, 32.6) | 29.2 (24.7, 34.0) | 11.6 (8.3, 16.2) |
| Never married | 30.5 (26.8, 34.5) | 31.7 (28.0, 35.7) | 20.2 (16.8, 24.1) | 45.4 (41.2, 49.6) | 21.5 (18.3, 25.1) | 28.2 (24.6, 32.0) | 48.6 (44.4, 52.8) | 15.2 (12.6, 18.3) |

being sexually abused compared to White Ohioans. In the 2019 sample, college graduates had the lowest prevalence of all educational levels across all ACE categories; the prevalence of having experienced parental separation was 46.5% among those with an elementary school education, compared to 35.6% among those with a high school education, and only 20.5% among persons with a college degree. Further, those with a college education also had a lower prevalence of having witnessed domestic violence compared to those with an elementary school education (30.6% compared to 12.2%).

**ACEs and Related Health Conditions and Behaviors**

Multivariable logistic regressions by ACEs revealed no relationship between the odds of high blood pressure, cancer, heart attack, stroke, or diabetes and the number of ACEs in either the 2015 or 2019 Ohio BRFSS sample (Appendix). However, in 2019, there was a significant relationship between the odds of COPD and the presence of 1 or more ACEs ($F_{(5, 7447)} = 6.53$, $p < 0.001$). Fur-

ther, there was a strong association between the odds of asthma and the number of ACEs in 2019, with those with 5 or more ACEs having nearly 4 times the odds of having asthma compared to those with no ACEs ($F_{(5, 7460)} = 14.51$, $p < 0.001$, Table 3). Those with greater numbers of ACEs also had higher odds of engaging in unhealthy behaviors. In the 2019 sample, when compared to those with no ACEs, those with 5 or more ACEs had 3.167 times higher odds of being current smokers ($F_{(5, 3377)} = 11.02$, $p < 0.001$), 4.455 times the odds of engaging in heavy drinking ($F_{(5, 7201)} = 11.88$, $p < 0.001$), and 3.259 times the odds of engaging in binge drinking ($F_{(5, 3167)} = 8.96$, $p < 0.001$).

Among 2019 respondents, there was a positive relationship between the odds of ever having been diagnosed with depression and the number of ACEs. Compared to those with no ACEs, those with 3 ACEs had 4.013 times the odds of depression, those with 4 ACEs had 4.307 times the odds of depression, and those with 5 or more ACEs had 8.250 times the odds of depression ($F_{(5, 7448)} = 45.80$, $p < 0.001$). These odds of depression represent an increase

compared to 2015 (Appendix). Further, there was a strong positive relationship between having poor mental health and higher numbers of ACEs in the 2019 sample, with those with 5 or more ACEs having 8.353 times the odds of poor mental health compared to those with no ACEs (F(5, 7259) = 34.79, p < 0.001.

The odds of both lifetime history of depression and current poor mental health were increased among persons who had experienced any category of ACE compared to those who had not experienced that category of ACE in both 2015 and 2019 (Appendix). Consistent with what was observed in 2015, in 2019 persons who had a family member with mental illness had the highest observed odds ratio for both lifetime history of depression (OR = 4.468) and current poor mental health (OR = 3.737) when controlling for sex.

## ACEs and Perception of Health Status

In the 2019 sample, a worse perception of general health was found to be associated with an increased number of cumulative ACEs (Appendix). Of the persons who reported their health as "excellent," 40.7% had no ACEs, whereas only 7.9% had 5 or more ACEs. In contrast, of those with a rating of "poor," 17.6% had no ACEs, while 23.2% had 5 or more ACEs.

A multinomial logistic regression model, coded to use 0 days in poor mental health in the past month as the referent, showed a strong association between the number of cumulative ACEs and the odds of poor mental health among 2019 respondents (F(10, 7254) = 26.60, p < 0.001, Table 4). The presence of 1 ACE is associated with 1.631 times the odds of having between 1 and 14 days of poor mental health compared to having no days and 1.768 times the odds of having poor mental health. This effect increases with the number of ACEs. Those with 4 ACEs had 7.019 times the odds of being in poor mental health, and those with 5 or more had 14.773 times the odds. Compared to 2015 (Appendix), this represents an increase in the strength of the association between ACEs and mental health impairment.

## Access to Health Care and Health Care Utilization

We also examined the association between ACEs and a person's access to health care through estimates of weighted proportions (Appendix) and multivariable logistic regression models (Table 5). In 2019, there appeared to be a positive correlation between the number of ACEs and the proportion of respondents indicating inability to access or utilize health care, with the exception of HIV testing. Compared to those reporting no ACEs, persons reporting at least 1 ACE had higher odds of not having a doctor because of cost (OR = 2.777, t(7466) = 6.66, p < 0.001); there was also a 72.2% increase in the odds of not having a personal doctor for any reason (t(7458) = 4.75, p < 0.001). While having any ACE was associated with increased odds of not having health insurance, when stratified by ACE score, only those with 4 or more ACEs had significantly increased odds of not having health insurance. Interestingly, HIV testing was significantly associated with ACE scores, with those reporting no ACEs having higher odds of never being tested for HIV (F(1, 7192) = 99.48, p < 0.001). These estimates were consistent between 2015 and 2019 (Appendix).

Cumulative ACEs can also significantly impact the utilization of health care (Table 5). The presence of ACEs was associated with increased odds of never having had cholesterol checked in 2019 (OR = 1.593, t(7102) = 2.61, p = 0.009). When analyzed by the number of ACEs, this effect was only significant among persons with 3 ACEs or 5 or more ACEs. Exposure to ACEs was also associated with not taking any blood pressure medications (OR = 2.009, t (3397) = 18.54, p < 0.001). Higher ACE scores were associated with higher odds of not taking blood pressure medication. There was no evidence that adjusting for health insurance status modified the association between ACEs and health care utilization indicators in the 2019 sample.

## DISCUSSION

We found evidence that exposure to ACEs was associated with numerous indicators of health care access. As health insurance

**Table 3. Odds Ratios Health Conditions, Behaviors, and Well-being by Cumulative ACEs with No ACEs as Referent Category, 2019 Ohio BRFSS**

| | 1 ACE OR (95% CI) | 2 ACEs OR (95% CI) | 3 ACEs OR (95% CI) | 4 ACEs OR (95% CI) | ≥5 ACEs OR (95% CI) |
|---|---|---|---|---|---|
| **Health conditions** | | | | | |
| High blood pressure | 0.850 (0.702, 1.028) | 0.910 (0.734, 1.129) | 0.762 (0.586, 0.991) | 0.879 (0.646, 1.195) | 0.698 (0.536, 0.908) |
| Cancer | 0.880 (0.711, 1.089) | 1.016 (0.785, 1.315) | 0.776 (0.571, 1.056) | 0.893 (0.611, 1.303) | 0.734 (0.507, 1.063) |
| Heart attack | 1.145 (0.772, 1.699) | 1.165 (0.825, 1.645) | 0.919 (0.562, 1.504) | 1.330 (0.766, 2.301) | 1.282 (0.844, 1.947) |
| Stroke | 1.142 (0.746, 1.748) | 1.312 (0.829, 2.077) | 0.986 (0.574, 1.696) | 1.699 (0.939, 3.077) | 1.080 (0.628, 1.859) |
| COPD | 1.258 (0.930, 1.701) | 1.474 (1.081, 2.010) | 1.557 (1.070, 2.265) | 1.920 (1.271, 2.901) | 2.501 (1.785, 3.504) |
| Diabetes | 0.905 (0.716, 1.142) | 0.766 (0.581, 1.010) | 0.656 (0.468, .920) | 0.934 (0.616, 1.416) | 0.796 (0.574, 1.103) |
| Asthma | 1.845 (1.377, 2.472) | 1.852 (1.354, 2.534) | 2.547 (1.762, 3.682) | 2.107 (1.377, 3.222) | 3.755 (2.728, 5.169) |
| Lifetime depression | 1.782 (1.356, 2.342) | 2.857 (2.137, 3.820) | 4.013 (2.932, 5.494) | 4.307 (3.091, 6.002) | 8.250 (6.088, 11.181) |
| **Unhealthy behaviors** | | | | | |
| Current smoking | 1.411 (1.036, 1.922) | 1.785 (1.292, 2.466) | 2.291 (1.579, 3.325) | 2.388 (1.598, 3.569) | 3.167 (2.232, 4.494) |
| Heavy drinking | 1.774 (1.235, 2.549) | 1.688 (1.137, 2.505) | 2.294 (1.506, 3.496) | 2.207 (1.371, 3.554) | 4.455 (3.020, 6.572) |
| Binge drinking | 2.089 (1.512, 2.888) | 1.535 (1.074, 2.195) | 2.576 (1.697, 3.911) | 1.801 (1.117, 2.904) | 3.259 (2.141, 4.917) |
| **Well-being** | | | | | |
| Poor mental health | 1.562 (1.077, 2.268) | 3.100 (2.101, 4.575) | 4.634 (3.127, 6.866) | 5.553 (3.656, 8.434) | 8.353 (5.765, 12.104) |
| Poor physical health | 1.279 (1.039, 1.575) | 1.400 (1.106, 1.773) | 2.223 (1.697, 2.913) | 1.972 (1.443, 2.694) | 2.592 (1.966, 3.418) |

**Table 4. Odds Ratios for Current Episodes of Poor Mental Health by Cumulative ACE, 2019 Ohio BRFSS**

| | 1 ACE (95% CI) | 2 ACEs (95% CI) | 3 ACEs (95% CI) | 4 ACEs (95% CI) | ≥5 ACEs (95% CI) | Any ACE (95% CI) |
|---|---|---|---|---|---|---|
| Days in poor mental health | | | | | | |
| 1-14 days | 1.631 (1.269, 2.096) | 2.049 (1.561, 2.689) | 1.984 (1.426, 2.762) | 2.265 (1.547, 3.316) | 4.682 (3.338, 6.567) | 2.140 (1.761, 2.601) |
| ≥14 days | 1.768 (1.214, 2.576) | 3.779 (2.545, 5.612) | 5.586 (3.727, 8.370) | 7.019 (4.548, 10.859) | 14.773 (9.931, 21.976) | 4.612 (3.429, 6.223) |

coverage does not modify the relationship between health care utilization and ACEs, there may be other factors that should be investigated to further examine that relationship. The relationship between a lack of health insurance and utilization of preventative medical care may be at least partially explained by the lower socioeconomic status of those who experienced 1 or more ACEs.

While we found that exposure to ACEs was negatively associated with having never tested for HIV, previous literature has found that exposure to childhood trauma was associated with increased odds of unprotected sex, medication nonadherence, and HIV disease progression.[48] It is possible that our findings concerning HIV testing may be confounded by the relationship between ACEs and risky sexual behavior or HIV disease progression. One potential hypothesis for our results is that persons with exposure to ACEs may engage in riskier sexual behaviors and are aware of the risks associated with these behaviors and are thus more likely to be tested for HIV, but this was not assessed.

There were notable differences in the prevalence of ACEs by age, race, gender, and education. Younger persons, racial minorities, and those with lower education levels were more likely to have experienced greater numbers of ACEs. One potential explanation for lower numbers of ACEs in persons aged 65 years and older is premature mortality. Past research suggests that premature death is associated with cumulative ACEs. Individuals with 6 or more cumulative ACEs have an expected life expectancy of 20 years shorter, on average, than those with no ACEs.[49]

Our analysis found evidence for a strong dose-response relationship between cumulative ACEs and odds of current poor mental health. Other literature has found strong links between ACEs and depressive disorders. A 2013 systematic review found that emotional abuse, sexual abuse, and physical abuse were the most important risk factors for the development of depression.[50] We found that all ACEs were strong risk factors for depression, though having a family member with mental illness was the strongest predictive ACE. This suggests a need to target clinical interventions and prevention programming for those who have experienced early childhood maltreatment.

Consistent with a national study of ACEs in 5 states,[51] we found the most prevalent ACEs reported were emotional/verbal abuse (39.0%), parental separation or divorce (31.7%), and living with a family member with substance abuse (28.0%). In our analysis, emotional or verbal abuse was highly prevalent across all demographic characteristics. Being exposed to a family member with

substance abuse in childhood was most prevalent among uninsured persons (34.9%) and those with an elementary school education (34.4%). Finally, currently uninsured individuals (48.8%), those with an elementary education (46.5%), and those never married (45.4%) experienced the highest prevalence of childhood divorce. These demographic patterns point to an association between social determinants of health and the experiences of childhood adversities.

Interventions to address issues related to the social determinants of health have been advanced as a method to reduce the incidence of ACEs.[52] Research demonstrates that preventative interventions, such as educational enrichment and comprehensive family services in early childhood, can improve adult health and well-being.[53] Further, sociodemographic interventions that target upstream structural determinants that contribute to childhood adversity may reduce ACEs.[54,55] While these interventions have shown promise through modest effect sizes, more robust evaluation designs are needed to evaluate the causal effect of these programs.

Trauma-informed care (TIC) is currently used in health services with the goal of health care workers becoming more approachable to individuals who have experienced ACEs.[56] This framework promotes information and values about how to promote and build alliances with those who have experienced trauma, with a focus on recognizing signs and symptoms of trauma and the integration of trauma knowledge into practices.[57] Trauma-informed care may help reduce the stigma associated with trauma and its potential health effects. As a large percentage of Ohioans have experienced trauma, implementing TIC practices in social service and health care settings could also help reduce retraumatization of individuals with ACEs and improve long-term health outcomes.

Our study has a few limitations. First, the BRFSS and ACE modules are self-report instruments that are subject to recall bias. This effect may be amplified as older respondents are being asked about events in early childhood. Second, our analysis uses a cross-sectional design and temporality must be inferred from the data. A longitudinal study may better illustrate the causal effect of ACEs on health outcomes. Similarly, due to the design of BRFSS as a telephone survey, there is the potential that those who choose to participate in BRFSS are substantially different from those who do not participate (ie, nonresponse bias). It is possible that given the surge of telemarketing calls experienced in the past few years, fewer persons may participate in BRFSS surveys as is evidenced

**Table 5. Odds Ratio for Access to Health Care Indicators and Utilizations for Chronic Conditions (crude and adjusted by insurance status) by Cumulative ACEs, 2019 Ohio BRFSS**

| | 1 ACE (95% CI) | 2 ACEs (95% CI) | 3 ACEs (95% CI) | 4 ACEs (95% CI) | ≥5 ACEs (95% CI) | Any ACE (95% CI) |
|---|---|---|---|---|---|---|
| **Health care access** | | | | | | |
| No doctor because of cost | 1.272 (0.855, 1.895) | 1.916 (1.235, 2.975) | 3.204 (2.105, 4.875) | 5.113 (3.254, 8.034) | 5.849 (3.999, 8.555) | 2.777 (2.056, 3.751) |
| No personal doctor | 1.330 (0.986, 1.795) | 1.610 (1.170, 2.216) | 2.214 (1.573, 3.117) | 2.219 (1.484, 3.318) | 1.943 (1.393, 2.711) | 1.722 (1.376, 2.155) |
| No health insurance | 0.836 (0.523, 1.335) | 1.188 (0.695, 2.029) | 1.445 (0.876, 2.385) | 2.745 (1.605, 4.694) | 2.253 (1.409, 3.602) | 1.435 (1.021, 2.015) |
| Never tested for HIV | 0.666 (0.525, 0.846) | 0.405 (0.314, 0.521) | 0.358 (0.269, 0.476) | 0.263 (0.190, 0.365) | 0.224 (0.169, 0.298) | 0.400 (0.334, 0.479) |
| **Health care utilization** | | | | | | |
| Never had cholesterol checked (no insurance) | 1.503 (0.964, 2.342) | 1.030 (0.635, 1.671) | 2.203 (1.361, 3.565) | 1.338 (0.756, 2.371) | 2.187 (1.340, 3.571) | 1.593 (1.123, 2.260) |
| Never had cholesterol checked with insurance | 1.520 (0.972, 2.377) | 0.999 (0.614, 1.627) | 2.137 (1.316, 3.469) | 1.199 (0.668, 2.153) | 1.986 (1.211, 3.257) | 1.536 (1.081, 2.183) |
| Not taking blood pressure medications (no insurance) | 1.598 (1.045, 2.443) | 1.607 (1.011, 2.555) | 1.903 (1.109, 3.266) | 2.418 (1.338, 4.371) | 3.866 (2.425, 6.161) | 2.009 (1.462, 2.760) |
| Not taking blood pressure medications with insurance | 1.668 (1.089, 2.556) | 1.690 (1.050, 2.722) | 1.747 (1.020, 2.994) | 2.102 (1.712, 3.771) | 3.909 (2.431, 6.288) | 2.007 (1.457, 2.765) |

by declining response rates. However, response rates tend to be an unreliable marker of nonresponse bias.[58] Nonetheless, this should be considered as an inherent limitation of telephone-based surveys.

A final limitation is that our analysis focuses on ACEs. In the past few years, literature on positive childhood experiences (PCEs) has highlighted their importance in moderating the negative effects of ACEs and in promoting more favorable outcomes.[59] However, the effects of PCEs on physical health outcomes and health behaviors have been mixed.[59] Future studies on ACEs and health care access and utilization should incorporate PCEs as potential mitigating factors. Despite these limitations, our analyses support the need for interventions to reduce the experience of childhood adversities and prevent their consequences once they have occurred.

## PUBLIC HEALTH IMPLICATIONS

Adverse childhood experiences remain a highly prevalent preventable risk factor for Ohioans. Adverse childhood exerpiences are strongly associated with adverse health outcomes and health behaviors. Implementation of evidence-based programs to reduce the prevalence of ACEs and support those affected by traumatic experiences has the potential to improve the health of the population, particularly among vulnerable groups disproportionately impacted by ACEs.

**AUTHOR CONTRIBUTION** Conceptualization–Jessica Linley, Kraig J. Knudsen; Data curation–Jessica Linley, Kraig J. Knudsen, Joshua Orack; Formal analysis–Geoffrey Carney-Knisely, Joshua Orack; Methodology–Geoffrey Carney-Knisely, Joshua Orack; Project administration–Jessica Linley, Kraig J. Knudsen, Geoffrey Carney-Knisely; Resources–Jessica Linley, Geoffrey Carney-Knisely; Software–Geoffrey Carney-Knisely, Joshua Orack; Validation–Geoffrey Carney-Knisely; Roles/Writing/Original Draft–Geoffrey Carney-Knisely, Joshua Orack, Jessica Linley, Kraig J. Knudsen; Review and editing–Geoffrey Carney-Knisely, Jessica Linley, Kraig J. Knudsen.

**CONFLICTS OF INTEREST** None.

**DATA AVAILABILITY STATEMENT** This analysis used data from the public use dataset for the Behavioral Risk Factor Surveillance System (BRFSS), which is available from the Ohio Department of Health. Nationwide data for BRFSS is available from the Centers for Disease Control and Prevention.

**REFERENCES**

1. Hughes K, Bellis MA, Hardcastle KA, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health*. 2017;2(8):e356-e366.
https://doi.org/10.1016/S2468-2667(17)30118-4

2. 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.
https://doi.org/10.1016/S0749-3797(98)00017-8

3. Bellis MA, Hughes K, Leckenby N, Hardcastle KA, Perkins C, Lowey H. Measuring mortality and the burden of adult disease associated with adverse childhood experiences in England: a national survey. *J Public Health*. 2015;37(3):445-454.
https://doi.org/10.1093/pubmed/fdu065

4. Anda RF, Felitti VJ, Bremner JD, et al. The enduring effects of abuse and related adverse experiences in childhood. A convergence of evidence from neurobiology and epidemiology. *Eur Arch Psychiatry Clin Neurosci*. 2006;256(3):174-186.
https://doi.org/10.1007/s00406-005-0624-4

5. Kessler RC, McLaughlin KA, Green JG, et al. Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys. *Br J Psychiatry*. 2010;197(5):378-385.
https://doi.org/10.1192/bjp.bp.110.080499

6. Anda RF, Brown DW, Dube SR, Bremner JD, Felitti VJ, Giles WH. Adverse childhood experiences and chronic obstructive pulmonary disease in adults. *Am J Prev Med*. 2008;34(5):396-403.
https://doi.org/10.1016/j.amepre.2008.02.002

7. Brown DW, Anda RF, Felitti VJ, et al. Adverse childhood experiences are associated with the risk of lung cancer: a prospective cohort study. *BMC Public Health*. 2010;10:20.
https://doi.org/10.1186/1471-2458-10-20

8. Danese A, Moffitt TE, Harrington H, et al. Adverse childhood experiences and adult risk factors for age-related disease. *Arch Pediatr Adolesc Med*. 2009;163(12):1135-1143.
https://doi.org/10.1001/archpediatrics.2009.214

9. Bellis MA, Lowey H, Leckenby N, Hughes K, Harrison D. Adverse childhood experiences: retrospective study to determine their impact on adult health behaviours and health outcomes in a UK population. *J Public Health*. 2014;36(1):81-91.
https://doi.org/10.1093/pubmed/fdt038

10. Kuh D, Ben-Shlomo Y, Lynch J, Hallqvist J, Power C. Life course epidemiology. *J Epidemiol Community Health*. 2003;57(10):778-783.
https://doi.org/10.1136/jech.57.10.778

11. Mayer KU. New directions in life course research. *Annu Rev Sociol*. 2009;35(1):413-433.
https://doi.org/10.1146/annurev.soc.34.040507.134619

12. Haas S. Trajectories of functional health: the 'long arm' of childhood health and socioeconomic factors. *Soc Sci Med*. 2008;66(4):849-861.
https://doi.org/10.1016/j.socscimed.2007.11.004

13. Haas S, Rohlfsen L. Life course determinants of racial and ethnic disparities in functional health trajectories. *Soc Sci Med*. 2010;70(2):240-250.
https://doi.org/10.1016/j.socscimed.2009.10.003

14. Schafer MH, Wilkinson LR, Ferraro KF. Childhood (mis)fortune, educational attainment, and adult health: contingent benefits of a college degree? *Soc Forces*. 2013;91(3):1007-1034.
https://doi.org/10.1093/sf/sos192

15. Walsemann KM, Geronimus AT, Gee GC. Accumulating disadvantage over the life course: evidence from a longitudinal study investigating the relationship between educational advantage in youth and health in middle age. *Res Aging*. 2008;30(2):169-199.
https://doi.org/10.1177/0164027507311149

16. Pearlin LI. The life course and the stress process: some conceptual comparisons. *J Gerontol B Psychol Sci Soc Sci*. 2010;65B(2):207-215.
https://doi.org/10.1093/geronb/gbp106

17. Pearlin LI, Schieman S, Fazio EM, Meersman SC. Stress, health, and the life course: some conceptual perspectives. *J Health Soc Behav*. 2005;46(2).
https://doi.org/10.1177/002214650504600206

18. Turner HA, Butler MJ. Direct and indirect effects of childhood adversity on depressive symptoms in young adults. *J Youth Adolesc*. 2003;32(2):89-103.
https://doi.org/10.1023/A:1021853600645

19. Giano Z, Wheeler DL, Hubach RD. The frequencies and disparities of adverse childhood experiences in the U.S. *BMC Public Health*. 2020;20(1):1327.
https://doi.org/10.1186/s12889-020-09411-z

20. Merrick MT, Ford DC, Ports KA, et al. Vital Signs: estimated proportion of adult health problems attributable to adverse childhood experiences and implications for prevention — 25 states, 2015–2017. *MMWR Morb Mortal Wkly Rep*. 2019;68(44):999-1005.
https://doi.org/10.15585/mmwr.mm6844e1

21. Merrick MT, Ford DC, Ports KA, Guinn AS. Prevalence of adverse childhood experiences from the 2011-2014 Behavioral Risk Factor Surveillance System in 23 states. *JAMA Pediatrics*. 2018;172(11):1038-1044.
https://doi.org/10.1001/jamapediatrics.2018.2537

22. Guinn AS, Ottley PG, Anderson KN, Oginga ML, Gervin DW, Holmes GM. Leveraging surveillance and evidence: preventing adverse childhood experiences through data to action. *Am J Prev Med*. 2022;62(6, Supplement 1):S24-S30.
https://doi.org/10.1016/j.amepre.2021.12.003

23. Marie-Mitchell A, Kostolansky R. A systematic review of trials to improve child outcomes associated with adverse childhood experiences. *Am J Prev Med*. 2019;56(5):756-764.
https://doi.org/10.1016/j.amepre.2018.11.030

24. Bonomi AE, Anderson ML, Rivara FP, et al. Health care utilization and costs associated with childhood abuse. *J Gen Intern Med*. 2008;23(3):294-299.
https://doi.org/10.1007/s11606-008-0516-1

25. Kalmakis KA, Chandler GE. Health consequences of adverse childhood experiences: a systematic review. *J Am Assoc Nurse Pract*. 2015;27(8):457-465.
https://doi.org/10.1002/2327-6924.12215

26. Alcalá HE, Valdez-Dadia A, von Ehrenstein OS. Adverse childhood experiences and access and utilization of health care. *J Public Health (Oxf)*. 2018;40(4):684-692.
https://doi.org/10.1093/pubmed/fdx155

27. Koball AM, Rasmussen C, Olson-Dorff D, Klevan J, Ramirez L, Domoff SE. The relationship between adverse childhood experiences, healthcare utilization, cost of care and medical comorbidities. *Child Abuse Negl*. 2019;90:120-126.
https://doi.org/10.1016/j.chiabu.2019.01.021

28. Testa A, Jackson DB, Vaughn MG, Ganson KT, Nagata JM. Adverse childhood experiences, health insurance status, and health care utilization in middle adulthood. *Soc Sci Med*. 2022;314:115194.
https://doi.org/10.1016/j.socscimed.2022.115194

29. Mercado RC, Wiltsey-Stirman S, Iverson KM. Impact of childhood abuse on physical and mental health status and health care utilization among female veterans. *Mil Med*. 2015;180(10):1065-1074.
https://doi.org/10.7205/MILMED-D-14-00719

30. Lanier P, Maguire-Jack K, Lombardi B, Frey J, Rose RA. Adverse childhood experiences and child health outcomes: comparing cumulative risk and latent class approaches. *Matern Child Health J*. 2018;22(3):288-297.
https://doi.org/10.1007/s10995-017-2365-1

31. LaNoue MD, George BJ, Helitzer DL, Keith SW. Contrasting cumulative risk and multiple individual risk models of the relationship between adverse childhood experiences (ACEs) and adult health outcomes. *BMC Med Res Methodol*. 2020;20(1):239.
https://doi.org/10.1186/s12874-020-01120-w

32. Centers for Disease Control and Prevention. About the Behavioral Risk Factor Surveillance System (BRFSS). Published February 9, 2019. Accessed February 15, 2023.
https://www.cdc.gov/brfss/about/index.htm

33. Pierannunzi C, Hu SS, Balluz L. A systematic review of publications assessing reliability and validity of the Behavioral Risk Factor Surveillance System (BRFSS), 2004–2011. *BMC Med Res Methodol*. 2013;13(1):49.
https://doi.org/10.1186/1471-2288-13-49

34. *Dietary guidelines for Americans, 2020-2025*. U.S. Department of Agriculture and U.S. Department of Health and Human Services; 2020.
https://dietaryguidelines.gov

35. Drinking levels defined. National Institute on Alcohol Abuse and Alcoholism. Published 2023.

36. Dawson DA, Grant BF, Li TK. Quantifying the risks associated with exceeding recommended drinking limits. *Alcohol Clin Exp Res*. 2005;29

(5):902-908.
https://doi.org/10.1097/01.ALC.0000164544.45746.A7

37. Centers for Disease Control and Prevention. *Measuring healthy days: population assessment of health-related quality of life.*; 2000:40.

38. Cree RA, Okoro CA, Zack MM, Carbone E. Frequent mental distress among adults, by disability status, disability type, and selected characteristics — United States, 2018. *MMWR Morb Mortal Wkly Rep*. 2020;69:1238-1243.
https://doi.org/10.15585/mmwr.mm6936a2

39. Moriarty DG, Zack MM, Kobau R. The Centers for Disease Control and Prevention's healthy days measures – population tracking of perceived physical and mental health over time. *Health Qual Life Outcomes*. 2003;1:37.
https://doi.org/10.1186/1477-7525-1-37

40. Hennessy CH, Moriarty DG, Zack MM, Scherr PA, Brackbill R. Measuring health-related quality of life for public health surveillance. *Public Health Rep*. 1994;109(5):665-672.

41. Andresen EM, Catlin TK, Wyrwich KW, Jackson-Thompson J. Retest reliability of surveillance questions on health related quality of life. *J Epidemiol Community Health*. 2003;57(5):339-343.
https://doi.org/10.1136/jech.57.5.339

42. Slabaugh SL, Shah M, Zack M, et al. Leveraging health-related quality of life in population health management: the case for healthy days. *Popul Health Manag*. 2017;20(1):13-22.
https://doi.org/10.1089/pop.2015.0162

43. Dube SR, Williamson DF, Thompson T, Felitti VJ, Anda RF. Assessing the reliability of retrospective reports of adverse childhood experiences among adult HMO members attending a primary care clinic. *Child Abuse Negl*. 2004;28:729-737.
https://doi.org/10.1016/j.chiabu.2003.08.009

44. Ford DC, Merrick MT, Parks SE, et al. Examination of the factorial structure of adverse childhood experiences and recommendations for three subscale scores. *Psychol Violence*. 2014;4(4):432-444.
https://doi.org/10.1037/a0037723

45. Mei X, Li J, Li ZS, et al. Psychometric evaluation of an adverse childhood experiences (ACEs) measurement tool: an equitable assessment or reinforcing biases? *Health Justice*. 2022;10(1):34.
https://doi.org/10.1186/s40352-022-00198-2

46. Centers for Disease Control and Prevention. *Complex sampling weights and preparing 2019 BRFSS module data for analysis*. Centers for Disease Control and Prevention; 2020.
https://www.cdc.gov/brfss/annual_data/2019/pdf/Complex-Smple-Weights-Prep-Module-Data-Analysis-2019-508.pdf

47. StataCorp LLC. *Stata Survey Data Reference Manual*. StataCorp LLC; 2023.
https://www.stata.com/manuals/svy.pdf

48. Pence BW, Mugavero MJ, Carter TJ, et al. Childhood trauma and health outcomes in HIV-infected patients: an exploration of causal pathways. *J Acquir Immune Defic Syndr*. 2012;59(4):409-416.
https://doi.org/10.1097/QAI.0b013e31824150bb

49. Brown DW, Anda RF, Tiemeier H, et al. Adverse childhood experiences and the risk of premature mortality. *Am J Prev Med*. 2009;37(5):389-396.
https://doi.org/10.1016/j.amepre.2009.06.021

50. De Venter M, Demyttenaere K, Bruffaerts R. The relationship between adverse childhood experiences and mental health in adulthood. a systematic literature review. *Tijdschr Psychiatr*. 2013;55(4):259-268.

51. Liu Y, Croft JB, Chapman DP, et al. Relationship between adverse childhood experiences and unemployment among adults from five US states. *Soc Psychiatry Psychiatr Epidemiol*. 2013;48(3):357-369.
https://doi.org/10.1007/s00127-012-0554-1

52. Bethell CD, Solloway MR, Guinosso S, et al. Prioritizing possibilities for child and family health: an agenda to address adverse childhood experiences and foster the social and emotional roots of well-being in pediatrics. *Acad Pediatr*. 2017;17(7, Supplement):S36-S50.
https://doi.org/10.1016/j.acap.2017.06.002

53. Reynolds AJ, Temple JA, Ou SR, et al. Effects of a school-based, early childhood intervention on adult health and well-being: a 19-year follow-up of low-income families. *Arch Pediatr Adolesc Med*. 2007;161(8):730-739.
https://doi.org/10.1001/archpedi.161.8.730

54. Courtin E, Allchin E, Ding AJ, Layte R. The role of socioeconomic interventions in reducing exposure to adverse childhood experiences: a systematic review. *Curr Epidemiol Rep*. 2019;6(4):423-441.
https://doi.org/10.1007/s40471-019-00216-2

55. Williams DR, Costa MV, Odunlami AO, Mohammed SA. Moving upstream: how interventions that address the social determinants of health can improve health and reduce disparities. *J Public Health Manag Pract*. 2008;14 Suppl(Suppl):S8-17.
https://doi.org/10.1097/01.PHH.0000338382.36695.42

56. Oral R, Ramirez M, Coohey C, et al. Adverse childhood experiences and trauma informed care: the future of health care. *Pediatr Res*. 2016;79(1):227-233.
https://doi.org/10.1038/pr.2015.197

57. Leitch L. Action steps using ACEs and trauma-informed care: a resilience model. *Health Justice*. 2017;5(1):5.
https://doi.org/10.1186/s40352-017-0050-5

58. Galea S, Tracy M. Participation rates in epidemiologic studies. *Ann Epidemiol*. 2007;17(9):643-653.
https://doi.org/10.1016/j.annepidem.2007.03.013

59. Han D, Dieujuste N, Doom JR, Narayan AJ. A systematic review of positive childhood experiences and adult outcomes: promotive and protective processes for resilience in the context of childhood adversity. *Child Abuse Negl*. 2023;144:106346.
https://doi.org/10.1016/j.chiabu.2023.106346

## APPENDIX

Demographic Characteristics of Weighted 2015 BRFSS Sample by Prevalence of ACEs

| | Overall N<br>% (95% CI) | No ACEs<br>% (95% CI) | At least one ACE<br>% (95% CI) | Number of ACEs<br>Mean (95% CI) |
|---|---|---|---|---|
| Total | 100.0 | 37.8 (36.0, 39.6) | 62.2 (60.4, 64.1) | 1.58 (1.50, 1.66) |
| **Biological sex** | | | | |
| Male | 48.7 (46.7, 50.7) | 48.1 (45.2, 51.0) | 49.1 (46.4, 51.8) | 1.51 (1.39, 1.62) |
| Female | 51.3 (49.3, 53.3) | 51.9 (49.0, 54.8) | 50.9 (48.3, 53.4) | 1.65 (1.54, 1.76) |
| **Age group** | | | | |
| 18-49 years | 50.2 (48.3, 52.1) | 38.1 (35.1, 41.3) | 57.6 (55.2, 60.0) | 1.96 (1.82, 2.11) |
| 50-64 years | 27.8 (26.2, 29.3) | 30.3 (27.9, 32.8) | 26.2 (24.3, 28.3) | 1.39 (1.29, 1.49) |
| 65 years or older | 24.5 (20.4, 22.7) | 30.7 (28.6, 33.0) | 15.9 (14.7, 17.3) | 0.95 (0.88, 1.02) |
| Missing | 0.5 (0.4, 0.7) | 0.8 (0.6, 1.3) | 0.3 (0.2, 0.5) | |
| **Race** | | | | |
| White/Caucasian | 82.7 (81.0, 84.4) | 88.2 (86.0, 90.1) | 79.4 (76.9, 81.7) | 1.49 (1.40, 1.57) |
| Black/African American | 10.3 (8.9, 11.9) | 6.1 (4.8, 7.8) | 12.9 (10.9, 15.2) | 2.02 (1.69, 2.35) |
| Asian | 2.1 (1.6, 2.8) | 2.8 (1.8, 4.4) | 1.6 (1.1, 2.3) | 1.33 (0.88, 1.78) |
| Other | 3.6 (2.9, 4.5) | 1.6 (1.0, 2.6) | 4.8 (3.7, 6.1) | 2.60 (2.14, 3.06) |
| Missing | 1.3 (1.0, 1.2) | 1.3 (0.8, 2.0) | 1.3 (0.8, 2.1) | |
| **Highest level of education** | | | | |
| Elementary school | 11.1 (9.5, 12.8) | 8.5 (6.5, 10.9) | 12.6 (10.6, 15.1) | 2.15 (1.76, 2.54) |
| Completed high school/GED | 33.4 (31.6, 35.3) | 32.7 (30.1, 35.3) | 33.9 (31.5, 36.4) | 1.57 (1.45, 1.69) |
| Some college | 30.8 (29.0, 32.7) | 30.2 (27.5, 33.1) | 31.2 (28.7, 33.7) | 1.65 (1.50, 1.80) |
| College degree or higher | 24.5 (23.0, 26.0) | 28.6 (26.2, 31.0) | 22.0 (20.2, 24.0) | 1.24 (1.13, 1.34) |
| Missing | 0.2 (0.1, 0.4) | 0.1 (0.0, 0.3) | 0.3 (0.1, 0.7) | |
| **Employment status** (Self-reported employment status. An employment status of other included responses of either "a homemaker," "a student," "retired," or "unable to work." | | | | |
| Employed | 57.8 (55.9, 59.7) | 54.8 (52.0, 57.6) | 59.6 (57.0, 62.2) | 1.59 (1.49, 1.70) |
| Unemployed | 5.0 (4.0, 6.1) | 2.2 (1.5, 3.4) | 6.6 (5.2, 8.4) | 2.90 (2.29, 3.51) |
| Other | 36.9 (35.1, 38.7) | 42.6 (39.8, 45.4) | 33.4 (31.1, 35.8) | 1.38 (1.28, 1.48) |
| Missing | 0.4 (0.2, 0.6) | 0.4 (0.2, 0.7) | 0.4 (0.2, 0.7) | |
| **Annual household income** | | | | |
| <$35 000 | 31.1 (29.2, 33.0) | 24.3 (21.9, 26.8) | 35.2 (36.7, 37.9) | 1.96 (1.80, 2.13) |
| $35 000-$74 999 | 26.9 (25.2, 28.6) | 28.3 (25.7, 30.9) | 26.1 (23.9, 28.4) | 1.48 (1.34, 1.62) |
| ≥$75 000 | 27.4 (25.6, 29.2) | 30.2 (27.5, 33.0) | 25.6 (23.3, 28.1) | 1.33 (1.19, 1.47) |
| Missing | 14.7 (13.4, 16.1) | 17.3 (15.3, 19.5) | 13.1 (11.4, 15.0) | |
| **Health care coverage** | | | | |
| Yes | 90.6 (88.9 92.0) | 93.2 (90.7, 95.1) | 89.0 (86.7, 90.9) | 1.51 (1.43, 1.59) |
| No | 8.7 (7.4, 10.2) | 6.3 (4.5, 8.8) | 10.1 (8.4, 12.2) | 2.25 (1.43, 1.59) |
| Missing | 0.7 (0.3, 1.8) | 0.5 (0.2, 0.9) | 0.9 (0.3, 2.8) | |
| **Marital status** | | | | |
| Married | 51.6 (49.6, 53.5) | 60.1 (57.1, 63.0) | 46.4 (43.8, 49.0) | 1.31 (1.22, 1.41) |
| Divorced/separated | 13.7 (12.4, 15.0) | 11.0 (9.5, 12.8) | 15.2 (13.6, 17.1) | 1.79 (1.62, 1.97) |
| Widowed | 7.9 (7.2, 8.6) | 10.3 (9.0, 11.6) | 6.4 (5.6, 7.3) | 1.15 (0.99, 1.31) |
| Never married | 26.6 (24.5, 28.7) | 18.1 (15.3, 21.4) | 31.7 (29.0, 34.6) | 2.11 (1.89, 2.33) |
| Missing | 0.4 (0.2, 0.6) | 0.5 (0.3, 0.8) | 0.3 (0.1, 0.7) | |

Odds Ratios Health Conditions, Behaviors, Well-being by Cumulative ACEs with No ACEs as referent category (2015 DATA)

| | 1 ACE<br>OR (95% CI) | 2 ACEs<br>OR (95% CI) | 3 ACEs<br>OR (95% CI) | 4 ACEs<br>OR (95% CI) | ≥5 ACEs<br>OR (95% CI) |
|---|---|---|---|---|---|
| **Health conditions** | | | | | |
| High blood pressure | 0.847 (0.692, 1.036) | 0.967 (0.761, 1.229) | 0.776 (0.582, 1.036) | 0.947 (0.666, 1.348) | 0.769 (0.555, 1.065) |
| Cancer | 0.751 (0.593, 0.950) | 0.828 (0.608, 1.127) | 0.755 (0.498, 1.146) | 0.613 (0.401, 0.938) | 0.594 (0.379, 0.929) |
| Heart attack | 1.061 (0.733, 1.536) | 1.092 (0.676, 1.763) | 0.995 (0.566, 1.745) | 0.700 (0.396, 1.235) | 0.517 (0.280, 0.956) |
| Stroke | 1.106 (0.713, 1.716) | 0.639 (0.393, 1.039) | 1.052 (0.643, 1.722) | 1.569 (0.787, 3.130) | 0.714 (0.378, 1.351) |
| COPD | 1.170 (0.798, 1.714) | 1.816 (1.208, 2.731) | 1.701 (1.108, 2.613) | 2.439 (1.450, 4.102) | 1.971 (1.256, 3.093) |
| Diabetes | 0.727 (0.558, 0.947) | 0.867 (0.636, 1.183) | 0.883 (0.613, 1.272) | 1.041 (0.650, 1.666) | 0.872 (0.590, 1.288) |
| Asthma | 1.485 (1.081, 2.041) | 1.899 (1.323, 2.727) | 1.913 (1.284, 2.852) | 1.933 (1.231, 3.038) | 4.717 (3.148, 7.068) |
| Lifetime depression | 1.421 (1.083, 1.865) | 2.162 (1.609, 2.904) | 2.762 (1.971, 3.869) | 4.207 (2.877, 6.152) | 7.390 (5.177, 10.549) |
| **Unhealthy behaviors** | | | | | |
| Current smoking | 1.921 (1.393, 2.651) | 2.159 (1.492, 3.123) | 3.207 (2.122, 4.847) | 2.887 (1.814, 4.594) | 5.947 (3.935, 8.987) |
| Heavy drinking | 2.029 (1.413, 2.913) | 1.979 (1.248, 3.137) | 2.785 (1.733, 4.476) | 3.226 (1.878, 5.542) | 3.426 (2.149, 5.463) |
| Binge drinking | 1.788 (1.292, 2.473) | 1.940 (1.304, 2.885) | 1.863 (1.206, 2.879) | 2.589 (1.518, 4.415) | 2.225 (1.343, 3.687) |
| **Well-being** | | | | | |
| Poor mental health | 1.527 (1.041, 2.241) | 1.494 (1.004, 2.221) | 2.858 (1.874, 4.358) | 3.055 (1.809, 5.159) | 5.550 (3.645, 8.451) |
| Poor physical health | 1.237 (0.982, 1.558) | 1.408 (1.084, 1.828) | 1.597 (1.183, 2.157) | 1.463 (1.018, 2.105) | 2.534 (1.812, 3.542) |

ACEs and History of Depressive Disorders Adjusting for Sex (2015 DATA)

|  | Lifetime history | Current poor mental health |
|---|---|---|
| Household mental illness | 4.185 (3.194, 5.485) | 3.578 (2.636, 4.857) |
| Emotional/verbal abuse | 2.787 (2.273, 3.419) | 2.213 (1.706, 2.870) |
| Physical abuse | 2.583 (2.001, 3.334) | 2.594 (1.916, 3.512) |
| Sexual abuse | 4.250 (3.196, 5.651) | 3.593 (2.558, 5.047) |
| Domestic violence | 2.348 (1.832, 3.011) | 2.179 (1.614, 2.943) |
| Household substance use | 2.870 (2.294, 3.590) | 2.569 (1.957, 3.372) |
| Parental separation/divorce | 1.445 (1.147, 1.819) | 1.326 (1.003, 1.753) |
| Family in prison | 2.546 (1.671, 3.880) | 1.922 (1.216, 3.038) |

ACEs and History of Depressive Disorders Adjusting for Sex (2019 DATA)

|  | Lifetime history | Current poor mental health |
|---|---|---|
| Household mental illness | 4.468 (3.642, 5.481) | 3.737 (2.962, 4.713) |
| Emotional/verbal abuse | 3.023 (2.527, 3.618) | 2.671 (2.153, 3.314) |
| Physical abuse | 2.660 (2.201, 3.214) | 2.226 (1.787, 2.772) |
| Sexual abuse | 2.957 (2.344, 3.731) | 2.242 (1.720, 2.921) |
| Domestic violence | 2.128 (1.727, 2.621) | 2.311 (1.833, 2.914) |
| Household substance use | 2.169 (1.802, 2.610) | 2.562 (2.064, 3.181) |
| Parental separation/divorce | 1.557 (1.285, 1.886) | 2.331 (1.870, 2.905) |
| Family in prison | 2.269 (1.696, 3.036) | 3.105 (2.294, 4.204) |

Self-reported General Health Rating by ACEs (2015 DATA)

|  | 0 ACEs % (95% CI) | 1 ACE % (95% CI) | 2 ACEs % (95% CI) | 3 ACEs % (95% CI) | 4 ACEs % (95% CI) | ≥5 ACEs % (95% CI) |
|---|---|---|---|---|---|---|
| General health |  |  |  |  |  |  |
| Excellent | 42.1 (37.5, 46.9) | 27.5 (22.8, 32.7) | 11.1 (8.5, 14.4) | 8.2 (5.5, 12.1) | 4.9 (2.9, 8.1) | 6.2 (3.9, 9.5) |
| Very good | 40.7 (37.5, 44.0) | 25.9 (22.9, 29.1) | 12.6 (10.4, 15.1) | 9.3 (7.5, 11.5) | 4.5 (3.3, 6.0) | 7.1 (5.4, 9.3) |
| Good | 36.4 (33.1, 39.7) | 24.2 (21.3, 27.4) | 11.3 (9.5, 13.3) | 8.6 (6.9, 10.7) | 7.0 (5.5, 9.0) | 12.5 (9.8, 15.9) |
| Fair | 30.0 (25.8, 34.4) | 23.0 (18.7, 27.9) | 13.2 (10.3, 16.7) | 13.4 (9.9, 17.9) | 8.8 (6.0, 12.8) | 11.7 (8.3, 16.4) |
| Poor | 27.4 (20.8, 35.1) | 22.7 (16.0, 31.2) | 14.2 (9.8, 20.1) | 10.1 (6.1, 16.1) | 6.7 (3.8, 11.5) | 18.9 (13.4, 26.1) |

Self-reported General Health Rating by ACEs (2019 DATA)

|  | 0 ACEs % (95% CI) | 1 ACE % (95% CI) | 2 ACEs % (95% CI) | 3 ACEs % (95% CI) | 4 ACEs % (95% CI) | ≥5 ACEs % (95% CI) |
|---|---|---|---|---|---|---|
| General health |  |  |  |  |  |  |
| Excellent | 40.7 (36.0, 45.6) | 23.5 (19.2, 28.4) | 12.6 (9.5, 16.6) | 10.1 (7.2, 14.1) | 5.2 (3.3, 8.0) | 7.9 (5.5, 11.3) |
| Very good | 36.1 (33.3, 39.0) | 22.5 (20.0, 25.2) | 15.0 (13.0, 17.3) | 11.5 (9.5, 13.9) | 6.5 (5.1, 8.3) | 8.4 (6.7, 10.4) |
| Good | 27.1 (24.7, 29.8) | 25.7 (22.9, 28.6) | 15.7 (13.5, 18.2) | 10.7 (8.8, 13.0) | 8.4 (6.7, 10.6) | 12.4 (10.0, 15.3) |
| Fair | 24.5 (21.1, 28.3) | 19.0 (15.9, 22.7) | 16.1 (12.9, 20.0) | 12.3 (9.5, 15.8) | 7.8 (5.9, 10.4) | 20.2 (16.6, 24.3) |
| Poor | 17.6 (13.4, 22.7) | 15.9 (11.9, 20.9) | 17.3 (12.4, 23.7) | 17.5 (11.6, 25.4) | 8.6 (5.6, 13.0) | 23.2 (17.2, 30.5) |

Odds Ratios for Current Episodes of Poor Mental Health by Cumulative ACEs (2015 DATA)

|  | 1 ACE (95% CI) | 2 ACEs (95% CI) | 3 ACEs (95% CI) | 4 ACEs (95% CI) | ≥5 ACEs (95% CI) | Any ACE (95% CI) |
|---|---|---|---|---|---|---|
| Days in Poor Mental Health |  |  |  |  |  |  |
| 1-14 days | 1.598 (1.192, 2.142) | 2.295 (1.670, 3.156) | 2.618 (1.824, 3.755) | 3.015 (1.987, 4.575) | 3.994 (2.614, 6.101) | 2.248 (1.792, 2.819) |
| ≥14 days | 1.683 (1.144, 2.477) | 1.824 (1.219, 2.731) | 3.648 (2.355, 5.652) | 4.108 (2.395, 7.046) | 8.392 (5.386, 13.074) | 2.881 (2.138, 3.883) |

Odds Ratios for Access to Health Care Indicators by Cumulative ACEs (2015 DATA)

|  | 1 ACE (95% CI) | 2 ACEs (95% CI) | 3 ACEs (95% CI) | 4 ACEs (95% CI) | ≥5 ACEs (95% CI) | Any ACE (95% CI) |
|---|---|---|---|---|---|---|
| No doctor because of cost | 1.389 (0.901, 2.141) | 1.431 (0.931, 2.201) | 2.178 (1.319, 3.597) | 3.012 (1.775, 5.113) | 5.752 (3.616, 9.149) | 2.227 (1.610, 3.080) |
| No personal doctor | 1.444 (1.036, 2.012) | 1.196 (0.785, 1.822) | 2.285 (1.524, 3.428) | 2.416 (1.490, 3.915) | 3.937 (2.626, 5.905) | 1.921 (1.493, 2.471) |
| No health insurance | 1.479 (0.903, 2.424) | 0.888 (0.492, 1.603) | 1.484 (0.793, 2.777) | 2.022 (1.047, 3.904) | 3.355 (1.836, 6.130) | 1.675 (1.106, 2.536) |
| Never tested for HIV | 0.458 (0.354, 0.593) | 0.569 (0.423, 0.766) | 0.267 (0.193, 0.368) | 0.250 (0.172, 0.363) | 0.212 (0.149, 0.302) | 0.364 (0.298, 0.444) |

Odds Ratios for Health Care Utilizations for Chronic Conditions, Crude and Adjusted by Insurance Status

| | 1 ACE (95% CI) | 2 ACEs (95% CI) | 3 ACEs (95% CI) | 4 ACEs (95% CI) | ≥5 ACEs (95% CI) | Any ACE (95% CI) |
|---|---|---|---|---|---|---|
| Never had cholesterol checked (no insurance) | 1.586 (1.095, 2.298) | 0.984 (0.641, 1.509) | 1.794 (1.136, 2.835) | 2.056 (1.247, 3.392) | 2.975 (1.945, 4.551) | 1.712 (1.285, 2.280) |
| Never had cholesterol checked w/ insurance | 1.428 (1.005, 2.030) | 1.019 (0.667, 1.557) | 1.831 (1.133, 2.959) | 1.905 (1.156, 3.137) | 2.656 (1.678, 4.202) | 1.612 (1.218, 2.134) |
| Not taking blood pressure medications (no insurance) | 1.823 (1.154, 2.882) | 1.931 (1.120, 3.329) | 2.082 (1.179, 3.677) | 2.971 (1.568, 5.628) | 3.590 (1.917, 6.720) | 2.199 (1.527, 3.167) |
| Not taking blood pressure medication with insurance | 1.751 (1.107, 2.769) | 1.952 (1.124, 3.390) | 2.045 (1.155, 3.621) | 2.900 (1.497, 5.616) | 2.929 (1.555, 5.515) | 2.088 (1.435, 3.038) |

Survey-weighted Percentage of Respondents Within Each Category of Health Care Access Indicators and Health Care Utilization Indicators by Cumulative ACEs, 2019 Ohio BRFSS

| | 0 ACEs (95% CI) | 1 ACE (95% CI) | 2 ACEs (95% CI) | 3 ACEs (95% CI) | 4 ACEs (95% CI) | ≥5 ACEs (95% CI) |
|---|---|---|---|---|---|---|
| Health care access | | | | | | |
| No doctor because of cost | 6.1 (4.7, 7.8) | 7.6 (5.8, 10.0) | 11.0 (8.0, 14.9) | 17.1 (13.0, 22.3) | 24.8 (18.7, 32.2) | 27.4 (22.4, 33.1) |
| No personal doctor | 14.5 (12.5, 17.3) | 18.7 (15.4, 22.5) | 21.8 (17.7, 26.5) | 27.7 (22.4, 33.8) | 27.7 (21.2, 35.4) | 25.2 (20.4, 30.7) |
| No health insurance | 6.8 (5.2, 8.9) | 5.8 (4.1, 8.3) | 8.0 (5.2, 12.0) | 9.6 (6.6, 13.8) | 16.7 (11.3, 24.0) | 14.2 (10.2, 19.3) |
| Never tested for HIV | 77.7 (75.0, 80.2) | 69.9 (65.9, 73.6) | 58.5 (53.5, 63.3) | 55.5 (49.4, 61.3) | 47.8 (40.7, 55.0) | 43.8 (38.0, 49.8) |
| Health care utilization | | | | | | |
| Never had cholesterol checked | 8.3 (6.3, 10.9) | 12.0 (9.0, 15.8) | 8.5 (6.0, 12.0) | 16.6 (12.1, 22.5) | 10.8 (7.0, 16.4) | 16.5 (11.9, 22.5) |
| Not taking blood pressure medications | 15.9 (12.7, 20.0) | 23.2 (17.8, 30.0) | 23.3 (17.2, 30.7) | 26.4 (18.3, 36.5) | 31.3 (21.1, 43.7) | 42.2 (33.2, 51.7) |

**RESEARCH ARTICLE**

# Application of the Healthy Migrant Theory to Maternal Morbidity and Mortality Data in Ohio

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## ABSTRACT

**Background:** The healthy migrant theory is a phenomenon describing a protective effect regarding specific health outcomes when a person is born outside of the United States (US). Previous literature has focused on the application of this theory to infant outcomes, leaving its application to maternal outcomes mostly unstudied. The objective of this research is to determine whether the healthy migrant theory, specifically as it applies to Black women, holds true to maternal morbidity in the Ohio population.

**Methods:** Birth record data from the Ohio Department of Health were analyzed from 2015-2020 that included mothers identifying as White or Black and data where country of birth was available (n=717 300). Mothers were grouped by race and nationality. Maternal morbidity and socioeconomic status were analyzed. One-way ANOVA was used to examine associations between socioeconomic status and number of maternal morbidity events. Binary logistic regression models were developed to examine the relationships among race, nationality, and occurrence of maternal morbidity events. Interaction between race and nationality was also evaluated.

**Results:** Among Black mothers, nationality was significantly associated with the likelihood of any maternal morbidity event occurring (OR = 1.659; 95% CI = 1.534, 1.795; p < 0.001), with foreign-born mothers having about 1.66 times greater odds of having a maternal morbidity event. This relationship persisted after adjusting for socioeconomic status. No statistical difference in low socioeconomic status indicators was found between foreign-born Black mothers and US-born Black mothers (p = 0.349, 95% CI = -0.007, 0.030).

**Conclusion:** Our findings appear to contradict the healthy migrant theory. More research regarding treatment and outcomes of foreign-born Black mothers must be implemented to better understand the nuances of the application of this theory to maternal outcomes. Caution should be taken when comparing infant and maternal outcomes and interventions since they may not be as closely connected as previously thought. Limitations of this project include inaccuracies in data collection from birth certificates, limited morbidity variables, and lack of stratification based on country of origin.

**Keywords:** Maternal and child health; Immigrant health; Health disparities; Structural racism; Logistic regression

## INTRODUCTION

Over the past several years, many articles have published data demonstrating a significant difference in infant morbidity and mortality between foreign-born women living in the United States (US) and US-born women of the same racial background.[1-4] For instance, prior research has demonstrated that the incidence of low birth weight in African-born Black women in the US more closely resembled the incidence of low birth weight in US-born White women compared to US-born Black women.[2] These findings challenged the prior theories that higher incidences of infant morbidity, including low birth weight, was higher in Black populations

due to genetic effects corresponding to each population's race.[2,3] These data pointed to an alternative explanation for the differences in infant mortality between Black women and White women. Instead of citing genetics as the cause for the increased rates of infant morbidity in US-born Black women, the data suggest that these increased rates are more likely attributed to the inherent societal racism and socioeconomic status of the mentioned populations.[2] This phenomenon has become known as the healthy migrant theory; the idea that there is a protective effect in regard to specific health outcomes when a person is born outside of the US and then migrates to the US compared to a person of similar ethnicity who is born in the US.[5]

Several published research studies have demonstrated differences in mortality and outcomes between infants of US-born women and infants of immigrant women of the same ethnicity. For example, one such study demonstrated a significant difference in low birth weight between infants of US-born women of Mexican descent and infants of Mexican-born women.  The data from this study found that infants of US-born Mexican Americans were found to be at 60 percent higher risk of low birth weight than infants of Mexican-born women.[6] Similar outcomes have been published for other immigrant populations, thereby demonstrating a trend that infants born to immigrant women have significantly lower incidence of poor outcomes compared to US-born women of the same ethnicity. Another research study produced data further supporting this trend, namely that there was a significantly lower rate of preterm birth and birth of SGA (small for gestational age) infants in foreign-born non-Hispanic Black women compared to US-born non-Hispanic Black women.[4] An additional article similarly outlined how the healthy migrant theory affects infant outcomes. This article analyzed preterm birth rates between US-born and foreign-born Black women. It was also found that US-born Black women had a 3.2 higher risk of preterm birth than foreign-born Black women and a 4.4 higher risk of preterm birth than US-born White women.[7]

The Ohio Department of Health listed maternal and infant health as a health outcome priority on the 2020-2022 State Health Improvement Plan, with an emphasis on improving health equity, with Black mothers experiencing disproportionately high rates of preterm birth, infant mortality, and severe maternal morbidity.[8] Based on the Ohio Department of Health's 2020 Infant Mortality Report, infant mortality is at its lowest level in over a decade, but there is a persistent race-based disparity, with Black infants dying at a rate 2.7 times greater than White infants.[9] There is a similar disparity in Ohio in both maternal mortality and maternal morbidity.[10,11] As of the 2020 US Census, 14.4% of Ohio's population identified as Black or Black and another race. From 2016 to 2019, non-Hispanic Black mothers in Ohio have a severe maternal morbidity rate more than double that of non-Hispanic White mothers in Ohio.[10] Additionally, from 2008 to 2016, pregnancy-related deaths in Ohio were significantly higher for non-Hispanic Black mothers at 29.5 deaths per 100 000 live births compared to 11.5 deaths for

non-Hispanic White mothers.[11] This reveals a significant health care burden, with Black citizens experiencing a disproportionate number of negative health outcomes. Understanding how demographic factors like race and immigrant status interact and relate to health outcomes in Ohio is necessary to develop effective strategies to eliminate health disparities and improve health outcomes.

As described above, previous researchers have investigated infant morbidity and mortality outcomes as they relate to the healthy migrant theory, however, there has been substantially less research examining maternal morbidity and mortality outcomes. The goal of this research is to investigate whether the healthy migrant theory holds true for maternal morbidity in the Ohio population, specifically for Black mothers.

## METHODS

### Sample

This analysis used deidentified birth record data for the state of Ohio accessed from the Ohio Department of Health's Vital Statistics. The protocol for this study was submitted to the Ohio Department of Health institutional review board and found to be exempt. Complete data from the years 2015-2020 were included. All cases included in the statistical analysis were single parity births that occurred in mothers who were residents of Ohio and gave birth in the state (n= 767 254). This study focused on a subset of cases composed of US-born White mothers, US-born Black mothers, and foreign-born Black mothers (n= 693 321), excluding foreign-born White mothers and mothers of other race/ethnicities from the analysis sample. These 2 populations were excluded because the main focus was among Black mothers specifically.

### Measures

Race. The mother's race was determined by the Vital Statistics race category coded for the Public Information Warehouse, with possible options of White, Black, Native American, Asian, Pacific Islander/Hawaiian, or Other/Unknown. Analysis focused on White and Black mothers. Mother's ethnicity was not evaluated.

Mother's Nationality. Nationality was evaluated as a binary categorical variable of US-born mothers and foreign-born mothers. Foreign-born mothers included any mother born in a known country that was not the US. Unknown countries of birth were marked as missing.

Group by Race and Nationality. A combined group variable was created with mothers separated into 3 group designations: US-born White mothers, US-born Black mothers, and foreign-born Black mothers.

Maternal Morbidity. Maternal morbidity events included perineal laceration, ruptured uterus, unplanned hysterectomy, admission to intensive care, unplanned operation, maternal transfusion, and hypertension eclampsia. Two separate variables were created to evaluate maternal morbidity as a combined variable for analysis. The first variable was a binary categorical variable with options

for no maternal morbidity event occurred or any maternal morbidity event occurred. The second combined variable was a numeric variable of the number of maternal morbidity events that occurred (possible values of 0-7, with 0 meaning no maternal morbidity, and 7 meaning all the maternal morbidity events were met).

Socioeconomic Status. Proxy measures were used to evaluate socioeconomic status. Mothers were identified as low socioeconomic status if they met at least 1 of the following criteria: payment method was self-pay or Medicaid, the mother completed less than a high school education, or the mother received WIC services. This created a binary socioeconomic status variable (low socioeconomic status or not low socioeconomic status). These proxy measures serve as conservative estimates of mothers that would fall into the low socioeconomic status category.

**Analysis**

Data processing and statistical analysis was conducted using IBM SPSS (version 29). Demographic characteristics were determined, including frequencies of mother's race, nationality, age, education level, payment source, and WIC use (Tables 1 and 2). In the event of missing data, cases were deleted.

Differences in the number of maternal morbidity events that occurred were evaluated based on the mother's race and nationality group (US-born White, US-born Black, and foreign-born Black) using one-way ANOVA. Post-hoc analyses were conducted using the Games-Howell test.

Binary logistic regression models were used to evaluate the effect of the mother's race and nationality (groups for US-born White, US-born Black or foreign-born Black mothers) on the occurrence of any maternal morbidity events and evaluate the effect of nationality on the occurrence of any maternal morbidity events among Black mothers (n=141 267). Unadjusted and adjusted relationships were investigated. Each model adjusted for socioeconomic status (low socioeconomic status) and the number of prenatal care visits.

**RESULTS**

The study sample included 717 300 singleton births occurring from 2015 to 2020 in Ohio among White mothers and Black mothers. Mother's age ranged from 11 to 59 years, with a mean age of 28.07 years (SD = 5.60). There were 43 237 cases where the mother was born in a country other than the US. Despite Black mothers

only accounting for 17.8% of births among mothers born in the US in the sample, 44.5% of the births among foreign-born mothers involved Black mothers (Table 1).

The subset of cases for analysis included cases only from US-born White mothers, US-born Black mothers, and foreign-born Black mothers (n= 693 313). Maternal morbidity events were rare, with 1 or more of the 7 maternal morbidity events occurring in only 2.5% of US-born White mothers, 2.6% of US-born Black mothers, and 4.2% of foreign-born Black mothers. The most prevalent maternal morbidity outcome was third-degree or fourth-degree perineal laceration, which occurred in less than 2% of cases. Additional demographic characteristics are available in Table 2, and maternal morbidity outcomes are listed in Table 3.

A one-way ANOVA was performed comparing the effects of mother's race and nationality group on maternal morbidity. This test revealed that there was a statistically significant difference in the number of maternal morbidity factors between mother groups ($F (2, 693 313) = 106.125$, $p < 0.001$) (Table 3). Post hoc test revealed that the mean number of maternal morbidity events was significantly different between foreign-born Black mothers and US-born Black mothers ($p < 0.001$, 95% CI = 0.014, 0.022), with foreign-born Black mothers having a greater number of maternal morbidity events, on average (0.05), than US-born Black mothers (0.03). Additionally, the mean number of maternal morbidity events was significantly different between foreign-born Black mothers and US-born White mothers ($p < 0.001$, 95% CI = 0.016, 0.024), with foreign-born Black mothers having a greater number of maternal morbidity events, on average (0.05), than US-born White mothers (0.03).

An unadjusted binary logistic regression was performed to evaluate the influence of the mother's race and nationality group on the odds of having any maternal morbidity event (n= 693 313). The mother's race and nationality were significantly associated with having a maternal morbidity event ($p < 0.001$). Compared to US-born White mothers, foreign-born Black mothers had about 1.7 times greater odds of having a maternal morbidity event (Odds Ratio (OR) = 1.716; 95% CI = 1.597, 1.845; $p < 0.001$). Additionally, compared to US-born Black mothers, foreign-born Black mothers had 1.6 times greater odds of having any maternal morbidity event (OR = 1.658; 95% CI = 1.534, 1.795; $p < 0.001$). However, the odds of having any maternal morbidity event were not significantly different between US-born White mothers and US-born Black mothers (OR = 1.034; 95% CI = 0.994, 1.076; $p = 0.092$).

**Table 1. Frequency of Cases by Mother's Race and Nationality**

|  |  | Mother's nationality | | |
|---|---|---|---|---|
|  |  | US-born | Foreign-born | Total |
| **Mother's race** | White | 553 654 (82.14) | 23 979 (55.46) | 577 633 (80.53) |
|  | Black | 120 409 (17.86) | 19 258 (44.54) | 139 667 (19.47) |
|  | Total | 674 063 (100) | 43 237 (100) | 717 300 (100) |

After adjusting for socioeconomic status and number of prenatal care visits, mother's race and nationality group was significantly associated with having a maternal morbidity event (p < 0.001). Holding socioeconomic status and number of prenatal care visits constant, foreign-born Black mothers have about 2 times greater odds of having a maternal morbidity event than US-born White mothers (OR = 2.002; 95% CI = 1.857, 2.158; p < 0.001), and foreign-born Black mothers have about 1.2 times greater odds of having a maternal morbidity event than US-born Black mothers (OR = 1.223; 95% CI = 1.173, 1.276; p < 0.001).

Among Black mothers, (n = 139 667), nationality was significantly associated with any maternal morbidity event occurring (OR = 1.659; 95% CI = 1.534, 1.795; p < 0.001), with foreign-born mothers having about 1.66 times greater odds of having a maternal morbidity event. This relationship persisted after adjusting for socioeconomic status (OR = 1.644; 95% CI = 1.519, 1.779; p < 0.001).

## DISCUSSION

The results from this analysis confirm what has previously been demonstrated regarding the significant difference in maternal morbidity in Black mothers compared to White mothers, with Black mothers experiencing more maternal morbidity than White mothers. When comparing immigration status, our study demonstrated that immigrant mothers had a statistically significant increased number of maternal morbidity events than US-born mothers. Additionally, immigrant mothers also had a significant mean number of low socioeconomic status indicators compared to US-born mothers. These findings are specifically important because in other studies throughout the US, there are often findings that demonstrate that Black immigrant mothers have improved pregnancy outcomes.[12]

The current study also demonstrated that when comparing Black immigrant mothers to US-born Black mothers, Black immigrant mothers had a great number of maternal morbidity events. When compared to US-born White mothers, Black immigrant mothers

again demonstrated a greater number of maternal morbidity events. In a similar outcome, Black immigrant mothers had a higher number of indicators for low socioeconomic status compared to US-born White mothers. However, there was not a statistically significant difference in indicators for low socioeconomic status between Black immigrant mothers and US-born Black mothers.

These outcomes are contradictory to the hypothesis that the healthy migrant theory proposes, specifically that US-born Black mothers would be predicted to have more maternal morbidity events compared to Black immigrant mothers. There are a few other studies that have analyzed specific maternal outcomes that have supported this healthy migrant theory when applied to Black mothers. One such study analyzed the prevalence of preeclampsia, which was demonstrated to be higher in US-born versus foreign-born non-Hispanic Black women. This study also interestingly analyzed how duration living in the US affected the health of foreign-born Black mothers, demonstrating that foreign-born Black women with more than 10 years of living in the US had a higher prevalence of chronic hypertension, obesity, smoking, and maternal stress.[13] Our investigation did not include information on length of time living in the US as this information is not available on birth records, a potential limitation of the study which may partially explain why our results do not corroborate the healthy migrant theory.

Given that the data in this research project demonstrate a significant increase in maternal morbidity in Black immigrant mothers compared to US-born Black mothers, further evaluation and research regarding treatment and outcomes of Black immigrant mothers must be implemented. Implicit bias has been discussed as one of the etiologies behind the discrepancy in maternal outcomes in Black mothers versus White mothers in the US. Prior research has been performed which outlines implicit bias and how it can impact the care that Black women receive.[14] Using this information, implicit bias could potentially be implicated as one reason why the Ohio Department of Health data in this research demonstrated an increase in maternal morbidity in Black immigrant

## Table 2. Demographic Characteristics of Ohio Residents with Singleton Births in the State of Ohio from 2015-2020 by Race and Nationality

| | | US-born White mothers | US-born Black mothers | Foreign-born Black mothers |
|---|---|---|---|---|
| Mother's average age (years) | | 28.39 | 26.21 | 30.49 |
| Mother's education (n, %) | | | | |
| | Less than high school | 59 815 (10.82) | 22 243 (17.73) | 4339 (23.0) |
| | High school graduate/ GED | 142 787 (25.82) | 46 394 (38.72) | 5833 (30.91) |
| | Some college | 159 704 (28.88) | 40 747 (34.0) | 4699 (24.9) |
| | Bachelor's degree | 120 416 (21.78) | 7666 (6.40) | 2729 (14.46) |
| | Graduate degree | 70 209 (12.7) | 3783 (3.16) | 1269 (6.73) |
| Payment source (n, %) | | | | |
| | Medicaid | 185 902 (33.75) | 88 702 (73.96) | 12 693 (66.23) |
| | Private insurance | 322 681 (58.59) | 26 100 (21.76) | 4441 (23.17) |
| | Self-pay/uninsured | 25 998 (4.72) | 2113 (1.76) | 1259 (6.57) |
| | Other | 16 193 (2.94) | 3014 (2.51) | 773 (4.03) |
| Mother used WIC (%) | | 27.18 | 55.21 | 52.13 |

mothers. Since implicit attitudes are thoughts that exist outside of conscious awareness, they can be difficult to control and can often go unrecognized.[15] Societies have also created and fostered racial discrimination throughout history by reinforcing inequitable systems such as housing, education, health care, and employment. These inequitable systems have then reinforced existing racial discrimination, creating an endless cycle of oppression and persecution.[16] This can specifically be seen in health care, where both perceived and actual racism have been shown to cause a measurably increased incidence in poor outcomes between Black persons versus White persons.[14,15,17,18] In the US, there has also been historically a great deal of discrimination toward immigrants stemming from a variety of factors including but not limited to stereotypes, perceived threat and competition, and the ideological climate. Political viewpoints often use stereotypes of immigrants to support restrictive immigration policies, further perpetuating this discrimination and solidifying the implicit bias toward immigrants.

Limitations of this project include limitations and inaccuracies of data available on birth certificates. Data variables for analysis were limited to what was available on birth record data, and maternal morbidity events may have been present that were not included in the birth records. In addition to this, results should be interpreted with caution as there may be uncontrolled confounding. These are inherent limitations related to the retrospective approach of the study. This study could not include the length of residence in the US for the women who identified as foreign born as this information was not available. However, length of time living in the US has been shown to be related to increased risk of maternal morbidity outcomes.[13] Another limitation was the lack of analysis by maternal age or number of pregnancies. Additionally, this investigation did not include a stratification of outcomes based on specific country of origin. The results may not be generalizable to mothers who do not identify as Black or non-Hispanic

White as the study included only mothers who identified as Black or non-Hispanic White.  Although a woman identifies as a foreign-born Black mother, these women should not be treated as a homogenous group since the unique country of origin likely contributes unique barriers and attributes that could affect maternal outcomes.

From 2004 to 2013, Ohio welcomed 18 261 refugees from 54 different countries, with the greatest number of refugees immigrating from Somalia (5712).[19] A 2018 study looking at maternal and reproductive health care access among Somali refugees in Ohio found unique barriers to care. Despite the majority of the Somali refugee women being employed, married, and having completed primary education, about half of the women in the study were living below the poverty line, a quarter of the women were uninsured, and the majority had no or limited English proficiency. Additionally, more than 80% of study respondents had experienced female genital circumcision. The most frequently cited reason to avoid or postpone maternal and reproductive care among the refugee women was a lack of insurance coverage.[20] Thus, the additional socioeconomic, language, and cultural barriers to access maternal health care among refugee immigrant populations could further explain the high maternal morbidity in Black immigrant mothers in Ohio, compared to Black immigrant populations in other communities with different refugee populations.

Future directions for this project could include further analysis of morbidity outcomes for foreign-born English-speaking women versus foreign-born non-English speaking women to determine how language barriers affect such outcomes. Further analysis could be done to examine how differences may exist among foreign-born White mothers as well, given that this population was not included in this study. As mentioned above, length of time living in the US was not evaluated. Given that other studies have demonstrated a correlation between negative outcomes and

**Table 3. Clinical Outcomes for Ohio Residents with Singleton Births in the State of Ohio from 2015-2020 by Race and Nationality**

| | US-born White mothers | US-born Black mothers | Foreign-born Black mothers |
|---|---|---|---|
| Route of delivery, n = 693 109 | n = 553 498 | n= 120 358 | n= 19 253 |
|     Spontaneous | 367 227 (66.35) | 78 601 (65.31) | 12 324 (64.01) |
|     Forceps | 6738 (1.22) | 1413 (1.17) | 279 (1.45) |
|     Vacuum | 19 065 (3.44) | 3270 (2.72) | 635 (3.30) |
|     Cesarean | 160 468 (28.99) | 37 074 (30.80) | 6015 (31.24) |
| Hypertension eclampsia, n = 693 321 | 1340/553 654 (0.24) | 401/120 409 (0.33) | 42/19 258 (0.22) |
| Maternal transfusion, n = 693 313 | 2725/553 649 (0.49) | 1133/120 409 (0.94) | 182/19 255 (0.95) |
| Perineal laceration (3$^{rd}$ degree or 4$^{th}$ degree), n = 693 313 | 6443/553 649 (1.16) | 682/120 409 (0.57) | 381/19 255 (1.98) |
| Ruptured uterus, n = 693 313 | 163/553 649 (0.03) | 67/120 409 (0.06) | 38/19 255 (0.20) |
| Unplanned hysterectomy, n = 693 313 | 248/553 649 (0.04) | 88/120 409 (0.07) | 20/19 255 (0.10) |
| Admit to intensive care, n = 693 313 | 990/553 649 (0.18) | 325/120 409 (0.27) | 79/19 255 (0.41) |
| Unplanned operation, n = 693 313 | 3346/553 649 (0.60) | 843/120 409 (0.70) | 167/19 255 (0.87) |
| Maternal morbidity (number of events), n = 693 313 | 0.028 ± 0.182 | 0.029 ± 0.193 | 0.047 ± 0.240 |
| Maternal morbidity (any event), n = 693 313 | 13 899/553 649 (2.51) | 3124/120 409 (2.59) | 815/19 255 (4.23) |

Data for continuous variables are displayed: mean ± SD, and data for categorical variables are displayed: frequency (%).

length of time living in the US, it would be prudent to investigate if this correlation also exists for the Ohio population examined in this study as this could give insight into the negative effects of assimilation.[12,13] Additionally, research could be done to compare maternal morbidity outcomes in foreign-born Black women versus foreign-born non-Black women to demonstrate the effect that race has on maternal outcomes. Outside of future research, the data from this project demonstrates a significant difference in outcomes for Black immigrant women versus US-born Black women, therefore further education and application of mindful medicine should be implicated. This could include standardizing health and equity morbidity, mortality, and improvement conferences for every hospital and residency program to create a platform to discuss the implications of race and background in medicine. Additionally, it would be recommended that forums for health care providers to discuss their implicit biases in a constructive manner be created for hospitals in the US.

## PUBLIC HEALTH IMPLICATIONS

Race-based disparities in maternal and infant birth outcomes are persistent. Based on the Centers for Disease Control and Prevention's *Morbidity and Mortality Weekly Report* (MMWR) released in 2019, from 2007-2016 in the US, Black women experience an average of 41 pregnancy related deaths per 100 000 live births, compared to an average of 13 deaths in White women. It was suggested that this disparity may arise from differences in access and quality of care or differences in the prevalence of chronic diseases.[21] Access and quality of health care is determined in part by historical, structural factors that have resulted in the under-allocation of community resources in low-income and minority communities. Additionally, these differences may also reflect additional structural implicit bias of health care providers. Identifying the root causes of race-based health disparities and the systemic causes that could be addressed through training and policy changes to address systemic and structural racism in the health care system is important.

## CONFLICTS OF INTEREST

The authors have none to report.

**Author Contribution**
Fiona Hodges: study design, protocol draft, manuscript drafting/editing
Cassidy Hughes-Lubanski: study design, protocol draft, data analysis, manuscript drafting/editing
Sara Paton: study design, protocol draft, IRB coordination, data request/collection, data analysis, manuscript drafting/editing,
Timothy Crawford: data analysis, manuscript drafting/editing
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**REFERENCES**

1. Forna F, Jamieson DJ, Sanders D, Lindsay MK. Pregnancy outcomes in foreign-born and US-born women. *Int J Gynecol Obstet*. 2003;83 (3):257-265.
   https://doi.org/10.1016/S0020-7292(03)00307-2

2. David RJ, Collins JW. Differing birth weight among infants of US-born blacks, African-born blacks, and US-born whites. *New Engl J Med*. 1997;337(17):1209-1214.
   https://doi.org/10.1056/NEJM199710233371706

3. Goldenberg RL, Cliver SP, Cutter GR, et al. Black-white differences in newborn anthropometric measurements. *Obstet Gynecol*. 1991 Nov;78 (5 Pt 1):782-788,
   https://journals.lww.com/greenjournal/Abstract/1991/11000/Black_White_Differences_in_Newborn_Anthropometric.12.aspx

4. Elo IT, Vang Z, Culhane JF. Variation in birth outcomes by mother's country of birth among non-Hispanic Black women in the United States. *Matern Child Health J*. 2014;18(10):2371-2381.
   https://doi.org/10.1007/s10995-014-1477-0

5. Wingate MS, Alexander GR. The healthy migrant theory: variations in pregnancy outcomes among US-born migrants. *Soc Sci Med*. 2006;62 (2):491-498.
   https://doi.org/10.1016/j.socscimed.2005.06.015

6. Guendelman S, Gould JB, Hudes M, Eskenazi B. Generational differences in perinatal health among the Mexican American population: findings from HHANES 1982-84. *Am J Public Health*. 1990;80(Suppl):61-65.
   https://doi.org/10.2105/AJPH.80.Suppl.61

7. DeSisto CL, Hirai AH, Collins JW, Rankin KM. Deconstructing a disparity: explaining excess preterm birth among US-born black women. *Ann Epidemiol*. 2018;28(4):225-230.
   https://doi.org/10.1016/j.annepidem.2018.01.012

8. Bush Stevens A, Akah H, Reat Z, et al. *State Health Improvement Plan Ohio 2020-2022*.; 2020.
   https://odh.ohio.gov/wps/portal/gov/odh/about-us/sha-ship

9. Ohio Department of Health. *2020 Infant Mortality Annual Report*.; 2020.
   https://odh.ohio.gov/know-our-programs/infant-and-fetal-mortality/reports/2020-ohio-infant-mortality-report

10. Ohio Department of Health. *Severe Maternal Morbidity and Racial Disparities in Ohio, 2016-2019*.; 2020.
    https://odh.ohio.gov/know-our-programs/pregnancy-associated-mortality-review/media/pamr-smm

11. Ohio Department of Health. *A Report on Pregnancy-Associated Deaths in Ohio 2008-2016*.; 2020.
    https://odh.ohio.gov/wps/wcm/connect/gov/f5f620c6-d444-4873-bbc8-bbc76bba1a71/A_Report_on_Pregnancy-Associated_Deaths_in_Ohio_2008-2016+website+version.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIK0N0JO00QO9DDDDM3000-f5f620c6-d444-4873-bbc8-bbc76bba1a71-nvUTYCq

12. Elsayed, A, Amutah-Onukagha NN, Navin L, et al. Impact of immigration and duration of residence in US on length of gestation among Black women in Newark, New Jersey. *J Immigr Minor Health* 21, 1095–1101 (2019).
    https://doi.org/10.1007/s10903-018-0813-7

13. Boakye E, Sharma G, Ogunwole SM, et al. Relationship of preeclampsia with maternal place of birth and duration of residence among non-Hispanic Black women in the United States. *Circ Cardiovasc Qual Out-*

*comes*. 2021;14(2).
https://doi.org/10.1161/CIRCOUTCOMES.120.007546

14. Saluja B, Bryant Z. How implicit bias contributes to racial disparities in maternal morbidity and mortality in the United States. *J Womens Health*. 2021;30(2):270-273.
https://doi.org/10.1089/jwh.2020.8874

15. Hall WJ, Chapman MV, Lee KM, et al. Implicit racial/ethnic bias among health care professionals and its influence on health care outcomes: a systematic review. *Am J Public Health*. 2015;105(12):e60-e76.
https://doi.org/10.2105/ajph.2015.302903

16. Bailey ZD, Feldman JM, Bassett MT. How structural racism works — racist policies as a root cause of US racial health inequities. *New Engl J Med*. 2021;384(8):768-773.
https://doi.org/10.1056/NEJMMS2025396

17. Crawford AD, Darilek U, McGlothen-Bell K, Gill SL, Lopez E, Cleveland L. Scoping review of microaggression as an experience of racism and perinatal health outcomes. *J Obstet Gyneol Neonatal Nurs*. 2022;51(2):126-140.
https://doi.org/10.1016/j.jogn.2021.12.007

18. Egede LE, Campbell JA, Walker RJ, Linde S. Structural racism as an upstream social determinant of diabetes outcomes: a scoping review. *Diabetes Care*. 2023;46(4):667-677.
https://doi.org/10.2337/dci22-0044

19. Refugee Arrivals. *Individuals Resettled in Ohio by County of Origin FFY 1983-2013*.
https://jfs.ohio.gov/cash-food-and-refugee-assistance/refugee-services/refugee-arrivals

20. Banke-Thomas A, Agbemenu K, Johnson-Agbakwu C. Factors associated with access to maternal and reproductive health care among Somali refugee women resettled in Ohio, United States: a cross-sectional survey. *J Immigr Minor Health*. 2019;21(5):946-953.
https://doi.org/10.1007/s10903-018-0824-4

21. Petersen EE, Davis NL, Goodman D, et al. Racial/ethnic disparities in pregnancy-related deaths — United States, 2007–2016. *MMWR Morb Mortal Wkly Rep*. 2019;68(35):762-765.
https://doi.org/10.15585/mmwr.mm6835a3

**RESEARCH ARTICLE**

# "When COVID Hit": Psychosocial Impacts and Coping Strategies Among Ohio's Public Health Workforce

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**ABSTRACT**

**Background:** The COVID-19 pandemic was associated with widespread occupational stress and burnout. Given the duties of public health, alongside the politicization of public health mandates in Ohio, we attempted to understand the potentially unique psychosocial impact of the pandemic on Ohio's public health workforce.

**Methods:** A mixed method study was conducted to understand the factors associated with everyday discrimination, burnout, perceived stress-anxiety, and commitment to continue in public health. Ohio public health workers were invited to participate in an anonymous online survey and/or confidential phone interview. Descriptive statistics, bivariate tests, and stepwise linear regression were calculated. Interpretive phenomenological analysis was used to evaluate the qualitative interview data.

**Results:** The majority reported symptoms of burnout, and nearly 1 in 3 indicated readiness to leave the public health workforce. Public facing response duties correlated with everyday discrimination, burnout, and commitment to continue. Everyday discrimination was associated with perceived stress-anxiety. Perceived stress-anxiety was linked to burnout. Job satisfaction correlated with both burnout and commitment to continue. Two qualitative themes focused on psychosocial impact and coping were organized into 7 subthemes which elaborated our understanding and affirmed the quantitative findings.

**Conclusion:** The findings represent a critical time of the COVID-19 pandemic and potential fallout on Ohio's public health workforce. Work is needed to develop and maintain a resilient workforce. To prevent burnout and loss of institutional knowledge, effective coping and capacity building efforts are needed to tackle the unpredictable conditions of public health. Initiatives to address the public's understanding and normative response to public health efforts are warranted.

**Keywords:** COVID-19; Public health workforce; Ohio; Mixed methods

## INTRODUCTION

The COVID-19 pandemic placed health care workers and first responders at risk for traumatic stress, depression, generalized anxiety, insomnia, occupational stress and dysfunction, moral distress, and a general disinterest in work.[1-5] COVID-19-related occupational stressors (CROS) contributing to this decline included grief and loss, witnessing a patient decline in health, a lack of personal protective equipment, feelings of helplessness, and fears of contracting the virus.[2] In response, health care workers utilized a variety of coping mechanisms such as practicing personal protective measures, relying on friends and family for emotional support,

meditation, religious/spiritual activities, as well as exercise to relieve workplace stress to deal with COVID-19 stressors.[6]

Given these concerns, it is important to specifically investigate the potentially unique impacts on the public health workforce and its coping mechanisms. This workforce not only provided recommendations and interventions, but also enforced COVID-19 policies and mandates, positioning them for distinct CROS like work-based threats or harassment[1] as well as concerning rates of negative occupational outcomes such as burnout and resignation, even compared to other health care workers.[7,8] Rizzo, for example, found 57% of public health officials left their position due to COVID-19 related events,[9] a finding consistent with Leider et al, who found nearly half of all public health employees surveyed left their positions between 2017 and 2021.[10]

A previous publication indicated public health workers experience occupational stigma and stress in the eye of the public due to the politicization of COVID-19 and the public health response.[11] As an expansion on the original article, this paper elaborates on the psychosocial impacts and coping strategies employed by public health workers in the state of Ohio. Ohio provides a rich and nuanced context for this examination, while also retaining transferability, particularly across other states in the United States. As elsewhere, Ohio public health mandates were highly politicized with substantial impacts on the public health workforce.

For example, tumultuous backlash including the spread of anti-Semitic messages during an angry protest outside her home landed on The Ohio Department of Health's (ODH) director Amy Acton. Acton's subsequent resignation was an impactful loss for Ohio's public health workforce and a critical moment for public health's reputation and future in the state. Governor Mike DeWine's decisions during COVID-19 also received strong criticism, fueling debates about the future status and role of the public health workforce and its evolving relationship with the public. This background provides critical context for understanding the impacts of the COVID-19 pandemic on Ohio public health workers' psychosocial well-being (everyday discrimination, burnout, perceived stress-anxiety), commitment to continue in public health, and strategies for managing stress and staying, if at all, in their positions.

## METHODS

Mixed methods were used to evaluate the impact of the COVID-19 pandemic on Ohio public health workers. This paper expands on the qualitative findings previously reported on the experiences of Ohio public health workers.[11] This study's protocol was approved by the institutional review board of Bowling Green State University.

### Participants

A non-probability sampling method with a snowballing recruitment strategy was used to recruit Ohio public health workers over the age of 18 years. Direct email invitation was sent to 472 public health workers in Ohio. Emails were publicly available via Ohio health department websites. Direct invitation was also sent to Ohio public health workers who attended continuing education events with Bowling Green State University. The Association of Ohio Health Commissioners and the Ohio Society of Public Health Educators also sent the electronic invitation to their respective members. Recipients were asked to forward the invitation to other Ohio public health workers.

### Procedures

From the invitation, participants could choose to participate in an online survey and/or a qualitative phone interview. An electronic consent process was used and no personal information was collected during the consent. Those agreeing to the survey were routed to an anonymous electronic questionnaire. Participants who consented to only the interview were directed to a separate confidential sign-up using Cognito Forms (Cognito LLC, Columbia, SC). Interview participants were encouraged to use a personal email instead of their work email, as well as a pseudonym in the sign-up and interview process. If a participant agreed to both study activities, they were initially directed to the anonymous questionnaire and then redirected to the confidential sign-up.

### Quantitative Data Collection and Measures

The anonymous electronic questionnaire was administered via Qualtrics XM survey software (Qualtrics, Provo, UT). Most items were closed ended with Likert scale response options; however, an opportunity for qualitative response was provided. The questionnaire collected data on independent and dependent variables; the measures are described below. Potential confounders such as demographic information, work history, COVID-19 work roles, health department size, and geographic location were also examined.

### Dependent Variables

Everyday discrimination

The online questionnaire assessed frequency of experiencing everyday discrimination[12] because of their job during COVID-19 (ie, "You are treated with less courtesy because of your job," "You receive poorer service at local businesses (stores, restaurants, etc) because of your job," "Your family has been threatened or harassed because of your job"). A 5-point Likert scale was used for 13 items of everyday discrimination ranging from "never" through "very often."

Burnout

A single item burnout measure[13] was used to screen what proportion of the sample reported job related burnout symptoms. Participants were asked to respond to the statement, "Overall, which statement best describes how you feel about your job since COVID-19?" with 5 response options ranging from: "I enjoy my work. I have no symptoms of burnout" to "I feel completely burned out and often wonder if I can go on. I am at the point

where I may need some changes or may need to seek some sort of help." In addition, a 5-item composite scale related to work related burnout was used. Statements were adapted from a teacher burnout measure.[14] Participants were asked to rate their level of disagreement/agreement using a 4-point Likert scale to statements such as "I am weary with all my job responsibilities," "I feel frustrated at work," and "I no longer have an interest in my work."

### Perceived stress-anxiety

Participants were asked about the frequency of perceived stress-anxiety (5-point Likert scale, "never" through "very often"). A total of 12 statements were selected from previous instruments[15,16] and used for this section (ie, "In the last month how often have you… been upset because of something that happened unexpectedly?" or "…felt that you were unable to control the important things in your life").

### Commitment to continue in public health

A single item was used. Participants were asked to select 1 of 5 statements that described their commitment (ie, "I would like to stop working in public health," "I would stop if I could find any job in which I could earn at least as much money as I am earning now," or "I would not stop working in public health").

### Independent Variables

#### Stigma

A composite scale was used to examine frequency of associative stigma[17,18] as a public health worker during COVID-19 (5-point Likert scale, "never" through "very often"). Sample statements included "People express the belief that public health workers are to blame for COVID-19 related challenges (ie, job loss, closure of business, restrictions)," "The media portrays public health workers as not being credible or trustworthy," "People stay away from me because they are afraid they might get COVID-19 from me," or "I have lost friends because of my job."

#### Mindfulness

A composite scale was used to assess frequency of engaging in mindfulness[19] related behaviors in the past 7 days (5-point Likert scale, ranging from "never or 0 days" through "very often or 6-7 days in the past week"). A total of 18 statements were used to assess frequency of behaviors such as relaxation activities, healthy eating, physical activity, meditation, time management, and positive self-talk.

#### Social support

We assessed social support from family, friends, and coworkers by asking participants to rate their level of disagreement/agreement to 10 statements adapted from previous instruments.[20,21] Sample statements included "I get the emotional help and support that I need from my family and friends," "My coworkers are understanding if I have a bad day," or "My local board of health supports the work we do."

### Job satisfaction

Participants were asked to rate their job satisfaction before and during COVID-19 using a 5-point Likert scale ("I hate it" through "I love it"). Satisfaction was also ascertained by asking participants to compare their job satisfaction with other public health workers ("No one dislikes this job more than I do" through "No one likes being a public health worker better than me"). A third item asked if they would recommend being a public health worker to a friend or family member.

### Cynicism

Participants were asked to evaluate their disagreement/agreement with 4 statements related to cynicism. Examples included "Many laws and/or standards of operating practice that we are supposed to enforce are not clear" or "The public seems to have more defiant attitudes than ever before."

### Resilience

Six statements to assess resilience[22] were included in the survey and participants could select their disagreement/agreement using a 4-point Likert scale. Examples included "I tend to bounce back quickly after hard times," "It is hard for me to snap back when something bad happens," or "I tend to take a long time to get over setbacks in my life."

### Quantitative Data Analysis

Survey data were evaluated using IBM Statistical Package for the Social Sciences (SPSS) for Macintosh, Version 28.0 (IBM Corp., Armonk, NY). Negatively worded measures were reverse coded. Composite scores and internal reliability were calculated for each scale. Cronbach alpha results ranged from .57 to .89 (job satisfaction $\alpha = .74$, everyday discrimination $\alpha = .85$, stigma $\alpha = .77$, work related burnout $\alpha = .89$, perceived stress-anxiety $\alpha = .88$, mindfulness $\alpha = .87$, social support $\alpha = .84$, resilience $\alpha = .91$, cynicism $\alpha = .57$). All composite scales, except cynicism, had acceptable internal reliability and were retained for further analysis.

Descriptive statistics were calculated to determine participant characteristics. A paired sample t test was calculated to evaluate the self-reported change in job satisfaction, from before to during COVID-19, and hours worked per week. Pearson correlation was calculated to examine the bivariate relationships among the composite variables. Stepwise linear regression was used to evaluate correlates of the dependent variables including everyday discrimination, perceived stress-anxiety, work related burnout, and commitment to continue in public health. Confounder variables were included in the stepwise linear regression and significant variables were retained in the final model. Collinearity statistics were evaluated for regression analyses.

### Qualitative Data Collection and Analysis

Qualitative interviews complemented survey data by elaborating our understanding of participant experiences. We utilized

interpretive phenomenological analysis (IPA) which is appropriate for mixed methods inquiry.[23] Semistructured phone interviews were recorded and transcribed using the mobile application, TapeACall (TelTech Systems Inc., 2020). Initial noting and emergent themes analysis were conducted to create and apply a coding system using Lumivero's qualitative software, NVivo 12, released 2017. Additional details are described in a previous publication.[11] We enhanced trustworthiness through memo writing, a detailed paper trail, ongoing peer consultation, and member checking.

## RESULTS

### Quantitative Data

Survey responses were collected from public health workers in Ohio (n = 53). Most identified as female (75.5%), White (92.5%), non-Hispanic (98.1%), and having a 4-year degree (54.7%) (Table 1).

Respondents reported a variety of roles/job titles, with registered sanitarian most often reported. Health departments/districts primarily served rural communities. Time working in public health ranged from less than 1 year to 38 years (mean (M) = 11.30, standard deviation (SD) = 11.42) and time in current position ranged from less than 1 year to 23 years (M = 4.92, SD = 5.36). Half had a supervisory role, and remote work was reported by 51% of the sample.

Based on the single item burnout screener, 73.6% of the respondents indicated some level of burnout (Table 2). We also observed an increase in reported hours during the pandemic; employees reported an increase in the average work hours per week from pre-COVID-19 (M = 36.69, SD = 11.36) to during COVID-19 M = 47.29, SD = 14.72), which was a significant increase (t = 6.34, p < .001). A shift in self-reported job satisfaction was observed, as

**Table 1. Sample Characteristics of Ohio Public Health Workers Completing Survey Describing Public Health Worker Experiences During COVID-19 (n = 53)**

| Characteristic | | n | %[a] |
|---|---|---|---|
| Sex | | | |
| | Male | 12 | 22.6 |
| | Female | 40 | 75.5 |
| | Other | 1 | 1.9 |
| Ethnicity | | | |
| | Non-Hispanic | 51 | 98.1 |
| | Hispanic or Latino or Spanish Origin | 1 | 1.9 |
| Race | | | |
| | Asian | 1 | 1.9 |
| | Black or African American | 1 | 1.9 |
| | White | 49 | 92.5 |
| | Other/Did not disclose | 2 | 3.8 |
| Education | | | |
| | High school diploma | 1 | 1.9 |
| | Associate degree | 2 | 3.8 |
| | 4-year degree | 29 | 54.7 |
| | Master's degree | 19 | 35.8 |
| | Doctoral degree | 2 | 3.8 |
| Primary job title/position | | | |
| | Registered nurse/public health nurse/licensed practical nurse | 5 | 9.4 |
| | Registered sanitarian | 13 | 24.5 |
| | Director of environmental services | 4 | 7.5 |
| | Director of nursing | 1 | 1.9 |
| | Health educator | 9 | 17 |
| | Administrative assistant | 2 | 3.8 |
| | Epidemiologist | 2 | 3,8 |
| | Health commissioner | 8 | 15.1 |
| | Community response planner | 1 | 1.9 |
| | Public information officer | 4 | 7.5 |
| | Other | 4 | 7.5 |
| COVID-19 responsibilities | | | |
| | Contact tracing | 40 | 75.5 |
| | Enforcement | 24 | 45.3 |
| | Direct clinical care | 10 | 18.9 |
| | Communication with public on COVID-19 | 37 | 69.8 |
| | Educating public on COVID-19 | 35 | 66 |
| | Educating local businesses/organizations on COVID-19 guidelines | 32 | 60.4 |
| | Other (ie, vaccination, outbreak investigation, data management, etc) | 19 | 35.8 |
| Primary community(ies) served | | | |
| | Rural | 33 | 62.3 |
| | Suburban | 13 | 24.5 |
| | Urban | 7 | 13.2 |
| Size of department/district | | | |
| | < 20 employees | 7 | 13.2 |
| | 21-30 employees | 16 | 30.2 |
| | 31-49 employees | 7 | 13.2 |
| | 50-74 | 0 | 0 |
| | 75+ employees | 23 | 43.4 |

[a] % based on valid percentage

28.3% reported disliking or hating their work during the pandemic. There was a significant decrease in job satisfaction from before (M = 4.61, SD = .60) to during COVID-19 (M = 3.10, SD = 1.06) (t = 10.92, p < .001). Regarding commitment to continue in public health, 30.2% indicated an interest to stop working in public health all together.

Bivariate correlation tests are summarized in Table 3. Everyday discrimination was associated with a higher level of stigma and a lower commitment to continue in public health. Work related burnout correlated with a higher level of perceived stress-anxiety, a lower level of job satisfaction, and decreased commitment to continue in public health. Job satisfaction, resilience, and mindfulness were associated with a lower level of perceived stress-anxiety. Social support correlated with higher levels of mindfulness and resilience.

Stepwise linear regression results are summarized in Table 4. Stigma, communication with the public on COVID-19, and educat-

ing local businesses on guidelines correlated with a higher level of everyday discrimination. A lower level of resilience correlated with a higher level of perceived stress-anxiety, while everyday discrimination, burnout, and size of health department were associated with a higher level of perceived stress-anxiety. Correlates of burnout included job satisfaction, perceived stress-anxiety, and educating the public on COVID-19. Job satisfaction was correlated with a higher level of commitment, while educating the public on COVID-19 and number of years in current position were correlated with a lower level of commitment to continue.

## Qualitative Results

Qualitative data were collected from 11 public health workers in both administrative and educational roles.[11] At the time of interview, participants' length of employment in their current position ranged from 1.5 years to 23 years (M = 6.22 years, SD = 6.33), and ages ranged from 24 years to 61 years (M = 43 years, SD = 10.39). Nearly all identified as White (n = 10, 90.91%) and female (n = 8,

### Table 2. Burnout Screening, Self-rated Job Satisfaction Before and During COVID-19, Commitment to Continue in Public Health Workforce

| Variable | n | %[a] |
|---|---|---|
| **Burnout screener** | | |
| I enjoy my work. I have no symptoms of burnout. | 2 | 3.8 |
| Occasionally I am under stress, and I don't always have as much energy as I once did, but I don't feel burned out. | 12 | 22.6 |
| I am burning out and have one or more symptoms of burnout, such as physical and emotional exhaustion. | 22 | 41.5 |
| The symptoms of burnout that I'm experiencing won't go away. I think about frustration at work a lot. | 9 | 17.0 |
| I feel completely burned out and often wonder if I can go on. I am at the point where I may need some changes or may need to seek some sort of help. | 8 | 15.1 |
| **Job satisfaction before** | | |
| It was okay | 3 | 5.9 |
| I liked it | 14 | 27.5 |
| I loved it | 34 | 66.7 |
| **Job satisfaction during** | | |
| I hate it | 3 | 5.7 |
| I dislike it | 12 | 22.6 |
| It's okay | 21 | 39.6 |
| I like it | 10 | 18.9 |
| I love it | 7 | 13.2 |
| **Commitment to continue in public health** | | |
| I would like to stop working in public health | 2 | 3.8 |
| I would stop working at once if I could get any other kind of job | 2 | 3.8 |
| I would stop if I could find any job in which I could earn at least as much money as I am earning now | 12 | 22.6 |
| I am not eager to stop, but I would do so if a better job opportunity in public health came along | 21 | 39.6 |
| I would not stop working in public health | 16 | 30.2 |

[a] % based on valid percentage

### Table 3. Bivariate Associations Among Composite Scales Assessed in Survey of Ohio Public Health Workers During COVID-19

| Variable | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 |
|---|---|---|---|---|---|---|---|---|---|
| V1 - Everyday discrimination | -- | | | | | | | | |
| V2 - Stigma | **.67**** | -- | | | | | | | |
| V3 - Work related burnout | 0.26 | 0.19 | -- | | | | | | |
| V4 - Job satisfaction | -0.18 | -0.16 | **-.79**** | -- | | | | | |
| V5 - Commitment to continue | **-.29*** | -0.22 | **-.53**** | **.54**** | -- | | | | |
| V6 - Perceived stress-anxiety | 0.19 | 0.19 | **.61**** | **-.45**** | -0.13 | -- | | | |
| V7 - Resilience | 0.02 | 0.04 | **-.41**** | **.36**** | 0.07 | **-.62**** | -- | | |
| V8 - Social support | 0.04 | -0.01 | **-.29*** | 0.19 | -0.004 | -0.22 | **.45**** | -- | |
| V9 - Mindfulness | -0.12 | 0.02 | -0.13 | 0.13 | -0.05 | **-.31*** | **.39**** | **.39**** | -- |

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

72.7%). The analysis revealed 2 main themes and 7 subthemes which are summarized below and in Table 5.

## Theme 1: Psychosocial Impacts

Qualitative analysis revealed workers' experiences of "when COVID hit." They confronted new challenges in their community by bearing the burden of top-down mandates and public backlash. Their role demanded more time and effort, limited the ability to separate the personal and professional, and intensified their emotional labor and the subsequent impacts. Table 5 illustrates the 3 subthemes categorizing these psychosocial impacts.

To begin, public health workers endured professional isolation through physical distancing through remote work, limited in-person contacts, and quarantining. This was exacerbated by a disconnect from state leaders, whom they perceived as devaluing local needs and contexts and failing to provide critical resources and information. Tensions surrounding public health mandates exposed a lack of understanding and empathy among the public. In turn, the role of the public health worker was increasingly stigmatized. This tenuous context only exacerbated the emotional toll on workers which included genuine distress over some of the actions they had to take. Participants found themselves feeling trapped and overwhelmed by the constant bombardment of COVID-19-related discussion in the media and among family and friends. One individual even compared the experience to an abusive relationship, as they were in a constant state of hyperarousal, anxiety, and exhaustion.

## Theme 2: Coping Strategies

In response to these psychosocial impacts, we found that workers employed a variety of emotional strategies, behaviors, and thoughts to help with adjusting. Table 5 elaborates on these through 4 subthemes. Firstly, participants revealed distancing as a strategy for managing their identity and the role strain they experienced. Most commonly, participants refrained from engaging on social media. Others became more selective about when and where they spent time in the community. Yet, this was not often fully possible due to the nature of the work. Politicization of the public health response, for example, strained many workers' personal relationships and necessitated firm boundaries. Relatedly, workers felt the need to "get away" and "let go" through short retreats or just a day off. Participants also took "mental unwind time" through hobbies, creative activities, exercise, and time outdoors. However, several noted the ongoing challenge of maintaining their desired routines and strategies given work demands. Several participants admitted getting away through an increase in alcohol consumption. One worker noted the importance of seeking therapy, while another indicated reservations about admitting they needed support. A supervisor from another location relayed that opportunities to take a mental health break from work were underused by workers.

A third major coping strategy was connecting through activities like "venting" with friends. Interviewees described the importance of coworkers in supporting one another. Another unintended benefit of the pandemic response and social distancing seemed to be that it "allowed us to truly focus on family" and "improve relationships." In this sense, distancing from everything else made room for more personal connection and opportunities to reevaluate priorities. Spiritual connection was also mentioned as important for emotional support and guidance, as a way to distance from worldly concerns and responsibility. With that, there were moments of intense questioning requiring mindfulness in the

**Table 4. Stepwise Linear Regression Results[a]—Correlates of Psychosocial Outcomes Including Everyday Discrimination,[b] Perceived Stress-Anxiety,[c] Burnout,[d] Commitment to Continue in Public Health[e]**

| Correlates | Beta | t | p | 95% CI[f] Lower | 95% CI Upper | VIF |
|---|---|---|---|---|---|---|
| Stigma | .56 | 5.65 | <.001 | .44 | .94 | 1.07 |
| Communication with the public on COVID-19 | .31 | 2.92 | .006 | 1.59 | 8.73 | 1.25 |
| Educating local businesses on COVID-19 guidelines | .23 | 2.19 | .034 | .27 | 6.69 | 1.17 |
| **Dependent Variable - Perceived Stress-Anxiety** | | | | | | |
| **Correlates** | | | | | | |
| Resilience | -.46 | -4.35 | <.001 | -1.04 | -.38 | 1.17 |
| Everyday discrimination | .27 | 2.46 | .018 | .05 | .54 | 1.29 |
| Burnout | .32 | 2.64 | .012 | .17 | 1.29 | 1.52 |
| Size of health department | .26 | 2.57 | .014 | .29 | 2.45 | 1.09 |
| **Dependent Variable - Work Related Burnout** | | | | | | |
| **Correlates** | | | | | | |
| Job satisfaction | -.65 | -7.40 | <.001 | -1.43 | -.82 | 1.16 |
| Perceived stress-anxiety | .28 | 3.14 | .003 | .04 | .20 | 1.17 |
| Educating public on COVID-19 | .19 | 2.39 | .021 | .23 | 2.72 | 1.01 |
| **Dependent Variable - Commitment to Continue in Public Health** | | | | | | |
| **Correlates** | | | | | | |
| Job satisfaction | .50 | 4.38 | <.001 | .13 | .35 | 1.00 |
| Educating public on COVID-19 | -.29 | -2.56 | .014 | -1.13 | -.13 | 1.04 |
| Years in current position | -.24 | -2.03 | .049 | -.096 | .00 | 1.04 |

[a] Collinearity tolerance and variance inflation rate (VIF) were acceptable for all final models.
[b] Everyday discrimination [higher score indicates higher level of everyday discrimination], $R^2$ = .61, F = 21.98, P < .001.
[c] Perceived stress-anxiety [higher score represents higher level of perceived stress-anxiety], $R^2$ = .60, F = 15.47, P < .001.
[d] Work related burnout [higher score represents higher level of work related burnout], $R^2$ = .71, F = 34.87, P < .001.
[e] Commitment to continue in public health [higher score represents higher commitment to staying in public health], $R^2$ = .45, F = 11.49, P < .001.
[f] CI = confidence interval.

**Table 5. Qualitative Themes, Subthemes, and Exemplar Quotes from Phone Interviews with Ohio Public Health Workers During COVID-19**

| Theme 1: Psychosocial Impact | |
|---|---|
| **Subtheme** | **Exemplar Quotes** |
| Isolation and stigmatization | I feel I'm not getting proper training.... I haven't even met half of my coworkers... I don't want a relationship, but rapport. (female sanitarian) |
| | We are from your community...Whatever side of the mask debate you fall on, whatever political affiliation you have .... We're all doing our best with the resources and information we have...Just be nice. (female sanitarian and health inspector) |
| Emotional toll | I'm a community member...people know who I am... I use [these] services, and to go and tell them and say they couldn't be open, it was just awful just to see the hate and the anger in their eyes. And it wasn't the hate towards me, it was just for the situation. (male sanitarian) |
| | I talked to a gentleman being admitted [to the hospital] ...[Later] I got a call from his parish because they were called to give the last rites. They wanted to know what the priest had to do to protect himself...Those are very emotional things that people in the public don't know and they don't understand. (female health commissioner) |
| Feeling trapped | People felt guilty if they were not working all the time.... There's no real defined line anymore between when you're working and when you're not working...There isn't really any way to avoid it at all. You're always there. (male health commissioner) |
| | One of the most difficult parts of it is, even if you're away from here, you're not away from COVID. It's in the media. It's everywhere...There isn't an escape. (male health commissioner) |
| **Theme 2: Coping Strategies** | |
| **Subtheme** | **Exemplar Quotes** |
| Managing identity and role strain | I read for the church once a month. I still do that...But it's just kind of difficult when you know that there are a lot of people who don't necessarily agree with what you do for a living...It's just kind of hard to separate that. (female health commissioner) |
| | I don't know if I will ever go in public again, at least for the coming years, displaying that I am a public health worker...I am constantly thinking, 'Oh my gosh...they're going to know I work for the health department.' I don't know what's going to happen, but I know it's not going to be a positive interaction. (female sanitarian and health inspector) |
| Getting away, taking space | I do like to work out...I like to do yoga. I did stop doing that...because I'd come home, and I was so tired. I would just collapse in the chair...You're literally working all day and sometimes into the evening. Then you go home and sleep, and then I get back up and it's all over again. (female environmental health director) |
| | I probably drink a little bit more...Not a lot, but yeah there's times where I need a beer. And not that I didn't before, but it's a little more than I used to. (female health educator and public information officer) |
| Connecting | Sometimes people in your personal life...don't understand... But I'm just grateful for the support that I had going through this. I think that was a definite positive and something I try to keep remembering, even on days where it's kind of difficult...Thank goodness for all my public [health] friends. (female environmental health officer) |
| | There were times I probably should have prayed more, but by the time you get home you're just kind of drained...But that is something that I try to do all the time...pretty much just reminding myself that it doesn't all fall on me, and we can get through this...just understanding that we're not alone.  (female health commissioner) |
| Mindfulness and meaning making | You have got to let your mind not focus on things. You need a short memory. And I'm lucky, I can do that for the most part. You can feel stressed, but it's just part of life, you know? I post pictures of sunsets and beautiful things I see. I want people to still see the beauty in the world, not the hate. I've always been that way. (male sanitarian) |
| | I just had [to] reset, rewind. This is just a little blurb in what my career is going to look like...I really enjoy working for public health...But there were times...I had to look at myself in the mirror and be like, "What are you doing? Why do you want to do this?" But then reality sets in, and you're like "No, this too shall pass. And we will get back to normal, whatever that looks like."  (female sanitarian and health inspector) |

everyday and making meaning or peace with their professional identity and practice. This included focusing on the good and viewing the pandemic as a piece of history, and a temporary opportunity to learn and adapt.

## DISCUSSION

Researchers were interested in determining the experiences and impacts of COVID-19 specifically on public health workers in Ohio. The combination of quantitative and qualitative data better tells the unique story of Ohio public health workers including the various stressors involved, how relationships and mental health were impacted, as well as the coping mechanisms used by workers. Our findings reveal unique perspectives of public health workers and provide a context for the importance of building and maintaining a resilient public health workforce.

The prevalence of burnout was quite high in the survey sample, and nearly 1 in 3 considered leaving public health altogether. The data are concerning, and it has been estimated that by 2025 nearly half of the public health workforce would leave or retire.[10] Although we did not assess if retirement was a factor in one's commitment, we did observe that number of years in position correlated with a lower level of commitment to continue. This could lead to limited institutional knowledge of the public health workforce.[24] Burnout was connected to job satisfaction and

perceived stress-anxiety. Further, we found that COVID-19 response roles that required public interaction were associated with negative psychosocial outcomes and a lower level of commitment to continue. It is conceivable that public facing roles increased the potential for stigma and discrimination which contributed to psychosocial impact.

Regarding psychosocial impacts, our interpretation is that participants experienced isolation and stigmatization, an emotional toll, and feeling trapped. These findings mirror those that report negative mental health impacts on health care workers, particularly those that experienced "long-work hours," "inability to take time off," and "inadequate compensation."[1] Tiesman and colleagues demonstrated that, among public health workers, these negative impacts were worse for those having experienced workplace harassment and violence.[25] Although workers reported these impacts, at least one administrator found employees did not take advantage of onsite mental health support. While this may be surprising, it is consistent with previous research. For example, Rose et al found nurses, physicians, and other health care workers were unlikely to utilize mental health services as a coping tool while concurrently agreeing that availability of mental health services in the workplace would help to decrease work related stress in future health emergencies.[6]

As a result of these and other psychosocial impacts, participant coping strategies included managing identity and role strain, getting away - taking space, connecting, and mindfulness and meaning making. Connecting with others is insightful given the simultaneous feeling of isolation and stigmatization from family, friends, and the public. These effects also heightened feelings of role strain, pressure to manage, and even to conceal their occupational identity. Given these realities, future research on the post-pandemic climate should explore how, if at all, public attitudes have shifted and the subsequent impacts and adjustments among this unique workforce. We observed that resilience was associated with a lower level of perceived stress-anxiety. Although resilience was not a primary outcome, the bivariate evaluation revealed a relationship with mindfulness as well as job satisfaction and commitment. Implications for practice include preparing a resilient workforce equipped with skills to resolve conflict, build relationships, employ stress management and coping strategies such as mindfulness, and prioritize self-care to mitigate burnout. It is conceivable that these efforts could foster job satisfaction, while minimizing psychosocial impact, and thus improve commitment to stay in public health. Ensuring public health agencies have the resources to support the workforce while carrying out essential duties is vital as is increasing efforts to elevate public understanding and receptivity to public health efforts.

### Strengths and Limitations

A strength of this study is the focus specifically on public health workers and within the generous context of the state of Ohio. Participants represented various public health positions. Still, limita-

tions include generalizability outside of Ohio, limited diversity in the sample, and the possibility that factors not examined (ie, retirement intention) impacted the outcomes assessed in this study. We did not explore possible correlates (ie, leadership or management style, work-life balance, salary) of job satisfaction which might influence burnout and commitment to continue. Data were collected from October 2020 through March 2021. Timing may have influenced respondent's perceptions and experiences. We collected limited information regarding such factors as political orientation. We supported trustworthiness of the qualitative analysis through peer consultation, collaborative coding, and memo writing as well as formal and informal member checking with each subsequent participant.

### PUBLIC HEALTH IMPLICATIONS

Our results suggest providing public health workers with education on effective coping strategies could help mitigate negative psychosocial effects, even as the COVID-19 public health emergency has ended. Public health remains an environment of unpredictability—full of potential for being volatile, uncertain, complex, and ambiguous (VUCA). An additional recent example relative to the Ohio public health workforce is the East Palestine train derailment.[26] Having an agile and resilient workforce is critical for future public health responses. As future pandemics and public health emergencies arise, promoting health and wellness, mindfulness, connectedness with coworkers, and taking time for oneself could ensure public health workers do not burnout and leave the profession. Employers can also implement evidence-based strategies to improve employee well-being such as paid time off for mental well-being[27] and flexible working hours.[28] Finally, more work is needed to understand the public's normative response to public health efforts and the impact on public health workers.

### Author Contribution

All authors contributed to the concept and design of the study. Kerri Lynn Knippen conducted recruitment, quantitative data collection, and analysis. Jeanelle Sears, Lauren Maziarz, Michelle Bussard, and Lara Wilken conducted qualitative interviews and qualitative data analysis. All authors contributed to the initial draft and subsequent revisions of the manuscript. All authors agreed to the final version to be published.

### REFERENCES

1. Bryant-Genevier J, Rao CY, Lopes-Cardozo B, et al. Symptoms of depression, anxiety, post-traumatic stress disorder, and suicidal ideation among state, tribal, local, and territorial public health workers during the COVID-19 pandemic - United States, March-April 2021. *MMWR*

*Morb Mortal Wkly Rep*. 2021;70(48):1680-1685.
https://doi.org/10.15585/mmwr.mm7048a6

2. Hendrickson RC, Slevin RA, Hoerster KD, et al. The impact of the COVID-19 pandemic on mental health, occupational functioning, and professional retention among health care workers and first responders. *J Gen Intern Med*. 2022;37(2):397-408.
https://doi.org/10.1007/s11606-021-07252-z

3. Hennein R, Lowe S. A hybrid inductive-abductive analysis of health workers' experiences and wellbeing during the COVID-19 pandemic in the United States. *PLoS One*. 2020;15(10):e0240646.
https://doi.org/10.1371/journal.pone.0240646

4. Jones AM, Clark JS, Mohammad RA. Burnout and secondary traumatic stress in health-system pharmacists during the COVID-19 pandemic. *Am J Health Syst Pharm*. 2021;78(9):818-824.
https://doi.org/10.1093/ajhp/zxab051

5. Sonis J, Pathman DE, Read S, Gaynes BN. A national study of moral distress among US internal medicine physicians during the COVID-19 pandemic. *PLoS One*. 2022;17(5):e0268375.
https://doi.org/10.1371/journal.pone.0268375

6. Rose S, Hartnett J, Pillai S. Healthcare worker's emotions, perceived stressors and coping mechanisms during the COVID-19 pandemic. *PLoS One*. 2021;16(7):e0254252.
https://doi.org/10.1371/journal.pone.0254252

7. Preti E, Di Mattei V, Perego G, et al. The psychological impact of epidemic and pandemic outbreaks on healthcare workers: rapid review of the evidence. *Curr Psychiatry Rep*. 2020;22(8):43.
https://doi.org/10.1007/s11920-020-01166-z

8. Stone KW, Kintziger KW, Jagger MA, Horney JA. Public health workforce burnout in the COVID-19 response in the US. *Int J Environ Res Public Health*. 2021;18(8):4369.
https://doi.org/10.3390/ijerph18084369

9. Rizzo S. Local health official report threats, vandalism and harassment during the pandemic, study finds. *Washington Post*. March 17, 2022.

10. Leider JP, Castrucci BC, Robins M, et al. The exodus of state and local public health employees: separations started before and continued throughout COVID-19. *Health Aff (Millwood)*. 2023;42(3):338-348.
https://doi.org/10.1377/hlthaff.2022.01251

11. Sears JS, Maziarz L, Wilken L, Bussard M, Knippen K. Public health in the public eye: experiences of Ohio's public health workforce during COVID-19. *Health Promot Pract*. 2024;25(2):227-234.
https://doi.org/10.1177/15248399221124598

12. Williams DR, Yan Yu, Jackson JS, Anderson NB. Racial differences in physical and mental health: socio-economic status, stress and discrimination. *J Health Psychol*. 1997;2(3):335-351.
https://doi.org/10.1177/135910539700200305

13. Dolan ED, Mohr D, Lempa M, et al. Using a single item to measure burnout in primary care staff: a psychometric evaluation. *J Gen Intern Med*. 2015;30(5):582-587.
https://doi.org/10.1007/s11606-014-3112-6

14. Richmond VP, Gorham J, Wrench JS. *Communication Affect & Learning in the Classroom: A Text, Workbook and Study Guide*. Tapestry Press; 2001.

15. Cohen S, Williamson, G. Chapter 3. Perceived stress in a probability sample of the United States. In Spacapan S, Oskamp S eds. *The Social Psychology of Health: Claremont Symposium on Applied Social Psychology*. Sage; 1988.

16. Robeldo, C. COVID19 Impact on health and wellbeing survey (CIHWS). The University of Texas Rio Grande Valley School of Medicine. Accessed June 12, 2024.
https://www.phenxtoolkit.org/toolkit_content/PDF/UTRGV_CIHWS_Anxiety.pdf

17. Yanos PT, Vayshenker B, DeLuca JS, O'Connor LK. Development and validation of a scale assessing mental health clinicians' experiences of associative stigma. *Psychiatr Serv*. 2017;68(10):1053-1060.
https://doi.org/10.1176/appi.ps.201600553

18. King M, Dinos S, Shaw J, et al. The stigma scale: development of a standardised measure of the stigma of mental illness. *Br J Psychiatry*. 2007;190:248-254.
https://doi.org/10.1192/bjp.bp.106.024638

19. Cook-Cottone CP. *Mindfulness and Yoga for Self-Regulation: A Primer for Mental Health Professionals*. Springer Publishing Company; 2015.

20. Zimet GD, Powell SS, Farley GK, Werkman S, Berkoff KA. Psychometric characteristics of the Multidimensional Scale of Perceived Social Support. *J Pers Assess*. 1990;55(3-4):610-617.
https://doi.org/10.1080/00223891.1990.9674095

21. Hammer TH, Saksvik PØ, Nytrø K, Torvatn H, Bayazit M. Expanding the psychosocial work environment: workplace norms and work-family conflict as correlates of stress and health. *J Occup Health Psychol*. 2004;9(1):83-97.
https://doi.org/10.1037/1076-8998.9.1.83

22. Smith BW, Dalen J, Wiggins K, Tooley E, Christopher P, Bernard J. The brief resilience scale: assessing the ability to bounce back. *Int J Behav Med*. 2008;15(3):194-200.
https://doi.org/10.1080/10705500802222972

23. Smith JA, Flowers P, Larkin M. *Interpretative Phenomenological Analysis. Theory, Method and Research*. Sage; 2009.

24. Hare Bork R, Robins M, Schaffer K, Leider JP, Castrucci BC. Workplace perceptions and experiences related to COVID-19 response efforts among public health workers - Public Health Workforce Interests and Needs Survey, United States, September 2021-January 2022. *MMWR Morb Mortal Wkly Rep*. 2022;71(29):920-924. Published July 22, 2022.
https://doi.org/10.15585/mmwr.mm7129a3

25. Tiesman HM, Hendricks SA, Wiegand DM, et al. Workplace violence and the mental health of public health workers during COVID-19. *Am J Prev Med*. 2023;64(3):315-325.
https://doi.org/10.1016/j.amepre.2022.10.004

26. Kent State University College of Public Health. The public health response to the East Palestine train derailment. Updated February 13, 2024. Accessed June 12, 2024.
https://www.kent.edu/today/news/public-health-response-east-palestine-train-derailment

27. Kim D. Does paid vacation leave protect against depression among working Americans? A national longitudinal fixed effects analysis. *Scand J Work Environ Health*. 2019;45(1):22-32.
https://doi.org/10.5271/sjweh.3751

28. Shiri R, Turunen J, Kausto J, et al. The effect of employee-oriented flexible work on mental health: a systematic review. *Healthcare (Basel)*. 2022;10(5):883.
https://doi.org/10.3390/healthcare10050883

**RESEARCH ARTICLE**

# Analysis of Tree Ordinances in Cuyahoga County, Ohio, and Recommendations for a Countywide Policy to Protect Trees

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**ABSTRACT**

**Background:** Trees and urban forests have significant public health benefits as well as providing both climate mitigation and adaptation impacts. The tree canopy in Cuyahoga County, Ohio, had suffered a 6% decline between 2010 and 2017, and some cities in the county had suffered as much as an 11% decrease by 2023.

**Methods:** All current county tree ordinances were analyzed. A review and analysis of the relevant scientific literature and similar ordinances of other cities and counties were completed. The most suitable sections of the tree ordinances were determined by selecting components that had the strongest attributes and compiling these to make a single, robust model ordinance.

**Results:** The results of this study recommended that an ideal tree ordinance must address or mention permitting for the removal of otherwise healthy trees, while allowing for the lawful removal of trees that are diseased or pose a threat to persons or property. Balancing the interests of private landowners with that of the general public health interests would be key to the success and implementation of such an ordinance.

**Conclusion:** The study found that by compiling different sections of various existing tree ordinances and providing suggestions for improvements, a model city ordinance was both feasible and scalable. This model tree ordinance would then be used by future lawmakers of Cuyahoga County, Ohio, or its constituent municipalities in order to effectively protect tree canopy.

**Keywords:** Tree canopy; Climate change; Public health benefits; Model tree ordinance

## INTRODUCTION

The Earth is experiencing warmer global temperatures, primarily due to the extraction, processing, and release of greenhouse gas emissions into the atmosphere[1] which are responsible for climate change.[2] Trees are important in the strategy in both mitigating and adapting to climate change by improving human and ecosystem health,[3] by reducing greenhouse gases, and lowering atmospheric temperatures.[4] This occurs through the process of photosynthesis, which absorbs carbon dioxide ($CO_2$) and other solid particles, including soot and heavy metals, and stores the carbon in tree tissues and soils and releases oxygen into the atmosphere.[4]

Trees also play a large role in the physical and mental health of a community and can improve overall public health.[5] The public health benefits are biophysical benefits (those pertaining to observable, ecological relationships) and nonbiophysical benefits (those pertaining to social and psychological relationships).[6] Biophysical benefits of trees include 4 main facets: carbon sequestration, stormwater management, energy savings, and reduction of climate change.[7] In relation to nonbiophysical benefits trees provide improvements in physiological and psychological health.[8] For example, tree cover in parks or forests provides suitable, outdoor sites for exercise and has shown to improve cardiovascular health and to decrease disease levels.[9]

In July 2017, Cuyahoga County, Ohio, joined the Global Covenant of Mayors for Climate and Energy, an international alliance of cities and local governments to promote and support voluntary action to combat climate change. Cuyahoga County developed a climate change action plan to reduce greenhouse gas emissions, implement and track actions to meet targets, and to address climate change mitigation and adaptations. As a preliminary, first step, and due to the importance of trees in combating climate impacts, an updated tree canopy survey was undertaken from 2010 to 2017. It found a 6% decrease of tree canopy. These results were published in May 2019 in the newly released Cuyahoga County Climate Change Action Plan (CCCCAP).[10]

In order to restore lost canopy and provide climate mitigation and adaptation strategies, the Healthy Urban Tree Canopy (HUTC) grant program was created from the CCCCAP document. The HUTC program was funded with $950 000 a year for 5 years. The first round of the competitive grant was approved in 2019 and is currently in its fifth and final year (2024-2025), as it was paused for 2020 due to the COVID-19 outbreak.

Numerous building projects in Cuyahoga County continued to clear-cut trees, where all vegetation is removed and the land is graded to form a completely bare, flat, beige mineral soil (Appendix A). In some cases, as much as 30 acres of tree canopy is cleared per site. As providing HUTC funds to plant and grow trees was in direct conflict with adjacent clear-cutting, a revision of city tree ordinances was started in 2020 by the HUTC Cuyahoga County committee member, with the aim of providing advice and suggestions to create a Cuyahoga County policy and ordinance to protect trees, public and ecosystem health, and provide more sustainable land use practices.

The city tree ordinances in Cuyahoga County had been compiled in 2010, organized by watersheds, by the Soil and Water Conservation District with the assistance of the West Creek Land Conservancy (personal communication, Jared Bartlett, and Peter Bode, 2021). The tree ordinances were compiled in an Excel spreadsheet with interactive links which listed the 10 watersheds.

While reviewing the Excel spreadsheet of the 10 county watersheds, it was found that numerous links to the city ordinances no longer worked, and many of the city tree ordinances were outdated, some having been written in 1965. None of the ordinances included the need for mitigation and adaptation to climate change, making an updated, in-depth revision necessary to account for climate impacts and large-scale development clear-cutting.

A review was undertaken in 2021-2022 as a capstone project for completion of a master of public health (MPH) degree.[11] The aim of the study was to highlight the importance of trees as a contributor to the improvement of public health while attempting to answer the following questions:

1. Why should more trees be planted in urban areas?
2. What benefits do trees provide from a health and legislation standpoint?
3. How can trees benefit areas in Cuyahoga County and, more specifically, the City of Cleveland, Ohio?

## METHODS

The materials for the project included files containing the tree ordinances of 59 cities throughout Cuyahoga County that belong to the 10 watersheds (Big Creek, West Creek, Chippewa Creek, Doan Brook, Dugway Creek, Nine Mile Creek, Euclid Creek, Mill Creek, Rocky River, and Tinkers Creek), an Excel spreadsheet created by the Soil and Water Conservation District in 2012 used for editing and making revisions to the tree ordinances, and maps of Cuyahoga County that represent the effect of different variables within different areas such as the number of trees in a specific area of Cuyahoga County.

The project commenced with the review and analysis of the relevant scientific literature and similar ordinances of other cities and counties to evaluate the current ordinances for improvement.  All the current tree ordinances were analyzed for completeness and gaps that may be present. Twenty-two sections were analyzed in each ordinance (Appendix B).  The spreadsheet was edited to ensure that the collected ordinance data was up to date. There were frequent check-ins with the HUTC committee and other departments of Cuyahoga County to provide updates of tree ordinance analysis and research. The most suitable sections of the 59 tree ordinances were determined by selecting components that had the strongest attributes and compiling these to make a single, robust model ordinance (Appendix C).

## RESULTS

The project had 2 major deliverables: (1) suggestions to improve current tree ordinances and 2) the creation of a model tree ordinance.

### Updating the Soil and Water Conservation District Spreadsheet and Providing Suggestions

The watershed spreadsheet of city tree ordinances was last edited in 2012. After a thorough review and analysis of the tree ordinances, suggestions and recommendations were created. The

recommendations consisted of a detailed revision of gaps in the ordinances and determining what could be done to fix or improve them. Additionally, the spreadsheet was edited to ensure that all data and information in this ordinance were up to date and accurate. The Mill Creek Watershed was selected to demonstrate the process of updating the tree ordinance spreadsheet database, as it had numerous existing tree ordinances which could be improved.

After thorough analysis of the Cuyahoga Heights tree ordinance, it was observed that the presence of an arborist would improve the enforcing of rules and regulations surrounding trees.[12] In addition, it was noted that the portion on the restoration of the understory was lacking. Cuyahoga Heights is an increasing suburban development and, thus, is clear-cutting more trees, resulting in canopy loss. Consequently, it is important to stress the restoration of canopy, and it should be outlined in greater detail in the ordinance.

Other examples in the Mill Creek Watershed that required edits, were the Maple Heights and North Randall municipalities. Both municipalities' ordinances were similar in the layout and context in which they were written. After thoroughly reviewing the ordinances, it was determined that both required a party that would properly execute the guidelines and regulations established within the tree ordinance. Neither ordinance had a tree commission, which is imperative in making decisions regarding trees, shrubs, and bushes. These suggestions were made for all ordinances in the 10 watersheds, which should be used to improve the existing ordinances and have greater success to protect trees.

**Resulting Ideal Tree Ordinance Model**

The model ordinance was compiled to aid in the creation of future ordinances that can be implemented by Cuyahoga County to reduce canopy loss and have improved health outcomes for its citizens by implementing the strongest ordinances possible to protect trees and canopy. The initial conception of the ordinance was countywide. Following feedback and discussions from policymakers it was determined that it would be more advantageous to approach individual municipalities and generate interest and momentum for increased participation. Drawing from existing ordinances around the United States allowed Cuyahoga County Board of Health (CCBH) to explore the most current and innovative tools being employed in real time by municipalities facing similar concerns.

The model ordinance has several main concepts. A permit structure is envisioned to mitigate the wholesale removal of otherwise healthy trees without adequate replanting. Trees with a diameter breast height (DBH) of 6 inches and below are exempted as well as dead trees and those that pose an imminent threat of harm. In other words, the permitting structure anticipates and respects private property rights and strives to find a balance between enhancing tree canopy and allowing property owners to enjoy their land for their own purposes.

Incentivizing tree retention through economic means leverages traditional market-economy measures in the presence of externalities. Indeed, the use of tax incentives has traditionally been an effective and tested means of inflecting desired outcomes.[13] The model ordinance intends to reward property owners who maintain a predetermined tree density with a modest reduction in local taxes, thereby encouraging tree planting on lots below the threshold and encouraging tree retention in areas already in attainment.

Lastly, citizen participation in the ordinance's policy outcomes is both practical and democratic. The model ordinance creates a Tree Commission, staffed by members of the community, where implementation strategies and tree policy can be developed at a grassroots level.

## DISCUSSION

To provide a pragmatic action for tree conservation, the biophysical benefits of trees (carbon sequestration, stormwater management, energy savings, and reduction of climate change) needs to be explained and quantified to mayors, city managers, engineers, and legislators. Carbon sequestration (removal of carbon from the atmosphere during photosynthesis) aids in climate mitigation. A mature tree (approximately 40 years old) can absorb 21.8 kilograms (48 pounds) of carbon dioxide per year,[14] which reduces net pollution produced by combustion and also improves air quality by absorbing soot and other particulate matter. The average vehicle produces about 6.8 kilograms (15 pounds) of carbon dioxide while in motion.[15]

In urban areas, stormwater runoff is due to the large amount of impervious surfaces; roads, parking lots, roofs, and sidewalks. This also increases stream and riverbank erosion and reduces water quality. Trees also serve as green, stormwater infrastructure and aid in stormwater management; the architecture of the trees branches, twigs, and leaves retain rain and slow down water release and are effective stormwater runoff mitigation techniques.[16] Trees are a crucial part in the urban hydrologic cycle for the uptake and purification of rain. Climate change, with increasing energy available in the atmosphere, results in more frequent and violent storms, in turn resulting in more stormwater runoff and more frequent flooding,[17] demonstrating trees are a part of a natural-based infrastructure to help reduce stormwater runoff.

Trees also cool the air, increase humidity, and aid in saving costs related to air conditioning usage and insulation as well as reducing indoor and outdoor temperatures.[18] Electricity demand in urban areas increases by roughly 1%-9% for each 2 °F increase in temperature, exacerbated by the urban heat island effect.[19] Additional air conditioning usage contributes to approximately 5%-10% of this electricity demand, which results in excess energy expenditure. Through alleviation of these heat islands it is estimated that, nationally, approximately $10 billion in energy usage can be saved.[20] Due to cooling effects of trees, the urban heat island effect is reduced by evapotranspiration (the process by

which trees respire, releasing water vapor and oxygen) while also reducing the canopy and ground temperatures by providing shade.[18]

These benefits improve the health of the urban and suburban population,[21] while also saving energy costs.  By providing scientific data to quantify the beneficial biophysical factors, lawmakers will be better able to create a tree policy and related environmental laws to protect and preserve trees.

Additional benefits of tree ordinances are essential in cities as they establish a standard for the upkeep of trees and cutting of mature trees. Additionally, trees aid in the maintenance of clean air and water quality. In a study conducted in the Atlanta metropolitan area, the effectiveness of zoning clauses and tree ordinances was analyzed.[22] Projects tied to the execution of a tree ordinance significantly improved canopy preservation. It was noted that the ordinances additionally had economic benefits for the area they served. A metropolitan city with an effective tree ordinance policy and plan of execution can expect to save approximately $10 million to $15 million annually, with a majority of these savings coming from the green infrastructure benefits that trees provide in terms of stormwater management.[22]

It is important to consider variables within Cuyahoga County and how they could influence public health. While there is scarce direct data linking public health and climate change impacts with canopy cover throughout Cuyahoga County, there are associative data showing relations between canopy cover and determinants of health and climate change. Social determinants of health are factors distinct from the medical care that an individual receives that can influence their health.[23] Factors that influence climate change, such as the heat island effect, can be analyzed similarly.[24] By looking at such determinants, it is possible to make assumptions regarding how canopy cover influences health and climate change in areas of Cuyahoga County.

Figure 1 shows the lack of canopy cover throughout Cuyahoga County. It is evident that canopy cover is very sparse in urban, city areas. Areas surrounding Cleveland, Parma, Lakewood, and Euclid have a lack of canopy coverage ranging from 85.3% to 97.1%, shown by the dark green in Figure 1.

Taking into account the population in these areas, there is an association between an increased population and a decreased canopy coverage; Cleveland with a population of 361 607 people, Parma at 79 358, Lakewood at 49 658 and Euclid with 48 496 were among the highest in Cuyahoga County as of 2020.[25] As the canopy cover is diminished in these areas of such large population density, a majority of the individuals that live in Cuyahoga County will be unable to experience the positive health benefits of trees and
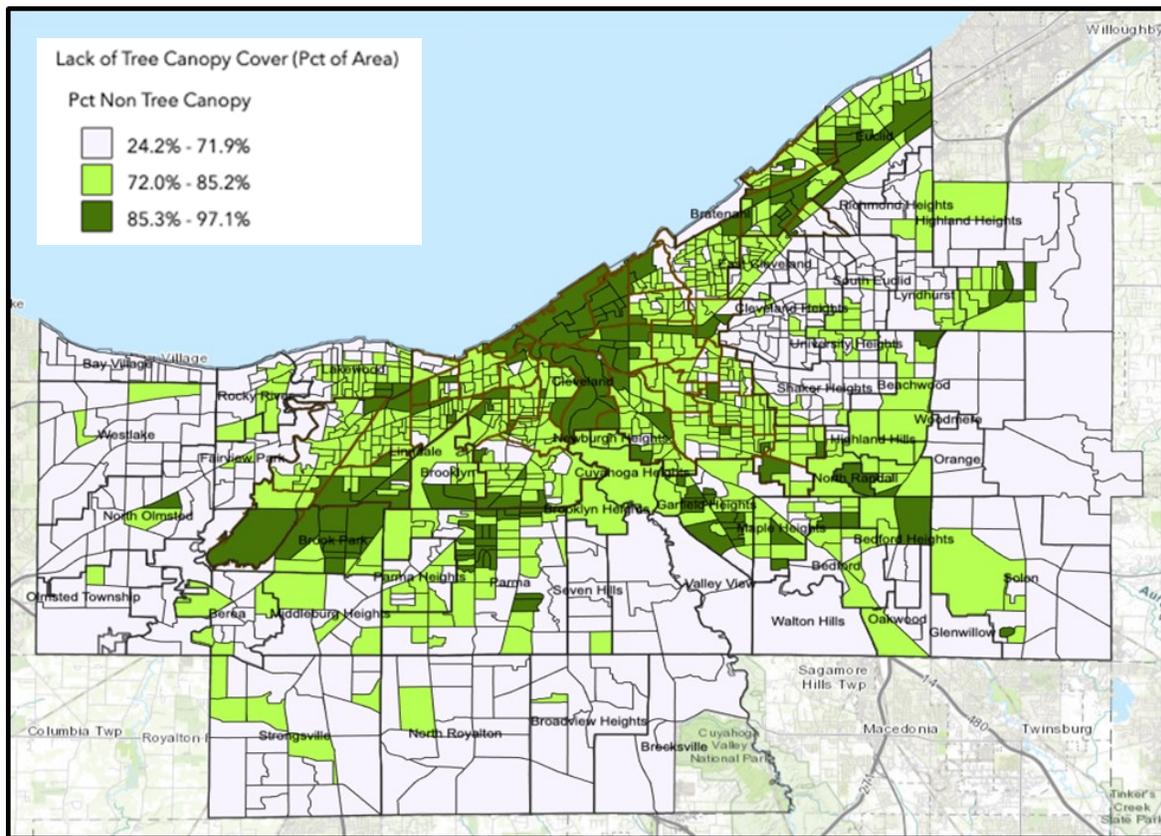


Abbreviations: PCT—percentage

**Figure 1. Climate Change Action Plan Climate Change Vulnerability Assessment Map Showing Lack of Canopy Cover in Cuyahoga County, Ohio**

will be at a greater risk than those that live in more sparsely populated areas with more canopy cover.

Socioeconomic status is also a large indicator of the health of the individual and is an influential social determinant of health.[26] Socioeconomic status affects the lifestyle of an individual and consequently may impact psychological and physical health. Socioeconomic status has a significant positive relationship with physical health, which demonstrates that those of higher socioeconomic status typically have improved health outcomes as compared to those of lower socioeconomic status.[27] Research shows that people in higher earning jobs generally work in less manual labor and with more autonomy, which could lead to better public health. In Figure 2, the heavily populated areas surrounding Cleveland and Bratenahl show a high positive correlation between those above poverty level and lack of canopy cover.

Heat islands are generally formed in urban areas and are caused by absorption and emission of heat (infrared radiation) by structures such as buildings, roads, and other dark infrastructure. This process increases the average near-surface temperature of that locale.[24] This warming contributes to the effects of global warming by increasing energy consumption and elevating air pollutants and greenhouse gases as the population and urbanization rates increase.

In Figure 3, areas with minimal canopy cover such as Cleveland, Parma, Lakewood, and Euclid contribute to the urban heat island effect, where the local temperature is increased by an average of 1.6 °C (2 °F). Concurrently, these same areas also have maximal impervious surface area, which is another factor that adds to the urban heat island effect and absorbs heat from the sun (Figure 4). Planting and protecting trees in such areas will provide shade and reflect radiation from the sun, to help in mitigating the effects of global warming.[28]

## PUBLIC HEALTH IMPLICATIONS

It can be concluded that many of the areas with a high population are primarily impacted by the effects of social determinants of health and climate change. The need to improve tree ordinances is evident, especially in urban and densely populated areas.

For this study to have more effect in Cuyahoga County, it is important to identify objectives and provide management with
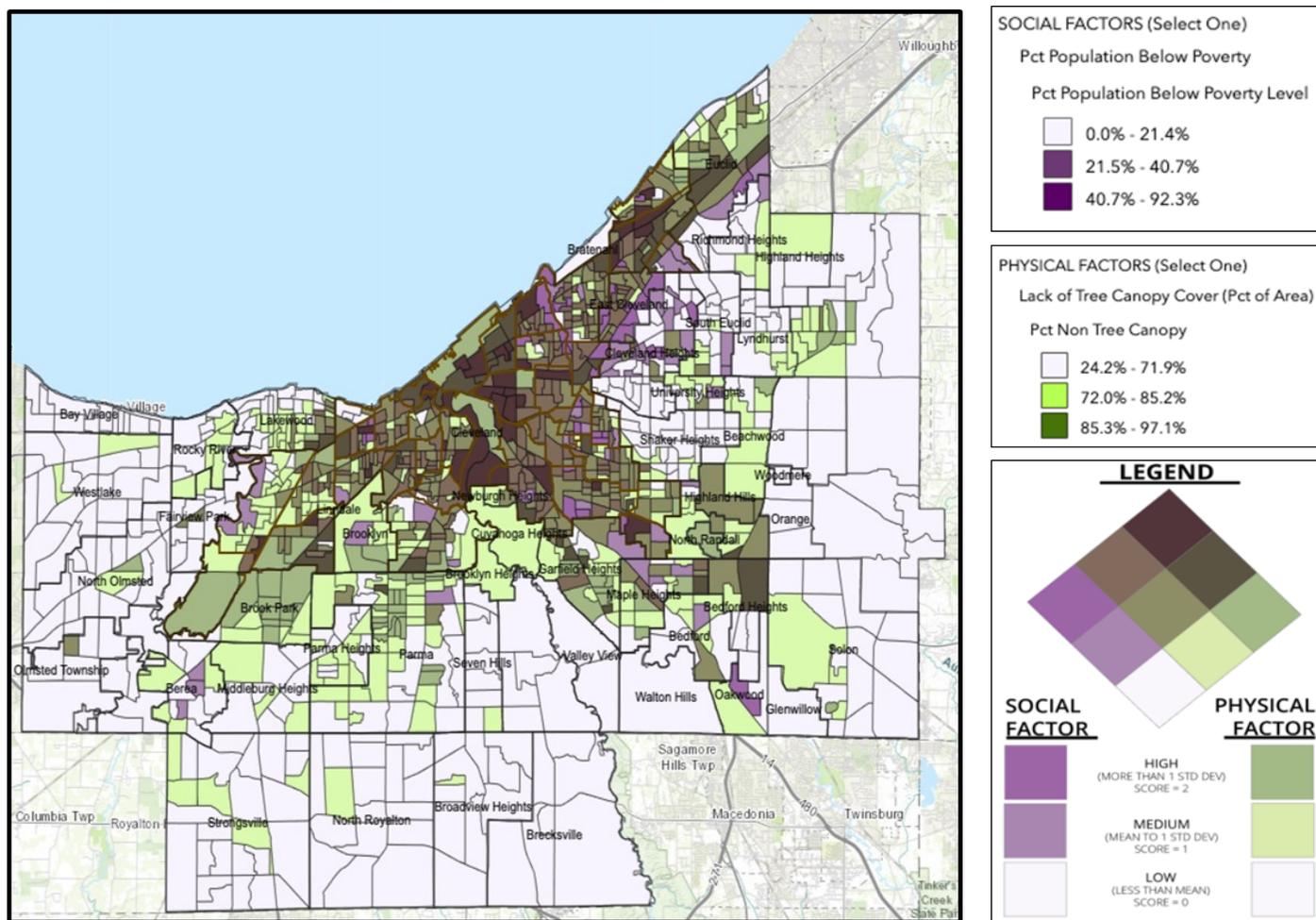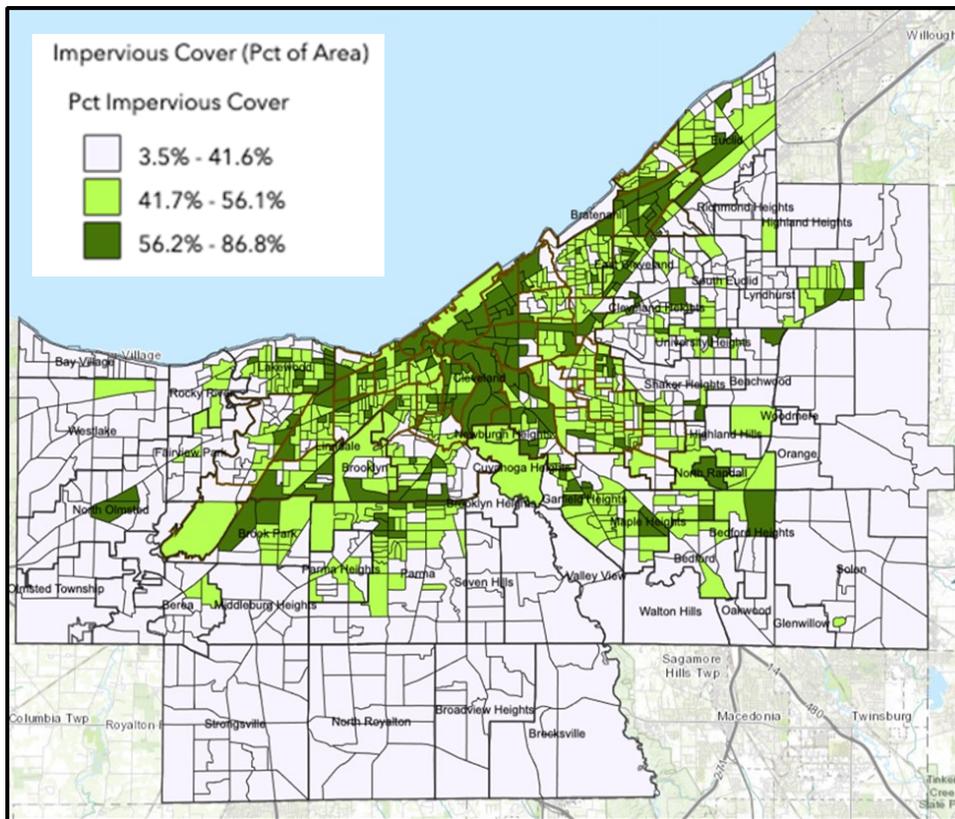


Abbreviations: PCT—percentage

**Figure 2. Climate Change Action Plan Climate Change Vulnerability Assessment Map Showing Association Between Areas of Lack of Tree Canopy Cover and Percentage of Population Below Poverty Level**
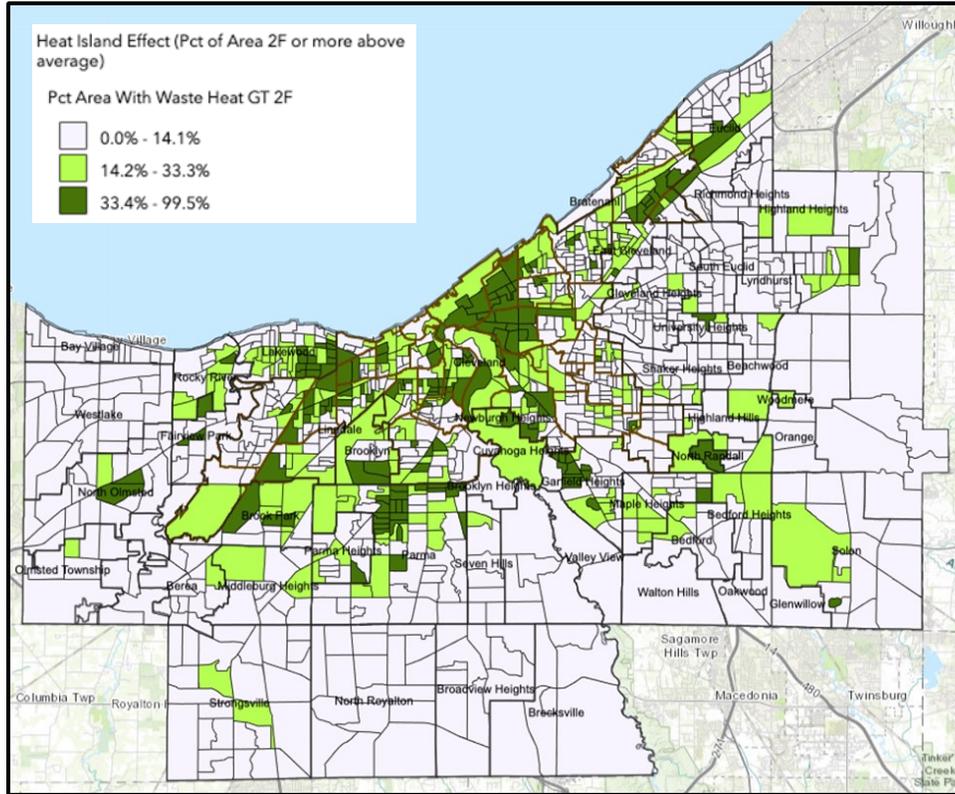
Abbreviations: PCT—percentage, 2F—2 °Fahrenheit; GT—greater than.

**Figure 3. Climate Change Action Plan Climate Change Vulnerability Assessment Map Showing Heat Island Effect (percentage of area 2 °F or more above average) in Cuyahoga County, Ohio**



Abbreviations: PCT—percentage

**Figure 4. Climate Change Action Plan Climate Change Vulnerability Assessment Map Showing Impervious Surface Area in Cuyahoga County, Ohio**

suggestions as how best to implement them. These objectives are listed below.

*Make the ideal ordinance public knowledge.* This would entail having conversations with lawmakers throughout Cuyahoga County and informing them of what could be added to a general ordinance in order for it to adequately protect trees.

*Establish contact with all municipalities to update their tree ordinances.* As gaps in older ordinances were identified in the smaller municipalities, it would be helpful to offer suggestions about their current ordinances and provide them with options from a suggested 'ideal ordinance.'

*Analyze the relationship between presence of trees and health of individuals in specific areas.* Research may be conducted on the effects of the relationship between trees and tree policy in localities in Cuyahoga County. This could include more specific analyses of the effects of trees in a highly urbanized setting, such as the City of Cleveland, and how increased tree canopy coverage would benefit the community.

*Highlight the importance of what doing nothing and maintaining status quo would eventuate, or show what would be the beneficial effects to protect and increase tree canopy.* Taking into account how a loss of tree canopy could potentially affect the public and ecosystem health of the individuals and ecosystem services and functions, increasing canopy would provide data to show how much of an effect the addition of trees could have.

*Put the ideal ordinance to work.* Translating a model ordinance into city law requires constant evaluation and adjustment to the needs of a particular community—the "open source" structure of the ordinance allows policymakers to edit, remove, or expand its concepts without undermining the effect of the whole. The ideal ordinance must allow a determination of whether it is truly adequate for tree protection and aided in the improvement of public health *in the community where it is implemented.*

**Author Contribution**
In October 2022, the results of the study (Venancius, 2022),[11] was used to establish a collaboration between the Case Western Reserve University Environmental Law Clinic and the CCBH Legal Counsel to compile the legal framework for a Cuyahoga Tree Ordinance. A 'best practice' draft policy has been compiled and written using legal language suitable for an ordinance. As Ohio is a 'home rule' state, in 2023 and 2024, the Cuyahoga draft tree ordinance was modified to make it suitable for 4 cities (Avon Lake, Euclid, Beachwood and Maple Heights) in Cuyahoga County (personal communication; John Mills, Robert Brand).

Jenish Venancius: Substantial contributions to the conception and design of the work; the acquisition, analysis, and interpretation of data for the work; AND drafting the work for important intellectual content; all authors made substantial contributions to the conception and design of the work, provided final approval of the version to be published, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Jenish Venancius drafted the work for important intellectual content. Jenish Venancius and Robert Brand were responsible for acquisition and interpretation of data for the work; Karen Mulloy contributed to interpretation of data for the work. Robert Brand, Andrew Morris, and Karen Mulloy critically reviewed the work for important intellectual content.

**REFERENCES**

1. IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland. 2023:1-34. Accessed November 1, 2022.
https://doi.org/10.59327/IPCC/AR6-9789291691647

2. NASA. Evidence. Climate Change. Updated March 26, 2024. Accessed March 30, 2024.
https://climate.nasa.gov/evidence/

3. Bastin J-F, Finegold Y, Garcia C, et.al. The global tree restoration potential. *Science.* 2019; 365: 76-79.
https://doi.org/10.1126/science.aax0848

4. Palmer L. How trees and forests reduce risks from climate change. *Nat Clim Chang.* 2021;11(5):374-377.
https://doi.org/10.1038/s41558-021-01041-6

5. Coder KD. Identified benefits of community trees & forests. University of Georgia Warnell School of Forestry and Natural Resources WSFNR, 11-01. January 2011. Accessed November 5, 2023.
https://hdl.handle.net/10724/36441

6. Donovan G H. Including public-health benefits of trees in urban-forestry decision making. *Urban For Urban Green.* 2017; 22:120-123.
https://doi.org/10.1016/j.ufug.2017.02.010

7. Peper PJ, McPherson EG, Simpson JR, Gardner SL, Vargas KE, Xiao Q. (2007). New York City, New York municipal forest resource analysis. [Technical Report]. US Department of Agriculture Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research. 65 p. Accessed November 1. 2022.
https://www.fs.usda.gov/research/treesearch/45969

8.  Kim J, Kaplan R. Physical and psychological factors in sense of community: new urbanist Kentlands and nearby Orchard Village. *Environ Behav.* 2004;36(3):313-340.
    https://doi.org/10.1177/0013916503260236

9.  Nilsson K, Sangster M, Gallis C.  Forests, trees and human health and well-being: introduction. In: Nilsson K. et al. (eds) *Forests, trees and human health.* 2011. Springer, Dordrecht .
    https://doi.org/10.1007/978-90-481-9806-1_1

10. Cuyahoga County Planning Commission. Cuyahoga County Climate Change Action Plan (CCCCAP). May 15, 2019. Accessed November 1, 2022.
    https://www.countyplanning.us/projects/climate-action-plan

11. Venancius J. (2022). Analyzing the Effect of Tree Ordinances on Public Health of Areas within Cuyahoga County, unpublished Master of Public Health (M.P.H.) Capstone Essay, Case Western Reserve University School of Medicine.

12. Dunster JA. (1998). The role of arborists in providing wildlife habitat and landscape linkages throughout the urban forest. *Arboric Urban For. Journal of Arboriculture.*1998;24(3):160-167.
    https://doi.org/10.48044/jauf.1998.021

13. Coase RH. The problem of social cost. *J Law Econ 3.*1960: 1–44. Accessed November 5, 2023.
    http://www.jstor.org/stable/724810

14. U.S. Department of Agriculture (USDA). The power of one tree - the very air we breathe. March 17, 2015. Accessed March 29, 2024.
    https://www.usda.gov/media/blog/2015/03/17/power-one-tree-very-air-we-breathe

15. We are planting 10 million trees in PA by 2025. Keystone 10 Million Trees Partnership. Accessed March 30, 2024.
    https://tenmilliontrees.org/about/

16. Environmental Protection Agency (EPA). Soak up the rain: trees help reduce runoff. Updated December 21, 2023.   Accessed March 30, 2024.
    https://www.epa.gov/soakuptherain/soak-rain-trees-help-reduce-runoff

17. Berland A, Shiflett SA, Shuster WD, et.al. The role of trees in urban stormwater management. *Landsc Urban Plan.*  2017;162:167-177.
    https://doi.org/10.1016/j.landurbplan.2017.02.017

18. Rahman MA, Stratopoulos LM, Moser-Reischl A, et.al. (2020). Traits of trees for cooling urban heat islands: a meta-analysis. *Build Environ.* 2020;170:106606.
    https://doi.org/10.1016/j.buildenv.2019.106606

19. Santamouris M. Recent progress on urban overheating and heat island research. Integrated assessment of the energy, environmental, vulnerability and health impact. Synergies with the global climate change. *Energy Build.* 2020;207:1-28.
    https://doi.org/10.1016/j.enbuild.2019.109482

20. Akbari H, Pomerantz M, Taha H. Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. *Sol Energy.* 2001;70(3):295-310.
    https://doi.org/10.1016/S0038-092X(00)00089-X

21. Wolf KL, Lam ST, McKeen JK, Richardson GRA, van den Bosch M, Bardekjian AC.  Urban trees and human health: a scoping review. *Int J Environ Res Public Health.* 2020;17(12), 4371.
    https://doi.org/10.3390/ijerph17124371

22. Hill E, Dorfman JH, Kramer E. Evaluating the impact of government land use policies on tree canopy coverage. *Land Use Policy.* 2010;27(2):407-414.
    https://doi.org/10.1016/j.landusepol.2009.05.007

23. Braveman P, Gottlieb L. The social determinants of health: it's time to consider the causes of the causes. *Public Health Rep.* 2014;129(Suppl 2):19-31.
    https://doi.org/10.1177/00333549141291S206

24. Park BJ, Tsunetsugu Y, Ishii H, et.al. The physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in a mixed forest in Shinano Town, Japan. *Scand J For Res.* 2010;23(3):278-283.
    https://doi.org/10.1007/s12199-009-0086-9

25. Cuyahoga County Planning Commission. 2020 Census: Total population. September 2021. Accessed November 1, 2022.
    https://www.countyplanning.us/resources/census-data/decennial-census/2020-total-population/#communities

26. Booysen F, Botha F, Wouters E. Conceptual causal models of socioeconomic status, family structure, family functioning and their role in public health. *BMC Public Health.* January 2021;21(191).
    https://doi.org/10.1186/s12889-021-10214-z

27. Wang J, Geng L. Effects of socioeconomic status on physical and psychological health: lifestyle as a mediator.  *Int J Environ Res Public Health.* 2019;16(2):281.
    https://doi.org/10.3390/ijerph16020281

28. Environmental Protection Agency (EPA).  Using trees and vegetation to reduce heat islands. Updated October 31, 2023. Accessed November 5, 2023.
    https://www.epa.gov/heatislands/using-trees-and-vegetation-reduce-heat-islands

## APPENDIX A—Clear-cutting

Appendix A. Photographs taken in Broadview Heights, Cuyahoga County, Ohio. Shown is the current land use practice of clear-cutting, resulting in the loss of all ecosystem services and functions, while creating novel habitat for invasive plants and animals. Photographs 1 to 8 show the stages in 'development' of a site for housing and illustrate the motivation responsible for the creation of the Cuyahoga Tree Ordinance.



Photographs: 1) Healthy indigenous forest showing good species composition with mature trees, saplings, and protected leaf-covered forest floor. 2) Clear-cutting process starts by removing all trees and understory vegetation, exposing soils to moisture, nutrient and carbon loss, increasing erosion. 3) Mature 100-year-old-plus trees cut while all other trees and vegetation become waste. 4) Water pooling in the foreground, showing clear-cut forest losing all stormwater retention benefits that trees provide, with runoff increasing flooding. 5) Clear-cutting almost completed, requiring stump and waste-tree removal in preparation for grading. 6) Graded site with compacted earth exposing sterile mineral soil. 7) Stormwater retention pond created to replace natural, extensive forest-floor wetlands, habitat for ephemerals. 8) Final phase of development creating black, impervious surfaces, increasing albedo, surface temperatures, stormwater run-off, eliminating seed stocks, indigenous biodiversity, and all ecosystem services and functions. All photographs in Appendix A are courtesy of Robert Brand.

## APPENDIX B—Review of Existing Tree Ordinances

A review of the existing tree ordinances, with comments on the 2012 watershed tree ordinance spreadsheet which includes a detailed list of each city's tree ordinances.

Part 1 of 2 (continued on next page)

| Watershed(s) | County | Municipality | Tree City? | Tree Commission? | Arborist? | Riparian Setback? | Wetland Setback? | Forest/Tree Regulations? | Tree Size Regulations? | Tree Planting & Management Schedules? | Residential Tree Density Regulations? | Commercial Tree Density (parking lots) Regulations? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Navigation Channel Lower Cuyahoga River Mill Creek | Cuyahoga | Cuyahoga Heights | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Mill Creek Lower Cuyahoga River Cuyahoga River CVNP | Cuyahoga | Garfield Heights | YES | MENTIONED | YES, Ch. 907.02 Trees and hedges (Powers of Parks and Recreation Director | YES, Ch. 1161 Riparian setbacks | YES, Ch. 1161.04c4 Riparian setbacks (Establishment of designated watercourse and riparian setbacks) | Yes, Ch. 907 Trees and Hedges | QUASI, Ch 907.03 Trees and Hedges (Permit required to plant, prune or remove on public property) | NO | Yes, Ch. 907.21 Trees and Hedges (Tree planting required: Fee) | NO |
| Mill Creek Tinkers Creek | Cuyahoga | Highland Hills | NO | QUASI, Ch. 905 Shade tree commission | YES, Ch. 909.01h Municipal Forestry Program (Definitions) | YES, Ch 1357.08 Construction Site Soil Erosion, Sediment, and Other Wastes and Stormwater Runoff (Construction Site Conservation Plan) | YES, Ch 1357.08 Construction Site Soil Erosion, Sediment, and Other Wastes and Stormwater Runoff (Construction Site Conservation Plan) | YES, Ch. 909 Municipal Forestry | YES, Ch. 905.07 Shade Tree Commission (Street trees species to be planted) | Yes, Ch. 913 Tree planting program | YES, Ch. 901.04 Trees generally (Location of trees) | YES, Ch 1119.12 Residential Townhouse District R-2 (Off-street parking and loading) |
| Tinkers Creek Mill Creek Lower Cuyahoga River | Cuyahoga | Maple Heights | NO | NO | YES, Ch. 1028.02 Trees (Authority of Director of Service) | YES, Ch. 1224.09a1A Water management and Soil Conservation Regulations (Performance standards) | YES, Ch. 1224.08 Water management and Soil Conservation Regulations (Comprehensive storm water management plans) | Yes, Ch. 1028 Trees | YES, Ch. 1028.14f Trees (Trees planted where there is new construction) | YES, Ch. 1028.04 Trees (Contents of permits for planting; Master Street Tree Plan; substitution) | YES, Ch. 1028.04 Trees (Contents of permits for planting; Master Street Tree Plan; substitution) | YES, Ch. 1294.11B Bufferyard and landscaping (Minimum landscape requirements) |
| Tinkers Creek Mill Creek | Cuyahoga | North Randall not available online | NO | NO | YES Ch. 1026.02 Trees (Power of Inspector of Buildings) | DEFINED, Ch. 1273.02 EE Comprehensive Stormwater Management (Definitions) | DEFINED, Ch. 1273.02 EE Comprehensive Stormwater Management (Definitions) | YES, Ch. 1026 Trees | YES, Ch. 1255.11 Landscaping (Landscaping Materials | YES, Ch. 1255.07d3B Landscaping (Minimum Landscape Requirements; Additional Landscaping Requirements) | YES, Ch 1255.09a1C Landscaping (Street Tree and Public Tree Requirements; Requirements for Trees Located on Village-owned Public Property | YES, Ch. 1255.07b Landscaping (Minimum Landscaping Requirements; Interior Landscaping for Vehicular Uses) |

Part 2 of 2 (continued from previous page)

| Commercial Tree Density (screening) Regulations? | Street Tree Regulations? | Tree Removal? (public) | Tree Removal? (private) | Protection of Trees, Roots, & Soil? | Tree Replacement? | Restoration of Understory? | Destruction of Trees or Shrubs? | Landscaping | Date of last Entry | JSV comments (11/8/2021) |
|---|---|---|---|---|---|---|---|---|---|---|
| NO | YES, Ch. 1483.05 (31) Telecommunications and Utility Systems and Facilities (Design and construction requirements; street and other public improvements; technical standards; tree trimming) | NO | YES, Ch. 248.06 Service department (Tree trimming and tree removal service for residents of the Village) | YES, Ch. 1405.03a5B Grading, Filling, or Changing the Topography of Land (Alteration of topography; permit required) | NO | NO | YES, Ch. 642.04 Offenses relating to property (injuring vines, bushes, trees or crops) | NO | 2/7/12 | Won't an arborist be necessary for any city along with the commission? Add some parts about the restoration of understory as Cuyahoga Heights is an area mainly with increasing suburban population, which may lead to more deforestation. |
| YES, Ch. 1155.08 Fences, Landscaping and Screening Requirements (Landscaping and screening requirements) | MENTIONED, Ch 907.21 Trees and hedges (Tree planting required: Fee) | YES, Ch. 907.03 Trees and Hedges (Permit required to plant, prune or remove on public property) | YES, Ch. 907.12 Trees and Hedges (Director's power to trim or remove trees on private property) | YES, Ch. 907.04 Trees and Hedges (Placing Deleterious Substances Near Trees) | YES, Ch 907.09 Trees and Hedges (Moving of trees) | YES, Ch. 908.07o Use of Public Rights-of-Way by Service Providers (Construction permit and standards) | YES, Ch. 541.06 Property Offenses (Destruction of shrubs, trees or crops) | YES, Ch. 1155.08 Fences, Landscaping and Screening Requirements (Landscaping and screening requirements) | 2/7/12 | Very in depth, no edits required. |
| YES, Ch 1131.05 landscaping, Screening, and Buffering Requirements for All Districts Except R-1 Districts (Screening and buffering) | YES, Ch. 1131.03 Landscaping, Screening and Buffering Requirements for All Districts Except R-1 Districts (Street planted strip) | YES, Ch. 909.08 Municipal forestry (Removal of a tree) | YES, Ch. 905.14 Shade Tree Commission (Pruning, corner clearance) | YES, Ch. 905.19 Shade Tree Commission (Removal or mutation of trees) | YES, Ch. 909.08 Municipal forestry (Removal of a tree) | NO | YES, Ch. 541.06 Property Offenses (Destruction of trees, shrubs, and crops) | YES, Ch. 1131.02 Landscaping, Screening and Buffering, Requirements for All Districts Except R-1 Districts (general landscaping) | 2/6/12 | May add part about restoration of understory, may not be required as slightly touched on earlier in the ordinance. |
| YES, Ch. 1294.07B Bufferyard and landscaping (Screening and buffering) | YES, Ch. 1294.13 Bufferyard and landscaping (Street tree planting requirements) | YES, Ch. 1028.10 Trees (Preservation and removal of trees on public property) | YES, Ch. 1028.08 Trees (Trimming of trees on public and private property) | YES, Ch. 1028.05 Trees (Placing deleterious substances near trees) | YES, Ch. 1028.07 Trees (Moving of trees) | YES, Ch. 884.01 Topsoil removal (Removal; permit required; application) | YES, Ch. 642.06 Offenses relating to property (injuring vines, bushes, trees or crops) | YES, Ch. 1294.11 Bufferyard and landscaping (Minimum landscape requirements) | 2/13/12 | Maple Heights and North Randall have very similar ordinances. It is evident that the two may require some more detail with regards to leadership of the area. |
| YES, Ch 1255.07A Landscaping (Minimum Landscaping Requirements; Perimeter Buffer Landscaping Requirements) | YES, Ch. 1255.09 Landscaping (Street Tree and Public Tree Requirements) | YES, Ch. 1026.12 Trees (Inspector's Power to Trim or Remove Trees on Public Property) | YES, CH. 1026.13 Trees (Village to Treat or Remove Diseased Trees on Private Property) | Yes, Ch. 1026.04 Trees (Placing Deleterious Substances Near Trees) | YES, Ch 1255.09h Landscaping (Street Trees and Public Tree Requirements; Removal, replating, and replacement in public places) | NO | YES, Ch 642.04 General Offenses (injuring vines, bushes, trees or crops) | YES, Ch. 1255 Landscaping | 3/5/12 | Maple Heights and North Randall have very similar ordinances. It is evident that the two may require some more detail with regards to leadership of the area. |

**APPENDIX C—Model Tree Ordinance Spreadsheet and Cuyahoga County Board of Health (CCBH) Model Tree Ordinance**

A Model Tree Ordinance created for Cuyahoga County based on selection of the most suitable sections of the original, existing 59 tree ordinances.

| Sections | Ordinance to Fulfill | Watershed(s) | Reasoning |
|---|---|---|---|
| Definitions | Cleveland Heights, "Chapter 1335.02- Definitions" | Doan Brook, Dugway Creek, Nine Mile Creek, Green Creek | Cleveland Heights has a very extensive definitions section, which is important for individuals to understand certain terms in the ordinance. |
| Member of Tree City USA | - | - | Becoming a part of Tree City USA aids in developing a program for tree conservation that is sustainable and healthy. |
| Tree Commission | Cleveland, "Chapter 163- Tree Commission" | Big Creek, Mill Creek, Euclid Creek, Lake Erie Drainage, Nine Mile Creek. Dugway Brook, Green Creek, Lower Cuyahoga River | The Cleveland Tree Commission is large, consisting of 19 members to make recommendations to the Director of Parks, Recreation, and Activities, for improvement in tree cover. Additionally, the duties of the tree commission are outlined thoroughly. |
| Arborist or Consultant | University Heights, "Chapter 1072.02- Tree Control Vested In Director" | Dugway Creek, Nine Mile Creek, Green Creek | The Service Director serves as the arborist. Having an arborist is beneficial as it aids in the direction and supervision of trees in the area. |
| Riparian Setbacks and Wetland Setbacks | Beachwood, "Chapter 1157- Riparian and Wetland Setbacks" | Euclid Creek, Mill Creek, Tinkers Creek, Doan Brook, Pepper/ Luce Creek | The applicability of the Riparian and Wetland setbacks are explained along with how to establish these types of setbacks. |
| Forest / Tree Regulations | South Euclid, "Chapter 907- Trees | Euclid Creek, Dugway, Nine Mile Creek | This section is extensive and additionally adds the aspect of obstructing materials/ nuisances and how to prevent them. |
| Tree Size Regulations | Cleveland, "Chapter 352.11- Table Containing Screening Intensity" | Big Creek, Mill Creek, Euclid Creek, Lake Erie Drainage, Nine Mile Creek. Dugway Brook, Green Creek, Lower Cuyahoga River | This table demonstrates the requirements for classifications of different types of trees to be considered either light, medium, heavy, or maximum. |
| Tree Planting & Management Schedules | South Euclid, "Chapter 771.50- Landscape Schedules and Tables" | Euclid Creek, Dugway, Nine Mile Creek | Very extensive list of schedules and species of trees. The species of trees are accompanied by descriptions as to where to plant them alongside their heights, which allows for ease of understanding. |
| Residential Tree Density Regulations | Bay Village, "Chapter 547.04- Approval to Plant Trees in Public Streets" | Cahoon Creek, Porter Creek | The approval process to plant trees seems extensive, as it is run by numerous individuals in higher power first. |
| Commercial Tree Density (parking lots) Regulations | Shaker Heights, "Chapter 1253.08- Parking Lot Landscaping and Screening" | Doan Brook, Dugway, Nine Mile Creek, Green Creek | The commercial tree density (parking lots) is outlined in detail with diagrams representing parking lots and necessary landscaping. The visuals aid in the explanation of how trees are to be structured within a parking lot. |
| Commercial Tree Density (screening) Regulations | Shaker Heights, "Chapter 1253.09- Landscape Buffers and Screening" | Doan Brook, Dugway, Nine Mile Creek, Green Creek | The commercial tree density (screening) provides tables with landscape buffer regulations, which makes it simple to understand. |
| Prohibited Trees and Areas of Planting | University Heights, "Chapter 1072.12- Certain Trees Prohibited" | Dugway Creek, Nine Mile Creek, Green Creek | Prohibiting certain trees in specific areas and allowing them in others allows the trees to thrive in environments that would allow for their maximal growth. |
| Street Tree Regulations | Cuyahoga Heights, "Chapter 1483.05- Design and Construction Requirements; Street and other Public Improvements; Technical Standards; Tree Trimming" | Navigation Channel, Lower Cuyahoga River, Mill Creek | This section contains more than just street tree regulations; it contains items such as construction limits, hazardous substances, and installation of electronic equipment, which can strengthen the regulations for street trees. |
| Tree Removal (public and private) | University Heights, "Chapter 1072.10 and 1072.11- Trimming Trees on Public Property, Trimming Trees on Private Property" | Dugway Creek, Nine Mile Creek, Green Creek | These two sections outline the specific regulations for tree maintenance on public and private property. By selecting both sections from the same ordinance, it is possible to observe the exact differences and similarities in both types of tree removal. |
| Protection of Trees, Roots & Soil | Shaker Heights, "Chapter 47.01- Injury to Trees and Shrubs" | Doan Brook, Dugway, Nine Mile Creek, Green Creek | The specificity in prohibited substances and actions near trees aids in the reasoning for adding this section. |
| Tree Replacement | Euclid, "Chapter 1311.17- Landscaping" | Euclid Creek, Euclid City/Lake County, Dugway Creek, Nine-Mile Creek, Green Creek | This section takes into account the prior existence of trees in the area to determine which should or which should not be replaced. |
| Restoration of Understory | Brecksville, "Chapter 1190.043e7- Restoration Plan' | Chippewa Creek, Central County Tribs, Furnace Run | The process for restoration in case of damage is outlined thoroughly and proves to be an adequate process for preventing any further damage. |
| Destruction of Trees or Shrubs | University Heights, "Chapter 642.04- Injuring Vines, Bushes Trees, or Crops" | Dugway Creek, Nine Mile Creek, Green Creek | The punishments for injuring trees and shrubs are specifically outlined in this section, with no room for alternate interpretation. |
| Landscaping | Garfield Heights, "Chapter 155.08- Landscaping and Screening Requirements" | Mill Creek, Lower Cuyahoga River | Many of the standard terms are defined in this section to ensure adequate care is taken when assessing whether a tree can or cannot be planted in an area. For example, 'standard plant,' 'standard shrub,' and 'standard tree' are among those defined. |
| Tree Pathogens and Arthropod Pests | University Heights, "1072.13,14- Dutch Elm Disease, Rights of Director" | Dugway Creek, Nine Mile Creek, Green Creek | It is necessary to state the required actions for when a tree becomes diseased with a certain pathogen, to prevent other flora and fauna from being affected. This section should be rewritten for other pathogens and arthropods (eg, oak wilt disease, spotted lantern fly) based on the pests that are present in each municipality. |

## Cuyahoga County Board of Health (CCBH) Model Tree Ordinance

ORDINANCE NO. 2024-XX
INTRODUCED BY:
MOTION FOR ADOPTION BY:
CO-SPONSORED BY:

AN ORDINANCE ENACTING NEW SECTION xxx THROUGH xxx TO CHAPTER xxx TO PROVIDE MINIMUM STANDARDS TO PROTECT, MAINTAIN, AND AUGMENT TREES AND TREE CANOPY CITYWIDE, AND DE-CLARING AN EMERGENCY.

WHEREAS, in accordance with Article X of the Ohio Constitution, the [City] adopted its own charter, thereby asserting home rule authority. Under this Charter, the legislative power of the City, including the power to introduce, enact and amend ordinances and resolutions relating to all matters within the legislative power, is vested in the City Council; and

WHEREAS, the City Council may exercise all powers specifically conferred by the Charter or that the Constitution and laws of Ohio grant or do not prohibit. This includes the concurrent exercise by the City of all or any powers vested in municipalities by the Ohio Constitution or by general law; and

WHEREAS, the urban tree canopy of both Cuyahoga County is in decline, at 37.3%; and

WHEREAS, Council finds that people are healthier and happier when they live with trees, and living with trees reduces stress-related diseases and depression, lung disease, and asthma, and that trees remove contaminants from both air and soil; and

WHEREAS, living with trees enhances people's lives in many ways, including more stable neighborhoods, increased property values, and better quality of life. This proposed Ordinance seeks to preserve and protect these health outcomes by promoting minimum standards for retention of existing trees, and augmentation of the future tree canopy; and

WHEREAS, this Ordinance recognizes that trees are keystone species to the overall health and stability of the local and global environment, and are essential to combat Climate Change and Biodiversity Collapse; and

WHEREAS, trees sequester carbon; provide cooling shade decreasing urban heat island effect and accompanying ground-level ozone; provide food and shelter for humans and other species; this proposed Ordinance encourages urgent and prolonged support of County, municipal, NGOs, and citizen groups focused on retention and augmentation of the tree canopy;

WHEREAS, the unnecessary removal of healthy trees degrades the City's tree canopy, creates nuisance, and is detrimental to the aesthetic and cultural values of the City; and

WHEREAS, the City Council desires to better protect and preserve the City's trees with these measures.

NOW, THEREFORE, BE IT ORDAINED by the council of the [City], county of Cuyahoga, state of Ohio that:

Section 1. The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Definitions
(a) Wildlife snag means a dead or dying tree left in place to decompose naturally and to provide a habitat for the forest biome.
(b) Canopy means the high, overarching covering provided by trees in leaf.
(c) Critical Areas means any area that is subject to natural hazards or a land feature that supports unique, fragile, or valuable natural resources including fish, wildlife, or other organisms or their habitats or such resources that carry, hold, or purify water in their natural state. Critical Areas includes associated buffers of perennial or intermittent wetlands and hydraulically connected steep slopes.
(d) DBH means diameter at breast height, or 4.5 feet from the ground.
(e) Exceptional Tree means a tree with historic or cultural value or that by reason of age, rarity, location, size, aesthetic quality, or endemic status is designated by the City Tree Commission to be worthy of preservation.
(f) Field Check means a survey of existing conditions conducted on site.
(g) Forest Management Plan means a written plan prepared and signed by a Qualified Tree Professional that prescribes measures to optimize production, utilization, regeneration, and harvest of timber, including schedule and timetables for the various silviculture practices used on forestlands, to maximum of 20 years.
(h) Grubbing means the removal of understory vegetation from a site.
(i) Hazard Tree means a tree which meets all of the following: 1) structural defects and/or disease which makes it subject to a high probability of failure; 2) in proximity to persons or property that can be damaged by tree failure; 3) a high to extreme risk rating

using the International Society of Arborists Tree Risk Assessment Qualification (TRAQ) method in its most current form; and 4) the condition of the tree cannot be remedied with reasonable and proper arboricultural practices.

(j) Healthy Tree means a tree with a minimum of 30% live crown, a full complement of needles, or dark green foliage, appropriate for the species, with little to no evidence of insects or disease.

(k) ISA means the International Society of Arboriculture.

(l) Land Use Permit means a permit issued by a public authority such as the Cuyahoga County Zoning Commission.

(m) Large Tree means a tree attaining a height of more than seventy (70) feet with a mature spread of thirty-five (35) feet or more.

(n) Medium Tree means a tree attaining a height of between thirty (30) and seventy (70) feet with a mature spread of twenty-five (25) feet or more.

(o) Municipal Arborist means an advanced qualification for an ISA Certified Arborist that focuses on the special needs of urban trees.

(p) Property Line means the outer edge of a street or highway right-of-way.

(q) Public Places means all lands explicitly designated for public use.

(r) Public Tree means a tree growing within a Treelawn or on any public land where otherwise indicated.

(s) Qualified Tree Professional means a tree care professional with an ISA TRAQ credential.

(t) Remove or Removal means to do away with or eliminate a tree by digging it up, cutting it down, or damaging it to the point it is unable to survive.

(u) Replacement Tree means a newly planted tree in the site where a previously standing tree was removed and is a minimum size of six (6) feet in height measured from top of the root flare, with a minimum trunk diameter of one (1) inch measured at four (4) inches above the top of the root.

(v) Small Tree means a tree attaining a height of between fifteen (15) and thirty (30) feet with a mature spread of fifteen (15) feet or more.

(w) Transplant means to relocate a living tree to a new location and replant it.

(x) Tree Preservation Plan means a document that details actions to prevent damage or removal of existing trees.

(y) Tree Replacement Plan means a document that identifies locations, species, and size for planting replacement trees.

(z) Treelawn means the part of a street or highway not covered by sidewalk or other paving, lying between the property line and the edge of the street.

(aa) Tree Topping means the practice of removing whole tops of trees or large branches and trunks from the tops of trees, leaving stubs or lateral branches that are too small to assume the role of a central leader.

(bb) Urban Forest means the shrubs, trees, vegetation and associated natural features that collectively make up the City canopy and its growing zone.

(cc) Invasive species means any species of tree identified in OAC 901:5-30-01."

**Section 2.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:

"Urban Tree Canopy Protection Program

There is hereby created the Urban Tree Canopy Protection Program to provide minimum standards for retention of existing trees and to restore lost tree canopy. Practicing arboriculture to these standards will ensure a healthy and attractive community; increase the overall tree canopy in an equitable manner that ensures all residents have access to the benefits that trees provide; maintain a positive community image; enhance the quality of life of City residents; protect and enhance property values; increase privacy between and within residential zones; increase compatibility between different land uses; increase carbon sequestration; promote retention and protection of existing noninvasive tree species; reduce the impacts of development on stormwater drainage systems and natural habitats; absorb wind and noise; enhance air quality; conserve valuable water resources; provide benefits of green stormwater infrastructure; and provide both mitigation and adaptation for impacts of Climate Change and biodiversity collapse by, among other things:

(a) Providing visual relief from large expanses of parking areas and reduction of perceived building scale;

(b) Providing physical separation between residential and nonresidential areas;

(c) Providing visual screens and barriers as a transition between differing land uses;

(d) Retaining existing vegetation by incorporating them into site designs;

(e) Promoting water-efficient landscaping by using appropriate native or climate-adapted trees and vegetation, which, once established, typically require less water;

(f) Protecting trees during construction activities from damage to tree roots, trunks, and branches;

(g) Preventing the introduction of noxious tree species in landscaping that may damage surrounding habitats over time;

(h) Absorbing greenhouse gas emissions,

(i) Reducing air pollution by removing dangerous particulate matter, nitrogen oxides, sulfur dioxide, and deterring the formation of ozone, known to aggravate asthma;

(j) Providing wildlife and pollinator food and habitat;

(k) Maintaining and increasing tree canopy equitably within the City and County;

(l) Mitigating the impacts of the urban heat island effect by increasing shade, thereby lowering the ambient temperature and reducing energy consumption necessary to cool buildings;

(m) Providing increased areas of permeable surfaces to increase infiltration of surface water into groundwater resources to reduce the quantity of stormwater discharge; reduce sediment runoff;

(n) act to bioaccumulate toxic substances, e.g. heavy metals, PCBs and PFAS; and

(o) improve the quality of stormwater discharge."

**Section 3.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:

"Applicability, Permitting, and Exemptions

(a) The regulations of this Section shall apply to all lands in the City except as stated herein.

    (1) No permit shall be issued for the construction, alteration or addition to a building or the grading or alteration of the land surface without conformance to the provisions of this Section. The regulations shall specifically apply to the following:

        (A) All development plans and new construction shall comply with the requirements of this Section.

        (B) All single-family subdivisions and development shall comply with this Section.

    (2) No tree with a DBH of six (6) inches or greater shall be cleared or removed without a tree removal permit issued by the City Arborist, unless otherwise exempt as stated herein.

        (A) No tree removal permit shall be issued for any parcel of land or development which requires a site approval plan until a Tree Preservation Plan is approved by the City Arborist.

        (B) The City Tree Commission may adopt preservation and protection guidelines to further the purposes of the Urban Tree Canopy Protection Program. The guidelines may include, but are not limited to:

            i. Phasing of tree removal and replanting;

            ii. Tree preservation, protection, replacement, and planting standards and procedures;

            iii. Recommended species and varieties of Replacement Trees.

        (C) The City Arborist may seek independent review of any land use application that involves tree removal or land clearing at the City Arborist's sole discretion by an independent qualified tree professional, at the applicant's expense.

(b) The following activities and uses are exempt from this Section:

    (1) Lands owned by the County of Cuyahoga, Ohio, the Cuyahoga County Land Reutilization Corp., or the State of Ohio, including its administrative agencies, departments, and commissions.

    (2) The removal of dead trees;

    (3) Removal of trees below six (6) inches DBH;

    (4) The removal of trees necessary for the construction, operation, and maintenance of sanitary and storm sewers;

    (5) Removal of trees by the City for any governmental function, or by emergency responders in situations involving danger to life or property, fire hazards, or interruption of traffic;

    (6) Trees located in Critical Areas;

    (7) Any land upon which a bona fide agricultural or commercial nursery or tree farm exists;

    (8) The removal of trees required for the installation, maintenance, and repair of underground and overhead public or private utilities.

    (9) The removal of invasive species;

    (10) Timber harvesting operations which qualify as forestry land management practices or agricultural operations not incidental to development, on tracts which are zoned for or used for forestry, silvicultural, or agricultural purposes, and

    (11) Tree removal required by other federal, state, or local laws.

(c) If a tree removal permit cannot be obtained before commencement of work, a remedial permit must be submitted to the City Arborist within fourteen (14) calendar days following tree removal unless the tree removal is exempt under this Section."

**Section 4.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:

"City Tree Commission

(a) There is hereby created and established a City Tree Commission. The City Tree Commission consists of five (5) members, citizens, and residents of Cuyahoga County, at least three (3) of whom must be residents of the City. All members will appointed by the Mayor with the approval of the Council, and serve at the pleasure of the Mayor.

(b) At least three (3) members shall be experienced in or have extensive knowledge of the care of trees through documented certification and/or education including training through the Ohio Department of Natural Resources Division of Forestry known as the Tree Commission Academy, or other silviculture organizations.

(c) In addition, a member of the Council and the Director of Service shall serve as *ex officio* members of the Commission. These officials or their designees shall attend all meetings of the Commission.

(d) The term of persons appointed to the City Tree Commission shall be three (3) years.

(e) Members of the City Tree Commission shall serve without compensation.

(f) The duties of the Tree Commission are:

    (1) To assist the properly constituted officials of the City as well as citizen and community groups, in the dissemination of news and information regarding the selection, planting, and maintenance of trees within the corporate limits of the City, whether they be on private or public property.

    (2) To study the Urban Forest including problems involving the tree population and distribution of the City, determine needs, compose, and review annually a tree plan and seek ways to implement it.

    (3) To provide regular and special meetings at which the subject of the Urban Forest may be discussed by the citizens of the City.

    (4) Determine, as resources allow, areas where appropriate trees could exist but are absent.

    (5) To represent the City and its residents in public forums and before public bodies.

    (6) To seek and apply for grants or public funding to further the objectives of the Urban Tree Canopy Protection Program.

    (7)  To approve and maintain a current list of Exceptional Trees within the City.

(8)  (g) Within a reasonable amount of time after the appointment of the City Tree Commission, the Commission shall meet and

organize by the election of a chairman, vice-chairman, determine committees, and standing committee chairs as needed.
(h) The City Tree Commission shall provide for the adoption of rules and procedures and for the holding of regular and special meetings as said Commission shall deem advisable and necessary in order to perform the duties set forth. A journal of proceedings and activities is to be recorded.
(i) A majority of voting members shall constitute a quorum for the transaction of business.
(j) The City Tree Commission may engage in any other lawful activity in pursuit of the mission of this commission which may benefit the Urban Forest including:

> (1) Apply for Tree City USA status with the National Arbor Day Foundation.
> (2) Conduct seminars and public education programs.
> (3) Review applications for tree plantings.
> (4) Organize tree plantings and care activities."

**Section 5.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"City Arborist
(a) There shall be one City Arborist, appointed by the Building Commissioner after certification by the Civil Service Commission of the City in accordance with its rules and regulations and in further compliance with the civil service statutes of the State.
(b) The City Arborist shall, where possible, be a person skilled or trained in forestry, ISA certified with addition credentials of Municipal Arborist and Tree Risk Assessment Qualified.
(c) Subject to the provisions of this Section, the City Arborist shall establish guidelines for the planting, maintenance, and removal of trees on both the public and private lands within the City; maintain a City-wide tree inventory of trees with a DBH of greater than six (6) inches, revised at least annually; attend all meetings of the Tree Commission and provide its members with professional recommendations, as needed.
(d) The City Arborist shall have the authority to issue, deny, or revoke permits under Section xxx to regulate the planting, maintenance, and removal of trees on public and privately owned properties to preserve the integrity of the Urban Forest, and to create such applications and forms for public use.
(e) The City Arborist shall have the authority to affix reasonable conditions any permit issued in accordance with Section xxx, including requirements for the replacement of trees being removed."

**Section 6**. The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Exceptional Trees
(a) Removal of an Exceptional Tree shall not occur before the issuance of a major tree removal permit pursuant under the following conditions:

> (1) On an undeveloped lot, Exceptional Trees shall not be removed unless:
>> (A) The tree(s) is determined to meet the criteria of a Hazard Tree by a Qualified Tree Professional; or
>> (B) The tree(s) poses an imminent risk to an inhabited structure.
> (2) On a proposed development site, Exceptional Trees shall not be removed unless:
>> (A) They are determined to meet the criteria of a Hazard Tree by a Qualified Tree Professional; or
>> (B) A Qualified Tree Professional determines the tree does not meet the definition of a Healthy Tree; or
>> (C) If retention will limit the constructible building coverage to less than eighty-five (85) percent of the maximum building coverage area allowed; or
>> (D) For a single-family residence, building coverage may be increased by twenty (20) percent or a reduction of the front setback by up to ten (10) feet.

(b) Exceptional Trees shall be protected during all permitted construction with concrete "K" barriers placed at three (3) times the diameter from the trunk."

**Section 7**. The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Permits
(a) No person may clear land of trees nor remove any tree with a DBH of six inches (6") or greater without having first obtained a permit pursuant to the provisions of Section xxx unless otherwise exempted.

> (1) A Major Tree Removal Permit is required for the removal of a large tree or exceptional tree.
> (2) A Tree Removal Permit is required for the removal of a medium tree or small tree.
> (3) A Transplant Permit is required for the transplant of a medium tree, large tree, or exceptional tree.

(b) Any person wishing to obtain a permit to remove, cause to be removed, or relocate a tree with a DBH of six (6) inches or greater, must make an application to the City Arborist and paying a fee as is established herein.
(c) Where an application for a major tree removal permit as required by this Section has been submitted, no such permit may be issued until a Tree Preservation Plan for the lot or parcel has been reviewed and approved by the City Arborist. The Tree Preservation Plan must show the following information sufficient to enable the determination of matters required under these regulations:

> (1) The shape and dimensions of the lot or parcel, together with the existing and proposed locations of all structures, improvements, and utilities if any.
> (2) The location of all existing trees with a trunk diameter of six inches (6") or more DBH, identified by common or botanical name. Any trees proposed to be transplanted or removed must be separately marked. Groups of trees in close proximity, three-to-five foot (3-5') spacing or closer, may be designated as a "copse" of trees, and the predominant species, estimated

number and average size must be listed.

(3) A statement showing how trees not proposed for removal are to be protected during land clearing and construction, e.g., a protective barrier.

(4) The location and dimensions of all setbacks and easements.

(5) Statements as to grade changes proposed for the lot or parcel.

(6) Any proposed Replacement Trees, pursuant to Section xxx.

(7) All trees and wildlife snags to be retained shall be conspicuously identified by some method, such as painting or flagging, prior to field inspection. Where protective barriers are necessary to prevent damage to a tree that is not to be removed, such barriers shall be erected, distanced three (3) times the diameter of the tree.

(8) A topographical survey sealed by a registered engineer or registered surveyor, which shows the information set forth in sub-sections (c)(1) through (7) above. A Tree Preservation Plan may substitute an aerial or satellite image of suitable quality (minimum 1" equals 200'), to facilitate plan review.

(d) If there are no trees greater than six inches (6") DBH located on the site to be developed which are required to be protected under the provisions of this Chapter, the applicant shall so state in the application for a "No Tree Verification." If substantiated by the City Arborist, the applicant shall be relieved of the necessity of complying with the provisions of this Chapter in regard to the removal of trees.

(e) Any permit issued under this Section are valid for up to one (1) year from the date of issuance.

(f) Land clearing on an undeveloped lot for the purpose of future development is prohibited."

**Section 8.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:

"Permit Procedure

(a) Removal or transplant of trees must be field-checked by the City Arborist prior to the issuance of a permit. The City Arborist may request a recommendation concerning the application from other City departments. The City Arborist must conduct field checks within ten (10) business days of receipt of an application submitted under Section xxx.

(b) Each applicant, at the time the application is filed, shall pay a nonrefundable permit fee of one hundred dollars ($100.00) for each single-family residential lot and a nonrefundable permit fee of one hundred fifty dollars ($150.00) for each lot other than a single-family residential lot.

(c) The City may withhold the issuance of any permit, building permit, or certificate of occupancy, on any property until the provisions of this Chapter, including conditions of any permits issued under Section xxx, have been fully met.

(d) Any person adversely affected by a decision of the City Arborist or any other City employee in the enforcement or interpretation of any of the terms or provisions of this Ordinance may appeal such decision to the Board of Zoning Appeals.

(e) Once a permit is issued, the applicant must display it continuously on site while trees are being removed, transplanted, or re-placed and for ten (10) days thereafter. As a condition to the issuance of a permit, the applicant must agree in writing to allow entry onto the property by representatives of the City to inspect the permit during normal business hours and at any time that work is be-ing performed. Failure to allow such entry is unlawful, constitutes a violation of Section xxx, and immediately voids any permit previously issued.

(f) At the time of application, the applicant shall deposit with the City an amount of five hundred dollars ($500.00) to ensure compli-ance with the provisions of this Chapter. After construction or development is completed, the City Arborist shall conduct an inspec-tion. If the inspection shows that the applicant has complied with all of the provisions of this Chapter and any permit conditions, the five hundred dollars ($500.00) shall be returned to the applicant. If the inspection shows that the applicant has failed to comply with all of the provisions of this Chapter or the permit conditions, in addition to the penalties and provisions set out in this Chapter, the applicant shall forfeit to the City the portion of the five hundred dollars ($500.00) necessary to remedy the noncompliance.

(g) All permit applications pursuant to Section xxx must be submitted in a form as prescribed by City Arborist and with all required fees. All such applications must include, at a minimum, the following:

(1) A written statement of the reason for the removal or transplant;

(2) A basic site plan or image showing the approximate location of large and Exceptional Trees on the site, including their size, species, condition, and clearly designating which tree(s) will be removed and which tree(s) will be retained. The application must also show all existing structures, driveways, and other impervious surfaces on the site.

(3) Verification that tree(s) proposed for removal or transplant are not in a Critical Area and an acknowledgment that tree re-moval will not result in a lot losing attainment under Section xxx.

(4) For replacement trees, a Tree Replacement Plan showing the location, size, species, and quantity of new trees in accordance with standards set forth in this Chapter

(h) The City Arborist may request additional information as needed to allow adequate review of the proposal, but the City Arborist must approve, approve with conditions, or deny an application for permit within 30 calendar days.

(i) Where it appears that this Chapter is being or is about to be violated, the chief legal officer of the Municipality may bring an ac-tion to enjoin the violation. This action is an additional remedy not dependent on the adequacy of the remedy at law."

**Section 9.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:

"Exceptional Tree Tax Deduction Incentive

(a) In an effort to incentivize the preservation of Exceptional Trees on private lands, City residents may deduct up to three thousand dollars ($3,000) per Exceptional Tree for qualified expenditures made during the taxable year to maintain the trees on private prop-erties pursuant to these guidelines:

(b) The tree must be designated as an Exceptional Tree by the City Tree Commission.

(c) Qualified expenditures are reasonably necessary expenses incurred to maintain the Exceptional Tree (excluding interest).
(d) No deduction is allowed in more than one (1) taxable year out of every three (3) consecutive taxable years. The deduction is allowed for amounts paid in taxable years beginning after January 1, 2023.
(e) To apply for the tax deduction, an affidavit signed by a Qualified Tree Professional of the City Tree Commission stating that the amount of expenditures is deemed reasonably necessary must be attached to an applicant's most recent tax return. The affidavit also must include the following information: (1) type of tree, (2) location of tree, and (3) description and amount of expenditures made to maintain the tree. The affidavit must be notarized."

<u>Section 10.</u> The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Tree Credits
(a) Properties with sufficient numbers of trees contribute to the health of the Urban Forest. To incentivize tree planting and retention, and to disincentivize unnecessary tree removal, there is created the Tree Credit program, subject to the requirements of this Chapter.
 (1) A property that meets the required minimum tree credit density is in attainment.
 (2) Subject to the provisions of Chapter 890 and state law, a lawful owner of a property in attainment for the purposes of this Section may claim a deduction of two percent (2%) on municipal income tax otherwise due and owing to the City, per calendar year.
 (3) Any lot that in its current condition is not in attainment must be brought into attainment by the planting of new trees when the following thresholds are met, unless attainment will limit the developable area to less than eighty-five (85) percent of the maximum buildable area:
  (A) Construction of a new structure that is five hundred (500) square feet or larger; or
  (B) Construction of an addition to an existing structure where the addition is five hundred (500) square feet or larger.
 (4) The Tree Credit program is voluntary; no penalty is incurred for a property not in attainment.
(b) Only properties in attainment are eligible to receive a Tree Credit deduction. A minimum tree credit density must be maintained at all times on each lot as specified in the table below, regardless of development status. Trees may consist of existing small, medium, large, exceptional trees, or a combination. Only Healthy Trees can be used to satisfy the required minimum tree credit density.

Table 1: Minimum tree credit density

| Land Use Type | Required minimum trees per 1000 square feet of developable area |
|---|---|
| Single-family development (detached dwellings, ADUs and DADUs) and townhouses on individual lots. | 1 |
| Multi-family development (attached dwellings including townhouse apartments and cottage housing). | 1 |
| Commercial, industrial, or nonresidential lots. | 0.15 |

(c) The minimum tree credit density is applied to the property's developable area. Developable area excludes Critical Areas, public street rights-of-way, private streets, shared driveways, and public trails. Fractions may be rounded to the next whole number. For example: If a single-family lot has a developable area of 5,400 square feet, the minimum required tree credits would be five (5) (5,400/1,000 = 5.4 rounded down to 5), which can be attained with one tree worth five credits, five trees worth one credit, or any combination thereof.
(d) Lots in excess of 10,000 square feet must have a minimum of fifty percent (50%) trees with a DBH of less than six inches (i.e., newly planted trees) to qualify for a tree credit deduction.
(e) If a lot is to be subdivided, the required minimum tree credits density shall be applied to the developable area of the short plat or subdivision. Additionally, each individual lot requires a minimum of two tree credits per lot. As an example, if a lot had 10,000 square feet of developable area, it would require ten tree credits for the entire property (10,000/1,000 = 10). If the parcel was divided into four (4) lots of equal size, each of the lots would require a minimum of two tree credits, for a total of eight tree credits (4 lots x 2 credits per lot = 8 tree credits). The remaining two tree credits (10 credits - 8 credits = 2) can be obtained on any combination of lots. Trees located within a Critical Area may not count towards that lot's required minimum tree credits.
(f) Trees growing on a Property Line shall count as half (1/2) of the tree credits listed in the table below.

Table 2: Tree credits

| Tree Diameter at DBH | Credits per tree |
|---|---|
| < 6 inches | 1 |
| 6-10 inches | 2 |
| 10.01-14 inches | 3 |
| 14.01-18 inches | 4 |
| 18.01-22 inches | 5 |
| 22.01-26 inches | 6 |
| 26.01-30 inches | 7 |
| 30 or more inches | 9 |

**Section 11.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:

"Forest Management Plan

(a) The City Tree Commission and City Arborist will jointly develop a Forest Management Plan to manage a forested City over an extended period of time and avoid inconsistent practices that can lead to the degradation of the Urban Forest. Consistent with this Chapter, the Forest Management Plan will allow for allows for lawful tree removal, pruning, and overall vegetation management of a property. A Forest Management Plan must be approved by a Qualified Tree Professional before implementation. The plan will identify current Urban Forest conditions and considerations for management over a minimum of ten(10) years.

(b)The Forest Management Plan may include the following:

(1) A description of the purpose of the plan including goals that are strategic, measurable, ambitious, realistic, time-bound, in-clusive, and equitable;

(2) Mapping of current conditions including Critical Areas;

(3) A description of the forest health including pests, pathogens, and noxious species;

(4) Urban Forest inventory including a map and list of all Large and Exceptional Trees proposed for management;

(5) Photos of trees and understory composition;

(6) A description of wildlife habitat;

(7) A description of existing structures and utilities;

(8) Forest management policy recommendations."

**Section 12**. The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:

"Replacement Trees

(a) Replacement Trees must be planted on a property from which medium, large, or exceptional trees are removed, whether or not pursuant to a permit. The City Arborist must make an individualized assessment of the impact of tree removal, including environ-mental degradation and mitigating factors, before determining the appropriate number of replacement trees and documenting the findings in a Tree Replacement Plan. Any Tree Replacement Plan must be roughly proportional to the impact of the removal, must be replaced in accordance with this Section, and follow the following standards.

(1) An exceptional, healthy tree lawfully removed by permit requires replacement at a ratio of up to three (3) trees for each tree removed.

(2) A Large, healthy tree lawfully removed by permit requires replacement at a ratio of up to two (2) trees for each tree removed.

(3) All other trees lawfully removed by permit require replacement at a ratio of one (1) tree for each tree removed.

(b) To the greatest extent possible, all Replacement Trees should be planted:

(1) Where removed trees previously existed;

(2) Within Critical Areas; or buffers if recommended by the City Arborist

(3) In locations appropriate to the species' growth habit and horticultural requirements;

(4) Away from areas where infrastructure damage is likely to occur, including utility easements;

(5) To provide screening of the development from adjacent properties, where appropriate;

(6) In areas that connect or are adjacent to sensitive areas or other open spaces, where appropriate; and

(7) With consideration of the trees' maturation and maintenance requirements, especially for those to be planted next to or un-der overhead utility lines.

(8) To promote the community benefits identified in Section xxx.

(9) Using accepted silviculture principles to create the right place for the right tree.

(c) Replacement Trees must be native to Ohio or climate-adapted, and planted with the following requirements, unless the City Ar-borist has approved alternative specifications:

(1) Soil shall be loosened within the planting hole three (3) times the widest dimension of the root ball;

(2) The top of the root ball shall be placed at finished grade and a four (4) inch high soil or berm shall be constructed around the root ball edge;

(3) The root ball shall be placed on existing or compacted soil to prevent settling;

(4) Four (4) inches of woodchip or bark mulch shall be placed over the loosened soil, tapering so no woodchip or bark mulch touches the tree trunk; and

(5) Organic matter or fertilizer shall be incorporated with native soils as needed according to best management practices.

(d) Neither invasive species nor Prohibited Trees, as defined in Schedule B may be Replacement Trees.

(e) Installation of Replacement Trees must comply with all material terms and conditions of a Tree Preservation Plan, or any other permit duly authorized by this Chapter.

(f) Subject to the requirements of Section xxx, a property owner must replace an illegally removed tree pursuant to the following table:

Table 3: Tree Replacement for Illegal Removal of Trees

| Diameter at standard height of tree removed | Number of required Replacement Trees |
|---|---|
| 6-10 inches | 1 |
| 10.01-14 inches | Up to 2 |
| 14.01-18 | Up to 3 |
| 18.01-22 | Up to 4 |
| 22.01-26 | Up to 5 |
| 26.01-30 | Up to 6 |
| Greater than 30 inches | Up to 7 |

(g) At the sole discretion of the City Arborist, a tree replacement fee-in-lieu may be requested by a person subject to this Section, to pay a fee in the amount of one hundred dollars ($100) for any replacement tree that is otherwise required to be planted."

**Section 13**. The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Tree maintenance
(a) Any tree that is Topped, unless recommended by a licensed and Qualified Tree Professional for the tree's structural stability and longevity, is considered to be removed and requires a tree permit. The assessment shall be conducted prior to topping. Removal without a permit is subject to tree replacement and code enforcement provisions for illegal removal. Trimming under and around utility lines is exempt.
(b) Except for wildlife snags intentionally retained to provide wildlife habitat, other dead, diseased, damaged, or stolen trees must be replaced within three (3) months or during the next planting season if the loss does not occur in a planting season. Removal of a wildlife snag containing cavities or other obvious signs of state or federally protected bird, or animal habitation is considered to be tree removal and is subject to tree replacement and code enforcement provisions for illegal removal unless determined to pose a risk using the ISA Tree Risk Assessment process by a Qualified Tree Professional.
(c) Trees or portions of trees that obstruct or hinder the use of any public right-of-way or designated trail, encroaching eight (8) feet or less above a pedestrian walkway or sidewalk and fourteen (14) feet or less above a paved street, must be trimmed.
(d) At its own expense, the City may trim or remove trees or portions of trees that obstruct or hinder the use of the public street right-of-way, city-owned property, or a designated trail without providing notice to the affected property owner.
(e) Before any large or Exceptional Tree has more than twenty-five (25) percent of the live tree canopy removed a qualified tree risk assessment report must be submitted by a Qualified Tree Professional in conjunction with a minor or major tree removal permit. Removal or pruning of more than twenty-five (25) percent of the live tree canopy without a permit is considered to be removed. Removal without a permit is subject to tree replacement and code enforcement provisions for illegal removal.
(f) Any tree that causes physical damage to a structure may be removed without a permit provided the problems associated with the tree cannot be corrected by reasonable practices, including but not limited to: pruning of the crown or roots of the tree, bracing, cabling, routine maintenance or cleaning of the structure, or construction modification. The property/owner or developer shall have a report prepared by a Qualified Tree Professional documenting the damage and mitigation options, which will be submitted to the City in conjunction with the permit.

**Section 14**. The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Nuisance
(a) The removal of trees contrary to the provisions of this Chapter is declared a nuisance and unlawful."

**Section 15**. The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Inspections
(a) The City Arborist shall have site access wherever an active permit has been applied for or issued to perform an on-site review and to ensure the accuracy of a permit application and permit compliance. The applicant shall request an inspection before any tree removal. Upon completion of planting, the applicant shall request a final tree inspection to ensure proper installation. Upon completion of the three (3) year maintenance period, the applicant shall request an inspection to ensure the survival of planted and retained trees and the release of associated bonds.
(b) Upon completion of construction activities and before issuance of the certificate of occupancy, the applicant shall request an inspection of all protected significant and Exceptional Trees. Any tree found to be irreparably damaged, dying, or a high risk shall be replaced consistent with Article xxx and subject to fines determined by the city and presented in Table xxx, if it is determined the damage was likely caused by construction activities.
(c) Whenever the City Arborist believes that a violation of this Ordinance has been or is being committed for which no active permit has been issued, the City Arborist may inspect the site pursuant to Section 16 below.
(d) Before any inspection, the Arborist shall present identification credentials, state the reason for the inspection, and request entry. If the property or any building or structure on the property is unoccupied, the City Arborist shall make a reasonable effort to locate the owner or an individual having charge or control of the property or portions of the property and request entry, before entering."

**Section 16.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Enforcement
(a) For any violation of this Ordinance, the City may pursue remedial enforcement and penalties in accordance with general law and this subsection. Where there is a conflict, this subsection shall prevail.
    (1) General Requirements. This section applies to all trees on private property. Enforcement shall be in accordance with procedures set forth in this Ordinance.
    (2) Authority. It shall be the duty of the applicable department Director to administer the provisions of this section.
(b)  It is unlawful to remove or damage trees in violation of these tree regulations. Tree removal includes the removal of a tree, directly or indirectly.
    (1) Any person who aids or abets in the violation shall be considered to have committed a violation for purposes of fines. This includes the arborist or company pruning or removing the tree.
    (2) Violations include, but are not limited to, the removal or damage to tree(s)

(A) Before final tree retention plan approval or the issuance of a minor or major tree removal permit;
(B) That are shown, or would be shown, to be retained on an approved tree retention plan or any other violation of an approved tree retention plan; or
(C) In violation of the terms and conditions of an issued City permit, which will require compliance with American National Standards Institute (ANSI) A300 pruning standards."

**Section 17.** The following new Section xxx is hereby enacted as part of the Streets, Utilities, and Public Services Code, to read as follows:
"Severability
(a) Should a court of competent jurisdiction find any section, paragraph, sentence, clause, or phrase of this Chapter, or its application to any person or circumstance, unconstitutional or otherwise invalid for any reason, or should any portion of this Chapter be pre-empted by state or federal law or regulation, such decision or pre-emption does not affect the validity of the remaining portions of this Chapter or its application to other persons or circumstances."

**Section 18.** It is necessary that this Ordinance becomes immediately effective for the usual daily operation of the City; the preservation of public peace, health, or safety of the City; and any additional reason set forth in the preamble.

**Section 19.** It is found and determined that all formal actions of this Council relating to the adoption of this Ordinance were adopted in an open meeting of the Council and that all deliberation of this Council and of any of its committees that resulted in such formal action were in meetings open to the public, in compliance with all legal requirements, including Section 121.22 of the Ohio Revised Code.

Yeas:
Nays:

_____ Council President _____ Date

_____ Mayor

_____ Clerk of Council _____ Date

First Reading/Referred to Committee:
Committee(s) Assigned:

EXHIBIT A
USER GUIDE
This section is intended to provide an overview of the tree regulations contained in this chapter.
1. Generally, these regulations apply to private property outside of Critical Areas, Associated Buffers, and Shoreline Management Areas.
2. Tree removal not associated with development. If the tree is being removed for reasons other than development (for example, so a Property Owner can install solar panels), then a minor tree removal permit (see Section 15) is required in the following situations:
   A. For tree removal exceeding the allowed limit of significant tree removal per year(s), see Table 3;
   B. For any removal of Exceptional Trees; or
   C. When the removal of trees would result in a lot falling below the required number of minimum tree credits per Table 2.
3. Tree removal associated with development.
   A. If the tree is being removed as part of a development (for example, to allow for the construction of a new home), a major tree removal permit is required, and:
   B. All applications shall be accompanied by a Tree Replacement Plan pursuant to Section 1(y) if the required minimum tree credits are not met by existing Significant and Exceptional Trees.
4. Tree removal on an undeveloped lot. All significant and Exceptional Trees on an undeveloped lot shall be retained. Tree removal or land clearing on an undeveloped lot for the purpose of future development is prohibited unless a Land Use Permit is approved by the City.

EXHIBIT B
PROHIBITED TREES
1. Apple .............................................................Fruit objectionable on street; insect pests, disease- prone
2. Birch..............................................................Susceptible to disease
3. Black Locust...................................................Insect pests
4. Box Elder .......................................................Breakage and insect pests
5. Catalpa ..........................................................Coarse; insect pests
6. Moline Elm ....................................................Breakage
7. Siberian Elm (Chinese Elm) ...........................Breakage

8. European Mountain Ash ...................................Susceptible to being blown over by wind
9. Evergreens ..................................................Cause obstructions to vision of traffic and signs
10. Horse Chestnut .............................................Leaf blight; messy
11. Mulberry ....................................................Fruit objectionably on street
12. Poplars ......................................................Breakage; insect pests, disease-prone; root system
Trees that clog sewers and pipes
13. Silver Maple ................................................Breakage; root system clogs sewers and pipes
14. Tree of Heaven .............................................Coarse; breakage
15. Tulip Tree ...................................................Insect pests; leaves drop during dry periods
16. Willows .....................................................Breakage; insect and disease prone; root system clogs sewers and pipes
17. Pear (Cleveland, Bradford, and Callery) .......Breakage
18. ANY OTHER TYPE OF TREE HAVING SIMILAR PROBLEMS AS LISTED ABOVE

For species not specifically described as permitted or prohibited, verification as to its acceptability may be necessary. Such verification may be done by contacting a reputable plant nursery or by contacting the Ohio Department of Natural Resources, Division of Forestry, 777 Columbus Avenue, Lebanon, Ohio 45036. Telephone: (513) 932-6836

# Development and Delivery of a Novel Interdisciplinary Online Course Focused on Pandemics and COVID-19

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**ABSTRACT**

Misinformation regarding COVID-19 has clouded the judgment and perspectives of many individuals. At Ohio Northern University, an interdisciplinary online elective course was developed to allow students the opportunity to gain evidence-based insight about the far-reaching implications of pandemics, with a specific focus on COVID-19. This course is open to any undergraduate student at the university without any prerequisites; however the majority of enrolled students come from the pharmacy and nursing programs. This paper describes the development, delivery, and assessment methods of this course. Course evaluation and modifications have allowed this course to evolve over time and remain a well-enrolled course at Ohio Northern University.

**Keywords:** Interdisciplinary education; Pandemic, Online course design; Misinformation, Public health education, Pharmacy professional elective

## INTRODUCTION

During the COVID-19 pandemic it became apparent that there was a dire need for public health education. After the discovery that SARS-CoV2 presented a global health emergency, citizens of the world were searching for answers in order to understand and better protect themselves from COVID-19. Early in the pandemic there was an emphasis on preventing transmission of the virus and it was evident that governmental and policy responses to the COVID-19 pandemic varied greatly.[1] Additionally, medical misinformation spread easily during the COVID-19 pandemic. This created challenges with conveying public health messaging and led to distrust of health care providers and the government.[2] The desire to dispel common myths and provide evidence-based information to our campus community was the goal of developing a course focused on understanding pandemics, with a focus on COVID-19. Universities and colleges with public health programming are an ideal setting to research and educate about this pandemic. Students represent a captive audience with potential to learn from the pandemic in real time and benefit from insights across various different disciplines

An interdisciplinary approach has been proposed as an ideal method to research COVID-19.[3] Scientific collaboration allowed COVID-19 researchers to evaluate various factors that facilitated management of challenges associated with the COVID-19 pandemic and, hopefully, prevent similar pandemics. Likewise, interdisciplinary education draws on multiple disciplines to acquire a deep understanding of complex issues.[4] The desire to provide pandemic-related content from various angles in an accessible, online format inspired the development of an elective course at Ohio Northern University, an independent, comprehensive university located in rural northwest Ohio. The course, offered through the Rudolph H. Raabe College of Pharmacy, is open to any student enrolled in one of the university's undergraduate programs: Arts & Sciences, Business; Engineering, Pharmacy. The purpose of this paper is to describe the development and ongoing evolution of an online, elective course focused on the COVID-19 pandemic.

## Course Development

During the spring of 2020 faculty members from the college of pharmacy began developing the framework for an elective, online course focused on the provision of accurate and scientific information regarding COVID-19. At the time, many other universities were developing educational courses and offering them to their students, as well as to the general public.  Likewise, we sought to bring together the expertise on our campus and surrounding areas to educate students enrolled at our institution. The initial course offerings focused on providing information on the virus, disease process, and impacts on society and economics. Each semester the course has been modified to include the latest medical, public health, and economic information as the pandemic progressed. Over the time period in which this course was developed there were various structural changes within the university that included pausing enrollment in the public health major, however the public health minor remained available. While this course is offered through the college of pharmacy, instructors involved with the public health major and minor have contributed to this elective.

During course development, the involved faculty identified 5 main content areas that were of great importance during the early stages of the pandemic that corresponded to individual expertise on our campus. These included public health, health care response, economics, sociology, and media. The public health and health care content was provided by faculty from the college of pharmacy including those with expertise in public health, social and administrative sciences, infectious diseases, and critical care. The arts and sciences college contributed to the sociology content, provided by a professor of sociology, and media content was provided by a professor of communication and media studies. The dean of the college of business administration contributed the economic content, which aligned with that individual's training and scholarly interests. Due to faculty turnover between fall and spring semester in the first year of the course, the media content was replaced with content focused on education starting in the spring of 2021, provided by a professor from the university's center for teacher education.

Because the future of in person education was unknown at the time of course development, it was determined that offering an online course would be preferable. In order to allow this course to be taken by a wide variety of students, it was developed to include 1 credit hour of content and be offered online so that it could easily fit into students' schedules. It also counts toward professional elective hours that are required for pharmacy students earning their PharmD degree.

The course coordinator attended the university's required instruction for teaching online courses during summer of 2020 and built the course in the learning management system (LMS). This process involved using best practices from the Quality Matters Higher Ed Rubric Standards.[5] A course alignment table was developed which aligned the course to the overall course outcomes (1 for each block of material) with associated learning objectives for each block of material. Course learning outcomes underwent approval through the college of pharmacy curriculum committee which is a requirement of all new courses offered through the college. These outcomes were developed with input from the instructors of each block and served as the basis for any content specific objectives and assessment materials. After completion of the first offering of the course, it was submitted through peer review according to university requirements and successfully passed the standards required to become a regular course offering.

The course coordinator is responsible for maintaining the course content on the LMS, creating and updating the syllabus, communicating with faculty and students involved in the course, providing content for the course, entering grades, reviewing evaluations, and making course updates as needed. During the development phase of the course, the course coordinator communicated with the instructors teaching in the course via email and virtual meetings to ensure some degree of consistency was present between the blocks of material. Examples of this include posting objectives and a weekly overview for each block at the beginning of each new LMS section; requiring new materials will be posted by Wednesday of the week they were scheduled, and; encouraging various methods to interact with students and deliver content.[6] Each block of material was designed to be independent. However, there is overlap among several of the concepts to ensure continuity and consistency of messaging. The course coordinator reviewed all material for the course. Additionally, because of the rapidly evolving dissemination of new information, especially early in the pandemic, this course was not designed to be fully self-paced. Instructors posted materials and any related assignments weekly and students were alerted to this through an email announcement each week. Finally, in order to create a sense of community within this course, students were expected to complete an introduction of themselves via a discussion board, participate in 3 to 4 virtual synchronous meeting times, and work in groups to complete group projects. This led to a delivery of an online course that provided a variety of learning modalities and assessment methods as described in the subsequent sections of this paper.

## Course Delivery

The majority of the material was available in an online asynchronous learning environment. During each block of content, lasting an average of 2 to 4 weeks, learning materials were posted by faculty members based on expertise of the subject matter. The method of delivery and assessment for each content area was at the discretion of the individual faculty members responsible for that block of content. As mentioned previously, the course coordinator reviewed all new materials to ensure they were consistent with the course design and aligned with student expectations. If needed, instructors agreed to be flexible with respect to modifying

their content. An example of this was when an instructor posted additional recordings that exceeded that allotted time for that week. To rectify this, the instructor posted the extra material under "Optional Materials" and there was no formal assessment of that material.

Faculty were encouraged to provide content at an introductory level that would be appropriate for students from any major at any point in their college education. Learning materials consisted of educational PowerPoints, recorded lectures, videos, scholarly articles, and publicly available videos. Each new course week expanded the horizons and added depth to discussions and assignments for those enrolled in the course.

In addition to the asynchronous environment described above, students were required to attend 3 live virtual panel discussions throughout the term. Areas of panelist expertise included medical providers (physicians and nurses) in leadership roles within local health departments, professionals with background in testing and vaccine development, teachers and administrators from various K-12 school systems in the state, as well as physicians and pharmacists with practice experience during the pandemic. Panelists and students interacted in a virtual meeting in a question-and-answer format where a faculty member served as a moderator. Panelists were able to share thoughts, ideas, and actions related to their professional and personal experiences during the pandemic. Some examples include discussing the usefulness and data surrounding mask wearing, working through difficult and stressful situations surrounded by everyday life due to the impact of COVID-19, understanding protocols and testing criteria for the different vaccines created, and the pros and cons of remote education. The virtual nature of these panel discussions benefits students and the panelists. It allows for professionals from other parts of the state and country to interact with students, many of which have been repeat panelists and expressed excitement and a positive overall experience speaking with our students and engag-

ing with other professionals within their field. Students gain valuable insights from the practical experiences of the panelists.

**Course Assessment**

Students are assessed by various methods throughout the course. Formative assessments, such as quizzes, are used to assess students' knowledge at the end of a block of content. These quizzes are delivered via the LMS and are open-resource. Completion of group projects is another assessment type that is utilized. Students complete 3 group projects focused around public health messaging, the economic impact of a specific business sector, and an educational topic. The final assessment method that students are graded on includes a reflection paper. Completion and participation points are earned for discussion question submission, panel meeting attendance, and a forum posting. Examples of course assignments and point allocations are listed in Table 1.

**Course Evaluation**

Several methods have been used to evaluate the course over the span of course offerings. A formal assessment process was used during the first 2 course offerings in the fall of 2020 and spring of 2021 through a research project which was granted exemption through the institutional review board at Ohio Northern University. Students enrolled in the course were encouraged to complete an optional 29 question Likert scale pre-survey and post-survey through a Qualtrics deidentified survey. Questions in the survey related to the topics that were included in the course. Results demonstrated that after completing the course, students were more likely to agree that information they had received about COVID-19 was accurate, less likely to agree that they had been lied to by the federal government, and more confident in their understanding of COVID-19 transmission, disease process, treatments, and vaccine development. Additionally, during the first semester of the course students were required to participate in focus group discussions to review what they learned in the course and identify what they liked best and least about the course.

**Table 1. Course Assessment Methods**

| | Content area | Assessment method (points) |
|---|---|---|
| Block 1 | History of pandemics and public health response | LMS Class Introductions (10)<br>LMS Quiz (10)<br>Panel 1 Question Submission (5)<br>Panel 1 Participation[a] |
| Block 2 | COVID-19: The virus and health care response | LMS Quiz (10)<br>Group Assignment (10)<br>Panel 2 Questions Submission (5)<br>Panel 2 Participation[a] |
| Block 3 | Societal impact of a pandemic | Online Forum Discussion (10)<br>Reflection Paper (25) |
| Block 4 | Economic impact of a pandemic | LMS Quiz (10)<br>Group Assignment (20) |
| Block 5 | COVID-19: Impact on education | Group Assignment (25)<br>Panel 3 Participation[a] |
| Final assessment | | Virtual Course Review (25)<br>LMS Summative Quiz (25) |

[a] No points are associated with this activity, but it is listed as a mandatory course activity. Attendance is required and failure to appropriately notify and arrange a makeup activity will lead to failure of the course.

Standardized university course evaluations are reviewed each semester. These evaluations are not mandatory; thus, the overall response rate has been low, ranging from 14%-52% of enrolled students over the 5 semesters it has been offered. The most useful aspect of these evaluations has been the open response boxes which have assisted with course modification. In addition to the university course evaluations, each semester students are invited to complete an instructor-developed evaluation of the course which asks questions about the various blocks of content, panel discussions, projects, and allows for narrative comments as well. Feedback from these evaluations have led to changes such as adjusting the length of each block, allowing students to select their own groups for group projects, and modifying assignment due dates.

## Lessons Learned

The course has been open to 50 students each semester it has been offered. It has been well enrolled, often reaching the enrollment cap and occasionally allowing students to enroll on an overload basis into this course. This illustrates a strong interest and demand for this type of an elective course. However, there have been several areas for improvement identified. Some of these course modifications have already been implemented and additional areas may be addressed in the future.

The online nature of this course, along with the involvement of multiple instructors has led to some inconsistency with course communication and student awareness of expectations. To address this, the course coordinator now offers a live, virtual course overview during the first week of the course. This is recorded and posted to the LMS. Additionally, an announcement is sent out at the beginning of each week alerting students of any new content posted, as well as any upcoming assignment due dates. Grading rubrics for group projects and any written assignments are posted to the LMS, along with assignment instructions.

Another challenge that has been faced includes recruiting diverse panelists with experience and background that supports the content students are learning. The virtual panel discussions occur during the content blocks focused on public health, the health care response, and education. Panelists have been invited based on relationships they may have to instructors in the course. Because these panels occur in the evenings at 7:00 PM EST, there can be challenges in availability of panelists. We have also encountered situations where certain panelists have dominated the conversation. Recruiting panelists continues to be a challenge, but through early invitations and additional networking we have been successful in hosting all panels in the course. To allow all panelists to contribute to the conversation, the moderator has been able to direct certain questions to specific panelists.

Another lesson learned is that this course needs to remain adaptable in the event of instructor turnover. Due to faculty leaving the university, the course has experienced the loss of 2 instructors since its creation. We were able to find replacements with minimal impact to the overall course structure. Some of these modifications allowed for new instructors to add content in their areas of expertise (medical misinformation and disinformation) and allowed for the addition of the final block of the course (The Impact on Education).

A final challenge we continue to encounter is the lack of diversity within our learning community of students. The majority of students enrolled in the course are pharmacy students, followed by nursing students. A very small number of non-health care majors have taken this course. An area that could be explored includes broadly disseminating information about this course to the entire campus community. Another opportunity would be working with other colleges on campus to see if this course would meet any specific needs of their students. A specific example of this would be adding this course to the allowed electives for the public health minor.

## PUBLIC HEALTH IMPLICATIONS

The intent of this course is to educate students about the complex impacts of the COVID-19 pandemic. Living through a pandemic and reflecting on what was done well and what could have been done better will hopefully leave students prepared to face similar challenges in the future. There were significant advances made in the areas of health care, but there were also areas where it was clear that the efforts fell short of what was expected and needed. One example that was discussed in various ways in all 5 content blocks was the impact and understanding of vaccine recommendations. Combating vaccine misinformation and disinformation through public education and funding is critical to life in a post-COVID-19 pandemic era. Better forms of communication to the public are essential to increasing the uptake of new vaccines, as well as knowledge about the proper actions to take to slow the spread of diseases.

This course was able to provide students with evidence-based information regarding the COVID-19 pandemic, opposing the misinformation and disinformation consumed by society. It remains a viable course offering to ensure we learn from the recent history of the COVID-19 pandemic, especially given the prevalence of "pandemic fatigue" as the world moves into a post-COVID-19 pandemic era. Pandemic fatigue is defined by the WHO as distress that can result in demotivation to follow the recommended protective behaviors, emerging gradually over time and being affected by a few emotions, experiences, and perceptions.[7] Findings indicate that pandemic fatigue emerged early in the pandemic and continues to be prevalent as evidenced by impacts on mental health, social well-being, and economic factors.[8] This course aims to provide enrolled students with a perspective that will allow them to face the challenges we continue to see as a result of the COVID-19 pandemic, as well as be prepared to face similar health emergencies in the future.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

**Author Contribution**

Brittany N. Bates: Substantial contributions to the conception of the course, drafting of the following sections: Introduction, Course Development, Course Evaluation, and Lessons Learned; editing of the overall work, including interpretation of data; involved in final approval of the version to be published and agreeable to be accountable for all aspects of the work.

Daniel G. Thoryk: Substantial contributions to the drafting of abstract and Course Delivery section; editing of the overall work; involved in final approval of the version to be published and agreeable to be accountable for all aspects of the work.

Ryan M. Augustine: Substantial contributions to the drafting of Course Assessment and Public Health Implications sections; editing of the overall work; involved in final approval of the version to be published and agreeable to be accountable for all aspects of the work.

## REFERENCES

1. Reiersen J, Romero-Hernández M, Adán-González R. Government reactions, citizens' responses, and COVID-19 around the world. *Int J Environ Res Public Health*. 2022;19(9):5667.
   https://doi.org/10.3390/ijerph19095667

2. Goldwire MA, Johnson ST, Abdalla M, et al. Medical misinformation: a primer and recommendations for pharmacists. *J Am Coll Clin Pharm.* 2023; 6(5):497-511.
   https://doi.org/10.1002/jac5.1760

3. Moradian N, Ochs HD, Sedikies C, et al. The urgent need for integrated science to fight COVID-19 pandemic and beyond. *J Trans Med*. 2020; 18 (1):205.
   https://doi.org/10.1186/s12967-020-02364-2

4. Pedagogy in Action. What is interdisciplinary teaching? Accessed May 2, 2024.
   https://serc.carleton.edu/sp/library/interdisciplinary/what.html

5. Quality Matters. Course design rubric standards. Accessed July 25, 2024.
   https://qualitymatters.org/qa-resources/rubric-standards/higher-ed-rubric

6. Crawford SR. Five tips for remote teaching. April 21, 2020. Quality Matters. Accessed July 22, 2024.
   https://www.qualitymatters.org/qa-resources/resource-center/articles-resources/higher-ed-remote-teaching-tips

7. World Health Organization. Pandemic fatigue: reinvigorating the public to prevent covid-19: policy framework for supporting pandemic prevention and management. Revised version November 2020. Accessed May 2, 2024.
   https://www.who.int/europe/publications/i/item/WHO-EURO-2020-1573-41324-56242

8. Abdul Rashid MR, Syed Mohamad SN, Tajjudin AIA, et al. COVID-19 pandemic fatigue and its sociodemographic, mental health status, and perceived causes: a cross-sectional study nearing the transition to an endemic phase in Malaysia. *Int J Environ Res Public Health*. 2023;20 (5):4476.
   https://doi.org/10.3390/ijerph20054476

# Implementation of Outbreak: A Population-Based Interprofessional Exercise

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**ABSTRACT**

In 2016, the Interprofessional Education Collaborative (IPEC) competencies expanded to include the health care needs of populations in addition to patients, and the Council on Education for Public Health (CEPH) added a required interprofessional education (IPE) competency for accredited public health programs. Addressing population health issues requires collaboration between public health and other health professionals, but most IPE education materials focus on patient care rather than population health. This manuscript describes a population-based virtual IPE experience for public health and health professions students.

In 2021, a total of 95 medical, pharmacy, public health, and clinical mental health counseling students participated in a virtual, infectious disease outbreak experience. Question prompts highlighted a joint response team's role in maximizing outcomes while ensuring equity, emphasizing the 2016 IPEC competencies.

Jefferson Teamwork Observation Guide (JTOG) results indicated that most participants believed their teams achieved the 14 IPEC competency-based items for interprofessional teamwork. Despite the challenges of hosting this activity in a virtual environment, students found it valuable to their learning.

Population health crises introduce unique challenges and uncertainties for health care providers. Establishing interprofessional relationships before a crisis prepares professionals to work with other disciplines. Future emphasis should be placed on facilitator onboarding, technology support, and the students' understanding of their roles and expectations.

**Keywords:** Population health; Interprofessional; Emergency preparedness; Outbreak; Virtual

## INTRODUCTION

In 2016, the Interprofessional Education Collaborative (IPEC) competencies expanded to include the health care needs of populations in addition to patients, and the Council on Education for Public Health (CEPH) added a required interprofessional education competency for accredited public health programs.[1,2]

However, the majority of published interprofessional education (IPE) literature and educational materials still focus on direct patient care teams. Health care professionals who play a vital role in maintaining community wellness during health crises are often not included in strategic planning. Additionally, public health and medicine students do not traditionally receive training in how to work with one another during public health crises until they have entered practice.

These opportunities and challenges prompted the creation of a population-based simulated disease outbreak experience. Faculty from 3 Ohio universities collaborated to develop an IPE experience centered around the formation of a joint response to a local outbreak of novel influenza. The event included graduate public health, medical, pharmacy, and clinical mental health students. In

contrast to other outbreak experiences used in health professions education,[3,4] the objective of this experience was to highlight the joint response team's role in maximizing population health outcomes.

This experience was first delivered in person in 2019. The COVID-19 pandemic necessitated the change to a virtual format. Coordination of learning materials, participants, and faculty required a virtual meeting platform (VMP) to deliver an IPE experience. Most universities use learning management systems (LMS) that do not typically allow access to individuals outside of a single institution. However, the team recognized that the use of commercially-available and off-the-shelf VMPs such as Zoom may overcome inter-institutional access barriers, allowing for more diversity and geographic separation beyond any single academic institution or community partner. The purpose of this manuscript is to describe the adaptation of an in-person, population health-based IPE experience for health professions students into a synchronous virtual format.

**Program Development and Delivery**

Event Development

A 6-person faculty development team spent approximately 40 hours in team meetings over 9 months to develop the exercise for the initial 2019 implementation. The team spent approximately 40 additional hours adapting the exercise for the 2021 VMP delivery. No collaborating university allocated development or implementation funds. An evening start time was chosen to allow for student participation across programs and facilitator availability.

The Wright State University institutional review board (IRB) reviewed and determined that the project was exempt from IRB review on March 28, 2019, in accordance with federally defined categories of exempt review per 45 CFR 46.104 and Wright State University IRB policies. The determination was for 36 months.

Case Structure

Time 1 (T1) content was intended to simulate the initial presentation of an outbreak in West Central Ohio, which provided public health students with a population-based emerging infectious dis-

ease (EID) problem. Time 2 (T2) and Time 3 (T3) contrasted intraprofessional and interprofessional communications while addressing clinical and population health considerations during a progressing outbreak (Figure 1). Select components of the Federal Emergency Management Agency (FEMA) Homeland Security Exercise and Evaluation Program (HSEEP) drove our curriculum design. The HSEEP emphasizes a flexible curriculum and evaluation process for discussion formats through full-scale exercises. Faculty utilized established professional relationships with local public health authorities to refine scenario realism. Students received question prompts at specified intervals during each time period. Prompts required each team of students to address evolving challenges introduced during the case. Mock news broadcasts and social media injects introduce realism and a sense of urgency to drive engagement throughout the activity. Previous years' experience highlighted the need for responding to equity issues during an outbreak. In 2021, a local public health professional specializing in health equity joined the team to enhance the focus on this area.

**Event Design and Logistics**

Students participated in the event based on their enrollment in classes taught by faculty team members (Table 1). Master of public health (MPH) students received preliminary case information (T1) a week before the event and developed a case definition and epidemic curve in addition to conducting descriptive analyses. Students were informed that they would be sharing this information in their role as the leaders of each joint response team. Students received discipline-specific training in advance of the activity from subject-matter experts. The content of this training varied based on each profession's programmatic requirements. Students received an overview of IPEC competencies at the beginning of the session via a short PowerPoint presentation

The interprofessional event (T2 and T3) used the Zoom platform. Faculty created 2 separate virtual meetings (Session A and Session B) for student transition between phases of the activity. In the first phase of the event (T2), students began in Session A where they were briefed about event expectations. They separated into virtual breakout rooms with other members of their disciplines where
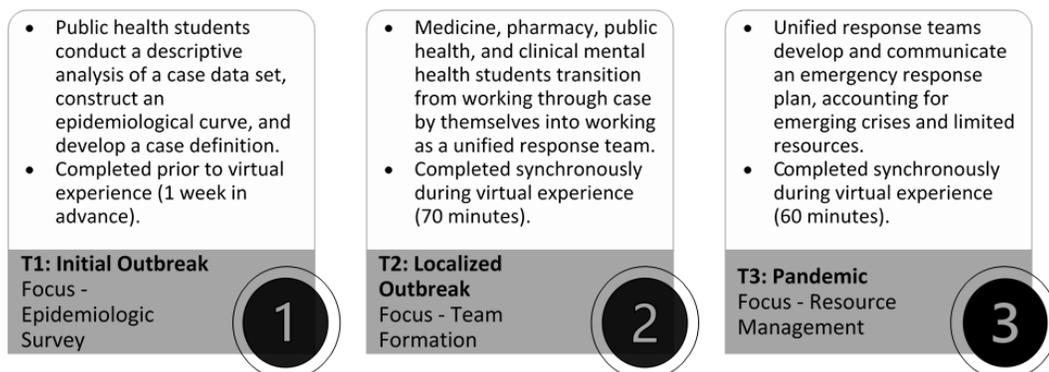


- Public health students conduct a descriptive analysis of a case data set, construct an epidemiological curve, and develop a case definition.
- Completed prior to virtual experience (1 week in advance).

**T1: Initial Outbreak**
Focus - Epidemiologic Survey
**1**

- Medicine, pharmacy, public health, and clinical mental health students transition from working through case by themselves into working as a unified response team.
- Completed synchronously during virtual experience (70 minutes).

**T2: Localized Outbreak**
Focus - Team Formation
**2**

- Unified response teams develop and communicate an emergency response plan, accounting for emerging crises and limited resources.
- Completed synchronously during virtual experience (60 minutes).

**T3: Pandemic**
Focus - Resource Management
**3**

**Figure 1. Interprofessional Education (IPE) Outbreak Scenario Progression**

**Table 1. IPE Outbreak Event Demographics**

| Profession | Student Attendance Requirement by Program | Students (n = 95) | Facilitators (n = 17) |
|---|---|---|---|
| Medicine[a] | Voluntary[b] | 16.8% (16) | 23.5% (4) |
| Pharmacy[c] | Required | 46.3% (44) | 23.5% (4) |
| Public health[d] | Required | 24.2% (23) | 41.2% (7)[e,f] |
| Clinical mental health[g] | Required | 12.6% (12) | 11.8% (2) |

[a] Second professional year doctor of medicine students.
[b] Medical students were not required to attend but received credit toward a programmatic interprofessional education requirement if they did.
[c] Third professional year doctor of pharmacy students.
[d] Master of public health students.
[e] Public health professionals (medical director, health commissioner, epidemiologist, emergency response; n = 5).
[f] Public health faculty (n = 2).
[g] Master of science in education clinical mental health counseling students.

they worked through a series of prompts about symptomatic patients presenting to medical facilities. Intraprofessional teams discussed and formulated discipline-specific approaches to the localized outbreak. Students were then prompted to join Session B at a designated period where they were randomized into interprofessional joint response teams. Students were provided with a description of their role on this team that was unique to their discipline. The transition from intraprofessional to interprofessional teams was intended to contrast the difference in perspectives among disciplines.

Links to a shared Google Drive were provided via the Zoom chat function, allowing a designated event controller to dynamically release content to participants throughout the activity. Mock social media posts and news broadcasts were released at designated times to increase urgency and influence team discussion. Team discussions and debriefing topics differed between T2 and T3 based on the progression of the scenario. For example, T2 focused heavily on patient triage and prevention whereas T3 focused on scarce resource management and effective community-level education.

Event Demographics

A total of 95 students were randomized into 12 teams, with each team having 1 to 3 representatives from each profession (Table 1). These teams were supervised by 17 facilitators, with each team being assigned a minimum of 1 facilitator.

Assessment

Participants used the Jefferson Teamwork Observation Guide (JTOG) to assess teams' dynamics as they relate to collaborative practice.[5] The JTOG is a 14-item, validated interprofessional collaborative practice tool developed by the Jefferson Center for Interprofessional Practice & Education to assess participant behavior in interprofessional teams. The instrument is aligned to IPEC competencies and leadership.[5,6] Frequencies and percentages were calculated using IBM, SPSS Statistics 29 software, and tables were created using Microsoft Excel. The Wright State University IRB determined that the project was exempt from review. The MPH students were required to complete reflections following the IPE. These reflections provided qualitative feedback.

Program Evaluation

The HSEEP program utilizes an established process that provides feedback for improvement through an after-action report (AAR). Faculty implemented the HSEEP AAR process in 2021 to provide an iterative program evaluation and improvement process.

**Outcomes**

Jefferson Teamwork Observation Guide (JTOG)

Jefferson Teamwork Observation Guide (JTOG) results indicated that 80% to 90% of respondents (n = 80) agreed or strongly agreed that their teams achieved 13 of the 14 IPEC competency-based items for interprofessional teamwork. While the competency ratings for Values, Teamwork, and Leadership were high, faculty observed that the areas of Communication and Roles had some disagreement regarding student team achievement.

Implementation Issues

The Zoom platform's breakout room capacity restrictions affected the ability to seamlessly move participants from intraprofessional to interprofessional discussions. As a result, participants had to log off and back onto the platform into separate sessions. Facilitation quality also varied. Student reflections indicated that some facilitators were not as skilled as others were, either dominating the conversation or not providing meaningful input.

**PUBLIC HEALTH IMPLICATIONS**

**Lessons Learned**

Converting an in-person interprofessional learning experience into a virtual setting presents unique challenges. Following the implementation of this virtual outbreak experience, AARs generated by facilitators and MPH students highlighted these major challenges: facilitator and participant preparation, and technology and communication.

First, the level of individual preparation for the event varied significantly among both facilitators and student participants. Facilitators received a facilitator guide and an onboarding slideshow a week in advance of the event. Most facilitators were volunteers and had practice or public health responsibilities, which reduced

their discretionary time to prepare. In contrast, faculty facilitators involved with planning had more intimate knowledge of the activity. Some health professions students may have been less likely to participate if the activity was optional rather than a graded course requirement. This outcome was difficult to avoid given the specific programmatic needs of the participating institutions. One AAR noted that "the wide variance in facilitator and fellow student preparedness (was) evident." Students also commented that their sense of engagement was better when facilitators integrated their professional experience into discussions and when there was at least 1 student participant designated to organize information and who was inclusive of peer perspectives.

Second, adopting new technology introduced challenges in facilitating communication. Similar technology-facilitated synchronous approaches in other simulations faced comparable challenges during this time.[7] The use of Zoom breakout rooms alleviated the need for physical space to conduct the experience. However, this platform limited the ability to assign students to more than 1 breakout group, requiring the use of multiple Zoom meeting rooms to deliver the experience as intended. Dedicated exercise controllers were needed to manage Zoom breakout rooms effectively. Some students were unfamiliar with this platform, slowing the transition between each Zoom meeting.

Productive interprofessional collaboration on the teams was dependent on effective communication. Student feedback noted that roles and expectations were unclear for some. Participants should receive predetermined roles and expectations in advance of the experience to allow each person to know their areas of responsibility, action, and concern. In addition, students found the virtual environment challenging for communication. Most teams reported that once the conversations began, the flow of the conversation was effective.

### Improvements

The AAR identified several recommendations for improvement. First, the faculty developed an online, free, publicly available toolkit (including instructor and facilitator guides, facilitator training materials, and case content) for others to implement similar activities. The toolkit now incorporates lessons learned from prior iterations. The toolkit is available upon request and authors are available for consultation. The facilitator guide now has a companion abbreviated guide for rapid reference at the event. Recorded training sessions are now available for extended access to orientation materials on YouTube.

Despite the increased adoption and experience with technology such as Zoom for synchronous instruction, the challenge of technology is likely to remain.[8] However, future iterations will incorporate more robust participant preparation materials to address issues with both activity content and VMP training.

While hosting this activity in a virtual environment was challenging, students found it valuable to their learning. One student shared, "...(having) this interprofessional experience during the time of an actual pandemic showed myself and a lot of people from my team the reality of health care services and why interprofessional communication is so important." As public health emergencies have illustrated, there is a need to broaden our understanding of what IPE may mean for population health. Interprofessional teams need expansion beyond frontline clinicians to better address social determinants of health and outbreak-specific issues. Challenges and team structures will always change, but exposing students to IPEC competencies through various IPE opportunities, including population health, may better equip them to navigate future outbreaks.

### Importance in Current Environment

Establishing interprofessional relationships before a crisis strikes prepares professionals to work and communicate effectively with other disciplines. The lack of interagency and interdisciplinary relationships can hinder emergency response efforts and lead to delays in recovery. In this event, the public health, medical, pharmacy, and mental health participants had the opportunity to develop a common language that facilitated professional interdisciplinary communication. Reinforcing IPEC competencies promotes future collaborative considerations and actions among all health care professionals.

Additionally, the experience engaged participants in problem-solving strategies in a dynamic scenario. The ability to weigh a large amount of complex information and make decisions in a rapidly changing environment is critical to the success of emergency response in maintaining population health. Students commented that it was difficult to begin a conversation when they did not know the other players. One student shared, "...there was probably a learning curve to the process that took some time to overcome." Student opportunities for interprofessional engagement facilitate familiarity and help shorten the learning curve.

Although this may have been the first time clinical and public health professional students found themselves in a population-based scenario, this IPE provided a foundation for rapid interprofessional cooperation in future scenarios that challenge population health. The fact that this IPE was successfully redeployed in a virtual format demonstrates that there is room for distributing other interprofessional learning activities in a similar manner. This improved access may enhance the ability to train clinical and public health professionals by overcoming interinstitutional and geographic access barriers.

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not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services.

## REFERENCES

1. Interprofessional Education Collaborative. Core competencies for interprofessional collaborative practice: 2016 update. Published 2016. Accessed September 25, 2022.
   https://ipec.memberclicks.net/assets/2016-Update.pdf

2. Council on Education for Public Health. Interprofessional Education. Accessed March 15, 2024.
   https://ceph.org/about/org-info/join-mailing-list/journal/ipe/

3. Colubri A, Kemball M, Sani K, et al. Preventing outbreaks through interactive, experiential real-life simulations. *Cell*. 2020;182(6):1366-1371.
   https://doi.org/10.1016/j.cell.2020.08.042

4. Ekert JO, Luchesa Smith A, Ramsey CL, et al. Medical student-led simulation in COVID-19 crisis. *Clin Teach*. 2021;18(3):252-257.
   https://doi.org/10.1111/tct.13308

5. Lyons KJ, Giordano C, Speakman E, Smith, K, Horowitz JA. Jefferson Teamwork Observation Guide (JTOG): an instrument to observe teamwork behaviors. *J Allied Health*. 2016;45(1):49-53.
   https://www.jstor.org/stable/48721893

6. Horowitz Andrews J, Speakman ET, Sicks S. The Jefferson Teamwork Observation Guide: Reliability and validity for use in education and practice. Poster presented at: NLN Education Summit; September 2016; Orlando, FL.

7. Clark A, Wagner R, Brubaker M, Acquavita S, Wilder C. Pandemic-related disruptions in nursing education: zooming out for an innovative interprofessional simulation. *Acad Med*. 2022;97(3S):S110-S113.
   https://doi.org/10.1097/ACM.0000000000004540

8. Jeffries PR, Bushardt RL, DuBose-Morris R, et al. The role of technology in health professions education during the COVID-19 pandemic. *Acad Med*. 2022;97(3S):S104-S109.
   https://doi.org/10.1097/ACM.0000000000004523

**PUBLIC HEALTH STUDENT REFLECTION**

# How Can Public Health Professionals Help to Improve Mental Health for Students Using Distance Learning?

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Having worked with patients hospitalized at Nationwide Children's Hospital over the past year, I have seen the complexity and, often, difficulty involved in accessing and completing assignments and homework virtually. Even as masks have gone away, students with chronic illnesses continue to learn and complete assignments outside of the traditional classroom environment. At the same time, these students must also navigate complex software, Wi-Fi challenges, and the monotony that often comes with online education. These problems are not exclusive to the hospital and, if educational institutions neglect the new struggles that students face during school, many learners may be left behind.

The COVID-19 pandemic forced schools to find alternative methods to reach and teach students. Across the board students transitioned to online education, losing valuable socialization time with their teachers and peers. Students fell behind in their learning, but there remains an even more pressing public health issue.[1] During and after the pandemic, diagnoses of mental health disorders increased in children and adolescents.[2] There could be multiple explanations for this alarming trend, including a lack of socialization, a loss of work-life balance, or stress about an uncertain future. Nonetheless, these data point to an essential objective: the mental health of students utilizing online learning must be prioritized.

To resolve educational gaps caused specifically by the COVID-19 pandemic, schools implemented solutions including additional online classroom time. However, giving students more work and online instruction time may discourage already weary learners. Moreover, technological advancements in schools that increased the prevalence of virtual education delivery methods, although helpful, have prevented students and teachers from maintaining a healthy work-life balance. This system appears to be teaching young people that work is monotonous, always looming, and overwhelming. Instead of giving students hurdles to overcome, public health experts can help schools to engage students with creative learning solutions and expand students' capacity for resiliency and growth, thereby improving mental health.

A promising case report outlined a unique strategy for assisting a student with sickle cell disease in her educational journey.[3] Researchers facilitated collaborations between a local hospital and the student's school. To help this student succeed, they developed a strategy focusing on metacognition to improve learning strategies, such as helping this student to create and optimize a personalized studying schedule. Soon, this patient successfully advanced to the next grade. Metacognition is the process of reflecting upon an individual's own thoughts and learning strategies to develop positive thought patterns, and metacognition can improve not only academic performance but also mental health by helping individuals to develop emotional resiliency.[4] Through metacognition, individuals can develop personalized strategies for growth. By teaching metacognition strategies, educators may also help students to better manage stress. Capable and motivated students, who are simply overwhelmed by online education, may benefit from new strategies for approaching work and stress. Public health experts can help improve student mental health by showing educational institutions a method for building emotional resiliency: metacognition.

**Author Contribution**
Colin Brame wrote and revised manuscript. Lorraine S. Wallace edited and reviewed manuscript.

**REFERENCES**

1.  New Data Show How the Pandemic Affected Learning Across Whole Communities. Harvard Graduate School of Education. Published May 11, 2023. Accessed February 25, 2024. https://www.gse.harvard.edu/ideas/news/23/05/new-data-show-how-pandemic-affected-learning-across-whole-communities

2.  Saulle R, De Sario M, Bena A, et al. School closures and mental health, wellbeing and health behaviours among children and adolescents during the second COVID-19 wave: a systematic review of the literature. *Epidemiol Prev.* 2022;46(5-6):333-352. https://doi.org/10.19191/EP22.5-6.A542.089

3.  Harden C, Rea H, Buchanan-Perry I, Gee B, Johnson A. A multidisciplinary educational approach for children with chronic illness: an intervention case study. *Contin Educ.* 2020;1(1):8-21. https://doi.org/10.5334/cie.2

4.  Bacadini França A, Samra R, Magalhães Vitorino L, Waltz Schelini P. The relationship between mental health, metacognition, and emotion regulation in older people. *Clin Gerontol.* 2024;47(2):298-306. https://doi.org/10.1080/07317115.2023.2231456

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